Danish Ministry of the Environment
Environmental Protection Agency

Survey of mercury and mercury compounds

Part of the LOUS-review

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Title:
Survey of mercury and mercury compounds

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Preface

Background and objectives

The Danish Environmental Protection Agency's List of Undesirable Substances (LOUS) is intended as a guide for enterprises. It indicates substances of concern whose use should be reduced or eliminated completely. The first list was published in 1998 and updated versions have been published in 2000, 2004 and 2009. The latest version, LOUS 2009 (Danish EPA, 2011) includes 40 chemical substances and groups of substances which have been documented as dangerous or which have been identified as problematic using computer models. For inclusion in the list, substances must fulfil several specific criteria. Besides the risk of leading to serious and long-term adverse effects on health or the environment, only substances which are used in an industrial context in large quantities in Denmark, i.e. over 100 tonnes per year, are included in the list.

Over the period 2012-2015, all 40 substances and substance groups on LOUS will be surveyed. The surveys include collection of available information on the use and occurrence of the substances, internationally and in Denmark, information on environmental and health effects, on alternatives to the substances, on existing regulation, on monitoring and exposure, and information regarding ongoing activities under REACH, among others.

On the basis of the surveys, the Danish EPA will assess the need for any further information, regulation, substitution/phase out, classification and labelling, improved waste management or increased dissemination of information.

This survey concerns mercury and mercury substances. These substances were included in the first list in LOUS and have remained on the list since that time.

The main reasons for the inclusion in LOUS are the following:

- Mercury and mercury compounds make the use of the residual products of waste streams (flue-gas cleaning products, slag, sludge and compost) problematic.

Several of the compounds have properties of concern with regard to the CLP Regulation. Mercury is in general a very toxic substance which may cause nerve damage even at low concentrations.

- The substances are the subject of particular focus in Denmark..

The main objective of this study is, as mentioned, to provide background for the Danish EPA's consideration regarding the need for further risk management measures.

The process

The survey has been undertaken by COWI A/S (Denmark). The work has been followed by an advisory group consisting of:

- Frank Jensen, Lone Schou and Thilde Fruergaard Astrup, Danish EPA
- Gudrun Hilbert and Dorthe Licht Cederberg, Danish Veterinary and Food Administration
- Lis Keiding and Lene Vilstrup, Danish Health and Medicines Authority
- Ulla Hansen Telcs, DI Confederation of Danish Industries
- Susanne Simonsen, Danish Nature Agency
- Pia Lauridsen, Danish Working Environment Authority
- Henrik Lous, Vattenfall A/S, for the Danish Energy Association
- Jakob Maag, COWI

Data collection

For mercury, a large number of reports and assessments are available from Danish authorities as well as internationally. The use of mercury and its compounds in Denmark, emissions to the environment, environment and health effects are well described. A long list of authoritative international documents including UNEP reviews, EU assessments, WHO assessments etc. are also available. The strategy of this review has therefore been to reference existing authoritative assessments, supplemented as necessary with other data particular for the current situation in Denmark.

As relevant, existing data have also been searched for in other data sources, including among others:

- Legislation in force from Retsinformation (Danish legal information database) and EUR-Lex (EU legislation database);
- Ongoing regulatory activities under REACH and intentions listed on ECHA's website (incl. Registry of Intentions and Community Rolling Action Plan);
- Relevant documents regarding International agreements from HELCOM, OSPAR, the PIC Convention, the Rotterdam Convention, the LRTAP Convention and the Basel Convention.
- Data on harmonised classification (CLP) and self-classification from the C&L inventory database on ECHAs website;
- Data on ecolabels from the Danish ecolabel secretariat (Nordic Swan and EU Flower).
- Pre-registered and registered substances from ECHA's website;
- Production and external trade statistics from Eurostat's databases (Prodcom and Comext);
- Data on production, import and export of substances in mixtures from the Danish Product Register (confidential data, not searched via the Internet);
- Data from the Nordic Product Registers registered in the SPIN database;
- Information from CIRCABC on risk management options (confidential, for internal use only, not searched via the Internet)
- Monitoring data from the National Centre for Environment and Energy (DCE), the Geological Survey for Denmark and Greenland (GEUS), the Danish Veterinary and Food Administration, and the European Food Safety Authority (EFSA).
- Reports, memorandums, etc. from the Danish EPA;
- Reports published at the websites of:
  - UNEP, The Nordic Council of Ministers, ECHA and the EU Commission;
  - US EPA and other national environmental authorities, as relevant.

Summary and conclusions

Besides elemental mercury, mercury is a constituent of a large number of substances, here called mercury compounds. The compounds are grouped in two groups, inorganic mercury compounds and organic mercury compounds, which each have some distinct group characteristics. The form of the mercury compound influence such characteristics as uptake in biological cells, bonding to organic and inorganic matter (bioavailability), atmospheric transport distances after emission, and retention efficiency of flue gas filters, among others. Being an element, no matter which form mercury is in, it may however ultimately be decomposed to elemental mercury in nature, which is in itself toxic to humans and in the environment. The critical exposure routes of all mercury compounds are via their decomposition and natural formation of methylmercury (MeHg) in the aquatic environment. The primary risk to the general population is thus exposure to methylmercury via ingestion of aquatic foods.

Due to its characteristics, mercury is capable of traveling long distances with the atmosphere and ocean currents, and is thus truly a global pollutant.

Elemental mercury plus 202 mercury compounds were pre-registered by industry under the REACH regulation, yet as of June 2013 only elemental mercury itself has been registered. This may indicate that the number of mercury compounds in use in the EU in the future will be reduced, but it however cannot be determined with certainty, as industry may still register existing mercury compounds, which are not classified as mutagenic or reprotoxic, and are used in amounts below 100 tonnes/y, until 2018.

Legislation

Mercury has been a prioritised substance in Danish pollution abatement for several decades. Due to its well documented adverse environmental characteristics, mercury and its compounds are among the most regulated hazardous substances both nationally in Denmark, in the EU and in international conventions. This is also reflected by the fact that mercury is among the few substances which are, or are soon to be, regulated globally. Denmark and other Nordic countries have been among the main promoters behind the formation of strict regulation of mercury and its compounds in the EU and globally.

Mercury pollution to all environmental media is targeted by legislation, yet with most emphasis on the atmospheric releases due to mercury's ability for long-range transport.

Denmark's ban on the marketing, import and export of mercury covers most intentional mercury uses, with exemptions for a number of mercury applications, partly such for which alternatives are not fully matured on the market (for example energy-saving lamps) and partly a number of uses for which exemptions are made in order to not impair trade among EU Member states. In the EU context, mercury is however also severely restricted, and with the dedicated focus of the Community mercury strategy, remaining intentional mercury uses may be further restricted as adequate alternatives for these are matured and accepted.

As regards other mercury source categories, mercury releases are also regulated to a varying extent. Waste incineration is regulated with an air emission limit in the Industrial Emissions Directive, and otherwise indirectly via facility-specific environmental permits which may also target releases to other media. Mercury releases to the atmosphere from coal combustion is addressed in Danish regulation indirectly only, in the form of a guideline on air emissions in environmental permits, which is to be considered in facility-specific environmental permits. Based on available emission estimates, atmospheric emissions from these major sources have been reduced heavily over the last decades. Mercury- specific filter types exist however, which have the capacity to reduce air emissions further. These are applied on many (but not all) of the Danish waste incineration plants, but not on any Danish coal fired power plants.

The negotiation of a global treaty - the Minamata Convention - on mercury was finalised in January 2013. The treaty is scheduled to be opened for signing during 2013. Mercury is also addressed by several existing international agreements addressing atmospheric emissions (CLRTAP), the marine environment (OSPAR, HELCOM), waste (Basel Convention), and export of chemicals (Rotterdam Convention).

Manufacture and use
Neither mercury, nor any mercury compounds are manufactured in Denmark. Manufacturing of metallic mercury in the EU is now limited to recycling of mercury, as all other EU sources of supply have been banned.

The Danish consumption of mercury declined by 90% already in the period 1993-2001 due to a prioritised strategy from Denmark's side. Restrictions on certain mercury uses were introduced even before the first general mercury ban in 1994. At the same time, a change in technology occurred from manual, mercury-filled instruments to mercury-free digital solutions with more functionalities, which also helped reduce the consumption.

A search for mercury and mercury compounds in the Danish Product Register, which register mixtures aimed at professional users in Denmark, did only show the use of elemental mercury and 4 mercury compounds, and in amounts in the range of a few kilograms per year. Similarly, a search in the Nordic chemicals database SPIN only gave few hits. This is in accordance with the absence of mercury compounds registered under REACH for the EU.

No recent comprehensive surveys of mercury consumption are available for Denmark. The latest detailed consumption data are from a substance flow analysis based on 2001 data. The table below shows mercury consumption (demand) data from 2001 for Denmark along with new data for dental amalgam from this survey. For other mercury sources, indicative expert estimates are given based on information on the current status of regulation of the mercury sources in question, as well as on other background knowledge. Note that some mercury uses, as for example laboratory uses, are expected to have quite effective separate collection and deposition/recycling schemes.

TABLE 1
MERCURY CONSUMPTION (DEMAND) DATA FROM 2001 AND INDICATIVE EXPERT ESTIMATES FOR 2013 CONSUMPTION IN DENMARK.

Application	2000/01 consumption kg Hg/y	Notes of consumption /presence today	Expert estimates of 2013 consump-tion*1, kg Hg/year
Mercury (intentional uses)			
Dental fillings	1,100-1,300	Used, but at lower rates, see text	130-150
Light sources	60-170	Increasing due to climate campaigns; substitutes (LED) are gaining ground in more uses	100-300
Switches, contacts and relays	0-20	Likely but minimal; is exempted from ban	0-10
Clinical thermometers	1.1	Banned in DK	0
Other thermometers	15-20	Banned with some exemptions	0-20
Other measuring and control equipment	10-50	Banned with some exemptions	0-30
Chlor-alkali production	-	Not present in DK (EU: Not BAT according to IE Directive/BREF conclusions)	0
Other uses as a metal	40-60	Laboratory uses, porosimetry is now known to be a significant use	50-250
Mercury compounds (intentional use)			
Mercury-oxide batteries	0.5-0.6	Not used in Denmark , regulated	0
Other batteries	70-150	Used in certain button cell types; alternatives on the market. No for other batteries; regulated and substituted	0-100
Laboratory chemicals	30-70	Limited, see text	30-70
Medical applications	0-1	Limited	0-1
Other chemical applications	5-50	Limited, see text	10-30
Total, intentional uses (rounded)	1,300-1,900		300-1000
Mercury input as impurities			
Coal	600-1,000	Present	No aggregated information (NAI)
Oil products	2-30	Present	NAI
Natural gas	0.4-3	Present	NAI
Biological fuels	18-80	Present	NAI
Cement	30-70	Present	NAI
Agricultural lime, fertilizer and feeding stuffs	11-40	Present	NAI
Foodstuffs	10-20	Present	NAI

Application	2000/01 consumption kg Hg/y	Notes of consumption /presence today	Expert estimates of 2013 consump-tion*1, kg Hg/year
All other goods	94-1,900	Present	NAI
Total, impurities	760-3,100		NAI
Total (rounded)	**2,100-5,000**		NAI

Note: *1: Based on very limited data.

Waste

Mercury is persistent and toxic no matter what chemical form it is in. Mercury once brought into the biosphere, for intentional use or as trace pollutant, thus needs to be managed to reduce or avoid adverse impacts on humans and the environment. In Denmark and the EU, waste fractions containing mercury are therefore categorized as hazardous waste needing special collection and treatment. Up till recently, recycling has been the preferred option for mercury waste, but as the demand for mercury for intentional use has decreased in developed countries over the last decades, the priority for high-concentration mercury waste is now turning towards environmentally safe final deposition.

Generated mercury waste is likely dominated by solid wastes from power plants, which are mainly re-used in construction works. Among intentional uses of mercury, the main sources of new generation of mercury waste are deemed to be:

- Dental amalgam;
- Fluorescent lamps including CFLs and some specialised discharge lamps;
- Button-cell batteries;
- Certain types of polyurethane elastomer products (low in amounts);
- U-tube type blood pressure gauges from professional uses (hospitals, clinics, etc.;
- Porosimetry,.

While some sectors have strict procedures for special collection of hazardous waste, consumers have been observed to have difficulties in or lack motivation for waste separation, and high collection rates have been difficult to achieve. Accordingly, a substantial fraction of the mercury waste disposed of must still be expected to be lost to municipal waste incineration.

Many mercury containing products have a significant life span, and on top of that, some are the types of technical products which private users tend to hoard before disposing them. It has thus earlier been observed that some product types still appear in the waste stream more than a decade after cessation of their use. Special collection schemes and filters capturing mercury in waste incineration flue gasses will thus still be necessary for a couple of decades after a potential total cessation of intentional mercury use.

Environmental effects and exposure

Mercury and mercury compounds are according to the CLP Regulation classified as very toxic to aquatic life with long lasting effects (Aquatic Acute 1, and Aquatic Chronic 1). Mercury is an element and therefore not degradable and some mercury compounds, not least methylmercury, have a high bioaccumulation potential.

Mercury and mercury compounds, in particular organic mercury compounds and above all methylmercury, are highly toxic to many aquatic organisms, often with short term effects levels in the low microgram per litre range and chronic NOECs below 1 µg/L. Bioconcentration factors in fish of several thousands have been reported.

Focus is in particular on top predators living in the aquatic environment or feeding on fish and shellfish, i.e. predatory fish, marine mammals, polar bears, and certain predatory birds. Mercury levels in these animals do not appear to be decreasing despite recent efforts to reduce use or phase-out mercury and the levels in edible species may exceed human health criteria. Terrestrial top predators appear to be less exposed to mercury compounds via the food chain than the aquatic species. Many mercury compounds are also known to be toxic to bacteria and other microorganisms and some have actively been used to control undesired microbial growth or impact.

Updated inventories of **mercury releases** to all environmental media are not available. The latest such inventory, or substance flow assessment, on mercury is for the year 2001. Aggregated quantification of atmospheric mercury emissions from 2010 is shown below; note that waste incineration is reported as part of "energy industries". The major contribution under the category "Waste" is from crematoria.

TABLE 2
ATMOSPHERIC EMISSIONS FROM MAJOR SOURCE CATEGORIES IN DENMARK, 2010

Sector	Emissions in 2010, kg Hg/y
Energy Industries (Including Incineration)	240
Manufacturing Industries and Construction	56
Transport	32
Non-industrial Combustion	48
Industrial Processes	15
Waste	48
Total	440

There are also **natural mercury releases** to the biosphere, volcanoes being one of the major sources. During the last decade, the best available estimates of atmospheric emissions indicated that natural mercury emissions were of about the same magnitude as current anthropogenic emissions, while a similar amount was re-emission of mercury previously emitted from human activity (i.e., about a third of total atmospheric emissions origins from each of these three source categories). New research presented at the 2013 International Conference of Mercury as a Global Pollutant held in Edinburgh indicate however that a larger part of what was previously considered natural emissions may in fact be re-emissions. The new research includes data of pre-industrial human use and release of mercury (used widely in gold and silver mining for millennia, among others). This underlines the significance of human releases, and emphasises the importance of reducing them in order to minimise their adverse impact.

Human health effects and exposure

Mercury has a number of human health effects. For methylmercury, the effects observed to occur at the lowest exposure levels are neurodevelopmental effects (loss of IQ; learning ability impairment) in unborn and young children. According to ECHA-RAC (Risk Assessment Committee under REACH), this effect does not appear to have a lower threshold. Other toxic effects include alteration of sensory functions, motor coordination, memory and attention. A link between methylmercury intake and cardiovascular diseases has been reported. According to the European Food Safety Authority, EFSA, although the observations related to myocardial infarction, heart rate variability and possibly blood pressure are of potential importance, they are still not conclusive.

EFSA states that the critical target organ for toxicity of inorganic mercury is the kidney. Other targets include the liver, nervous system, immune system, reproductive and developmental functions (EFSA, 2012).

An assessment finalised by the National Food Institute, Technical University of Copenhagen (DTU Food) in 2013 indicated that the exposures via food of the general Danish population to methylmercury (from aquatic foods) and inorganic mercury (other foods) are within the levels considered by the DTU Food Institute to be safe.

EFSA concluded in its 2012 assessment that a significant part of the EU population may be exposed to methylmercury via fish and other aquatic foods beyond what is considered to be safe levels. Exposure to inorganic mercury from the diet seems to be within what is considered to be safe levels, yet the presence of dental amalgam may lead to exposure beyond safe levels for a part of the population.

Arctic populations, including the populations of Greenland and the Faroe Islands, are subject to higher mercury exposures due to their dependence/preference for aquatic diets, in combination with the high mercury deposition (from remote sources) and bio-magnification in the many trophic levels of the arctic marine food web.

Alternatives

Today alternatives are commercially available for almost all applications of mercury. This has enabled a near total phase-out of mercury use in some countries, including in Denmark. The substitution of mercury has been a priority in both the Nordic countries, in Europe as a whole and in North America for several decades. In Denmark, elimination of mercury in products and materials has been prioritised to enable optimal use of waste for energy production, without escalating mercury emissions from the incineration processes. At the same time, electronic solutions with added performance characteristics have been introduced over the last decades, outdating many of the mercury-based instruments.

A full mercury phase-out may take extra time for the following mercury applications, with the mentioned reasons:

TABLE 3
MAJOR MERCURY APPLICATIONS FOR WHICH SUBSTITUTION MAY REQUIRE MORE TIME, AND REASONS FOR THIS

Mercury application	Status of substitution and observed barriers
ASGM – Artisanal and small-scale gold mining (not used in Denmark)	The only matured alternative is cyanidation, which is acutely toxic and therefore requires high-tech containment. Low-tech solutions are available which, in combination with training of miners, can reduce mercury use and release by 90%. ASGM is poverty-driven which makes it more difficult to implement reductions.
Dental amalgam	Mercury-free composites fillings (and compomer fillings) are available and are dominating the market in some countries. They could in principle eliminate mercury usage, but for complex fillings, this would be with reduced life-time of fillings and increased price as a consequence. Low-price low-impact glasiomer fillings are deemed by some to be a better alternative to amalgam in such developing countries where price and availability of technical equipment are the determining factors (in spite of lower strength of this filling material). The use of dental amalgam is restricted in Denmark and the Danish Health and Medicines Authority has issued guidelines for their use.
Fluorescent lamps including CFL's	Over the last decade, low-energy high-lifetime LED lamps have emerged on the global market. Within the last few years, they have reached a light quality suitable for office and home lighting, but so far at substantially higher prices than fluorescent lamps. Fluorescent lamps can now be produced with lower mercury concentrations than previously, but their use has increased due to climate campaigns, implying an increase in mercury consumption for this application in Denmark and globally.
Various laboratory and research uses	Laboratory analyses are governed by analysis standards, which take long time to change due to inertia and costs of paradigm changes. In Denmark, they are deemed to be used in relatively closed systems within strict hazardous waste collection and treatment schemes.

Data gaps
As indicated, the environmental characteristics of mercury are well described, should it however be prioritised, the following issues are pointed out for potential follow up as regards the Danish situation:

- Update of selected aspects of mercury's flow and cycle in Denmark for which no recent data are available. For example the fate of mercury in solid residues from coal fired power plants used in cement production,.
- Assessment of collection efficiency of separate collection of mercury-containing waste in Denmark (especially articles) and establishing a better insight in the time it takes for obsolete mercury-added articles to get out of circulation in society. One element in this could be analysis of data from the newly introduced continuous mercury measurements in some waste incineration facilities, which can show peaks in emissions from mercury-added products.

Future challenges in the Danish context may be the implementation of the Minamata Convention in Denmark. While most provisions of the convention are likely already covered in Danish and EU legislation, some adjustments and supplements may be needed.

In the global context much remains to be illuminated as regards national mercury releases inventories, development of guidelines for inventories, waste management and other aspects under the Minamata Convention, as well as many other issues.

Sammenfatning og konklusion

Udover elementært kviksølv, er kviksølv en bestanddel af et stort antal kemiske forbindelser, som her samlet vil blive betegnet kviksølvforbindelser. Forbindelserne er inddelt i to grupper, uorganiske kviksølvforbindelser og organiske kviksølvforbindelser, som hver har sine karakteristika. Kviksølvforbindelsernes form påvirker en række egenskaber som for eksempel optagelse i levende celler, adsorption til organisk og uorganisk materiale (biotilgængelighed), atmosfæriske transportafstande efter udledning samt hvor effektivt forbindelserne tilbageholdes af røggasfiltre. Uanset hvilken form kviksølv er i, kan det i sidste ende blive omdannet til elementært kviksølv i naturen, hvilket i sig selv er giftigt for mennesker og miljø. De kritiske eksponeringsveje for alle kviksølvforbindelser er via deres nedbrydning og efterfølgende naturlig dannelse af methylkviksølv (MeHg) i vandmiljøet . Den primære risiko for den almindelige befolkning er således eksponering for methylkviksølv via indtagelse af fede fisk og visse andre akvatiske fødevarer.

På grund af dets egenskaber er kviksølv i stand til at bevæge sig over lange afstande med atmosfæren og havstrømmene og det udgør dermed et globalt miljøproblem.

Elemental kviksølv plus 202 kviksølvforbindelser blev præ-registreret af industrien under REACH-forordningen, men per juni 2013 er kun metallisk kviksølv blevet registreret. Dette kan indikere, at antallet af kviksølvforbindelser i brug i EU i fremtiden vil blive reduceret, men dette kan dog fortsat ikke siges med sikkerhed, da industrien stadig kan registrere eksisterende kviksølvforbindelser, der ikke er klassificeret som mutagene eller reproduktionstoksiske, og som anvendes i mængder under 100 tons/år, indtil 2018.

Regulering

Kviksølv har været et prioriteret stof i dansk forureningsbekæmpelse i flere årtier. På grund af dets veldokumenterede miljøeffekter er kviksølv og dets forbindelser blandt de mest regulerede farlige stoffer både nationalt i Danmark, i EU og i internationale konventioner. Dette afspejles også af det faktum, at kviksølv er blandt de få stoffer, som er, eller snart bliver, reguleret globalt. Danmark og øvrige nordiske lande har været blandt de vigtigste aktører bag dannelsen af en stærk regulering af kviksølv og dets forbindelser i EU og globalt.

Kviksølvudledning til alle dele af miljøet er reguleret i lovgivningen, men med størst vægt på udledninger til luft, fordi kviksølv spredes over lange afstande med atmosfæren.

Danmarks forbud mod markedsføring, import og eksport af kviksølv dækker de fleste **tilsigtede kviksølvanvendelser**. Der er dog undtagelser for en række anvendelser, dels sådanne hvor alternativerne ikke er fuldt markedsmodnede (f.eks. lysstofrør og energisparepærer), dels en række anvendelser, hvor der er fundet særlig grund til at sikre fri samhandel mellem EU-medlemsstaterne. I EU-sammenhæng er kviksølv imidlertid også stærkt begrænset og med den dedikerede fokus i EU's kviksølvsstrategi kan resterende tilsigtede kviksølvanvendelser meget vel blive yderligere begrænset i takt med at kviksølv-frie alternativer bliver bredt accepteret.

Øvrige kilder til kviksølvudledninger er også reguleret i varierende omfang. Forbrænding af affald er reguleret med en grænseværdi for udledninger til atmosfæren i Direktivet om industrielle emissioner, mens de øvrige er reguleret via anlægsspecifikke miljøtilladelser, som også kan målrettes udledninger til andre miljøer. Kviksølvudledninger til atmosfæren fra kulforbrænding er kun behandlet indirekte i dansk regulering i form af Luftvejledningen, som giver generelle retningslinjer for anlægs -specifikke miljøtilladelser. Baseret på tilgængelige emissionsopgørelser vurderes atmosfæriske udledninger fra disse store kilder at være reduceret væsentligt i de seneste årtier. Der findes dog kviksølv-specifikke røggasfiltre, som kan reducere luftudledningerne yderligere; disse anvendes på mange (men ikke alle) af de danske affaldsforbrændingsanlæg, men ikke på nogen danske kulfyrede kraftværker.

Forhandlingerne om en global aftale om kviksølv, Minamata-konventionen, blev afsluttet i januar 2013. Aftalen bliver åbnet for underskrivelse i efteråret 2013. Kviksølv er også omfattet af flere eksisterende internationale aftaler om atmosfæriske emissioner (CLRTAP), havmiljøet (OSPAR , HELCOM), affald (Basel-konventionen) samt eksport af kemikalier (Rotterdam-konventionen).

Fremstilling og anvendelse

Hverken kviksølv eller kviksølvforbindelser produceres i Danmark. Fremstilling af metallisk kviksølv i EU er nu begrænset til genbrug af kviksølv, idet alle andre EU- forsyningskilder er blevet forbudt.

Det danske forbrug af kviksølv faldt med 90% allerede i perioden 1993-2001 som følge af en prioriteret strategi fra Danmarks side. Begrænsninger i brugen af kviksølv til visse anvendelser blev indført før det første generelle forbud mod kviksølv i 1994. Samtidig skete en ændring i teknologien fra manuelt betjente kviksølv-holdige instrumenter til kviksølv-fri digitale løsninger med flere funktioner, som også bidrog til at reducere forbruget.

En søgning på kviksølv og kviksølvforbindelser i den danske Produktregister, der registrerer blandinger, som anvendes professionelt i Danmark, viste et registreret forbrug af frit kviksølv samt 4 kviksølvforbindelser og i mængder af størrelsesordenen et par kilo om året. Tilsvarende gav en søgning i den nordiske kemikaliedatabase SPIN kun få hits. Dette er i overensstemmelse med fraværet af kviksølvforbindelser registreret under REACH for EU.

Ingen nyere omfattende undersøgelser af forbruget af kviksølv i Danmark er til rådighed. De seneste detaljerede forbrugsdata fremgår af en massestrømsanalyse baseret på data fra 2001.. Tablelen nedenfor viser forbruget af kviksølv i 2001 i Danmark sammen med nye data for dental amalgam fra nærværende kortlægning. For andre kviksølvkilder er givet groft anslåede mængder baseret på oplysninger om den aktuelle status for regulering af de pågældende kviksølvkilder, såvel som på andre baggrundsviden. Bemærk, at nogle kviksølvanvendelser, for eksempel laboratorieformål, forventes at have ganske effektive ordninger til indsamling og deponering/genanvendelse.

TABLE 4
FORBRUG AF KVIKSØLV I DANMARK I 2001 SAMT GROFT ANSLÅET FORBRUG FOR 2013

Application	2000/01 forbrug kg Hg/år	Bemærkninger om forbrug/situation i 2013	Groft anslået forbrug i 2013 *1, kg Hg/år
Tilsigtede anvendelser af kviksølv			
Dental amalgam	1,100-1,300	Bruges, men i lavere mængder, se tekst	130-150
Lysstofrør, sparepærer og speciallamper med Hg	60-170	Stigende pga. klimakampagner; alternativet (LED) får stadig større udbredelse	100-300
Kontakter og relæer	0-20	Muligt men minimalt forbrug, er undtaget i kviksølvbekendtgørelsen	0-10
Febertermometre	1.1	Reguleret	0
Andre termometre	15-20	Reguleret med visse undtagelser	0-20
Andet måle- og kontroludstyr	10-50	Reguleret med visse undtagelser	0-30
Klor-alkali produktion	-	Ikke til stede i DK. (EU: ikke BAT ifølge IE Direktiv/BREF konklusion)	0
Andre anvendelser af metallisk kviksølv	40-60	Laboratoriebrug; porosimetri udgør et ikke ubetydeligt forbrug	50-250
Mercury compounds (intentional use)			
Kviksølvoxid batterier	0.5-0.6	Anvendes ikke i DK, reguleret	0
Andre batterier	70-150	Anvendes i visse knapceller; alternativer er på markedet. Anvendes ikke i andre batterier; regulerede og substituerede	0-100
Laboratorie kemikalier	30-70	Begrænset anvendelse, se tekst	30-70
Medicinske anvendelser	0-1	Begrænset anvendelse	0-1
Andre anvendelser af kemikalier	5-50	Begrænset anvendelse, se tekst	10-30
Sum, bevidste anvendelser	1,300-1,900		300-1,000
Kviksølv som følgestof			
Kul	600-1,000	Til stede	Ingen aggregerede oplysninger (IAO)
Olieprodukter	2-30	Til stede	IAO
Naturgas	0.4-3	Til stede	IAO
Bio-fuels	18-80	Til stede	IAO
Cement	30-70	Til stede	IAO
Landbrugskalk, kunstgødning og foder	11-40	Til stede	IAO
Fødevarer	10-20	Til stede	IAO
Andre varer og materialer	94-1,900	Til stede	IAO

Application	2000/01 forbrug kg Hg/år	Bemærkninger om forbrug/situation i 2013	Groft anslået forbrug i 2013 *1, kg Hg/år
Sum, følgestof	760-3,100		IAO
Sum (afrundet)	**2,100-5,000**		IAO

Note: *1: Baseret på meget begrænsede oplysninger.

Affald

Kviksølv er unedbrydeligt og er giftigt uanset hvilken kemisk form det er i. Kviksølv der én gang er bragt ind i biosfæren, som tilsigtet anvendelse eller som følgestof, skal således håndteres med henblik på at reducere eller undgå negative indvirkninger på mennesker og miljø. I Danmark og EU er affaldsfraktioner, der indeholder kviksølv, derfor kategoriseret som farligt affald og der er krav om særlig behandling og indsamling. Indtil for nylig har genbrug været den foretrukne løsning for kviksølvholdigt affald, men da efterspørgslen efter kviksølv til tilsigtede anvendelser er faldet i i-landene i de seneste årtier, sigtes der i højere grad mod at affald med høje kviksølvkoncentrationer slutdeponeres.

Frembringelse kviksølvholdigt affald er i Danmark sandsynligvis domineret af restprodukter fra kraftværker, der hovedsagelig genanvendes til produktion af gipsplader (afsvovlingsprodukt) og cement (flyveaske), samt direkte til anlægsarbejder (slagge og flyveaske). Blandt tilsigtede anvendelser af kviksølv anses de vigtigste kilder til frembringelse af kviksølvholdigt affald at være:

- Dental amalgam;
- Lysstofrør herunder sparepærer og nogle specialiserede udladningslamper;
- Knapcelle batterier;
- Visse typer polyuretan elastomer produkter (lille kviksølvmængde);
- Traditionelle U-rørs blodtryksmålere fra professionelle anvendelser (hospitaler, klinikker osv.);
- Porosimetri.

Mens nogle sektorer har strenge procedurer for særlig indsamling af farligt affald, har det vist sig at private forbrugere har svært ved, eller mangler motivation for, affaldssortering, og det har været vanskeligt at opnå høje indsamlingsprocenter. Derfor forventes en væsentlig del af det bortskaffede kviksølvholdige affald fra private stadig at blive bortskaffet til forbrændingsanlæg for husholdningsaffald.

Mange kviksølvholdige produkter har en betydelig levetid, og desuden er nogle af dem tekniske produkter, som private brugere har en tendens til at gemme længe inden bortskaffelse. Det er således tidligere blevet observeret, at visse varetyper stadig findes i affaldsstrømmen mere end 10 år efter ophør af deres anvendelse. Særlige indsamlingsordninger for affald samt filtre, der tilbageholder kviksølv i røggas fra affaldsforbrændingsanlæg, vil således stadig være nødvendige et par årtier efter et potentielt ophør af tilsigtet anvendelse af kviksølv.

Miljømæssige effekter og eksponering

Kviksølv og kviksølvforbindelser er ifølge CLP-forordningen klassificeret som meget giftige for vandlevende organismer, ved såvel akut som langvarig eksponering (Aquatic Acute 1 og Aquatic Chronic 1). Kviksølv er et grundstof og er derfor ikke nedbrydeligt og nogle kviksølvforbindelser, ikke mindst methylkviksølv, har et højt potentiale for bioakkumulering.

Kviksølv og kviksølvforbindelser, navnlig organiske kviksølvforbindelser og frem for alt methylkviksølv, er meget giftige for mange vandlevende organismer, ofte med effekter ved kortvarig eksponering ved lave mikrogram per liter værdier og kroniske NOEC værdier under 1 mg/L. Biokoncentreringsfaktorer i fisk på flere tusinde er blevet rapporteret.

Fokus er især på rovdyr øverst i fødekæden i vandmiljøet eller som lever af fisk og skaldyr, dvs. rovfisk, havpattedyr, herunder isbjørne, og visse rovfugle. Kviksølvniveauet i disse dyr synes ikke at være faldende på trods af de seneste årtiers bestræbelser på at reducere brugen af kviksølv og kviksølv-niveauerne i spiselige arter kan overstige de relevante grænseværdierne for fødevarer. Rovdyr øverst i fødekæden i det terrestriske miljø synes at være mindre udsat for kviksølvforbindelser via fødekæden end de akvatiske arter. Mange kviksølvforbindelser er også kendt for at være giftige for bakterier og andre mikroorganismer, og nogle har været aktivt brugt til at hindre uønsket mikrobiel vækst.

Opdaterede opgørelser over kviksølvudledninger til alle miljøer er ikke tilgængelige. Den seneste opgørelse er en massestrømsanalyse for året 2001. Den årlige opgørelse af atmosfæriske kviksølv-udledninger i 2010 er vist nedenfor. Bemærk at affaldsforbrænding er rapporteret som en del af "energiproduktion". Størstedelen af udledningen under kategorien "affald" er fra krematorier.

TABLE 5
ATMOSFÆRISKE UDLEDNINGER AF KVIKSØLV FRA DE VÆSENTLIGSTE KILDETYPER I DANMARK I 2010

Sektor	Emissioner i 2010, kg Hg/år
Energiproduktion (herunder affaldsforbrænding)	240
Produktion og anlægsvirksomhed	56
Transport	32
Ikke-industriel forbrænding	48
Industrielle processer	15
Affald	48
Sum	440

Der findes også naturlige kviksølvudledninger til biosfæren. Vulkaner er en af de vigtige kilder globalt set. I det seneste årti har opfattelsen været, at naturlige kviksølvemissioner til luft var af omtrent samme størrelse som de nuværende menneskeskabte emissioner, mens en tilsvarende mængde var re-emission af kviksølv fra tidligere menneskeskabte udledninger (dvs. omkring en tredjedel af de samlede emissioner til luften kom fra hver af disse tre kategorier). Ny forskning præsenteret summarisk på International Conference on Mercury as a Global Pollutant 2013 afholdt i Edinburgh antyder imidlertid, at en større del af det, der tidligere blev anset som naturlige emissioner, faktisk kan være re-emissioner. Den nye forskning omfatter – i modsætning til tidligere opgørelser - data fra før-industriel anvendelse af kviksølv (har blandt andet været udbredt anvendt til udvinding af guld og sølv i årtusinder). Dette understreger betydningen af den menneskeskabte udledning af kviksølv, og understreger vigtigheden af at reducere udledningerne for at minimere miljøeffekterne.

Sundhedseffekter og eksponering

Kviksølv har en række sundhedsmæssige effekter. For **methylkviksølv** er de effekter, der forekommer på de laveste eksponeringsniveauer, neurotoksiske effekter (tab af IQ; svækkelse af indlæringsevne) hos ufødte og små børn. Ifølge ECHA-RAC (udvalget for risikovurdering under REACH), ser denne effekt ikke ud til at have en laveste tærskel. Andre toksiske effekter inkluderer ændring af føle-funktioner, motorik, hukommelse og opmærksomhed. En sammenhæng mellem indtaget af methylkviksølv og hjerte/kar sygdomme er rapporteret. Den Europæiske Fødevareautoritet, EFSA anser de rapporterede observationer om en sammenhæng mellem eksponering for methylkviksølv og blodpropper, pulsvariationer og muligvis forhøjet blodtryk som potentielt vigtige, om end de ifølge EFSA ikke er endeligt påvist.

Ifølge EFSA er nyrerne det kritiske målorgan for toksicitet af **uorganisk kviksølv**. Andre mål omfatter leveren, nervesystemet, immunsystemet, reproduktive og udviklingsmæssige funktioner.

En vurdering færdiggjort af DTU Fødevareinstituttet i 2013 viste, at eksponeringen af den generelle danske befolkning via fødevarer med methylkviksølv (fra akvatiske fødevarer) og uorganiske kviksølv (andre fødevarer) er inden for de niveauer, der anses for at være sikre.

EFSA konkluderede i sin 2012 vurdering, at en væsentlig del af befolkningen i EU kan blive udsat for methylkviksølv via fisk og andre akvatiske fødevarer i mængder, der anses for at være ud over det sikre niveau. Eksponering med uorganisk kviksølv fra kosten synes at være inden for, hvad der anses for at være et sikkert niveau, om end tilstedeværelsen af tandfyldninger af amalgam måske kan føre til eksponering over sikre niveauer for en del af befolkningen.

Den arktiske befolkning, herunder befolkningerne i Grønland og på Færøerne, er udsat for højere niveauer af kviksølveksponering på grund af deres afhængighed af og præference for akvatiske fødevarer, set i sammenhæng med den høje regionale kviksølv deposition (fra fjerntliggende kilder) og opkoncentrering i de mange led i den arktiske marine fødekæde.

Alternativer
I dag er der kommercielt tilgængelige alternativer til næsten alle anvendelser af kviksølv. Dette har muliggjort en næsten total udfasning af brugen af kviksølv i nogle lande, herunder i Danmark. Substituering af kviksølv har været en prioritet i både de nordiske lande, i Europa som helhed, og i Nordamerika i flere årtier. I Danmark er eliminering af kviksølv i artikler og materialer blevet prioriteret for at muliggøre optimal udnyttelse af affald til energiproduktion, uden at øge kviksølvemissionerne fra forbrændingen. Samtidig er elektroniske løsninger med forbedrede egenskaber blevet indført i de seneste årtier, som har erstattet mange af de kviksølvholdige instrumenter.

En fuldstændig udfasning af kviksølv kan af de nævnte årsager tage længere tid for følgende kviksølvanvendelser:

TABLE 6
STØRRE KVIKSØLVANVENDELSER FOR HVILKE UDFASNING KAN KRÆVE LÆNGERE TID

Mercury application	Status of substitution and observed barriers
ASGM – Småskala guldudvinding (ikke udført i Danmark)	Det eneste fuldt modnede alternativ er cyanid-ekstrahering. Cyanid er akut giftigt og kræver derfor optimalt set højteknologiske lukkede processystemer for at reducere risikoen. Lavteknologiske løsninger som i kombination med uddannelse af minearbejdere kan reducere kviksølvanvendelsen og -udslippet med 90% er tilgængelige. ASGM er fattigdoms-drevet, hvilket gør det vanskeligere at gennemføre tiltag til reduktioner.
Dental amalgam	Kviksølv-frie kompositfyldninger (og compomerfyldninger) er tilgængelige på markedet og er i dag dominerende i nogle lande. De kunne i princippet helt erstatte kviksølv, men for komplekse fyldninger ville dette være resultere i reduceret levetid og øget pris. Billigere og lettere anvendte glasiomer-fyldninger anses af nogle for at være et bedre alternativ til amalgam i de udviklingslande, hvor pris og tilgængelighed af teknisk udstyr er de afgørende faktorer (på trods af lavere styrke i dette fyldmateriale). Brugen af amalgam er begrænset i Danmark og den danske Sundhedsstyrelse har udstedt retningslinjer for deres anvendelse.
Lysstofrør og sparepærer	I løbet af det sidste årti er lavenergi LED lamper med lang levetid slået igennem på det globale marked og inden for de sidste få år har de nået en lyskvalitet velegnet til indendørsbelysning, dog indtil videre til væsentligt højere priser end lysstofrør. Lysstofrør kan nu produceres med lavere kviksølvkoncentrationer end tidligere, men deres anvendelse er steget på grund af klimakampagner, hvilket indebærer en stigning i forbrug af kviksølv til denne anvendelse i Danmark og globalt.
Diverse laboratorie- og forskningsanvendelser	Laboratorieanalyser styres af analyse-standarder, som det tager lang tid at ændre på grund af inerti og omkostninger ved paradigme ændringer. I Danmark anses disse anvendelser for at blive brugt i relativt lukkede systemer med strenge krav indsamling og behandling som farligt affald.

Manglende viden
Som anført er kviksølvs miljøegenskaber velbeskrevne. Skulle det imidlertid være ønsket at opdatere datagrundlaget vedrørende kviksølv i Danmark foreslås følgende tiltag:

- Opdatering af udvalgte aspekter af kviksølvs cirkulation i det danske samfund og miljø, som der ikke findes nylige data for. Eksempelvis kviksølvs skæbne i restprodukter fra kulkraftværker, der anvendes til cementproduktion.
- Vurdering af indsamlingseffektiviteten ved separat indsamling af kviksølvholdigt affald i Danmark (især artikler), herunder en vurdering af hvor lang tid det tager før udtjente kviksølvholdige artikler er ude af cirkulationen i samfundet. Et element i en sådan undersøgelse kunne være analyse af de nyligt indførte kontinuerlige kviksølvmålinger i nogle affaldsbrændingsanlæg, som kan detektere kortvarige udslips-hændelser forårsaget af kviksølvholdige artikler.

En fremtidig udfordring vedrørende kviksølv kan være implementeringen af Minamata-konventionen i Danmark. Mens de fleste bestemmelser i konventionen sandsynligvis allerede er dækket i dansk lovgivning og EU lovgivning, kan nogle justeringer og tilføjelser være nødvendige.

I den globale sammenhæng er der stadig meget der skal gøres for så vidt angår nationale udledningssopgørelser for kviksølv, udvikling af retningslinjer for sådanne opgørelser og for affaldshåndtering samt andre aspekter i forbindelse med Minamata-konventionen, foruden en lang række andre spørgsmål.

1. Introduction to the substance group

1.1 Definition of the substance group

Besides elemental mercury, mercury is a constituent of a large number of substances, here called mercury compounds. The compounds are grouped in two groups, inorganic mercury compounds and organic mercury compounds, which each have some distinct group characteristics. Inorganic mercury compounds are mainly in the ionic form with varying solubility depending on the ions involved. Organic mercury compounds involve covalent chemical bonds between mercury and varying organic radicals (for example methyl). This mercury-organo entity can be either a molecule or an ion capable of forming ionic compounds with a large variety of other ions. The form of the mercury compound influence such characteristics as uptake in biological cells, bonding to organic and inorganic matter (bioavailability), atmospheric transport distances after emission, and retention efficiency of flue gas filters, among others. These characteristics will be dealt with in the report as relevant for the description of the key features of mercury as an environmental pollutant.

Section 3 describes the most used mercury compounds and Appendix 1 lists all mercury compounds pre-registered under the EU Reach regulation.

It is important to understand that mercury can be brought into the biosphere by humans by two different overall mechanisms: by 1) intentional extraction and technical use of mercury, and 2) as a natural constituent in other materials which are processed in a way that releases mercury to the biosphere (environment). The latter is for example the case for coal combustion in power plants, cement production and zinc mining, which are all major mercury release sources. A third component in current mercury pollution of the biosphere is the so-called re-emission of mercury previously emitted from human activity. This happens by natural processes, due to mercury's evaporation at low temperatures, and is also enhanced by human activity such as the use of bio-fuels, changes in land-use and as a consequence of global warming. Re-emission prolongs the effects of human releases of mercury. Reducing current human releases of mercury is however the only way to obtain reduced impacts of mercury to humans and the environment. This, in combination with mercury's toxicity and its capacity to remain in (and be re-emitted to) the atmosphere and thus be transported with the atmosphere on a global scale, has been the main impetus for creating a global treaty on reduction of mercury pollution. The negotiations of the treaty were finalised in January 2013 and the treaty is expected to be opened for signature during 2013 in Minamata, Japan (scene of one of the World's worst local pollution incidents caused by mercury).

An important feature of mercury, being an element, is however that no matter which form it is in, it may ultimately be decomposed to elemental mercury in nature, which is in itself toxic to humans and in the environment. Furthermore, the organic mercury compound methylmercury (MeHg) can be formed by natural microbial processes from elemental mercury in aquatic and terrestrial environments, including in landfills in their methane-producing phase.

The primary risks to the general population is caused by exposure to methylmercury via ingestion of aquatic foods, and the critical exposure routes of all mercury compounds are via their decomposition and natural formation of methylmercury (MeHg) in the aquatic environment. The health and environment sections of this report therefore focus on methylmercury, rather than on the specific mercury compounds. Elemental mercury and inorganic mercury compounds have similar uptake mechanisms in the body, and they are also dealt with on an aggregate level in the human health section.

Elemental mercury plus 202 mercury compounds were pre-registered by industry under the REACH regulation, yet as of March 2013 only elemental mercury itself has been registered, even though 101 mercury compounds had registration deadlines in 2010(ECHA, 2013a). The 203 mercury compounds pre-registered by ECHA are presented in Annex 1.

Similarly, as of March 2013, no mercury compounds were found (using a search on "mercu") in the ECHA's list of substances identified by industry to be registered by 31 May 2013 (ECHA, 2013d). This may indicate that the number of mercury compounds in use in the EU in the future will be reduced, but it however cannot be determined with certainty, as industry may still register mercury compounds within the deadline in spite of no early notification to ECHA of doing so.

1.2 Physical and chemical properties

TABLE 7
PHYSICAL AND CHEMICAL PROPERTIES OF MERCURY

	Mercury	Reference
EC number	231-106-7	
CAS number	7439-97-6	
Synonyms		
Molecular formula	Hg	
Physical state	Liquid, at 20°C and 1013 hPa	
Melting/freezing point	-38.87 °C, measurement performed at 1013.25 hPa	Registration at ECHAs website
Boiling point	356.58 °C, measurement performed at 1013.25 hPa	-"-
Relative density	13.53 g/cm³ at 25 °C	-"-
Vapour pressure	0.002666 hPa at 25 °C	-"-
Surface tension	0.47 N/m at 20 °C	-"-
Water solubility	0.00013 mg/L at 25 °C	-"-
Atomic weight	200.59 g/mol	

1.3 Function of the substances for main application areas

With its special characteristics, mercury has been used for a large variety of purposes since roman times (and even earlier for cosmetics), where it was applied in gold extraction just as it is today in artisanal and small scale gold mining (ASGM). ASGM is, even today, the largest intentional use of mercury.

Table 5 gives examples of the application of mercury and its compounds as well as the key features of mercury making them technically suitable for the purpose.

TABLE 8
EXAMPLES OF APPLICATIONS OF MERCURY AND MERCURY COMPOUNDS AND THE KEY CHARACTERISTICS MAKING THEM TECHNICALLY SUITABLE

Examples of applications of mercury and mercury compounds	Key mercury characteristics used in application
Elemental mercury:	
Chlor-alkali production	Good conductor of electricity, fluent at room temperature
Dental amalgam	Can amalgamate (mix into/"dissolve") certain other metals (Au, Ag, Al, etc.)
Thermometers	Volume very temperature-dependent, fluent at room temperature
Manometers and barometers	Fluent at room temperature, high density
Porosimetry	High density, suitable wetting properties
Electric and electronic switches	Good conductor of electricity, fluent at room temperature
Fluorescent lamps	Low boiling point, suitable emitted light wave length
Gold and silver extraction	Can amalgamate (mix into/"dissolve") certain other metals (Au, Ag, Al, etc.)
"Bogie tubes" for straightening out constricted intestines in the human body	High density, fluent at room temperature
Mercury compounds:	
Batteries	Good electrochemical potential, suppresses gas formation
Pesticides, biocides and medicals	Toxic to microorganisms and other life forms
Catalyst for production of chemicals and polymers	Good electron source; specific effects on chemical structures used in chemical reactions
Laboratory chemicals and standards for various purposes	Various characteristics depending on use

Besides intentional use of mercury, mercury is present naturally, or as a man-made trace pollutant, in most materials. In sectors processing large volumes of materials, such as coal fired power plants, mining, cement production and oil and gas uses, mercury is emitted in significant quantities.

2. Regulatory framework

This chapter gives an overview of how mercury and mercury compounds are addressed in existing and forthcoming EU and Danish legislation, international agreements and eco-label criteria. The overview reflects the findings from the data search (reference is made to data collection strategy in the foreword).

For readers not used to dealing with legislative issues regarding chemicals, Appendix 1 provides an overview of legislative instruments in EU and Denmark. The appendix also gives a brief introduction to chemicals legislation, explanation for the lists referred to in Section 2, and provides a brief introduction to international agreements and selected eco-label schemes.

2.1 Legislation

This section first lists existing legislation addressing mercury and mercury compounds and then gives an overview of on-going activities.

2.1.1 Existing legislation

Table 6 gives an overview of the main pieces of existing legislation addressing mercury and mercury compounds. For each area of legislation, the table first list applicable EU legislation and then its possible transposition into Danish law and/or other national rules. Mercury may be mentioned in other legal instruments (e.g. defining commodity groups for statistics).

The following table lists the main instruments regulating the use, release and disposal of mercury and mercury compounds. As can be seen, mercury and mercury compounds are regulated through a range of cross-cutting chemicals legislation (incl. numerous restrictions), as well as sector-specific and media specific (e.g. air, sludge, water) legislation.

TABLE 9
DANISH AND EU LEGISLATION SPECIFICALLY ADDRESSING MERCURY AND MERCURY COMPOUNDS

Legal instrument*1	Requirements as concerns mercury (includes amendments to the parent instruments)
Legislation addressing products	
Statutory order no. 627 of 1 july 2003 on prohibition of import, sale and export of mercury and mercury-containing products ("Danish mercury order") ***Bekendtgørelse om forbud mod import, salg og eksport af kviksølv og kviksølvholdige produkter*** **BEK nr 627 af 01/07/2003**	1.-(1) Import, sale and export of mercury and mercury-containing products shall be prohibited. (2) Mercury means the element mercury, both in its metallic form and in chemical compounds. (3) Mercury-containing products means products in which mercury constitutes more than 100 ppm (mg/kg) of their homogeneous components. (4) Irrespective of the prohibition in subsection (1) hereof, import, sale and export of the mercury-containing products listed in the Annex shall be permitted. (5) This Order shall not apply to: - natural impurities in coal - used products which fulfilled Danish requirements at the time they were first offered for sale - products regulated by other legislation, unless they are stated in the Annex. List of mercury-containing products for which import, sale and export are permitted - irrespective of the prohibition laid down in section 1 of the Order

Legal instrument*1	Requirements as concerns mercury (includes amendments to the parent instruments)
	1. Dental products for filling permanent molar teeth, where the filling is worn 2. Mercury-wetted film switches and relays which meet EN 119000, for specified applications in businesses: - data and telecommunication - process control - PLC remote control of energy supply - electrical test systems 3. Thermometers for special applications: - calibration of other thermometers - analysis equipment 4. Special light sources: - discharge lamps, including energy-saving bulbs - for analysis operations - for graphic operations 5. Flash units for safety installations on railway lines 6. Manometers for calibration of other pressure gauges 7. Barometers for calibration of other barometers 8. Electrodes for special applications: - polarographic analysis - potentiometric analysis - calomel reference 9. Mercury-containing chemicals for special applications: - raw materials for analysis reagents - analysis reagents - standards - preservation of starch for laboratory use - isotope dilution testing - catalysts 10. Products for research, including odontological research 11. Products for teaching 12. Products for vital applications in aircraft 13. Products for the repair of existing mercury-containing equipment
- As amended by Statutory Order BEK nr 115 af 12/02/2009	The amendment implements Direktive 2007/51/EF of 25. September 2007 on restrictions for mercury containing measuring instruments for private use.
Regulation No 1907/2006 (EC) on the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH)	REACH Annex XVII (latest available consolidated version of the REACH legal text, dated 09.10.2012; which does not include provisions for phenylmercury compounds and measuring instruments; see below): Restrictions on the manufacture, placing on the market and use of certain dangerous substances, mixtures and articles. For substances which have been incorporated in this Annex as a consequence of restrictions adopted in the framework of Directive 76/769/EEC (Entries 1 to 58), the restrictions shall not apply to storage, keeping, treatment, filling into containers, or transfer from one container to another of these substances for export, unless the manufacture of the substances is prohibited. **Mercury - CAS No 7439-97-6 EC No 231-106-7:** 1. Shall not be placed on the market: (a) in fever thermometers; (b) in other measuring devices intended for sale to the general public (such as manometers, barometers, sphygmomanometers,

Legal instrument*1	Requirements as concerns mercury (includes amendments to the parent instruments)
	thermometers other than fever thermometers). 2. The restriction in paragraph 1 shall not apply to measuring devices that were in use in the Community before 3 April 2009. However Member States may restrict or prohibit the placing on the market of such measuring devices. 3. The restriction in paragraph 1(b) shall not apply to: (a) measuring devices more than 50 years old on 3 October 2007; (b) barometers (except barometers within point (a)) until 3 October 2009. [4. is obsolete; see below] **Mercury compounds:** Shall not be placed on the market, or used, as substances or in mixtures where the substance or mixture is intended for use: (a) to prevent the fouling by micro-organisms, plants or animals of: — the hulls of boats, — cages, floats, nets and any other appliances or equipment used for fish or shellfish farming, — any totally or partly submerged appliances or equipment; (b) in the preservation of wood; (c) in the impregnation of heavy-duty industrial textiles and yarn intended for their manufacture; (d) in the treatment of industrial waters, irrespective of their use. Reproductive toxicant category 1B adverse effects on sexual function and fertility or on development (Table 3.1) or reproductive toxicant category 2 with R60 (May impair fertility) or R61 (May cause harm to the unborn child) (Table 3.2) listed in Appendix 6 (Eds.: to the Annex; the appendix includes elemental mercury): Without prejudice to the other parts of this Annex the following shall apply to entries 28 to 30: 1. Shall not be placed on the market, or used, — as substances, — as constituents of other substances, or, — in mixtures, for supply to the general public when the individual concentration in the substance or mixture is equal to or greater than: — either the relevant specific concentration limit specified in Part 3 of Annex VI to Regulation (EC) No 1272/2008, or, — the relevant concentration specified in Directive 1999/45/EC. Without prejudice to the implementation of other Community provisions relating to the classification, packaging and labelling of substances and mixtures, suppliers shall ensure before the placing on the market that the packaging of such substances and mixtures is marked visibly, legibly and indelibly as follows: 'Restricted to professional users'. 2. By way of derogation, paragraph 1 shall not apply to: (a) medicinal or veterinary products as defined by Directive 2001/82/EC and Directive 2001/83/ EC; (b) cosmetic products as defined by Directive 76/ 768/EEC; (c) the following fuels and oil products: — motor fuels which are covered by Directive 98/70/EC, — mineral oil products intended for use as fuel in mobile or fixed combustion plants, — fuels sold in closed systems (e.g. liquid gas bottles); (d) artists' paints covered by Directive 1999/45/.
As amended by COMMISSION REGULATION (EU) No 848/2012	(a) Phenylmercury acetate EC No: 200-532-5 CAS No: 62-38-4 (b) Phenylmercury propionate EC No: 203-094-3 CAS No: 103-27-5 (c) Phenylmercury 2-ethylhexanoate EC No: 236-326-7 CAS No: 13302-00-6 (d) Phenylmercury octanoate EC No: - CAS No: 13864-38-5 (e) Phenylmercury neodecanoate EC No: 247-783-7 CAS No: 26545-49-3: 1. Shall not be manufactured, placed on the market or used as substances or in mixtures after 10 October 2017 if the concentration of mercury in the mixtures is equal to or greater than 0,01 % by weight.

Legal instrument*1	Requirements as concerns mercury (includes amendments to the parent instruments)
	2. Articles or any parts thereof containing one or more of these substances shall not be placed on the market after 10 October 2017 if the concentration of mercury in the articles or any part thereof is equal to or greater than 0,01 % by weight.'
As amended by COMMISSION REGULATION (EU) No 847/2012	In Annex XVII to Regulation (EC) No 1907/2006, the entry 18a is amended as follows: (1) paragraph 4 is deleted; (2) the following paragraphs 5 to 8 are added: 5. The following mercury-containing measuring devices intended for industrial and professional uses shall not be placed on the market after 10 April 2014: (a) barometers; (b) hygrometers; (c) manometers; (d) sphygmomanometers; (e) strain gauges to be used with plethysmographs; (f) tensiometers; (g) thermometers and other non-electrical thermometric applications. The restriction shall also apply to measuring devices under points (a) to (g) which are placed on the market empty if intended to be filled with mercury. 6. The restriction in paragraph 5 shall not apply to: (a) sphygmomanometers to be used: (i) in epidemiological studies which are ongoing on 10 October 2012; (ii) as reference standards in clinical validation studies of mercury-free sphygmomanometers; (b) thermometers exclusively intended to perform tests according to standards that require the use of mercury thermometers until 10 October 2017; (c) mercury triple point cells which are used for the calibration of platinum resistance thermometers. 7. The following mercury-using measuring devices intended for professional and industrial uses shall not be placed on the market after 10 April 2014: (a) mercury pycnometers; (b) mercury metering devices for determination of the softening point. 8. The restrictions in paragraphs 5 and 7 shall not apply to: (a) measuring devices more than 50 years old on 3 October 2007; (b) measuring devices which are to be displayed in public exhibitions for cultural and historical purposes.'
Regulation (EC) No 689/2008 the European Parliament and of the Council of 17 June 2008 concerning the export and import of dangerous chemicals	Implements the Rotterdam convention in the EU, and includes additional provisions for EU Member States. Mercury compounds, including inorganic mercury compounds, alkyl mercury compounds and alkyloxyalkyl and aryl mercury compounds are included in the Regulation's list of chemicals subject to export notification procedure, Annex I, Part 1 and Part 3. Cosmetic soaps containing mercury are subject to an export ban according to Annex V, Part 2.
Regulation (EU) No 649/2012 of the European Parliament and of the Council of 4 July 2012 concerning the export and import of hazardous chemicals	The regulation replaces Regulation (EC) No 689/2008 with effect as of 1 March 2014. In addition to the above mentioned, it includes the following export bans: Mercury compounds except compounds exported for research and development, medical or analysis purposes: Cinnabar ore, mercury (I) chloride (Hg 2 Cl 2 , CAS No 10112-91-1), mercury (II) oxide (HgO, CAS No 21908-53-2); CN code 2852 00 00. Metallic mercury and mixtures of metallic mercury with other substances, including alloys of mercury, with a mercury concentration of at least 95 % weight by weight. CAS No 7439-97-6 CN code 2805 40.
Regulation (EC) No 1223/2009 on cosmetic products	Mercury and its compounds are included in list of substances prohibited in cosmetic products. However two mercury containing compounds may be legally used in cosmetic products, within certain threshold concentrations: Phenyl Mercuric Acetate and Thimerosal

Legal instrument*1	Requirements as concerns mercury (includes amendments to the parent instruments)
Directive 2011/65/EU on the restriction of the use of certain hazardous substances in electrical and electronic equipment (recast) [RoHS Directive] **Danish Statutory Order on the limitation of import, marketing and manufacture for eksport within the EU of electric and electronic appliances.** ***Bekendtgørelse om begrænsning af import og salg samt fremstilling til eksport inden for EU af elektrisk og elektronisk udstyr, der indeholder visse farlige stoffe,r*** **BEK nr 284 of 24/03/2011(as later amended by BEK nr. 1041 of 30/10/2012)**	New electrical and electronic equipment put on the market shall not contain mercury in concentrations over 0.1 w% in electrical equipment. Exceptions are (exemption number in brackets): (1) Mercury in (compact) fluorescent tubes with one holder, maximum (per burner): (1.a) For general lightning purposes < 30W: 2,5 mg per burner (1.b) For general lightning purposes ≥ 30W, but < 50 W: 3,5 mg per burner (1.c) For general lightning purposes ≥ 50W, but < 150 W: 5 mg (1.d) For general lightning purposes ≥ 150W: 15 mg (1.e) For general lightning purposes of circular or squared form and with tube diameter ≤ 17mm : 7 mg per burner (1.f) For specific purposes: 5 mg (2.a) Mercury in linear fluorescent tubes with two holders for general lightning purposes, maximum (per tube): (2.a.1) Three-powder-tubes with normal lifetime and tube diameter < 9 mm (fx T2): 3 mg per burner (2.a.2) Three-powder-tubes with normal lifetime and tube diameter ≥ 9 mm, but ≤ 17 mm (fx T5): 3.5 mg per tube (2.a.3) Three-powder-tubes with normal lifetime and tube diameter > 17 mm, but ≤ 28 mm (fx T8): 3.5 mg per tube (2.a.4) Three-powder-tubes with normal lifetime and tube diameter > 28 mm (fx T12): 5.5 mgper tube (2.a.5) Three-powder-tubes with long lifetime (≥ 25 000 hours): 5 mg per tube (2.b) Mercury in other fluorescent tubes, maximum (per tube): (2.b.3) Non-linear three-powder-tubes with tube diameter > 17 mm (fx T9): 15 mg per tube (2.b.4) Light sources for other general lightning purposes and specific purposes (fx induction light sources): 15 mg per tube (3) Mercury in cold cathode fluorescent tubes (CCFL) or fluorescent tubes with external electrodes (EEFL) for special purposes, maximum (per tube) (3.a) Short (≤ 500 mm): 3,5 mg per tube (3.b) Average (> 500 mm and ≤ 1500 mm): 5 mg per tube (3.c) Long (> 1500 mm): 13 mg per tube may be used after 31. December 2011) (4.a) Mercury in other low-pressure discharge tubes (per tube) (15 mg per tube may be used after 31. December 2011) (4.b) Mercury in high-pressure sodium lamps for general lightning purposes not above (per burner) in light source with improved colour rendering Ra > 60: (4.b.1) P ≤ 155W (No application limitation until 31. December 2011; 30 mg per tube may be used after 31. December 2011) (4.b.2) 155W < P ≤ 405 W (No application limitation until 31. December 2011; 40 mg per tube may be used after 31. December 2011) (4.b.3) P > 405W (No application limitation until 31. December 2011; 40 mg per tube may be used after 31. December 2011) (4.c) Mercury in other high-pressure sodium lamps for general lightning purposes not above (per burner): (4.c.1) P ≤ 155W (No application limitation until 31. December 2011; 25 mg per tube may be used after 31. December 2011) (4.c.2) 155W < P ≤ 405 W (No application limitation until 31. December 2011; 30 mg per tube may be used after 31. December 2011)

Legal instrument*1	Requirements as concerns mercury (includes amendments to the parent instruments)
	(4.c.3) P > 405W (No application limitation until 31. December 2011; 40 mg per tube may be used after 31. December 2011) (4.d) Mercury in other high-pressure mercury lamps (HPMV) (Expires 13. April 2015) (4.e) Mercury in metal halide lamps (MH) (4.f) Mercury in other discharge lamps for specific purposes, which are not mentioned in this appendix (36) Mercury applied as cathode nebulizer inhibitor in direct-current plasma screen, up to 30 mg per screen (Expires 1. July 2010) For medical equipment and monitoring and regulation equipment: (1) Mercury in detectors for ionising radiation. (1.c) Mercury in IR-detectors. (1.d) Mercury in reference electrodes: mercury chloride with low chloride content, mercury sulphate and mercury oxide. (16) Mercury in capacitance and dissipation factor measuring circuit with very high precision and in high frequency RF-connection and relay in monitoring and regulation equipment, which do not exceed 20 mg mercury per connection or relay.
Directive 2000/53/EC of the European Parliament and of the Council on end-of-life vehicles [ELV Directive] **Danish Statutory Order on limitation of import, marketing and manufacturing within the EU and EFTA of vehicles containing certain hazardous substances** ***Bekendtgørelse om begrænsning af import, salg samt fremstilling til eksport inden for EU og til EFTA-lande af person- og varebiler m.v., der indeholder visse farlige stoffer*** **BEK nr 1257 af 11/12/2008**	Member States shall ensure that materials and components of vehicles put on the market after 1 July 2003 do not contain lead, mercury, cadmium or hexavalent chromium other than in cases listed in Annex II under the conditions specified therein. Discharge lamps and instrument panel displays are exempted with no end data, and should be labelled. A maximum concentration value up to 0,1 % by weight and per homogeneous material, for mercury shall be tolerated. Treatment operations for depollution of end-of-life vehicles: — Removal, as far as feasible, of all components identified as containing mercury. The Danish Statutory order specifies that the exemptions are valid only for cars of types approved before 1 July 2012, and spare parts for the same.
Council Directive 88/378/EEC on the approximation of the laws of the Member States concerning the safety of toys **Danish Statutory Order on safety requirements for toys and products, which due to appearence can be mistaken for**	Bioavailability of mercury resulting from the use of toys must not, as an objective, exceed the following levels per day: 0.5 µg/day. Part of this Directive was repealed in July 2011. The Directive is to be completely repealed by 20 July 2013 - please see below. Changes have been made in 11/01/2013, but they only impact the limit values for cadmium.

Legal instrument*1	Requirements as concerns mercury (includes amendments to the parent instruments)
foods ***Bekendtgørelse om sikkerhedskrav til legetøj og produkter, som på grund af deres ydre fremtræden kan forveksles med levnedsmidler*** **BEK nr 1116 af 12/12/2003 (Legetøjsbekendtgørelsen)**	
Directive 2009/48/EC relating to toy safety **Danish Statutory Order on safety requirements for toys** ***Bekendtgørelse om sikkerhedskrav til legetøjsprodukter*** **BEK nr 13 af 10/01/2011**	Limit values for mercury in toys (Commission Directive 2012/7/EU of 2 March 2012 to be adopted by 2o Jan. 2013 at the latest): - in dry, brittle, power-like or pliable toy material: 7.5 mg/kg - in liquid or sticky toy material: 1.9 mg/kg - in scrapped-off toy material: 94 mg/kg
Directive 2006/66/EC of the European Parliament and of the Council of 6 September 2006 on batteries and accumulators and waste batteries and accumulators **Danish Statutory order on import, marketing and export of batteries and accumulators** ***Bekendtgørelse om import og salg samt eksport af batterier og akkumulatorer*** **BEK nr 943 af 23/09/2008** **Danish Statutory order on batteries and accumulators including spent batteries and accumulators (regarding recycling of the batteries)** ***Bekendtgørelse om batterier og akkumulatorer og udtjente batterier og akkumulatorer*** **BEK nr 1186 af 07/12/2009**	Prohibition of all batteries or accumulators, including those incorporated into appliances that contain more than 0,0005 % of mercury by weight, except for button cell batteries, which may contain up to 2% mercury by weight. Member States shall ensure that: (a) producers or third parties set up schemes using best available techniques, in terms of the protection of health and the environment, to provide for the treatment and recycling of waste batteries and accumulators; and (b) all identifiable batteries and accumulators collected in accordance with Article 8 of this Directive or with Directive2002/96/EC undergo treatment and recycling through schemes that comply, as a minimum, with Community legislation, in particular as regards health, safety and waste management. However, Member States may, in accordance with the Treaty, dispose of collected portable batteries or accumulators containing cadmium, mercury or lead in landfills or underground storage when no viable end market is available. Member States may also, in accordance with the Treaty, dispose of collected portable batteries or accumulators containing cadmium, mercury or lead in landfills or underground storage as part of a strategy to phase out heavy metals which, on the basis of a detailed assessment of the environmental, economic, and social impacts, shows that this disposal option should be preferred over recycling Batteries, accumulators and button cells containing more than 0,0005 % mercury shall be marked with the chemical symbol for mercury: Hg.
Directive 94/62/EC of 20	The sum of concentration levels of lead, cadmium, mercury and hexavalent chromium present in

Legal instrument*1	Requirements as concerns mercury (includes amendments to the parent instruments)
December 1994 on packaging and packaging waste	packaging or packaging components shall not exceed 100 ppm by weight. The concentration levels referred to in paragraph 1 shall not apply to packaging entirely made of lead crystal glass as defined in Directive 69/493/EEC (1).
Danish Statutory Order on certain requirements for packaging ***Bekendtgørelse om visse krav til emballager*** **BEK nr 1049 af 10/11/2011**	Danish Statutory Order stipulates in addition: Mercury may not be added intentionally in the production of plastic boxes or pallets. By derogation of the general requirements, glass packaging may be used if the sum of the substances does not exceed 250 ppm in weight, in glass packaging based on recycled glass where the substances are not intentionally added.
Danish Statutory Order: ***Bekendtgørelse om begrænsning i anvendelse af visse farlige kemiske stoffer og produkter til specielt angivne formål*** **BEK nr 857 af 05/09/2009**	Mercury and mercury compounds may not be used in chemical substances or products intended for painting, lacquer or alike purposes in concentrations above 0,0001 pct. This is not applicable for mercuric sulphide (cinnabar).
Danish law on chemicals ***Kemikalieloven*** **LBK nr 878 af 26/06/2010**	According to §24, very toxic and toxic substances (including mercury compounds) may only be sold with prior written permit by the police (case by case). The individual permit shall include information of the intended purpose of the substance or article/mixture. General exemptions are given in the law to the health sector, higher educational institutions, accredited laboratories, and a number of other specified sectors.
Statutory order on the labeling etc. of medicals. **Bekendtgørelse om mærkning m.m. af lægemidler, BEK nr 869 af 21/07/2011**	Provisions for labelling of thiomersal phenylmercurynitrate/acetate/borate with possible risks related to exposures via different use of medicals.
Statutory order on Danish standards for medicals. **Bekendtgørelse om Danske Lægemiddelstandarder 2012.21, BEK nr 707 af 19/06/2012**	Mercuric chloride, Phenylmercuric acetate, Phenylmercuric borate, Thiomersal and Phenylmercuric nitrate are listed in the statutory order.
Legislation addressing waste	
Regulation (EC) No 1102/2008 of 22 October 2008 on the banning of exports of metallic mercury and certain mercury compounds and mixtures and the safe storage of metallic mercury	1. The export of metallic mercury (Hg, CAS RN 7439-97-6), cinnabar ore, mercury (I) chloride (Hg_2Cl_2, CAS RN 10112-91-1), mercury (II) oxide (HgO, CAS RN 21908-53-2) and mixtures of metallic mercury with other substances, including alloys of mercury, with a mercury concentration of at least 95 % weight by weight from the Community shall be prohibited from 15 March 2011. 2. The prohibition shall not apply to exports of compounds referred to in paragraph 1 for research and development, medical or analysis purposes. 3. The mixing of metallic mercury with other substances for the sole purpose of export of metallic mercury shall be prohibited from 15 March 2011. From 15 March 2011, the following shall be considered as waste and be disposed of in accordance with Directive 2006/12/EC of the European Parliament and of the Council of 5 April

Legal instrument*1	Requirements as concerns mercury (includes amendments to the parent instruments)
	2006 on waste in a way that is safe for human health and the environment: (a) metallic mercury that is no longer used in the chlor-alkali industry; (b) metallic mercury gained from the cleaning of natural gas; (c) metallic mercury gained from non-ferrous mining and smelting operations; and (d) metallic mercury extracted from cinnabar ore in the Community as from 15 March 2011. By way of derogation from Article 5(3)(a) of Directive 1999/31/EC, metallic mercury that is considered as waste may, in appropriate containment, be (a) temporarily stored for more than one year or permanently stored (disposal operations D 15 or D 12 respectively, as defined in Annex II A of Directive 2006/12/EC) in salt mines adapted for the disposal of metallic mercury, or in deep underground, hard rock formations providing a level of safety and confinement equivalent to that of those salt mines; or (b) temporarily stored (disposal operation D 15, as defined in Annex II A of Directive 2006/12/EC) for more than one year in above-ground facilities dedicated to and equipped for the temporary storage of metallic mercury. In this case, the criteria set out in section 2.4 of the Annex to Decision 2003/33/EC shall not apply. Member states shall report to the Commission any permits given to operators of mercury waste storage facilities and importers, exporters and operators shall report annually to both the competent authorities of their country and the Commission on amounts, origin, etc. of any mercury and waste traded. Chlor-alkali facilities shall report annually about their inventory and trade of mercury, and companies buying mercury from the mentioned sources shall report on their purchases annually to the to both the competent authorities of their country and the Commission.
Directive 2011/97/EU of 5 December 2011 amending Directive 1999/31/EC as regards specific criteria for the storage of metallic mercury considered as waste	The Directive gives specific provisions for the storage of mercury; container requirements, procedures, etc.
Directive 1999/31/EC on the landfill of waste **Danish Statutory Order: Bekendtgørelse om deponeringsanlæg BEK nr 650 af 29/06/2001 with later amendments**	No direct mentioning of mercury in the original Directive, but see amendment above. A maximum content of mercury at 1 mg/kg TS in the waste is a criterion for a waste type to be on the positive list for a waste storage plant.
Regulation (EC) No 1013/2006 on shipments of waste	This Regulation implements the Basel Convention in EU, establishing procedures and control regimes for the shipment of waste, depending on the origin, destination and route of the shipment, the type of waste shipped and the type of treatment to be applied to the waste at its destination. The Regulation requires e.g. that export of certain waste types (also waste intended for recovery) shall be prohibited depending on the type of waste and the country of destination. However, derogations are possible. Waste subject to export prohibition (included in Annex V) includes: - Metallic waste and alloys with mercury

Legal instrument*1	**Requirements as concerns mercury (includes amendments to the parent instruments)**
	- Wastes having as constituents or contaminants mercury and mercury compounds - Waste of electronic and electrical appliances with mercury-switches or other mercury contents - Mercury containing wastes from petroleum refining, natural gas purification and pyrolytic treatment of coal - Wastes from inorganic chemical processes containing mercury - Waste from gas cleaning in thermal processes containing mercury - Waste batteries with mercury - Other unspecified waste containing mercury - Construction and demolition wastes containing mercury - Fluorescent tubes and other mercury-containing waste
Council Directive 86/278/EEC on the protection of the environment, and in particular of the soil, when sewage sludge is used in agriculture **Danish Statutory Orders** ***Bekendtgørelse om anvendelse af affald til jordbrugsformål (Slambekendtgørelsen)*** **BEK nr 1650 af 13/12/2006** **Bekendtgørelse om tilsyn med spildevandsslam m.m. til jordbrugsformål BEK nr 56 af 24/01/2000**	Limit values for mercury in soil to which sludge is applied: 1 - 1.5 mg/kg dw. Limit value for mercury concentration in sludge for use in agriculture: 16 - 25 mg/kg dw. Limit value for amounts of mercury added annually to agricultural land based on 10-years average: 0.1 kg/ha/year . Danish Statutory order: Limit value for mercury in sludge for use in agriculture : 0.8 mg/kg dw; Sets the frequency of analysis and control
Danish Statutory Order: ***Bekendtgørelse om anvendelse af restprodukter og jord til bygge- og anlægsarbejder og om anvendelse af sorteret, uforurenet bygge- og anlægsaffald*** **BEK nr 1662 af 21/12/2010**	Limit values of mercury in residual products and earth to be used in construction, etc. in three categories: 1: 0-1 mg/kgDW and 0-0,1 µg/L eluate 2: >1 mg/kgDW and 0-0,1 µg/L eluate 3: >1 mg/kgDW and 0,1-1 µg/L eluate
Danish Statutory Order: ***Bekendtgørelse om anvendelse af bioaske til jordbrugsformål (Bioaskebekendtgørelsen)*** **BEK nr 818 af 21/07/2008**	Limit values for mercury in bio-ash used in agriculture and watery extract is 0.8 mg/kg dm. Soil quality limit values for mercury is 0.5 mg/kg dm in soil. Mercury can be left out of analysis if the ash-producer can document that the previous 5 tests have been below 50% of the limit values.
Danish Statutory Order: ***Bekendtgørelse om anlæg, der forbrænder affald*** **BEK nr 1451 af 20/12/2012**	Limit value for mercury in flue gas from waste incineration: 0,05 mg/normal m^3 Limit value for mercury in waste water from flue gas cleaning: 0.03 mg/L

Legal instrument*1	Requirements as concerns mercury (includes amendments to the parent instruments)
Transposes part of the provisions of Directive 2010/75/EU on industrial emissions (see below)	
Danish Statutory Order: ***Bekendtgørelse om anmeldelse og dokumentation i forbindelse med flytning af jord BEK nr 1479 af 12/12/2007 (Jordflytningsbekendtgørelsen)***	Stipulates rules for notification and documentation when soil containing mercury and other hazardous substances above the limit values is displaced under certain conditions. Limit values: Category 1: </= 1 mg/kg dw. Category 1: </= 3 mg/kg dw.
Legislation addressing emissions	
Regulation (EC) No 166/2006 concerning the establishment of a European Pollutant Release and Transfer Register and amending Council Directives 91/689/EEC and 96/61/EC (PRTR Regulation)	Releases of mercury and mercury compounds shall be reported by operators with activities above a certain activity threshold, if the releases are above a certain threshold releases: To air: 1o kg/year To water: 1 kg/year To land: 1 kg/year
Directive 2010/75/EU on industrial emissions (integrated pollution prevention and control) (Recast)	For combustion plants firing coal or lignite, the emissions of total mercury shall be measured at least once per year. Air emission limit values for waste incineration plants for mercury and its compounds, expressed as mercury (Hg): 0.05 nm/Nm3 Emission limit values for discharges of waste water from the cleaning of waste gases from waste incineration and waste co-incineration for mercury and its compounds, expressed as mercury (Hg): 0.03 mg/l. Mercury emission limits set in BAT conclusions shall be binding maximum limits.
Danish Statutory Order on environmental permissions, Appendix 5 ***Bekendtgørelse nr. 486 af 25. maj 2012, bilag 5 (Godkendelsesbekendtgørelsen)***	Standard conditions for crematoria: Filter retaining dust and mercury is required on all crematoria and an emission limit applies for mercury: 0.1 mg/normal m^3.
Directive 2004/107/EC relating to arsenic, cadmium, mercury, nickel and polycyclic aromatic hydrocarbons in ambient air **Danish Statutory Order:** ***Bekendtgørelse om vurdering og styring af luftkvaliteten*** **BEK nr 1326 af 21/12/2011 (Luftkvalitetsbekendtgørelsen)**	Require that that ambient air quality is maintained where it is good and that it is improved in other cases. Determine common methods and criteria for the assessment of concentrations of mercury in ambient air and deposition. Danish Statutory Order: Deadline for assessment of measure 31 December 2012.
Guideline on air emissions ***Luftvejledningen***	The guideline gives guidance for the environmental authorities on the establishment of environmental permits for individual industrial facilities. The guideline gives examples of

<table>
<tr><th>Legal instrument*1</th><th>Requirements as concerns mercury (includes amendments to the parent instruments)</th></tr>
<tr><td>VEJ nr 12415 af 01/01/2001</td><td>emission thresholds for mercury to air (1g/hour, 0.1 mg/normal m3 and immission contribution value ("B-value") of 0,00001 mg/m3 to local air. The guideline in itself does not have legal status, but the individual environmental permits established based on the guideline have legal status. The actual permits may have other thresholds for mercury taking into account local conditions.</td></tr>
<tr><td>Danish Statutory order on (environmental) permits of listed enterprises
Bekendtgørelse om godkendelse af listevirksomhed
BEK nr 486 af 25/05/2012 with later amendments</td><td>The Order sets requirements for establishment of environmental permits for enterprises of types with potentially significant releases. The order mentions specifically for mercury:
Specific measurement standards are mentioned for control of mercury releases.
Rules for sorting and containment of hazardous waste from mercury containing lamps and other mercury containing waste.</td></tr>
<tr><td>Directive 2008/105/EC of 16 December 2008 on environmental quality standards in the field of water policy (the Water framework Directive)

Implemented by Danish statutory orders:

Bekendtgørelse om miljøkvalitetskrav for vandområder og krav til udledning af forurenende stoffer til vandløb, søer eller havet
BEK nr 1022 af 25/08/2010

Bekendtgørelse om fastsættelse af miljømål for vandløb, søer, kystvande, overgangsvande og grundvand
BEK nr 1433 af 06/12/2009

Bekendtgørelse om</td><td>Mercury and its compounds are identified as priority hazardous substance in the Directive. Specific environmental quality standards (EQS) for mercury and its compounds . AA: annual average; MAC: maximum allowable concentration; Unit: µg/L:

<table><tr><th>AA-EQS (2) Inland surface waters (3)</th><th>AA-EQS (2) Other surface Waters</th><th>MAC-EQS (4) Inland surface waters (3)</th><th>MAC-EQS (4) Other surface waters</th></tr><tr><td>0.05 *1</td><td>0,05*1</td><td>0.07</td><td>0.07</td></tr></table>
AA: Annual average concentration; MAC: maximum allowable concentration. Note *1: If Member States do not apply EQS for biota they shall introduce stricter EQS for water in order to achieve the same level of protection as the EQS for biota set out in Article 3(2) of this Directive and they shall notify the Comission of the selected EQS and the reasons for its selection.

Member States may opt to apply EQS for sediment and/or biota instead of those laid down in Part A of Annex I in certain categories of surface water. Member States that apply this option shall apply, for mercury and its compounds, an EQS of 20 µg/kg [...], these EQS being for prey tissue (wet weight), choosing the most appropriate indicator from among fish, molluscs, crustaceans and other biota.

In the Danish statutory order "BEK nr 1022 af 25/08/2010", mercury is indicated as prioritised in EU policy in Annex 1 ("Bilag 1"). In Annex 3, giving EU-EQS's for surface waters, the general EQS for marine and freshwaters is 0.05 µg/l, and for short time 0.07 µg/l. For biota (the most suitable indicator species), the EQS is 20 µg/kg wet weight.

Stipulates the rules for establishment of reference conditions and environmental targets for surface water bodies. Indicates mercury as a substance for which establishment of threshold values should be considered.

Sets action levels by quality control and requirements regarding the quality of analyses.</td></tr>
</table>

Legal instrument*1	Requirements as concerns mercury (includes amendments to the parent instruments)
kvalitetskrav til miljømålinger **BEK nr 900 af 17/08/2011**	
Directive 2006/118/EC on the protection of groundwater against pollution and deterioration **Danish Statutory Order:** ***Bekendtgørelse nr 1434 af 06/12/2009 om overvågning af overfladevand, grundvand, beskyttede områder og om naturovervågning i internationale naturbeskyttelsesområder mv.***	Requires MS to consider establishing threshold values for groundwater. The provided "Minimum list of pollutants and their indicators for which Member States have to consider establishing threshold values in accordance with Article 3" includes mercury. Establish rules for monitoring of groundwater
Directive 2006/113/EC on the quality required of shellfish waters (codified version) **Danish Statutory Order:** ***Bekendtgørelse om kvalitetskrav for skaldyrvande*** **BEK nr 38 af 19/01/2011**	Sets quality values for shellfish waters for mercury and other substances
Bekendtgørelse af lov om beskyttelse af havmiljøet (Havmiljøloven) BEK nr 929 af 24/09/2009	Mercury and mercury compounds may only be found in insignificant amounts and concentrations in dredging material.
REGULATION ADDRESSING FOOD AND FEED	
Regulation (EC) No 1881/2006 setting maximum levels for certain contaminants in foodstuffs	Sets maximum levels for mercury in a number of aquatic foodstuffs and food supplements. Fishery products (26) and muscle meat of fish (24) (25), excluding species listed below. The maximum level for crustaceans applies to muscle meat from appendages and abdomen (44). In case of crabs and crab-like crustaceans (Brachyura and Anomura) it applies to muscle meat from appendages: 0.5 mg/kg wet weight. Muscle meat of the following fish (24) (25): 1 mg/kg wet weight: Muscle meat of the following fish (24) (25): anglerfish (*Lophius* species) Atlantic catfish (*Anarhichas lupus*) bonito (*Sarda sarda*) eel (*Anguilla* species) emperor, orange roughy, rosy soldierfish (*Hoplostethus* species) grenadier (*Coryphaenoides rupestris*) halibut (*Hippoglossus hipp*oglossus) kingklip (*Genypterus capensis*) marlin (*Makaira* species) megrim (*Lepidorhombus species*) mullet (*Mullus* species) pink cusk eel (*Genypterus blacodes*) pike (*Esox lucius*) plain bonito (*Orcynopsis unicolor*) poor cod (*Tricopterus minutes*) Portuguese dogfish (*Centroscymnus coelolepis*) rays (Raja species) redfish (*Sebastes marinus, S. mentella, S. viviparus*) sail fish (*Istiophorus platypterus*) scabbard fish (*Lepidopus caudatus, Aphanopus carbo*) seabream, pandora (*Pagellus* species) shark (all species) snake mackerel or butterfish (*Lepidocybium flavobrunneum*, *Ruvettus pretiosus, Gempylus serpens*) sturgeon (*Acipenser*

Legal instrument*1	**Requirements as concerns mercury (includes amendments to the parent instruments)**
	species) swordfish (*Xiphias gladius*) tuna (*Thunnus* species, *Euthynnus* species, *Katsuwonus* pelamis) Food supplements (39): 0,10 mg/kg wet weight
Directive 2002/32/EC on undesirable substances in animal feed as regards lead, fluorine and cadmium **Danish Statutory Order:** ***Bekendtgørelse om foder og foderstofvirksomheder*** **BEK nr 1360 af 15/12/2005 (with later amanedments)**	Sets maximum content of mercury in different types of feed stuff
Regulation 396/2005 of 23 February 2005 on maximum residue levels of pesticides in or on food and feed of plant and animal origin and amending Council Directive 91/414/EEC	The regulation sets maximum limits for pesticide (including mercury) concentrations in/on vegetable and animal food and feed.
REGULATION ADDRESSING THE WORKING ENVIRONMENT	
Directive 98/24/EC and amending Commission Directive 2000/39/EC on the protection of the health and safety of workers from the risks related to chemical agents at work, as amended with Directive 2009/161/EU of 17 December 2009 **Danish Statutory Order;** ***Bekendtgørelse om ændring af bekendtgørelse om grænseværdier for stoffer og materialer*** **BEK nr 1134 af 01/12/2011**	Establish indicative occupational exposure limits for chemical agents. Specific values for mercury are listed in Directive 2009/161/EU : Mercury and divalent inorganic mercury compounds including mercuric oxide and mercuric chloride (measured as mercury): 0,02 mg/m3. Limit values: Mercury and inorganic compounds, incl. vapour: 0.02 mg/m3 (as Hg) Alkylmercury compounds: 0.01 mg/m3 (as Hg) Other organic mercury compounds: 0.05 mg/m3 (as Hg)
Danish Statutory order: ***Bekendtgørelse om arbejde med stoffer og materialer med senere ændringer*** **BEK nr 292 af 26/04/2001**	This Statutory Order applies to any work with substances and materials, including their manufacture, use and handling. The Order demands the employer to ensure that dangerous substances and materials at the workplace are eliminated, replaced or reduced to a minimum.
Directive 2004/37/EF (Cancer Directive)	Methylmercury compounds and methylmercurychloride are covered.

Legal instrument*1	Requirements as concerns mercury (includes amendments to the parent instruments)
Danish Statutory Order; *Arbejdstilsynets kræftbekendtgørelse (Measures to protect workers from the risks related to exposure to carcinogenic substances and materials at work)* BEK nr 908 af 27 september 2005 and later amendments	
Danish Statutory Order; *Bekendtgørelse om unges arbejde* BEK 239 af 6. april 2005, implementing Directive 1994/33/EC	Young people below age 18 are not allowed to work with specified substances, including such that are covered by BEK nr 908 af 27 september 2005 with later amendments; i.e. including methylmercury compounds and methylmercurychloride
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	Article 4: Assessment and information: 1. For all activities liable to involve a specific risk of exposure to the agents, processes or working conditions of which a non-exhaustive list is given in Annex I, the employer shall assess the nature, degree and duration of exposure, in the undertaking and/or establishment concerned, of workers within the meaning of Article 2, either directly or by way of the protective and preventive services referred to in Article 7 of Directive 89/391/EEC, in order to: - assess any risks to the safety or health and any possible effect on the pregnancys or breastfeeding of workers within the meaning of Article 2; - decide what measures should be taken. Mercury and mercury compounds are on the list in the Directives Annex I.

*1 Un-official translation of name of Danish legal instruments.

2.1.2 Classification and labelling

Harmonised classification in the EU

Substances and mixtures placed on the market in EU shall be classified, labelled and packaged according to the CLP regulation (1272/2008/EC). According to Annex VI of the CLP regulation, mercury and all mercury compounds have a classification; either as specific for a number of individual substances, or as a general classification of "other inorganic mercury compounds" or of "other organic mercury compounds". An exception is mercuric sulphide (cinnabar), which - according to the annex - is not classified. The classification of mercury and mercury compounds is shown in Table 7 below.

TABLE 10
HARMONISED CLASSIFICATION ACCORDING TO ANNEX VI OF REGULATION (EC) NO 1272/2008 (CLP REGULATION)

Index No	International Chemical Identification	CAS No	Classification	
			Hazard Class and Category Code(s) *1	Hazard statement Code(s) *2

Index No	International Chemical Identification	CAS No	Classification	
			Hazard Class and Category Code(s) *1	Hazard statement Code(s) *2
080-001-00-0	Mercury	7439-97-6	Repr. 1B Acute Tox. 2 * STOT RE 1 Aquatic Acute 1 Aquatic Chronic 1	H360D*** H330 H372** H400 H410
080-002-00-6	Inorganic compounds of mercury with the exception of mercuric sulphide and those specified elsewhere in this Annex	-	Acute Tox. 2 * Acute Tox. 1 Acute Tox. 2 * STOT RE 2 * Aquatic Acute 1 Aquatic Chronic 1	H330 H310 H300 H373 ** H400 H410
080-003-00-1	Dimercury dichloride; mercurous chloride; calomel	10112-91-1	Acute Tox. 4 * Eye Irrit. 2 STOT SE 3 Skin Irrit. 2 Aquatic Acute 1 Aquatic Chronic 1	H302 H319 H335 H315 H400 H410
080-004-00-7	Organic compounds of mercury with the exception of those specified elsewhere in this Annex	-	Acute Tox. 2 * Acute Tox. 1 Acute Tox. 2 * STOT RE 2 * Aquatic Acute 1 Aquatic Chronic 1	H330 H310 H300 H373 ** H400 H410
080-005-00-2	Mercury difulminate; mercuric fulminate; fulminate of mercury	628-86-4	Unst. Expl. Acute Tox. 3 * Acute Tox. 3 * Acute Tox. 3 * STOT RE 2 * Aquatic Acute 1 Aquatic Chronic 1	H200 H331 H311 H301 H373 ** H400 H410
080-005-01-X	Mercury difulminate; mercuric fulminate; fulminate of mercury [≥ 20 % phlegmatiser]	628-86-4	Expl. 1.1 Acute Tox. 3 * Acute Tox. 3 * Acute Tox. 3 * STOT RE 2 * Aquatic Acute 1 Aquatic Chronic 1	H201 H331 H311 H301 H373 ** H400 H410
080-006-00-8	Dimercury dicyanide oxide; mercuric oxycyanide	1335-31-5	Expl. 1.1 Acute Tox. 3 * Acute Tox. 3 * Acute Tox. 3 * STOT RE 2 Aquatic Acute 1 Aquatic Chronic 1	H201 H331 H311 H301 H373** H400 H410

Index No	International Chemical Identification	CAS No	Classification	
			Hazard Class and Category Code(s) *1	Hazard statement Code(s) *2
080-007-00-3	Dimethylmercury; [1] diethylmercury [2]	593-74-8 [1] 627-44-1 [2]	Acute Tox. 2 * Acute Tox. 1 Acute Tox. 2 * STOT RE 2 * Aquatic Acute 1 Aquatic Chronic 1	H330 H310 H300 H373 ** H400 H410
080-008-00-9	phenylmercury nitrate; [1] phenylmercury hydroxide; [2] basic phenylmercury nitrate [3]	55-68-5 [1] 100-57-2 [2] 8003-05-2 [3]	Acute Tox. 3 * STOT RE 1 Skin Corr. 1B Aquatic Acute 1 Aquatic Chronic 1	H301 H372 ** H314 H400 H410
080-009-00-4	2-methoxy-ethylmercury chloride	123-88-6	Acute Tox. 3 * STOT RE 1 Skin Corr. 1B Aquatic Acute 1 Aquatic Chronic 1	H301 H372 ** H314 H400 H410
080-010-00-X	mercury dichloride; mercuric chloride	7487-94-7	Muta. 2 Repr. 2 Acute Tox. 2 * STOT RE 1 Skin Corr. 1B Aquatic Acute 1 Aquatic Chronic 1	H341 H361f*** H300 H372** H314 H400 H410
080-011-00-5	phenylmercury acetate	62-38-4	Acute Tox. 3 * STOT RE 1 Skin Corr. 1B Aquatic Acute 1 Aquatic Chronic 1	H301 H372 ** H314 H400 H410

1 Use of "" in connection with a hazard category (e.g. Acute Tox. 4 *) implies that the category stated shall be considered as a minimum classification.

*2 Use of "**" in connection with a hazard statement code (e.g. H373**) implies that the route of exposure is not specified.

*3 Use of "***" in connection with a hazard statement code (e.g. H373**) implies a hazard statement for reproductive toxicity.

Substances that have a harmonised classification as carcinogenic, mutagenic or reproductive toxicity in Cat 1A or 1B must not be used in substances or mixtures placed on the market for sale to the general public According to REACH Annex XVII. This is the case for elemental mercury, which, among others, is classified as Repr. 1B.

Self-classification

In the light of the full coverage of mercury and mercury compounds in the harmonised classification, no efforts were made here to describe any self-classifications made by industry.

2.1.3 REACH

This section concerns registration and pipeline activities under REACH, whereas existing regulations are included in Table 6 above.

Information on mercury compounds registered by ECHA

According to ECHA's list of registered chemical substances (downloadable xls format file, dated 13 June 2013; ECHA, 2013a), only one mercury substance is currently registered, namely elemental mercury.

An extract of ECHA's list of pre-registered substances (ECHA, 2013b) with all substance with the search string "mercu" in them, is shown in nnex 1.

102 pre-registered substances were due for registration 30 November 2010 (while elemental mercury was actually registered; ECHA, 2013b), whereas 86 pre-registered substances/mixes are due for registration by 31 May 2013, and 12 are due for registration by 31 May 2008.

According to ECHA, their database on registered substances should as of June 2013 include:

- Substances manufactured or imported at 100 tonnes or more per year (deadline 31st May 2013),
- Substances which are carcinogenic, mutagenic or toxic to reproduction with manufacture or import above 1 tonne per year (mercury and most of its compounds; deadline for registration was 30 November 2010).

Community Rolling Action Plan (CoRAP)

The Community Rolling Action Plan (CoRAP) is a tool for coordination of substance evaluation between EU member states, indicating when a given substance is expected to be evaluated and by whom (Appendix 1). As of march 2013 there are no mercury compounds in CoRAP.

Registry of Intentions

Table 8 shows Registry of Intentions by ECHA and Member States' authorities for Substances of Very High Concern (SVHC). It shows any intentions for introducing further restrictions on the import, use and marketing of mercury compounds, any harmonised classification and labelling proposals submitted for mercury compounds, and any intentions for proposing mercury compounds as Substances of Very High Concern (SVHC).

TABLE 11
MERCURY COMPOUNDS IN REGISTRY OF INTENTIONS (AS OF MARCH 2013)

Registry of:	CAS No	Substances	Scope (reproduced as indicated in the Registry of intentions)	Dossier intended by:	Expected date of submission:
Harmonised Classification and Labelling intentions					
Annex XV dossiers submitted	115-09-3	Methylmercuric chloride	Proposed classification according to DSD: Acute toxicity, Repeated dose toxicity, Carcinogenicity, Mutagenicity – Genetic toxicity, Toxicity to reproduction – fertility, Toxicity to reproduction – development, Toxicity to reproduction – Breastfed babies Proposed classification according to CLP: Acute	France	Submitted: 13/07/2011

			toxicity, Germ cell mutagenicity, Carcinogenicity, Reproductive toxicity, STOT-RE		
Withdrawn intentions					
Harmonised Classification and Labelling intentions	22967-92-6	Methylmercury			Notified: 03/03/2011 Withdrawn: 19/08/2011

Candidate list

As of March 2013, no mercury compounds have been included in the candidate list (ECHA, 2013c).

Annex XIV recommendations

According to the latest lists of Annex XIV recommendations (17 January 2013), no mercury compounds are included in the list.

2.1.4 Other legislation/initiatives

Revision of the Statutory order on mercury ("Kviksølvbekendgørelsen")

A proposal for update of the Statutory order no. 627 of 1 July 2003 on prohibition of import, sale and export of mercury and mercury-containing products (Bekendtgørelse om forbud mod import, salg og eksport af kviksølv og kviksølvholdige produkter, BEK nr 627 af 01/07/2003, as later amended) was submitted for public consultation in early 2013 (Consultation dissemination from the Danish EPA dated 13th February 2013). The proposed update specifies the exemptions for the use of dental amalgam further to certain situations.

The EU community strategy on mercury

The mercury strategy pinpoints in 20 prioritised actions the major remaining possibilities for reductions of mercury pollution, cutting supply and demand and protecting against exposure, especially to methylmercury found in fish. Among the actions, several pertain to the input to the process of creating a legally binding global treaty on mercury and otherwise supporting mercury reductions globally. The strategy can be considered a concise and ambitious plan for mercury policy in the Union (EC, 2005). In 2010, a review of the mercury strategy was published by the European Commission, and a communication was issued on the progress made (EC, 2010). The communication states that progress has been made on most actions of the strategy, while additional focus was needed in a few areas, for example as regards mercury emissions from large sources. To this end, the IED Directive (see Table 3) gives legal status to limit values and BAT described in the BREF notes for relevant industries, waste incineration and large combustion plants for which BAT conclusions are given explicitly.

Guideline on the use of dental fillings

In 2008, a guideline was issued by the Danish Health and Medicines Authority on the use of dental filling materials (VEJ nr 9670 af 30/09/2008). The guideline specifies in which situations composite fillings, amalgam and glasionomer fillings are to be used. It specifies that composite ("plastic") fillings can be used for all filling types, and that for new fillings, this material shall be the primary choice (except in cases where glasionomer is used). Dental amalgam can be used in staying molars in case where it is clear that this material will last longer. The case are limited to situations where, the cavity cannot be dried, where the access to the cavity is difficult, where the cavity is particularly large, or where there is a large distance to the next tooth. Glasionomer is recommended for a number of situations, including among others preliminary fillings and all fillings in milk teeth.

Contaminated sites

At present the Danish EPA is funding a project concerning mercury in soil with focus on investigations made on contaminated sites. The project is carried out together with two Danish regional authorities. The project gathers data and descriptions about mercury compounds, chemical reactions in soil, toxicity and limit values of mercury, a description of mercury-contaminated sites, and a description of analysis techniques in soil and remediation techniques. The project will be published at the Danish EPA's website (Danish EPA, 2013a).

Mercury-containing button cell batteries

According to the Danish EPA, the restrictions of mercury-containing button cell batteries will be tightened further in the EU Batteries Directive with a full ban on mercury-containing button cell batteries. The revision is expected to be published early 2014 and enter into force in 2015 (date not confirmed) (Danish EPA, 2013a).

2.2 International agreements

Table 9 gives an overview of how mercury and mercury compounds are addressed in the main international agreements relevant for Europe and globally. Mercury is on the OSPAR priority list with intentions of reducing discharges in order to reach near-background concentrations in the OSPAR maritime area (the North-East Atlantic), and mercury is also targeted in the HELCOM (Baltic Sea), Barcelona (Mediterranean Sea) and Bucharest (Black Sea) Conventions.

Mercury-containing waste is also addressed by the Basel Convention on the control of transboundary movements of hazardous wastes as well as by the Rotterdam Convention on prior informed consent (the PIC-procedure; implemented in the EU as Regulation (EC) No 689/2008 (see Table 3).

The main international development on mercury in the global context is however the resent creation of a global treaty on reduction of mercury pollution. The negotiations of the treaty were finalised in January 2013 and the treaty is expected to be opened for signature during 2013 in Minamata, Japan, the scene of one of the World's worst local pollution incidents caused by mercury. Accordingly, the treaty will be named the Minamata Convention.

TABLE 12
MAIN INTERNATIONAL AGREEMENTS ADDRESSING MERCURY AND MERCURY COMPOUNDS

Agreement	Substances	Requirements
Minamata Convention (negotiations finalised in January 2013, adoption expected in October 2013, entering into force when 50 countries have ratified the treaty)	Mercury and mercury compounds (with certain specifications)	The Convention (final draft from INC report, March 2013) includes provisions on: • Supply and trade of mercury: Dedicated mercury mining: No new facilities to be established; cessation of existing mining within 15 years from entering into force of the Convention. Retirement of excess mercury from decommissioned chlor-alkali facilities. Restrictions on export and import of mercury. Etc. • Mercury-added and products: Ban on the manufacture, import or export of mercury-added products listed, after specified dates, etc. Exemptions are allowed, required that the party submits specified documentation. • Manufacturing processes: Parties shall not allow mercury or mercury compounds in the manufacturing processes listed, after specified dates; etc. Exemptions are allowed, required that the party submits specified documentation. • Artisanal and small-scale gold mining: Parties shall reduce, and where feasible eliminate, the use of mercury in mining and processing; etc. • Emissions to the atmosphere: Set goals for mercury control, and where feasible, reductions, and where feasible adopt BAT/BEP for specified major Hg sources, establishment of a national release inventory, etc. • Releases to land and water from point sources not addressed in other provisions of the Convention : Take measures to control releases, establishment of a national release inventory, etc. • Environmentally sound intermediate and final storage of mercury and mercury containing waste, based on guidelines to be developed; etc. • Contaminated sites: Parties shall endeavour to develop strategies for identifying and assessing contaminated sites, based on guidelines to be developed, etc. • Financial resources and technical and implementation assistance • Capacity-building, technical assistance and technology transfer • Health aspects • Awareness-raising, research and monitoring, and communication of information • A number of administrative issues A number of specifications are still outstanding in the convention; issues which need to dealt with by the Conference of the Parties once the Convention has entered into force; these include, among others development of: • A guideline for national inventories of mercury emissions and releases • A guideline for interim storage of elemental mercury • Principles for monitoring the effect of the Convention

Agreement	Substances	Requirements
Convention on Long-range Transboundary Air Pollution (CLRTAP)	Mercury	The convention aims at reducing the emission of air pollutants, and promote multilateral cooperation in this respect. The emissions and long-range trans-boundary movements of pollutants are regularly quantified to monitor this work. The Convention has been extended by eight protocols, including the 1998 Aarhus Protocol on Heavy Metals, amended twice in 2012. The objective of the protocol is to reduce emissions of heavy metals caused by anthropogenic activities that are subject to long-range transboundary atmospheric transport and are likely to have significant adverse effects on human health or the environment. Each party shall reduce their atmospheric emissions relative to a selected reference year in the period 1985-1995, using measures stipulated in the protocol, or other measures with equal effect. The Protocal (2012 consolidated version) mentions specifically for mercury, among others: • Existing chlor-alkali plants using the mercury cell process shall convert to use of mercury free technology or close by 31 December 2020; during the period up until conversion the levels of mercury released by a plant into the air of 1 g per Mg2 chlorine production capacity apply. • New chlor-alkali plants are to be operated mercury free. • Limit value for mercury emissions for waste incineration: 0.05 mg/m^3. • Limit value for mercury emissions for co-incineration of waste in combustion plants and cement production facilities: 0.05 mg/m^3. • Limits for mercury contents in alkaline batteries (a) 0.05 % w/w in batteries for prolonged use in extreme conditions (e.g. temperature below 0° C or above 50° C, exposed to shocks); and (b) 0.025 per cent of mercury by weight in all other alkaline manganese batteries. • Management solutions for the primary mercury-added products.
Basel Convention	Mercury	Set out control measures of the movements of hazardous waste incl. of waste containing mercury between nations, and restricts transfer of hazardous waste from developed to less developed countries (LDC's; non adopted). The Convention also intends to minimize the amount and toxicity of wastes generated, to ensure their environmentally sound management as closely as possible to the source of generation, and to assist LDCs in environmentally sound management of the hazardous and other wastes they generate. A comprehensive guideline to safe mercury waste management was developed recently under auspices of the convention.
Rotterdam Convention	Mercury compounds, including inorganic mercury compounds, alkyl mercury compounds and alkyloxyalkyl and aryl mercury compounds (categorised as pesticides)	The Convention includes two key provisions, namely the Prior Informed Consent (PIC) Procedure and Information Exchange. The Prior Informed Consent (PIC) procedure is a mechanism for formally obtaining and disseminating the decisions of importing Parties as to whether they wish to receive future shipments of those chemicals listed in Annex III of the Convention and for ensuring compliance with these decisions by exporting Parties. Information Exchange: The Convention facilitates information exchange among Parties for a very broad range of potentially hazardous chemicals. The Convention requires each Party to notify the Secretariat when taking a domestic regulatory action to ban or severely restrict a chemical. The mercury compounds mentioned to the left are subject to the PIC procedure.

Agreement	Substances	Requirements
OSPAR Convention	Mercury	Included on the OSPAR list of priority substances. The Convention aims at preventing pollution of by continuously reducing discharges, emissions and losses of hazardous substances, with the ultimate aim to achieve concentrations in the OSPAR maritime area near background values for naturally occurring substances and close to zero for synthetic substances. Many decisions and recommendations were issued on mercury, and OSPAR has been a major driver in the promotion of reducing mercury releases in the region. Relevant recommendations include, among others: PARCOM Decision 90/3 of 14 June 1990 on reducing atmospheric emissions from existing chlor-alkali plants (setting limits for atmospheric emissions and recommending mercury cell closure or conversion by 2010).; and a number of older decisions on this sector. OSPAR Recommendation 2003/4 on Controlling the Dispersal of Mercury from Crematoria. PARCOM Decision 90/2 on Programmes and Measures for Mercury and Cadmium Containing Batteries (requires separate collection and disposal of mercury batteries and promotes recycling of batteries and use of mercury-free batteries) PARCOM Recommendation 93/2 on Further Restrictions on the Discharge of Mercury from Dentistry. PARCOM Recommendation 89/3 on Programmes and Measures for Reducing Mercury Discharges from Various Sources (recommending substitution and recycling of mercury for a range of intentional uses) PARCOM Recommendation 97/2 on Measures to be Taken to Prevent or Reduce Emissions of Heavy Metals and Persistent Organic Pollutants Due to Large Combustion Plants (> 50 MWth) (recommends use of best available technologies to minimize emissions)
HELCOM (Helsinki Convention)	Mercury	A number of recommendations pertaining to mercury has been adopted under the convention, including among others: Recommendation 23/4 Adopted 6 March 2002 recommends limit values to mercury contents in light sources. Recommendation 31E/2 adopted 20 May 2010 recommends bans on batteries containing mercury above certain concentrations, substitution, labelling and collection of used batteries containing mercury, collection targets for batteries with mercury, etc. Recommendation 23/6 Adopted 6 March 2002 on the reduction of emissions and discharges of mercury from chlor-alkali industry recommends limit values to mercury in releases and produced products. Recommendation 6/4 adopted 13 march 1985: Recommendation concerning measures aimed at the reduction of mercury resulting from dentistry.

2.3 Eco-labels

The use of mercury is generally prohibited or restricted in criteria for Eco-labels. In Appendix 3 an overview is provided on which product groups are covered by EU and Nordic eco-labelling schemes as regards mercury and mercury compounds. Mercury may either be restricted specifically, or by generic requirements prohibiting the use of PBT substances in certain types of products, materials and processes. Only the labels with mercury-specific restrictions are included in the Annex.

2.4 Summary and conclusions

Mercury has been a prioritised substance in Danish pollution abatement for several decades. Due to its well documented adverse environmental characteristics, mercury and its compounds are among the most regulated hazardous substances both nationally in Denmark, in the EU and in international conventions. This is also reflected by the fact that mercury is among the few substances which are, or are soon to be, regulated globally. Denmark and other Nordic countries have been among the main promoters behind the formation of strict regulation of mercury and its compounds in the EU and globally.

Mercury pollution to all environmental media is targeted by legislation, yet with most emphasis on the atmospheric releases due to mercury's ability for long-range transport and re-emission of mercury. The atmospheric component represents the fastest spreading of mercury pollution, yet mercury is also spread regionally with rivers and globally with ocean currents, the latter being a component which may warrant more attention in the future.

Denmark's ban on the marketing, import and export of mercury covers most intentional mercury uses, with exemptions for a number of mercury applications, partly such for which alternatives are not fully matured on the market (for example energy-saving lamps) and partly a number of uses for which exemptions are made in order to not impair trade among EU Member states. In the EU context, mercury is however also severely restricted, and with the dedicated focus of the Community mercury strategy, remaining intentional mercury uses may likely be further restricted as adequate alternatives for these are matured and accepted.

As regards other mercury source categories, than intentional uses mercury releases are also regulated to a varying extent. Waste incineration is regulated with an air emission limit in the Industrial Emissions Directive, and otherwise indirectly via facility-specific environmental permits which may also target releases to other media. Mercury releases to the atmosphere from coal combustion is addressed in Danish regulation indirectly only, in the form of a guideline on air emissions in environmental permits, which is to be considered in facility-specific environmental permits.

The negotiation of a global treaty - the Minamata Convention - on mercury was finalised in January 2013. The treaty is scheduled to be opened for signing during 2013. Mercury is also addressed by several existing international agreements addressing atmospheric emissions (CLRTAP), the marine environment (OSPAR, HELCOM, Barcelona, Bucharest), waste (Basel), and export of chemicals (Rotterdam).

3. Manufacture and uses

This section describes the most updated information available on manufacture and use of mercury compounds globally, in the EU and - as regards use - in Denmark. Very informative data are available for most parameters, but an updated assessment of the consumption of mercury and mercury compounds is not available. The latest of three substance flow assessments performed for mercury in Denmark is from 2004 and based on 2001-data. Based on the available data, an indication is however given of the recent developments.

3.1 Manufacturing

3.1.1 Manufacturing processes

Virgin mercury is produced from dedicated mercury mining, as a by-product of other non-ferrous metal mining and to a limited degree from natural gas production. Besides, mercury is marketed by some recycling facilities.

3.1.2 Manufacturing sites

No production of mercury or mercury compounds take place in Denmark.

In the EU, dedicated mercury mining is no longer practised; the world's formerly largest mercury mine was however located in Almadén, Spain. Production here ceased in 2004, after which the company has only marketed mercury from stocks of re-used/recycled mercury (primarily from shut down or converted chlor-alkali plants).

By-product mercury from some non-ferrous metal facilities in the EU has also been marketed, but with the 2011 regulation on a ban on mercury exports and safe storage of waste mercury (see Table 6), by-product mercury as well as mercury from dedicated mining is considered waste to be safely stored and may not be marketed in the EU or exported out of the EU. By-product mercury production in the EU from natural gas condensates are also covered by the regulation.

Recycled mercury is marketed by a number of companies in the EU. Since the 2011 EU mercury export ban, no exports out of the EU are allowed of elemental mercury, calomel and certain other mercury compounds included in the ban. Mercury and the mentioned mercury compounds produced in the EU may thus only be sold inside the EU. In the light of the EU export ban and safe storage regulation, some of the recycling companies are now developing and marketing services for immobilisation and final storage of obsolete mercury.

Various mercury compounds were in 2007 produced in the EU for example at their facility in Spain . It is unknown, if the absence of REACH registrations of mercury compounds (other than elemental mercury) is an indication as to whether production and marketing of these have ceased.

Globally, dedicated mercury mining is currently only on-going in Kyrgyzstan and China. By-product mercury is produced from many non-ferrous metal smelters globally, yet in smaller amounts per facility.

Statistics on production of mercury and mercury compounds (as such) in the EU
Data from Eurostat's Prodcom database on production in the EU is shown in Table 10. The data do not illuminate the supply situation on mercury in the EU, as the only available data are not specific to mercury.

TABLE 13
EU27 PRODUCTION OF MERCURY COMPOUNDS (EUROSTAT, 2013B)

PRODCOM Code	Text	Production, t/y	
		Average 2006-2010	2011
20132300	Alkali or alkaline-earth metals; rare-earth metals, scandium and yttrium; mercury	82,286	77,366
20135185	Colloidal precious metals; compounds and amalgams of precious metals (excluding silver nitrate)	No data in Prodcom	No data in Prodcom
20135270	Compounds, inorganic or organic, of mercury, excluding amalgams	No data in Prodcom	No data in Prodcom
20135290	Other inorganic compounds n.e.c.; amalgams (excluding distilled and conductivity water and water of similar purity, liquid air and compressed air, those of precious metals)	No data in Prodcom	No data in Prodcom

3.1.3 Manufacturing volumes
As mentioned, no production of mercury or mercury compounds take place in Denmark.

The overall mass balance for mercury in intentional uses in the EU was summarised for the year 2007 by Lassen, *et al.* (2008) as shown in Figure 1 below.

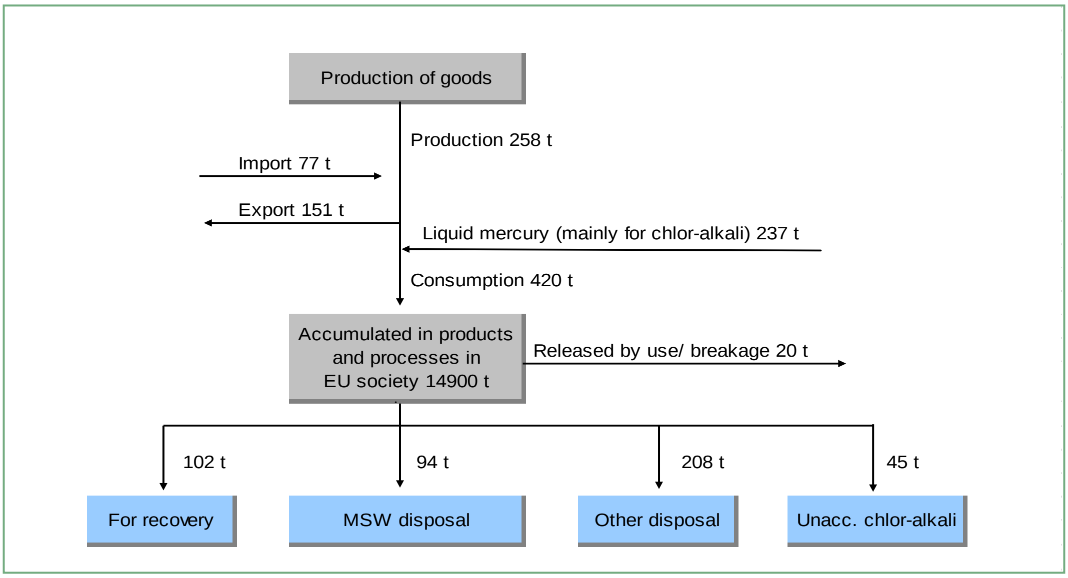


FIGURE 1
MERCURY MASS BALANCE FOR EU27+2 SOCIETY (MEDIUM ESTIMATES FOR 2007), ALL FIGURES IN TONNES/YEAR (FROM LASSEN *ET AL.*, 2008).

Global manufacture of mercury and mercury compounds

Estimates of global supply and demand of mercury for intentional uses have in the last decade or so been produced by Maxson of Concorde East/West. His latest estimates are shown in Table 11 below (Maxson, 2009 and 2013).

TABLE 14

ESTIMATES OF GLOBAL MERCURY SUPPLY BY MAIN SOURCES (MAXSON, 2009, 2013) [TABLE FORMAT CNJE]

Mercury supply, by main sources, t Hg/y	2007*1	2010**2
Primary mercury mining	1,300-1,600	1,200-1,600
By-product mercury from non-ferrous metal sector	400-600	500-700
Recycling/re-use from chlor-alkali facilities	700-900	600-800
Recycling of mercury from catalysts, production wastes, tailings and products	600-800	1,000-1,300
Commercially available mercury stocks	As needed (+)	??
Total	3,000-3,900+	3,300-4,400

Note *1: As estimated by Maxson (2009). Recent updates for mercury demand for ASGM indicate that the total mercury supply may be higher. *2: Updated, rough estimate for 2010 (Maxson, 2013, personal communication).

No global numbers on the manufacture of mercury compounds have been identified. The major mercury compound produced is no doubt calomel (Hg_2Cl_2, also known as mercurous chloride), because this is produced as a by-product from flue gas cleaning in non-ferrous metal production (notably zinc production). Most of the marketed calomel is however used for production of elemental mercury.

3.2 Import and export

3.2.1 Import and export of mercury and mercury compounds (on their own) in Denmark

Mercury and mercury compounds are not manufactured in Denmark. Based on previous national mercury mass balances (see below), only a minor import and export of mercury (probably within 100-200 kg) and mercury substances would be expected to take place. Besides these, import and export of some article types with these substances take place.

Statistical data from Statistics Denmark (DST, 2013) and Eurostat are presented in Table **12**. The data from Statistics Denmark look unlikely based on experience on the issue. Statistics Denmark was contacted and data were corrected, yet the import for code numbers 28521000 and 28529000 still looks unlikely high. As shown, Eurostat data on the same commodities are not in accordance. The data should likely be considered as unreliable. The reason is unknown, but may be erroneous reporting by importers. Less likely, but not to be ruled out fully, they may indicate unexpected trade in mercury with Denmark for uses exempted in the Danish mercury ban order, or illegal trade.

TABLE 15
DANISH IMPORT AND EXPORT OF MERCURY AND MERCURY COMPOUNDS (STATISTICS DENMARK AND EUROSTAT TRADE DATABASES ACCESSED IN 2013).

CN code	Text	Source	Import, tonnes/year		Export, tonnes/year	
			Average 2007-2011	2012	Average 2007-2011	2012
28054010	Mercury - In flasks of a net content of 34.5 kg (standard weight), of a fob value, per flask, not exceeding € 224	Statistics Denmark	0.067	0.002	0.064	0.84
		EUROSTAT	Av. of 2007 and 2011: 0.1	NA	0.1	0.8
28054090	Mercury - Other	Statistics Denmark	0.15	0.017	0.454	0.003
		EUROSTAT	0	0	2007: 2.2	NA
28520000 *1	Inorganic or organic compounds of mercury, whether or not chemically defined, excluding amalgams	EUROSTAT	2007: 0 2008: 0 2010: 10	NA	2007-09: 5.6	NA
28521000 *1	Inorganic or organic compounds of mercury, whether or not chemically defined, excluding amalgams - Chemically defined	Statistics Denmark	0	106.3	0	1.09
28529000 *1	Inorganic or organic compounds of mercury, whether or not chemically defined, excluding amalgams - Other	Statistics Denmark	0	53.3	0	41.5

Note: *1: Codes 28521000 and 28529000 are not recorded as such in EUROSTAT statistics, so these numbers from Statistics Denmark should be summed and compared to the overall code 28520000 in EUROSTAT data.

According to Statistics Denmark, the biggest imports and exports of mercury and compounds to and from Denmark come from/go to Germany, France, Netherlands, Sweden and Finland.

3.2.2 Import and export of mercury and mercury compounds in the EU

Available data on EU external trade in tonnes of mercury and mercury compounds (as such) is shown in Table 13. The data indicate that the mercury trade in and out of the EU has been quite extensive up till 2010, where the EU mercury export ban was entering into force. This was expected, as a major surplus of mercury was build up from decommissioned or converted mercury cell chlor-alkali production facilities. The average export in the years 2006-2012 more than equals the estimated total global demand for mercury.

TABLE 16
EU27 EXTERNAL IMPORT AND EXPORT OF MERCURY AND ITS COMPOUNDS (EUROSTAT, 2012A)

CN code	Text	Import, t/y		Export, t/y	
		Average 2006-2011	2012	Average 2006-2011	2012
28054010	Mercury - In flasks of a net content of 34,5 kg (standard weight), of a fob value, per flask, not exceeding € 224	11.3	N.A.	241.5	0.9
28054090	Mercury - Other	207.9	27.7	416.2	20.3
28521000	Inorganic or organic compounds of mercury, whether or not chemically defined, excluding amalgams - Chemically defined	N.A.	3.1	N.A.	114.3
28529000	Inorganic or organic compounds of mercury, whether or not chemically defined, excluding amalgams - Other	N.A.	35.5	N.A.	45.2
85063000	Mercuric oxide	261.2	270.1	31.1	12.3

N.A. - Not available

3.3 Uses

3.3.1 Use, and trends in use, of mercury and mercury compounds in Denmark

No recent aggregated surveys of mercury consumption are available for Denmark. The latest detailed consumption data from the 2001 mercury mass flow analysis (Christensen *et al.*, 2004) are shown in Table 14 below, along with consumption assessment results from the older substance flow assessments for 1982/83 and 1992/93 (Maag *et al.*, 1996). As shown, the major intentional use in 2000/01 was dental amalgam, with light sources and batteries as runner-ups. This is likely the picture today also, though probably with smaller consumption for at least dental amalgam and batteries, due to the severe restrictions on these uses in Denmark. While light sources may on average contain lowers amounts of mercury per lamp today than in 2001, the sales of energy saving bulbs (also Called CFLs, compact fluorescent lamps) is expected to have increased significantly and the total mercury consumption with light sources may thus have increased.

The table also shows that very significant reductions of the mercury consumption were achieved even prior to 2001. In fact, the consumption with intentional mercury uses was in 2001 reduced to about 10% of the level in 1983, or from 16 to 1.6 tonnes/year, whereas the mercury input to Danish society as impurities in materials was on about the same level, with coal for energy production and various high-volume materials as the main contributors.

TABLE 17
END USES OF MERCURY IN DENMARK IN 2000/01 AND HISTORICAL DEVELOPMENT SINCE 1992/93 AND 1982/83

Application	1982/83*1 kg Hg/y	1992/93*1 kg Hg/y	2000/01*1 kg Hg/y
Mercury (intentional uses)			
Dental fillings	3,100	1,800	1,100-1,300
Light sources	140	170	60-170
Switches, contacts and relays	160-520	200-400	0-20
Clinical thermometers	750	50	1.1
Other thermometers	1,300-1,800	100	15-20
Other measuring and control equipment	430-630	500	10-50
Chlor-alkali production	3,000	2,500	-
Other uses as a metal	-	-	40-60
Chemical compounds (intentional uses)			
Mercury-oxide batteries	2,400	280-430	0.5-0.6
Other batteries	2,300	120-430	70-150
Laboratory chemicals	500	60-120	30-70
Medical applications	-	-	0-1
Other chemical applications	1,050-1,900	<50	5-50
Total, intentional uses	**15,100-17,000**	**5,800-6,600**	**1,300-1,900**
As impurity*1			
Coal	1,000-2,000	500-1,300	600-1,000
Oil products	<50	2-34	2-30
Natural gas	-	-	0,4-3
Biological fuels	-	30-45	18-80
Cement	10-80	60-220	30-70
Agricultural lime, fertilizer and feeding stuffs	20-130	<50	11-40
Foodstuffs	-	<50	10-20
All other goods	30-600	70-1,400	94-1,900
Total, impurities	1,100-2,900	660-3,100	760-3,100
Total (rounded)	**16,200-19,900**	**6,400-9,600**	**2,100-5,000**

Notes: *1: Data source for historical data (Christensen et al., 2004).

*2: The Danish substance flow assessments for mercury (and other elements) include mercury inputs to the biosphere with trace concentrations in high-volume materials (natural impurities, or a result of previous human mercury releases). Similar data are generally not available from most other data sources on mercury inputs to society.

Data from the Danish Product Register

The Danish Product Register includes substances and mixtures used occupationally and which contain at least one substance classified as dangerous in a concentration of at least 0.1% on 1%, depending on the classification of the substance. Of the mercury compounds, all are classified as dangerous and should thus be registered. For substances included in mixtures used for formulation of other mixtures in Denmark, the quantities may be double-counted as both the raw material and the final mixture may be registered (provided both are marketed in Denmark). As stated above, the amounts registered are for occupational use only, but for substances used for the manufacture of mixtures in Denmark, the data may still indicate the quantities of the substances in the finished products placed on the market both for professional and consumer applications.
Laboratory chemicals may be purchased on the Internet and such single item impact is likely not registered anywhere.

A search in the Product Register for mercury and all the mercury compounds listen in Table 20 (deep) below (most of the major mercury compounds believed to be used in the EU) was performed by the Danish Working Environment Authority for the Danish EPA for use in this study.

Only four of these more than 50 substances were registered in the Product Register, and among these only two in a number of products and by a number of companies enabling public reporting. Consumption (demand) in terms of substance amounts are reported in Table 15. Note that (neodecanoato-o)phenyl-mercury is one of the phenyl-mercury compounds used as PUR elastomer catalysts for which marketing in articles is restricted as of 10 October 2017 (Regulation No 848/2012 amending the REACH Regulation).

As shown in Table 16, only one application had significant number of hits for public reporting: Paints, lacquers and varnishes, where mercury compounds most likely act as a catalyst or an in-can preservative.

While the self-reporting under the Product Register cannot be expected to provide a precise picture of the consumption of mercury and mercury compounds in Denmark, those data support other indications that the consumption of these substances in pure form, or as mixtures, is minimal in Denmark today.

TABLE 18
MERCURY COMPOUNDS IN MIXTURES PLACED ON THE DANISH MARKET IN 2012 AS REGISTERED IN THE DANISH PRODUCT REGISTER

CAS No	Chemical name	No of mixtures/companies	Registered tonnage, kg/y		
			Production + import	Export	Consumption
7439-97-6	Mercury	59/13	0-0.06	0-0.01	0-0.05
26545-49-3	Mercury, (neodecanoato-o)phenyl-	4/3	14.1	2.7	11.4

TABLE 19
CONSUMPTION OF MERCURY COMPOUNDS REGISTERED IN THE DANISH PRODUCT REGISTER, 2012

Application area	Consumption (production + import – export)	
	Prod./ Comp.*1	kg/y
Paints, lacquers and varnishes	45/9	0-0.04

*1: number of products and companies registered.

Thimerosal/Thiomersal

The consumption of mercury with the mercury compound and preservative Thimerosal (also calledThiomersal; CAS no 54-64-8) in Denmark has not been big in recent decades. However, according to Vaccineinfo.dk, http://vaccineinfo.dk/index.php?option=com_content&task=view&id=576&Itemid=28, thimerosal use in child vaccines stopped in Denmark in 1992, and was by April 2011 also no longer used in influenza vaccines in Denmark. It was however used in the H1N1 vaccines in 2009 due to lack of availability of vaccines on an overheated marked at that time, which also was discussed in the Danish parliament (http://www.ft.dk/samling/20081/almdel/mpu/spm/695/svar/647790/735950/index.htm).

New data on dental amalgam fillings

The Danish Health and Medicines Authority has supplied new data on the number of amalgam fillings made in Denmark by private dental clinics over the last years for this study (data on publicly subsidised fillings). In addition to private clinics, a limited number of adults are treated in public dental clinics (1%) for which there are no aggregated data. The Danish Health and Medicines Authority considers amalgam fully substituted in school clinics (has also been banned since 2003 in milk teeth.

Three different size categories are applied, 1, 2 and 3 surface fillings, where 3 are the largest and often most complicated fillings. Based on detailed Danish studies (Maag et al., 1996, and Skårup et al., 2003), on average 0.4g of mercury is used per surface, of which about 60% stays in the tooth and the rest is waste from the fillings process. Combining these data with the data on numbers of fillings made per year yields the mercury consumption for dental fillings shown in Table 17. Figure 2 shows the development in number of 1, 2 and 3 surface fillings made in the same period. As shown, the number of amalgam fillings has declined steadily in the period. It should be noted that the majority of the decline in amalgam use was seen before 2007. Most amalgam fillings made where 3 surface fillings (of which some are exempted in the Danish mercury ban order), but also a significant number of fillings of presumably less complicated nature were made with amalgam.

TABLE 20
MERCURY DEMAND FOR AMALGAM FILLINGS IN DENMARK 2007-2012 (DANISH HEALTH AND MEDICINES AUTHORITY, 2013).

Mercury consumption	Hg demand, kg/filling	Annual mercury demand with amalgam, kg					
year		2007	2008	2009	2010	2011	2012
1 surface fillings	0,0004	50	41	22	19	17	14
2 surface fillings	0,0008	102	83	45	40	35	30
3 surface fillings	0,0012	305	247	134	117	102	89
Total		457	371	201	176	154	133

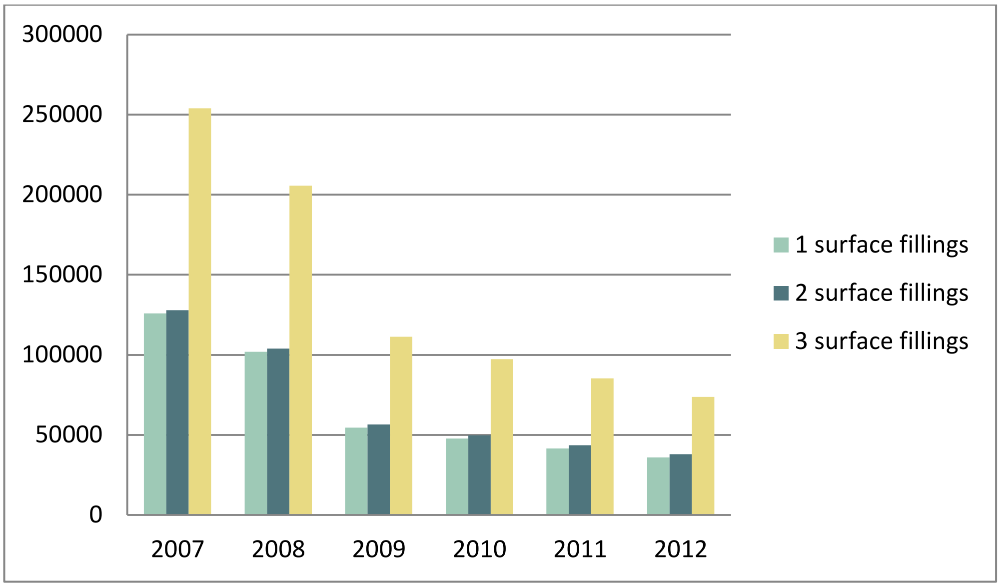


FIGURE 2
NUMBER OF AMALGAM FILLINGS MADE IN PRIVATE CLINICS IN DENMARK BY SIZE (DANISH HEALTH AND MEDICINES AUTHORITY, 2013)

Laboratory uses

As alternatives have been available for most uses for 1-2 decades and most uses are regulated, laboratory use is expected to be minimal and limited to standards for calibration and certain analytical uses exempted in the Danish mercury ban order. A recent survey (Lassen *et al.*, 2008) highlighted that porosimetry (measurement of pore characteristics in solid materials) constitute asignificant mercury consumption in the EU, which has so far not been quantified for Denmark. Porosimetry is known to be used regularly in Denmark in measurements on industrial ceramics, etc.. According to Lassen et al. (2008), a consumption of some 12-240 kg Hg/y is roughly estimated by suppliers of porosimetry equipment.

Current consumption

Table 18 below shows mercury consumption (demand) data from 2001 (Christensen et al., 2004) along with new data for dental amalgam from this study. For other mercury sources indicative expert estimates are given based on information on the current status of regulation of the mercury sources in question.

TABLE 21
MERCURY CONSUMPTION (DEMAND) DATA FROM 2001 AND INDICATIVE EXPERT ESTIMATES FOR 2013 CONSUMPTION.

Application	2000/01 kg Hg/y	Notes on consumption /presence today	2013 consumption, kg Hg/year *1
Mercury (intentional uses)			
Dental fillings	1,100-1,300	Yes but at lower rates, see text	130-150
Light sources	60-170	Increasing due to climate campaigns; substitutes (LED) are gaining ground in more uses	100-300
Switches, contacts and relays	0-20	Likely but minimal; is exempted from ban	0-10
Clinical thermometers	1.1	Banned in DK	0-1
Other thermometers	15-20	Banned with some exemptions	0-20
Other measuring and control equipment	10-50	Banned with some exemptions	0-30
Chlor-alkali production	-	Not present in DK; not BAT according to IE Directive/BREF note	0
Other uses as a metal	40-60	Laboratory uses, see text	50-250
Mercury compounds (intentional use)			
Mercury-oxide batteries	0.5-0.6	No, regulated and substituted	0
Other batteries	70-150	Certain button cell types yes, alternatives on the market. Others no, regulated and substituted	0-100
Laboratory chemicals	30-70	Limited, see text below	30-70
Medical applications	0-1	Limited	0-1
Other chemical applications	5-50	Limited, see text	10-30
Total, intentional uses (rounded)	**1,300-1,900**		**300-1000**
Mercury input as impurities			
Coal	600-1,000	Yes	NAI*2
Oil products	2-30	Yes	NAI
Natural gas	0,4-3	Yes	NAI
Biological fuels	18-80	Yes	NAI
Cement	30-70	Yes	NAI
Agricultural lime, fertilizer and feeding stuffs	11-40	Yes	NAI
Foodstuffs	10-20	Yes	NAI
All other goods	94-1,900	Yes	NAI
Total, impurities	**760-3,100**		**NAI**
Total (rounded)	**2,100-5,000**		**NAI**

Note to table 18: *1: Rough estimates based on limited data and background knowledge only. *2: NAI = No aggregated information.

3.3.2 Use of mercury and mercury compounds in the EU

The newest aggregated and detailed assessment of production and consumption of mercury (and its compounds) in the EU is the European Commission report "Options for reducing mercury use in products and applications, and the fate of mercury already circulating in society"(Lassen *et al.*, 2008). Consumption data from this study are shown in Table 19. Note that this study was performed prior to the entering into force of the restrictions of the marketing of certain measuring instruments for private use. This study mentions chlor-alkali production[1], dental amalgam and chemicals/miscellaneous as major application categories, which is deemed still to be the case.

Table 34 (deep) below shows Maxson's (2012) latest estimate of mercury consumption (including mercury compounds) for major product uses in the world including the EU. He also assessed dental amalgam and "other uses" as the major application areas, which seems reasonable considering that most other product use categories mentioned are severely restricted in the EU.

[1] Chlor-alkali production is still a major Hg-consuming sector in the EU in contrast to the rest of the World, where this technology is less used. Closures and conversions are however also ongoing in the EU, and the industry has voluntarily committed to cease mercury use before 2020.

TABLE 22
MERCURY CONSUMPTION IN INDUSTRIAL PROCESSES AND PRODUCTS IN THE EU IN 2007 (LASSEN *ET AL.*, 2008)

Application area	Mercury consumption, t/y	Percentage, of total
Chlor-alkali production *1	**160 - 190**	**41.2**
Light sources	**11 - 15**	**3.1**
Fluorescent tubes	3.3 - 4.5	0.9
Compact fluorescent tubes	1.9 - 2.6	0.5
HID lamps	1.1 - 1.5	0.3
Other lamps (non electronics)	1.6 - 2.1	0.4
Lamps in electronics	3.5 - 4.5	0.9
Batteries	**7 - 25**	**3.8**
Mercury button cells	0.3 - 0.8	0.1
General purpose batteries	5 - 7	1.4
Mercury oxide batteries	2 - 17	2.2
Dental amalgams	**90 - 110**	**23.5**
Pre-measured capsules	63 - 77	16.5
Liquid mercury	27 - 33	7.1
Measuring equipment	**7 - 17**	**2.8**
Medical thermometers	1 - 3	0.5
Other mercury-in-glass thermometers	0.6 - 1.2	0.2
Thermometers with dial	0.1 - 0.3	0
Manometers	0.03 - 0.3	0.04
Barometers	2 - 5	0.82
Sphygmomanometers	3 - 6	1.1
Hygrometers	0.01 - 0.1	0.01
Tensiometers	0.01 - 0.1	0.01
Gyrocompasses	0.005 - 0.025	0.004
Reference electrodes	0.005 - 0.015	0.002
Hanging drop electrodes	0.1 - 0.5	0.1
Other uses	0.01 - 0.1	0.01
Switches, relays, etc.	**0.3 - 0.8**	**0.1**
Tilt switches for all applications	0.3 - 0.5	0.09
Thermoregulators	0.005 - 0.05	0.01
Read relays and switches	0.025 - 0.05	0.01
Other switches and relays	0.01 - 0.15	0.02
Chemicals	**28 - 59**	**10.2**

Application area	Mercury consumption, t/y	Percentage, of total
Chemical intermediate and catalyst (excl PU) *2	10 - 20	3.5
Catalyst in polyurethane (PU) production	20 - 35	6.5
Laboratories and pharmaceutical industry	3 - 10	1.5
Preservatives in vaccines and cosmetics	0.1 - 0.5	0.1
Preservatives in paints	4 - 10	1.6
Disinfectant	1 - 2	0.4
Other applications as chemical	0 - 1	0.1
Miscellaneous uses	**15 - 114**	**15.2**
Porosimetry and pycnometry	10 - 100	12.9
Conductors in seam welding machines (mainly maintenance)	0.2 - 0.5	0.1
Mercury slip rings	0.1 - 1	0.1
Maintenance of lighthouses	0.8 - 3	0.4
Maintenance of bearings	0.05 - 0.5	0.1
Gold production (illegal)	3 - 6	1.1
Other applications	0.5 - 3	0.4
Total (round) ‘2	**320 - 530**	**100**

Notes: *1: Represents the amount added each year to the cells including of which a part is recycled internally within the plants.*2 In order to avoid double counting, the mercury used as chemical intermediates and catalysts (excluding PU elastomers) is not included when calculating the total.

Further on mercury compounds in the EU

According to Lassen *et al.* (2008), well over 100 mercury compounds were marketed in the EU in 2007 (e.g. Chemos 2008). 41 of these compounds were selected for further investigation by Lassen et al., and actual sale on the EU market was confirmed by the industry for more than 75% of these selected compounds. In addition, there were significant imports and exports of mercury compounds between EU and non-EU countries.

The main EU applications of mercury compounds in 2007 were (Lassen *et al.*, 2008):

- Production of batteries or parts of batteries;
- Production of reference electrodes;
- Catalyst in production of polyurethanes;
- Chemical intermediate in the pharmaceutical industry;
- Chemical intermediate for production of other mercury compounds;
- Laboratory chemical reagents for COD analyses and a number of analyses in the medical and food sector;
- Mercury standards for calibration;
- Preservative in vaccines, eye/nasal preparations;
- Preservative and fungicide in paints;
- Disinfection of medical equipment and process equipment;
- Disinfectants for veterinary uses;
- Pigment for artwork and restoration.

Lassen et al. (2008) also investigated the consumption of the selected 41 mercury chemicals in the EU.

Table 20 below summarises the available information on the consumption of mercury chemicals in the EU in 2007, based on data from a limited number of relevant European mercury chemicals suppliers (see reference for details). Eight compounds are indicated to be used in the EU in quantities above 0.5 tonnes (indicated in bold in the table): Mercury-I-chloride, mercury-II-chloride, mercury-II-oxide, phenylmercury acetate, phenylmercury neodecanoate, phenylmercury octoate, phenylmercury-2-ethylhexanoate and mercurochrome.

SPIN search for Nordic countries

A search was conducted for this study in the Nordic product database SPIN (www.spin.net) using the partial name "mercu" as the search string. 5 of the substances quantified by Lassen *et al.* (2008) as used in the EU in quantities above 0.5 tonnes were also registered in SPIN, while 13 mercury compounds registered in SPIN was indicated as with lower consumption by Lassen *et al.*, and 5 mercury compounds registered in SPIN were not among the 41 mercury compounds studied by in that EU study. The results of the search in SPIN are summarized in Table 20 (for substances indicated as with major consumption by Lassen et al., 20089) and Table 21 (for other substances).

Besides these mercury compounds, elemental mercury was registered in SPIN with many potential uses and an indication of probably risk via all three exposure routes listed in SPIN (see table notes). However, most of the substances considered with lower volume or not included in Lassen *et al.*'s list (in the table below) do not have indications of number of applications or risk of exposure in SPIN (only 5 have any such indications). This could either be due to confidentiality issues (less than 3 companies registered), or because such information has not been registered originally by the companies marketing the products in question.

TABLE 23
MERCURY COMPOUNDS MARKETED IN THE EU AND THEIR MAIN APPLICATIONS. MARKET VOLUME AS ESTIMATED BY MAJOR SUPPLIERS OF MERCURY CHEMICALS IN 2007 (LASSEN *ET AL.*, 2008) AND RESULTS OF THE SPIN SEARCH PERFORMED FOR THIS STUDY.

Hg compound	CAS number	SPIN details*1	Hg content	Main applications in the EU	EU market 2006 in tonnes compound						
					~ 0	<0.01	0.01-0.1	0.1-0.5	0.5-5	5-15	>15
Inorganic compounds:											
Mercury-II-bromide	7789-47-1	NA	56	Laboratory analyses		x					
Mercury-I-chloride, mercurous chloride	10112-91-1		85	Medicine, acousto-optical filters, used as a standard in electrochemistry, agricultural chemical, insecticide, fungicide						x	
Mercury-II-chloride, mercuric chloride	7487-94-7	NA	74	Pharmaceutical industry, disinfectant, preservative, metallurgy, chemical intermediate							x
Mercury-II-cyanide	592-04-1		80	Pharmaceutical, germicidal soaps, photography and in making cyanogen gas		x					
Mercury-I-fluoride	13967-25-4		91		x						
Mercury-II-fluoride	7783-39-3		84		x						
Mercury iodide	7783-30-4	NA	61	Disinfectant soaps				x			
Mercury-I-iodide	15385-57-6		61	Topical disinfectant, bactericide	x						
Mercury-II-iodide, red – mercuric iodide	7774-29-0	NA	44	Pharmaceutical industry, Laboratory analyses							
Mercury-I-nitrate, mercurous nitrate	10415-75-5 14836-60-3		76	Laboratory analyses: Millon's Protein Test Reagent		x					
Mercury-II-nitrate, mercuric nitrate	10045-94-0	NA	62	Laboratory analyses		x					

Hg compound	CAS number	SPIN details*1	Hg content	Main applications in the EU	EU market 2006 in tonnes compound						
					~ 0	<0.01	0.01-0.1	0.1-0.5	0.5-5	5-15	>15
Mercury oxycyanide	1335-31-5		86	Disinfectant		x					
Mercury-II-oxide mercuric oxide	21908-53-2	NA	93	Batteries, cosmetics, paint pigment, perfumes, pharmaceuticals, polishing compounds, fungicides, chemical intermediate						x	
Mercury-II-sulfate, mercuric sulfate	7783-35-9	1-3 SE2010	68	Laboratory analyses: COD analysis, Kjeldahl method, pharmaceutical industry				x			
Mercury-II-sulfide, cinnabar, red mercury sulphide	1344-48-5	1-3 NO2009, waw	86	Pharmaceutical industry, artistic paints			x				
Mercury-II-thiocyanate	592-85-8	NA	63	Pharmaceutical industry, photography				x			
Mercury-I-perchlorate	65202-12-2		67	Chemical intermediate							
Mercury-II-perchlorate	7616-83-3		50	Chemical intermediate							
Mercury potassium iodide	7783-33-7		26	Laboratory: Nessler's reagent			x				
Mercury II selenide	20601-83-6		72		x						
Mercury silver iodide	7784-03-4		22	Disinfectant	x						
Mercury II telluride	12068-90-5		61	Semiconductors	x						
Mercury fulminate	628-86-4		70	Explosives, detonators	x						
Mercury-II-hydride	72172-67-9		99	Chemical intermediate	x						
Organic compounds:											

Hg compound	CAS number	SPIN details*1	Hg content	Main applications in the EU	EU market 2006 in tonnes compound						
					~ 0	<0.01	0.01-0.1	0.1-0.5	0.5-5	5-15	>15
Mercury-II-acetate	1600-27-7	NA	63	Pharmaceutical industry							
Mercury-II-ammonium chloride, ammoniated mercury	10124-48-8		80	Pharmaceutical industry				x exp.			
Phenylmercury acetate	62-38-4	1-3 DK2010: occxx, NO	60	Fungal control (e.g. paints, building materials), catalyst for polyurethane production							x
Phenylmercuric borate	102-98-7		59	Pharmaceutical industry		x					
Diphenylmercury	587-85-9		57	Pharmaceutical industry, catalyst for isocyanate-hydroxyl reactions		x					
Phenylmercury neodecanoate	26545-49-3	11-31 DK2010: wawxx, conx, occxxx, NO, SE	45	Catalyst in polyurethane elastomers							x
Phenylmercury nitrate	55-68-5	NA	59	Pharmaceutical industry		x					
Phenylmercury-II-nitrate	8003-05-2	NA	67	Pharmaceutical industry							
Phenylmercury oleate	104-60-9	NA	36								
Phenylmercury octoate	7439-98-7		?	Bactericide, fungicide, polyurethane catalyst					x		
Diethyl mercury	627-44-1		78	Laboratory analyses		x					
Dimethylmercury	593-74-8		87	Laboratory analyses, toxicology, calibration, antifungal agents, insecticides		x					

Hg compound	CAS number	SPIN details*1	Hg content	Main applications in the EU	EU market 2006 in tonnes compound						
					~ 0	<0.01	0.01-0.1	0.1-0.5	0.5-5	5-15	>15
Phenylmercuric propionate	103-27-5	1-3 DK2010: occxx	57	Catalyst in polyurethane elastomers							
Thimerosal, thiomersal, merthiolate	54-64-8	1-3 SE2010: wawx, conx, occxx	50	Preservative in vaccines, drops and ointments for eyes, in blood plasmas, in veterinary medicine and for antiseptic surgical dressing				x			
Mercurochrome, merbromin, mercury dibromofluorescein	129-16-8		27	Disinfecting, antiseptic, pharmaceutical industry					x		
Mercury methanesulfonate	29526-41-8		68								
Phenylmercuric 2-ethylhexanoate	13302-00-6		58	Bactericide, fungicide in paints [+PU catalyst according to KLIF, 2010]							

Note to table above: *1: SPIN details: NA = not available. Other data in sequence used: 1) Number of applications registered 2) in the country and year mentioned after; and 3) indicator for possible exposure: waw = via waste water, con = for consumers, occ = via occupational exposure. The suffixes x,xx, xxx indicates the probability of exposure via the route with: x = "One of several uses indicate a potential exposure"; xx = "One or several uses indicate a probable exposure"; xxx = "One or several uses indicate a very probable exposure".

TABLE 24
OTHER MERCURY COMPOUNDS (AND MERCURY) REGISTRED IN SPIN OR MENTIONED BY KLIF (2010) OR ECHA'S REGISTRY OF INTENTIONS.

Hg compound	CAS number	SPIN details*1	Applications in the EU	Reference
Mercury, chlorophenyl-	100-56-1	1-3 SE2009	NA	SPIN
MERCURY, HYDROXYPHENYL-	100-57-2	NA	NA	SPIN
Mercury	7439-97-6	11-32 DK2010: wawxxx, conxxx, occxxx ,NO,SE	NA	SPIN
nitric acid, mercury(2+) salt, monohydrate	7783-34-8	NA	NA	SPIN
Mercury, [.mu.-[(oxydi-2,1-ethanediyl 1,2-benzenedicarboxylato)(2-)]]diphenyl-	94070-93-6	NA	NA	SPIN
Acetic acid, mercury salt (KVIKSØLVACETAT (USPEC.))	592-63-2	NA	NA	SPIN
Phenylmercuric octanoate	13864-38-5		PU catalyst	Klif (2010)
Methylmercuric chloride	115-09-3		NA (natural reaction product)	ECHA's Registry of intentions (March, 2013)

Note to table above: *1: SPIN details: NA = not available. Other data in sequence used: 1) Number of applications registered 2) in the country and year mentioned after; and 3) indicator for possible exposure: waw = via waste water, con = for consumers, occ = via occupational exposure. The suffixes x,xx, xxx indicates the probability of exposure via the route with: x = "One of several uses indicate a potential exposure"; xx = "One or several uses indicate a probable exposure"; xxx = "One or several uses indicate a very probable exposure".

3.3.3 Global use of mercury and mercury compounds

Maxson (2012) produced updates of the best available estimates of the global consumption of mercury with products distributed on main product uses and regions for the Technical Background report for the report "Global Mercury Assessment 2013 - Sources, Emissions, Releases and Environmental Transport" (UNEP/AMAP, 2013). These consumption estimates are shown in Table 22 below. As shown, the major product uses are dental fillings, batteries and "other uses" with each around 300 tonnes of consumption annually. The reference indicates that measuring devices may be underestimated. Note that the globally major uses of metallic mercury, such as ASGM, chlor-alkali production and VCM production are not included in this list.

TABLE 25
ESTIMATES OF THE GLOBAL CONSUMPTION OF MERCURY WITH PRODUCTS 2010 DISTRIBUTED ON MAIN PRODUCT USES AND REGIONS (MAXSON, 2012)

Region	Batte-ries	Mea-suring devices	Lamps	Elec-trical devices	Other use *1	Dental fillings	Total
Average, t							
East and Southeast Asia	191	98	42	50	56	67	504
South Asia	26	27	13	18	21	24	129
European Union (27 countries)	23	15	18	2	105	90	253
CIS and other European countries	7	17	7	10	12	10	63
Middle Eastern States	5	13	6	7	6	16	53
North Africa	2	5	2	4	2	5	20
Sub-Saharan Africa	4	9	4	6	5	6	34
North America	11	34	15	43	76	34	213
Central America and the Caribbean	4	10	4	5	7	17	47
South America	16	18	10	10	13	33	100
Australia New Zealand and Oceania	2	4	2	3	2	4	17
Total	291 (230-350)	250 (219-280)	123 (105-135)	158 (140-170)	305 (222-389)	306 (270-341)	1433 (1186-1664)

Notes: *1 The 'other use' category includes, for example, pesticides, fungicides, laboratory chemicals, polyurethane elastomers, pharmaceuticals, preservative in paints, traditional medicines, cultural and ritual uses, cosmetics – especially skin-lightening creams, etc.

3.4 Summary and conclusions on manufacture and uses

Neither mercury, nor any mercury compounds are manufactured in Denmark. Manufacturing in the EU is now limited to recycling of mercury, as all other EU sources of supply have been banned.

The Danish consumption of mercury declined with 90% already in the period 1993-2001 due to a prioritised strategy from Denmark's side. Restrictions on mercury use were introduced even before the first general mercury ban in 1994. At the same time, a change in technology occurred from manual, mercury-filled instruments to mercury-free digital solutions with more functionalities, which also helped reduce the consumption.

A search for mercury and mercury compounds in the Danish Product Register, registering products aimed at professional users, did only show the use of elemental mercury and 4 mercury compounds, and in amounts in the range of a few kilograms per year. Similarly, a search in the Nordic chemicals database SPIN only gave few hits. This is in harmony with the absence of mercury compounds registered under REACH for the EU (elemental mercury is however registered).

Statistics on the import and export of mercury (as such) were retracted, but are much too high for being correct based on all other information available; most likely the data reflect erroneous data reporting. If this should be the case, they indicate a most unusual import of around 300 tonnes/year in 2012, for which the use cannot be accounted.

No recent aggregated surveys of mercury consumption are available for Denmark. The latest detailed consumption data are from the report Mercury mass flow analysis 2001 (Christensen *et al.*, 2004). Table 18 above shows mercury consumption (demand) data from 2001 along with new data for dental amalgam from this study. For other mercury sources indicative expert estimates are given based on information on the current status of regulation of the mercury sources in question, as well as other background knowledge.

4. Waste management

As noted above, mercury is persistent and toxic no matter what chemical form it is in. Mercury once brought into the biosphere, for intentional use or as trace pollutant, thus needs to be managed to reduce or avoid adverse impacts on humans and the environment. In Denmark and the EU, waste fractions containing mercury is therefore categorized as hazardous waste needing special collection and treatment. According to Directive 1999/31/EC on the landfill of waste, a maximum content of mercury at 1 mg/kg TS is allowable in waste to be disposed in regular waste deposits.

4.1 Waste from production processes and industrial use of mercury and mercury compounds

As mercury and mercury compounds are only used in insignificant amounts industrially in Denmark, the amounts of currently generated waste with problematic mercury concentrations from industrial use are expected to be absolutely minimal. As mentioned above, mercury and mercury compounds are not manufactured in Denmark.

Minimal waste amounts with elevated mercury concentrations may still be generated from laboratory use (which can also be from industries). As alternatives have been available for most uses for 1-2 decades, even laboratory use is expected to be minimal and limited to standards for calibration and certain analytical uses exempted in the Danish mercury ban order. A recent survey (Lassen *et al.*, 2008) highlighted that porosimetry (measurement of pore characteristics in solid materials) constitutes a significant mercury consumption in the EU, which has so far not been quantified fully for Denmark. Porosimetry is known to be used regularly in Denmark in measurements on industrial ceramics, etc. According to Lassen et al, (2008), a rough estimate of 12-240 kg Hg/y is used in Denmark. Laboratory waste is generally subject to strict hazardous waste collection in Denmark. Porosimetry is not covered in recent REACH amendment regulating professional use of mercury in measuring and control equipment.

Some types of industrial waste may likely still occasionally have elevated mercury concentrations due to the disposal of older equipment and materials. A recent quantification of mercury in waste has not been made, but indications of upper limits for such amounts (for the society as a whole, not only industrial) are indicated by the national mercury mass balance numbers from 2001 shown in Section 3.3.1.

Fly ash and flue gas cleaning products from coal fired **power plants** contain mercury and will continue to do so. The mercury amounts in the solid residues will increase with any improvements in mercury capture from the flue gas (improved filters) and will be reduced with higher energy contributions from renewable energy sources like wind power and solar energy. Solid residues from power plants in Denmark are mainly used in construction work (mainly slag) and in cement production (fly ash; Danish Energy Association, 2013). From coal combustion, the mercury amounts in slag are generally small; most of the mercury is emitted to the air or retained in solid residues from desulphurization (including gypsum construction boards) and in fly ash.

As shown in Table 27 in Section 5, a total turnover (with releases and output materials) of 260-420 kg/y of mercury was estimated for Danish power production in 2001. Assuming that a similar amount is fed into the system with fuels today (may be slightly less with today's fuels), and considering that some 100-150 kg mercury per year are emitted to the atmosphere (see Table 26), some 150-300 kg of mercury is transferred to cement production, gypsum board production and construction works annually.

In **cement production**, filter dust is generally fed back into the klinker kiln, but regular purging may be necessary as mercury will otherwise not be retained and emission thresholds may be passed. The purging of mercury containing filter dust may either be to the marketed cement (mixed into the final product) or when concentrations are too high, to waste deposition (UNEP, 2013).

4.2 Waste products from the use of mercury and mercury compounds in mixtures and articles

The remaining product uses of mercury and mercury compounds are the following. Mercury concentration by product weight is indicated for uses with data available.

TABLE 26
SOURCES OF CURRENT GENERATION OF MERCURY CONTAINING WASTE IN DENMARK

Product	Mercury concentration (Source for numbers: UNEP, 2013, others: background knowledge)	Fate of waste	Expected trend in amounts of waste
Dental amalgam	Ca. 50% mercury in pure fillings, moderate (but significant) concentrations in amalgam separator sludge, medium concentrations in chair-side strainers and lost teeth)	Most is properly disposed as hazardous waste, but teeth and fillings lost outside dental clinics are disposed to municipal waste or lost diffusely in society/nature	Most reduction has been achieved already, slow future decline
Fluorescent lamps, double end	0.01 - 0.025% mercury	Collected and treated as waste electrical and electronic equipment (WEEE) but many may be lost to municipal waste and incinerated	Increase due to climate campaign
CFLs = "energy saving bulbs"	0.01 -0.02% mercury	Collected and treated as waste electrical and electronic equipment (WEEE) but many may be lost to municipal waste and incinerated	Increase due to climate campaign
Some specialised discharge lamps (professional use)	>0.025% mercury	Most expected to be collected and treated as waste electrical and electronic equipment (WEEE)	Decrease due to climate campaign and LED substitution
Button-cell batteries	Zinc-air: 1.2% mercury Alkaline: 0.5% Silver oxide: 0.4%	Collected and treated as hazardous waste but many are lost to municipal waste and incinerated	Decrease due to substitution
Certain types of polyurethane elastomer products (low in	Moderate but significant concentrations	Likely lost to municipal and industrial waste	Marketing to stop in a few years. Decrease due to adopted regulation

Product	Mercury concentration (Source for numbers: UNEP, 2013, others: background knowledge)	Fate of waste	Expected trend in amounts of waste
amounts)			
U-tube type blood pressure gauges from hospitals and health clinics (professional uses)	>50% mercury	Most expected to be collected and treated as hazardous waste	Marketing to stop in 2017. Decrease due to adopted regulation
Fever thermometers from hospitals and health clinics (professional uses)	25% mercury	Most expected to be collected and treated as hazardous waste	Marketing to stop in 2014. Decrease due to adopted regulation
Porosimetry	Relatively high concentrations (likely above 25% mercury)	Most expected to be collected and treated as hazardous waste or recycled via equipment supplier	Use is driven by analysis standards and available alternatives do not measure exactly the same characteristics. Use is therefore expected to continue unless regulation pressure drives development towards the use of new standards for the measurement of porosity in materials

Many mercury containing products has a significant life span, and on top of that, some are the types of technical products which private users tend to hoard before disposing them. It has thus earlier been observed that some product types still appear in the waste stream more than a decade after cessation of their use (Christensen *et al.*, 2004). Special collection schemes and filters capturing mercury in **waste incineration** flue gasses will thus still be necessary for decades after a potential total cessation of intentional mercury use. Mercury containing products are subject to special collection and treatment in Denmark. Surveys of for example NiCd batteries have indicated, however, that substantial amounts are not collected, but are lost to the municipal waste stream, meaning mainly to waste incineration. As stated by ECHA (2010; citing Lassen et al.,2008) for the EU situation, collection efficiencies of mercury in accordance with requirements set out in the hazardous waste legislation are estimated to be as low as approximately 20% for mercury containing measuring devices and collection efficiencies above 50% should in general not be expected.

Similarly, current use of dental amalgam contributes to the mercury concentrations in **sewage sludge**, but now in smaller amounts yearly, due to the decline in the mercury consumption with dental fillings and a large coverage of amalgam separators in the dental clinics. Old filling material accumulated in the sewers probably still has significant contributions to mercury releases to sewage water and sewage sludge. The sludge is used as agricultural fertiliser, incinerated or deposited on landfills depending on local facility configurations and mercury concentration in the sludge. Only sludge with mercury concentration under a specific threshold may be used on agricultural land (see Section 2).

Other waste materials also contain mercury in trace concentrations (with natural and unintentional man-made origin), and mercury from this kind of sources will continue to be led to the waste stream.

The concentrations of mercury in flue gas and other **outputs from waste incineration** are only measured sporadically (typically as stipulated in their environmental permits), and do thus only mirror the background input and releases of mercury from bulk materials, and not any peaks from the incineration of mercury-added products. Continuous mercury measurement in the flue gas has however been implemented recently on at least one Danish waste incineration plant (Lisbjerg, Aarhus). With mercury being less common in the waste stream, mercury inputs and emissions will to a higher extent be episodic. No recent quantifications of the mercury mass balance in waste management in Denmark have been identified. Solid filter residues from waste incineration – containing most of the mercury not emitted - are exported for controlled deposition in Norway, whereas slag is used for road construction and similar purposes. As shown in Table 27 in Section 5, an estimated 2,000-2,900 kg/y of mercury in solid residues from Danish waste incineration activity was deposited in 2001. Similar or perhaps slightly lower mercury amounts are expected to be deposited today.

By way of example, Vestforbrænding, a major waste incineration facility in the capital region, reported average mercury concentrations in slag (sampled after 3 months of outdoor storage) of 0.022-0.092 mg/kg in the years 2010-2012. All slag was re-used (purpose not stated). Solid residues from flue gas cleaning were exported for controlled deposition in Norway. Mercury concentrations in this waste fraction were not measured as there were no legal demands for this (Vestforbrænding, 2013).

Waste fractions with high mercury concentrations (dental amalgam waste, some mercury-added products) are exported from Denmark for safe storage in old salt mines or for recycling, as Denmark does not have national facilities for this.

An indicative draft from the national database on import and export of waste with contents of mercury was prepared by the Danish EPA for this study. For the used data search combination, an export of 1.02 and 0.563 tonnes/year of dental amalgam waste was reported for 2011 and 2012, respectively, whereas the export of so-called “mixed mercury waste” was 4.063 and 1.707 tonnes/year for the same years. It should be noted that these numbers may underestimate the actual amounts exported, as the waste categorisation used in the data search does not ensure a full coverage. A full quantification of all mercury-containing waste can be made with the system, should the need arise. The data search also showed export of sulphur waste (probably from flue gas cleaning) and import (probably for re-export) of “mercury waste residues” (Danish EPA, 2013b).

Recycling and final storage

In Europe, there has been a move from recycling towards final deposition of mercury containing waste. This is due to an excess of mercury on the global market, rendering mercury available at relatively low prices and thus motivating for continued usage in regions of the world where mercury is less strictly regulated. For pure or almost pure mercury and some inorganic mercury compounds, provisions for safe storage and a ban of export has entered into force in the EU with export ban and safe storage regulation (see section on regulation above). This trend is expected to become global in the near future, as the Minamata Convention includes similar provisions on supply and storage, as well as other provisions for mercury containing waste (as does the EU legislation).

In the light of the declining consumption and the EU export ban and safe storage regulation, some of the recycling companies are now developing and marketing services for immobilisation and final storage of obsolete mercury. However, recycling (except from chlor-alkali facilities) and import are the only remaining legal sources of mercury supply in the European Union.

4.1 Release of mercury from waste disposal

As mentioned above, no recent quantifications of mercury releases to all environmental media from waste disposal have been made. See however the latest available quantification (2001, from Christensen *et al.*, 2004) in Section 5.3.1. The official reporting of mercury releases from waste incineration is included in the "energy production" category in Table 25 in Section 5.3.1. Expected trends in mercury inputs to waste (equaling total releases) are described above.

4.2 Summary and conclusions for waste management

Mercury is persistent and toxic no matter what chemical form it is in. Mercury once brought into the biosphere, for intentional use or as trace pollutant, thus needs to be managed to reduce or avoid adverse impacts on humans and the environment. In Denmark and the EU, waste fractions containing mercury is therefore categorized as hazardous waste needing special collection and treatment. Up till recently, recycling has been the preferred option for mercury waste, likely for the general waste hierarchy, but as the demand for mercury for intentional use has decreased in developed countries over the last decades, the priority for high-concentration mercury waste is now turning towards environmentally safe final deposition.

New generation of mercury waste is likely dominated by solid wastes from power plants, which are mainly re-used in construction works. Among intentional uses of mercury, the main sources of new generation of mercury waste are deemed to be:

- Dental amalgam
- Fluorescent lamps including CFLs and some specialised discharge lamps
- Button-cell batteries
- Certain types of polyurethane elastomer products (low in amounts)
- U-tube type blood pressure gauges from professional uses (hospitals, clinics, etc.)

While some sectors have strict procedures for special collection of hazardous waste, consumers have been observed to have difficulties in, or lack motivation, for waste separation, and high collection rates have been difficult to achieve. Accordingly, a substantial fraction of the mercury waste disposed of must still be expected to be lost to municipal waste incineration.

Many mercury containing products has a significant life span, and on top of that, some are the types of technical products which private users tend to hoard before disposing them. It has thus earlier been observed that some product types still appear in the waste stream more than a decade after cessation of their use. Special collection schemes and filters capturing mercury in waste incineration flue gasses will thus still be necessary for decades after a potential total cessation of intentional mercury use.

5. Environmental effects and exposure

5.1 Environmental hazard

5.1.1 Classification

Elemental mercury and all mercury compounds except mercuric sulphide (cinnabar) have the classification Aquatic Acute 1, Aquatic Chronic 1 with the hazard statements H400, H410, according to Annex VI of Regulation (EC) No 1272/2008 (CLP Regulation).

These classifications apply to substances that are ”very toxic to aquatic life” (H400), i.e. exert 50 % acutely lethal or other significant toxic effects (LC50/EC50) on fish, crustacean or algae/aquatic plants at concentrations below 1 mg/l (Acute Category 1), or are “very toxic to aquatic life with long lasting effects” (H410). I.e. in addition to the high acute toxicity mercury (compounds) are not rapidly degradable in the aquatic environment and they have a potential for bioaccumulation (bioconcentration factor (BCF) >500 in fish or log Kow ≥4) (Chronic Category 1).

5.1.2 Environmental effects

Aquatic environment

Inorganic forms of mercury, including elemental mercury, are dominant in the aquatic environment. However, the focus of the environmental concern pertaining to mercury has been on the organic mercury substances, above all methylmercury (MeHg), as these substances are generally more toxic to living organisms than the inorganic forms and, further, may accumulate to high levels in fish, (marine) mammals and birds via marine food webs (AMAP, 2011; UNEP, 2013). Bioconcentration factors (BCF) in fish of several thousands have been reported for methylmercury and it is found that methylmercury can account for more than 95 % of the total body burden in fish (ECHA, 2011b).

Although the acute and chronic toxicities of methylmercury to fish are high, the direct exposure of fish to this form of mercury in the water column is apparently not of serious concern to adult fish where the accumulation is rather due to the intake via food. Early life stages of fish (embryos, larvae) do, however, appear to be more sensitive to direct exposure to waterborne methylmercury (ECHA 2011b, quoting UNEP 2002).

According to UNEP’s Global Mercury Assessment (cfr. ECHA 2011b) there is only very limited data on acute/short term effects in crustaceans and other aquatic invertebrates but indications are that larval stages may typically be 100 times more sensitive to mercury than adult life stages. Typical larval stage EC50 values could be around 10 µg/L. A chronic NOEC for survival of *D. magna* exposed to methyl mercuric chloride was reported at 0.26 µg/L with a corresponding NOEC for reproduction at 0.04 µg/L (ECHA, 2011b). Older studies with the same substance using the eastern oyster (*Crassostrea virginica*) as test organism are not considered suitable for use in risk assessment.

Among algae and aquatic plants, the most sensitive endpoint reported by ECHA (2011b) was a 14 day NOEC = 1 µg/L for the marine macrophyte oarweed (*Laminaria saccharina*). A NOEC of 0.2

µg/L has been reported for bacteria exposed to organic mercury while for inorganic mercury an average NOEC = 11 µg/L was calculated.

ECHA (2011b) summarizes the most important ecotoxicological endpoints for methylmercury in the aquatic environment as shown in Table 24.

TABLE 27
SUMMARY OF MOST IMPORTANT ECOTOXICOLOGICAL ENDPOINT FOR METHYLMERCURY (MEHG) IN THE AQUATIC ENVIRONMENT (SOURCE: ECHA, 2011B).

	Species	Value (µg/L)	Remarks
Acute toxicity (MeHg)	Rainbow trout (*Onchorhynchus mykiss*)	5.0	96 h LC50
Chronic toxicity (MeHg)	Brook trout (*Salvelinus fontinalis*)	0.08	248 d NOEC, growth of larvae
Chronic toxicity (methyl mercuric chloride)	Water flea (*Daphnia magna*)	0.26/0.04 (as Hg)	NOEC, survival/reproduction, respectively
Chronic toxicity (MeHg)	Tubellarian flatworm (*Dugesia dorotocephala*)	0.03	14 d NOEC, fissioning and neurotoxic effects
Short term toxicity (MeHg)	Marine macrophyte, oarweed (*Laminaria saccharina*)	1	14 d NOEC, development of zoospores, growth of sporophytes.

For another organomercury compound such as phenylmercury acetate (PMA) acute toxicities (LC50/EC50) down to 8.6 µg/L for fish (rainbow trout fingerlings; *O. mykiss*) have been reported in ECHA (2011b) together with a chronic NOEC for growth at 0.11 µg/L for *O. mykiss* and 1.12 µg/L for survival of *Daphnia magna*. So PMA is also to be considered very toxic to aquatic organisms.

Soil/terrestrial environment
In the soil environment the common form of mercury is Hg (II) while methylmercury normally only occurs in low percentages (0.5-1.5 %). Earthworms are considered an ecologically important group of organisms and as they typically constitute over 90 % of the invertebrate biomass in soil, they are considered appropriate for assessment of bioaccumulation in terrestrial food webs. In a study with *Eisenia fetida* the biota-soil accumulation factors (BSAF) were in the range 0.6 – 3.3 for total mercury while for methylmercury BASFs ranged from 175 to 249 (ECHA, 2011b). It was found that direct exposure through soil was more important for the uptake than ingestion of food.

An LD50 = 2.39 ppm was found when the earthworm *Ocotchaetus pattoni* was exposed for 10 days to mercury chloride. In a 21 day study with the earthworm *Eisenia fetida* a NOEC (reproduction) = 10 mg Hg/kg dw was calculated. Effect concentrations on springtails (*Collembola*) were approximately at the same order of magnitude (ECHA, 2011b).

Historically, a number of organic mercury salts have been used as active ingredients in e.g. seed dressings for cereals to prevent deterioration by undesired microorganisms (primarily fungal diseases) but also for other types of control of bacteria and fungi. E.g. phenylmercury acetate (PMA) has been shown to be toxic to soil microorganisms and completely inhibiting bacteria populations at a concentration of 25 mg PMA/kg soil up to 33 days after treatment (ECHA, 2011b).

Many seabirds feeding on fish and shellfish etc. often contain high concentrations of mercury. Field observations of certain fish-eating predatory birds (sea eagle, fish eagle) indicate that intoxications and reproductive impairment occurred when the birds had fed on fish containing 0.2 – 0.2 mg/kg of methylmercury (ECHA, 2011b). Birds and terrestrial mammals not feeding on fish or other aquatic organisms appear to be less exposed to mercury via the food chain.

5.2 Environmental fate

Being an element, mercury cannot be degraded by natural processes, but only transformed between different chemicals forms and physical states. Mercury once released to the environment thus persists there and is only gradually demobilised by absorption to other persistent materials and through burial in deep sea sediments. As described elsewhere, present day releases of mercury in Denmark are much lower than just 2 or 3 decades ago, and while local new mercury releases contribute to mercury's impacts today, the legacy of mercury releases from former decades still have their consequences today. Another significant and continuing input of mercury to the Danish environment is mercury travelling with the atmosphere from around the globe.

Mercury released to the atmospheric environment is deposited via wet and dry deposition on vegetation, soil and water surfaces. Elemental mercury can travel in the range of thousands of kilometres with the air masses before being deposited, whereas oxidised mercury has a higher affinity for adsorption on other materials and dilution in precipitation water and aerosols, and is thus generally deposited within a range of hundreds of kilometres from the emission source.

Mercury once deposited on solid surfaces can be re-emitted to the atmosphere. This happens by natural processes, due to mercury's low boiling point, and is also enhanced by human activity such as the use of bio-fuels, changes in land-use and as a consequence of global warming. Re-emission prolongs the travelling distances of mercury and makes it a truly global pollutant.

When mercury is discharged to aquatic environments, some of it is adsorbed to organic matter and certain inorganic materials, and will precipitate to the sediments, while a minor part stay in the diluted phase. Biological and physical processes in the sediment may however re-mobilise the mercury to the water phase. In large rivers, mercury is transported over transnational distances, and to the marine environment, where it can be transported globally by the ocean currents (UNEP, 2013). Discharges of mercury to the aquatic environment are not well reported in an international/global context, and their importance may likely be underestimated. For the Danish situation, discharges with wastewater to the aquatic environment are however monitored as part of the national environmental surveillance programme, NOVANA.

In the aquatic (sediments) and terrestrial environments, elemental mercury is transformed by natural microbial processes to the more toxic organic mercury compound methylmercury (MeHg), in particular under anoxic/anaerobic conditions. The same happens in landfills in their methane producing phase. The toxic effects of methylmercury are the key endpoints in both the human and environmental toxicity of mercury and its compounds.

Further aggravating the impacts of mercury, methylmercury is heavily bio-accumulated and bio-magnified in the aquatic environment, producing methylmercury concentrations in top predators which are toxic to both humans (eating tooth whales, seals, etc.) and to the top predators themselves, as observed in the hatching pattern and behavioural changes in birds feeding on aquatic foods (UNEP, 2002).

In soil, mercury has a relatively strong affinity to organic matter, yet in an equilibrium with the air and water phases, which means that mercury once deposited or disposed is subject to possible further transport in the biosphere. Immobilisation of mercury waste is therefore very important in order to prevent further spreading and exposure.

5.2.1 Long range transport and mercury and mercury compounds in the Arctic Environment

Besides the general transport mechanisms of mercury in the environment mentioned above, special mechanisms accumulate mercury to a higher degree than average in the polar environments, where the cold climate and specific chemical processes linked to prevailing atmospheric conditions enhance mercury deposit on snow and ice and ultimately into the aquatic environment. This, in combination with the high bio-magnification of methyl-mercury in the polar aquatic environment, results in higher than average exposure of wildlife and indigenous populations on traditional hunter/fisherman's diets, in spite of the few local mercury release sources (AMAP, 2011).

As all other countries, also territorial Denmark receives mercury deposition from remote sources due to global transport of mercury. This global transport has been one of the main reasons for the Nordic and European countries' continued focus on mercury, even after many national mercury sources have been reduced or eliminated, a key reason for these countries' support for the creation of a global treaty on mercury, the Minamata Convention.

5.3 Environmental exposure

5.3.1 Sources of release emissions to the environment in Denmark

DCE (formerly NERI/DMU; 2012) annually produces national estimates of atmospheric emissions of various priority pollutants, including mercury, for Denmark's reporting to international fora. In the case of mercury the estimates are submitted to the UNECE under the Convention on Long-range Transboundary Air Pollution (CLRTAP). The estimates are based on the use of activity rate data (such as coal consumption) and emission factors. The official time series of thus estimated emissions from 1990, including the latest available aggregated estimates for mercury from 2012 are listed in Table 25 below.

It should be noted that waste incineration is categorised under energy industries, and that the emissions categorised under waste are primarily originating from crematoria (from the use of dental amalgam). Non-industrial combustion is dominated by wood combustion in residential facilities. The fluctuations in emissions from industrial processes owe to the shut-down in 2002 followed by re-opening and a second shut-down in 2005 of the only Danish electro-steelwork (DCE, 2012).

These estimates should likely be considered incomplete, as they do not include all release source categories. For the sources included, however, a clear trend towards lower emissions can be observed. Total quantified releases in 2010 were only 14% of those in 1990 according to these estimates.

TABLE 28

OFFICIALLY REPORTED ESTIMATES OF ATMOSPHERIC EMISSIONS FROM SELECTED MAJOR SOURCES IN DENMARK (DCE, 2012).

Hg, kilogramme	Energy Industries	Manufacturing Industries and Construction	Transport	Non-industrial Combustion	Industrial Processes	Waste	Total
1990	2469	193	30	179	145	47	3062
1991	2551	219	31	184	144	47	3176
1992	2291	212	33	167	144	48	2895
1993	2208	220	33	153	155	50	2819
1994	1964	210	34	145	168	49	2570
1995	1763	200	34	127	174	50	2348
1996	1842	209	36	110	162	50	2409
1997	1370	226	37	95	93	50	1870
1998	1151	228	35	65	70	48	1598
1999	992	210	34	84	59	50	1429
2000	596	210	33	66	99	48	1051
2001	514	209	32	57	193	48	1053
2002	526	200	33	70	8	49	886
2003	548	201	33	77	18	49	925
2004	390	223	33	84	19	48	798
2005	385	208	33	60	81	47	815
2006	334	215	34	54	19	48	703
2007	306	220	35	54	21	48	683
2008	340	188	34	52	19	48	681
2009	262	128	32	40	11	48	522
2010	240	56	32	48	15	48	440

Estimated mercury releases from specific major power plants in Denmark in 2010-2012 were reported by the Danish Energy Association (2013) for this study. They are shown in Table 26. The estimates are based on calculations in the "EMOK" model using standard values for mercury concentrations in fuels and standard retention rates for mercury in air pollution abatement systems. According to the association, the atmospheric emissions have been reduced due to improved filters for acid gas removal with co-benefit mercury release reductions. The planned increase in the use of biofuels in the coming years is expected to lower mercury emissions further, states the association. It can be added that the increasing reliance on wind power will likely also reduce mercury releases from the sector.

TABLE 29
ESTIMATED ATMOSPHERIC MERCURY RELEASES FROM SPECIFIC MAJOR POWER PLANTS IN DENMARK IN 2010-2012 (DANISH ENERGY ASSOCIATION (2013).

Hg emission kg/y	2012	2011	2010
Asnæs blok 2	9,87	4,36	4,74
Asnæs blok 5*	0,37	11,36	11,91
Asnæs total	10,2	15,7	16,6
Avedøreværket blok 1	4,54	7,48	7,32
Avedøreværket biokedel	0,128	0,13	0,21
Avedøreværket blok 2	4,00	2,83	3,07
Avedøreværket total	8,7	10,4	10,6
Enstedværket biokedel	0,12	0,14	0,20
Enstedværket blok 3	2,61	10,90	14,50
Enstedværket total	2,7	11,0	14,7
Esbjergværket	10,01	15,78	10,68
Skærbækværket	0,00	0,02	0,00
Studstrupværket blok 3	5,7	6,4	12,2
Studstrupværket blok 4	15,3	8,6	6,4
Studstrupværket total	20,9	15,0	18,6
Kyndbyværket	0,21	0,24	0,26
HC Ørstedværket	0,05	0,04	0,08
Svanemølleværket	0,00	0,54	0,87
Herningværket biokedel	0,15	0,05	0,03
Måbjerg	9,36	6,03	13,09
Horsens	0,37	0,75	0,51
Grenå	-	0,50	0,87
Vejen	-	-	0,55
Odense			0,7

AMV 1 **AMV 3**	0,44 8,26	0,69 13,81	0,83 10,87
Amagerværket	8,7	14,5	11,7
FYV 8 **FYV 7**	0,3 11,08	0,23 10,47	0,3 15,6
Fynsværket	11,3	10,7	15,9
Nordjyllandsværket	11	20,3	30,4
Total emission for these facilities (rounded)*1	**94**	**122**	**146**

Note: *1: The use of several digits should likely not be deemed as indicative of the precision of the estimates.

Based on available emission estimates emissions from Danish coal fired power plants have been reduced heavily over the last decades. Mercury- specific filter types exist however, which have the capacity to reduce air emissions further. These are applied on many (but not all) of the Danish waste incineration plants, but not on any Danish coal fired power plants.

Updated inventories of mercury releases to other environmental media are not available. A summary of the latest such inventory, "Mass flow analyses of mercury 2001" is given in Table 27 below. Three of such mass flow analyses, also called substance flow assessments, for mercury has been performed for Denmark in a time span of some 20 years and significant reduced releases have been observed over the decades, especially as regards intentional mercury uses (Christensen *et al.*, 2004). It should be noted that the substance flow assessment methodology is different from the methodology used for the atmospheric emission estimates given in Table 25. The substance flow assessments are primarily based on specific and detailed data inquiries to the original data sources, and may thus be more accurate, yet somewhat outdated, as no recent substance flow assessments for mercury has been performed.

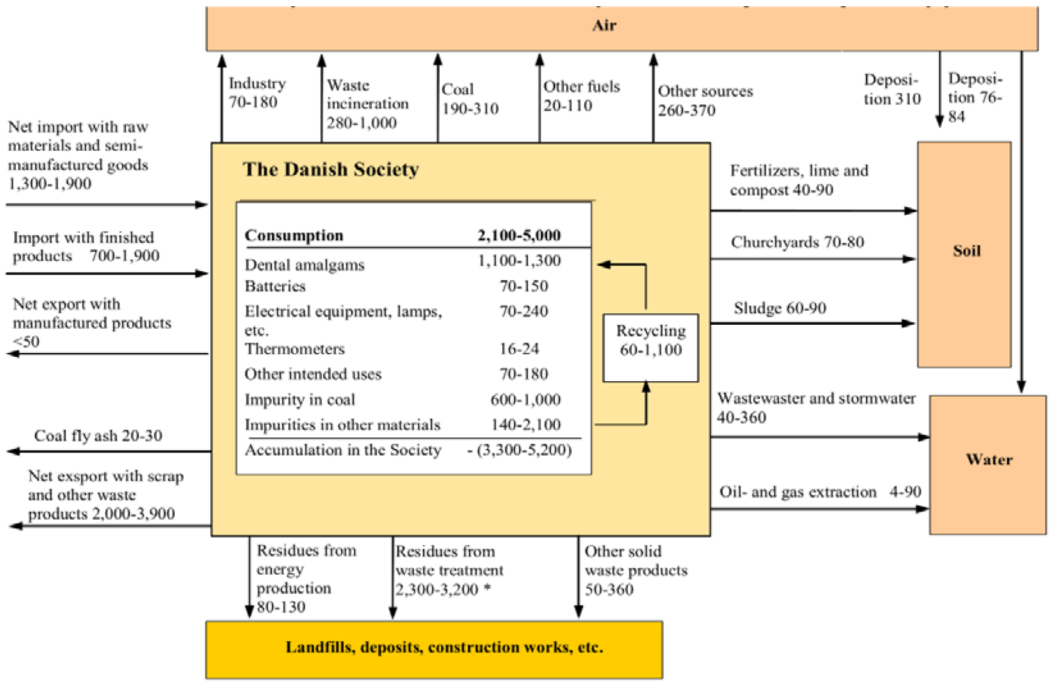
TABLE 30
RELEASES OF MERCURY TO AIR, WATER AND SOIL, AND DEPOSITION WITH WASTE IN DENMARK IN 2001 (CHRISTENSEN *ET AL.*, 2004)

Process/source	Estimated loss (kg mercury) to:				
	Air	Water	Soil	Landfills	Total (rounded)
Industrial processes					
Cement production	70-170	-	-	-	70-170
Production of iron and steel	0.5	-	-	52	53
Manufacture and repair of light sources	-	-	-	-	-
Oil and gas extraction	0.2-11	4-86	0.3-10	-	4.7-110
Energy production					
Coal	190-310	-	-	68-110 *3	260-420
Oil	6-46	5-7	-	6-13 *3	17-66
Natural gas	1-4	-	-	-	1-4
Biological fuels	14-61	-	1-5	2-10 *3	18-76
Use of products					

Process/source	Estimated loss (kg mercury) to:				
	Air	Water	Soil	Landfills	Total (rounded)
Dental clinics	-	50-250 *1	-	-	50-250 *1
Thermometers	-	20-40 *1	-	-	20-40 *1
Monitoring equipment	20-50	20-50 *1	-	-	40-100 *1
Laboratories	-	-	-	-	-
Fertiliser and feeding stuffs	-	-	11-36	-	11-36
Agricultural lime	-	-	2-4.4	-	2-4.4
Lighthouses	5-10	-	-	-	5-10
Waste management					
Disposal of light sources	1-9	-	-	-	1-9
Collection of metallic mercury	-	-	-	-	-
Other recycling activities	-	-	-	-	- *1
Waste incineration	270-1,000	-	-	2,000-2,900 *3	2,300-3,900
Biological waste treatment	-	-	30-49	-	30-49
Deposition (excl. residual products of incineration)	-	2,5	-	120-480	120-480
*4	6-13	0.14	-	7.6	14-21
Discharges from municipal sewage treatment plants	-	14-280	-	-	14-280
Other discharges of wastewater	-	20-80	-	-	20-80
Wastewater sludge	20-46	-	62-94	40-47	120-190
Scrap management	40-60	-	-	180-220	220-280
Other activities					
Cremations/burials	170-190	-	67-75	-	240-270
Total (rounded	820-2,000	50-460	170-270	2,400-3,700	3,500-6,500

Notes: *1 The stated quantities are discharged to wastewater where, after treatment in sewage treatment plants, the mercury will end in the sludge and water discharged by the plant. These quantities are therefore included under "Discharged from municipal sewage treatment plants" and "wastewater sludge," and are not included under "total." *2 Deposited abroad. *3 Included in "deposition (excl. residual products of incineration). *4 Source name is missing in the reference.

The total mercury mass balance for Denmark in 2001 was depicted graphically by Christensen *et al.* (2004) as shown in Figure 3. It should be noted that the consumption of mercury with intentional uses has likely declined since 2001 for several of the applications; see Section 3.



* Most of this (1,900-2,900 kg mercury per year) is exported.

FIGURE 3
MERCURY BALANCE FOR THE DANISH SOCIETY IN 2001 (ALL FIGURES IN KG MERCURY/YEAR; FROM CHRISTENSEN *ET AL.* (2004).

5.3.2 Monitoring data

NOVANA programme monitoring

TABLE 31
MERCURY INCLUDED IN THE NATIONAL MONITORING AND ASSESSMENT PROGRAMME FOR THE AQUATIC AND TERRESTRIAL ENVIRONMENT, NOVANA 2011-2015 (NOVANA, 2011)

Substance	Point sources	Marine Environment	Streams	Air pollution	Ground water
Hg	x	x	x	x	x*1

*1 only if surface water shows a hg content

Results from the NOVANA programme

The most recent data on mercury and mercury compounds from the NOVANA programme are summarised in Table 32.

TABLE 32

MOST RECENT MONITORING DATA FOR MERCURY AND MERCURY COMPOUNDS IN BIOTA IN THE ENVIRONMENT FROM THE NATIONAL MONITORING AND ASSESSMENT PROGRAMME, NOVANA.

Substance	Medium	Number of samples	Average (maximum) concentration mg/kg ww	Median concentration, mg/kg dw	Year	Source
Hg	Flounder liver	15	0.196 (0.630)*1	-	2011	Hansen, J.W. (red) 2012
Hg	Flounder muscle	24	0.612 (1.34)*1	-	2011	Hansen, J.W. (red) 2012
Hg	Flounder muscle	24	0.083 (0.188)	-	2011	Hansen, J.W. (red) 2012
Hg	Lake sediment	25	0.254 (3.13)*1	0.104	2009	Bjerring, R. et. al. 2010
MeHg	Roach, muscle	1	0.082	-	2009	Strand, J. et al. (2010)
Total Hg	Roach, muscle	1	0.078	-	2009	Strand, J. et al. (2010)
MeHg	Eel, muscle	3	0.091	-	2009	Strand, J. et al. (2010)
Total Hg	Eel, muscle	5	0.100	-	2009	Strand, J. et al. (2010)
MeHg	Flounder, muscle	5	0.083	-	2009	Strand, J. et al. (2010)
Total Hg	Flounder, muscle	5	0.087	-	2009	Strand, J. et al. (2010)
MeHg	Eelpout, muscle	6	0.031	-	2008	Strand, J. et al. (2010)
Total Hg	Eelpout, muscle	6	0.030	-	2008	Strand, J. et al. (2010)
MeHg	Eelpout, young	6	<0.010	-	2008	Strand, J. et al. (2010)
Total Hg	Eelpout, young	6	0.004	-	2008	Strand, J. et al. (2010)
MeHg	Clams*1	11	0.005	-	2008	Strand, J. et al. (2010)
Total Hg	Clams*1	11	0.021	-	2008	Strand, J. et al. (2010)
MeHg	Cormorant, muscle	3	0.236	-	2009	Strand, J. et al. (2010)
Total Hg	Cormorant, muscle	13	0.883	-	2009	Strand, J. et al. (2010)

Substance	Medium	Number of samples	Average (maximum) concentration mg/kg ww	Median concentration, mg/kg dw	Year	Source
MeHg	Otter, muscle	3	0.418	-	2006	Strand, J. et al. (2010)
Total Hg	Otter, muscle	3	0.430	-	2006	Strand, J. et al. (2010)
MeHg	Spotted seal, muscle	3	0.936	-	-	Strand, J. et al. (2010)
Total Hg	Spotted seal, muscle	3	1.178	-	-	Strand, J. et al. (2010)

*1 – Concentration in mg/kg dw

*2 - 10 common clams + 1 thick shelled river clam sample.

TABLE 33

Mercury and mercury compounds in aquatic point sources in Denmark

The most recent monitoring data concerning municipal waste water treatment plants (MWWTP), industrial sources and rainwater outlets from the NOVANA programme are shown in the table below.

TABLE 32
MOST RECENT MONITORING DATA FOR MERCURY AND MERCURY COMPOUNDS IN OUTLET TO THE AUQATIC ENVIRONMENT FROM POINT SOURCES FROM THE NATIONAL MONITORING AND ASSESSMENT PROGRAMME

Substance	Point source	Number of samples *1	Average µg/L	Median µg/L	Year	Source
Hg	Separate industrial outlets	38	0.51 (0.81)	-	2009	Naturstyrelsen 2010
Hg	Outlets from MWWTPs	41 (from 31 MWWTPs)	0.00	0.00 (95% percentile = 0.02	2011	Naturstyrerlsen 2013

Kjølholt et al. (2011) calculated for the Danish Nature Agency ”Mean Nation Concentrations (NMC)” for several contaminants in outlets from MWWTPs based on the complete data from the point source part of the NOVANA programme from 1998-2009 and found for total mercury a NMC = 0.086 µg/L.

According to the latest Artic assessment report on mercury (AMAP, 2011), more than 90 % of the present-day concentration of mercury in upper trophic level animals in the Arctic is believed to have originated from human sources. The average rate of increase in wildlife species over the past 150 years is 1 % to 4 % per year. In total, the level has increased by a factor of 10 over the last 150 years.

Most of the time-series datasets showing increasing trends in recent decades are for marine species, followed by predatory freshwater species. Increasing trends have been observed in some marine species in Canada and West Greenland despite reductions in North American emissions while in northern Europe such trends are less apparent (AMAP, 2011).

5.4 Summary and conclusions on environmental effects and exposure

Mercury and mercury compounds are according to the CLP Regulation classified as very toxic to aquatic life with long lasting effects (Aquatic Acute 1, and Aquatic Chronic 1). Mercury is an element and therefore not degradable and some mercury compounds, not least methylmercury, have a high bioaccumulation potential.

Mercury and mercury compounds, in particular organic mercury compounds and above all methylmercury, are highly toxic to many aquatic organisms, often with short term effects levels in the low microgram/liter range and chronic NOECs below 1 µg/L. Bioconcentration factors in fish of several thousands have been reported.

Focus is in particular on top predators living in the aquatic environment or feeding on fish and shellfish, i.e. predatory fish, marine mammals, polar bears, and certain predatory birds. Mercury levels in these animals do not appear to be decreasing despite recent efforts to reduce use or phase-out mercury, and the levels in edible species may exceed human health criteria. Terrestrial top predators appear to be less exposed to mercury compounds via the food chain than the aquatic/marine species. Many mercury compounds are also known to be toxic to bacteria and other microorganisms and some have actively been used to control undesired microbial growth or impact.

Updated inventories of mercury releases to all environmental media are not available. The latest such inventory, or substance flow assessment, on mercury is for the year 2001. Aggregated quantification of atmospheric mercury emissions from 2010 are shown below; note that waste incineration is reported as part of “energy industries”.

TABLE 33
OFFICIALLY REPORTED ESTIMATES OF ATMOSPHERIC EMISSIONS FROM SELECTED MAJOR SOURCES IN DENMARK IN 2010 (DCE, 2012).

Sector	Emissions in 2010, kg Hg/y
Energy Industries	240
Manufacturing Industries and Construction	56
Transport	32
Non-industrial Combustion	48
Industrial Processes	15
Waste	48
Total	440

6. Human health effects and exposure

As mentioned earlier in this report, and as concluded by the WHO (see below), the RAC opinion on phenylmercury compounds (ECHA, 2011a), and EFSA (2012), the primary risks to the general population are caused by exposure to methylmercury via ingestion of aquatic foods. The critical exposure route of all mercury compounds are via their decomposition and natural formation of methylmercury (MeHg) in the aquatic environment. The description here therefore focuses on methylmercury, rather than on the specific mercury compounds. Inorganic mercury is also dealt with on an aggregate level.

6.1 Human health hazard

Mercury has a number of human health effects. For methylmercury the effects observed to occur at the lowest exposure levels is neurodevelopmental effects (loss of IQ; learning ability impairment) in unborn and young children. Other toxic effects include alteration of sensory functions, motor coordination, memory and attention (National Food Institute,Technical University of Copenhagen, 2013).

A link between methylmercury intake and cardiovascular diseases has been reported. According to EFSA (2012), although the observations related to myocardial infarction, heart rate variability and possibly blood pressure are of potential importance, they are still not conclusive.

EFSA states that the critical target organ for toxicity of inorganic mercury is the kidney. Other targets include the liver, nervous system, immune system, reproductive and developmental mechanisms (EFSA, 2012).

The RAC opinion on phenyl-mercury compounds states the following as regards effect levels of methylmercury (ECHA, 2011a):*"The main toxicological concern is for the neurodevelopment in humans observed after exposure during pregnancy of women consuming notably fish containing methylmercury. This type of effect does not appear to have a threshold and thus calls again for reducing any emission as much as possible. Although a provisional Tolerable Weekly Intake (PTWI) has been established for methylmercury by JECFA based on the most sensitive toxicological endpoint (developmental neurotoxicity) in the most susceptible species (humans), the non-threshold approach should be considered.*

In adults, the earliest neurological effects of methylmercury poisoning are symptoms such as paraesthesia, discomfort, and blurred vision. At higher exposure the following symptoms may appear: disturbances of the visual field, deafness, dysarthria, ataxia, and ultimately coma and death (UNEP, 2002). The developing nervous system is more sensitive to methylmercury than the adult. Offspring from mothers consuming methylmercury-contaminated food during pregnancy have shown a variety of developmental neurological abnormalities including microcephaly, hyperreflexia, and gross motor and mental impairment (UNEP, 2002; 2008). A provisional classification for methylmercury has been agreed by the TC C&L on acute toxicity, repeated dose toxicity, mutagenicity, carcinogenicity, reproduction toxicity and environmental hazards (T;

R48/25; T+; R26/27/28; Muta. Cat. 3; R68; Carc. Cat. 3; R40, Repr. Cat. 1; R61, Repr. Cat. 3; R62, R64, N; R50/53) (Ex-ECB, 2010). Effects on the central nervous system including ataxia and paresthesia have been observed in subjects with blood mercury levels as low as 200 µg Hg/l, corresponding to 50 µg Hg/g of hair (EPA, 1997).

The monitoring data in the Faroe Islands have been used to epidemiologically link the exposures through seafood – notably the traditional consumption of pilot whale meat - and the IQ effects in infants (Grandjean et al. 1997). The Joint FAO/ WHO Joint Expert Committee on Food Additives (JECFA) established a provisional Tolerable Weekly Intake (PTWI) for methylmercury to 1.6 µg/kg body weight / week (WHO, 2003). This Committee determined that a steady-state daily ingestion of methylmercury of 1.5 µg/kg bw/day would result in concentrations in maternal blood estimated to be without appreciable adverse effects in the offspring in the Faroe and Seychelles Island studies. From this figure, a general-population DNEL long-term for the oral route can be calculated by using the assessment factors 10 for the intraspecies differences (general public) and 1 for the quality of the whole database: DNEL = LOAEL/AF = 1.5/10 = 0.15 µg/kg bw/day."

EFSA (2012) summarised the kinetics of mercury in the human body as follows: "*After oral intake, methylmercury is much more extensively and rapidly absorbed than mercuric and mercurous mercury. In human blood mercuric mercury is divided between plasma and erythrocytes, with more being present in plasma, whereas methylmercury is accumulated to a large extent (> 90 %) in the erythrocytes. In contrast to mercuric mercury, methylmercury is able to enter the hair follicle, and to cross the placenta as well as the blood-brain and blood-cerebrospinal fluid barriers, allowing accumulation in hair, the fetus and the brain. Mercuric mercury in the brain is generally the result of either in situ demethylation of organic mercury species or oxidation of elemental mercury. Excretion of absorbed mercuric mercury occurs mainly via urine, whereas the main pathway of excretion of absorbed methylmercury is via faeces in the form of mercuric mercury.*"

WHO (2010) provided the following short overview of the toxicity of - and exposure to - mercury and its compounds:

"Mercury exists in the environment in three forms: elemental, inorganic (e.g., mercuric oxide, mercuric chloride, etc.), and organic (e.g., methylmercury, thimerosal). The form of mercury affects its absorption and retention in the body.

The primary targets for toxicity of mercury and mercury compounds are the nervous system, kidneys, and the cardiovascular system. Other systems that may be affected include the respiratory, gastrointestinal, hematologic, immune, and reproductive systems. It is generally accepted that developing organ systems (such as the fetal nervous system) are most sensitive to the toxic effects of mercury.

Nervous System

Methylmercury's key target is the nervous system. Methylmercury is the most toxic and the most common form of mercury found in the environment. Exposure to methylmercury occurs from eating fresh or marine water fish and animals that feed on fish. Due to methylmercury's ability to cross the placental barrier, developing fetuses are particularly sensitive. Studies have shown that children exposed to 10 - 20% of the toxic level seen in adults can [develop] *cognitive deficits …… Effects on the nervous system are also the most sensitive toxicological end-point observed following exposure to elemental mercury. Inorganic mercury, however, has a limited capacity to cross the blood-brain barrier and thus exposure to inorganic mercury compounds is not associated with effects on the central nervous system.*

Kidney
Kidney damage is the most sensitive endpoint of exposure to inorganic mercury compounds. Depending on the dose, inorganic mercury exposure can cause an abnormal amount of protein to be released into the urine, blood in the urine, a decreased production of urine, and acute kidney failure.

Cardiovascular
Methylmercury has been found to be associated with increased risks of heart attack and high blood pressure. It has been reported that increased mortality from cardiovascular effects may be due to even small increases in methylmercury exposure. Acute exposure to elemental and inorganic mercury has been associated with increased blood pressure, abnormal heart beat, and rapid heart rate. There are numerous risk factors to be considered when evaluating cardiovascular disease, however. "

6.1.1 Classification

The harmonized classification of mercury and mercury compounds as regards human health effects is strict. It varies slightly among the compound groups as shown in Table 35 below. Elemental mercury, inorganic and organic mercury compounds all exhibit varying degrees of acute toxicity from one or more exposure routes as well as specific target organ toxicity from single or repeated exposure. In addition elemental mercury and mercury dichloride are classified as toxic to reproduction in category 1B and 2 respectively.

TABLE 34
HARMONISED HUMAN HEALTH CLASSIFICATION ACCORDING TO ANNEX VI OF REGULATION (EC) NO 1272/2008 (CLP REGULATION)

Index No	International Chemical Identification	CAS No	Classification	
			Hazard Class and Category Code(s) *1	Hazard statement Code(s) *2
080-001-00-0	Mercury	7439-97-6	Repr. 1B Acute Tox. 2 * STOT RE 1	H360D*** H330 H372**
080-002-00-6	Inorganic compounds of mercury with the exception of mercuric sulphide and those specified elsewhere in this Annex	-	Acute Tox. 2 * Acute Tox. 1 Acute Tox. 2 * STOT RE 2 *	H330 H310 H300 H373 **
080-003-00-1	Dimercury dichloride; mercurous chloride; calomel	10112-91-1	Acute Tox. 4 * Eye Irrit. 2 STOT SE 3 Skin Irrit. 2	H302 H319 H335 H315
080-004-00-7	Organic compounds of mercury with the exception of those specified elsewhere in this Annex	-	Acute Tox. 2 * Acute Tox. 1 Acute Tox. 2 * STOT RE 2 *	H330 H310 H300 H373 **
080-005-00-2	Mercury difulminate; mercuric fulminate; fulminate of mercury	628-86-4	. Acute Tox. 3 * Acute Tox. 3 * Acute Tox. 3 * STOT RE 2 *	 H331 H311 H301 H373 **
080-005-01-X	Mercury difulminate; mercuric fulminate; fulminate of mercury [≥ 20 % phlegmatiser]	628-86-4	Acute Tox. 3 * Acute Tox. 3 * Acute Tox. 3 * STOT RE 2 *	 H331 H311 H301 H373 **
080-006-00-8	Dimercury dicyanide oxide; mercuric oxycyanide	1335-31-5	Acute Tox. 3 * Acute Tox. 3 * Acute Tox. 3 * STOT RE 2	 H331 H311 H301 H373**
080-007-00-3	Dimethylmercury; [1] diethylmercury [2]	593-74-8 [1] 627-44-1 [2]	Acute Tox. 2 * Acute Tox. 1 Acute Tox. 2 * STOT RE 2 *	H330 H310 H300 H373 **
080-008-00-9	phenylmercury nitrate; [1] phenylmercury hydroxide; [2] basic phenylmercury nitrate [3]	55-68-5 [1] 100-57-2 [2] 8003-05-2 [3]	Acute Tox. 3 * STOT RE 1 Skin Corr. 1B	H301 H372 ** H314
080-009-00-4	2-methoxyethylmercury chloride	123-88-6	Acute Tox. 3 * STOT RE 1 Skin Corr. 1B	H301 H372 ** H314

Index No	International Chemical Identification	CAS No	Classification	
			Hazard Class and Category Code(s) *1	Hazard statement Code(s) *2
080-010-00-X	mercury dichloride; mercuric chloride	7487-94-7	Muta. 2 Repr. 2 Acute Tox. 2 * STOT RE 1 Skin Corr. 1B	H341 H361f*** H300 H372** H314
080-011-00-5	phenylmercury acetate	62-38-4	Acute Tox. 3 * STOT RE 1 Skin Corr. 1B	H301 H372 ** H314

1 Use of "" in connection with a hazard category (e.g. Acute Tox. 4 *) implies that the category stated shall be considered as a minimum classification.

*2 Use of "**" in connection with a hazard statement code (e.g. H373**) implies that the route of exposure is not specified.

*3 Use of "**" in connection with a hazard statement code (e.g. H373**) implies a hazard statement for reproductive toxicity.

6.2 Human exposure and risk assessment

Indirect exposure in Denmark

The National Food Institute, Technical University of Copenhagen (2013) assessed the dietary exposure of mercury of the Danish population in the period 2004-2011. The fish species cod and plaice were used as marker foods. They found an indication that the environmental levels of mercury had been at a stable level over the last decades. For some food types, concentration data from previous monitoring periods were used in the calculations of the exposure.

They estimated the mean exposure at 1.7 µg/kg bw/day, which is slightly lower than the estimated exposure from the previous monitoring period at 1.9 µg/kg bw/day for adults. On the other hand, the exposure for the high-end consumers had increased as indicated by an increase in the 95th percentile to 4.3 µg/kg bw/day compared to 4.1 µg/kg bw/day in the previous period. Fish and fish products contributed with 68.1% of the total average mercury exposure. Other food groups with significant mercury contributions were fruits and fruit products (9.5%), cereals and cereal products (5.9%) and beverages (3.9%).

Converting the total mercury concentrations to methylmercury and inorganic mercury using the conversion factors used by EFSA (2012), the National Food Institute, Technical University of Copenhagen (2013) concluded as regards risk assessment: The mean and 95th percentile exposures were calculated to be at 0.018 and 0.051 µg/kg bw/day, respectively. This corresponds to 10% (mean) and 27% (95th percentile) of the EFSA TWI value for methyl-mercury. Similarly, for inorganic mercury a mean and 95th percentile exposure at 0.012 and 0.034 µg/kg bw/day, respectively, were calculated. These values correspond to 2.2% (mean) and 6.0% (95th percentile), respectively, of the EFSA TWI value for inorganic mercury. In other words, the assessment indicated that the exposures via food of the general Danish population to methylmercury (from aquatic foods) and inorganic mercury (other foods) were within the levels considered by the National Food Institute, Technical University of Copenhagen to be safe.

TABLE 35
OVERVIEW OF HEALTH-BASED GUIDANCE VALUES FOR THE TOLERABLE EXPOSURE TO MERCURY SPECIES

Element/species	Body	Year	Type	Value
Mercury, inorganic	JECFA	2011a	PTWI	4 µg/kg bw/week
	EFSA	2012a	TWI	4 µg/kg bw/week
Methylmercury	JECFA	2004	PTWI	1.6 µg/kg bw/week
	EFSA	2012a	TWI	1.3 µg/kg bw/week
	US EPA	2001*	Reference dose, RfD	0.1 µg/kg bw/day

Note *1: The Reference dose was established in 2001 and is defined somewhat differently than the TWI's; the reference here is US EPA (2013).

Consumer advice related to mercury

The Danish Veterinary and Food Administration has issued consumer advice as regards fish consumption. It recommends eating fish twice a week as a main dish and several times a week as lunch cold cuts, totaling at least 350 gram fish/week, of which at least 200 grams should be fatty fish like salmon, trout, mackerel and herring. As regards mercury, it states that pregnant women and children under age 14 should restrict their intake of predator fish to 100g/week, and children below age 3 years should have only 25 g/week. Predator fish explicitly mentioned are ray, halibut, escolar, swordfish, shark, pike, perch, pikeperch and tuna (both canned and steaks).

Indirect exposure in the Faroe Islands and Greenland

As regards the situation in the Faroe Islands, a comprehensive study was performed (and is still being performed) that provided evidence that unborn and young children's neural development was adversely affected by methylmercury in the mothers' tissue at much lower levels than previously observed (Grandjean *et al.*, 1997). Examinations of the same children at age 14 suggested that the cognitive deficits were permanent (Debes *et al.*, 2006). The study's results have been among the main drivers behind the increased attention to mercury as a global pollutant and are a primary source of data for establishment of exposure thresholds globally. The population of the Faroe Islands are subject to high exposures due to their high intake of aquatic foods and especially intake of pilot whale, which is a traditional food in the islands. Predatory whale tissue has high mercury concentrations because they are at the top of the aquatic food web where methylmercury is accumulated. Recent research in a UK birth cohort indicates that a substantial fraction of the population (about 20% who have at least 4 mutations in 4 important genes) is genetically much more susceptible to methylmercury's adverse health effects than population with none or only one mutation. This implies that the (average) effects observed in earlier studies may underestimate the toxicity in the most vulnerable part of the population (Julvez *et al.*, 2013).

Similarly, studies have observed high exposure of inhabitants in Greenland (UNEP, 2012): "*A 2011 report by the Arctic Monitoring and assessment Programme (AMAP) reported that mercury levels are continuing to rise in some Arctic species, despite reductions over the past 30 years in emissions from human activities in some parts of the world. It reports a ten-fold increase in the last 150 years in levels in belugas, ringed seals, polar bears and birds of prey. Over 90 per cent of the mercury in these animals, and possibly in some Arctic human populations, is therefore believed to have originated from human sources. The average rate of increase in wildlife over the past 150 years is one to four per cent annually. The report is clear about the implications for human health:* "The fact that trends are increasing in some marine species in Canada and West Greenland despite reductions in North American emissions is a particular cause for concern, as these include species used for food" *(AMAP, 2011). A recent study of the preschool children in three* *regions of the Arctic showed that almost 59% of children exceeded the provisional tolerable weekly intake (PTWI) level for children (Tian et al., 2011; WHO, 1998).*"

Indirect exposure in the EU

As regards the general European situation, EFSA (2012) concluded the following on exposure levels: "*EFSA was asked by the European Commission to consider new developments regarding inorganic mercury and methylmercury toxicity and evaluate whether the Joint FAO/WHO Expert Committee on Food Additives (JECFA) provisional tolerable weekly intakes for methylmercury of 1.6 µg/kg body weight (b.w.) and of 4 µg/kg b.w. for inorganic mercury were still appropriate. In line with JECFA, the CONTAM Panel established a tolerable weekly intake (TWI) for inorganic mercury of 4 µg/kg b.w., expressed as mercury. For methylmercury, new developments in epidemiological studies from the Seychelles Child Developmental Study Nutrition Cohort have indicated that n-3 long-chain polyunsaturated fatty acids in fish may counteract negative effects from methylmercury exposure. Together with the information that beneficial nutrients in fish may have confounded previous adverse outcomes in child cohort studies from the Faroe Islands, the Panel established a TWI for methylmercury of 1.3 µg/kg b.w., expressed as mercury.*

The mean dietary exposure across age groups (based on data collected for EU countries, Eds.) *does not exceed the TWI for methylmercury, with the exception of toddlers and other children in some surveys. The 95th percentile dietary exposure is close to or above the TWI for all age groups. High fish consumers, which might include pregnant women, may exceed the TWI by up to approximately six-fold. Unborn children constitute the most vulnerable group. Biomonitoring data from blood and hair indicate that methylmercury exposure is generally below the TWI in Europe, but higher levels are also observed. Exposure to methylmercury above the TWI is of concern. If measures to reduce methylmercury exposure are considered, the potential beneficial effects of fish consumption should also be taken into account.*

Dietary inorganic mercury exposure in Europe does not exceed the TWI, but inhalation exposure of elemental mercury from dental amalgam is likely to increase the internal inorganic mercury exposure; thus the TWI might be exceeded."

The Danish Health and Medicines Authority (2013) is aware of that there may be discussion on the principle in this EFSA opinion, where methylmercury exposure is “allowed” to diminish or cancel health benefits from the consumption of nutrients in seafood.

The results indicate, in other words, that a significant part of the EU population may be exposed to methylmercury via aquatic foods beyond what is considered to be safe levels. Exposure to inorganic mercury from the diet seems to be within what is considered to be safe levels, yet the presence of dental amalgam may lead to exposure beyond safe levels for a part of the population.

The RAC opinion on phenyl-mercury compounds states the following regarding exposure in Nordic countries (ECHA, 2011):
In Nordic European countries a significant increase of the mercury levels has been observed in 2008 compared to levels in fish caught in the period 1990 – 2001 (Ranneklev et al., 2009). The concentrations (Norway, Sweden and Finland) increase with fish size, and the EU maximum level for placing fish products on the market - 0.5 mg Hg/kg (EC, 2006) – in average has been often exceeded (about 50-80% of the more than 1500 monitored lakes) and even regularly has exceeded 1.0 mg/kg which is an accepted limit for some fish in 5-20% of the lakes (Munthe et al., 2009*)."*
(*Eds: References are missing in the published version of (ECHA, 2011)).

Exposure in the global context
WHO (2010) provided the following short overview of the exposure to mercury and its compounds in the general, global context:
"Fish, shellfish, and marine mammal consumption. *Some populations have greater exposure to methylmercury because of the quantity and type of fish, shellfish, and marine mammal consumed, and the location where the fish, shellfish and marine mammals are harvested. For example, subsistence fishers and recreational anglers who frequently consume fish from mercury-contaminated water bodies would have a higher exposure than the general population. Those who consume long-lived predatory species (such as shark and swordfish) would also have a higher exposure.*

Consumer exposure. *Exposure to elemental or inorganic mercury may occur from dental amalgams; use of some skin-lightening creams and soaps; some traditional and ethnic medicines; and some cultural and religious practices.*

Occupational. *Occupational exposures of concern include chlor-alkali manufacturing; artisanal gold mining and processing; and dentistry. Highly exposed workers may take mercury home to family members on their clothing and persons.*

Hot spot exposures. *Hot spots may include artisanal gold mining (mercury is used to remove the gold from the ore), waste sites, and industrial emissions."*

WHO (2010) stated the following as regards populations at particular risk and on susceptibility:

"Populations that may be particularly at risk from mercury exposure include the young and those with pre-existing disease, deficient diets, genetic predisposition, and/or physiologic limitations. Populations may also have an increased risk because of their consumption of fish, shellfish, and marine mammals; occupational exposure; and various consumer and "hot spot" exposures.

Susceptibility
Children. *The fetus, the newborn and children are especially susceptible to mercury exposure because of the sensitivity of the developing nervous system. Levels of mercury not found to have an effect in adults or pregnant women, can have persistent adverse effects in children. Methylmercury from fish consumption may be 50% to 100% greater in a fetus' blood than in the mother's blood due to active transport across the placenta. Thus, new mothers, pregnant women, and women who might become pregnant should be particularly aware of the potential danger of methylmercury. In addition to in utero exposures, neonates can be further exposed by consuming contaminated breast milk. Nervous system development continues into adolescence; thus a child can be considered more susceptible to mercury exposure even years after birth.*

Pre-existing disease. *Individuals with diseases of the liver, kidneys, nervous system, and lungs have a higher risk of suffering the toxic effects of mercury than the general population.*

Diet. *Individuals with certain dietary deficiencies (e.g., zinc, selenium) and those who are malnourished may also be more sensitive.*

Population variability. *The inter-individual ability to eliminate methylmercury from the body, and the genetic predisposition to effects of mercury, both have an effect on the risk of mercury-induced disease."*

As mentioned above, there are indications that certain population groups are genetically predisposed to the adverse effects of methylmercury.

6.2.1 Direct exposure pathways in Denmark

Consumers

The most important direct exposure to mercury of Danish consumers is via dental amalgam fillings. The effects on human health of this exposure is a subject of intense debate. The current understanding of the issue can be summarized as that effects on persons more susceptible than the average population have been indicated (se description of susceptibility above), but that impacts on the general population have not been proven scientifically. A new review of the issue is currently in process in SCENIHR.

Besides, consumers may be exposed to mercury from broken fluorescent light, which use has increased significantly due to campaigns against global warming, as well as from old fever thermometers, barometers, etc. which may still be used, but are not sold anymore in Denmark due to legal restrictions.

Some consumers may be exposed indoors from mercury spilled previously from broken thermometers, etc., hidden in floor materials and cracks.

Occupational exposure

Occupational exposure has been observed with dental personnel, especially earlier when dental amalgam was mixed in the open clinic environment. Today, the use of dental amalgam has been reduced significantly in Denmark, as its use is restricted to special purposes with high wear and complex fillings. It is however still considered the best filling material by some dentist due to its technical qualities. Yet today all, or most, dental amalgam is mixed in closed capsules meaning that the exposure of dental personnel per filling made is considered to be reduced.

Other occupational use of mercury and its compounds in Denmark is considered very minimal, compared to the general exposure via the diet, as no widespread uses of mercury and mercury compounds remain. Mercury compounds were earlier used in a number of laboratory processes, but they have now largely been substituted for. Porosimetry (measurement of porosity) with mercury may still be applied in some materials testing laboratories. Laboratories (in Denmark) however generally have good safety precautions such as fume hoods, etc. , minimizing direct exposure.

When products containing mercury are disposed or recycled they form a potential risk of exposure for employees handling the waste. This source of exposure unlike the more specific sources as e.g. amalgam or mercury bulbs is diffuse and may vary between waste groups, over time and between single deliveries of waste, even if they belong to the same group of waste. The employer's duty according to the Danish working environmental regulation to evaluate the risk of exposure before the work is initiated may be challenged by this diffuse nature. A similar risk of exposure may be present where employees handle, clean up or in other ways are exposed to emissions of e.g. waste combustion residues containing mercury (AT, 2013).

6.3 Biomonitoring data

As regards biomonitoring of mercury in mother's hair in the EU, DEMOCOPHES (2013), found in a relatively small survey in a number of EU countries that (territorial) Denmark is among the countries with the higher mercury exposure relative to other EU countries, as illustrated in Figure 4. It should be noted that the study was intended for assessing the relevance of a common EU monitoring strategy and not to provide a substantial assessment of mercury exposure. The numbers behind the figure were not yet published (as of late April 2013).

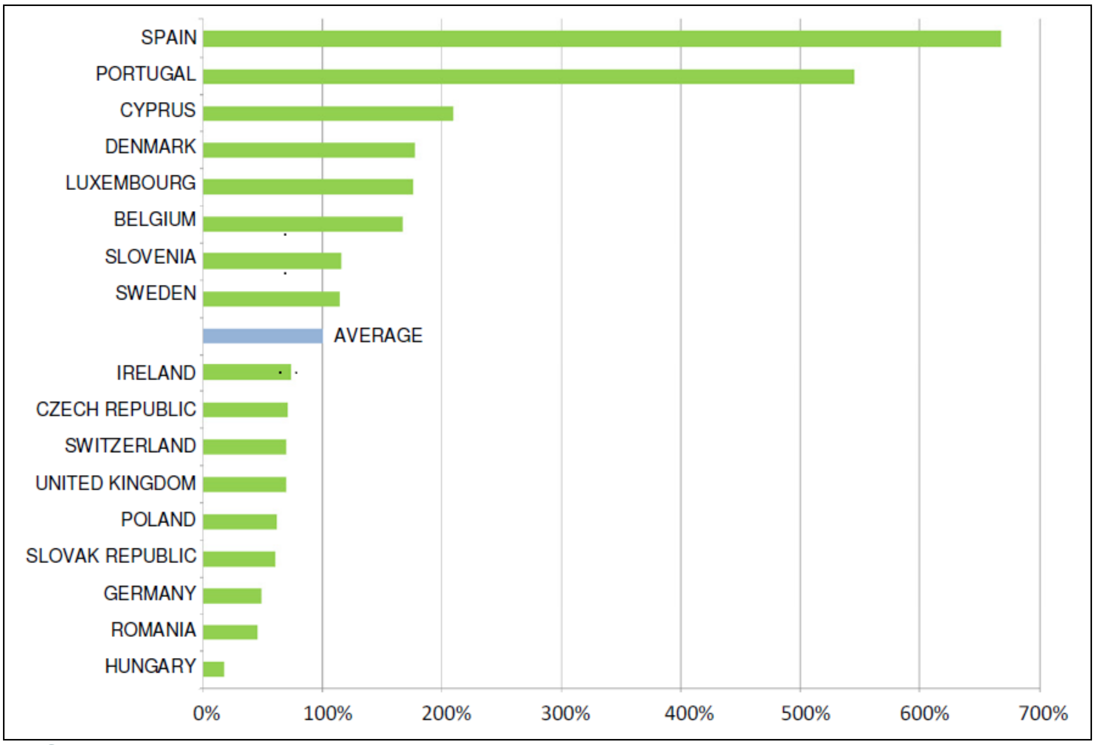


FIGURE 4
RELATIVE VARIATION IN MERCURY CONCENTRATIONS IN MOTHERS' HAIR AMONG EU MEMBER STATES FROM A SMALL SAMPLE (AGE-ADJUSTED; DEMOCOPHES, 2013).

6.4 Summary and conclusions regarding human health effects and exposure

Mercury has a number of human health effects. For methylmercury the effects observed to occur at the lowest exposure levels is neurodevelopmental effects (loss of IQ; learning ability impairment) in unborn and young children. According to ECHA-RAC, this effect does not appear to have a lower threshold. Other toxic effects include alteration of sensory functions, motor coordination, memory and attention. A link between methylmercury intake and cardiovascular diseases has been reported. According to EFSA, although the observations related to myocardial infarction, heart rate variability and possibly blood pressure are of potential importance, they are still not conclusive.

EFSA states that the critical target organ for toxicity of inorganic mercury is the kidney. Other targets include the liver, nervous system, immune system, reproductive and developmental systems (EFSA, 2012).

An assessment finalised for the National Food Institute, Technical University of Copenhagen (DTU Food) in 2013 indicated that the exposures via food of the general Danish population to methylmercury (from aquatic foods) and inorganic mercury (other foods) are within the levels considered by theDTU Food to be safe.

EFSA concluded in its 2012 assessment that a significant part of the EU population may be exposed to methylmercury via aquatic foods beyond what is considered to be safe levels. Exposure to inorganic mercury from the diet seems to be within what is considered to be safe levels, yet the presence of dental amalgam may lead to exposure beyond safe levels for a part of the population.

Arctic populations, including the populations of Greenland and the Faroe Islands, are subject to higher mercury exposures due to their dependence/preference for aquatic diets, in combination with the high mercury deposition (from remote sources) and bio-magnification in the many trophic levels of the arctic marine food web.

7. Information on alternatives

7.1 Identification of possible alternatives

Today alternatives are commercially available for practically all applications of mercury. This has enabled a near total phase-out of mercury use in some countries. The Scandinavian countries have been among the fore-runners on mercury substitution globally. An overview of alternatives to intentional uses mercury was given in the Global Mercury Assessment (UNEP, 2002) and has been updated for this project, see Table 34 below.

TABLE 36
OVERVIEW OF ALTERNATIVES TO MERCURY AND ITS COMPOUNDS (ADAPTED FROM UNEP, 2002);

Product or application	Alternative(s)	General cost relative to mercury technology
Mercury cell process for producing chlorine, sodium hydroxide, potassium hydroxide, etc. referred to as chlor-alkali	Best Available Technology (BAT) for the production of chlor-alkali is considered to be membrane technology. Non-asbestos diaphragm technology can also be considered as BAT. Mercury cell technology is considered obsolete worldwide and no new plants of the type are reported planned.	=/+ Capital investment costs for conversion to the other processes are significant, but electricity and raw material costs (together comprising about half of total operating costs) for the membrane process, as well as waste treatment and disposal costs, are lower than for the mercury cell process (Lassen *et al.*, 2008)

Product or application	Alternative(s)	General cost relative to mercury technology
Dental amalgam	Polymeric composite and compomer fillings are now the standard for most uses in Scandinavia. Glasionomer fillings are less costly but have lower physical strength; they can however be used with less/no drilling and are thus considered a viable alternative for so-called non-traumatic treatment and treatment in developing countries because less equipment is needed for the performing the dental restoration. Glasionomer is recommended for milk teeth in Denmark. The use of dental amalgam is banned in Denmark, yet an exemption is made for fillings on molar teeth with high wear. In a 2013 draft text for a revision of the Danish general mercury ban, the exempted used are specified further to some distinct restoration situations (DEPA, 2013).	=/+ Some alternatives are less expensive and some are more expensive than mercury amalgams, some are easier to apply and others are more difficult, but none of the alternatives require the specialized wastewater treatment equipment that dental professionals need to meet environmental regulations in many countries. For the Danish and EU situation, the standard alternative, composite fillings, as well as compomer fillings, are more expensive than amalgam filling, primarily because of the longer time needed to place large filling in the clinic. For smaller fillings, the time may be equivalent to amalgam fillings. The Danish subsidy system for dental services has negotiated low standard prices for amalgam fillings, but the same has not been obtained for the alternatives. The lifetime costs including waste management of mercury are debated. Glasionomer is considered to be a low cost alternative in non-complex situations.
Batteries	Mercury oxide batteries have been substituted by other battery types, exempt perhaps in military and other highly standardised uses All other batteries are now available in mercury -free versions; for cylindrical and other large batteries, mercury-free is now the standard in global brands. Button cells have become mercury-free as the last, but are now fully available.	= While comparisons are difficult across a broad range of batteries (and as battery capacities increase), standard mercury-free batteries generally cost about the same as the batteries they replace. Mercury-free button cells are reported to be 0-10 % more expensive than mercury-containing equivalents (for no-Hg-Oxide types); (BIO-IS, 2012)
Medical thermometers	Electronic fewer thermometers There are also other alternatives to clinical mercury-thermometers, “disposables” designed for a single use, and glass thermometers containing a Ga/In/Sn “alloy”, etc.	=/+ Electronic thermometers are the standard for consumer use in Europe after recent restrictions of mercury thermometers; they are now available at almost the same price as previously paid for clinical mercury thermometers. Taking into consideration waste handling cost of mercury, the alternatives are not deemed more expensive than the mercury containing types. (ECHA, 2010)

Product or application	Alternative(s)	General cost relative to mercury technology
Other thermometers	Non-medical thermometers are used very widely. Alternatives to mercury as the measuring medium include other liquids, gas, electrical and electronic (probably the most common) sensors. The choice of alternative depends on the temperature range, the specific application, and the need for precision. (Mercury thermometers are worthless at temperatures below –39°C, when mercury turns solid) For temperature readings in buildings, a bimetal device is often used, or a Pt-100 or thermocouple is used when a temperature signal needs to be transferred to a controller or recorder. Electronic alternatives have several advantages over mercury. One thermometer can be adjusted to several different measuring ranges, thereby substituting for several mercury thermometers. Further, it is possible to read temperatures digitally and record them remotely. This could reduce the chance of human error, as well as reduce operating costs. For a very small number of precision applications, mercury thermometers are still preferred for technical reasons, e.g. for calibration of other thermometer types, for international standards, etc.	= There is such a great range of mercury alternatives and applications that it can only be said that prices of alternatives vary widely, but are not necessarily more expensive. It should also be noted that, while the initial cost of a mercury glass thermometer is lower than an electronic device, the frequency of broken mercury thermometers is higher, and one electronic thermometer may replace several mercury ones. If an annual cost is calculated, the price of an electronic measuring device is probably no higher than the mercury device it replaces (UNEP, 2002). Taking into consideration waste handling cost of mercury, the alternatives are not more expensive than the mercury containing types.
Laboratory use of mercury	It is entirely possible to restrict mercury use in school or university laboratories to a few specific, controllable uses (mainly references and standard reagents). Also for several of the classic standard analyses, such as COD analysis and Kjeldhls N analysis, mercury-free alternative reagents are available Porosimetry can be performed with other techniques for most purposes, but this would require a change in established industry and laboratory practices.	= This initiative has already been implemented in Swedish legislation. The alternatives are generally no more expensive, and the need for control of mercury sources in the laboratory is greatly reduced (UNEP, 2002). ? No data have been found on the costs of substitution of porosimetry
Pesticides and biocides for different products and processes.	The use of mercury in pesticides and biocides has been discontinued or banned in many countries. Two main alternatives have been promoted in their place: 1) Use of processes not requiring chemical pesticides/biocides, and 2) Easily degradable, narrow-targeted substances with lower environmental impact. Biocide use in multi-dose vaccines is still considered needed for some purpose by the WHO. Single dose vaccines of the same types do however not contain mercury.	= These alternatives are in place in many countries. The range of products and applications is too diverse to make definitive statements about cost comparisons, although it is likely that in the majority of cases costs are roughly comparable, and environmental benefits are considerable.

Product or application	Alternative(s)	General cost relative to mercury technology
Mercury cell process for producing chlorine, sodium hydroxide, potassium hydroxide, etc. referred to as chlor-alkali	Best Available Technology (BAT) for the production of chlor-alkali is considered to be membrane technology. Non-asbestos diaphragm technology can also be considered as BAT. Mercury cell technology is considered obsolete worldwide and no new plants of the type are reported planned.	=/+ Capital investment costs for conversion to the other processes are significant, but electricity and raw material costs (together comprising about half of total operating costs) for the membrane process, as well as waste treatment and disposal costs, are lower than for the mercury cell process (Lassen *et al.*, 2008)
Dental amalgam	Polymeric composite and compomer fillings are now the standard for most uses in Scandinavia. Glasionomer fillings are less costly but have lower physical strength; they can however be used with less/no drilling and are thus considered a viable alternative for so-called non-traumatic treatment and treatment in developing countries because less equipment is needed for the performing the dental restoration. Glasionomer is recommended for milk teeth in Denmark. The use of dental amalgam is banned in Denmark, yet an exemption is made for fillings on molar teeth with high wear. In a 2013 draft text for a revision of the Danish general mercury ban, the exempted used are specified further to some distinct restoration situations (DEPA, 2013).	=/+ Some alternatives are less expensive and some are more expensive than mercury amalgams, some are easier to apply and others are more difficult, but none of the alternatives require the specialized wastewater treatment equipment that dental professionals need to meet environmental regulations in many countries. For the Danish and EU situation, the standard alternative, composite fillings, as well as compomer fillings, are more expensive than amalgam filling, primarily because of the longer time needed to place large filling in the clinic. For smaller fillings, the time may be equivalent to amalgam fillings. The Danish subsidy system for dental services has negotiated low standard prices for amalgam fillings, but the same has not been obtained for the alternatives. The lifetime costs including waste management of mercury are debated. Glasionomer is considered to be a low cost alternative in non-complex situations.

Product or application	Alternative(s)	General cost relative to mercury technology
Pressure measuring and control equipment	Mercury is used as a "heavy liquid" in pressure gauges, pressure switches and pressure transmitters. All of these may be substituted without any loss of accuracy or reliability. Three main technologies are used: • flexible membranes with mechanical/aneroid meters, • electronic piezoelectric crystals and other sensors that change some physical property when the pressure changes, and • fiber-optic pressure sensors, based on light transmission. In pressure gauges like U-tube meters, barometers, and manometers, mercury is used to continuously indicate pressure differentials. Here, mercury can be replaced by another liquid, by gas or by other techniques. Mercury pressure switches are used to measure pressure or vacuum differentials. They can be replaced by the same alternatives as for pressure gauges, but also equipped with a non-mercury breaker switch. For remote transmission of measurement readings, a pressure transmitter is often used. A special mercury transmitter is a circular tube which may contain up to 8 kg of mercury. Alternatives use a potentiometer or a differential transformer to measure pressure changes and transmit an electronic signal. The most common alternative device is a diaphragm sensor.	= Alternatives based on gas, other liquids or a mechanical spring show no significant differences in price, compared to mercury devices. Alternatives in the form of electric and electronic instruments are only slightly more expensive, but have several advantages over mercury.
Electrical and electronic components*1	With very few exceptions, there are no technical obstacles to replacing electrical components, conventional relays and other contacts (even when these are contained in level switches, pressure switches, thermostats, etc.) with equivalent mercury-free components. A number of examples are given below.*1	= There are no significant price differences between conventional mercury and mercury-free relays and contacts, except for very specific applications. There are also examples of mercury components, which are more expensive than the alternatives.
Catalysts in PUR elastomers	A full array of mercury-free alternatives is available for this application of mercury compounds (Lassen et al., 2008). No mercury catalysts for this application have been registered under REACH as of June 20th 2013.	= Assumed equal price as the alternatives are fully present on the market and may in fact today dominate the market.

Product or application	Alternative(s)	General cost relative to mercury technology
Energy-efficient lamps	CFL's with lower mercury concentrations are required in EU legislation. LED lamps are now matured to a level where they meet light quality demands in offices and home lighting and fully available on the market. Other mercury-containing light sources exist, mainly for special, limited purposes and sold in much lower quantities. Mercury-free lamps for these purposes also exists in most cases.	= /+ CLF's with lower mercury concentrations are slightly more expensive. LED's with indoor light quality are still significantly more expensive. Low price LED are marketed for other purposes with less strct light quality requirements.
Artisanal gold extraction	One alternative is a cyanidation process, which is reportedly used by many relatively small-scale miners in Mexico and some elsewhere, despite the fact that it requires greater investments and greater process skills, and involves acute toxicity. UNIDO's approach in addressing this problem is to encourage the substitution of low recovery, high mercury consuming and discharging processes with environmentally safer and high-yield gold extraction alternatives that reduce the discharge of mercury. Depending upon the technique, cost and delivery method, some proposals are better received than others, but none as yet have been widely adopted.	= Low tech solutions to reduce mercury releases with 90% are low-priced, but training in their use is needed. The economics of these alternatives have not been investigated in detail here, but indications (the first process used on a wide scale, and the second delivering more gold and using less mercury) are that they are no more expensive than the traditional mercury process. If they were, they would not be adopted by the small scale miners. CETEM/IMAAC/CYTED (2001), ICON (2000), UNIDO (1997), UNIDO (2000), MMSD (2002)

Note *1: Details on alternatives to electrical and electronic components:

Mercury component	Alternative component	Application
Tilt-switch – silent switch	Various, e.g. manual/mechanical (rolling steel ball, alternative conducting fluid), micro-switch	Circuit control, thermostats, communications
Electronic-switch	Solid state-switch, optical switch	Circuit control, thermostats, communications
Reed-switch – "mercury-wetted"	Solid-state-switch, electro-optical-switch, semi-conductor	Communications, circuit control in sensitive electronic devices
Proximity sensor/switch – "non-touch-contact"	inductive sensor capacitive sensor photoelectric sensor ultrasonic	shaft rotation, conveyors conveyors conveyors conveyors

7.2 Historical and future trends

The substitution of mercury has been a priority in both Scandinavia, Europe as a whole and North America for several decades. In Denmark, elimination of mercury in products and materials has been prioritised to enable optimal use of waste for energy production, without escalating mercury emissions from the incineration processes. See the resulting decline in Section 3.3.1 .At the same time, electronic solutions with added performance characteristics have been introduced over the last decades, outdating many of the mercury-based instruments.

Lassen et al. (2008) developed an overview of the level of substitution attained in the EU for different applications of mercury based on the methodology developed by Maag et al. (2007); see Table 34. As shown, many of the mercury uses have reached a high level of substitution (indicators 3 or above). Since then substitution has been implemented further for some mercury uses. Based on background knowledge, this is for instance the case for the light sources, where LED light has evolved quickly and reached a light quality making it suitable for general lighting of offices and homes and have been marketed for this purpose and others.

TABLE 37
MERCURY SUBSTITUTION LEVEL IN INDUSTRIAL PROCESSES AND PRODUCTS IN THE EU IN 2007 ADAPTED FROM (LASSEN *ET AL.*, 2008)

Application area	Level of substitution
Light sources	
Fluorescent tubes	1
Compact fluorescent tubes	1
HID lamps	0
Other lamps (non electronics)	2
Lamps in electronics	2
Batteries	
Button cells	2
General purpose batteries	4
Mercury oxide batteries	4
Dental amalgams	
Pre-measured capsules	2
Liquid mercury	3
Measuring equipment	
Medical thermometers	3
Other mercury-in-glass thermometers	3
Thermometers with dial	4
Manometers	4
Barometers	4
Sphygmomanometers	4
Hygrometers	4
Tensiometers	4

Application area	Level of substitution
Gyrocompasses	4?
Reference electrodes	3
Hanging drop electrodes	3
Switches, relays, etc.	
Tilt switches for all applications	4
Thermoregulators	4
Read relays and switches	3
Other switches and relays	4
Chemicals	
Chemical intermediate and catalyst (excl PU) *1	2
Catalyst in polyurethane (PU) production	4
Laboratories and pharmaceutical industry	3
Preservatives in vaccines and cosmetics	3
Preservatives in paints	4
Disinfectant	4
Other applications as chemical	3
Miscellaneous uses	
Porosimetry and pycnometry	2
Conductors in seam welding machines (mainly maintenance)	3
Mercury slip rings	N
Maintenance of lighthouses	0
Maintenance of bearings	0

Notes: Key to assigned substitution level indices:

0 No substitution indicated in assessed data sources; development often underway

1 Alternatives are ready to be marketed, or are present on the market but with marginal market share

2 Alternatives are being marketed and have significant market share, but do not dominate the market

3 Alternatives dominate the market, but new products with mercury also have significant market share

4 Mercury use is fully, or almost fully, substituted

N Not enough data was found to assign an indicator

Maag *et al.* (2007) produced detailed overviews of the observed level of substitution based on expert judgement in a number of developed countries in Europe, North America and Asia, in an effort to describe the global substitution possibilities.

Based on the assessment, global phase-out periods for the individual mercury uses were suggested. By far the most used were assessed to be fully substitutable globally within 8 years (by 2015), while some were assessed to need a medium transition time of 12 years (to 2019) and only 10 uses were suggested transition times of 25 years (2032). In total, the lists include 72 individual uses of mercury and its compounds. See the reference for the full assessment. Table 35 below show the 10 mercury uses deemed to need the longest transition time. They include some major mercury uses including chlor-alkali production with mercury cells, small-scale gold mining (ASGM), dental amalgam and light sources. For these uses, a more detailed analysis of the obstacles for substitution is given in the reference. Other uses listed include some very specialised applications with small mercury consumption; primarily laboratory and research uses. Based on current knowledge, the substitution of mercury cell chlor-alkali production and light sources may actually move faster today than was expected in 2007.

TABLE 38
MERCURY USES DEEMED AS NEEDING THE LONGEST PHASE-OUT PERIOD IN A GLOBAL CONTEXT (MAAG *ET AL.*, 2007).

Hg use	Time proposed for "99%" global phase-out, years	General substitution level (overall assessment)	Focus of future substitution efforts	Price of Hg-free vs. Hg product /process	Relative magnitude of Hg consumption globally
Uses needing longer transition time(?)					
Chlor-alkali production with mercury cells	25	3	S	=, +	xxxx
Small scale gold and silver mining	25	4	S, T	?	xxxx
Dental amalgam fillings	25	2-4	I, S, P, T	-, =, +	Xx
Linear fluorescent lamps	25	1	T	?	Xx
Compact fluorescent lamps (CFL, commonly called energy saving lamps/bulbs)	25	1	T	=/+?	Xx
Laboratory atomic absorption spectrometry	25	0-1?	I	?	X
Electrodes and references for physiochemical measurements, such as calomel electrodes, references for Hg analysis etc.	25	2-3	I	?	X
Ethnic/cultural/ritualistic uses and folklore medicine	25	4	S, I	?	X
Infra-red light detection semiconductors	?	N	0	?	X?
Neutron source in synchrotron light establishments and perhaps other high-intensity physical instruments	?	N	?	?	X

Legend:
Index, description of substitution level :
0 No substitution indicated in assessed data sources; development often underway.
1 Alternatives are in commercial maturation, or are present on the market but with marginal market shares.
2 Alternatives are commercially matured and have significant market shares, but do not dominate the market.
3 Alternatives dominate the market, but new production with mercury also have significant

market shares.

4 Mercury use is fully, or almost fully, substituted.

N Not enough data found to assign an indicator.

? Indicator uncertain due to limited data.

Index, focus of needed substitution efforts:

P: Prices of mercury free alternatives are presently markedly higher when environmental and health costs are not considered.

T: Need for technical development of alternatives.

S: Uses with social implications, such as in small scale gold mining where mercury use is currently vital to some, but not all, gold mining communities.

I: Institutional (or structural) implications such as in standardized chemical laboratory analyses.

0, or

[empty]: No major hurdles identified (other than perhaps resistance in the market to adopt new products/processes).

INdex, sales prices (not life-cycle prices):

- Sales price of alternative smaller than Hg use

= Approximately same price

+ Sales price of alternative larger than Hg use

? Limited or no data on sales prices available in assessed reviews

7.3 Summary and conclusions on alternatives

Today alternatives are commercially available for almost all applications of mercury. This has enabled a near total phase-out of mercury use in some countries, including Denmark. The substitution of mercury has been a priority in both Scandinavia, Europe as a whole and North America for several decades. In Denmark, elimination of mercury in products and materials has been prioritised to enable optimal use of waste for energy production, without escalating mercury emissions from the incineration processes. At the same time, electronic solutions with added performance characteristics have been introduced over the last decades, outdating many of the mercury-based instruments.

A full mercury phase-out may take extra time for the following major mercury applications, with the mentioned reasons mentioned in Table 36.

TABLE 39
MAJOR MERCURY APPLICATIONS FOR WHICH SUBSTITUTION MAY REQUIRE MORE TIME, AND REASONS FOR THIS

Mercury application	Status of substitution and observed barriers
ASGM – Artisanal and small-scale gold mining (not used in Denmark)	The only matured alternative is cyanidation, which is acutely toxic and therefore requires high-tech containment. Low-tech solutions are available which, in combination with training of miners, can reduce mercury use and release by 90%. ASGM is poverty-driven which makes it more difficult to implement reductions.
Dental amalgam	Mercury-free composites fillings (and compomer fillings) are available and are dominating the market in some countries. They could in principle eliminate mercury usage, but for complex fillings, this would be with reduced life-time of the fillings and increased price as a consequence. Low-price low-impact glaisomer fillings are deemed by some to be a better alternative to amalgam in such developing countries where price and availability of technical equipment are the determining factors (in spite of lower strength of this filling material).
Fluorescent lamps including CFL's	Over the last decade, low-energy high lifetime LED lamps have emerged on the global market. Within the last few years, they have reached a lighting quality suitable for office and home light, but so far at substantially higher prices than fluorescent lamps. Fluorescent lamps can now be produced with lower mercury concentrations, but their use has increased due to climate campaigns, implying an increase in mercury consumption for this application in Denmark and globally.
Various laboratory and research uses	Laboratory analyses are governed by analysis standards, which take long time to change due to inertia and costs of paradigm changes. In Denmark, they are deemed to be used in relatively closed systems within strict hazardous waste collection and treatment schemes.

8. Overall findings and conclusions

For a summary of overall findings, please read the executive summary of the report.

Conclusions
The seriousness of mercury's environmental impacts are well described and widely acknowledged. Most intentional uses and other mercury release sources are well regulated in Denmark and in the EU, and a new global convention on mercury is under implementation. In a few cases, abatement technology or management solutions exist which has the potential to reduce mercury releases further, should this be found necessary. While much has been done to reduce mercury releases and impacts in Denmark, a substantial workload remains in the developing countries of the world, for which expertise and other support is needed in order to effectively implement the new global Minamata Convention on Mercury. Such work is necessary in order to further reduce mercury deposition and impacts in Denmark, and notably in Greenland and the Faroe Islands.

Data gaps
As indicated, the environmental characteristics of mercury are well described, should it however be prioritised, the following issues are pointed out for potential follow up as regards the Danish situation:

- Update of selected aspects of mercury's flow and cycle in Denmark for which no recent data are available. For example the fate of mercury in solid residues from coal fired power plants in cement production, etc.
- Assessment of collection efficiency of separate collection of mercury-containing waste in Denmark (especially products) and establishing a better insight in the time it takes for obsolete mercury-added products to get out of circulation in society. One element in this could be analysis of data from the newly introduced continuous mercury measurements in some waste incineration facilities, which can show peaks in emissions from mercury-added products.

Future challenges in the Danish context may be the implementation of the Minamata Convention in Denmark. While most provisions of the convention are likely already covered in Danish and EU legislation, some adjustments and supplements may be needed.

In the global context much remains to be illuminated as regards national emission inventories, development of guidelines for inventories, waste management and other aspects under the Minamata Convention, as well as many other issues.

9. Abbreviations and acronyms

Au	Gold
Ag	Silver
Al	Aluminium
ASGM	Artisanal and small-scale gold mining
MeHg	Methylmercury
BCF	Bioconcentration factor
BEK	Bekendtgørelse (Statutory Order)
Bw	body weight
CAS	Chemical Abstracts Service
CLP	Classification, labelling and packaging of substances and mixtures (EU regulation)
DEPA	Danish Environmental Protection Agency
EC	European Community
ECHA	European Chemicals Agency
EEC	European Economic Community
EFSA	European Food Safety Authority
ELV	End of Life Vehicles (EU regulation)
ESIS	ESIS (Europan chemical Substances information System)
EPA	Environmental Protection Agency
EU	European Union
EU27	European Union med 27 member states
FAO	United Nations Food and Agriculture Organization
HELCOM	Helsinki Commission - is the governing body of the Helsinki Convention for the protection of the Marine Environment of the Baltic Sea Area.
Kg	Kilogram
Kow	Octanol/water partitioning coefficient
LED	Light emitting diode
LDCs	Least developed countries
LOUS	List of undesirable substances
MWWTP	Municipal waste water treatment plant
mg	Milligram (10^{-3} gram)
NOVANA	Danish National Monitoring and Assessment Programme for the Aquatic and Terrestrial Environment
OSPAR	The OSPAR-Convention covering the marine environment of the North-East Atlantic.
PTWI	Provisional Tolerable Weekly Intake
REACH	Registration, Evaluation, Authorisation and Restriction of Chemicals
SVHC	Substance of Very High Concern
T	Tonnes (= metric tons)
TWI	Tolerable Weekly Intake
Y	Year (/y = per year)

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Appendix 1: Mercury compounds pre-registered by ECHA (2013)

Mercury compounds identified in ECHA's (2013b) list of pre-registered substances and certain mixtures (identified with the use of the search string "mercu"). ECHA's statement of registration deadline for the substance is also shown.

EC-Number	CAS-Number	Name (as indicated in the pre-registration)	Registration Date (according to ECHA, 2013)
200-242-9	55-68-5	phenylmercury nitrate	30-11-2010
200-442-6	59-85-8	4-chloromercuriobenzoic acid	30-11-2010
200-532-5	62-38-4	phenylmercury acetate	30-11-2010
201-962-6	90-03-9	2-chloromercuriophenol	30-11-2010
202-331-8	94-43-9	phenylmercury benzoate	30-11-2010
202-865-1	100-56-1	phenylmercury chloride	30-11-2010
202-866-7	100-57-2	phenylmercury hydroxide	30-11-2010
203-068-1	102-98-7	dihydrogen [orthoborato(3-)-O]phenylmercurate(2-)	30-11-2010
203-094-3	103-27-5	phenylmercury propionate	30-11-2010
203-217-0	104-59-6	phenylmercury stearate	30-11-2010
203-218-6	104-60-9	(oleato)phenylmercury	30-11-2010
203-477-5	107-26-6	Bromoethylmercury	30-11-2010
203-478-0	107-27-7	ethylmercury chloride	30-11-2010
203-547-5	108-07-6	(acetato-O)methylmercury	30-11-2010
203-688-2	109-62-6	(acetato-O)ethylmercury	30-11-2010
204-064-2	115-09-3	Chloromethylmercury	30-11-2010
204-560-9	122-64-5	Lactatophenylmercury	30-11-2010
204-659-7	123-88-6	2-methoxyethylmercury chloride	30-11-2010
204-670-7	124-01-6	2-ethoxyethylmercury chloride	30-11-2010
204-678-0	124-08-3	2-ethoxyethylmercury acetate	30-11-2010
205-600-8	143-36-2	Iodomethylmercury	30-11-2010
205-719-5	148-61-8	2-(ethylmercuriothio)benzoic acid	30-11-2010
205-790-2	151-38-2	2-methoxyethylmercury acetate	30-11-2010
207-869-7	498-73-7	Mercurobutol	30-11-2010
207-935-5	502-39-6	1-cyano-3-(methylmercurio)guanidine	30-11-2010
208-057-5	506-83-2	Bromomethylmercury	30-11-2010
208-231-0	517-16-8	N-(ethylmercurio)toluene-4-sulphonanilide	30-11-2010
208-371-2	525-30-4	Mercuderamide	30-11-2010

EC-Number	CAS-Number	Name (as indicated in the pre-registration)	Registration Date (according to ECHA, 2013)
208-672-9	537-64-4	di-p-tolylmercury	30-11-2010
208-716-7	539-43-5	p-tolylmercury chloride	30-11-2010
209-499-1	583-15-3	mercury dibenzoate	30-11-2010
209-534-0	584-18-9	2-hydroxy-5-(1,1,3,3-tetramethylbutyl)phenylmercury acetate	30-11-2010
209-537-7	584-43-0	disuccinimidomercury	30-11-2010
209-606-1	587-85-9	diphenylmercury	30-11-2010
209-656-4	589-65-1	mercury succinate	30-11-2010
209-735-3	591-89-9	dipotassium tetracyanomercurate	30-11-2010
209-741-6	592-04-1	mercury dicyanide	30-11-2010
209-766-2	592-63-2	mercury acetate	30-11-2010
209-773-0	592-85-8	mercury dithiocyanate	30-11-2010
209-805-3	593-74-8	Dimethylmercury	30-11-2010
210-499-9	616-99-9	di-o-tolylmercury	30-11-2010
211-000-7	627-44-1	Diethylmercury	30-11-2010
211-057-8	628-86-4	mercury difulminate	30-11-2010
211-161-3	631-60-7	dimercury di(acetate)	30-11-2010
214-760-8	1192-89-8	Bromophenylmercury	30-11-2010
215-187-6	1310-88-9	dimercury amidatenitrate	30-11-2010
215-191-8	1312-03-4	trimercury dioxide sulphate	30-11-2010
215-629-8	1335-31-5	dimercury dicyanide oxide	30-11-2010
215-696-3	1344-48-5	mercury(II) sulfide	30-11-2010
215-717-6	1345-09-1	Cadmium mercury sulfide	30-11-2010
216-491-1	1600-27-7	mercury di(acetate)	30-11-2010
219-471-0	2440-42-8	Ethyliodomercury	30-11-2010
221-961-4	3294-58-4	(bromodichloromethyl)phenylmercury	30-11-2010
222-673-1	3570-80-7	bis(acetato-O)[μ-(3',6'-dihydroxy-3-oxospiro[isobenzofuran-1(3H),9'-[9H]xanthene]-2',7'-diyl)]dimercury	30-11-2010
227-228-5	5722-59-8	[benzoato(2-)-C2,O1]mercury	30-11-2010
227-596-7	5902-76-1	methyl(pentachlorophenolato)mercury	30-11-2010
227-719-4	5954-14-3	(acetato-O)[3-(chloromethoxy)propyl-C,O]mercury	30-11-2010
228-465-7	6273-99-0	[μ-[orthoborato(2-)-O:O']]diphenyldimercury	30-11-2010
228-497-1	6283-24-5	4-aminophenylmercury acetate	30-11-2010

EC-Number	CAS-Number	Name (as indicated in the pre-registration)	Registration Date (according to ECHA, 2013)
229-867-5	6795-81-9	bis(trichloromethyl)mercury	30-11-2010
231-106-7	7439-97-6	mercury	30-11-2010
231-299-8	7487-94-7	mercury dichloride	30-11-2010
231-430-9	7546-30-7	mercury chloride	30-11-2010
231-873-8	7774-29-0	mercury diiodide	30-11-2010
231-990-4	7783-33-7	dipotassium tetraiodomercurate	30-11-2010
231-992-5	7783-35-9	mercury sulphate	30-11-2010
232-144-7	7789-10-8'	mercury dichromate	30-11-2010
232-169-3	7789-47-1	mercury dibromide	30-11-2010
233-152-3	10045-94-0	mercury dinitrate	30-11-2010
233-160-7	10048-99-4	barium tetraiodomercurate	30-11-2010
233-307-5	10112-91-1	dimercury dichloride	30-11-2010
233-335-8	10124-48-8	aminomercury chloride	30-11-2010
233-886-4	10415-75-5	dimercury dinitrate	30-11-2010
234-306-2	11083-41-3	mercury, compound with titanium (1:3)	30-11-2010
235-108-9	12068-90-5	mercury telluride	30-11-2010
236-315-7	13294-23-0	bis[(trimethylsilyl)methyl]mercury	30-11-2010
239-409-6	15385-57-6	dimercury diiodide	30-11-2010
239-766-8	15682-88-9	disodium tetra(cyano-C)mercurate(2-)	30-11-2010
239-934-0	15829-53-5	"mercurous oxide"	30-11-2010
242-667-2	18917-83-4	bis(lactato-O1,O2)mercury	30-11-2010
243-910-5	20601-83-6	mercury selenide	30-11-2010
244-654-7	21908-53-2	mercury monoxide	30-11-2010
245-006-6	22450-90-4	amminephenylmercury(1+) acetate	30-11-2010
247-783-7	26545-49-3	(neodecanoato-O)phenylmercury	30-11-2010
249-914-3	29870-72-2	cadmium mercury telluride	30-11-2010
251-657-7	33724-17-3	bis[(+)-lactato]mercury	30-11-2010
264-100-8	63325-16-6	diiodobis(5-iodopyridin-2-amine)mercury dihydroiodide	30-11-2010
269-247-1	68201-97-8	(acetato-O)diamminephenylmercury	30-11-2010
281-717-8	84029-43-6	bis(acetato-O)[Î¼-[1,3-dioxane-2,5-diylbis(methylene)-C:C',O,O']]dimercury	30-11-2010
301-792-3	94070-93-6	[μ-[(oxydiethylene phthalato)(2-)]]diphenylmercury	30-11-2010
304-523-8	94276-38-7	bis(5-oxo-DL-prolinato-N1,O2)mercury	30-11-2010

EC-Number	CAS-Number	Name (as indicated in the pre-registration)	Registration Date (according to ECHA, 2013)
304-637-8	94277-53-9	hydrogen µ-hydroxy[µ-[orthoborato(3-)-O:O']]diphenyldimercurate(1-)	30-11-2010
305-388-8	94481-62-6	bis(5-oxo-L-prolinato-N1,O2)mercury	30-11-2010
309-609-9	100403-63-2	Residues, zinc refining flue dust wastewater, mercury-selenium	30-11-2010
310-062-3	102110-61-2	Slimes and Sludges, copper conc. roasting off gas scrubbing, lead-mercury-selenium-contg.	30-11-2010
903-480-8		Reaction mass of cadmium selenide and cadmium sulphide and ethylene and lead and mercury	30-11-2010
905-110-0		Reaction mass of 4,4',6,6'-tetrabromo[1,1'-biphenyl]-2,2'-diol and 4,4'-dibromobiphenyl and 4-bromobiphenyl and butyl acrylate and cadmium and hexabromo-1,1'-biphenyl and lead and mercury and nonabromo-1,1'-biphenyl and tetrabromo(tetrabromophenyl)benzene	30-11-2010
907-375-8		Reaction mass of Carbon black and cadmium and carbon and chromium and diiron trioxide and lead and manganese and mercury and pentaerythritol and titanium dioxide	30-11-2010
912-701-7		Reaction mass of chromium and copper and lanthanum and mercury	30-11-2010
912-708-5		Reaction mass of cadmium and chromium and copper and lead and lithium and mercury and nickel and potassium hydride	30-11-2010
912-719-5		Reaction mass of cadmium and chromium and lead and mercury	30-11-2010
912-904-0		Reaction mass of chromium and copper and mercury and nickel	30-11-2010
			102 substances with deadline 30-11-2010
205-112-5	133-58-4	6-methyl-3-nitrobenzoxamercurete	31-05-2013
205-340-5	138-85-2	sodium 4-hydroxymercuriobenzoate	31-05-2013
205-485-4	141-51-5	iodo(iodomethyl)mercury	31-05-2013
211-458-8	645-99-8	mercury distearate	31-05-2013
214-667-2	1184-57-2	methylmercury hydroxide	31-05-2013
214-741-4	1191-80-6	mercury dioleate	31-05-2013
215-308-2	1320-80-5	chloro(hydroxyphenyl)mercury	31-05-2013
215-651-8	1336-96-5	Naphthenic acids, mercury salts	31-05-2013
218-790-2	2235-25-8	tris(ethylmercury) phosphate	31-05-2013

EC-Number	CAS-Number	Name (as indicated in the pre-registration)	Registration Date (according to ECHA, 2013)
218-909-8	2279-64-3	(phenylmercurio)urea	31-05-2013
220-286-2	2701-61-3	(maleoyldioxy)bis[phenylmercury]	31-05-2013
220-469-7	2777-37-9	chloro-o-tolylmercury	31-05-2013
220-875-4	2923-15-1	mercury(1+) trifluoroacetate	31-05-2013
220-966-9	2949-11-3'	dimercury(I) oxalate	31-05-2013
221-358-6	3076-91-3	chloro[p-[(2-hydroxy-1-naphthyl)azo]phenyl]mercury	31-05-2013
221-700-4	3198-04-7'	sodium 4-chloromercuriobenzoate	31-05-2013
221-960-9	3294-57-3	phenyl(trichloromethyl)mercury	31-05-2013
221-963-5	3294-60-8	phenyl(tribromomethyl)mercury	31-05-2013
222-356-8	3444-13-1	mercury(II) oxalate	31-05-2013
222-834-6	3626-13-9	methylmercury benzoate	31-05-2013
223-288-1	3810-81-9	dimethyl[μ-[sulphato(2-)-O:O']]dimercury	31-05-2013
227-481-1	5857-39-6	chloro-2-thienylmercury	31-05-2013
227-722-0	5955-19-1	chloro-m-tolylmercury	31-05-2013
227-760-8	5970-32-1	[salicylato(2-)-O1,O2]mercury	31-05-2013
231-525-5	7616-83-3	mercury diperchlorate	31-05-2013
231-532-3	7620-30-6	sodium [3-[[(3-carboxylatopropionamido)carbonyl]amino]-2-methoxypropyl]hydroxymercurate(1-)	31-05-2013
231-814-6	7756-49-2	mercury(2+) (9Z,12Z)-octadeca-9,12-dienoate	31-05-2013
231-988-3	7783-30-4	mercury iodide	31-05-2013
231-989-9	7783-32-6	mercury diiodate	31-05-2013
231-993-0	7783-36-0	dimercury sulphate	31-05-2013
231-994-6	7783-39-3	mercury difluoride	31-05-2013
232-045-9	7784-03-4'	mercury disilver tetraiodide	31-05-2013
232-062-1	7784-37-4	mercury hydrogenarsenate	31-05-2013
233-939-1	10451-12-4	phosphoric acid, mercury salt	31-05-2013
235-601-9	12344-40-0	mercury silver iodide	31-05-2013
236-113-9	13170-76-8	mercury bis(2-ethylhexanoate)	31-05-2013
236-250-4	13257-51-7	mercury bis(trifluoroacetate)	31-05-2013
236-326-7	13302-00-6	(2-ethylhexanoato)phenylmercury	31-05-2013
236-694-9	13465-33-3	mercury(1+) bromate	31-05-2013
237-634-4	13876-85-2	dicopper tetraiodomercurate	31-05-2013
237-747-9	13967-25-4	dimercury difluoride	31-05-2013

EC-Number	CAS-Number	Name (as indicated in the pre-registration)	Registration Date (according to ECHA, 2013)
237-918-8	14066-61-6	(2-carboxyphenyl)hydroxymercury	31-05-2013
237-949-7	14099-12-8	mercury dipotassium tetrathiocyanate	31-05-2013
238-316-8	14354-56-4	phenyl(quinolin-8-olato-N1,O8)mercury	31-05-2013
239-548-2	15516-76-4	mercury bis(4-chlorobenzoate)	31-05-2013
242-096-9	18211-85-3	trimercury biscitrate	31-05-2013
242-613-8	18832-83-2	bromo(2-hydroxypropyl)mercury	31-05-2013
242-673-5	18918-06-4	(lactato-O1,O2)mercury	31-05-2013
242-997-7	19367-79-4	[µ-[metasilicato(2-)-O:O]]bis(2-methoxyethyl)dimercury	31-05-2013
244-913-4	22330-18-3	potassium triiodomercurate(1-)	31-05-2013
245-581-3	23319-66-6	[2,2',2''-nitrilotri(ethanol)-N,O,O',O'']phenylmercury lactate	31-05-2013
247-796-8	26552-50-1	hydrogen [3-[(Î±-carboxylato-o-anisoyl)amino]-2-hydroxypropyl]hydroxymercurate(1-)	31-05-2013
247-925-8	26719-07-3	mercury(2+) chloroacetate	31-05-2013
248-355-2	27236-65-3	diphenyl[µ-[(tetrapropenyl)succinato(2-)-O:O']]dimercury	31-05-2013
248-426-8	27360-58-3	(dihydroxyphenyl)phenylmercury	31-05-2013
248-538-7	27575-47-9	mercury fluoride	31-05-2013
248-559-1	27605-30-7	[2-ethylhexyl hydrogen maleato-O']phenylmercury	31-05-2013
248-602-4	27685-51-4	mercury(2+) tetrakis(thiocyanato-N)cobaltate(2-)	31-05-2013
248-828-3	28086-13-7	phenylmercury salicylate	31-05-2013
250-518-8	31224-71-2	(metaborato-O)phenylmercury	31-05-2013
250-736-3	31632-68-5	[naphthoato(1-)-O]phenylmercury	31-05-2013
251-026-6	32407-99-1	phenylmercury dimethyldithiocarbamate	31-05-2013
251-524-3	33445-15-7	diammonium tetrachloromercurate	31-05-2013
251-672-9	33770-60-4	[2,5-dichloro-3,6-dihydroxy-2,5-cyclohexadiene-1,4-dionato(2-)-O1,O6]mercury	31-05-2013
258-195-5	52795-88-7	(2-carboxy-m-tolyl)hydroxymercury, monosodium salt	31-05-2013
259-075-5	54295-90-8	tetrakis(acetato-O)[µ4-(3',6'-dihydroxy-3-oxospiro[isobenzofuran-1(3H),9'-[9H]xanthene]-2',4',5',7'-tetrayl)]tetramercury	31-05-2013
259-779-2	55728-51-3	(2',7'-dibromo-3',6'-dihydroxy-3-oxospiro[isobenzofuran-1(3H),9'-[9H]xanthen]-4'-yl)hydroxymercury	31-05-2013
263-211-9	61792-06-1	[(2-hydroxyethyl)amino]phenylmercury acetate	31-05-2013

EC-Number	CAS-Number	Name (as indicated in the pre-registration)	Registration Date (according to ECHA, 2013)
263-665-8	62638-02-2	mercury hydrogen cyclohexanebutyrate	31-05-2013
264-306-8	63549-47-3	di(acetato-O)anilinemercury	31-05-2013
264-920-6	64491-92-5	hydrogen [metasilicato(2-)-O](2-methoxyethyl)mercurate(1-)	31-05-2013
274-638-5	70514-23-7	Slimes and Sludges, chlorine manuf. mercury cell brine treatment	31-05-2013
275-904-3	71720-55-3	mercury(1+) ethyl sulphate	31-05-2013
276-613-4	72379-35-2	hydrogen triiodomercurate(1-), compound with 3-methyl-3H-benzothiazol-2-imine (1:1)	31-05-2013
293-676-3	91081-69-5	Slimes and Sludges, chlorine manuf. mercury cell process	31-05-2013
293-784-0	91082-69-8	Turpentine, Venice, sulfurized, reaction products with hydrogen tetrachloroaurate(-1), sulfurized turpentine oil and mercurous nitrate, mixed with mercurous oxide	31-05-2013
294-413-5	91722-12-2	Slimes and Sludges, chlorine manuf. mercury cell brine treatment wastewater	31-05-2013
295-924-6	92200-97-0	Mercury, reaction products with stibnite (Sb2S3)	31-05-2013
298-602-3	93820-20-3	diiodo(5-iodopyridin-2-amine-N1)mercury	31-05-2013
299-418-6	93882-20-3	[µ-[[4,4'-(oxydiethylene) bis(dodecenylsuccinato)](2-)]]diphenyldimercury	31-05-2013
301-543-9	94022-47-6	mercury thallium dinitrate	31-05-2013
301-791-8	94070-92-5	[µ-[(oxydiethylene but-2-enedioato)(2-)]]diphenyldimercury	31-05-2013
304-575-1	94276-88-7	Mercurate(1-), [dodecenylbutanedioato(2-)-O']phenyl-, hydrogen	31-05-2013
309-608-3	100403-62-1	Residues, carbon black-ethylene manufg. pyrolysis pitch carbonization	31-05-2013
900-275-5		Reaction mass of antimony and arsenic and barium and cadmium and chromium and dibutyl phthalate and formaldehyde and lead and mercury and selenium	31-05-2013
900-276-0		Reaction mass of antimony and arsenic and barium and chromium and dibutyl phthalate and formaldehyde and lead and mercury and selenium and zinc	31-05-2013
			86 substances with deadline 31-05-2013
906-798-5		Reaction mass of (neodecanoato-O)phenylmercury and butane-1,4-diol	31-05-2018
909-392-6		Reaction mass of diboron trioxide and mercury monoxide	31-05-2018

EC-Number	CAS-Number	Name (as indicated in the pre-registration)	Registration Date (according to ECHA, 2013)
910-320-0		Reaction mass of dimercury amidatenitrate and mercury	31-05-2018
910-560-6		Reaction mass of Vanadium yttrium oxide (VYO4), europium-doped and aluminium oxide and dysprosium triiodide and europium and mercury and nickel and niobium and sodium and sodium iodide and yttrium oxide	31-05-2018
911-619-9		Reaction mass of (neodecanoato-O)phenylmercury and 3-isocyanatomethyl-3,5,5-trimethylcyclohexyl isocyanate	31-05-2018
912-905-6		Reaction mass of mercury and silver	31-05-2018
912-906-1		Reaction mass of mercury and tin	31-05-2018
912-907-7		Reaction mass of bismuth and mercury and tin	31-05-2018
912-908-2		Reaction mass of mercury and zinc	31-05-2018
912-909-8		Reaction mass of bismuth and indium and mercury	31-05-2018
913-777-4		Reaction mass of mercury iodide and potassium iodide	31-05-2018
915-515-4		Reaction mass of (neodecanoato-O)phenylmercury and neodecanoic acid	31-05-2018
			12 substances with deadline 31-05-2018

Appendix 2: Background information to Section 2 on regulatory framework

The following annex provides some background information on subjects addressed in Section 2. The intention is that the reader less familiar with the legal context may read this concurrently with Section 2.

EU and Danish legislation
Chemicals are regulated via EU and national legislations, the latter often being a national transposition of EU directives.

There are four main EU legal instruments:

- Regulations (DK: Forordninger) are binding in their entirety and directly applicable in all EU Member States.
- Directives (DK: Direktiver) are binding for the EU Member States as to the results to be achieved. Directives have to be transposed (DK: gennemført) into the national legal framework within a given timeframe. Directives leave margin for manoeuvering as to the form and means of implementation. However, there are great differences in the space for manoeuvering between directives. For example, several directives regulating chemicals previously were rather specific and often transposed more or less word-by-word into national legislation. Consequently and to further strengthen a level playing field within the internal market, the new chemicals policy (REACH) and the new legislation for classification and labelling (CLP) were implemented as Regulations. In Denmark, Directives are most frequently transposed as laws (DK: Love) and statutory orders (DK: Bekendtgørelser).

The European Commission has the right and the duty to suggest new legislation in the form of regulations and directives. New or recast directives and regulations often have transitional periods for the various provisions set-out in the legal text. In the following, we will generally list the latest piece of EU legal text, even if the provisions identified are not yet fully implemented. On the other hand, we will include currently valid Danish legislation, e.g. the implementation of the cosmetics directive) even if this will be replaced with the new Cosmetic Regulation.

- Decisions are fully binding on those to whom they are addressed. Decisions are EU laws relating to specific cases. They can come from the EU Council (sometimes jointly with the European Parliament) or the European Commission. In relation to EU chemicals policy, decisions are e.g. used in relation to inclusion of substances in REACH Annex XVII (restrictions). This takes place via a so-called comitology procedure involving Member State representatives. Decisions are also used under the EU ecolabelling Regulation in relation to establishing ecolabel criteria for specific product groups.
- Recommendations and opinions are non-binding, declaratory instruments.

In conformity with the transposed EU directives, Danish legislation regulate to some extent chemicals via various general or sector specific legislation, most frequently via statutory orders (DK: bekendtgørelser).

Chemicals legislation

REACH and CLP

The REACH Regulation[2] and the CLP Regulation[3] are the overarching pieces of EU chemicals legislation regulating industrial chemicals. The below will briefly summarise the REACH and CLP

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[2] Regulation (EC) No 1907/2006 concerning the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH)

[3] Regulation (EC) No 1272/2008 on classification, labelling and packaging of substances and mixtures

provisions and give an overview of 'pipeline' procedures, i.e. procedures which may (or may not) result in an eventual inclusion under one of the REACH procedures.

(Pre-)Registration
All manufacturers and importers of chemical substance > 1 tonne/year have to register their chemicals with the European Chemicals Agency (ECHA). Pre-registered chemicals benefit from tonnage and property dependent staggered dead-lines:

- 30 November 2010: Registration of substances manufactured or imported at 1000 tonnes or more per year, carcinogenic, mutagenic or toxic to reproduction substances above 1 tonne per year, and substances dangerous to aquatic organisms or the environment above 100 tonnes per year.
- 31 May 2013: Registration of substances manufactured or imported at 100-1000 tonnes per year.
- 31 May 2018: Registration of substances manufactured or imported at 1-100 tonnes per year.

Evaluation
A selected number of registrations will be evaluated by ECHA and the EU Member States. Evaluation covers assessment of the compliance of individual dossiers (dossier evaluation) and substance evaluations involving information from all registrations of a given substance to see if further EU action is needed on that substance, for example as a restriction (substance evaluation).

Authorisation
Authorisation aims at substituting or limiting the manufacturing, import and use of substances of very high concern (SVHC). For substances included in REACH annex XIV, industry has to cease use of those substance within a given deadline (sunset date) or apply for authorisation for certain specified uses within an application date.

Restriction
If the authorities assess that that there is a risks to be addressed at the EU level, limitations of the manufacturing and use of a chemical substance (or substance group) may be implemented. Restrictions are listed in REACH annex XVII, which has also taken over the restrictions from the previous legislation (Directive 76/769/EEC).

Classification and Labelling
The CLP Regulation implements the United Nations Global Harmonised System (GHS) for classification and labelling of substances and mixtures of substances into EU legislation. It further specifies rules for packaging of chemicals.

Two classification and labelling provisions are:

1. **Harmonised classification and labelling** for a number of chemical substances. These classifications are agreed at the EU level and can be found in CLP Annex VI. In addition to newly agreed harmonised classifications, the annex has taken over the harmonised classifications in Annex I of the previous Dangerous Substances Directive (67/548/EEC); classifications which have been 'translated' according to the new classification rules.

2. **Classification and labelling inventory**. All manufacturers and importers of chemicals substances are obliged to classify and label their substances. If no harmonised classification is available, a self-classification shall be done based on available information according to the classification criteria in the CLP regulation. As a new requirement, these self-classifications should be notified to ECHA, which in turn publish the classification and labelling inventory based on all

notifications received. There is no tonnage trigger for this obligation. For the purpose of this report, self-classifications are summarised in Appendix 2 to the main report.

Ongoing activities - pipeline
In addition to listing substance already addressed by the provisions of REACH (pre-registrations, registrations, substances included in various annexes of REACH and CLP, etc.), the ECHA web-site also provides the opportunity for searching for substances in the pipeline in relation to certain REACH and CLP provisions. These will be briefly summarised below:

Community Rolling Action Plan (CoRAP)
The EU member states have the right and duty to conduct REACH substance evaluations. In order to coordinate this work among Member States and inform the relevant stakeholders of upcoming substance evaluations, a Community Rolling Action Plan (CoRAP) is developed and published, indicating by who and when a given substance is expected to be evaluated.

Authorisation process; candidate list, Authorisation list, Annex XIV
Before a substance is included in REACH Annex XIV and thus being subject to Authorisation, it has to go through the following steps:

1. It has to be identified as a SVHC leading to inclusion in the candidate list[4]
2. It has to be prioritised and recommended for inclusion in ANNEX XIV (These can be found as Annex XIV recommendation lists on the ECHA web-site)
3. It has to be included in REACH Annex XIV following a comitology procedure decision (substances on Annex XIV appear on the Authorisation list on the ECHA web-site).

The candidate list (substances agreed to possess SVHC properties) and the Authorisation list are published on the ECHA web-site.

Registry of intentions
When EU Member States and ECHA (when required by the European Commission) prepare a proposal for:

- a harmonised classification and labelling,
- an identification of a substance as SVHC, or
- a restriction.

This is done as a REACH Annex XV proposal.

The 'registry of intentions' gives an overview of intensions in relation to Annex XV dossiers divided into:
- current intentions for submitting an Annex XV dossier,
- dossiers submitted, and
- withdrawn intentions and withdrawn submissions

for the three types of Annex XV dossiers.

International agreements

OSPAR Convention

[4] It should be noted that the candidate list is also used in relation to articles imported to, produced in or distributed in the EU. Certain supply chain information is triggered if the articles contain more than 0.1% (w/w) (REACH Article 7.2 ff).

OSPAR is the mechanism by which fifteen Governments of the western coasts and catchments of Europe, together with the European Community, cooperate to protect the marine environment of the North-East Atlantic.

Work to implement the OSPAR Convention and its strategies is taken forward through the adoption of decisions, which are legally binding on the Contracting Parties, recommendations and other agreements. Decisions and recommendations set out actions to be taken by the Contracting Parties. These measures are complemented by other agreements setting out:

- issues of importance
- agreed programmes of monitoring, information collection or other work which the Contracting Parties commit to carry out.
- guidelines or guidance setting out the way that any programme or measure should be implemented
- actions to be taken by the OSPAR Commission on behalf of the Contracting Parties.

HELCOM - Helsinki Convention

The Helsinki Commission, or HELCOM, works to protect the marine environment of the Baltic Sea from all sources of pollution through intergovernmental co-operation between Denmark, Estonia, the European Community, Finland, Germany, Latvia, Lithuania, Poland, Russia and Sweden. HELCOM is the governing body of the "Convention on the Protection of the Marine Environment of the Baltic Sea Area" - more usually known as the Helsinki Convention.

In pursuing this objective and vision the countries have jointly pooled their efforts in HELCOM, which is works as:

- an environmental policy maker for the Baltic Sea area by developing common environmental objectives and actions;
- an environmental focal point providing information about (i) the state of/trends in the marine environment; (ii) the efficiency of measures to protect it and (iii) common initiatives and positions which can form the basis for decision-making in other international fora;
- a body for developing, according to the specific needs of the Baltic Sea, Recommendations of its own and Recommendations supplementary to measures imposed by other international organisations;
- a supervisory body dedicated to ensuring that HELCOM environmental standards are fully implemented by all parties throughout the Baltic Sea and its catchment area; and
- a co-ordinating body, ascertaining multilateral response in case of major maritime incidents.

Stockholm Convention on Persistent Organic Pollutants (POPs)

The Stockholm Convention on Persistent Organic Pollutants is a global treaty to protect human health and the environment from chemicals that remain intact in the environment for long periods, become widely distributed geographically, accumulate in the fatty tissue of humans and wildlife, and have adverse effects to human health or to the environment. The Convention is administered by the United Nations Environment Programme and is based in Geneva, Switzerland.

Rotterdam Convention

The objectives of the Rotterdam Convention are:

- to promote shared responsibility and cooperative efforts among Parties in the international trade of certain hazardous chemicals in order to protect human health and the environment from potential harm;
- to contribute to the environmentally sound use of those hazardous chemicals, by facilitating information exchange about their characteristics, by providing for a national decision-making process on their import and export and by disseminating these decisions to Parties.

- The Convention creates legally binding obligations for the implementation of the Prior Informed Consent (PIC) procedure. It built on the voluntary PIC procedure, initiated by UNEP and FAO in 1989 and ceased on 24 February 2006.

The Convention covers pesticides and industrial chemicals that have been banned or severely restricted for health or environmental reasons by Parties and which have been notified by Parties for inclusion in the PIC procedure. One notification from each of two specified regions triggers consideration of addition of a chemical to Annex III of the Convention. Severely hazardous pesticide formulations that present a risk under conditions of use in developing countries or countries with economies in transition may also be proposed for inclusion in Annex III.

Basel Convention

The Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal was adopted on 22 March 1989 by the Conference of Plenipotentiaries in Basel, Switzerland, in response to a public outcry following the discovery, in the 1980s, in Africa and other parts of the developing world of deposits of toxic wastes imported from abroad.

The overarching objective of the Basel Convention is to protect human health and the environment against the adverse effects of hazardous wastes. Its scope of application covers a wide range of wastes defined as “hazardous wastes” based on their origin and/or composition and their characteristics, as well as two types of wastes defined as “other wastes” - household waste and incinerator ash.

The provisions of the Convention center around the following principal aims:

- the reduction of hazardous waste generation and the promotion of environmentally sound management of hazardous wastes, wherever the place of disposal;
- the restriction of transboundary movements of hazardous wastes except where it is perceived to be in accordance with the principles of environmentally sound management; and
- a regulatory system applying to cases where transboundary movements are permissible.

Convention on Long-range Transboundary Air Pollution, CLRTAP

Since 1979 the Convention on Long-range Transboundary Air Pollution (CLRTAP) has addressed some of the major environmental problems of the UNECE (United Nations Economic Commission for Europe) region through scientific collaboration and policy negotiation.

The aim of the Convention is that Parties shall endeavour to limit and, as far as possible, gradually reduce and prevent air pollution including long-range transboundary air pollution. Parties develop policies and strategies to combat the discharge of air pollutants through exchanges of information, consultation, research and monitoring.

The Convention has been extended by eight protocols that identify specific measures to be taken by Parties to cut their emissions of air pollutants. Three of the protocols specifically address the emission of hazardous substances of which some are included in LOUS:

- The 1998 Protocol on Persistent Organic Pollutants (POPs); 33 Parties. Entered into force on 23 October 2003.
- The 1998 Protocol on Heavy Metals; 33 Parties. Entered into force on 29 December 2003.
- The 1991 Protocol concerning the Control of Emissions of Volatile Organic Compounds or their Transboundary Fluxes; 24 Parties. Entered into force 29 September 1997

Eco-labels

Eco-label schemes are voluntary schemes where industry can apply for the right to use the eco-label on their products if these fulfil the ecolabelling criteria for that type of product. An EU scheme (the flower) and various national/regional schemes exist. In this project we have focused on the three most common schemes encountered on Danish products.

EU flower

The EU ecolabelling Regulation lays out the general rules and conditions for the EU ecolabel; the flower. Criteria for new product groups are gradually added to the scheme via 'decisions'; e.g. the Commission Decision of 21 June 2007 establishing the ecological criteria for the award of the Community eco-label to soaps, shampoos and hair conditioners.

Nordic Swan

The Nordic Swan is a cooperation between Denmark, Iceland, Norway, Sweden and Finland. The Nordic Ecolabelling Board consists of members from each national Ecolabelling Board and decides on Nordic criteria requirements for products and services. In Denmark, the practical implementation of the rules, applications and approval process related to the EU flower and Nordic Swan is hosted by Ecolabelling Denmark "Miljømærkning Danmark" (http://www.ecolabel.dk/). New criteria are applicable in Denmark when they are published on the Ecolabelling Denmark's website (according to Statutory Order no. 447 of 23/04/2010).

Appendix 3: Ecolabels

The use of mercury is generally prohibited or restricted in criteria for Eco-labels. The table below gives an overview of in which product groups, mercury and mercury compounds are explicitly targeted by the EU and Nordic eco-labelling schemes.

ECO-LABELS TARGETING MERCURY AND MERCURY COMPOUNDS

Eco-label	Substances	Document title and product group
Nordic Swan	Mercury (Hg)	Nordic Ecolabelling of Primary batteries
	Mercury (Hg)	Nordic Ecolabelling of Rechargeable batteries
	Mercury (Hg)	Nordic Ecolabelling of Car and boat care products
	Mercury (Hg)	Nordic Ecolabelling of Vehicle wash installations
	Mercury (Hg)	Nordic Ecolabelling of Sanitary products
	Mercury (Hg)	Nordic Ecolabelling of Stoves
	Mercury (Hg)	Nordic Ecolabelling of Panels for the building, decoration and furniture industries
	Mercury (Hg)	Nordic Ecolabelling of Floor coverings
	Mercury (Hg)	Nordic Ecolabelling of Small houses, apartment buildings and pre-school buildings
	Mercury (Hg)	Nordic Ecolabelling of Solid biofuel boilers
	Mercury (Hg)	Nordic Ecolabelling of Chemical building products
	Mercury (Hg)	Ecolabelling of Compost bins
	Mercury (Hg)	Nordic Ecolabelling of Imaging equipment
	Mercury (Hg)	Nordic Ecolabelling of Cosmetic products
	Mercury (Hg)	Nordic Ecolabelling of Paper envelopes – Supplementary Module
	Mercury (Hg)	Nordic Ecolabelling of Toys
	Mercury (Hg)	Nordic Ecolabelling of Indoor paints and varnishes
	Mercury (Hg)	Nordic Ecolabelling of Fabric cleaning products containing microfibers
	Mercury (Hg)	Nordic Ecolabelling of Furniture and fitments
	Mercury (Hg)	Nordic Ecolabelling of Dish washers
	Mercury (Hg)	Nordic Ecolabelling of Computers
	Mercury (Hg)	Nordic Ecolabelling of Writing instruments
	Mercury (Hg)	Nordic Ecolabelling of Machines for parks and gardens
	Mercury (Hg)	Nordic Ecolabelling of Candles
	Mercury (Hg)	Nordic Ecolabelling of De-icers
	Mercury (Hg)	Nordic Ecolabelling of Toner cartridges
	Mercury (Hg)	Nordic Ecolabelling of Durable wood
	Mercury (Hg)	Nordic Ecolabelling of Printing companies, printed matter, envelopes and other converted paper products
	Mercury (Hg)	Nordic Ecolabelling of Audiovisual equipment

Eco-label	Substances	Document title and product group
	Mercury (Hg)	Nordic Ecolabelling of Outdoor furniture and playground equipment
	Mercury (Hg)	Nordic Ecolabelling of Washing machines
	Mercury (Hg)	Nordic Ecolabelling of Windows and Exterior Doors
EU Flower	Mercury (Hg)	COMMISSION DECISION of 6 June 2011 on establishing the ecological criteria for the award of the EU Ecolabel for light sources
	Mercury (Hg)	COMMISSION DECISION of 30 November 2009 on establishing the ecological criteria for the award of the Community Ecolabel for textile floor coverings
	Mercury (Hg)	COMMISSION DECISION of 13 August 2008 establishing the ecological criteria for the award of the Community eco-label to indoor paints and varnishes
	Mercury (Hg)	COMMISSION DECISION of 9 July 2009 establishing the ecological criteria for the award of the Community Ecolabel for bed mattresses
	Mercury (Hg)	COMMISSION DECISION of 6 June 2011 on establishing the ecological criteria for the award of the EU Ecolabel for notebook computers
	Mercury (Hg)	COMMISSION DECISION of 9 June 2011 on establishing the ecological criteria for the award of the EU Ecolabel for personal computers
	Mercury (Hg)	COMMISSION DECISION of 21 June 2007 establishing the ecological criteria for the award of the Community eco-label to soaps, shampoos and hair conditioners
	Mercury (Hg)	COMMISSION DECISION of 26 November 2009 on establishing the ecological criteria for the award of the Community Ecolabel for wooden floor coverings
	Mercury (Hg)	COMMISSION DECISION of 30 November 2009 on establishing the ecological criteria for the award of the Community eco-label for wooden furniture
	Mercury (Hg)	COMMISSION DECISION of 16 August 2012 establishing the ecological criteria for the award of the EU Ecolabel for printed paper
	Mercury (Hg)	COMMISSION DECISION of 12 March 2009 establishing the revised ecological criteria for the award of the Community Eco-label to televisions
	Mercury (Hg)	COMMISSION DECISION of 13 August 2008 establishing the ecological criteria for the award of the Community eco-label to outdoor paints and varnishes
	Mercury (Hg)	COMMISSION DECISION of 9 November 2007 establishing the ecological criteria for the award of the Community eco-label to electrically driven, gas driven or gas absorption heat pumps

Survey of mercury and mercury compounds

This survey is part of the Danish EPA's review of the substances on the List of Undesirable Substances (LOUS). The report define the substance groups and present information on the use and occurrence of mercury as such, internationally and in Denmark, brief information on environmental and health effects, on alternatives to the substances, on existing regulation, on monitoring and exposure, waste management and information regarding ongoing activities under REACH, among others.

Kortlægning af kviksølv og kviksølvforbindelser

Denne kortlægning er et led i Miljøstyrelsens kortlægninger af stofferne på Listen Over Uønskede Stoffer (LOUS). Rapporten definerer stofgruppen og indeholder blandt andet en beskrivelse af brugen og forekomsten af kviksølv, internationalt og i Danmark, en beskrivelse af miljø- og sundhedseffekter af stofferne, og viden om alternativer, eksisterende regulering, moniteringsdata, eksponering, affaldsbehandling og igangværende aktiviteter under REACH.

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