

**Guidance on best available
techniques and best
environmental practices**

Introduction

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Introduction

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1 Introduction

1.1 Purpose of document

This document presents guidance related to best available techniques (BAT) and best environmental practices (BEP) to assist parties in fulfilling their obligations under Article 8 of the Minamata Convention on Mercury (hereinafter referred to as “the Convention”), which concerns controlling and, where feasible, reducing emissions of mercury and mercury compounds to the atmosphere from the point sources falling within the source categories listed in Annex D to the Convention. The guidance has been prepared and adopted as required by Article 8: it does not establish mandatory requirements, nor does it attempt to add to, nor subtract from a Party’s obligations under Article 8. Paragraph 10 of Article 8 requires Parties to take the guidance into account, and requires the Conference of the Parties to keep it under review, and update it as appropriate in order to reflect circumstances not currently fully covered in the guidance

In determining BAT, each Party will take account of its national circumstances in accordance with the definition of BAT contained in paragraph 2(b) of Article 2 that explicitly takes into account economic and technical considerations for a given Party or a given facility within its territory. It is recognized that some of the control measures described in this guidance may not be available to all parties for technical or economic reasons. Financial support, capacity building, technology transfer, or technical assistance are made available as elaborated in Articles 13 and 14 of the Convention.

1.2 Structure of the guidance

The guidance is arranged in seven chapters. The present introductory chapter includes general information on the challenges of mercury and the provisions of the Convention, in particular those relevant to mercury emissions to air. It also provides some cross-cutting information, including considerations in selecting and implementing BAT and BEP.

Chapter 2 provides general information on common emission control techniques generally applicable to all the source categories covered by Article 8, and chapter 3 provides information on common elements of monitoring mercury emissions to the atmosphere from these sources.

Chapters 4, 5, 6 and 7 address the source categories listed in Annex D. Each source category is presented in an individual chapter, although guidance on coal-fired power plants and coal-fired industrial boilers is presented in a single chapter, given the similarities in the processes and applicable controls.

Appendix A contains information on some technologies that were considered not to be of sufficient maturity to be included in the body of the guidance but which may be of interest in the future.

Additional information, in the form of case studies, is also available as a separate document, although these case studies do not form part of the formal guidance.

1.3 Chemical forms of mercury

Mercury is an element, but may be found in different chemical forms. The Convention deals with both elemental mercury and compounds of mercury, but only where mercury and its compounds are anthropogenically emitted or released.¹ Inorganic mercury compounds include oxides, sulfides or chlorides, for example. In this guidance, “mercury” refers to both elemental mercury and mercury compounds unless the context makes it clear that a specific form is meant. This is consistent with the scope of Article 8 on emissions, which addresses controlling and, where feasible, reducing emissions of mercury and mercury compounds, often expressed as “total mercury”.

The chemical form of mercury emissions from the categories in Annex D varies depending on source type and other factors. Gaseous elemental mercury is the most common in anthropogenic emissions to the atmosphere (UNEP, 2013). The remaining emissions are in the form of gaseous oxidized mercury or as mercury bound to emitted particles. These forms have a shorter atmospheric lifetime than gaseous elemental mercury and are deposited to land or water bodies more rapidly after their release (UNEP, Global Mercury Assessment, 2003). Elemental mercury in the atmosphere can undergo transformation into oxidized mercury that is more readily deposited.

Mercury can also be found in organic compounds – for example methyl or ethyl mercury, which are the most toxic forms. Organic compounds of mercury are not emitted by the sources covered by Article 8 of the

¹ See Convention text, article 1 and article 2

Convention, but elemental or oxidized mercury, once deposited, can be transformed under certain circumstances into organic compounds by bacteria in the environment.

1.4 Why are we concerned about mercury emissions?

Mercury has been recognized as a chemical of global concern, owing to its long-range atmospheric transport, its persistence in the environment, its ability to bioaccumulate in ecosystems and its significant negative effects on human health and the environment.²

Mercury is toxic to the central and peripheral nervous systems at high concentrations, in both elemental and organic forms, and inhaling mercury vapour can produce harmful effects on the nervous, digestive and immune systems, lungs and kidneys. Even at lower concentrations, organic compounds of mercury can affect developing organs, such as the foetal nervous system. Mercury is also widely found in many ecosystems – elevated levels have been measured in numerous freshwater and marine fish species throughout the world. Mercury is bioaccumulative, and is therefore found in higher concentrations in organisms at the top of the food chain.³ The majority of human exposure occurs through eating fish.

The most significant anthropogenic releases of mercury globally are through emissions to air, but mercury is also released from various sources directly to water and land. Once in the environment mercury persists and circulates in various forms between air, water, sediments, soil and biota. Emissions and releases from virtually any local source add to the global pool of mercury that is continuously mobilized, deposited on land and water, and remobilized. Rivers and ocean currents are also media for long-range transport. Even countries with minimal mercury releases, and areas remote from industrial activity, may be adversely affected. For example, high mercury levels are observed in the Arctic,⁴ far from the sources of any significant releases.

Implementing measures to control or reduce mercury emissions can be expected to realize clear benefits in terms of public health, and for the environment. These benefits have an economic value. Quantified estimates have been made in some countries and regions of the scale of these benefits,⁵ but it is very difficult to make any global estimate of the value of these benefits in monetary terms. Nevertheless, their value is likely to be considerable.

Implementing measures to control mercury emissions will, however, usually involve some cost. There may be either capital costs in installing control technologies, or increased costs in operating and maintaining facilities, or both. The chapters on each of the source categories give examples of these costs for particular facilities, where reliable information is available. The actual costs, however, are likely to depend on the specific circumstances of a facility; thus, the figures quoted should be taken only as a broad indication of the likely scale of costs. For any particular case, specific information will need to be obtained for that particular facility. It is recognized that these costs will generally fall to the operator of the specific facility, while the benefits described above accrue to society in general.

1.5 Sources of mercury emissions covered by this guidance

The Convention is concerned only with anthropogenic emissions and releases of mercury (naturally occurring sources, such as volcanoes, are outside its scope), and Article 8 deals with five specific source categories that are listed in Annex D to the Convention. The initial list contains coal-fired power plants, coal-fired industrial boilers, smelting and roasting processes used in the production of non-ferrous metals,⁶ waste incineration facilities, and cement clinker production facilities. Chapters 4, 5, 6 and 7 describe these processes in detail. Mercury may be emitted from these sources if it is present in the fuels and raw materials used in the associated processes, or in the waste burned in incineration plants.

Emissions to the atmosphere also arise from other sources not listed in Annex D – such as artisanal and small-scale gold mining, which is probably the biggest single source of emissions, or from industrial processes in

² For example, in the preamble to the Convention.

³ Further information about the health effects of mercury may be found at:
<http://www.who.int/mediacentre/factsheets/fs361/en>.

⁴ UNEP (2013) Global Mercury Assessment

⁵ For example, K. Sundseth, J.M. Pacyna, E.G. Pacyna M. Belhaj and S. Astrom. (2010). Economic benefits from decreased mercury emissions: Projections for 2020. *Journal of Cleaner Production*. 18: 386–394 .

⁶ For these purposes, “non-ferrous metals” refers to lead, zinc, copper and industrial gold.

which mercury is used as part of the process, for example as a catalyst. Other articles of the Convention deal with these sources and they are not covered by the present guidance.

The 2013 UNEP Global Mercury Assessment provides estimates of anthropogenic mercury emissions to the atmosphere. The categories used in that assessment do not, however, correspond exactly to those set out in Annex D.

1.6 Relevant provisions of the Minamata Convention

The Convention deals with all aspects of the life cycle of anthropogenic mercury, and its provisions need to be considered as a whole.

There are provisions on mercury supply sources and trade; mercury-added products and manufacturing processes using mercury; artisanal and small-scale gold mining; emissions and releases; environmentally sound interim storage of mercury; mercury wastes; and contaminated sites. There are also provisions on monitoring, inventories, reporting by parties, information exchange, public information, awareness and education, research, development and monitoring, and health aspects. There are also provisions relating to financial resources and capacity-building, technical assistance and technology transfer.

Article 2 of the Convention sets out the following definitions of mercury and mercury compounds, and of best available techniques and best environmental practices:

“(b) ‘Best available techniques’ means those techniques that are the most effective to prevent and, where that is not practicable, to reduce emissions and releases of mercury to air, water and land and the impact of such emissions and releases on the environment as a whole, taking into account economic and technical considerations for a given Party or a given facility within the territory of that Party. In this context:

“‘Best’ means most effective in achieving a high general level of protection of the environment as a whole;

“‘Available’ techniques means, in respect of a given Party and a given facility within the territory of that Party, those techniques developed on a scale that allows implementation in a relevant industrial sector under economically and technically viable conditions, taking into consideration the costs and benefits, whether or not those techniques are used or developed within the territory of that Party, provided that they are accessible to the operator of the facility as determined by that Party; and

“‘Techniques’ means technologies used, operational practices and the ways in which installations are designed, built, maintained, operated and decommissioned;

“(c) ‘Best environmental practices’ means the application of the most appropriate combination of environmental control measures and strategies;

“(d) ‘Mercury’ means elemental mercury (Hg(0), CAS No. 7439-97-6);

“(e) ‘Mercury compound’ means any substance consisting of atoms of mercury and one or more atoms of other chemical elements that can be separated into different components only by chemical reactions”.

Paragraphs 1–6 of Article 8 of the Convention and its Annex D are reproduced below.

Article 8

Emissions

1. This Article concerns controlling and, where feasible, reducing emissions of mercury and mercury compounds, often expressed as “total mercury”, to the atmosphere through measures to control emissions from the point sources falling within the source categories listed in Annex D.

2. For the purposes of this Article:

(a) “Emissions” means emissions of mercury or mercury compounds to the atmosphere;

(b) “Relevant source” means a source falling within one of the source categories listed in Annex D. A Party may, if it chooses, establish criteria to identify the sources

covered within a source category listed in Annex D so long as those criteria for any category include at least 75 per cent of the emissions from that category;

(c) “New source” means any relevant source within a category listed in Annex D, the construction or substantial modification of which is commenced at least one year after the date of:

- (i) Entry into force of this Convention for the Party concerned; or
- (ii) Entry into force for the Party concerned of an amendment to Annex D where the source becomes subject to the provisions of this Convention only by virtue of that amendment;

(d) “Substantial modification” means modification of a relevant source that results in a significant increase in emissions, excluding any change in emissions resulting from by-product recovery. It shall be a matter for the Party to decide whether a modification is substantial or not;

(e) “Existing source” means any relevant source that is not a new source;

(f) “Emission limit value” means a limit on the concentration, mass or emission rate of mercury or mercury compounds, often expressed as “total mercury”, emitted from a point source.

3. A Party with relevant sources shall take measures to control emissions and may prepare a national plan setting out the measures to be taken to control emissions and its expected targets, goals and outcomes. Any plan shall be submitted to the Conference of the Parties within four years of the date of entry into force of the Convention for that Party. If a Party develops an implementation plan in accordance with Article 20, the Party may include in it the plan prepared pursuant to this paragraph.

4. For its new sources, each Party shall require the use of best available techniques and best environmental practices to control and, where feasible, reduce emissions, as soon as practicable but no later than five years after the date of entry into force of the Convention for that Party. A Party may use emission limit values that are consistent with the application of best available techniques.

5. For its existing sources, each Party shall include in any national plan, and shall implement, one or more of the following measures, taking into account its national circumstances, and the economic and technical feasibility and affordability of the measures, as soon as practicable but no more than ten years after the date of entry into force of the Convention for it:

(a) A quantified goal for controlling and, where feasible, reducing emissions from relevant sources;

(b) Emission limit values for controlling and, where feasible, reducing emissions from relevant sources;

(c) The use of best available techniques and best environmental practices to control emissions from relevant sources;

(d) A multi-pollutant control strategy that would deliver co-benefits for control of mercury emissions;

(e) Alternative measures to reduce emissions from relevant sources.

6. Parties may apply the same measures to all relevant existing sources or may adopt different measures in respect of different source categories. The objective shall be for those measures applied by a Party to achieve reasonable progress in reducing emissions over time.

Annex D

List of point sources of emissions of mercury and mercury compounds to the atmosphere

Point source category:

Coal-fired power plants;

Coal-fired industrial boilers;

Smelting and roasting processes used in the production of non-ferrous metals; 1/
Waste incineration facilities;
Cement clinker production facilities.

1/ For the purpose of this Annex, “non-ferrous metals” refers to lead, zinc, copper and industrial gold.

1.7 Considerations in selecting and implementing BAT

The definition of “best available techniques” in Article 2 of the Convention, and set out in section 1.6 above, forms the basis for the determination by a party of BAT for a facility within its territory.

The use of BAT to control and, where feasible, to reduce emissions is required for new sources as defined in paragraph 2 (c) of Article 8 and is one of several measures which a party may use for existing sources, as defined in paragraph 2 (e) of Article 8. A party may apply the same measures to all relevant existing sources or may adopt different measures in respect of different source categories. The present section is intended to support parties in selecting and implementing BAT.

The process for selecting and implementing BAT could be expected to include the following general steps.

- Step 1: establish information about the source, or source category. This may include, but not be limited to, information on the processes, input materials, feedstocks or fuels, and on the actual or expected activity levels, including throughput. Other relevant information could include the expected life of the facility, which is likely to be of particular relevance when an existing facility is being considered, and any requirements or plans for controlling other pollutants.
- Step 2: identify the full range of options of emission control techniques and combinations thereof which are relevant for the source under consideration, including the techniques described in the chapters of this guidance on common techniques and on specific source categories.
- Step 3: among these, identify technically viable control options, giving consideration to techniques applicable to the type of facility within the sector, and also to any physical limitations which may influence the choice of certain techniques.
- Step 4: from these, select the control technique options which are the most effective for the control and, where feasible, reduction of emissions of mercury, taking into account the performance levels mentioned in this guidance, and for the achievement of a high general level of protection of human health and the environment as a whole.
- Step 5: determine which of these options can be implemented under economically and technically viable conditions, taking into consideration costs and benefits and whether they are accessible to the operator of the facility as determined by the party concerned. Note that the options selected may differ for new and existing facilities. The need should also be taken into account for sound maintenance and operational control of the techniques, so as to maintain the achieved performance over time.

1.8 Performance levels

The individual chapters on each of the source categories include information about the performance levels which have been achieved in facilities operating the control techniques described in those chapters, where such information is available. This information is not intended to be interpreted as recommendations for emission limit values (ELVs). An “emission limit value” is defined in paragraph 2 (f) of Article 8 to mean “a limit on the concentration, mass or emission rate of mercury or mercury compounds, often expressed as ‘total mercury’, emitted from a point source.” Paragraph 4 of that Article provides that a party may control and, where feasible, reduce emissions from new sources by setting ELVs that are consistent with the application of BAT. Paragraph 5 of the Article includes ELVs in the list of measures, one or more of which parties may select for application to their existing sources. If a party chooses to use ELVs, it should consider similar factors to those described in the previous section in relation to the selection and implementation of BAT.

Guidance on how parties may choose to determine goals and set ELVs for existing sources under the Convention may be found in a separate document, entitled: “Guidance on support for Parties in implementing the measures set out in paragraph 5, in particular in determining goals and in setting emission limit values” (in preparations as at September 2015).

1.9 Best environmental practices

The Convention defines “best environmental practices” as “the application of the most appropriate combination of environmental control measures and strategies”.

Good maintenance of facilities and measurement equipment are important to the effective operation of control and monitoring techniques. Well-trained operators, who are aware of the need to pay attention to the processes, are indispensable to ensuring good performance. Careful planning and commitment from all levels within the organization operating the facility will also help to maintain performance, as will administrative controls and other facility management practices.

Information on BEP specific to each source category is provided in the respective chapters on those source categories.

1.10 Cross-media effects

Mercury emissions from the source categories listed in Annex D can be controlled or reduced using the techniques described in this guidance. Information on cross-media effects relevant to each source category is provided in the respective chapters on those source categories. The mercury that is removed from flue gases will appear elsewhere – for example, in solid phases such as fly ash or bottom ash, or in liquid or solid-liquid mixed phases such as sludge. Because mercury may be more concentrated in these materials than in input materials, care should be taken to avoid the potential for mercury release through leaching, or cross-media transfers of mercury and other constituents of concern resulting from the disposal of such residues, or from their use as components in other processes. In defining BAT/BEP at the national level, regulators should take into account these factors. Other articles of the Convention may be relevant, in particular Article 11, on mercury wastes.

1.11 Multi-pollutant control techniques

There are techniques that may be used to control the emissions of a range of pollutants, such as particulate matter, organic pollutants, SO_x and NO_x, and heavy metals, including mercury. Consideration should be given to the advantages of using techniques capable of controlling several pollutants simultaneously to deliver mercury co-benefits. In assessing these techniques, factors such as efficiency of mercury control, control of other pollutants, and any potential adverse consequences, such as reduced efficiency within the overall system or cross-media effects, should also be considered.

The use of a multi-pollutant control strategy that can deliver co-benefits for the control of mercury emissions is included in paragraph 5 of Article 8 as an option for managing emissions from existing sources.

1.12 Other international agreements

Parties to the Convention may also be parties to other relevant global or regional multilateral environmental agreements that may need to be considered alongside the Minamata Convention.

For example, the provisions of the Stockholm Convention on Persistent Organic Pollutants cover many of the same source categories as those listed in Annex D of the Minamata Convention, and countries which are parties to both conventions will therefore need to ensure that they also take account of any relevant provisions of that Convention.⁷

Two relevant agreements to which some parties to the Minamata Convention may also be parties are the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal, and the Convention on Long-range Transboundary Air Pollution adopted within the framework of the United Nations Economic Commission for Europe.

1.12.1 Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal

The goal of the Basel Convention is to protect human health and the environment from the adverse effects resulting from the generation, management, transboundary movements and disposal of hazardous and other wastes.

The implementation of measures to control and reduce mercury emissions can generate wastes that may be hazardous. The handling of these wastes is covered under Article 11 of the Minamata Convention, paragraph 3 of which requires parties to manage mercury wastes in an environmentally sound manner, taking into account

⁷ Detailed guidance on the use of BAT/BEP to meet the requirements of that Convention may be found at <http://chm.pops.int/Implementation/BATandBEP/Overview/tabid/371/Default.aspx>.

the obligations and guidelines under the Basel Convention, and, for parties to the Basel Convention, not to transport mercury wastes across international boundaries except for the purpose of environmentally sound disposal in conformity with that Article and with the Basel Convention. The technical guidelines developed under the Basel Convention on waste management are relevant to the management of sludge and other wastes resulting from the capture of mercury from relevant sources, and could be valuable in minimizing or preventing cross-media effects which may result from poor management of such wastes.⁸

1.12.2 Convention on Long-range Transboundary Air Pollution

The aim of the Convention on Long-range Transboundary Air Pollution is to limit and, as far as possible, gradually reduce and prevent air pollution, including long-range transboundary air pollution, caused by a range of pollutants. Under the Convention, the Protocol on Heavy Metals was adopted in 1998 in Aarhus, Denmark, and entered into force in 2003. It targets three metals: cadmium, lead and mercury. The stationary source categories covered by the Protocol include the relevant sources listed in Annex D to the Minamata Convention.

One of the basic obligations assumed by parties to the Protocol on Heavy Metals is to reduce their emissions for these three metals below their levels in 1990 (or an alternative year between 1985 and 1995). The Protocol aims to reduce emissions of cadmium, lead and mercury from industrial sources (iron and steel industry, non-ferrous metal industry, cement manufacturing, glass manufacturing, chlor-alkali industry), combustion processes (power generation, industrial boilers) and waste incineration. It lays down stringent limit values for emissions from stationary sources and suggests BAT for these sources. The Protocol was amended in 2012 to introduce flexibilities to facilitate the accession of new parties, notably countries in Eastern Europe, the Caucasus and Central Asia. A guidance document on BAT for controlling emissions of heavy metals from the source categories covered by the Protocol was also adopted in 2012.

1.13 UNEP Global Mercury Partnership

The UNEP Governing Council has called for partnerships between governments and other stakeholders as a means of reducing risks to human health and the environment from the release of mercury and its compounds to the environment.⁹ The overall goal of the resulting Global Mercury Partnership is to protect human health and the global environment from the release of mercury and its compounds by minimizing and, where feasible, ultimately eliminating global, anthropogenic mercury releases to air, water and land.

The Partnership currently has eight identified priorities for action (or partnership areas), of which four are particularly relevant to the present guidance: mercury control from coal combustion; mercury waste management; mercury supply and storage; and mercury reduction from the cement industry.

Experience gained within these partnership areas, together with relevant guidance developed within the partnership, has been considered in the development of the present BAT/BEP guidelines.

Further information may be found at:

<http://www.unep.org/chemicalsandwaste/Mercury/GlobalMercuryPartnership/tabid/1253/Default.aspx>

⁸ The technical guidelines are available at <http://www.basel.int/Implementation/Publications/TechnicalGuidelines/tabid/2362/Default.aspx>.

⁹ UNEP Governing Council decision 23/9.