



Emissions of mercury, PAHs, dioxins and PCBs related to NFR 3

“Solvent and Other Product Use
in Nordic countries”

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Preface

There are a large number of sources to atmospheric emissions of mercury, PAHs, dioxins and PCBs; some are direct through industrial activities and via consumer use of products and others are indirect, e.g. via disposal or incineration of pollutant containing products and materials. Emissions related to the use of products are to a limited extent covered by international conventions. For example POP and heavy metal emissions are under the existing reporting obligations of the Convention on Long-Range Transboundary Air Pollution (CLRTAP). Existing emission inventories are, however, not covering all relevant sources. There is therefore a need for improved emission inventories of chemicals that are known to be highly critical for humans and the environment. The information included on ways to reduce emissions may also be useful in other regions.

Mercury, PAHs, dioxins and PCBs are some of the most toxic chemicals that are present in industrial activities and consumer products. Although there are legally binding instruments in force within the Nordic countries, the EU and globally, which aim to limit the use and spreading in the environment and the exposure to humans, they are still found in various consumer products and occur in the environment. This joint Nordic project contributes to improving the emission inventories for mercury, PAHs, dioxins and PCBs, which will help the Nordic countries to assess whether they reach the overall environmental objective of clean and healthy surroundings and several targets in the Nordic Environmental Action Programme 2009–2012 and the international air quality conventions, such as CLRTAP.

This project “Emissions of mercury, PAHs, dioxins and PCBs related to NFR 3 Solvent and Other Product Use in Nordic countries” was funded by the Nordic Council of Ministers, the Climate and Air Quality Group. The project was initiated in May 2010 and in March 2011 the report was finalized. Four Nordic countries were represented in the project by the persons responsible for performing the emission inventories for category NFR 3 “Solvent and Other Product Use”:

- Denmark: *Patrik Fauser*, National Environmental Research Institute (NERI), Aarhus University.
- Finland: *Kristina Saarinen*, Finnish Environment Institute SYKE.
- Norway: *Kristin Aasestad*, Statistics Norway.
- Sweden: *Helena Danielsson*, IVL Swedish Environmental Research Institute.

The report covers the emission inventory procedures in the Nordic countries. It also lists various ways to limit emission, which may be applicable in other areas. The report is mainly aimed at experts performing the national emission inventories, but also policy makers and the general public may find information on sources to emissions, working procedures for emission inventories and on measures implemented on an international and national level for reducing emissions.

It is our hope that the report will make a significant contribution to the Nordic and international co-operation on the efforts to reduce the emissions of these toxic chemicals to the atmosphere.

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Project Leader

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Summary

The NFR 3 sector “Solvent and Other Product Use” contains many sources of emissions to mercury (Hg), Poly Aromatic Hydrocarbons (PAH), dioxins (PCDD/F) and Poly Chlorinated Biphenyls (PCB). No single source in this sector is the dominant pollutant source; however the sum of all sources may be significant overall. Due to data gaps both on activity data and emission factors it is not possible to quantify the actual emissions.

This survey compiles the present information and data structures and highlights the data gaps where resources must be put in order to reach more complete and accurate air emission inventories for these priority pollutants. The work can facilitate the development of more complete guidelines, from which national emission inventories will benefit.

Mercury

Denmark: A substance flow analysis has been undertaken for 2001 data. This is the most comprehensive study made for Danish conditions. Product and activities may have changed since 2001, but the study gives an important quantitative assessment of which sources are significant and must be emphasised in coming years. Mercury emissions are still decreasing due to ban and out phasing, but there are still products in circulation in the Danish society, which give unintentional emissions from use and disposal. The Solvent and Other Product Use sector contributes with approximately 3% of the overall emissions to air of 820–2000 kg mercury/year based on 2001 data. Conclusions from the present study are that updated activity data and emission factors should be obtained for the most dominant sources; e.g. dental amalgam fillings, light sources, manometers and gauges. Personal care products and pesticide manufacture were not included in the 2001 study and should also be assessed.

Finland: The Finnish inventory includes mercury emissions from all combustion sources (49%), automobile tyre and brake wear (3%), mineral industry (3%), chemical industry (7%), iron and steel industry (31%), non-ferrous metals and other metal production processes (0.8%), product use (<0.1%) and waste sector (6%). No other relevant national sources of mercury are estimated to be missing except possible emissions from the use of pharmaceuticals and cosmetics, electrical equipment containing mercury and light sources.

Norway: Mercury emissions to air are decreasing due to lower emissions from the industry. Emissions are also decreasing due to ban and out phasing, but there are still products in circulation in the society, which give unintentional emissions from use and disposal. The Solvent and Other Product Use sector contributes with approximately 5% of the overall emissions to air of 513 kg Mercury in 2009. Personal care products, fire-works and pesticide use and manufacture should also be assessed.

Sweden: In the European Commission D-G Environment report "Options for reducing mercury use in products and applications, and the fate of mercury already circulating in society" (2008) the most important areas of consumption of mercury in industrial processes and products in the EU is presented. According to this report the chlor-alkali production represents over 40% of the total amounts used. Other important areas of use are light sources (3%), batteries (4%), dental amalgams (24%), measuring equipment (3%), switches, relays (0.1%), chemicals (10%) and miscellaneous uses (15%, representing i.e. porosimetry and maintenance of lighthouses). The Swedish inventory covers mercury emissions to air from the chlor-alkali production (reported in 2B5) and partly mercury emissions from dental amalgam (emissions from cremation reported in 3D3) but covers currently not emissions of mercury from light sources, batteries, measuring equipment, electrical switches and relays, chemicals and from other miscellaneous uses. To conclude, activity data and emission factors for estimations of mercury emissions are not yet available and have to be obtained for the most relevant emission sources in Sweden (electrical switches and relays, light sources, laboratory chemicals and equipment).

PAH

Denmark: No PAH emissions to air for NFR 3 have been included yet. However, Statistics Denmark and SPIN holds information on many products and some industrial categories, which can be used as activity data. Focus will be on PVC products, natural and synthetic rubber products, wood preservation and creosote operations. The recent project on PAHs in toys and child care articles (Hoffman et al., 2011 in press) presents concentrations of PAHs in products. Still emission factors to air from production, manufacturing and use are missing.

Finland: The Finnish inventory includes PAH-4 emission estimates from all combustion sources (92%), transport (7%), metal and forest industries (0.1%), product use (0.2%) and waste sector (0.6%). PAH-4 emissions from the tyre and brake wear as well as from road abrasion are not estimated due to lack of data suitable for the existing method; however, efforts are made to include these emissions in the next years while the emissions are expected to contribute around 1% to the total

emissions. It is therefore concluded that the major sources are already included in the PAH-4 inventory.

Norway: Emissions from Solvent and other product use contributed to less than 1 per cent of the total emission of PAH-4 for Norway in 2009. Of the sources in Table 2, Norway is currently reporting PAH emissions from flaring of natural gas in NRF 1B2a and from use of rubber tyre in NRF 1A3b vi. Emissions from Creosote treated materials, tarry jointing paste and production of asphalt are reported under 3C, while emissions from tobacco smoking is reported under 3D. Toys should also be assessed.

Sweden: The Swedish reporting of PAHs sums up to around 13 Gg for 2009. Of the sources in Table 2 Sweden is currently reporting PAH emissions from coke production in NRF 1B1b, refining in NRF 1B2a iv and from use of rubber tyre in NRF 1A3b vi. Emissions from tobacco smoking can readily be estimated by using national statistics and emission factor from EMEP/CORINAIR Guidebook (2009). Efforts should be made to compile data for estimations of PAH emissions from manufacturing of rubber tires.

Dioxins

Denmark: A substance flow analysis was performed for the dioxin circulation in the Danish society for the period 2000 to 2002. No such detailed investigation has been performed in more recent years. The emissions have decreased with approximately 8% compared with 1998–1999 level primarily caused by lower emissions from steel, aluminium and cable scrap reclamation and hazardous and municipal waste incineration. Formation of dioxins is predominantly related to combustion processes, and the Solvent and Other Product Use sector contributes with approximately 6% of the total emissions to air of 11–163 g I-TEQ/year based on 2000–2002 data. In conclusion updated activity data and emission factors should be retrieved for PCP-treated wood and for manufacture and use of currently not assessed products; e.g. PVC, rubber, bleaching agents, printing circuit boards containing brominated flame retardants, dioxazine dyes and pigments.

Finland: The Finnish inventory includes dioxin emission estimates from all combustion sources (55%), transport (24%), mineral industry (2%), chemical industry (0.4%), metal industry (16%), product use (<0.1%) and waste sector (2%). It is estimated that no major sources are missing from the dioxin emission inventory.

Norway: Emissions from Solvent and other product use contributed to less than 1 per cent of the total emission of dioxins for Norway in 2009. Of the sources in Table 2 Norway is currently reporting emissions of dioxins from manufacturing of chemical products in NRF 2B5. Emis-

sions from production of asphalt are reported under 3C, and emissions from combustion of tobacco are reported under 3D. Fireworks should also be assessed.

Sweden: Sweden covers the main sources of dioxin emissions to air. For 2009 Sweden reports in total around 36 g of which over 90% is reported in NRF 1. Some probably minor sources to be reported in NRF 3 are not currently included. Dioxin from PCP treated wood products, from production of rubber, from tobacco smoking and from use of fireworks are today not included in the emission inventory. Activity data and emission factors are available for estimations of dioxin from tobacco smoking. Emission factor for estimations of emissions from the use of fireworks have to be obtained as activity data and emission factor for dioxin emissions from rubber manufacturing and PCP treated wood. Also activity data and emission factors for estimates of dioxin emissions from brominated flame retardants manufacturing have to be obtained.

PCB

Denmark: No substance flow analysis has been made for PCBs in Denmark. Surveys have primarily dealt with specific activities, such as energy production, mobile sources and waste disposal. No PCB air emission inventories for the use of product categories are available for Danish conditions. However, even though PCB in consumer products is banned the SPIN database and Statistics Denmark may hold use data for some relevant product categories where PCB may still be present and which may serve as activity data in an emission inventory. Emission factors for the chemical industry are not available at present. In the EMEP/EEA guidebook (EMEP, 2009) there is a Tier 1 default emission factor for category NRF 2F Consumption of Persistent Organic Pollutants and Heavy Metals of 0.1 g PCB/capita, which constitutes an average value of estimated emission factors for leaks from transformers and capacitors for European countries in 1990 (EMEP, 2009; Berdowski et al., 1997). The Tier 1 emission factor thus comprise some of the sources relevant to the Solvent and Other Product Use sector but also includes recycling of ferrous scrap, which falls outside this sector. In conclusion activity data and emission factors should be found for; manufacture and processing of chlorinated organic chemicals, use of transformers, capacitors, heat transfer systems, paints, adhesives, sealants and other products that may show to apply significant emissions to air.

Finland: The Finnish inventory includes PCB emission estimates from all combustion sources (16%), transport (12%), mineral industry (1.5%), metal industry (8%) and waste sector (62%). PCB emissions from the use of product are currently not included in the inventory and may contribute to some extent to the total emissions.

Norway: There is an ongoing project estimating emissions of PCB to air. This project has primarily dealt with specific activities, such as energy production, mobile sources and waste disposal. No PCB air emission inventories for the use of product categories are available. Emissions from PCB-containing materials in buildings should also be assessed.

Sweden: A Swedish EPA report estimates that a total of 175 to 585 tonnes are bound in materials and equipment's in buildings. Lilliehorn & Bernevi-Rex (2010) indicates that the total initial amount of PCBs in buildings was around 260 tonnes of which about 100 tonnes remains to be cleaned. Information of other sources of emissions of PCBs is scarce.

1. Aim

The aim of this study is to improve or initiate the air emission inventories of mercury, PAHs, dioxins and PCBs from sector NFR 3 “Solvent and Other Product Use” in industries and from consumer product use in Denmark, Finland, Norway and Sweden.

The following is done in this project:

- List pollutants that are currently included in the Nordic countries national emission inventories “solvent and other product use” sector.
- Summarise methodology and data availability for calculating emissions to air of currently included pollutants in the Nordic countries.
- Compile gross list of activities, i.e. use of products and industrial processes, that cause emissions to air of mercury, PAHs, dioxins and PCBs, respectively.
- Identify which of above activities that are comprised in the “solvent and other product use” sector.
- Investigate data availability for activity data and emission factors for identified activities. This is done for each country.
- Compile available data. This is done for each country.
- State data gaps, where further investigations are necessary to generate data. This is done for each country.
- State means of actions to reduce emissions of mercury, PAHs, dioxins and PCBs from use in “solvent and other product use” sector.

These activities are specifically relevant for the UNECE-Convention on Long-Range, Transboundary Air Pollution (CLRTAP), e.g. in relation to long-range transport and eco-toxicity in the Arctic. Emissions will be given in Nomenclature For Reporting (NFR) and Selected Nomenclature for Air Pollution (SNAP) and CORE INventory on AIR emissions (CORINAIR) codes.

The gross list of activities that contribute to emissions can be used to prioritise sectors apart from NFR 3 where actions should be taken to improve the national inventories with respect to mercury, PAH, dioxin and PCB emissions.

2. Introduction and background

There is an increasing awareness on the effect of chemicals on the environment, human health and the global climate. Chemicals in focus are i.a. organic compounds and heavy metals, each comprising a large group of chemicals with diverse characteristics in terms of persistence and toxicity towards humans and the environment. They are used in numerous industrial activities in closed and open processes and are comprised in various household consumption products such as cosmetics, detergents, packaging, paints and foodstuff. Some organic compounds occur in the vapour phase at normal ambient conditions and these Non-Methane Volatile Organic Compounds (NMVOCs) are susceptible to increasing the greenhouse effect and long-range transboundary air pollution. Even less volatile chemicals may sorb onto air bound particulate matter, and thus constitute regional and global concern.

PCBs and dioxins are among the most toxic organic chemicals and where the latter is an unwanted bi-product primarily from residential wood burning, fires, municipal waste incineration and steel reclamation, PCBs have been widely used in a number of industrial and commercial products and activities. Although the manufacture, processing and distribution of PCBs have been prohibited in almost all industrial countries since the late 1980s, they are still present in critical levels in indoor air to an extent that is not yet fully monitored. Further critical organic chemicals are PAHs that are produced when materials containing carbon and hydrogen are burned. PAHs are most commonly non-volatile, but are very harmful because of their carcinogenic/mutagenic properties. The heavy metal mercury is also one of the most toxic chemicals that is being used today and although there are legally binding instruments in force within the EU and globally, which aim to limit the use and spreading of mercury in the environment it is still found in various consumer and commercial products.

These chemicals, or pollutants, and the activities and products they are used in give rise to emissions to air. In addition to air pollution the activities may eventually introduce the pollutants in solid waste and in wastewater and affect the recipients; surface water, soil and marine areas.

NMVOC and heavy metal air emissions inventories are part of the national emission inventories, which are prepared and submitted by Member Countries to fulfil the national obligations to United Nations Framework Convention on Climate Change (UNFCCC), the European Commission and CLRTAP. The national monitoring inventories can support the development and validation of the European Monitoring and Evaluation

Programme (EMEP) model for organic compounds and the coupling to the The Regional Air Pollution Information and Simulation (RAINS/GAINS) model developed by the International Institute for Applied Systems Analysis (IIASA).

The current report will include emissions originating from the sources and activities that to a large extent are covered by the national Pollutant Release and Transfer Registers (PRTR) and which are included in the reporting obligations under the above stated international air emission conventions. PRTR is a national or regional environmental database or inventory of potentially hazardous chemical substances and/or pollutants emitted to air, water and soil and transferred off-site for treatment or disposal. The industrial or business facilities quantify and report the amounts of substances emitted to each environmental medium (air, water, soil) or transferred off-site for waste management or wastewater treatment. PRTRs include mainly industrial activities such as energy production, industrial processes, products manufacturing, storage and handling activities, mining, intensive life-stock farming and aquaculture, as well as waste and wastewater handling. Information on emissions from diffuse sources such as transport, residential combustion, and agriculture are also included as part of the PRTRs by some countries, for instance in the European Union. Some PRTRs also include estimates of emissions from diffuse sources, such as agriculture and transport.

Emissions related to the use of products are to a limited extent covered by the international conventions. For example POP and heavy metal emissions from the use of products are under the existing reporting obligations of the CLRTAP, but existing inventories of these currently are often not covering all relevant sources. Compiling activity data and emission factors and estimating emissions from use phase of end-products is therefore a challenge. At the moment the knowledge of emissions from the use of products is restricted to certain product groups and substances. Furthermore, there is not much knowledge of the actual contribution of emissions from the use phase of end-products to the total emissions of most substances/chemicals. However, there is a clear indication that a large part of the national total emissions of certain substances may already originate from the use of products. It is therefore important not to double count emissions from substances that occur in products.

This joint Nordic effort in assessing and improving the emission inventories for mercury, PAHs, dioxins and PCBs related to NFR 3 "Solvents and Other Product Use" will contribute to see if the Nordic countries reach the overall environmental objective of clean and healthy surroundings and several targets in the Nordic Environmental Action Programme 2009–2012: Strengthening the Nordic collaboration and sharing knowledge, focusing on chemicals which can be transported over long distances and have negative effects on human health and the environment, such as Persistent Organic Pollutants (POPs) and heavy

metals (1); Improving air quality and strengthening the international air quality conventions such as CLRTAP (1.3); Identifying and reducing use and emissions of chemicals, such as dioxins, mercury and PCB, that are harmful to marine systems (2.3); preventing negative effects of consumption and production (4); reduction of greenhouse gas emissions (1). Targets in the “Nordisk Strategi for Klima og Miljøgifter i Arktis” will also be dealt with in this project, mainly through information on sources, use and emissions of POPs and heavy metals.

3. Methods and pollutants in current inventories

Industrial activities and use of consumer products and their associated emissions of pollutants that are included in the current national emission inventories “Solvent and Other Product Use” sector under the NFR 3, are listed in Table 1. NMVOCs are most abundantly covered as pollutants in the CLRTAP reporting and also as an indirect greenhouse gas relevant to reporting to the UNFCCC and Kyoto Protocol.

In addition to NMVOCs Finland includes total suspended particulate matter (TSP), PM₁₀ and PM_{2.5} from the use of fireworks, tobacco smoking and car and house fires; HCB from the aggregated use of chlorinated solvents including domestic use; PCDD/F from tobacco smoking, car and house fires; PAH-4s from tobacco smoking, impregnation of wood and use of impregnated wood; As, Cd, Cu, Cr, Pb and Hg from tobacco smoking, and N₂O from use in anaesthetics. Denmark includes NMVOC, N₂O from use of anaesthetics and all CLRTAP pollutants from use of fireworks. In addition to NMVOCs Norway includes PAHs emissions from Creosote-treated materials, tarry jointing paste and PAHs and dioxin emissions from production of asphalt. In the next submission TSP, PM₁₀, PM_{2.5}, PAHs, dioxins, NO_x, CO, Pb, Cd, Hg, As, Cr and Cu will be reported under Other Product Use – Tobacco Smoking. Norway furthermore includes N₂O in various activities and mercury emissions from use of mercury containing products. In addition to NMVOC Sweden also report to CLRTAP TSP, PM₁₀ and PM_{2.5} from tobacco smoking and use of fireworks. To UNFCCC Sweden also report emissions of N₂O from various uses aggregated in Common Reporting Format category CRF 3D4.

Table 1 Activities and uses and associated pollutants included under NFR 3 “Solvent and Other Product Use” in the Nordic countries. Some specific activities are stated in CRF categories.

Reporting code	Product group	Air pollutants included in the national inventories			
		Finland	Denmark	Sweden	Norway
NFR 3A1 Decorative coating application	Domestic use	NMVOC ¹⁾	NMVOC	NMVOC	NMVOC ¹⁾
	Construction and buildings	NMVOC ¹⁾	NMVOC	NMVOC	NMVOC ¹⁾
	Agriculture, forestry, fishing and fish farms	*		NMVOC	
NFR 3A2 Industrial coating application	Manufacture of automobiles ⁵⁾	NMVOC, TSP, PM ₁₀ , PM _{2.5}	NMVOC	NMVOC ²⁾	NMVOC
	Coil coating ⁵⁾	NMVOC	NMVOC	NMVOC ²⁾	NMVOC
	Car repair ⁵⁾	*	NMVOC	NMVOC ²⁾	NMVOC
	Wood ⁵⁾	NMVOC	NMVOC	NMVOC ²⁾	NMVOC
	Other industrial paint application ⁵⁾	NMVOC, TSP, PM ₁₀ , PM _{2.5}	NMVOC	NMVOC ²⁾	NMVOC

Reporting code	Product group	Air pollutants included in the national inventories			
		Finland	Denmark	Sweden	Norway
	Boat building ⁵⁾	NMVOC, TSP, PM ₁₀ , PM _{2.5}	NMVOC	NMVOC ²⁾	NMVOC
NFR 3A3 Other coating application	Other non-industrial paint application	NMVOC	NMVOC	IE (3A1)	NMVOC
NFR 3B1 De-greasing	Metal degreasing ⁵⁾	NMVOC, TSP, PM ₁₀ , PM _{2.5}		IE(3C)	NMVOC
	Other industrial (dry) cleaning ⁵⁾	NMVOC		IE (3C, 3D3)	NMVOC
	Electronic components manufacturing ⁵⁾	NMVOC		IE(3D3)	NMVOC
NFR 3B2 Dry cleaning	Dry cleaning ⁵⁾	NMVOC	NMVOC	NMVOC	NMVOC
NFR 3C Solvents in chemical products manufacture and processing	Polyester processing ⁵⁾	NMVOC	NMVOC	IE (2B5)	NMVOC
	Polyvinylchloride processing ⁵⁾	NMVOC	NMVOC	IE (2B5)	NMVOC
	Polyurethane foam processing ⁵⁾	NMVOC	NMVOC	IE (2B5)	NMVOC
	Polystyrene foam processing ⁵⁾	NMVOC, TSP, PM ₁₀ , PM _{2.5}	NMVOC	IE (2B5)	NMVOC
	Rubber processing ⁵⁾	NMVOC		NMVOC	NMVOC
	Pharmaceutical products manufacturing ⁵⁾	NMVOC, TSP, PM ₁₀ , PM _{2.5}		IE (2B5)	NMVOC
	Paints manufacturing ⁵⁾	NMVOC	NMVOC	NMVOC	NMVOC
	Inks manufacturing ⁵⁾	NMVOC, TSP, PM ₁₀ , PM _{2.5}	NMVOC	NMVOC	NMVOC
	Vehicle manufacturing ⁵⁾			NMVOC ³⁾	
	Glues manufacturing ⁵⁾	NMVOC		IE (2B5)	NMVOC
	Adhesive, magnetic tapes, films & photographs manufacturing ⁵⁾	NMVOC	NMVOC	IE (3D3)	
	Textile finishing ⁵⁾	NMVOC		IE (3D3)	
	Leather tanning ⁵⁾	NMVOC		IE (3D3)	NMVOC
	Other ⁵⁾	NMVOC, TSP, PM ₁₀ , PM _{2.5}	NMVOC	IE (3D3)	NMVOC
	Asphalt blowing ⁵⁾			NE	
	Creosote-treated materials	*		NE	PAH, PAH-OSPAR, PAH-4
	NFR 3D1 Printing	Printing industry ⁵⁾	NMVOC, TSP, PM ₁₀ , PM _{2.5}	NMVOC	NMVOC
NFR 3D2 Domestic solvent use including fungicides	Domestic solvent use (other than paint application)	NMVOC	NMVOC	IE (3D3)	NMVOC
	Personal care products	*	NMVOC ⁴⁾	IE (3D3)	NMVOC
	Pharmaceuticals (see below)	*	NMVOC ⁴⁾	IE (3D3)	NE
	Household cleaning agents	*	NMVOC ⁴⁾	IE (3D3)	NMVOC
	Motor & vehicle cleaning agents	*	NMVOC ⁴⁾	IE (3D3)	NMVOC
	Use of adhesives and sealants	*	NMVOC ⁴⁾	IE (3D3)	NMVOC
	Use of textiles		NMVOC ⁴⁾	IE (3D3)	NE
	Fungicide	HCB	NMVOC ⁴⁾	IE (3C, 3D3)	A part of NMVOC emissions are estimated
Pesticides	HCB	NMVOC ⁴⁾	IE (3C, 3D3)	A part of NMVOC emissions are estimated	
NFR 3D3 Other product use	Glass wool enduction ⁵⁾	NMVOC, TSP, PM ₁₀ , PM _{2.5}	NMVOC ⁴⁾	IE (2A7a)	NMVOC
	Mineral wool enduction ⁵⁾	NMVOC, TSP, PM ₁₀ , PM _{2.5}	NMVOC	IE (2A7a)	NMVOC
	Fat, edible and not edible oil extraction	NMVOC		IE (2D2, only edible)	

Reporting code	Product group	Air pollutants included in the national inventories			
		Finland	Denmark	Sweden	Norway
	Application of glues and adhesives	NMVOC	NMVOC	NMVOC	NMVOC
	Preservation of wood	NMVOC PAH-4		NMVOC	NMVOC
	Underseal treatment and conservation of vehicles	*		NMVOC	NMVOC
	Vehicles dewaxing	*		NMVOC	NMVOC
	Domestic use of pharmaceutical products	*		NMVOC	NE
	Other (preservation of seeds,...): use of pesticides in cultivations and in construction	NMVOC, TSP, PM ₁₀ , PM _{2.5}	NMVOC	NMVOC	NE
	Tobacco smoking	NMVOC, TSP, PM ₁₀ , PM _{2.5} , PCDD/F PAH-4, HM (As, Cd, Cu, Cr, Pb, Hg)		TSP, PM ₁₀ , PM _{2.5}	NMVOC, TSP, PM ₁₀ , PM _{2.5} , PAH, PAH-ospar, PAH-4, dioxins, NOx, CO, Pb, Cd, Hg, As, Cr, Cu
	Tobacco manufacturing ⁵⁾			NMVOC	
	Use of fireworks	TSP, PM ₁₀ , PM _{2.5}	All CLRTAP pollutants are considered	TSP, PM ₁₀ , PM _{2.5}	NE
	Concrete, wall and floor coverings	*		NMVOC	A part of NMVOC emissions are estimated
	transformers and capacitors			NE	NMVOC
	surface coating , sealants and adhesives	*	NMVOC ⁴⁾	NMVOC	NMVOC
	Enclosures and monitors			NE	NMVOC
	Construction and building products use			NMVOC	NMVOC
	Mercury-containing products; Research and development	will be added 2011		NE	Hg
	Mercury-containing products; Health and social work	will be added 2011		NE	Hg
	Mercury-containing products ;Private household	will be added 2011		NE	Hg
	Other, house and car fires	PCDD/F, TSP, PM ₁₀ , PM _{2.5} , HM (As, Cd, Cu, Cr, Pb, Hg)	IE (CRF6D)	NE	
CRF 3D1	Use of N ₂ O for Anaesthesia	N ₂ O	N ₂ O	N ₂ O	N ₂ O
CRF 3D3 & 3D4	Use of N ₂ O, Private household	N ₂ O		N ₂ O	N ₂ O
CRF 3D3 & 3D4	Use of N ₂ O, Research and development	N ₂ O		N ₂ O	N ₂ O
CRF 3D3 & 3D4	Use of N ₂ O, Recreational, cultural and sporting activities	N ₂ O		N ₂ O	N ₂ O

¹⁾ No distinction between domestic paint use and paint use in constructions and buildings

²⁾ Only from paint use

³⁾ NMVOC emissions from other than paint use

⁴⁾ Pollutants are possible to quantify but have not been done yet in the old NFR categories

⁵⁾ Mainly industrial sources

* These subcategories are more or less covered by the domestic use which cannot be disaggregated into the subgroups

Sources included under nfr 3 solvent and other product use in the nordic countries

NE Not estimated

IE Included elsewhere

The methods and data for calculating emissions to air of pollutants stated in Table 1 are summarized below for each country. Full context of the text can be found in the Informative Inventory Reports (IIR) within the framework of commitments under the Convention on Long-range Transboundary Air Pollution (CLRTAP), and to the European Commission within the context of commitments under the NEC directive. Reference is also made to the National Inventory Reports (NIR) for the Climate Convention.

3.1 Denmark

3.1.1 *General procedure for all categories*

Emission modelling of “Solvent and Other Product Use” can basically be done in two ways: 1) By estimating the amount of (pure) solvents, and their associated NMVOCs or pollutants, consumed, or 2) By estimating the amount of solvent containing products consumed, taking account of their solvent, and their associated NMVOCs or pollutants, content (EMEP/CORINAIR, 2004). In 1) all relevant solvents must be estimated, or at least those together representing more than 90% of the total solvent emission, and in 2) all relevant source categories must be inventoried or at least those together contributing more than 90% of the total solvent emission. The detailed method 1) is used in the Danish emission inventory for “Solvent and Other Product Use”, where each pollutant is estimated separately. The sum of emissions of all pollutants equals the total emission. However, when activity data are missing for some pollutants, information on e.g. pollutant containing products are used, which represents method 2).

The pollutants that are covered in the current Danish emission inventory to Kyoto and CLRTAP are chemicals defined as solvents according to the solvent directive; i.e. organic compounds with a vapour pressure of 0.01 kPa at 20° C or at the specific use temperature. The inventory comprises 33 organic chemicals or groups of organic chemical representing more than 95% of the total NMVOC emission from solvent use of the known NMVOCs. Furthermore N₂O used in anaesthesia is included and all CLRTAP pollutants have been inventoried in the NFR 3D3 fireworks category. Mercury, PAHs, dioxins and PCBs are thus new additions for this sector.

Activity data

For each pollutant a mass balance is formulated:

$$\text{Consumption} = (\text{production} + \text{import}) - (\text{export} + \text{destruction/disposal} + \text{hold-up}) \text{ (Eq. 1)}$$

Data concerning production, import and export amounts of pollutants and pollutant containing products are collected from StatBank DK (2010), which contains detailed statistical information on the Danish society. Manufacturing and trading industries are committed to reporting production and trade figures to the Danish Customs & Tax Authorities in accordance with the Combined Nomenclature. Import and export figures are available on a monthly basis from 1995 to present and contain trade information from 272 countries world-wide. Production figures are reported quarterly as “industrial commodity statistics by commodity group and unit” from 1995 to present.

Destruction and disposal of pollutants lower the emissions. In principle this amount must be estimated for each pollutant in all industrial activity and for all uses of pollutant containing products. At present the solvent inventory only considers destruction and disposal for a limited number of pollutants. For some pollutants it is inherent in the emission factor, and for others the reduction is specifically calculated from information obtained from the industry or literature.

Hold-up is the difference in the amount in stock in the beginning and at the end of the year of the inventory. No information on solvents in stock has been obtained from industries. Furthermore, the inventory spans over several years so there will be an offset in the use and production, import and export balance over time.

In some industries the solvents are consumed in the process, e.g. in the graphics and plastic industry, whereas in the production of paints and lacquers the solvents are still present in the final product. These products can either be exported or used in the country. In order not to double count consumption amounts of pollutants it is important to keep track of total solvent use, solvents not used in products and use of solvent containing products. Furthermore some chemicals may be represented as individual chemicals and also in chemical groups, e.g. “o-xylene”, “mixture of xylenes” and “xylene”. Some chemicals are better inventoried as a group of pollutants rather than individual pollutants, due to missing information on use or emission for the individual pollutants. The Danish inventory considers single pollutants, with a few exceptions.

Activity data for pollutants are thus primarily calculated from Equation 1 with input from StatBank DK (2010). When StatBank (2010) holds no information on production, import and export or when more reliable information is available from industries, scientific reports or expert judgements the data can be adjusted or even replaced.

Emission factors

For each pollutant the emission is calculated by multiplying the consumption with the fraction emitted (emission factor), according to:

$$\text{Emission} = \text{consumption} * \text{emission factor}$$

The present Danish method uses emission factors that represent specific industrial activities, such as processing of polystyrene, dry cleaning etc. or that represent use categories, such as paints and detergents. Some chemicals have been assigned emission factors according to their water solubility. Higher hydrophobicity yields higher emission factors, since a lower amount ends in waste water, e.g. ethanol (hydrophilic) and turpentine (hydrophobic).

Emission factors are categorised in four groups in ascending order: (1) Lowest emission factors in the chemical industry, e.g. lacquer and paint manufacturing, due to emission reducing abatement techniques and destruction of solvent containing waste, (2) Other industrial processes, e.g. graphic industry, have higher emission factors, (3) Non-industrial use, e.g. auto repair and construction, have even higher emission factors, (4) Diffuse use of pollutant containing products, e.g. painting, where practically all the pollutants present in the products will be released during or after use.

For a given pollutant the consumed amount can thus be attributed with two or more emission factors; one emission factor representing the emissions occurring at a production or processing plant and one emission factor representing the emissions during use of a solvent containing product. If the pollutant is used in more processes and/or is present in several products more emission factors are assigned to the respective amounts.

Emission factors can be defined from surveys of specific industrial activities or as aggregated factors from industrial branches or sectors. Furthermore, emission factors may be characteristic for the use pattern of certain products. The emission factors used in the Danish inventory also rely on the work done in the joint Nordic project (Fauser et al., 2009).

Source allocation

The Danish Working Environment Authority (WEA) is administrating the registrations of chemicals and products to the Danish product register. All manufacturers and importers of products for occupational and commercial use are obliged to register. The following products are comprised in the registration agreement:

- Chemicals and materials that are classified as dangerous according to the regulations set up by the Danish Environmental Protection Agency (EPA)
- Chemicals and materials that are listed with a limit value on the WEA "limit value list"
- Materials, containing 1% or more of a chemical, which is listed on the WEA "limit value list"
- Materials, containing 1% or more of a chemical, which are classified as hazardous to humans or the environment according to the EPA rules on classification

There are the following important exceptions for products, which do not need to be registered:

- Products exclusively for private use
- Pharmaceuticals ready for use
- Cosmetic products

The Danish product register does therefore not comprise a complete account of used chemicals. Source allocations of exceptions from the duty of declaration are done based on information from trade organisations, industries, scientific reports and information from the internet.

Registrations in the Danish product register are entered in the database for Substances in Preparations in Nordic Countries (SPIN), which comprises information on chemical consumption in industrial categories and product use categories defined according to the Standard nomenclature for economic activities (NACE) system and Use Categories Nordic (UCN). SPIN is the main information source for allocating use amount of chemicals in the “Solvent and Other Product Use” sector. SPIN is by-passed when information is missing, e.g. due to confidentiality, or when expert judgement favours information from, e.g. contact with industries or scientific reports. This is the case for e.g. naphthalene where there are few producers and processing industries and for propane and butane used as propellant, where trade organisations hold reliable information that deviates from SPIN.

Pollutants and categories, with significant emissions, where SPIN and/or Statistics Denmark and the above procedure are by-passed, are mentioned below.

3.1.2 Propane and butane: NFR 3A1 and NFR 3D2

Domestic use of decorative coating application and domestic use of personal care products

Propane and butane are used as propellants in spray paints and in cosmetic products. Use information from Statistics Denmark can not be differentiated from other uses such as heating. Instead data obtained from Aerosol Industriens Brancheforening and Branchen for Kompri-merede Gasser are used with a 20% and 80% distribution in domestic use of spray paints and cosmetic products, respectively. Emission factors of 1 are used for both categories.

3.1.3 Methanol: NFR 3C and NFR 3D3

Various uses in industries and other product use

85% of the use amount of methanol stated in Statistics Denmark can be accounted for by use in various chemical industries. These industries

have been contacted and emission factors have been approximated to a mean of 0.0006. The remaining 15% of the methanol use are assigned according to the use pattern in SPIN.

3.1.4 Pentane: NFR 3C and NFR 3D3

Polyurethane and polystyrene foam processing and other product use

Use amounts of expandable polystyrene pellets and polyurethane, derived from Statistics Denmark, give rise to pentane emissions. Polystyrene pellets comprise approximately 6% pentane of which two thirds are emitted during processing and one third during use of final product. Polyurethane foam processing gives rise to pentane emissions corresponding to 3% of processed polyurethane. Emission factors are obtained from reports and communication with industries.

3.1.5 Ethanol: NFR 3D2

Domestic use of windscreen washing agent

Statistics Denmark reports an import of anti-freezing preparations, some of which comprises ethanol in windscreen washing agents. An approximate annual use of 18 million litres of windscreen washing agent is reported in a Danish inventory presented by the Danish consumer television program "Rabatten", which account for approximately half the imported amount of anti-freezing preparations. This use amount of ethanol in windscreen washing agents is not reflected in SPIN.

3.1.6 Naphthalene: NFR 3C and NFR 3D3

Use in industries and other product use

Naphthalene is only imported and produced by one industry, i.e. Koppers Danmark A/S. Koppers informs that the entire production is exported. Import and export but not export is found in Statistics Denmark and accordingly the information from the industry is used in the inventory.

3.1.7 N₂O: NFR 3D3 and CRF 3D1

Use of N₂O for Anaesthesia

Five companies sell N₂O in Denmark and only one company produces N₂O. N₂O is primarily used in anaesthesia by dentists, veterinarians and in hospitals and in minor use as propellant in spray cans and in the production of electronics. Due to confidentiality no data on produced amount are available and thus the emissions related to N₂O production are unknown. An emission factor of 1 is assumed for all uses, which

equals the sold amount to the emitted amount. Sold amounts are obtained from the respective companies and the produced amount is estimated from communication with the company.

3.1.8 NFR 3D3

Use of fireworks

The cross-border shopping and use of illegal fireworks are assumed negligible. Activity data for the years 1990–2009 are collected from Statistics Denmark, these data are based on information on import and export. The production of fireworks in Denmark is presumed negligible (Danish Pyrotechnical Association). It is also assumed that the effect from irregular stock control is negligible. Letting off fireworks (2008), which is based on Brouwer et al. (1995), is used as source for CH₄, CO₂ and N₂O emission factors. Activity data and emission factors for dioxins, PAHs and PCBs are not available. Mercury emissions are relatively low partly due to the replacement with other metals.

3.2 Finland

The emission inventory for solvent and other product use is based on calculated emission estimates and emission data received from the industry. Emission data reported by the plants according to the emission monitoring programmes in their environmental permits or complied in surveys or from industrial associations' statistics are used in the inventory when available, after it has been cross-checked, for instance by comparing against default emission estimates calculated from statistical data and emission factors.

3.2.1 NFR 3A

Paint application

The inventory covers NMVOC and particle emissions from paint application.

More than 95% of these NMVOC emissions are based on calculations carried out by the Association for Finnish Paint Industry (VTY). The wide majority of Finnish paint producers or importers are members of the Association, which is following the annual sales of paint products in Finland. The paint sales and products statistics is divided into decorative (DIY/architectural) and industrial sectors. For these two sectors, the statistics are further divided into subgroups of several types of products and various types of surface to be painted, such as "waterborne decorative indoor paints" or "solvent borne decorative indoor paints". For each of these subgroups an average NMVOC content and an average density has been estimated by the expert group set by the member companies of

the association. Emissions due to application of paints from those paint manufacturers that do not belong to the association are estimated on basis of replies to questionnaires sent to non-members of the association on their paint production and sales.

The inventory for decorative painting includes paint application in boat building (based on data reported by operators and surveys), domestic paint application (based on estimation by paint industry), constructions and buildings (based on surveys and estimation by paint industry) and other non-industrial paint application (based on surveys).

The inventory of industrial coating application covers paint application in manufacture of automobiles, car repair and coil coating (based on data reported by the plants, on surveys and on estimates by paint industry), paint application on wood (based on surveys and estimation by paint industry, and in other industrial applications reported by plants and based on surveys and estimation by paint industry).

The inventory of particle emissions (TSP, PM₁₀, PM_{2.5}) from spray paint application in industry is based on TSP emissions reported by the plants and domestic fraction factors for PM₁₀ and PM_{2.5} (Karvosenoja, 2002).

3.2.2 NFR 3B

The inventory for degreasing and dry cleaning activities include NMVOC emissions and the inventory for degreasing also particle emissions.

The estimation of emissions is based on import statistics of pure solvents and products containing chlorinated organic solvents and the volume of solvent waste processed in the hazardous waste treatment plants. There is no production of chlorinated organic solvents in Finland. All the solvents used are imported and the annual use is available from the customs statistics. In the calculation it is assumed that all purchased chemicals are used during the year of import. The emission factor 0.7 kg/kg used in the calculation is an expert estimate. The sources estimated include metal degreasing, other industrial cleaning, electronic components manufacturing and dry cleaning activities.

The inventory of particle emissions (TSP, PM₁₀, PM_{2.5}) for chemical in industry is based on TSP emissions reported by the plants and domestic fraction factors for PM₁₀ and PM_{2.5} (Karvosenoja, 2002).

3.2.3 NFR 3C

The inventory for chemical products manufacture and processing includes NMVOC and particle emissions.

NMVOC emission estimates from chemical products manufacture and processing are based on emission data reported by the plants and on information from questionnaires to small and medium sized companies

in the paints, inks and glues manufacturing, pharmaceutical industry, plastic, textile and leather industries as well as rubber conversion. Emissions based on data from replies to the questionnaires on the emission and/or activity data information are calculated.

Paint manufacturing

NMVOC emissions are based on calculated emission estimates and emission data reported by the plants. Majority of paint producers report emissions from the production processes to the supervising authorities and this emission data is used in the inventories. Questionnaires are sent to those companies, which are not obliged to report emissions from their production processes. These emissions are calculated based on information from responses to the questionnaire.

Particulate matter emissions (TSP, PM₁₀ and PM_{2.5}) from chemical products manufacturing are based on TSP data reported by the plants. PM₁₀ and PM_{2.5} emissions are calculated with domestic fraction factors. Particle emissions are mainly generated during manufacturing of pharmaceutical products and inks.

3.2.4 NFR 3D

Printing

From printing activities the inventory includes estimates for NMVOC and particle emissions.

NMVOC emissions from printing industry are based on emission data reported by the plants as well as on information from the survey sent to printing houses that do not report their emissions. The largest printing houses are obligated to report their emissions to the environmental authorities. Emissions from the remaining sources are estimated on basis of data collected through the survey. Printing inks used in Finland vary widely in the composition, but they consist of three major components: pigments, binders and solvents. The type of ink which is used is usually the most important factor in estimating emissions from printing operations.

Domestic solvent use including fungicides

Emissions from the use of personal care, adhesive and sealant and household cleaning products has been estimated by the Finnish Cosmetic, Toiletry and Detergent Association. Emissions from the use of car care products are included in this estimation. The emission estimate is a total for all these sources and based on information received from the members of the association.

3.2.5 Other product use

The inventory of other product use includes emissions of NO_x, NMVOC, SO_x, NH₃, TSP, PM₁₀, PM_{2.5}, CO, Pb, Cd, Hg, As, Cr, Cu, PCDD/F, PAH-4, HCB.

Glass and Mineral Wool Enduction

NO_x, SO_x, NH₃, NMVOC and CO emissions are based on data reported by the plants. The emissions are mainly generated during manufacturing of rock and mineral wool.

Solvent Extraction of edible oils

NMVOC emissions from solvent extraction of edible oils from oilseeds are based on emission data reported by the plants and on information from the questionnaire to companies that do not report their emissions. The emissions are estimated based on data on the solvent content of products and assuming that all NMVOCs are evaporated.

Industrial application of glues and adhesives

NMVOC emission data from industrial application of glues and adhesives is reported by the plants, although being included in the total NMVOC emissions of the plants, they are aggregated under the main activity of the plant, for instance under NFR 2D3. Domestic use of adhesive and sealants are included in the emissions reported under domestic solvent use.

Tobacco smoking

From tobacco smoking NMVOC, particle (TSP, PM₁₀ and PM_{2.5}), NO_x, CO, Pb, Cd, Hg, As, Cr, Cu, PAH-4 and PCDD/F emissions are included in the inventory. The NMVOC emission factors are based on EMEP/EEA Guidebook 2009, and for particle emissions on emission factors from TNO's CEPMEIP database, for all heavy metal emissions and for PCDD/F emissions from tobacco smoking on Norway's IIR 2005. National statistics on tobacco sales is used as activity data.

Impregnation of wood, use of impregnated wood and pesticides

NMVOC and PAH-4 emissions are included in the inventory of emissions from impregnation of wood, use of impregnated wood and pesticides.

Part of NMVOC emissions from wood impregnation is reported by the plants, and the rest of the emissions are based on calculation NMVOC emission factors for impregnation of wood and the use of pesticides are country specific and based on expert estimation. The amount of pesticide use and the amount of sold creosote oil are used as activity data.

Part of PAH-4 emissions from wood impregnation is reported by the plants. The remaining emissions from impregnation of wood are calculated as well as emissions from the use of impregnated wood with emission factors from the UBA. Data on the use of impregnation agents are used as activity data.

Use of chlorinated chemicals

HCB from the use of chlorinated chemicals are calculated using emission factors from the EEA/EMEP Guidebook and information from customs statistics on the imports of chlorinated chemicals). Chlorinated solvents are not produced in Finland.

Use of fire works

Particle emissions from the use of fire works are calculated with emission factors from the CEPMEIP database and the Norway's IIR and national population statistics.

House and car fires

Heavy metal and PCDD/F emissions from house fires and smoking are calculated using emission factors from the Norwegian IIR and national statistics on fire accidents.

3.3 Norway

3.3.1 Solvent and other product use

In addition to solvent-containing products emitting NMVOC, there are other products that emit volatile components. Creosote treated materials and tarry jointing paste cause emissions of PAH (poly-aromatic hydrocarbons). PAH and dioxins are also emitted during production of asphalt. Emissions of N₂O from anaesthesia procedures and propellants as well as mercury from mercury-containing products and emissions from combustion of tobacco are also included in the Norwegian inventory.

3.3.2 NFR 3A, 3B, 3C and 3D Solvent losses (NMVOC)

Our general model is a simplified version of the detailed methodology described in Chapter 6 of the EMEP/CORINAIR Guidebook 2007 (EEA, 2007). It represents a mass balance *per substance*, where emissions are calculated by multiplying relevant activity data with an emission factor. For better coverage, point sources reported from industries to the Climate and Pollution Agency and calculated emissions from a side model for cosmetics are added to the estimates. For a detailed description of method and activity data, see Holmengen and Kittilsen (2009).

No official definition of solvents exists, and a list of substances to be included in the inventory on NMVOC emissions was thus created. The substance list used in the Swedish NMVOC inventory (Skårman *et al.* 2006) was used as a basis. The resulting list comprises 678 substances. Of these, 355 were found in the Norwegian Product Register for one or more years in the period 2005–2007.

Cosmetics

Cosmetics are not subject to the duty of declaration. The side model is based on a study in 2004, when the Climate and Pollution Agency calculated the consumption of pharmaceuticals and cosmetics (Norwegian pollution control authority 2005a). The consumption was calculated for product groups such as shaving products, hair dye, body lotions and antiperspirants. The consumption in tonnes each year is calculated by using the relationship between consumption in Norwegian kroner and in tonnes in 2004. Figures on VOC content and emission factors for each product group were taken for the most part from a study in the Netherlands (IVAM 2005), with some supplements from the previous Norwegian solvent balance (the previous NMVOC emission model).

Activity data

The data source is the Norwegian Product Register. Any person placing dangerous chemicals on the Norwegian market for professional or private use has a duty of declaration to the Product Register, and import, export and manufacturing is reported annually. The only exception is when the amount of a given product placed on the market by a given importer/producer is less than 100 kg per year.

The information in the data from the Product Register makes it possible to analyse the activity data on a substance level, distributed over product types (given in UCN codes; (The Norwegian product register 2007)), industrial sectors (following standard industrial classification (NACE; (Statistics Norway 2003)), including private households (no NACE), or a combination of both. As a consequence, the identification of specific substances, products or industrial sectors that have a major influence on the emissions is greatly facilitated.

It is assumed that all products are used the same year as they are registered, and substances are not assumed to accumulate in long-lived products. In other words, it is assumed that all emissions generated by the use of a given product during its lifetime take place in the same year as the product is declared to our data source, the Norwegian Product Register. In sum, this leads to emission estimates that do not fully reflect the actual emissions taking place in a given year. Emissions that in real life are spread out over several years all appear in the emission estimate for the year of registration. However, this systematic overestimation for a given year probably more or less compensates for emissions due to previously accumulated amounts not being included in the estimate figures.

Cosmetics

The side model for cosmetics is updated each year with data on from the Norwegian Association of Cosmetics, Toiletries and Fragrance Suppliers (KLF).

Point sources

Data from nine point sources provided by the Climate and Pollution Agency are added to the emissions estimates. The point sources are reported from the industrial sector "Manufacture of chemicals and chemical products" (NACE 24). In order to avoid double counting, NMVOC used as raw materials in this sector are excluded from the emission estimates from the Product Register data.

Emission factors

Emission factors are specific for combinations of product type and industrial sector. Emission factors from the Swedish model for estimating NMVOC emissions from solvent and other product use (Skårman *et al.*, 2006) are used. The emission factors take into account different application techniques, abating measures and alternative pathways of release (e.g. waste or water). These country-specific emission factors apply to 12 different industries or activities that correspond to sub-divisions of the four major emission source categories for solvents used in international reporting of air pollution (EEA, 2007).

It is assumed that the factors developed for Sweden are representative for Norwegian conditions, as we at present have no reason to believe that product types, patterns of use or abatement measures differ significantly between the two countries. Some adjustments in the Swedish emission factors were made (See Holmengen and Kittilsen, 2009).

In accordance with the Swedish model, emission factors were set to zero for a few products that are assumed to be completely converted through combustion processes, such as EP-additives, soldering agents and welding auxiliaries. Quantities that have not been registered to industrial sector or product type are given emission factor 0.95 (maximum). Emission factors may change over time, and such changes may be included in this model. However, all emission factors are at the moment constant for all years.

3.3.3 NFR 3C Use of solvents

Creosote-treated materials

Creosote is mainly used in quay materials and conduction poles, but also in fence poles and roof boards. In Norway there is a requirement that all creosote in use should contain less than 50 mg/kg benzo(a)pyrene (Miljøverndepartementet, 2004). PAH-components will evaporate from the creosote-treated materials in hot weather. In addition, PAH-components will evaporate during impregnation. The smallest PAH-components, like naphthalene, are most volatile, but several components used in wood treatment will not evaporate. Emission of PAH is calculated based on the import of creosote oil taken from Statistics Norway's

statistics on external trade and emission factors taken from (Finstad *et al.*, 2001).

Tarry jointing paste

Tarry jointing paste is resistant to oil and fuels, and is therefore used in concrete constructions where spills of such products can occur, e.g. in joints in bridges, auto repair shops and airports. Tarry jointing paste contains PAH components that can evaporate to air. The Norwegian institute for air research (NILU) and the Norwegian institute for water research (NIVA) (1995) have estimated an annual emission of 125 kg PAH/year. This estimation is based on imported tarry paste and a tar content of 16 per cent. This kind of jointing paste is mainly used at airports. There is no available PAH-profile for this emission, and due to the lack of data, the same PAH-profile as that of asphalt production is used. The emission is assumed to be rather constant each year.

Production of asphalt

PAH. Most of the asphalt produced in Norway uses the batch-method (Haakonsen *et al.*, 1998). Emissions are calculated by multiplying the amount of asphalt produced with an emission factor.

Dioxins. Asphalt preparations and asphalt recycling are supposed to be a possible dioxin source, especially in countries using extensive recycling, and that use salt on the roads during winter. A lot of salt is used on Norwegian roads during winter, and when this asphalt is heated during recycling, it is assumed to give emissions of dioxins (Hansen, 2000).

3.3.4 NFR 3D Other product use

Use of N₂O in anaesthesia

N₂O is used in anaesthesia procedures and will lead to emissions of N₂O. The figures are based on N₂O data from the two major producers and importers in 2000. These figures are related to the number of births and number of bednights in hospitals for each year to estimate consumption.

Activity data

For this source, actual sale of N₂O is used for the year 2000. Number of births and bednights in hospitals are taken from the Statistical yearbook of Norway each year. No emission factors are used since the figures are based on sales of N₂O.

Use of N₂O as propellant

N₂O is used as a propellant in spray boxes and this use will lead to emissions of N₂O. It is also used in research work, for instance in the food industry and at universities. Small amounts are used at engineering workshops, among others for drag-racing. There is no production of N₂O for these purposes in Norway. Information on sales volumes is reported

by the plants to Statistics Norway. Statistics Norway assumes that all propellant is released to air.

Mercury-containing products

Breakage of mercury-containing thermometers, fluorescent tubes and various measuring and analytical instruments lead to emissions of mercury. The emission estimates are based on an annual report from the Climate and Pollution Agency ("Miljøgifter i produkter"). The sale of mercury-containing thermometers and fluorescent tubes has decreased strongly since the mid-1990s, and the mercury content in these products has been reduced. A prohibition against the production, import and export of mercury-containing products entered into force in 1998, except for some thermometers for professional use, which were then prohibited in 2001. Since these products have long operating life times, there will be emissions from these products for many years. In the calculations, however, it is assumed that the emissions occur the same year as the product is sold.

Tobacco

Emission factors are based on Sandmo (2010). Activity data comes from Statistics Norway's external trade statistics.

3.4 Sweden

Estimates reported by Sweden in NFR/CRF 3 include NMVOC emissions from paint application (NFR/CRF 3A), degreasing and dry cleaning (NFR/CRF 3B), chemical products, manufacture and processing (NFR/CRF 3C), printing (NFR 3D1/ CRF 3D5), domestic solvent use including fungicides (NFR 3D2/ CRF 3D5) and other solvent use (NFR 3C3/ CRF 3D5). In NFR 3D3 Sweden also reports particulate emissions from tobacco smoking and use of fireworks. Reported emissions to UN-FCCC from use of N₂O (CRF 3D1, 3D3 and 3D4) include evaporative emissions of N₂O arising from other types of product use, including N₂O emissions from anaesthesia and aerosol cans. Due to confidentiality, data for 3D1 (Use of N₂O for Anaesthesia) and 3D3 (N₂O from Aerosol cans) cannot be reported separately and the total amounts are therefore reported in 3D4. No N₂O are used in fire extinguishers. Thus, CRF 3D2 is reported NO.

3.4.1 Emissions of NMVOC from product and solvent use

The Swedish method for estimates of NMVOC emissions from product and solvent use is consumption-based with a product related approach. All primary data is derived from the Products Register at the Swedish

Chemicals Agency. A detailed description of the model can be found in Skårman et al. (2006).

Sold amounts of solvents and solvent based products, (production + import – export), is derived from the Products Register at the Swedish Chemicals Agency. Substances defined as NMVOCs and in quantities over 100 tonnes in the Products Register forms the list which all estimates are based on. Using the threshold of 100 tonnes result in a substance list representing over 99% of the total solvent sales of around 400 000 tonnes. The definition of NMVOC found in COUNCIL DIRECTIVE 1999/13/EC of 11 March 1999 and in UNECE Emission Reporting Guidelines is used:

“Volatile organic compound (VOC) mean any organic compound having a vapour pressure of 0.01 kPa or more at 293.15 K, or having a corresponding volatility under the particular conditions of use. The fraction of creosote, which exceeds this value of vapour pressure at 293.15 K shall be considered a VOC.”

The list used when compiling data for submission 2011 contained 382 substances defined as NMVOC. The extractions also include CAS-number, name, molecular formula and carbon content for each substance. In cases when mixtures of substances are included in the substance list the carbon content has been estimated by the Chemicals Agency as 85% of NMVOC, based on information in the Products Register. In cases when the carbon content not can be derived from the Products Register, the default value given in the 2006 IPCC guidelines (IPCC, 2006) (60%) has been used.

Data extractions have been made for each year from 1995 as accurate activity data only can be obtained from 1995. The extractions show for each year:

- The intended use of the product and the type of product (product code)
- Industry to which the product is sold (industry category)
- Quantity NMVOC
- Quantity C

The extractions from the Products Register are used to compile a connection diagram with all combinations of “product codes” and “industry categories”. In order to avoid double-counting of reported emissions within other sectors, decisions whether to include or exclude a combination have been made, based on expert judgements. The industries that are excluded in the extractions from the Products Register are considered to be reported in NFR/CRF 1, 2 or 6.

If the combination of “product code” and “industry category” should be included in NFR/CRF 3, its specific NFR/CRF code has been identified. Furthermore, it has to be determined if the product is used as raw mate-

rial or not. The quantities of NMVOC used as raw material in processes have been identified and treated separately from remaining quantities for each NFR/CRF code, due to that most of the solvents used as raw material will not be emitted. An Excel macro has been written in order to compile time series with quantities of NMVOC for each sub-code within NFR/CRF sector 3.

As sold amount of solvent not always is identical to the amount of solvent used, activity data has been recalculated using a moving average over three years. This leads to need for updating of reported emissions for the latest three years in the time series in every new submission.

Country-specific emission factors for solvents used as raw material and for remaining solvents were developed for each reported activity within each NFR/CRF code. The emission factors have been based on the old emission time series 1988–2001, which were developed by SMED in 2002 (Kindbom et al., 2003). The old time series were mostly based on information in earlier national reports, investigations and estimations of national NMVOC emissions. These investigations were dedicated specific emission inventories focusing on NMVOC, which is why they are still to be considered as reliable. The emission factors have been developed also considering the application techniques, the reported emissions presented in environmental reports for specific industries, as well as other pathways of release (e.g. waste or water). The emission factors for raw material are set very low, since most of the solvents will not be emitted during production, but will end up in the product.

As accurate data for compiling time series for NMVOC from “Solvents and other product use” only can be found in the Products Register from 1995, reported emissions for NFR/CRF codes 3A-D for 1990 until 1994 were taken from the old time series (Kindbom et al., 2003) and in some cases emission data for 1990 – 1994 has been interpolated. The reported time series are considered to be consistent, except for last year (2009) where data for previous year (2008) has been reported. This is due to the fact that activity data from the Product Register is not official at the time data is needed for the calculations and reporting in a timely manner. Data for last reported year is therefore always updated in the following submission.

Allocation of NMVOC emissions in NFR/CRF 3:

- NFR/CRF 3A – Includes paints sold for “industrial use” (NFR 3A2/CRF 3A) and for “consumer and other professional use” (NFR 3A1/CRF 3A). “Other coating application” (NFR 3A3/CRF 3A) is included in NFR 3A1/CRF 3A
- CRF/NFR 3B – Includes solvents sold to the laundry and dry cleaning industry (NFR 3B2/CRF 3B). Degreasing (NFR 3B1/CRF 3B) is included in “Other product use” (NFR 3D3/CRF 3B)
- CRF/NFR 3C – Includes solvents sold for car manufacturing, paint industry and rubber industry. According to the Guidelines, NMVOC

emissions from production of glue should be allocated to 3C. In the Swedish reporting, these NMVOC emissions are allocated to NFR/CRF 2B5, since the industries concerned often produce other chemical products as well, and are classified as chemical industries in the Products Register

- CRF/NFR 3D – Includes solvents sold to the printing industry (NFR 3D1/CRF 3D5), for preservation of wood, to leather industry and to textile industry (NFR 3D3/CRF 3D5). “Other product use” (NFR 3D3/CRF 3D5) also includes solvents used by other industries not reported separately in sector 2, and solvents for domestic use. Emissions originating from “Domestic use including fungicides” (NFR 3D2/CRF 3D5) is included in NFR 3D3/CRF 3D5, since it not is estimated separately in the developed model

3.4.2 Emissions of TSP, PM₁₀ and PM_{2.5} from product and solvent use

Emissions of particles from product use, included in NFR 3D3, cover the use of fireworks and tobacco smoking. Emissions are based on activity data from official statistics on sold amounts of tobacco and fireworks for the whole time series from 1980. Activity data include only “legal” purchases of tobacco products in Sweden; products that are purchased through tax-free and cross-border trading are not included. For fireworks the activity data for 1980–1987 has been assumed, based on available data after 1987, which shows an increasing trend in the use of fireworks. An increasing tendency has been applied also to the years where activity data are lacking. Emission factors from the CEPMEIP study (TNO, CEPMEIP 2001) have been used.

3.4.3 Emissions of N₂O from product and solvent use

There are two companies in Sweden selling N₂O in gas cylinders. Information on sold amounts was obtained from one of the companies (1990–1991) and from the Products Register at the Swedish Chemicals Agency (1992–2008). The time series of use of N₂O in Sweden are reported in Other use of N₂O (3D4) since no background data is available to separate between the source categories Use of N₂O for Anaesthesia (3D1) and N₂O from Aerosol cans (3D3). Consequently CRF codes 3D1 and 3D3 are both reported as IE. Activity data from the Product Register for the latest year is not official at the time data is needed for the calculations and reporting in a timely manner. Data for last reported year is therefore always updated in the following submission.

4. Activities and product use with mercury, PAH, dioxin and PCB emissions

As shown above some countries already include some sources, i.e. activities and product uses that generate emissions to air of the four pollutants. To obtain a more complete list of the sources a literature survey has been conducted. This will allow an allocation of sources which are relevant to the “Solvent and Product Use” sector but also bring an awareness to other sectors where relevant uses and emissions occur. The literature survey comprise international working groups, EU and OECD directives, national investigations from e.g. US and EU and a brief survey of scientific work that describes and investigates sources to emissions. The gross lists for each of the pollutants thus comprise all possible sources not only to air but also to e.g. water and waste. In Table 2 the lists are cropped down to the fit in the focus of this study.

4.1 Mercury

Mercury is one of the most toxic chemicals that is being used today; concern is especially related towards brain and nervous system in mammals. On EU and national levels there are legally binding instruments in force which aim to limit the use and spreading of mercury in the environment. Focus is on long-range transport and occurrence in the Arctic (e.g. CLRTAP) and furthermore mercury and its compounds are priority substances in the Water Framework list.

There are natural and anthropogenic sources to mercury emissions to air. Mercury can be found in various consumer and commercial products. Apart from emissions during disposal of mercury containing products, when a mercury-containing product breaks and the mercury is spilled, the exposed mercury can evaporate and become an invisible, odourless toxic vapour. The following list of sources is based on UNEP (2002 & 2010), US EPA (2010), Kindbom & Munthe (2007) and Skårup et al. (2003). Sources of mercury emissions to air relevant to the sector NFR 3 are marked in bold:

Extraction and use of fuels/energy sources

- Coal combustion in large power plants
- Other coal use
- Mineral oils – extraction, refining and use
- Natural gas – extraction, refining and use
- Other fossil fuels – extraction and use
- Biomass fired power and heat production
- Geothermal power production

Primary (virgin) metal production

- Mercury extraction and initial processing
- Gold and silver extraction with mercury-amalgamation process
- Zinc extraction and initial processing
- Copper extraction and initial processing
- Lead extraction and initial processing
- Gold extraction and initial processing by methods other than mercury amalgamation
- Aluminum extraction and initial processing
- Other non-ferrous metals – extraction and processing
- Primary ferrous metal production

Production of other minerals and materials with mercury impurities

- Cement production
- Pulp and paper production
- Production of lime and light weight aggregate
- Others minerals and materials

Intentional use of mercury in industrial processes

- Chlor-alkali production with mercury-technology
- VCM (vinyl-chloride-monomer) production with mercury-dichloride (HgCl_2) as catalyst
- Acetaldehyde production with mercury-sulphate (HgSO_4) as catalyst
- Other production of chemicals and polymers with mercury compounds as catalysts

Consumer products with intentional use of mercury

- Thermometers with mercury
- Electrical switches and relays with mercury
- Light sources with mercury
- Batteries with mercury
- Polyurethane with mercury catalysts
- Biocides and pesticides
- Paints and laquers
- Pharmaceuticals for human and veterinary uses (vaccines, eye drops)
- Cosmetics and related products

Other intentional product/process uses

- Dental mercury-amalgam fillings
- Manometers and gauges
- Laboratory chemicals and equipment
- Other product uses (hardeners and resins for plastics, fillers, fireworks, LCD screens, lenses for lighthouses)
- Mercury metal use in religious rituals and folklore medicine

Production of recycled metals (“secondary” metal production)

- Production of recycled mercury (“secondary production”)
- Production of recycled ferrous metals (iron and steel)
- Production of other recycled metals

Waste incineration

- Incineration of municipal/general waste
- Incineration of hazardous waste
- Incineration of medical waste
- Sewage sludge incineration
- Informal waste incineration

Waste deposition/landfilling and waste water treatment

- Controlled landfills/deposits
- Diffuse deposition under some control
- Informal local disposal of industrial production waste
- Informal dumping of general waste
- Waste water system/treatment

Crematoria and cemeteries

- Crematoria
- Cemeteries

Potential hotspots

4.2 PAH

Polynuclear Aromatic Hydrocarbons (PAHs) are organic compounds produced when materials containing carbon and hydrogen are burned. PAHs are most commonly non-volatile, but are very harmful because of their carcinogenic/mutagenic content. Over 100 compounds existing in indoor air have been identified to date. PAHs are accounted for either as a sum or as single chemicals. Benzo(a)pyrene, benzo(b)fluoranthene, benzo(g,h,i)perylene, benzo(k)fluoranthene, indeno(1,2,3-cd)pyrene cover the four PAHs prioritised in CLRTAP and also the five PAHs that are classified as priority hazardous substances on the Stockholm Convention POP list.

The main sources to PAHs in consumer products are extender oils and carbon black. Extender oils are mineral oil products which are derived from crude oil whereas carbon black is produced by the incomplete combustion or thermal decomposition of heavy petroleum such as e.g. coal tar. Extender oils and carbon black are used as additives in natural and synthetic rubber and soft plastics and as black pigment dye (Hoffmann et al., 2011).

The diffuse sources of PAHs are primarily incomplete combustion of wood, coal and coke for domestic heating and emissions from the incomplete combustion of fuels in the traffic sector (Illerup et al., 2006). Diffuse pollution with PAHs is not restricted to city centres as emissions have increased in suburban areas as well due to the popularity of wood burning stoves. The relative importance of PAH emissions categorised on sources (Falkenberg et al., 2002a & 2002b) is:

- Heating of households (oil, gas, fire places and stoves): 48%
- Traffic (mobile sources): 37%
- Combustion (waste): 12%
- Industries (gas works etc.): 2%
- Energy production (heat and electricity): 1%

It is estimated that pollution from remote sources does not contribute significantly to the PAH-load in Denmark compared to local sources.

The following list of sources is based on, i.a., PAH Position Paper (2001), Falkenberg et al. (2002a & 2002b) and Hoffmann et al. (2011). Sources of PAH emissions to air relevant to the sector NFR 3 are marked in bold.

Household (and industry) Sources

- Furnaces
- Automobile and other exhausts
- Fireplaces and woodstoves
- Cigarette/tobacco smoke
- Unvented gas and space heaters
- Contaminated ground/well water
- Kitchens/Cooking
- Tarry jointing paste, tar paper, fishing nets, anticorrosive paints

Industrial Emissions

- Coal and oil-fired power plants.
- Waste incinerators
- Coke/bitumen/asphalt/petroleum production and use
- Aluminium/iron smelting/production
- Wood preservation/creosote operations
- Railway ties, wharves or pilings
- Gas works
- Agricultural burning

- Cement production
- Petrochemical and related industries: Refineries
- Other industrial sources: Motor test rigs

Products

PVC (various products)

Natural and synthetic rubber use:

- *Transport sector*: tyres, inner tubes, automotive belts
- *Industrial sector*: conveyor and transmission belting, tyres, castors, seismic materials, hoses, belts, plates, packing and sealing devices, industrial gloves, automotive mats
- *Consumer sector*: threads, erasers, golf balls, inflatable articles, mats, grips and handles, shoes, gloves, ski goggles, headphones, pulse monitors, eye-cups, desk pads, bracelets, steering wheel cover, computer mice, mouse pads, watch straps, toys and textiles
- *Hygiene and medical sector*: examination and surgical gloves, contraceptives, blood bags, syringes, implantable devices

Natural Emissions

- Forest/brush fires
- Volcanic eruptions
- Decaying organic matter

4.3 Dioxins

Dioxins, polychlorinated dibenzodioxins and dibenzofuranes (PCDD/PCDFs) comprise 75 different congeners, depending on the number and position of chlorine atoms. PCDD/PCDFs are persistent and are on the Stockholm Convention POP list. PCDD/PCDFs concentrate in fatty tissues and some congeners are probably carcinogens and show effects on reproduction and sexual development and on the immune system. The main sources of PCDD/PCDF emissions to air are residential wood burning, fires, municipal waste incineration and steel reclamation. In relation to the solvent sector sources such as PCP-treated wood, production of pesticides and pharmaceuticals in chemical industry, production of feedstuff, metal manufacturing, tobacco smoking and fireworks may be relevant.

The following list of known and suspected sources of PCDDs/CDFs sources is based on, i.a., US EPA (2006) and Henriksen et al. (2006). Sources of dioxin emissions to air relevant to the sector NFR 3 are marked in bold.

4.3.1 Combustion sources

Waste incineration

- Municipal waste combustion
- Hazardous waste incineration
- Boilers/industrial furnaces
- Medical waste/pathological incineration
- Crematoria
- Sewage sludge incineration
- Tire combustion
- Pulp and paper mill sludge incinerators
- Biogas combustion

Power/energy generation

- Vehicle fuel combustion – leaded – unleaded – diesel
- Wood combustion – residential – industrial Coal combustion – residential- industrial/utility
- Oil combustion – residential- industrial/utility

Other high-temperature sources

- Cement kilns (hazardous waste burning)
- Cement kilns (nonhazardous waste burning)
- Coal tar production
- Asphalt preparation
- Asphalt mixing plants
- Petroleum refining catalyst regeneration
- Cigarette combustion
- Carbon reactivation furnaces
- Kraft recovery boilers
- Manufacture of ball clay products
- Glass Manufacturing
- Lime Kilns
- Rubber Manufacturing

Minimally controlled or uncontrolled combustion

- Combustion of landfill gas in flares
- Landfill fires
- Accidental fires (structural)
- Accidental fires (vehicles)
- Forest, brush, and straw fires
- Backyard barrel burning
- Uncontrolled combustion of PCBs
- Burning of candles
- Fireworks

Metal smelting/refining

Ferrous metal smelting/refining

- Sintering plants
- Coke production
- Electric arc furnaces
- Ferrous foundries

Nonferrous metal smelting/refining

- Primary aluminium
- Primary copper
- Primary magnesium
- Primary nickel
- Secondary aluminium
- Secondary copper
- Secondary lead

Scrap electric wire recovery

Drum and barrel reclamation

Chemical manufacturing (releases to the environment)

- Bleached chemical wood pulp, cork and paper
- Bleaching agents (hypochlorite salts)
- Brominated flame retardants
- Mono- to tetrachlorophenol
- Pentachlorophenol for preservation and conservation (wood, leather, textiles)
- Chlorobenzenes
- Chlorobiphenyls (leaks/spills)
- Ethylene dichloride/vinyl chloride
- PVC
- Dioxazine dyes and pigments
- 2,4-Dichlorophenoxy acetic acid
- Municipal wastewater treatment
- Tall oil-based liquid soaps
- Vitamin manufacturing
- Production of pesticides and pharmaceuticals
- Spray drying

4.3.2 Biological and photochemical processes

Reservoir sources

- Land
- Air
- Water
- Sediments

Anthropogenic structures

- PCP-treated wood
- PCP in textiles
- PCP in leather
- Production of feedstuff
- Bleaching processes
- Use of bleaching agents

4.4 PCB

Polychlorinated biphenyls (PCBs) cover a group of 209 different PCB congeners, which can be divided into two groups according to their toxicological properties. One group consisting of 12 congeners shows toxicological properties similar to dioxins and the other group exhibits a variety of other toxic effects. PCBs are on the Stockholm Convention POP list (2011). The general human exposure to the dioxin-like PCBs in Europe is close to the tolerable daily intake (TDI) set by the EU (SCF, 2001) and in Sweden it is estimated that 10% of the population exceeds the TDI. PCBs have been widely used in a number of industrial and commercial products and activities and although the manufacture, processing and distribution of PCBs have been prohibited in almost all industrial countries since the late 1980s, they are still introduced into the environment, especially due to improper disposal practices or leaks in electrical equipment and hydraulic systems. Main emissions to air are from energy production, mobile sources and waste combustion (Thomsen et al., 2009). In relation to the solvent sector PCBs are used in industry as heat exchange fluids, in electric transformers and capacitors, and as additives in paint, carbonless copy paper, sealants and plastics.

Approximate usage of PCBs in the US is summarized as follows (EIP Associates, 1997):

- Closed system and heat transfer fluids (transformers, capacitors, fluorescent light ballasts, etc.): 60%
- Plasticizers: 25%
- Hydraulic fluids and lubricants: 10%
- Miscellaneous uses: 5%

The following list of known and suspected sources of PCB sources is based on PCB Fact Sheet (2003), ATSDR (2006), EIP Associates (1997), UNEP (1999), EPA (2011), EEA (2007), de Voigt & Brinkman (1989). Sources of PCB emissions to air relevant to the sector NFR 3 are marked in bold.

Primary Applications:

- Dielectric fluids and transformers
- Capacitors
- Fluorescent light ballasts
- Electromagnets
- Miscellaneous electrical equipment
- Heat transfer systems
- Hydraulic fluids
- Plasticizers
- Lubricants

Other applications of PCBs:

- Dust control (dedusting agents)
- Pesticides
- Fire retardants
- Paints, coatings
- Carbonless copy paper
- Printing inks
- Investment casting waxes
- Wood treatment
- Laminating and impregnating agents
- Adhesives
- Waxes
- Additives to cement and plaster
- Casting agents
- Sealing liquids

Due to the long service life of many PCB-containing items and the use of PCBs in some durable, relatively inert products, PCB-containing materials will continue to be disposed of and processed in waste and recycling operations. Waste products and recycling operations that may process significant quantities of PCB-containing materials are described below:

PCB Sources in Waste Materials and Recycling Operations

- Material or Operation
- Scrap metal recycling
- Auto salvage yards, auto crushing
- Repair activities
- Used oil
- Recycled paper
- Effluent
- Asphalt roofing materials, tar paper, and roofing felt
- Building demolition
- Dredge spoils
- Landfills
- Wastewater treatment plant sludge

Care must be taken when a product containing the pollutant is disposed and recycled. If an emission considers the total amount of pollutant containing product, then the recycled amount must not be added again to avoid double counting.

For all four pollutants the sources marked in bold are entered in Table 2 in the following chapter according to the appropriate NFR category.

5. Activities and product use relevant to NFR 3 “Solvent and Other Product Use”

Sources to emissions are many and diverse, some emissions are direct through industrial activities or use of products, and some are indirect, e.g. via disposal or incineration of pollutant containing products and materials. In the previous sections gross lists of sources and activities leading to pollutant emissions to the environment are shown. These lists are cropped down to comprise only activities and products that lead to air emissions relevant for sector NFR 3 “Solvent and Other Product Use”, cf. Table 2.

Table 2 Activities with mercury, PAH, dioxin and PCB emissions to air related to NFR 3 “Solvent and Other Product Use”.

NFR	Product group	Pollutant			
		Mercury	PAH	Dioxin	PCB
NFR 3A1 Decorative coating application	Domestic use Construction and buildings Agriculture, forestry, fishing and fish farms	Paints Paints	Anticorrosive paints		Paints, Coatings Paints, Coatings, Repair activities
NFR 3A2 Industrial coating application	Manufacture of automobiles ¹⁾ Coil coating ¹⁾ Car repair ¹⁾ Wood ¹⁾ Other industrial paint application ¹⁾ Boat building ¹⁾	Paints	Anticorrosive paints Anticorrosive paints		Repair activities Paints, Coatings, Repair activities
NFR 3A3 Other coating application	Other non-industrial paint application	Paints	Anticorrosive paints		Paints, Coatings, Repair activities
NFR 3B1 Degreasing	Metal degreasing ¹⁾ Other industrial (dry) cleaning ¹⁾ Electronic components manufacturing ¹⁾				Lubricants, Heat transfer systems, Miscellaneous electrical equipment, Capacitors
NFR 3B2 Dry cleaning	Dry cleaning ¹⁾				
NFR 3C	Polyester pro-				

NFR	Product group	Pollutant			
		Mercury	PAH	Dioxin	PCB
Solvents in chemical products manufacture and processing	cessing ¹⁾				
	Polyvinylchloride processing ¹⁾	VCM (vinylchloride-monomer) production with mercury-dichloride (HgCl ₂) as catalyst	PVC products	PVC	Plasticizers
	Polyurethane foam processing ¹⁾	Polyurethane with mercury catalysts			
	Polystyrene foam processing ¹⁾				
	Rubber processing ¹⁾		Natural and synthetic rubber products	Rubber	Plasticizers
	Pharmaceutical products manufacturing ¹⁾	Pharmaceuticals for human and veterinary uses		Manufacturing and spray drying	
	Paints manufacturing ¹⁾	Paints	Anti-corrosive paints	Manufacturing and spray drying	Paints, Heat transfer systems
	Inks manufacturing ¹⁾		Pigment in inks	Manufacturing and spray drying	Printing inks
	Vehicle manufacturing ¹⁾				
	Glues manufacturing ¹⁾				Heat transfer systems
NFR 3D1	Adhesive, magnetic tapes, films & photographs manufacturing ¹⁾				Adhesives, Plasticizers, Heat transfer systems
	Textile finishing ²⁾			PCP in textiles	Fire retardants, Heat transfer systems
	Leather tanning ¹⁾			PCP in leather	
	Other ¹⁾	Other production of chemicals and polymers with mercury compounds as catalysts, Biocides and pesticides, Electrical switches and relays with mercury, Cosmetics and related products, Batteries with mercury, Light sources with mercury, Thermometers with mercury, Hardeners and resins for plastics, Fillers, LCD screens, Lenses for lighthouses, Fireworks, Dental amalgam fillings, Manometers and gauges	Tarry jointing paste, tar paper, fishing nets	Bleaching agents (hypochlorite salts), Brominated flame retardants, Mono- to tetrachlorophenol, Pentachlorophenol (PCP), Chlorobenzenes, Chlorobiphenyls (leaks/spills), Ethylene dichloride/vinyl chloride, Dioxazine dyes and pigments, 2,4-Dichlorophenoxy acetic acid, Tall oil-based liquid soaps, Production of pesticides and pharmaceuticals, Vitamin manufacturing	Fire retardants in various products, Pesticides, Dust control (dedusting agents), Recycled paper, Lubricants, Plasticizers, Hydraulic fluids, Heat transfer systems, Capacitors, Dielectric fluids and transformers, Sealing liquids, Waxes, Casting agents, Laminating and impregnating agents
	Asphalt blowing ¹⁾			Asphalt preparation, Asphalt mixing plants	Asphalt roofing materials, tar paper, and roofing felt (IE CRF2A5) Heat transfer systems
	Creosote-treated materials		Wood preservation/creosote operations		
	Printing industry ¹⁾		Printing inks		Printing inks

NFR	Product group	Pollutant			
		Mercury	PAH	Dioxin	PCB
Printing NFR 3D2 Domestic solvent use including fungicides	Domestic solvent use (other than paint application) Personal care products Pharmaceuticals (see below) Household cleaning agents Motor & vehicle cleaning agents Use of adhesives and sealants Use of textiles Fungicide Pesticides	Cosmetics and related products See below Biocides and pesticides Biocides and pesticides	Hygiene products of rubber and PVC Sealants Textiles with rubber	 Use of textiles, Use of leather Use of fungicides Use of pesticides	 Dust control (dedusting agents) Adhesives, Plasticizers Fire retardants in textiles Pesticides
NFR 3D3 Other product use	Glass wool enduction ¹⁾ Mineral wool enduction ¹⁾ Fat, edible and not edible oil extraction Application of glues and adhesives Preservation of wood Underseal treatment and conservation of vehicles Vehicles dewaxing Domestic use of pharmaceutical products Other (preservation of seeds,...): use of pesticides in cultivations and in construction Tobacco smoking	 Pharmaceuticals for human and veterinary uses Electrical switches and relays with mercury, Biocides and pesticides, Cosmetics and related products, Batteries with mercury, Light sources with mercury, Thermometers with mercury, Dental mercury-amalgam fillings, Manometers and gauges, Laboratory chemicals and equipment, Mercury metal use in religious rituals and folklore medicine, Hardeners and resins for plastics, Fillers, LCD screens, Lenses for lighthouses	 Wood preservation/creosote operations Kitchens/Cooking, Railway ties, wharves or pilings, Tarry jointing paste, tar paper, fishing nets, Natural and synthetic rubber products, PVC products	 Used oil, Repair activities, Lubricants, Hydraulic fluids, Auto salvage yards, auto crushing Investment casting waxes, Carbonless copy paper, Fire retardants in various products, Pesticides, Dust control (dedusting agents), Recycled paper, Lubricants, Plasticizers, Hydraulic fluids, Heat transfer systems, Miscellaneous electrical equipment, Electromagnets, Fluorescent light ballasts, Dielectric fluids and transformers, Sealing liquids, Waxes, Casting agents, Laminating and impregnating agents	
			Cigarette/tobacco	Cigarette com-	

NFR	Product group	Pollutant			
		Mercury	PAH	Dioxin	PCB
	Tobacco manufacturing ¹⁾		smoke	bustion	
	Use of fireworks	Fireworks		Fireworks	
	Concrete, wall and floor coverings				
	Transformers and capacitors				Capacitors
	Surface coating, sealants and adhesives		Sealants		Coatings, Fire retardants, Plasticizers
	Enclosures and monitors				
	Construction and building products use		Tarry jointing paste, tar paper		Fire retardants in building materials, Repair activities, Plasticizers
	Mercury-containing products; Research and development				
	Mercury-containing products; Health and social work				
	Mercury-containing products ;Private household				
	Other, house and car fires				
CRF 3D1	Use of N ₂ O for Anaesthesia				
CRF 3D3 & 3D4	Use of N ₂ O, Private household				
CRF 3D3 & 3D4	Use of N ₂ O, Research and development				
CRF 3D3 & 3D4	Use of N ₂ O, Recreational, cultural and sporting activities				

¹⁾ Mainly industrial sources

Sources included under nfr 3 solvent and other product use
IE included elsewhere.

6. National methods and data for mercury, PAHs, dioxins and PCBs

Table 2 forms the basis for finding activity data and emission factors for sector NFR 3. Some countries already include some of the activities and products in their emission inventories but to a large extent the knowledge of emissions from the use of products is restricted to certain product groups and pollutants and many activities and products are therefore not currently included. Compiling activity data and emission factors and estimating emissions from use phase of end-products and from diverse industrial activities is therefore a challenge.

Furthermore, it can also be argued that the actual emissions from many sources are small and it will not be a cost-efficient task to derive data and calculating emission. However, to be able to prioritize sources and their emissions it is important to get an understanding of the extent of use and in this process the availability of data is critical. An important issue is therefore to investigate data sources and not least to identify data gaps where important data may be missing and emphasis must be put in the future. Due to the scarcity of data an uncertainty assessment is not feasible, but in the process of deriving more data a Tier 1 uncertainty assessment complying with the IPCC (2006) can be employed.

In previous sections a summary of the four Nordic countries methodologies and data sources for sector NFR 3 is presented. The approach for the pollutants considered in this report may be similar, but the availability of data sets the frame for deriving data and calculating emissions. Data compiling is a time consuming effort and accordingly in this study the primary purpose will be to identify data sources and to evaluate the data availability in terms of directly usable data and the need for calculating activity data and emission factors derived from available data. Some pollutants are only comprised in limited products and the contents may therefore be subjected to confidentiality.

In a recent project at the Finnish Environment Institute SYKE for the OECD PRTR Task Force and funded by the Nordic Council of Ministers, (<http://www.ymparisto.fi/download.asp?contentid=124343&lan=fi>) information related to release estimation techniques for releases from the use of products was compiled from the literature, and through surveys to national research institutes and authorities. The results of the study are used to prioritize product groups to be included in national

PRTR registers, using the following criteria: (1) releases of a chemical from the use of the product is likely, (2) the product has widespread and high volume use, and (3) the releases from use of the product reach the environment in relevant volumes.

Conclusions from the SYKE project are that at the moment the knowledge of emissions from the use of products is restricted and there is not much knowledge of the actual contribution of emissions from the use phase of end-products to the total emissions of most pollutants. However, there is a clear indication that a large part of the national total emissions of certain pollutants may originate from the use of products.

In this current report "Emissions of mercury, PAHs, dioxins and PCBs related to "Solvent and Other Product Use" in Nordic countries emission data and emission factors are compiled and a preparation procedure for inclusion in emission inventories is proposed. Data and information will be collected from trade and production statistics, published substance flow analysis, reporting from industries and databases such as SPIN. Emissions will be given in SNAP/CORINAIR and NFR codes. Implementation and emissions calculation will be carried out during the next reporting period or in Sweden after decision by the Swedish EPA.

6.1 Denmark

6.1.1 *Mercury*

Data are from a substance flow analysis performed for the Danish society covering 2001 data (Skårup et al., 2003). No such detailed investigation has been performed in more recent years therefore the data from Skårup et al. (2003) are used in this report. The investigation concludes that a general decrease in the use and emissions of mercury is found up to 2001 and it is expected that a further decrease has taken place up to present.

6.1.2 *Available data (emissions to air)*

NFR 3A1, 3A2 & 3A3 Decorative, Industrial & Other Coating Application

- Use of paints and lacquers (included in use; see NFR 3D3)

NFR 3C Solvents in Chemical Products Manufacture and Processing

- Production of chemicals and polymers with mercury compounds as catalysts (included in use; see NFR 3D3)
- Paints & lacquers manufacturing (included in use; see NFR 3D3)
- Pharmaceutical products manufacturing (included in use; see NFR 3D3)

- Other products manufacturing (electrical switches and relays, batteries, light sources, thermometers, hardeners and resins for plastics, fillers, LCD screens, lenses for lighthouses, fireworks, dental amalgam fillings, manometers and gauges, laboratory chemicals) (included in use; see NFR 3D3)

NFR 3D3 Other Product Use

- Other product use (paints, lacquers, pharmaceuticals, hardeners and resins for plastics, fillers, fireworks): Annual use of 5–50 kg Hg. Marginal atmospheric emissions are assessed from use and production
- Other product use (dental amalgam fillings): Annual use of 1,100–1,300 kg Hg. Disposal is through waste, wastewater and cremation. Marginal atmospheric emissions are assessed from use and production
- Other product use (light sources, LCD screens): Annual use of 60–170 kg Hg. Waste disposal and handling gives emissions to air. Marginal atmospheric emissions are assessed from use and production.
- Other product use (electrical switches and relays): Used switches and relays are collected and exported and a minor fraction is disposed as waste. Marginal atmospheric emissions are assessed from use and production
- Other product use (thermometers): Used thermometers are disposed as chemical waste, recycling and emitted with waste water. Marginal atmospheric emissions are assessed from use and production.
- Other product use (lenses for lighthouses): 5–10 kg Hg/year.
- Other product use (manometers and gauges): 20–50 kg Hg/year.
- Other product use (batteries): Annual use of 70–150 kg Hg. Disposed as waste. Marginal atmospheric emissions are assessed from use and production
- Other product use (laboratory chemicals): Annual use of 30–70 kg Hg. Disposed as chemical (hazardous) waste. Marginal atmospheric emissions are assessed from use and production

Data gaps

NFR 3C Solvents in Chemical Products Manufacture and Processing

- Other products manufacturing (biocides, pesticides, cosmetics): No data

NFR 3D2 Domestic Solvent Use

- Personal care products (cosmetics): No data
- Biocide and pesticide use: No data

6.1.3 PAH

No PAH emissions to air for the Solvent and Other Product Use sector have been included yet. However, Statistics Denmark and SPIN holds information on many products and some industrial categories, which can be used as activity data. The recent project on PAHs in toys and child care articles (Hoffman et al., 2011 in press) presents concentrations of PAHs in products. Still emission factors to air from production, manufacturing and use are missing.

6.1.4 Available data (emissions to air)

NFR 3C Solvents in Chemical Products Manufacture and Processing

- Manufacture of PVC products, natural and synthetic rubber products, anti-corrosive paints, pigments in inks: Produced amounts (activity data) of some products are available from Statistics Denmark and industries
- Other products manufacturing (tarry jointing paste, tar paper, fishing nets): Produced amounts (activity data) are available from Statistics Denmark and industries
- Other products manufacturing (wood preservation, creosote operations): Produced amounts (activity data) are available from Statistics Denmark and industries. Emission factors for manufacture are included in NFR 3D3 product use. Data are from IPCC (2006)

NFR 3D1 Printing

- Printing industry: Used amount of printing inks (activity data) can be found in Statistics Denmark and SPIN

NFR 3D2 & 3D3 Domestic Use and Other Product Use

- Domestic and Other product use (hygiene products of rubber and PVC, sealants, textiles with rubber, railway ties, wharves or pilings, tarry jointing paste, tar paper, fishing nets, natural/synthetic rubber products, PVC products, cigarettes/tobacco): Used amount (activity data) of some products can be found in Statistics Denmark and SPIN

NFR 3D3 Other Product Use

- Other product use (wood preservation, creosote operations): Used amounts (activity data) are available from Statistics Denmark and industries. Emission factors are stated in IPCC (2006)

6.1.5 Data gaps

NFR 3A1, 3A2 & 3A3 Decorative, Industrial & Other Coating Application

- Application of anti-corrosive paints: No data

NFR 3C Solvents in Chemical Products Manufacture and Processing

- Manufacture of PVC products, natural and synthetic rubber products, anti-corrosive paints, pigments in inks: Emission factors for manufacture are not known
- Other products manufacturing (tarry jointing paste, tar paper, fishing nets): Emission factors for manufacture are not known

NFR 3D1 Printing

- Printing industry: Emission factors for use of printing inks are not known, but assumed high

NFR 3D2 & 3D3 Domestic Use and Other Product Use

- Domestic and Other product use (hygiene products of rubber and PVC, sealants, textiles with rubber, railway ties, wharves or pilings, tarry jointing paste, tar paper, fishing nets, natural/synthetic rubber products, PVC products, cigarettes/tobacco): Emission factors for use are not known

NFR 3D3 Other Product Use

- Other product use (kitchens/cooking): No data

6.1.6 Dioxins

Data are from Hansen & Hansen (2003) and NERI (2006). The substance flow analysis in Hansen & Hansen (2003) comprises a description of the dioxin circulation in the Danish society for the period 2000 to 2002. No such detailed investigation has been performed in more recent years therefore the data from Hansen & Hansen (2003) are used in this report. The unit I-TEQ stands for International Toxicity Equivalent.

6.1.7 Available data (emissions to air)

NFR 3C Solvents in Chemical Products Manufacture and Processing

- Manufacturing of chemicals (pesticides and pharmaceuticals): 0.001 – 0.007 g I-TEQ/year
- Manufacture of PCP containing products (wood, leather, textiles): Emissions to air included under use in NFR 3D2 & 3D3
- Other manufacturing processes (incl. asphalt preparation/recycling, spray drying, vitamin manufacturing): 0.04 – 0.1 g I-TEQ/year (other processes are stated in this category which are not relevant to NFR 3)

NFR 3D2 & 3D3 Domestic Use and Other Product Use

- Use of PCP treated wood: 0.5 – 26 g I-TEQ/year
- Use of other PCP treated materials (leather, textiles): <0.05 g I-TEQ/year

- Other product use (incl. fireworks): 0.1 – 0.2 (fireworks are only fraction of this emission, other activities are stated in this category which are not relevant to NFR 3)
- Cigarette combustion: emission factor pr. cigarette 0.1 pg I-TEQ/cigarette (UNEP, 2005) and approximately 14,000 million cigarettes sold in DK in 2009 (Statistics Denmark, 2005): 0.0014 g I-TEQ/year

Data gaps

NFR 3C Solvents in Chemical Products Manufacture and Processing

- Manufacturing of other chemical products (incl. PVC, ethylene dichloride, hydrogen chloride, rubber, bleaching agents, plastics and printing circuit boards containing brominated flame retardants, dioxazine dyes and pigments, tall oil-based liquid soaps): No data
- Chlorine bleaching (incl. cork, paper, cardboard): No data
- Manufacture of other chemicals (Mono- to tetrachlorophenol, chlorobenzenes, chlorobiphenyls, 2,4-Dichlorophenoxy acetic acid): No data

NFR 3D2 & 3D3 Domestic Use and Other Product Use

- Bleaching processes and use of bleaching agents: No data
- Other product use (pesticides, PVC, cork, paper, plastics and printing circuit boards containing brominated flame retardants): No data

6.1.8 PCB

No substance flow analysis has been made for PCBs in Denmark. Surveys have primarily dealt with specific activities, such as energy production, mobile sources and waste disposal. No PCB air emission inventories for the use of product categories are available for Danish conditions. Even though PCB in consumer products is banned the SPIN database and Statistics Denmark holds use data for some relevant product categories, which may serve as activity data in an emission inventory. Emission factors for use of products are not available at present. Thomsen et al. (2009) states activity data from Statistics Denmark for use of chlorine containing solvents in organic chemicals production in the chemical industry (187 tonnes in 2005). Emission factors for PCB emissions from the chemical industry are not known. In the EMEP/EEA guidebook (EMEP, 2009) there is a Tier 1 default emission factor for category NFR 2F Consumption of Persistent Organic Pollutants and Heavy Metals of 0.1 g PCB/capita, which constitutes an average value of estimated emission factors for leaks from transformers and capacitors for European countries in 1990 (EMEP, 2009; Berdowski et al., 1997). The Tier 1 emission factor thus comprise some of the sources relevant to the Sol-

vent and Other Product Use sector but also includes recycling of ferrous scrap, which falls outside this sector.

6.1.9 Available data (emissions to air)

NFR 3C Solvents in Chemical Products Manufacture and Processing

- Manufacture of other chemicals (chlorinated organic chemicals): use of chlorine containing solvents in 2005: 187 tonnes
- Manufacture of other products (various products): Activity data for some products may be available from SPIN and Statistics Denmark

NFR 3A, 3B, 3D2 & 3D3 Paint Application, Degreasing, Domestic Use and Other Product Use

- Paint application: Activity data for paints are available from SPIN and Statistics Denmark
- Domestic and other product use (various products): Activity data for some products may be available from SPIN and Statistics Denmark

6.1.10 Data gaps

All NFR categories

- Emission factors for manufacture, processing and use of chemicals and various products

6.2 Finland

Available data

The Finnish inventory includes some product use related emissions. Further work to include more sources is carried out when resources are available for the work.

6.2.1 Mercury

Available data (emissions to air are estimated)

- NFR 3C – Hg emissions from production of paint do not occur in Finland
- NFR 3C – Hg emissions from industrial chlor-alkali processes are reported in NFR 2B5
- NFR 3D2 & 3D3 – Biocides and pesticides used in Finland do not contain mercury
- NFR 3D3 – Tobacco smoking (also As, Cd, Cu, Cr and Pb included)
- NFR 3D3 – House and car fires (also As, Cd, Cu, Cr and Pb included)

- NFR 3D3 – Dental mercury-amalgam fillings are included in the inventory under NFR 6Cd

Data gaps (sources exist but emissions are not estimated)

- NFR 3C and 3D – Pharmaceutical and cosmetic products
- NFR 3C & 3D3 – Electrical switches and relays including mercury
- NFR 3D3 – Light sources, incl. light houses (but included in the inventory for their waste handling operations)
- NFR 3C and 3D3 – Use of batteries, thermometers, instruments and laboratory chemicals (but included in the inventory for their waste handling operations)

PAH-4

Available data (emissions to air included in the inventory)

- NFR 3C – Coke/bitumen/asphalt/petroleum production and use included under NFR 1B1b and 1B2a iv
- NFR 3D3 – Tobacco smoking
- NFR 3D3 – Impregnation of wood

Data gaps (sources exist but emissions are not estimated)

- NFR 1A3bvi and 1A3bvii – Tyre and brake wear, road abrasion
- NFR 3C – Road paving and asphalt roofing
- NFR 3C – Use of consumer products releasing PAH-4

Dioxins

Available data (emissions to air included in the inventory)

- NFR 3C –All emissions from manufacturing of chemical products are allocated to 2B5 and from combustion of chlorine containing products to NFR 1A1a
- NFR 3D3 – Tobacco smoking
- NFR 3D3 – House and car fires

Data gaps (sources exist but emissions are not estimated)

- Not identified sources

6.2.2 PCB

Available data (emissions to air)

- Emissions from combustion and industrial sources are included under NFR 1 and 2 and from waste handling operations under NFR 6

Data gaps (sources exist but emissions are not estimated)

- NFR 3A – 3D: Emissions from the use of products

6.3 Norway

6.3.1 Mercury

Available data (emissions to air)

- NFR 3 A 1 Decorative coating application –Mercury emissions are reported as NA
- NFR 3 A 2 Industrial coating application – Mercury emissions are reported as NA
- NFR 3 A 3 Other coating application – Mercury emissions are reported as NA
- NFR 3 B 1 Degreasing – Mercury emissions are reported as NA
- NFR 3 B 2 Dry cleaning – Mercury emissions are reported as NA
- NFR 3 C Chemical products – Mercury emissions are reported as NE
- NFR 3C, – Pharmaceuticals for human and veterinary uses:
Thiomersal, an antiseptic and antifungal agent containing mercury, is used in small amounts as a biocide in some vaccinations products. During the flu vaccination in 2009 almost 3 million people were vaccinated. 3 million shots contain around 7.5 g of mercury.
- NFR 3C – Paints manufacturing: Mercury emissions from production of paint are negligible
- NFR 3C – Emissions of mercury from flaring of natural gas from methanol production, emissions of Mercury from production of titanium dioxide and production of chlor alkali are reported in NFR 2B5
- NFR 3C – Biocides and pesticides: According to emission estimates based on an annual report from the Climate and Pollution Agency (The Norwegian Climate and Pollution Agency 2010 a). 2 kg of mercury was included as impurities in mineral fertilizers, lime, in 2007. None of this mercury is assumed emitted to air.
- NFR 3 D 1 Printing – Mercury emissions are reported as NA
- NFR 3 D 2 Domestic solvent use including fungicides – Mercury emissions are reported as NA
- NFR 3 D 3 Other product use
- NFR 3D3 – Thermometers with mercury: Breakage of mercury-containing thermometers Mercury thermometers are not available on the Norwegian market but they are still present in older appliances, e.g. autoclaves in universities. The sale of mercury-containing thermometers has decreased strongly since the mid-1990s, and the mercury content in these products has been reduced. The supply of mercury to air through thermometers in 2007 was 0 kg (The Norwegian Climate and Pollution Agency 2010)
- NFR 3D3 – Laboratory chemicals and equipment: Various measuring and analytical instruments lead to emissions of mercury. The supply of mercury to air through laboratory chemicals and equipment in

2007 was 7 kg (The Norwegian Climate and Pollution Agency 2010 a)

- NFR 3D3 Fluorescent tubes. The sale of mercury-containing fluorescent tubes has decreased strongly since the mid-1990s, and the mercury content in these products has been reduced
- A prohibition against the production, import and export of mercury-containing products entered into force in 1998, except for some thermometers for professional use, which were then prohibited in 2001. Since these products have long operating life times, there will be emissions from these products for many years. In the calculations, however, it is assumed that the emissions occur the same year as the product is sold. The annual supply of mercury to air through fluorescent tubes in 2007 was 36 kg
- NFR 3D3 – Dental mercury-amalgam fillings: Emissions from the use of mercury for dental purposes are reported in NFR 6Cd. Emissions to air from dental mercury-amalgam fillings are estimated from cremation. The emissions to air were for 2007 53 kg. This is reported under NFR 6D
- NFR 3D3 – Batteries with mercury: The supply of mercury to air through batteries in 2007 was 0 kg (The Norwegian Climate and Pollution Agency 2010)

Data gaps

- NFR 3C – Production of other minerals and materials with mercury impurities: No data
- NFR 3C – Biocides and pesticides: No data
- NFR 3C – Light sources with mercury: No data
- NFR 3D3 – Miscellaneous product uses: No data
- NFR 3D3 – Fireworks: Activity data is available. Emissions are not estimated

6.3.2 PAH

Only PAH emissions to air for use of solvents, NFR 3C, have been included in the inventory. Emissions from coating application, degreasing, dry cleaning printing, and other product use have not been estimated.

Available data (emissions to air)

- NFR 3C – Creosote treated materials. Emissions of PAH are calculated based on import of creosote oil and EF taken from Finstad et al (2001)
- NFR 3C – Tarry jointing paste. Emissions of PAH are calculated based on import of tarry paste and the content of tare
- NFR 3C – Production of asphalt. Emissions of PAH are calculated based on the amount of asphalt produced
- PAH from flaring of natural gas is reported in NRF 1B2a iv

- NFR 3D3 – Cigarette/tobacco smoke: National statistics and EF from Finstad et al (2001) gives an emission of 34 kg for 2009
- PAH from tyre wear: PAH from tyre wear is reported in NFR 1A3b vi. The PAH₄ emission was for 2009 165 kg

Data gaps

- NFR 3A1, 3A2 and 3A3 – No data
- NFR 3B1 and 3B2 – No data
- NFR 3C – Toys: No data

6.3.3 Dioxins

Available data (emissions to air)

- NFR 3C – Production of asphalt. Emission of dioxins is calculated based on the amount of asphalt produced and EF from Sandmo (2010)
- Chemical products: All emissions from manufacturing of chemical products are allocated to 2B5
- Emissions from agricultural residue burning are included under 4F.
- NFR 3D3 – Cigarette combustion: National statistics and EF from Finstad et al (2001) gives an emission of 0.005 g for 2009

Data gaps

- NFR 3C – Chlorine bleaching (incl. cork, paper, cardboard): No data
- NFR 3D2 – Use of fungicides: No data
- NFR 3D2 – Use of pesticides: No data
- NFR 3D3 – Fireworks: Activity data is available. Emissions are not estimated
- NFR 3D3 – Burning of rubbish in private households, grass fires: No data

6.3.4 PCB

There is an ongoing project estimating emissions of PCB to air. This project has primarily dealt with specific activities, such as energy production, mobile sources and waste disposal. No PCB air emission inventories for the use of product categories are available for Norwegian conditions. Emission factors for use of products are not available at present.

Available data (emissions to air)

- NFR 3A, 3B, 3D Paint application: It has been forbidden to produce, sell and use substances or preparations that contain polychlorinated biphenyls in Norway since 1980. Activity data is not occurring
- NFR 3C – Domestic and other product use (various products): Some estimation has been done trying to estimate the amount of PCB in

materials in buildings. It is particularly plaster, jointing paste and paint, used in the period 1940–1980, which may contain PCB

Data gaps

- Emissions of PCB are not included in the Norwegian inventory yet

Emissions of PCB from electrical equipment is assumed to be the most important usage category of PCBs. Respectively PCBs in electrical equipment are potentially the greatest source of environmental pollution by PCBs due to leaks from operating installations. These emissions should be reported under 2F.

Incineration of different types of wastes (especially PCB wastes or PCBs contaminated material) may be a significant source of PCB emissions. These emissions should be reported under 1A1a.

6.4 Sweden

6.4.1 Mercury

Available data (emissions to air)

- NFR 3A – Mercury emissions from use of paint is by Sweden reported NA. Historically (over 30 years ago) could paints contain toxins such as mercury. These were so toxic that they gave strong protection against fouling (The Swedish Paint and Printing Ink Makers Association, www.sveff.se, 2011-01-24)
- NFR 3C – Polyurethane with mercury catalysts: Information in the consultancy report by Gustafsson et al. (2010) to the Swedish Chemicals Agency, indicates that Mercury as catalyst in polyurethane production has most likely not been used for the past 25 years in Sweden
- NFR 3C, NFR 3D2 & NFR 3D3 – Pharmaceuticals for human and veterinary uses: Thiomersal, an antiseptic and antifungal agent containing mercury, is used in small amounts as a biocide in some vaccinations products. During the flu vaccination 2009 the total amount for the whole Swedish population if all shots were to be used was 13–15 g mercury. Mercury in small quantities is also found in pharmaceuticals (for eyes and rheumatism) and some homeopathic products. (Gustafsson et al. 2010)
- NFR 3C – Paints manufacturing: Mercury emissions from production of paint do not occur in Sweden
- NFR 3C – Other production of chemicals and polymers with mercury compounds as catalysts: Mercury emissions from the chlor-alkali process is reported in NFR 2B5

- NFR 3C & NFR 3D3 – Electrical switches and relays with mercury: Mercury in relays, contactors and switches is phased out in Sweden. As LED technology is starting to replace different types of lights, signal systems with mercury relays are gradually being removed and exchanged in Sweden according to the Swedish Transport Administration. In 2004 about 250 kilo mercury was still present in signal system relays in Sweden. Mercury in personal motion alarms have not been used for many years. Mercury switches in ABS brakes and airbag activators have been phased out more than 20 years ago in Swedish Volvo cars and replaced with other sensor techniques. (Gustafsson et al. 2010)
- NFR 3C, NFR 3D2 & NFR 3D3 – Cosmetics and related products: According to the Cosmetics Directive 2008/42/EC it is not permitted to place cosmetic products on the market if they contain mercury or mercury compounds. The Directive, however, contains exemptions that mean that phenylmercury salts and thiomersal are permitted in eye make-up and products for removing eye make-up subject to a maximum mercury content of 0.007% (KemI, 2004). There are very few eye make-up products or products for removing make-up on the Swedish market which contain mercury and liquids for eye lenses have not contained thiomersal for the last 15–20 years (Gustafsson et al. 2010)
- NFR 3C – Batteries with mercury: No production in Sweden
- NFR 3C – Biocides and pesticides: According to the Pesticides register at the Swedish Chemicals Agency no biocides or pesticides with mercury have been approved for use in Sweden for more than 20 years
- 3D2 & NFR 3D3- Biocides and pesticides: According to the Pesticides register at the Swedish Chemicals Agency no biocides or pesticides with mercury have been approved for use in Sweden for more than 20 years
- NFR 3D3 – Batteries with mercury: The annual supply of mercury to society through batteries in 2006 was 126 kg (www.kemi.se, 2011-01-24)
- NFR 3D3 – Light sources with mercury: In some types of lighthouses, the lens unit floats on a mercury bath as a low-friction rotation mechanism. In Sweden, there are presently seven lighthouses with this type of mercury application. Each lighthouse mercury bath contains about 13 litres of mercury (Gustafsson et al. 2010). The total amount of mercury used in lighthouses is therefore just below 100 kg. The annual supply of mercury to society through light sources in 2007 was 130 kg (www.kemi.se, 2011-01-24)
- NFR 3D3 – Thermometers with mercury: Mercury thermometers are not available on the Swedish market but they are still present in older appliances, e.g. autoclaves in universities. At present both the

University of Stockholm and Chalmers University of Technology of Gothenburg are making inventories on mercury contents in their chemicals and appliances (Gustafsson et al. 2010). The annual supply of mercury to society through thermometers in 2006 was 0.03 kg (www.kemi.se, 2011-01-24)

- NFR 3D3 – Manometers and gauges: The number of mercury manometers still existing in Sweden is likely very few. A special form of pressure measurement occurs in the polyethylene manufacture industry, where precision measurement is made at high temperature and therefore mercury manometers have been used. The Swedish company producing polyethylene have exchanged all the mercury manometers for new digital devices (Gustafsson et al. 2010)
- NFR 3D3 – Laboratory chemicals and equipment: Estimates made by the Swedish Chemicals Agency (2004) gives that the quantities of mercury compounds used in the form of analytical chemicals in Sweden in 2003 correspond to about 53 kg of mercury
- NFR 3D3 – Mercury metal use in religious rituals and folklore medicine: Not relevant for Sweden
- NFR 3D3 – Dental mercury-amalgam fillings: Emissions from the use of mercury for dental purposes are reported in NFR 6Cd. The emissions are for later years around 100 kg yearly

Data gaps

- NFR 3C – Production of other minerals and materials with mercury impurities: No data
- NFR 3C – Light sources with mercury: No data
- NFR 3C – Thermometers with mercury: No data
- NFR 3D3 – Miscellaneous product uses: No data

6.4.2 PAH

Available data (emissions to air)

- NFR 3 – Solvent and Other Product Use: The SPIN database gives the information that for 2007 the total used amounts were 39 tonnes
- NFR 3C – Coke/bitumen/asphalt/petroleum production and use: PAH from coke production is reported in NFR 1B1b. PAH from refining/storage is reported in NFR 1B2a iv
- NFR 3C – Petrochemical and related industries: Refineries: Reported in 1B2a iv
- NFR 3D3 – Rubber tyre use: PAH from tyre wear is reported in NFR 1A3b vi. The PAH4 emission was for 2009 5.3 kg
- NFR 3D3 – Cigarette/tobacco smoke: National statistics and EF from EMEP/CORINAIR Guidebook (2009) gives an approximate yearly emission of between 35 and 78 kg

Data gaps

- NFR 3C – Paints manufacturing: No data
- NFR 3C – No information is available to report PAH from road paving and asphalt roofing
- NFR 3C – Rubber tyre manufacturing: No data
- NFR 3C – Tarry jointing paste, tar paper, fishing nets: No data
- NFR 3C – Toys: No data
- NFR 3D3 – Wood preservation/creosote operations: No data
- NFR 3D3 – Railway ties, wharves or pilings: No data

Dioxins

Available data (emissions to air).

- NFR 3C – Pentachlorophenol: No production in Sweden
- NFR 3C – Brominated flame retardants. 200 tonnes of brominated flame retardant was in 2005 imported to the Swedish industry
- NFR 3C – Chemical products: All emissions from manufacturing of chemical products are allocated to 2B5. For a few of the included facilities, information on dioxin emissions to air is available
- NFR 3D3 – PCP-treated wood: Estimates presented in Swedish EPA Report 5911 (2009) show that between 0.4 and 3.7 kg dioxin (I-TEQ) can be found in PCP treated wood products
- NFR 3D3 – Tobacco smoking: National statistics and EF from EMEP/Corinair Guidebook gives an approximate yearly emission of between 0.005 and 0.012 g
- NFR 3D3 – Fireworks: Activity data is available. EF for estimations of dioxin emissions is missing
- NFR 3D3 – Use of PVC. Dioxin emissions from combustion of PVC containing products included in NFR 1A1a

Data gaps

- NFR 3C – Rubber Manufacturing: No data
- NFR 3C – Tall oil-based liquid soaps: No data
- NFR 3C – Asphalt mixing plants: No data
- NFR 3C – Textile finishing, PCP in textiles: No data
- NFR 3C – Leather tanning, PCP in leather: No data
- NFR 3D2 – Use of textile finishing: No data
- NFR 3D2 – Use of leather: No data
- NFR 3D2 – Use of fungicides: No data
- NFR 3D2 – Use of pesticides: No data

6.4.3 PCB

Available data (emissions to air)

- NFR 3: In the Swedish EPA Report “Omhändertagande av PCB i byggnader” (2002, Dnr 643-2492-02) are estimates of the amount of PCBs in buildings presented. The amounts in sealants used are estimated to have been between 100 to 500 tons. The corresponding figure for PCBs in insulating glass units are estimated to originally have been about 115 tonnes, but the estimated remaining amount are 35 tonnes of PCBs. PCBs in acrylic floor mass was estimated to be 20 – 30 tonnes while the amounts in capacitors in fluorescent light was estimated to be 20 tonnes. (Swedish EPA Report, 2002, Dnr 643-2492-02). Lilliehorn and Bernevi-Rex (2010) indicate that the total initial amount of PCBs in buildings was around 260 tonnes of which about 100 tonnes remains to be cleaned

Data gaps

- NFR 3A – 3D: Almost no data

7. Means of actions to reduce emissions

7.1 Mercury

Mercury is one of the most toxic chemicals that is being used today and on the EU and national levels there are legally binding instruments in force which aim to limit the use and spreading of mercury in the environment. These include banning of use and of export to limit the emissions on a global basis. Regulation in the EU comprises, i.a., EC (2008) on the banning of exports of metallic mercury and certain mercury compounds and mixtures and the safe storage of metallic mercury. Furthermore in the EU, legislation has been laid down to restrict the presence of mercury in products, e.g. directives include legislative requirements for lead: Mercury restriction in packaging, mercury in restriction batteries and mercury prohibition in electronics (EIATrack, 2010). Denmark has implemented regulations that are more extensive than stated by the EU, and is working on establishing internationally binding regulations. In Denmark mercury and mercury containing products, excluding measuring instruments, may not be imported, sold or exported. Furthermore import and sale of mercury containing medical thermometers for professional and private use and other mercury containing measuring instruments for private use is banned. Exceptions are import and sale of mercury containing measuring instruments that on the third of October 2007 are older than 50 years. Further exceptions are import, sale and export of mercury and mercury containing products for the following purposes: dental fillings on permanent molars, switches and relays for certain uses, certain light sources, blinking devices on railways, electrodes for certain uses, mercury containing chemicals for certain uses, research, education, life saving devices on airplanes, repair of existing mercury containing equipment. Some products are not included by the above regulation but must comply with other regulation; e.g. batteries, cosmetics, medical equipment, paints, lacquers, packaging, waste, electric and electronic products. Desinfection of brickwalls, wood and textiles are also comprised by other regulations (DEPA, 2011b).

Mercury has high priority in Norway's efforts to minimise harm caused by hazardous substances. The national target is for releases and use of mercury and other substances that pose a serious threat to health or the environment is to be continuously reduced with a view to eliminating them by 2020. Emissions of mercury have been reduced by 65

per cent since 1990. The main reason for the decline is less process emissions from production of iron, steel and ferro alloys. The most important source of mercury emissions is combustion without energy utility, which comprises cremations. It is prohibited to manufacture, import, export, sell and use substances or preparations that contain mercury or mercury compounds. In 2008, Norway introduced a general ban on the use of mercury in new products, with only a few time-limited exceptions. The ban applies to the production, import, export and placing on the market of products containing mercury. Norway banned new mercury thermometers for private use as early as 1998, and for professional use from 2000. A nationwide campaign to collect discarded mercury thermometers was very successful, and most of the thermometers in private households were collected. Norwegian hospitals phased out the use of blood pressure instruments containing mercury voluntarily before 2008. Norway, like the EU, prohibited the use of mercury in new electrical and electronic equipment from 2006. There are exceptions for fluorescent tubes and energy-saving light bulbs, which must comply with rules on maximum mercury content. There are easily available alternatives to most types of batteries that contain mercury. Norway has banned mercury in all batteries except button cells. Dental amalgam used to be the largest area of use for mercury in products in Norway. The Norwegian health authorities have been urging dentists to use alternative products since 1991. Consumption of dental amalgam has been eliminated with the general ban on mercury in products from 2008, although mercury will continue to be released from old fillings. (The Norwegian Climate and Pollution Agency 2010b).

Finland does not have national legislation restricting emissions of mercury emissions over those regulations by the UN, the UNECE or the EU. In addition to general chemical legislation there are decisions by the government on biocide products, use of organic solvents, substances dangerous to water environment, on waste and wastewater containing amalgam, on effective substances in pesticides, on harmful substances in batteries and accumulators and in electrical and electronic devices, and on exceptions from the REACH regulation annex XVII concerning marketing and use of substances.

The Swedish government decided on 15 January 2009 on a general ban on mercury and products containing mercury. The decision came into force on 1 June 2009. The ban means that mercury and mercury compounds and preparations may not be placed on the Swedish market, used in Sweden or professionally exported from Sweden. Products containing mercury may not be placed on the Swedish market or professionally exported from Sweden. Products containing mercury which are already in use, are not prohibited to use but they may not be transferred further, i.e. placed on the market or be exported from Sweden, or filled with new mercury.

7.2 PAH

The European regulation of chemicals, REACH regulation (EC) No. 1907/2006 (EC, 2006) includes certain PAHs in a specified use, i.e. the content in extender oils used for production of tyres. The rules apply to all types of tyres on the approved vehicles and entered into force on 1 January 2010. EU regulation on safety of toys is at the moment covered by directive 88/378/EEC and a new directive 2009/48/EC will be in force in 2011. In addition to the restrictions in REACH, criteria have also been laid out under the Nordic environmental labelling scheme. So called Ecolabelling criteria have been developed for two product groups relevant in relation to PAH; Vehicle tyres (Nordic Ecolabeling, 2009) and toys (Nordic Ecolabeling, 2010). Apart from these measures there are largely no specific regulations for PAHs in consumer products. The German Federal Institute for Occupational Safety and Health (Baua, 2010) proposed the REACH, Annex XVII to be changed/extended to cover PAHs in consumer products by adding a Fifth paragraph to the section on PAH: "5. Articles which could be used by consumers (including articles in contact with the oral mucosa, toys, and childcare articles) shall not be placed on the market, if they contain any of the PAHs listed in column 1 at levels above the limit of quantification (LOQ). Currently the LOQ is located at 0.2 mg/kg for any of the listed PAHs" The eight listed PAHs are Benzo(a)pyrene, Benzo(e)pyrene, Benzo(b)fluoranthene, Benzo(j)fluoranthene, Benzo(k)fluoranthene, Benzo(a)anthracene, Chrysene, Dibenzo(a,h)anthracene.

Regarding creosote, a classified R45 category 2 carcinogen, the hazard assessment and risk characterisation for human health performed by KemI (2007) concludes; an inclusion in Annex I of Directive 98/8/EC cannot be recommended at present for creosote as an active substance in wood preservatives. It is also recommended that the benefits of creosote products are analysed before a final decision is taken.

In Norway the national target for releases and use of PAHs is to continuously reduce the emission with a view to eliminating them by 2020. Emissions of PAHs have been reduced by three quarters since 1990, mainly due to reduced emissions from aluminium production. The PAH emissions continued to decrease from 2008 to 2009, primarily because of the closing down of Soederberg technology in the aluminium production. Wood-burning is the most important source of emissions of PAHs and contributed to 46 per cent of the emissions in 2009. New building regulations with requirements for approval of closed fireplaces in houses and information about optimal ways of heating has probably led to some reduction in emissions from new dwellings.

Finland does not have national legislation restricting emissions of PAH-4 emissions over those regulations by the UN, the UNECE or the EU.

7.3 Dioxins

In Denmark unintentional emissions of dioxins, primarily from industrial production, energy production and (waste)incineration, must not exceed a limit value of 0.1 ng/(normal m³ emitted air). If an industry's overall annual emission exceeds 0.01 g emission reducing measures must be made. Dioxins must not be found in consumer products in EU and occurrence in imported products from other parts of the world is rare. The Danish EPA Chemical Inspection Service are supervising compliance with the regulations and ensures that any illegalities are dealt with. This may imply that an illegal product is withdrawn from the Danish market or that the product is made legal by other means. If regulations are violated the offender will be fined or in more severe matters will be imprisoned for up to two years (DEPA, 2011c).

In Norway the national target for releases and use of dioxin is to continuously reduce the emission with a view to eliminating them by 2020. Emissions of dioxin have been reduced by 83 per cent since 1990. A large proportion of this reduction is due to the shutting down of one industrial plant and one mine. In addition, emissions from energy supply were reduced by 97 per cent from 1990 to 2009 due to the introduction of cleaning measures at waste incineration plants. The transition to unleaded gasoline has reduced dioxin emissions per car and new building regulations with requirements for approval of closed fireplaces in houses and information about optimal ways of heating has probably led to some reduction in emissions from new dwellings.

Finland does not have national legislation restricting emissions of dioxin emissions over those regulations by the UN, the UNECE or the EU.

7.4 PCB

Directive 96/59/EC on the disposal of PCBs and PCTs aims at disposing completely of PCBs and equipment containing PCBs as soon as possible. This Directive sets the requirements for an environmentally sound disposal of PCBs. EU Member States have to make an inventory of big equipment containing PCBs, have to adopt a plan for disposal of inventoried equipment, and outlines for collection and disposal of non inventoried equipment (small electrical equipment very often present in household appliances manufactured before the ban on marketing of PCBs). The PCB Directive further mandates that Member States had to dispose of big equipment (equipment with PCB volumes of more than 5 litres) by the end of 2010 at the latest. The Commission will verify the implementation of this provision.

Since October 1986 production, import, use and sale of PCB and apparatus containing PCB has been banned in Denmark. Further uninten-

tional emissions, primarily from industrial production, energy production and incineration, must not exceed 0.0001 mg PCB/(normal m³ emitted air). Regulations were applied in 1986 to ensure environmentally safe disposal of PCB containing waste. A PCB fact sheet issued by the Danish Environmental Protection Agency describes how PCB in building joints and other building materials, in indoor air, in the working environment and in waste must be handled (DEPA, 2011). The regulations are not directed towards the activities in NFR 3 Solvent and Other Product Use sector but give directions on how to handle waste and disposed products, which are associated with this sector.

It has been forbidden to produce, sell and use substances or preparations that contain polychlorinated biphenyls in Norway since 1980. Although PCBs are banned, there are still PCBs in some products and materials produced before 1980. Use and handling of PCB products and materials are now largely regulated by:

- Regulations on restrictions on the use of hazardous chemicals and other products (Product Regulations)
- Regulations relating to the recycling of waste (Waste Regulations)

At the end of 2008 is expected approx. 90% of PCB products in Norway are taken out of use. It is nevertheless estimated that nearly 150 tonnes of PCBs still in use in products and materials. The most important known, national sources for the remaining PCBs are buildings from the period 1940-1980, contaminated soil and sediments and oil in transformers and capacitors. There are large uncertainties associated with estimating the amount of PCBs used in Norway. (SFT, 2009).

Finland does not have national legislation restricting emissions of PCB emissions over those regulations by the UN, the UNECE or the EU.

In Sweden all use of PCBs was banned in 1978 and PCBs have been phased out gradually since then. PCBs were primarily used as insulating and lubricating oil in capacitors and transformers in, sealants, paints, carbonless paper, etc. (KemI, www.kemi.se, 2011-02-08). Since 2007 it is regulated that buildings and structures erected between 1956 and 1973 should be investigated and remediated for PCBs in the sealants and flooring materials. The total amount of PCBs detected by the inventory is very difficult to assess but a rough calculation indicates that the initial amount of PCBs was around 260 tonnes of which about 100 tonnes remains to be cleaned. The company SAKAB, who has the only facility for the destruction of PCBs in Sweden, is estimated to have 1998-2009 destroyed around 40 tonnes of pure PCBs in sealants. (Lilliehorn & Bernevi-Rex, 2010). The PCB regulation (SFS 2007:19) requires the removal of sealants containing PCBs to be completed in 2011 and 2013, respectively, depending on the type of building. The Swedish EPA suggested in 2010 that the regulation time limits should be

moved. The two dates for the remediation to be completed is thus suggested to be 30 June 2014 and 30 June 2016, respectively. (Swedish EPA, www.naturvardsverket.se, 2011-02-08).

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Sammenfatning på dansk

Sektor NFR 3 „Solvents and Other Product Use“ omfatter mange kilder og aktiviteter der giver kviksølv, PAH, dioxiner og PCB emissioner til luft. Da emissionerne er relativt små set i forhold til de totale nationale emissioner, er der ikke en enkelt af disse kilder der er dominerende, hvorimod summen kan være betydende. Da der generelt er datamangler for både aktivitetsdata og emissionsfaktorer er det ikke muligt at beregne emissioner til luft for størstedelen af kilderne. For enkelte kilder er der emissionsestimater, og disse er angivet i rapporten.

I dette studie samles de eksisterende informationer og viden omkring aktivitetsdata, emissionsfaktorer og luftemissioner af kviksølv, PAH, dioxiner og PCB fra sektor NFR 3. Et væsentligt formål er at identificere datamangler, hvilket kan anvendes til at prioritere områder for den mest kost-effektive forbedring af emissionsopgørelserne. Udover at forbedre de nordiske landes opgørelser vil resultaterne også kunne anvendes til at udarbejde mere komplette internationale guidelines.

Kviksølv

Danmark: En massebalance blev udført med 2001 data, hvilket er det mest fyldestgørende studie der er lavet for danske forhold. Produkter og aktiviteter kan være ændrede siden 2001, men undersøgelsen giver vigtige kvantitative vurderinger og data for væsentlige kilder som efterfølgende kan fokuseres på. Kviksølvemissionerne er stadig faldende på grund af forbud og udfasning, men der er stadig produkter i cirkulation som giver uønskede emissioner som følge af anvendelse og bortskaffelse. Sektor NFR 3 bidrager med ca. 3 % af de totale danske luftemissioner på 820–2000 kg kviksølv/år, baseret på 2001 data. Konklusionerne fra dette projekt er at der skal beregnes opdaterede aktivitetsdata og emissionsfaktorer for følgende væsentlige kilder: amalgam tandfyldninger, lyskilder, manometre og måleinstrumenter. Hygiejneprodukter og pesticidproduktion er potentielle kilder, der ikke blev undersøgt i 2001 studiet og som også bør vurderes.

Finland: Den finske emissionsopgørelse inkluderer kviksølvemissioner fra forbrændingskilder (49 %), anvendelse af bildæk og bremsebelægning (3 %), mineral industri (3 %), kemisk industri (7 %), jern og stål industri (31 %), non-jern metaller og andre metal produktionsprocesser (0,8 %), produktanvendelse (<0,1 %) og affaldssektoren (6 %). Det vurderes at der ikke er andre relevante kilder til kviksølvemissioner, udover mulige emis-

sioner fra anvendelse af farmaceutiske produkter og kosmetik, elektrisk udstyr indeholdende kviksølv samt lyskilder.

Norge: Kviksølvemissioner til luft er aftagende hovedsagelig på grund af faldende emissioner fra industrien. Yderligere fald skyldes forbud og udfasning, men der er stadig produkter i brug, som giver uønskede emissioner fra anvendelse og bortskaffelse. Sektor NFR 3 bidrager med ca. 5 % af de totale norske luftemissioner på 513 kg kviksølv i 2009. Hygiejneprodukter, fyrværkeri samt anvendelse og produktion af pesticider bør også indgå i opgørelsen.

Sverige: I den Europæiske Kommissions D-G Environment rapport „Options for reducing mercury use in products and applications, and the fate of mercury already circulating in society“ (2008) er de væsentligste anvendelsesområder i industrielle processer og produkter i EU vist. Ifølge rapporten udgør chlor-alkali produktion over 40 % af den totale anvendte mængde kviksølv. Andre vigtige kilder er lyskilder (3 %), batterier (4 %), amalgam tandfyldninger (24 %), måleudstyr (3 %), kontakter og relæer (0,1 %), kemikalier (10 %) og øvrige anvendelser som porosimetri og vedligehold af fyrtårne (15 %). Den svenske emissionsopgørelse dækker kviksølvemissioner til luft fra chlor-alkali produktion (rapporteret i 2B5) og delvis amalgam tandfyldninger under emissioner fra krematorier (rapporteret i 3D3). Men der mangler emissioner fra fyrtårne, batterier, måleudstyr, elektriske kontakter og relæer, kemikalier og øvrige anvendelser. Som konklusion skal der frembringes aktivitetsdata og emissionsfaktorer for følgende potentielt væsentlige kilder; elektriske kontakter og relæer, fyrtårne, laboratoriekemikalier og udstyr.

PAH

Danmark: PAH emissioner fra sektor NFR 3 er endnu ikke inkluderet i den danske emissionsopgørelse. Danmarks Statistik og SPIN har data for mange produkter og industrielle kategorier, der kan indgå som aktivitetsdata. I det kommende arbejde vil fokus være på PVC produkter, naturlige og syntetiske gummiprodukter, træbeskyttelse og kreosotbehandling af træ. Et netop afsluttet projekt omkring PAH i legetøj og børneartikler (Hoffmann et al., 2011) præsenterer PAH koncentrationer i disse produkter. Der mangler dog stadig emissionsfaktorer fra produktion, fremstilling og anvendelse.

Finland: Den finske emissionsopgørelse inkluderer PAH-4 emissioner fra forbrændingsprocesser (92 %), transport (7 %), metal og skovindustrier (0,1 %), produktanvendelse (0,2 %) og affaldshåndtering (0,6 %). PAH-4 emissioner fra dæk- og bremseafslidning samt vejafslidning er ikke inkluderet i øjeblikket på grund af manglende data. De forventes dog at være indeholdt i den kommende opgørelse og at bidrage med ca.

1 % af de totale PAH emissioner. Det vurderes derfor at de væsentligste kilder er inkluderet i den finske PAH-4 emissionsopgørelse.

Norge: PAH emissioner fra sektor NFR 3 bidrager med mindre end 1 % af de totale norske PAH emissioner i 2009. I henhold til Tabel 2, rapporterer Norge i øjeblikket PAH emissioner fra flaring i NFR 1B2a og anvendelse af gummidæk i NFR 1A3b vi. Emissioner fra kreosotbehandlede materialer, tarry jointing paste og produktion af asfalt er rapporteret under 3C. Emissioner fra tobaksrygning er rapporteret under 3D. PAH emissioner fra legetøj skal vurderes i kommende opgørelser.

Sverige: De svenske PAH emissioner udgør i alt ca. 13 Gg i 2009. I henhold til Tabel 2 rapporterer Sverige i øjeblikket PAH emissioner fra koksproduktion i NFR 1B1b, raffinering i NFR 1B2a iv og anvendelse af gummidæk i NFR 1A3b vi. PAH emissioner fra tobaksrygning kan estimeres ud fra nationale statistikker sammenholdt med emissionsfaktorer fra EMEP/CORINAIR Guidebook (2009). Der skal samles data for PAH emissioner fra produktion af gummidæk i kommende opgørelser.

Dioxiner

Danmark: En massebalance for dioxin cirkulationen i Danmark er blevet udført for perioden 2000 til 2002. Ingen tilsvarende detaljerede undersøgelser er blevet udført siden. Dioxin emissionerne er faldet med ca. 8 % sammenlignet med 1998 – 1999 niveauet, primært på grund af lavere emissioner fra stål, aluminium og kabelskrot genindvinding og forbrænding af farligt affald. Dannelse af dioxin er primært knyttet til forbrændingsprocesser og sektor NFR 3 bidrager med ca. 6 % af de totale danske 2000–2002 emissioner på 11 – 163 g I-TEQ/år. Som konklusion skal der frembringes opdaterede aktivitetsdata og emissionsfaktorer for PCP-behandlet træ og for fremstilling og anvendelse af PVC, gummi, blegemidler, printkort med brommerede flammehæmmere, dioxazine farvestoffer og pigmenter.

Finland: Den finske emissionsopgørelse inkluderer dioxin emissionsestimater for forbrændingsprocesser (55 %), transport (24 %), mineralindustri (2 %), kemiskindustri (0,4 %), metalindustri (16 %), produktanvendelse (<0,1 %) og affaldshåndtering (2 %). Det vurderes at der ikke mangler væsentlige kilder i dioxin emissionsopgørelsen.

Norge: Dioxin emissioner fra sektor NFR 3 bidrager med mindre end 1 % af de totale norske dioxin emissioner i 2009. I henhold til Tabel 2 rapporterer Norge dioxin emissioner fra fremstilling af kemiske produkter i NFR 2B5. Emissioner fra asfaltproduktion rapporteres under NFR 3C og emissioner fra tobaksrygning rapporteres under NFR 3D. Dioxin emissioner fra fyrværkeri skal inkluderes i kommende opgørelser.

Sverige: Den svenske emissionsopgørelse dækker de væsentligste kilder til dioxin emissioner til luft for sektor NFR 3. I 2009 blev der totalt rapporteret ca. 36 g, hvoraf over 90 % indgik i sektor NFR 1. Følgende mulige mindre

kilder under NFR 3 er i øjeblikket ikke inkluderet; dioxin emissioner fra PCP-behandlet træ, gummi produktion, tobaksrygning og fra anvendelse af fyrværkeri. Til konklusion er aktivitetsdata og emissionsfaktorer tilgængelige for tobaksrygning. Emissionsfaktorer for anvendelse af fyrværkeri skal frembringes. Aktivitetsdata og emissionsfaktorer for gummiproduktion og PCP-behandlet træ skal frembringes ligesom aktivitetsdata og emissionsfaktorer for anvendelse af brommerede flammehæmmere.

PCB

Danmark: Der er ikke udført massebalancer for PCB i Danmark. Undersøgelser har omhandlet specifikke aktiviteter, som energiproduktion, mobile kilder og affaldsbortskaffelse. Ingen PCB luftemissioner for anvendelse af produkter er tilgængelige for Danmark. Selv om PCB i forbrugerprodukter er forbudt kan der være aktivitetsdata for relevante aktiviteter og produkter, hvor der stadig forekommer PCB, i Danmarks Statistik og SPIN. Emissionsfaktorer for den kemiske industri haves ikke i øjeblikket. I EMEP/EEA guidebook (EMEP, 2009) er der Tier 1 default emissionsfaktorer for kategori NFR 2F „Consumption of Persistent Organic Pollutants and Heavy Metals“ på 0,1 g PCB/capita, hvilket udgør en middelværdi for estimerede emissionsfaktorer for spild fra transformere og kapacitorer, for europæiske lande i 1990 (EMEP, 2009; Berdowski et al., 1997). Tier 1 emissionsfaktorerne indeholder nogle kilder, der er relevante for NFR 3, men også kilder såsom genanvendelse af jernskrot, som falder udenfor sektoren. Som konklusion skal der frembringes aktivitetsdata og emissionsfaktorer for; fremstilling af chlorerede organiske kemikalier, anvendelse af transformere, kapacitorer, varmeoverførelses-systemer, maling, klæbemidler, tætningsmidler og andre produkter med mulige PCB emissioner til luft.

Finland: Den finske emissionsopgørelse inkluderer PCB emissioner fra forbrændingsprocesser (16 %), transport (12 %), mineralindustri (1,5 %), metalindustri (8 %) og affaldshåndtering (62 %). PCB emissioner fra produktanvendelse er i øjeblikket ikke inkluderet i opgørelsen og kan i nogen grad bidrage til de totale PCB emissioner.

Norge: Der er i øjeblikket et projekt i gang vedrørende PCB emissioner til luft primært fra energiproduktion, mobile kilder og affaldshåndtering. Der er ikke lavet emissionsopgørelser for PCB som følge af produktanvendelse. Der skal bestemmes PCB emissioner fra bygningsmaterialer.

Sverige: En svensk EPA rapport angiver, at der er mellem 175 og 585 tons PCB bundet til materialer og udstyr i bygninger i Sverige. Lilliehorn og Bernevi-Rex (2010) indikerer et total indhold af PCB i bygninger på ca. 260 tons, hvoraf ca. 100 tons stadig forefindes i bygninger. Der er kun sparsomme oplysninger om andre kilder til PCB og deres emissioner til luft.