SNAP CODE: **N/A**

SOURCE ACTIVITY TITLE: **PRODUCTS CONTAINING MERCURY**

NOSE CODE: **112.09.14**
112.09.15

NFR CODE:

1 ACTIVITIES INCLUDED

This chapter considers mercury emissions from the manufacturing, use and disposal of products containing mercury.

The main products containing mercury are divided into four categories:

- batteries;
- measuring and control equipment;
- electrical equipment;
- lighting.

The ‘destination’ of these products after their use has been divided into five different pathways including recycling, recovery and different ways of disposal. Emissions of mercury from products which have been disposed in landfill are included in this chapter.

Emissions from incineration and secondary steel/copper production are not covered in this chapter since they are included in chapters in SNAP Group 3 and 9 respectively.

2 CONTRIBUTION TO TOTAL EMISSIONS

Mercury emissions from products containing mercury have been estimated for Western and Eastern Europe by WS Atkins (1997), and are given in Table 2.1, below:

Table 2.1 Estimated annual mercury emissions in Western and Eastern Europe

Source	Western Europe (1995) (tonnes)	Eastern Europe (1995) (tonnes)
Batteries	0.09	0.015
Measuring and Control Equipment	1.81	0.500
Electrical Equipment	0.77	0.125
Lighting	0.21	0.121
Total	**2.88**	**0.761**

(WS Atkins, 1997)

Table 2.2 Contribution to total mercury emissions of the OSPARCOM-HELCOM-UNECE emission inventory *(up to 39 countries)*

Source-activity	SNAP-code	Contribution to total mercury emissions [%]
Mercury thermometers and vapour lamps		0.3 %

The contribution to total mercury emissions from products containing mercury varies significantly from country to country. It has been estimated (AEAT Environment 1998) that the total Hg emission for the UK was 20.5 tonnes in 1995. The contribution to total mercury emissions for the UK in 1995 was estimated to be 2% (AEAT Environment 1998).

3 GENERAL

3.1 Description / Definitions

The sources of emissions representing this sector have been divided into four groups:

1. Batteries, including button cells (used in hearing aids, calculators, photographic equipment etc.);
2. Measuring and control equipment including laboratory and hospital equipment (including thermometers) and devices such as barometers;
3. Electrical equipment;
4. Lighting.

In the third group, mercury is used in a range of electrical equipment, including Level, Multipoled, Thermo and mechanical switches, which are used for railway signals, telecommunications, computer communications and data transmission, portable telephones, burglar alarms and hearing aids.

For lighting, mercury is used in discharge lamps including fluorescent tubes, high pressure mercury vapour, metal halide and high and low pressure sodium lamps.

Other products containing mercury are paints, pharmaceuticals, other medical/health products and dental amalgams, but the emissions from those products are unlikely to be significant and have not been included in the calculations (Maxson 1991).

3.2 Techniques

Not applicable.

3.3 Emissions

Mercury emissions from products containing mercury can derive from the manufacturing process, the different 'final destination' sources after disposal and fugitive emissions from the different stages of the disposal procedure.

Disposal has been divided into 6 different pathways (WS Atkins 1997):

- Recollection/Recycling;
- Incineration/burning of waste including products containing mercury;
- Steel/copper scrap;
- Disposal via landfill;
- Release by breaking;
- Accumulation/recovery.

From the distribution factors tabulated below (Tables 3.1 and 3.2), it is evident that the biggest proportion of the mercury content of products ends up in landfill. In Eastern Europe, a big proportion of the disposed products is openly burnt rather than incinerated, or dumped rather than disposed in a covered landfill.

Table 3.1 Distribution factors for Western Europe

Pathway	Batteries	Measuring and control equipment	Electrical equipment	Lighting
Recollection / recycling	0.3	0.1	0.1	0.1
Incineration	0.14	0.1	0.08	0.09
Steel / copper scrap	0	0	0.1	0
Landfill	0.55	0.4	0.32	0.36
Release by breaking	0.01	0.05	0	0.05
Accumulation / recovery	0	0.35	0.4	0.4

(WS Atkins 1997)

Table 3.2 Distribution factors for Eastern Europe

Pathway	Batteries	Measuring and control equipment	Electrical equipment	Lighting
Recollection / recycling	0	0	0	0
Open burning / incineration	0.495	0.3	0.25	0.275
Steel / copper scrap	0	0	0.1	0
Dumped / Landfill	0.495	0.3	0.25	0.275
Release by breaking	0.01	0.05	0	0.05
Accumulation / recovery	0	0.35	0.4	0.4

(WS Atkins 1997)

Regarding the steel/copper scrap pathway, the electrical equipment that ends up in a steel/copper scrap are fragmentised and the steel/copper parts recycled. Mercury may also be emitted through the fragmentisation process.

Additionally, mercury is emitted via the incineration of wastes that include products containing mercury. Emissions from recycling of steel/copper scrap and from incineration are covered in other chapters.

Studies (Maxson 1991 and WS Atkins 1997) have considered the recovery of mercury from products as a separate destination before disposal. It can be assumed that the currently recovered mercury will be disposed and potentially emitted through the above mentioned pathways in the future. This additional emission has not been included in the calculation of mercury emission factors in this chapter.

In summary, the annual mercury emissions from products have been calculated by considering emissions from landfills and releases from the breaking of products containing mercury. Mercury emissions from the manufacturing process of products containing mercury, the recycling process and the fragmentisation of the electrical components that end up in a metal scrap are considered to be relatively low and are not included in the calculation of mercury emissions. Future emissions from currently recovered mercury has not been considered either.

Figure 3.1 Pathways of emission sources in Western Europe

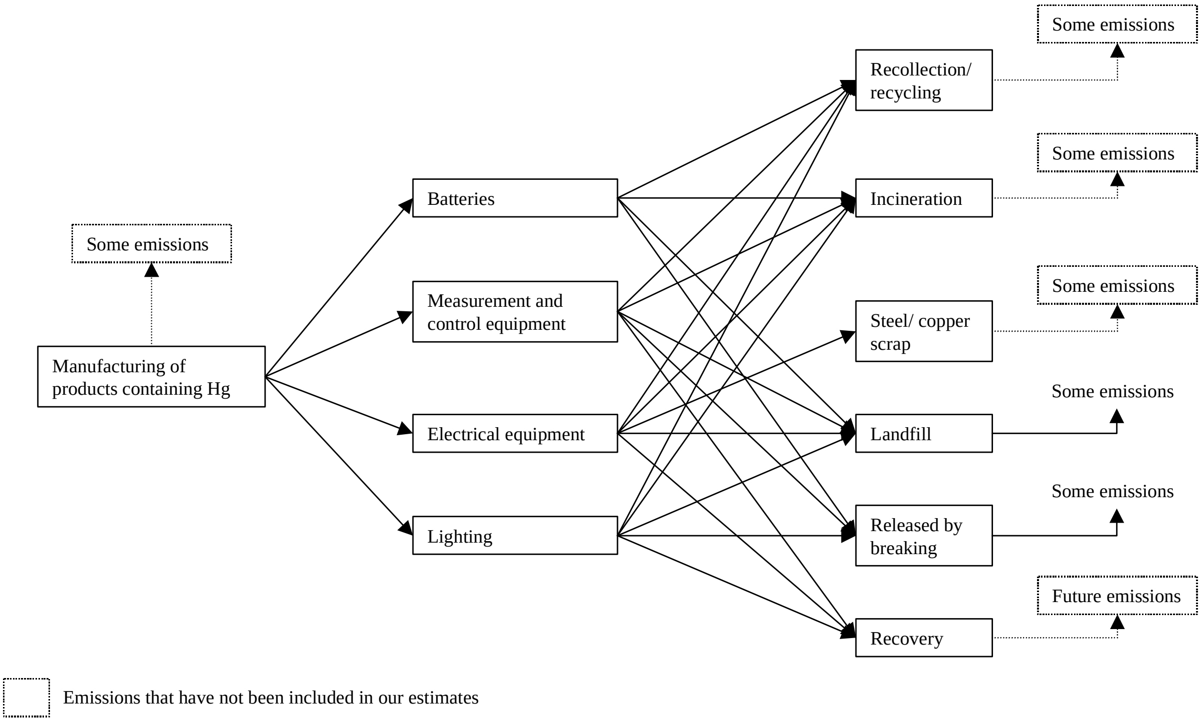
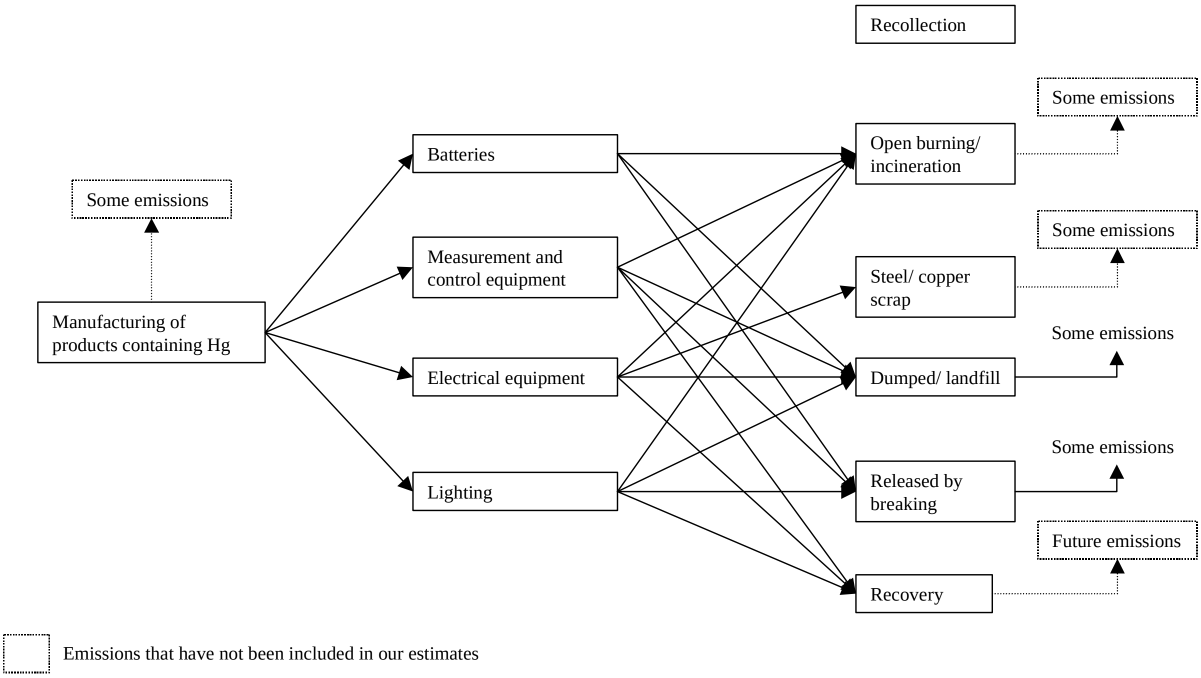


Figure 3.2 Pathways of emission sources in Eastern Europe



The emission factors differ depending on the product and destination. In general, the emission factors are higher in Eastern Europe, mostly because of less modern technology (WS Atkins 1997).

Considering the fact that almost 50% of the products containing mercury end up in the landfill in Western Europe, landfills/dumping can be considered as the major source of mercury emissions for the whole of UNECE.

3.4 Controls

Options to reduce mercury emissions from this sector include:

- Banning/phasing out of the production and sale of products containing or needing metallic mercury for their functioning;
- Limitation of the amount of mercury in products.

These will depend on the availability of substitutes not containing mercury and the actual need to use products containing mercury in the future.

3.4.1 Batteries

Since 1990, mercury consumption in primary batteries has declined significantly in the EU due to the introduction of the Directive 91/157/EEC on batteries and accumulators containing certain dangerous substances. The Directive came into force in 1994 (NSCA 1998).

The Directive covers, amongst the other types of batteries, the commonly used alkaline-manganese energy cell, the zinc-carbon battery, the zinc-air button cell as well as the silver oxide button cell and the mercuric oxide battery (two small battery types which also contain mercury). Most of mercury-oxide batteries can be substituted by zinc-air (whose power characteristics are being improved rapidly), silver-oxide and lithium batteries. Zinc-carbon and a significant percentage of alkaline-manganese batteries will soon be mercury-free (Maxson 1991). Silver Oxide batteries, are being recycled by jewellers and watch repairers and mercuric oxide batteries (used in hearing aids) are declining in number (Haigh 1995).

Consequently, the biggest part of current mercury emissions from batteries in the EU originates from special purpose mercury button cells.

3.4.2 Measuring and control equipment

Until now there is no legislation regarding the consumption of mercury in measuring and control equipment. Studies have shown that mercury thermometers are likely to be replaced by digital electronic ones or heat sensitive instruments based on liquid crystals (Maxson 1991).

3.4.3 Electrical Equipment and Lighting

There is no legislation regarding electrical equipment and lighting.

Two Directives establishing the ecological criteria for the award for the Community eco-label to single-ended (95/533) and double ended (96/337) light bulbs can probably be used as an incentive towards the reduction of the use of mercury in these products.

Due to the likely forthcoming legislation, some industry is trying to find mercury-free substitutes, in order to reduce the use of mercury in different items. For example in the electrical equipment category, mercury usage in reed switches is being phased out, but mercury is still used in tilt switches in the automotive industry.

Consumption estimates for fluorescent tubes in the mid-1990s, based on 1989 figures, have found that the levels had remained almost unchanged. In Western Europe, mercury consumption in individual lamps is declining, but use of fluorescent lamps is increasing slightly. It has been estimated, that since 1990, mercury consumption in lamps has declined by about a third (WS Atkins 1997). Additionally, discharge lamps are more energy efficient than incandescent lamps and their longer life contributes to lower mercury emissions in electricity generation (WS Atkins 1997).

4 SIMPLER METHODOLOGY

The simpler methodology involves the combination of emission factors according to different category from the four product types mentioned earlier (e.g. Hg emissions per million population) with activity statistics (e.g. population of each country for a certain year). Equation (1) gives an example of the simple methodology:

$$\text{Total Emission} = \sum_{\text{different products}}[\text{Hg emission per capita}] \times [\text{Population}] \qquad (1)$$

Emissions from the manufacturing process, the recycling and the fragmentisation stages are not included.

5 DETAILED METHODOLOGY

The detailed methodology for Hg emissions may initially involve a mercury audit to find out the amount of the Hg content in different products and the amount of products sold per year. Collection of data can take place by sector after the manufacturing plants have been located. Estimates for each sector would be combined to give a more accurate estimate of the total emission.

Audits on the destinations of the different products have to be carried out for better estimates on the distribution factors.

Emissions from the manufacturing process should be added. Also, emissions from the recycling process of products that have been recollected, as well as an estimate of emissions from the fragmentisation of products that end to the metal scrap, can be included.

Equation (2) is an example of how to calculate Hg emissions for each category:

$$\begin{aligned}
[\text{Hg emission}]_{\text{product}} = \; & \{[\text{Mass of Hg used in each item}] \times [\text{Items consumed per year}]\} \times \\
& \sum_{\text{Distribution f(pathway)}}\{[\text{Distribution factor}]_{\text{Distribution f(pathway)}} \times [\text{Emission factor}]_{\text{Distribution f(pathway)}}\} + \\
& [\text{Emissions from manufacturing process}]_{\text{product}} \times [\text{Number of manufacturing plants}]_{\text{product}} + \\
& [\text{Emissions from recycling process after recollection}]_{\text{product}} + \\
& [\text{Emissions from fragmentisation of metal scrap}] \qquad (2)
\end{aligned}$$

However, it is unlikely that information is available at present to enable the detailed methodology to be used in order to improve emissions estimated by the simple method.

6 RELEVANT ACTIVITY STATISTICS

6.1 Simpler methodology

The simpler methodology requires the following activity statistics:

- population of the country

6.2 Detailed methodology

The detailed methodology requires the following activity statistics for each plant:

- mass of mercury contained in products containing mercury per year;
- amount of items consumed per year;
- number of plants producing products containing mercury;
- details about the extent of recollection/recycling;
- details about the fragmentisation process.

For some countries, national statistics are not easy to obtain and it may be necessary to directly contact manufacturing plants and trade organisations.

7 POINT SOURCE CRITERIA

The biggest part of the emissions for the whole of Europe derives from the landfills or because products have been dumped. Therefore, landfills should be considered as a point source where site specific data are available. Otherwise they should be considered as area sources.

As the contribution of the mercury emissions from products containing mercury to the overall mercury emissions represents only a small percentage, other emission pathways covered by this chapter can be considered as an area source.

8 EMISSION FACTORS, QUALITY CODES AND REFERENCES

8.1 Simpler Methodology

Table 8.1 Emission Factors for Hg from products containing Hg

Compound	Product	Emission factor (tonnes per million population)		Data Quality	Reference
		Western Europe	Eastern Europe		
Hg	Batteries	0.0002	0.00004	E	WS Atkins 1997
Hg	Measurement and control equipment	0.0044	0.0013	E	WS Atkins 1997
Hg	Electrical equipment	0.0019	0.0003	E	WS Atkins 1997
Hg	Lighting	0.0005	0.0003	E	WS Atkins 1997

8.2 Detailed Methodology

Emission factors should be derived through any measurement data. However, these are unlikely to be available in sufficient detail to improve emission estimated by the simple method.

9 SPECIES PROFILES

Species profiles are not applicable.

10 UNCERTAINTY ESTIMATES

There is an uncertainty in estimating mercury emissions from mercury containing products:

- during the manufacturing process;
- during the recycling process, after products containing mercury have been recollected;
- during the fragmentisation stage of the products containing mercury that have ended in a steel/copper scrap.

There is also much uncertainty in the distribution factors, the emission factors and the activity statistics.

11 WEAKEST ASPECTS/PRIORITY AREAS FOR IMPROVEMENT IN CURRENT METHODOLOGY

The weakest aspect of the methodology is the accuracy of the emission factors and the lack of field-based emission data.

The recommended emission factors should be improved through measurement. However since there is a difficulty in making these measurements, activity data should be investigated first. If the investigation shows that activities are decreasing, then it will be less necessary for measurements to be carried out.

The EPBA (1992) report suggests that emissions via disposal of dental amalgams might be as significant as some of the main four product categories, and this needs to be reviewed.

If the chapter on landfills (90400) is updated to include mercury emissions, then the potential for double counting should be addressed.

12 SPATIAL DISAGGREGATION CRITERIA FOR AREA SOURCES

Mercury emissions from products may be considered to be distributed according to population. However, given that most of the emissions come after the products have been disposed and particularly from landfills, a significant improvement in the spatial disaggregation would be made if the main territorial units were identified according to landfills.

The figures that derive from landfills have to then be combined with the population that uses the specific landfill.

In case landfill locations are not available, population should be used for measuring emissions from all sources.

13 TEMPORAL DISAGGREGATION CRITERIA

Unless better information is available, emissions may be considered to occur evenly through out the diurnal and annual cycles. However, emissions of mercury are likely to vary with temperature.

14 ADDITIONAL COMMENTS

No additional comments.

15 SUPPLEMENTARY DOCUMENTS

No supplementary documents are required.

16 VERIFICATION PROCEDURES

Verification of the emission factors given for the simple methodology should involve the audit-type activities described as the detailed methodology (section 5).

17 REFERENCES

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20 POINT OF ENQUIRY

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