

Statistics Norway
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**Material flow analysis of
Cadmium and di-2-
ethylhexylphthalate (DEHP) in
Norway**

Documents



1. Summary

Material flow analyses of Cadmium and di-2-ethylhexylphthalate (DEHP) in Norway have been performed. The aim of this methodical study has been to validate the use of existing statistics and registers as a possible data sources for material flow analyses of such substances. All numbers and estimates given in the report are preliminary results based on the available information given in these datasources. This report gives an overview of relevant commodities in the two cases, methods, validation of various data sources and a summary on the main flow patterns, consumption and user groups.

Cadmium and DEHP are considered as possible toxic compounds and represent potential hazards to the environment. Both substances are introduced through the consumption of a large variety of products which leads to a diffuse flow pattern and exposure to the environment.

The total consumption of di-2-ethylhexylphthalate (DEHP) in Norway is preliminary estimated to about 2331 tonnes in 1988 and 2808 tonnes in 1993. Most of this consumption is connected to use of plastic products. DEHP is found in PVC plastic products, paints, printing ink, fungicides and bactericides. 10 per cent of the DEHP consumption were connected to private households. The total level is in consistence with other surveys on DEHP, and the method is expected to provide reliable time series.

The method of using existing statistics and registers to perform a material flow analysis proved successful in the case of DEHP. The existing statistics and registers proved to be sufficient to perform a complete material flow analysis, covering flow patterns, total consumption products and user groups.

Cadmium is found in fossil fuels, fertiliser and lime, alloys, as corrosive protection, cathodic protective electrodes, imported plastic products, pigments, batteries, food and tobacco. The most important exposure is through consumption of food and tobacco.

The method of using existing statistics and registers to perform a material flow analysis proved less successful in the case cadmium than found on DEHP. This was due to the large number of products involved, lack of sufficient detail in the statistics and lack of information about the cadmium contents of the relevant products. The identification of relevant commodities was more difficult and the existing registers and statistics proved to be insufficient to alone cover the needs of a complete material flow analysis. A complete material flow information can however be provided, combining the existing statistics with other sources of information like special surveys, importers, research institutes and literature.

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2. Introduction

2.1. Background

Material flow analysis is a useful tool serving several applications. It may be used to follow flows of high volume materials in the economy or low volume flows of specific substances of interest e.g. due to toxicity. The two cases of material flow analysis require different techniques, accuracy and use of data sources. This work will focus on methodologies for material flows of two toxic substances; cadmium and di-2-ethylhexylphthalate (DEHP). For cadmium the emissions to air and discharges to water are of high interest. For DEHP the material flow itself through various products may lead to exposure. The two subjects chosen are of interest to the public as well as policy makers.

Material flow analysis of toxics is a challenging task because a high accuracy is needed, and combining various statistical sources is often needed to achieve this accuracy. Often special surveys may be required, but this study focuses on the possibility of utilising existing data. Another challenge is how to determine non-statistical parameters, e.g. the concentration of a particular substance in a commodity.

These material flow analysis consist of the following steps:

- a) Find relevant commodities in the statistics of foreign trade and choose a suitable problem.
- b) Quantify imports, exports, production and raw material use of the relevant commodities from official statistics in Statistics Norway.
- c) Look at the same parameters from the Product Register.
- d) Preliminary conclusions and recommendation from a-c.
- e) Perform revisions.
- f) Determine non-statistical parameters.
- g) Quantify flows, emissions and discharge.
- h) Discuss the usefulness of material flow analyses with respect to reporting (to e.g. the North Sea protocol) and constructing environmental indicators.

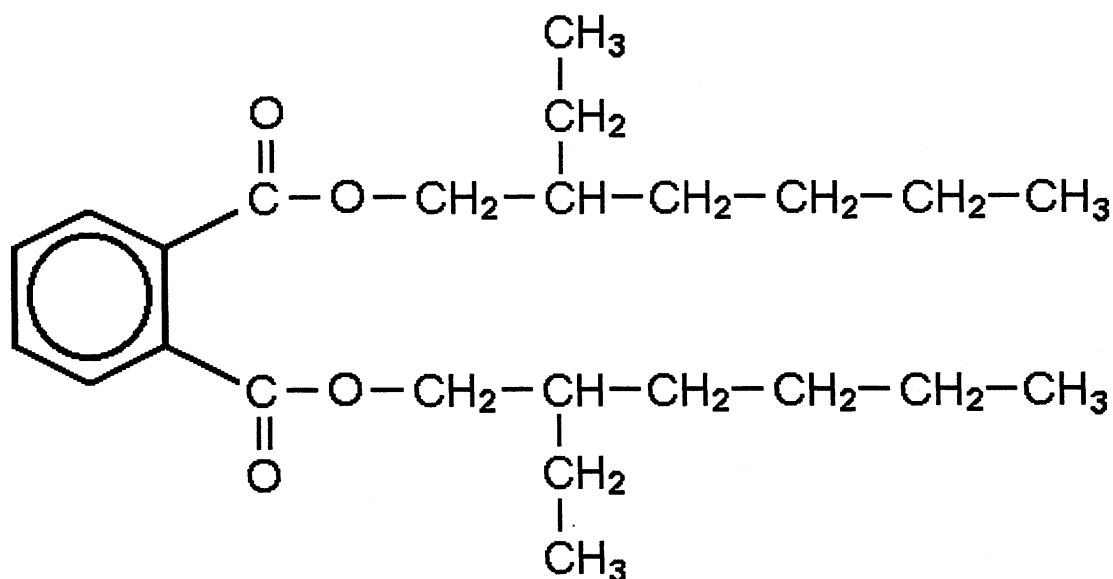
The current report covers mainly a-d in the above list. A possible step 2 of the project will focus on emissions and discharges.

2.2. Properties and applications

2.2.1. Phthalates

Phthalates are produced by the ester reaction between orthophthalic acid and alcohols. Their boiling points are between 200 and 360 °C. They have low volatility and very low solubility in water.

Figure 1. The structure of di-2-ethylhexylphthalate (DEHP).



Phthalates are mainly used as plasticisers in various polymers. Compounds with eight to eleven carbon atoms in the side chains are used as plasticisers in PVC and rubber. Dioctylphthalates are the most important, with di-2-ethylhexylphthalate (DEHP) as the most used isomer. DEHP is also used as an additive in paints and in bactericides and fungicides.

2.2.2. Cadmium

Cadmium (Cd) is element number 48 in the periodic system and belongs to the heavy metals. It has a relative low melting point of 321 °C (Kofstad 1987). The concentration of cadmium in precipitation and sediments has been increasing during the last century as a consequence of the increased combustion of oil products (NIVA 1996). Cadmium ions are easily soluble in water and can therefore easily be transported by the run off from catchment to lakes and streams, and this effect is increased with acidification (NIVA 1996).

Cadmium is mainly used as protection against corrosion in iron and steel (Kofstad 1987). It is also used in nickel-cadmium batteries, as a stabiliser in PVC, and cadmium sulphide (CdS) is used as a yellow pigment in paints. Further cadmium is found as a pollutant in fertilisers and oil products, in some alloys and in corrosion protective paints and electrodes.

2.3. Health effects and environmental effects

2.3.1. di-2-ethylhexylphthalate (DEHP)

DEHP is currently under a full risk investigation in the european classification system of existing chemicals. It has a low acute toxicity but is suspected to be carcinogenic. Animal experiments with DEHP have shown disturbance of the development of the sexual organs and lowered fertility for some mammals exposed to DEHP (Huse 1995). Young individuals are more sensitive, but the effect is reversible if the exposure to DEHP stops before puberty. Furthermore, DEHP exposure to pregnant mammals caused low birth weight. The animal experiments have not discovered any mutagenic effects of DEHP, but it has lead to the development of liver tumours.

DEHP is not marked as carcinogenic in the declaration of chemicals but is considered hazardous in a work environment. The phthalates are in focus in two areas of human medicine; oestrogen mimicry and infantile asthma (Norsk Hydro A.S. 1995). Neither area is yet fully investigated.

DEHP has low solubility in water, and in most tests with aquatic organisms the toxic concentration exceeds the solubility. Studies with invertebrates like daphnia pulex exhibit a LC₅₀ (lethal concentration to 50 per cent of the individuals) at 0.13 mg/l after 48 hours and NOEC (no observed effect concentration) at 0.072 mg/l (Huse 1995). Some studies have given effect to fish and fry at very low concentration of DEHP and an acute toxicity at 0.17 mg/l for fish and 0.5-100 mg/l for fish fry. DEHP is low degradable and has a bioaccumulation coefficient of 20-13600 and an octanol-water coefficient of 4.88 (Huse 1995).

2.3.2. Cadmium

Cadmium is considered very toxic and a potential environmental problem. It accumulates in liver and kidneys and inactivates enzymes containing sulphur (Beck and Jaques 1993). Cadmium inhibits the metabolism of essential metals like iron, zinc and copper. Larger degree of cadmium poisoning leads to bone deformation and fracture (Kofstad 1987, Tryland 1991). Chronicle cadmium poisoning of industrial workers have occurred and effects like lunge damage, anaemia, high blood pressure and loss of the sense of smell have been observed. Long term exposure to cadmium are believed to cause mutagenic effects, lowered fertility and damage of the foetus in case of exposure during pregnancy (Tryland 1991). Eleven cadmium compounds are proved carcinogenic to rat (Tryland 1991).

The most important exposure of cadmium in the population is through consumption of food and tobacco (Tryland 1991). Vegetables like cereals and vegetables account for about ¾ of the daily uptake of cadmium. Cadmium accumulated in the organism and the biological half-time is 10-30 years.

Studies exhibits a LC₅₀ (lethal concentration to 50 per cent of the individuals) of daphnia at 0.065 mg/l after 48 hours and a LC₅₀ to salmon at 0.005 mg/l after 25 days (Beck and Jaques 1993).

3. Methods

The flow and emissions of substances related to use of products are in most cases best described by a material flow analysis approach.

3.1. Material flow analysis of DEHP

The aim of the material flow analysis is to cover all DEHP (di-2-ethylhexylphthalate) consumed in Norway. This analysis is in some aspects similar to the Norwegian model of solvent emission (Rypdal 1995), but is more focused on material flow than a pure material balance. Furthermore, the material flow study of DEHP only focuses the total flow and consumption of DEHP, and the aspects of DEHP exposure from the use of products are not considered.

The material flow analysis of DEHP in products is based on a balance calculated from the national import and export statistics (External Trade 1995). The relevant products containing DEHP were selected from the commodity list of external trade (Commodity List 1996). This includes both the relatively pure DEHP or plasticisers used as feedstock in the production and more diffuse goods, like soft plastic products where DEHP represents some fraction of the product. The model calculates a separate consumption balance for each relevant product, which are then added to specific groups of products and a total national consumption. The consumed phthalates must either be imported or produced. Phthalates are not produced in Norway, and the consumption is thereby given from:

$$\textit{Consumption}' = \textit{Import} - \textit{Export} \quad [1]$$

Direct import data for pure DEHP and plasticisers were obtained in order to follow the flow of feedstock DEHP through various industries. As mentioned above, Norway does not produce pure phthalate, but various products containing DEHP, like soft PVC products, are produced. This production is based on the imported DEHP and plasticisers. Equation [1] above gives the correct total consumption of DEHP in Norway, but since we wish to follow the material flow connected to products and activities, the DEHP-containing products must be considered in the balance. When the production of these products are included in the model, we must also subtract the DEHP used to make them. This gives the equation two new parts:

$$\textit{Consumption}'' = \textit{Import} - \textit{Export} + \textit{Production} - \textit{Feedstock} \quad [2]$$

This consumption of phthalate containing products from equation [2] provides the base of the calculation of DEHP consumption. Only few of the products contains mainly phthalate, and consequently for every product the consumption must be multiplied with the DEHP content.

$$\textit{Consumption}''' = \textit{Consumption}'' * \textit{DEHP_content} \quad [3]$$

Combining equation [2] and [3] gives:

$$\textit{Consumption} = (\textit{Import} - \textit{Export} + \textit{Production} - \textit{Feedstock}) * \textit{DEHP_content} \quad [4]$$

The consumption is calculated separately for every product and then added to specific groups of products and a national DEHP consumption. The consumption of DEHP and products is also divided between different industries and activities, including private consumption.

3.2. Material flow analysis of cadmium

The material flow analysis of cadmium was performed in the same way as the material flow analysis of DEHP. The relevant commodities containing cadmium were selected from the commodity list of external trade (Commodity List 1996). The cadmium in products is based on a balance calculated from the national import and export statistics (External Trade 1995). The production of cadmium-containing products is added and the feedstock is subtracted. The net consumption of commodities is

multiplied with the cadmium contents of the individual commodities in order to calculate the total cadmium consumption. This can be described in equation [5]:

$$\text{Consumption} = (\text{Import} - \text{Export} + \text{Production} - \text{Feedstock}) * \text{Cadmium_content} \quad [5]$$

The selection of commodities and the identification of the cadmium concentrations of the individual commodities turned out to be more difficult in some aspects than experienced in the analysis of DEHP. In cases like oil products and fertilisers the identification was easy. It is more difficult to identify and single out relevant objects among complex commodities like glazed and enamelled ceramics, plastic building materials or products with batteries or electronic components, from commodities not containing cadmium and not relevant for the study. The existing statistics and registers are not suitable for the identification of metal products surface protected by cadmium electrolysis, alloys containing cadmium as minor pollutants, cathodic protective electrodes without any other supporting information. On one hand it is desirable to follow the substance to the end product in order to easily identify the flow pattern and the consumers, but on the other hand a more correct calculation is obtained in some cases by ending the calculation in semi-manufactured products like pigments, corrosion protectives, electronic components and batteries, and then use other sources of information to identify the further flow, finished products and consumers. This leads to calculation of consumption of fewer commodities according to equation [4]. A total material flow analysis may be performed by calculations according to equation [4] to a suitable level and then combining it with special surveys and other information concerning the more difficult products.

4. Sources of data

The art of performing a material flow analysis is to utilise as much available data and information as possible to get the most accurate results. Even published data will often need a revision to achieve the desired accuracy.

4.1. Consumption

The material flow analysis of DEHP and cadmium is mainly based on existing statistics and registers. The lists of products relevant for the analysis (Appendix A) are obtained from the commodity list of external trade (Commodity List 1996), and the external trade statistics are the source of the import and export data (External Trade 1995). These statistics are produced by Statistics Norway in collaboration with the customs authorities. Import data for the companies importing pure DEHP and plasticiser were obtained in order to control the flow pattern of imported DEHP as feedstock for production. These data are covered by professional secrecy and may not be published in a way that can identify the single importers, but they were very useful for the control of the material flow. The data from the external trade statistics are detailed and of good quality for the total import/export balance of commodities containing phthalates.

Data on production are obtained from Statistics Norway's annual survey covering all main manufacturers; industry, mining and oil production. The data are covered by professional secrecy and must not be published if single manufacturers can be identified. Since the number of manufacturers in various industries in Norway are low, the results of the DEHP and cadmium consumption of the various activities and industries must be aggregated to a higher level before publishing. These statistics regularly include feedstock data. The production and feedstock statistics use almost the same commodity classification as the trade statistics, but the list is less detailed and often uses different units. This may cause some problems in the calculations since the feedstock and production data often cover a larger group than relevant. In the case of DEHP this is only a minor problem because of the simplicity of the DEHP flow pattern, and can mostly be overcome by reasonable assumptions. In the case of cadmium, however, the lack of details caused larger difficulties.

4.2. DEHP and cadmium content

The DEHP content of the various commodities has been determined from several sources. The most important source was the Norwegian Product Register, where all products with possible harmful human health effects are registered along with the mass imported or produced, the main consumers and the chemical composition. The data in the Norwegian Product Register are therefore also covered by strict professional secrecy and must not be published in a way where single manufacturers or products can be identified. The Product Register does not apply the same commodity classification as the national trade statistics, but the classification is in many aspects more detailed and suitable for a material flow analysis on DEHP than the classification of the national statistics. The difference between the classifications did not lead to any difficulties in coupling the data of the Product Register with the data from Statistics Norway. A more serious problem connected to this data source is that only the most harmful products are registered and may lead to a wrong assumption about the average contents of a type of commodities. Import or production of commodities smaller than 100 kg annual, products not considered harmful to human health or solid manufactured goods, like plastic products, are not covered by the register. The Product Register covers about 1300 tonnes of DEHP in about 60 different products which equals about half of the assumed total consumption. The Product Register provides a large amount of useful background data although not directly publishable because of the professional secrecy. It would be possible to make a material flow analysis without the aid of the Product Register, but it would be more time consuming and challenging since the information then would have to be collected directly from the importers and the industry.

In the case of cadmium the Product Register turned out to be a weak source of information. Only three products containing cadmium were found in the register and they turned out to be pure chemicals. The cadmium contents of the commodities must therefore be determined from other sources like information from the customs authorities laboratory, research publications, industrial surveys and literature. The cadmium contents of the products have not yet been determined and the total flow of cadmium is therefore not presented in this work. This may be included in a possible step 2 of the material flow analysis.

4.3. User groups

The DEHP consumption was distributed between the main economic sectors using various information from the commodity list, feedstock statistics and data from the Norwegian Product Register. In the Product Register 25 economic sectors are registered as consumers of products containing DEHP, most of them in various manufacturing industries. The Register does not use the same sector classification as the national statistics, but in this case that causes only minor problems.

Cadmium has not yet been distributed between the various economic sectors. A distribution can be made by the use of the feedstock statistics, the energy statistics and various consumption surveys. The part of cadmium consumption that is connected to the combustion of oil products, are reasonably well described in the national calculation of emissions to air (Daasvatn et al. 1992, Natural Resources and the Environment 1996).

The book «PVC and the Environment 1996» (Norsk Hydro A.S. 1995) provided a large amount of background information on use of additives in PVC production and plastic products.

Most of the input data can be updated yearly. Hence, DEHP and cadmium consumption can be estimated independently for every year. Information on feedstock is not collected every year. For the year in between the counting, feedstock data is estimated based on the trends of the production and import statistics.

A more comprehensive and time consuming study of the material flow of DEHP would be possible by following the imported DEHP and plasticiser through the various companies and products combined with a direct survey to relevant manufacturers. Such a survey has just been made and published by the Norwegian Pollution Control Authority (Mosland et al. 1996). It has not yet been possible to fully

combine the results of the survey with this material flow analysis. The use of DEHP in Norwegian production is limited to a relatively small number of companies. This simplifies a very detailed tracing of the DEHP flow patterns but makes the publishing of the more detailed results difficult, as most of the data are covered by the professional secrecy of Statistics Norway and the Product Register.

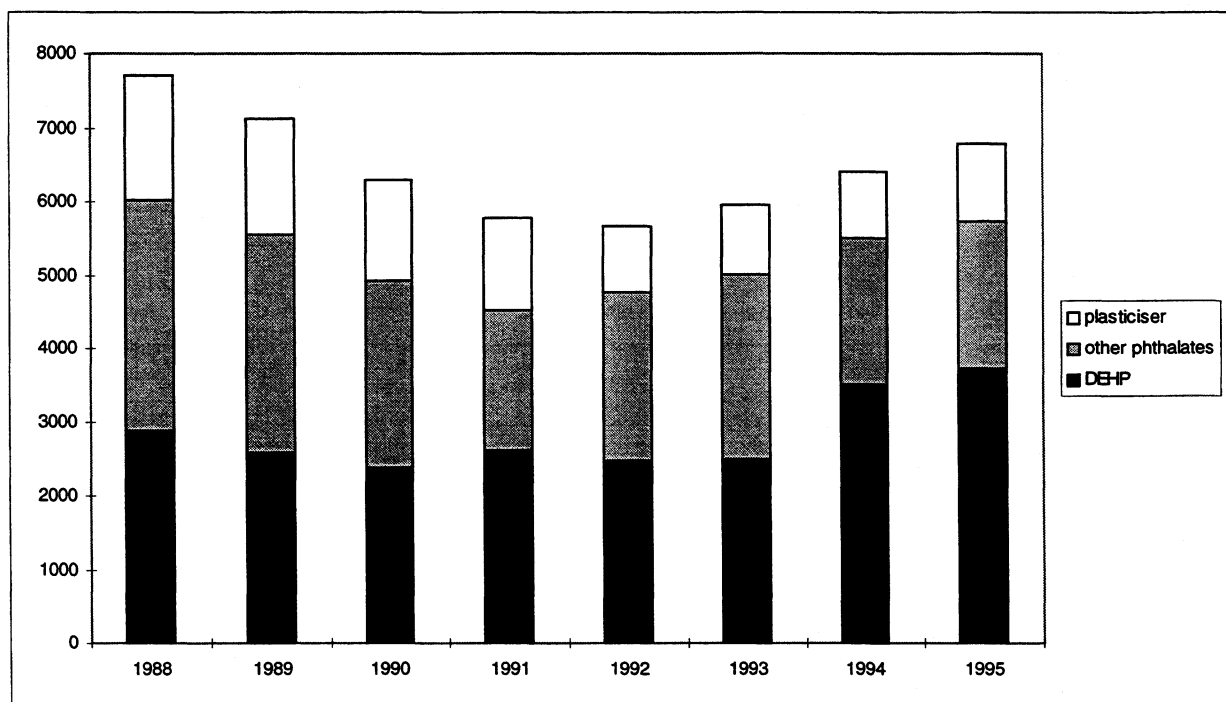
5. Results

5.1. The use and consumption of DEHP

5.1.1. Import and production of DEHP

According to the statistics on production, DEHP is not produced in Norway, and all pure DEHP used as feedstock in production must therefore be imported from abroad. This import is registered in the external trade statistics under the commodity number 29173200 dioctyl orthophthalates. This group also contains other isomers than DEHP, but DEHP is by far the most used isomer in the group (Huse 1995, Norsk Hydro A.S. 1995). During the period 1988-1994 the annual import of dioctyl orthophthalates has been between 2500 - 3500 tonnes (figure 2). A small decrease in the import has been followed by an increase the last two years. During the same period the import of other phthalates has decreased. This may indicate either a change in preference between the different phthalates, or that some of the imported DEHP may have been misplaced in the group "other orthophthalates" (commodity number 29173400). The phthalates imported to Norway originates from Belgium, Great Britain, Germany, Netherlands and Sweden. No export of DEHP is registered. The majority of the import is made by wholesale trading companies (figure 3). These companies distributes the phthalate to other industries like the plastic, paint and chemical industries. The plastic industry, which is the main consumer of DEHP, only accounts for about 10 per cent of the phthalate import. The rest of the plasticisers needed in the plastic industry must be imported through wholesale companies. According to the Norwegian Product Register the importers of DEHP consider the substance as hazardous to human health.

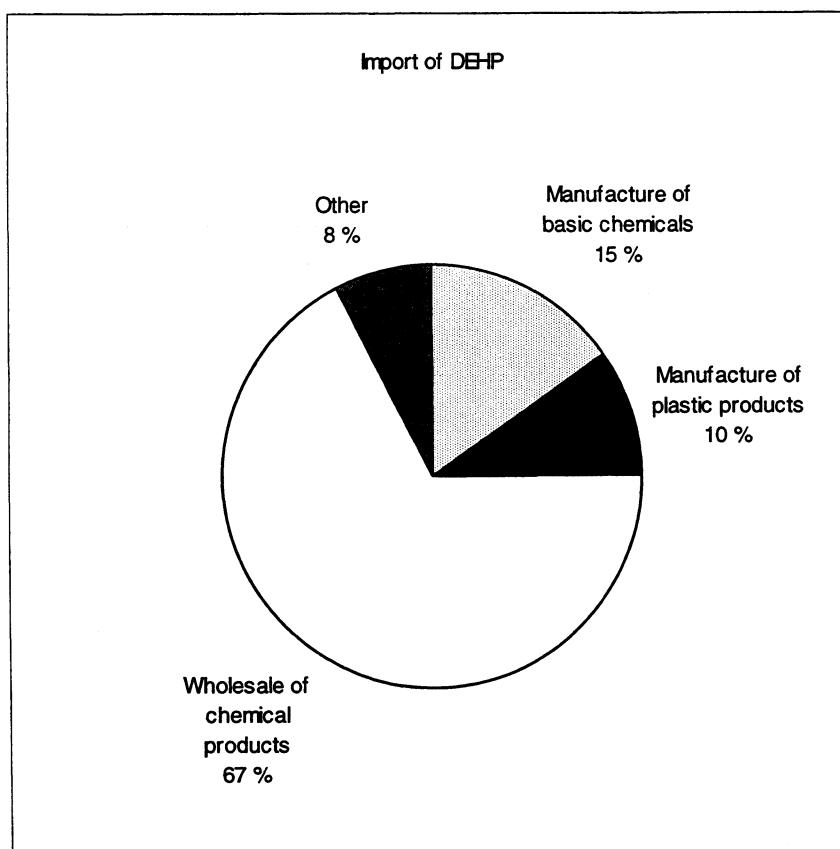
Figure 2. Import of DEHP, other phthalates and plasticiser to Norway. 1988-1995. Tonnes



Source: Statistics Norway.

In addition to the pure dioctyl orthophthalates one has to consider the import of commodity number 38122000 compound plasticisers for rubber or plastics. This commodity can be expected to mainly contain DEHP. Plasticisers are both imported and exported in Norway, but the import is 3-10 times larger than the export. According to the foreign trade statistics the net import of plasticisers has been decreasing from 1702 tonnes in 1988 to 950 tonnes in 1993 (figure 2). The Product Register informs that about 1200 tonnes DEHP was imported in plasticisers in 1993, which also places the plastic industry as the largest consumer of DEHP. The difference between the data from the foreign trade statistics and the Product Register can be explained by the fact that some of the DEHP (29173200) in the foreign trade statistics is registered as plasticiser in the Product Register. The Norwegian production of plasticisers is small, about 35 tonnes in 1993, compared to the 382 tonnes export the same year. This indicates either that about 350 tonnes of the imported plasticiser is re-exported or more likely that the 35 tonnes production are underestimated. This may be caused by a name-changing process where the substance is imported as DEHP and exported under the name plasticiser without any major change in the product. The total pattern of the import of pure DEHP is that a major amount of the compound is imported by wholesale trading companies that distributes most of it to chemical industry and plastic industry. Most of the pure DEHP imported is used as plasticisers or as a raw material for plasticisers in the production of paints and plastic products.

Figure 3. The importers of DEHP

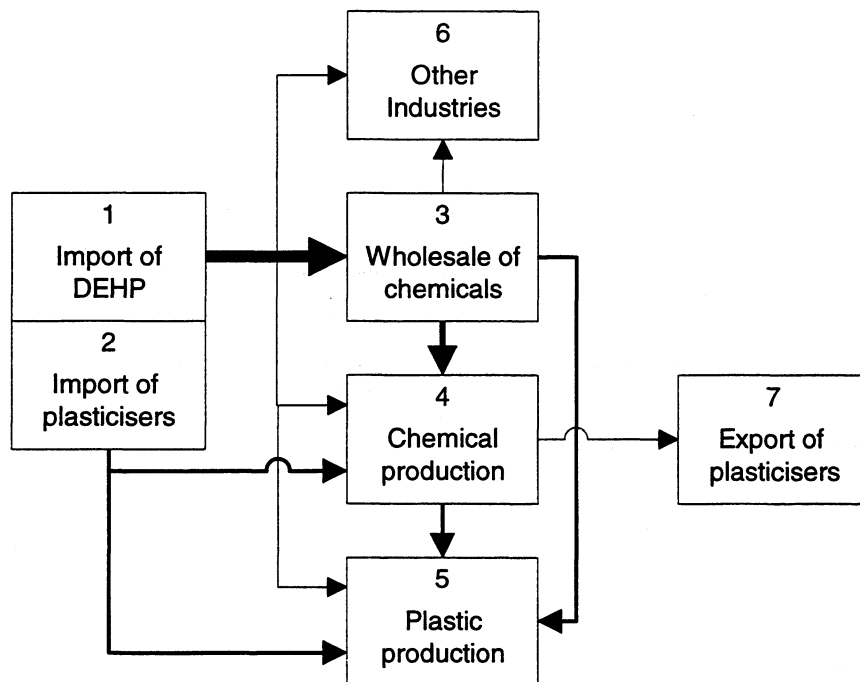


Source: Statistics Norway.

A large amount of phthalic acid (commodity number 29173500) is imported to Norway every year. This import, which exceeds the import of DEHP, has been stable during the period. Whether phthalic acid is used as feedstock in production that leads to phthalates in the end product has not yet been investigated. The import data on phthalic acid have been restrained by Statistics Norway since 1976 by professional secrecy but will again be available from 1996.

Figure 4 indicates the flow-pattern of imported DEHP and plasticisers. The amounts are indicated, but not given in absolute values since these data so far is largely uncertain and so few companies are involved that it might be in conflict with the professional secrecy.

Figure 4. Flow diagram for imported DEHP and plasticisers



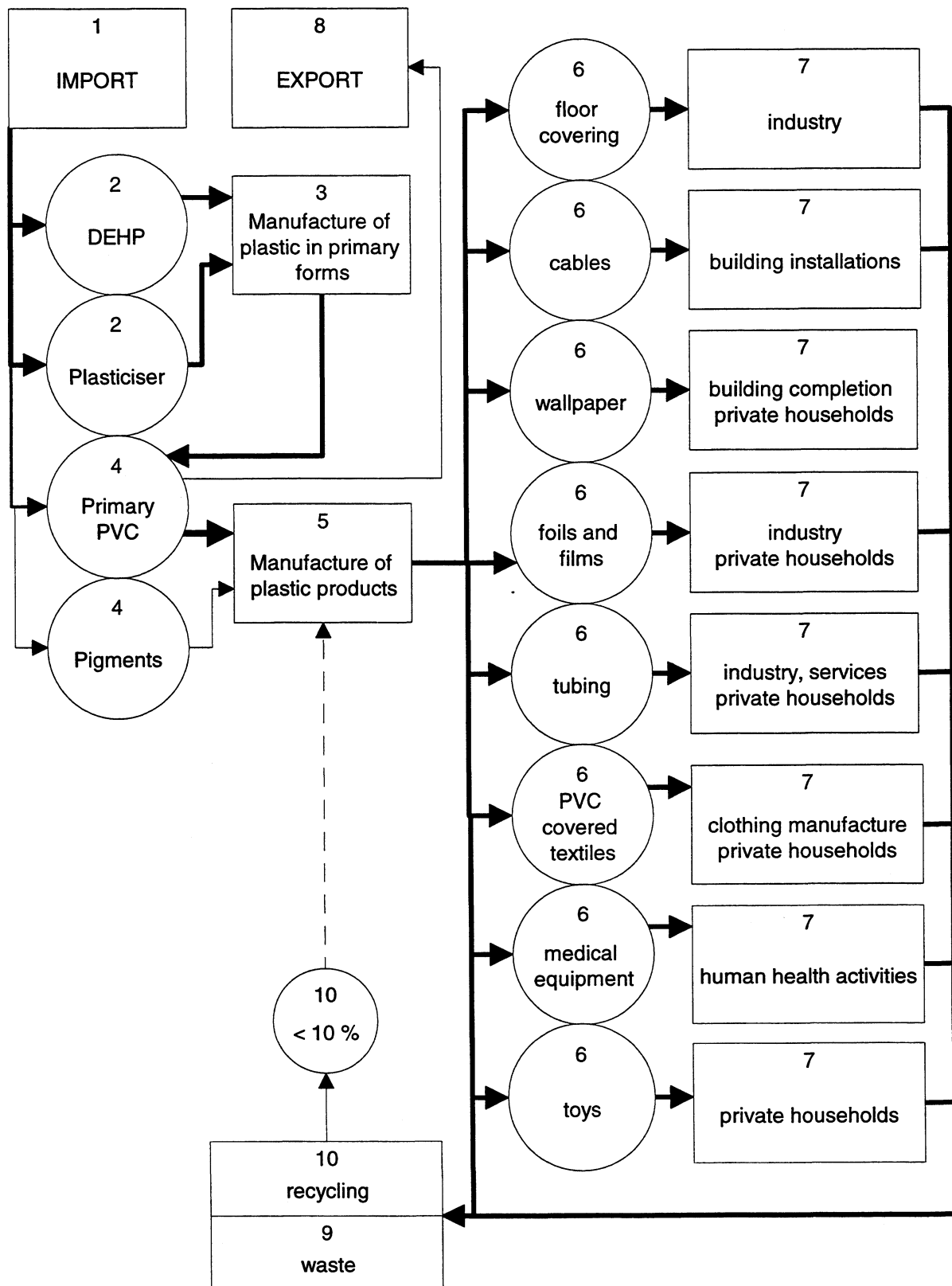
5.1.2. DEHP in PVC

Polyvinylchloride (PVC) is a hard, inflexible and brittle material. By adding plasticisers PVC is provided a greater flexibility and temperature stability and thereby making it suitable for many purposes. By far the largest group of plasticisers in PVC are the phthalates with DEHP as the most important isomer. These compounds have been used as plasticisers in PVC since the 1960s. DEHP is used in most soft PVC used for products like floor covering, wallpaper, cables, tubing, raincoats, toys, bottles and food packaging and medical equipment as blood storage bags, intravenous infusion bags, feeding tubes and blood tubes. The concentration of plasticiser amounts to 10-50 per cent of the weight of the soft PVC products (Huse 1995). In the largest volumes of soft PVC products produced in Norway the concentration of the plasticiser is in the range of 30-40 per cent of the weight.

The DEHP consumption by use of plastic products was through the model calculated to 2032 tonnes in 1988 and 2554 tonnes in 1993. This is about 90 per cent of the total consumption. The model only focuses on the products classified as plastic products. Other products which might contain an unknown amount of PVC like clothes, shoes, furniture, electric machinery, vehicles and sport requisites, were not evaluated because of the difficulty of estimating the plastic and DEHP content.

Even though DEHP is the most used plasticiser it could be useful to also consider the consumption of other phthalates. In the recent years an increasing fraction of longer phthalates has been used as plasticisers in the production of cable coatings. This change is caused partly by economic and partly by technical reasons. The manufacturers of plasticisers and plastic products claim that no real alternative exists today to the use of phthalates in PVC, in fact phthalates have replaced other plasticisers like chloroparafines.

Figure 5. Flow diagram of DEHP in the plastic industry and in plastic products



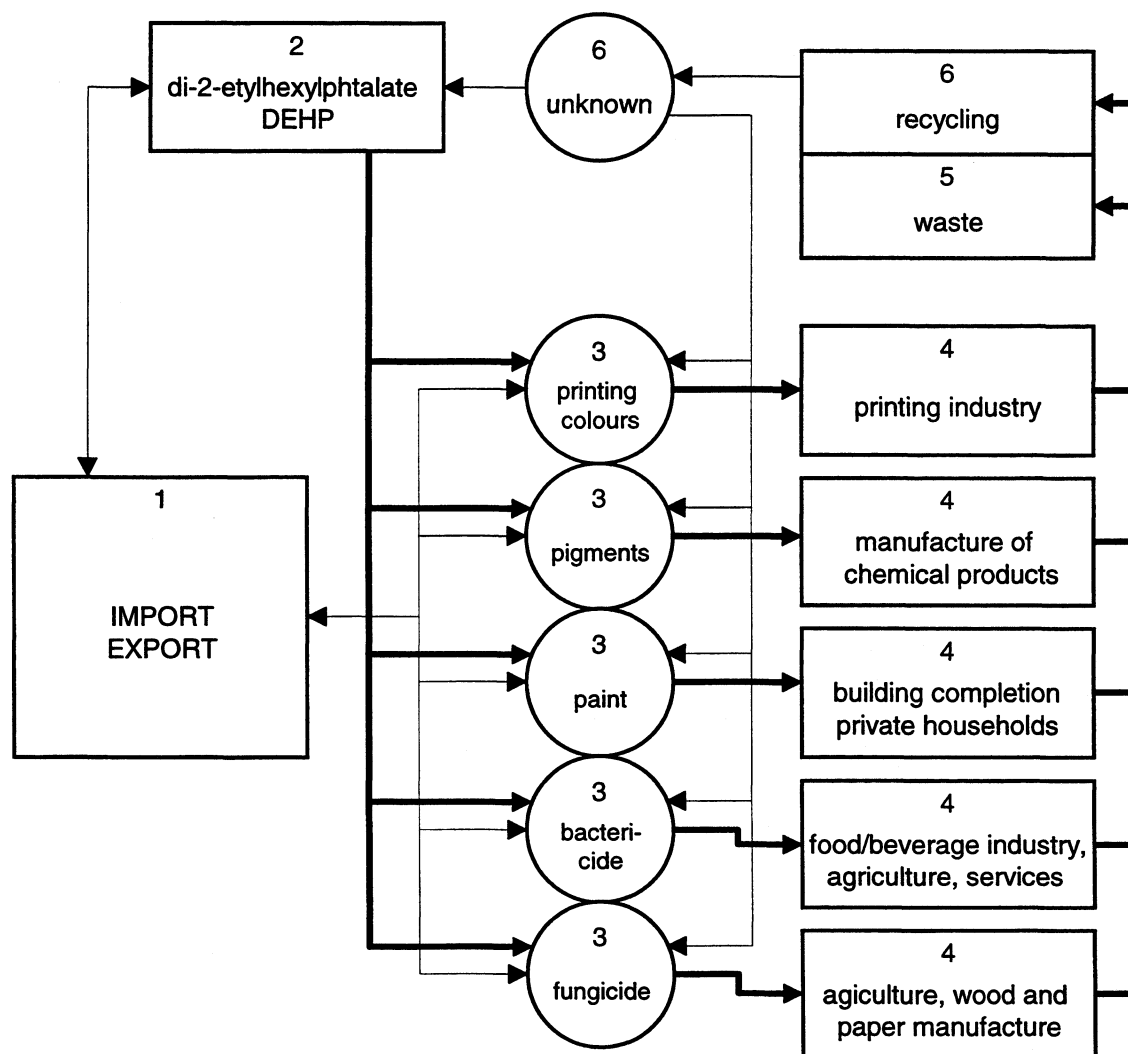
142,000 tonnes plastic waste is generated every year (Bruvoll 1996). Of this about 9000 tonnes are recycled. Plastic can be divided into two categories; hardened plastics that are not recyclable and thermo plastics which can be melted and recycled. Half of the plastic recycled today is waste material originating from the plastic industry.

5.1.3. DEHP in paint and glue

Phthalates is used as plasticiser in products like paint, printing ink, glue, vernishes and painters' fillings but in smaller concentrations than in plastic products. The DEHP consumption in paint, glue and printing ink accounts for 276 tonnes in 1988 and 176 tonnes in 1993 or about 6-12 per cent of the total consumption. The great concern about additives and solvents in paint and domestic clima has caused the use to decrease during the last few years (Huse 1995). The estimate in this study is calculated on the basis of data from the Product Register and might be insufficient to catch this change since only the most harmful products are registered.

The destruction of waste of paint, glue and printing colours has increased from about 1000 tonnes in 1986 to about 2800 tonnes in 1994 (Norsas A.S 1995). Any recycling of these products is not known.

Figure 6. Flow chart of DEHP consumption in products other than plastic



5.1.4. DEHP in fungicides and bactericides

DEHP consumption by the use of fungicides and bactericides were the most difficult products to estimate in the model. The compound is found in products registered in the Product Register, but only concerning very few products and a very small fraction of the total consumption. In addition, these products had a very large DEHP content (more than 50 per cent) and may therefore not be representative for the group as a whole. In the model it is therefore assumed a very low average DEHP content which gives a DEHP consumption of about 24 tonnes in 1988 and 78 tonnes in 1993. These results represent a first rough estimate and are highly uncertain and possibly overestimated. It is however difficult to make a more complete estimate without a more detailed survey concerning the products.

5.1.5. The DEHP consumption in various economic sectors

The Product Register mainly provided information about DEHP in products used as feedstock for production, and was therefore not considered a suitable data source for the distribution of DEHP consumption between the main economic sectors.

One of the aims of this study is to distribute the DEHP consumption from the use of products between the main economic sectors. The large consumption connected to the use of plastic products makes this distribution difficult and requires reasonable assumptions. Some articles which are primarily used by manufacture or private service sectors, are secondary consumed by the private households. Similar, the building industry is primary consumer of floorcovering, wallcovering and cables, but a part of this consumption secondary ends up in private homes. DEHP is not used in PVC for food covering in Norway. A rough preliminary distribution indicates that about 10 per cent of the DEHP is consumed by the private households, but this may be underestimated.

Table 1. Preliminary results. DEHP consumption 1988 and 1993. Tonnes

	1988	1993
Paint	137	109
Printing ink	139	67
Plastic commodities	2032	2554
Bactericide/fungicide	24	78
Total	2331	2808

5.2. The use and consumption of cadmium

5.2.1. Cadmium in oil and coal products

The cadmium from the combustion and consumption of oil and coal products is annually calculated in the national model of emissions to air (Daasvatn et al. 1992). The total consumption and sector distribution of various oil and coal products are well known through the national energy statistics (Energy Statistics 1994). Cadmium is among the most volatile trace elements in oil and may be found in even the lightest of the oil distillates. About 9-10 Mtonnes of fossil fuels are consumed in Norway every year, and the cadmium emissions from full combustion of the fuel amount to about 0.7 tonnes annual as a first rough estimate. The cadmium content of North Sea crude oil is low compared to other crudes. This subject is treated in great detail in the national model of emissions to air.

5.2.2. Cadmium in fertiliser and lime

Cadmium is found among minor pollutants in phosphate fertiliser and lime used in agriculture (Tryland 1991, Erstad 1992). The cadmium contents of fertilisers originate from the phosphate minerals used to produce them. The cadmium concentration of the phosphate varies with the mineral's source (Tryland 1991), but an average concentration based on the knowledge of the import countries and the concentration of these specific sources can be produced. An average phosphate concentration in the various types of fertilisers can also be provided.

The cadmium exposure to agricultural land is of great concern, and data of the cadmium contents of lime and fertiliser can be provided from several sources (Kaarstad 1990, Tryland 1991, Erstad 1992).

5.2.3. Cadmium in plastic products

Cadmium has been used as a stabiliser and pigment in plastic products (Tryland 1991). Cadmium is no longer used as a stabiliser in Norwegian plastic (Norsk Hydro A.S.1995) but may still be found in imported products. The most important plastic potentially containing cadmium is the long-lived, hard plastic used in building materials like window profiles, gutter and fittings exposed to light and weather. Statistics Norway can provide relatively detailed statistics on these products. The cadmium contents of the relevant products are not yet known and will probably require a special survey to the importers. Such a survey were performed five years ago (Tryland 1991) with little success. The Product Register does not contain any information on this type of products. An estimate given in Tryland 1991 suggest a consumption of cadmium of about 400 kg in plastic products.

5.2.4. Cadmium in batteries

The statistics on batteries and accumulators are detailed, and singles out cadmium batteries as a sole commodity. The cadmium contents of the batteries should be easily obtained by the importers. In 1988 the consumption of cadmium-containing batteries was 127 tonnes and it has increased to 301 tonnes in 1993. If the cadmium concentration of the batteries has been constant at 5 per cent of the battery weight during the period, the total cadmium consumption through batteries has increased from about 6.4 tonnes in 1988 to 15 tonnes in 1993. This may be a wrong assumption since other surveys indicates significant lower cadmium contents in 1995. A direct survey of the companies importing batteries would give more correct data.

The Norwegian Competence Center for Waste and Recycling (Norsas A.S 1995) collects heavy metal containing batteries for recycling. Recycling will not influence on the total balance, but this flow should be considered in the material flow analysis as it may influence on the exposure patterns.

5.2.5. Cadmium used as pigments

Cadmium sulphide (CdS) gives bright yellow and orange colours and has therefore been used as pigments in enamelled and glazed products like ceramics and glass products. This use has decreased rapidly during the recent years due to the great concern of heavy metals. Norwegian Customs Authorities provide control of the level of heavy metal in imported goods and would probably be a source of information about the cadmium concentration in imported ceramics and glass products. The consumption of cadmium sulphide (commodity number 28303000) was 702 kg in 1988 and only 32 kg in 1993. And the consumption of commodity number 32063000 (Pigments and preparations based on cadmium compounds) was 4 tonnes in 1988 and decreased to 0.2 tonnes in 1993.

5.2.6. Cadmium in alloys, as corrosive protection and in cathodic protective electrodes

The cadmium contents of alloys, corrosive protection and cathodic protective electrodes are maybe the most difficult subjects in the material flow analysis of cadmium. The potential number of relevant products is large, the statistics on the commodities lack sufficient detail and the concentrations of cadmium in the products are largely variable, probably low but unknown. These products are not covered by the Product Register. According to the statistics of Statistics Norway the consumption of commodity number 81070000 (Cadmium and articles thereof) was 168 tonnes in 1988 and 239 tonnes in 1993. An unknown amount of cadmium may be imported through other products.

Cadmium is used as surface treatment to avoid corrosion. Important subjects are the body and undercarriage of aeroplanes and cathodic protective electrodes for ships. Other cadmium-containing products are solder, fishing hooks and military equipment (Tryland 1991). According to Tryland 1991 only few companies perform cadmiation and sale of cadmiated metal goods in Norway. A special survey will be necessary on this subject.

5.2.7. Cadmium in food products and tobacco

Food products and tobacco are the most important sources of cadmium in the population (Tryland 1991). The cadmium concentration in tobacco is about 0.5 g/tonne. Tobacco is not produced in Norway. The consumption of tobacco was 6500 tonnes in 1988 and 5700 tonnes in 1993. The use of tobacco is included in the national model of emissions to air (Daasvatn et al. 1992).

Cadmium found in food products mainly originates from two sources. Most of it originates from the use of fertiliser and lime and some is precipitated from long transported pollution from the combustion of oil and coal products. The cadmium from these sources have already been calculated, so including the cadmium in food produced in Norway may lead to a double counting. On the other hand, excluding food produced in Norway from the material flow analysis would not be satisfying, since food is considered to be one of the main sources of exposure. This problem may be solved by calculating the cadmium content of the food and subtracting it from the cadmium originating from fertiliser, lime and deposits. The cadmium in imported food should be included in the material flow analysis. The cadmium concentration of various food articles can be obtained from the Authorities of Food Control (SNT).

An estimate of the cadmium exposure from the consumption of drinking water can be obtained in co-operation with the State Institute of Public Health and the Norwegian Institute of Water Research. Care should be taken to avoid double counting, like for food products.

Table 2. Preliminary results. Cadmium consumption 1988 and 1993. Kg

	1988	1993
Combustion of fossil fuels	700	700
Fertiliser and lime	165	165
Tobacco	3	3
Food	not available	not available
Plastic commodities	400	400
Batteries	6400	15000
Pigments	546	25
Cadmium commodities	168000	239000
Total	176214	245293

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Appendix A. Relevant commodities for the material flow analysis of DEHP

ORGANIC CHEMICALS

VII.	CARBOXYLIC ACIDS, AND THEIR ANHYDRIDES, HALIDES, PEROXIDES AND PEROXYACIDS, AND THEIR HALOGENATED, SULPHONATED, NITRATED OR NITRO-SATED DERIVATIVES
29.17	Polycarboxylic acids, their anhydrides, halides, peroxides and peroxyacids; their halogenated, sulphonated, nitrated or nitrosated derivatives: - Aromatic polycarboxylic acids, their anhydrides, halides, peroxides, peroxyacids and their derivatives:
3100	-- Dibutyl orthophthalates
3200	-- Dioctyl orthophthalates
3300	-- Dinonyl or didecyl orthophthalates
3400	-- Other esters of orthophthalic acid
3500	-- Phthalic anhydride
3600	-- Terephthalic acid and its salts
3700	-- Dimethyl terephthalate
CHAPTER 32	TANNING OR DYEING EXTRACTS; TANNINS AND THEIR DERIVATIVES; DYES, PIGMENTS AND OTHER COLOURING MATTER; PAINTS AND VARNISHES; PUTTY AND OTHER MASTICS; INKS
32.04	Synthetic organic colouring matter, whether or not chemically defined; preparations based on synthetic organic colouring matter; synthetic organic products of a kind used as fluorescent brightening agents or as luminophores, whether or not chemically defined: - Synthetic organic colouring matter and preparations based thereon
1100	-- Disperse dyes and preparations based thereon
32.08	Paints and varnishes (including enamels and lacquers) based on synthetic polymers or chemically modified natural polymers, dispersed or dissolved in a non-aqueous medium; solutions: - Based on polyesters
1000	- Based on acrylic or vinyl polymers
2000	- Other
9000	- Other
32.09	Paints and varnishes (including enamels and lacquers) based on synthetic polymers or chemically defined modified natural polymers, dispersed or dissolved in an aqueous medium: - Based on acrylic or vinyl polymers
1000	- Other
9000	- Other
32.15	Printing ink, writing or drawing ink and other inks, whether or not concentrated or solid: - Printing ink:
1100	-- Black
1900	-- Other
9000	- Other
CHAPTER 38	MISCELLANEOUS CHEMICAL PRODUCTS
38.08	Insecticides, rodenticides, fungicides, herbicides, anti-sprouting products and plant-growth regulators, disinfectants and similar products, put up in forms or packings for retail sale or as preparations or articles (for example, sulphur-treated bands, wicks and candles, and fly-papers): - Fungicides
2000	- Disinfectants
4000	- Other
9000	- Other
38.09	Finishing agents, dye carriers to accelerate the dyeing or fixing of dyestuffs and other products and preparations (for example, dressings and mordants), of a kind used in the textile, paper, leather or like industries, not elsewhere specified or included: -- Of a kind used in the textile or like industries: --- Textile washing and rinsing agents, including those for domestic washing machines
9101	--- Other
9109	--- Other
38.12	Prepared rubber accelerators; compound plasticisers for rubber or plastics, not elsewhere specified or included; anti-oxidising preparations and other compound stabilisers for rubber or plastics: - Compound plasticisers for rubber or plastics
2000	- Compound plasticisers for rubber or plastics
CHAPTER 39	PLASTICS AND ARTICLES THEREOF
I. PRIMARY FORMS	
39.04	Polymers of vinyl chloride or of other halogenated olefins, in primary forms: - Other polyvinyl chloride: -- Plasticised
2200	- Vinyl chloride-vinyl acetate copolymers
3000	- Other vinyl chloride polymers
4000	- Other vinyl chloride polymers
II. WASTE, PARINGS AND SCRAP; SEMIMANUFACTURES; ARTICLES	
39.15	Waste, parings and scrap, of plastics: - Of polymers of vinyl chloride
3000	- Of polymers of vinyl chloride

- 39.16 Monofilament of which any cross-sectional dimension exceeds 1 mm, rods, sticks and profile shapes, whether or not surfaceworked but not otherwise worked, of plastics:
- 2000 - Of polymers of vinyl chloride
- 39.17 Tubes, pipes and hoses, and fittings therefor (for example, joints, elbows, flanges), of plastics:
- Tubes, pipes and hoses, rigid:
- 2300 -- Of polymers of vinyl chloride
- Other tubes, pipes and hoses:
- Flexible tubes, pipes and hoses, having a minimum burst pressure of 27.6 MPa:
- 3110 --- Of condensation, polycondensation and polyaddition products
- 3120 --- Of other addition polymerisation products
- 3190 --- Other
- Other, not reinforced or otherwise combined with other materials, without fittings:
- 3210 --- Of condensation, polycondensation and polyaddition products
- 3220 --- Of other addition polymerisation products
- 3290 --- Other
- 3300 -- Other, not reinforced or otherwise combined with other materials, with fittings
- Other
- 39.18 Floor coverings of plastics, whether or not self-adhesive, in rolls or in the form of tiles; wall or ceiling coverings of plastics:
- Of polymers of vinyl chloride:
- 1001 -- With a thickness of less than 1.5 mm
- 1009 -- Other
- 39.19 Self-adhesive plates, sheets, film, foil, tape, strip and other flat shapes, of plastics, whether or not in rolls:
- In rolls of a width not exceeding 20 cm:
- 1010 -- Of condensation, polycondensation and polyaddition products
- 1020 -- Of other addition polymerisation products
- 1090 -- Other
- Other:
- 9010 -- Of condensation, polycondensation and polyaddition products
- 9020 -- Of other addition polymerisation products
- 9090 -- Other
- 39.20 Other plates, sheets, film, foil and strip, of plastics, non-cellular and not reinforced, laminated, supported or similarly combined with other materials:
- Of polymers of vinyl chloride:
- 4200 -- Flexible
- 39.21 Other plates, sheets, film, foil and strip, of plastics:
- Cellular:
- Of polymers of vinyl chloride:
- 1201 --- Containing regulated chlorofluorocarbons
- 1209 --- Other
- 39.23 Articles for the conveyance or packing of goods, of plastics; stoppers, lids, caps and other closures, of plastics:
- Boxes, cases, crates and similar articles:
- Of a capacity of 15 litres or more:
- 1003 --- Containing regulated chlorofluorocarbons
- 1004 --- Other
- Of a capacity of less than 15 litres:
- 1005 --- Containing regulated chlorofluorocarbons
- 1006 --- Other
- Sacks and bags (including cones):
- Of other plastics:
- 2910 --- Shopping bags
- 2990 --- Other
- Carboys, bottles, flasks and similar articles:
- Of a capacity of 3 litres or more
- 3001 -- Of a capacity of less than 3 litres
- 4000 - Spools, cops, bobbins and similar supports
- 5000 - Stoppers, lids, caps, and other closures
- Other:
- 9002 -- Extruded netting in tubular form
- Cups used for packing purposes (cylindrical or conical):
- 9003 --- Containing regulated chlorofluorocarbons
- 9004 --- Other
- Other:
- 9005 --- Containing regulated chlorofluorocarbons
- 9006 --- Other
- 39.24 Tableware, kitchenware, other household articles and toilet articles, of plastics:
- Tableware and kitchenware:
- 1001 -- Cups, bowls, plates, saucers, boards and similar articles
- 1009 -- Other
- Other:
- 9001 -- Buckets, pails, pots, tubs and vats
- 9002 -- Clothes pegs
- 9003 -- Cloths, curtains, hangings and the like
- 9009 -- Other
- 39.26 Other articles of plastics and articles of other materials of headings nos. 39.01 to 39.14:
- 1000 - Office or school supplies

- 2000 - Articles of apparel and clothing accessories (including gloves)
- 3000 - Fittings for furniture, coachwork or the like
- 4000 - Statuettes and other ornamental articles
- Other:
- 9010 -- Shoe trees and lasts
- 9020 -- Machines joints and gaskets
- 9030 -- Transmission, conveyor or elevator belts or belting
- Other:
- 9091 --- Fishing net floats
- 9092 --- Sponges (other than rectangular or square) whether or not containing soap
- Stuffing materials, foamed, in finished forms (for example chips, angles, flakes):
- 9093 ---- Containing regulated chlorofluorocarbons
- 9094 ---- Other
- 9098 --- Other

Appendix B. Relevant commodities for the material flow analysis of cadmium

CHAPTER 24	TOBACCO AND MANUFACTURED TOBACCO SUBSTITUTES
24.01	Unmanufactured tobacco; tobacco refuse:
1000	- Tobacco, not stemmed/stripped
2000	- Tobacco, partly or wholly stemmed/stripped
3000	- Tobacco refuse
24.02	Cigars, cheroots, cigarillos and cigarettes, of tobacco or of tobacco substitutes:
	- Cigars, cheroots and cigarillos, containing tobacco:
1001	-- Cigars
1009	-- Other
2000	- Cigarettes containing tobacco
9000	- Other
24.03	Other manufactured tobacco and manufactured tobacco substitutes; "homogenised" or "reconstituted" tobacco; tobacco extracts and essences:
1000	- Smoking tobacco, whether or not containing tobacco substitutes in any proportion
	- Other:
9100	-- "Homogenised" or "reconstituted" tobacco
	-- Other:
9910	--- Tobacco extracts and essences
9990	--- Other
CHAPTER 25	SALT; SULPHUR; EARTHS AND STONE; PLASTERING MATERIALS, LIME AND CEMENT
25.10	Natural calcium phosphates, natural aluminium calcium phosphates and phosphatic chalk:
1000	- Unground
2000	- Ground
25.17	Pebbles, gravel, broken or crushed stone, of a kind commonly used for concrete aggregates, for road metalling or for railway or other ballast, shingle and flint, whether or not heat-treated; macadam of slag, dross or similar industrial waste, whether or not incorporating the materials cited in the first part of the heading; tarred macadam; granules, chippings and powder, of stones of heading no. 25.15 or 25.16, whether or not heat-treated:
3000	- Tarred macadam
CHAPTER 27	MINERAL FUELS, MINERAL OILS AND PRODUCTS OF THEIR DISTILLATION; BITUMINOUS SUBSTANCES; MINERAL WAXES
27.01	Coal; briquettes, ovoids and similar solid fuels manufactured from coal:
	- Coal, whether or not pulverised, but not agglomerated:
1100	-- Anthracite
1200	-- Bituminous coal
1900	-- Other coal
2000	- Briquettes, ovoids and similar solid fuels manufactured from coal
27.02	Lignite, whether or not agglomerated, excluding jet:
1000	- Lignite, whether or not pulverised, but not agglomerated
2000	- Agglomerated lignite
27.04	Coke and semi-coke of coal, of lignite or of peat, whether or not agglomerated; retort carbon:
	- Of coal:
0001	-- Coke or semi-coke, not including pulverised coke
0004	-- Pulverised coke
0005	- Of lignite or of peat; retort carbon
27.06	0000 Tar distilled from coal, from lignite or from peat, and other mineral tars, whether or not dehydrated or partially distilled, including reconstituted tars
27.07	Oils and other products of the distillation of high temperature coal tar; similar products in which the weight of the aromatic constituents exceeds that of the non-aromatic constituents:
1000	- Benzole
2000	- Toluole
3000	- Xylole
4000	- Naphthalene
5000	- Other aromatic hydrocarbon mixtures of which 65% or more by volume (including losses) distils at 250°C by the ASTM D 86 method
6000	- Phenols
	- Other:
9100	-- Creosote oils
9900	-- Other
27.08	Pitch and pitch coke, obtained from coal tar or from other mineral tars:
1000	- Pitch
2000	- Pitch coke
27.09	0000 Petroleum oils and oils obtained from bituminous minerals, crude
27.10	Petroleum oils and oils obtained from bituminous minerals other than crude; preparations not elsewhere specified or included, containing by weight 70% or more of petroleum oils or of oils obtained from bituminous minerals, these oils being the basic constituents of the preparations:

- Medium distillates:
 - Heavy medium distillates:
 - 0026 --- Gas oils (no. 1 furnace oil, diesel oil for motor vehicles and bunker oil)
 - 0027 --- Diesel oils (no. 2 furnace oil, marine diesel)
 - 0029 --- Other, including heavy distillates
 - Other oils and products derived from oils:
 - Heavy furnace oil (for heating or for use as motor fuel):
 - 0091 --- Containing not more than 1.0% sulphur
 - 0093 --- Other
 - 0094 -- Oil used in road building
 - 0095 -- Lubricating oils
 - 0096 -- Lubricating greases
 - 0099 -- Other oils and products derived from oils
- 27.13 Petroleum coke, petroleum bitumen and other residues of petroleum oils or of oils obtained from bituminous minerals:
 - Petroleum coke:
 - 1100 -- Not calcined
 - 1200 -- Calcined
 - 2000 - Petroleum bitumen
 - 9000 - Other residues of petroleum oils or of oils obtained from bituminous minerals
- 27.14 Bitumen and asphalt, natural; bituminous or oil shale and tar sands; asphaltites and asphaltic rocks:
 - 1000 - Bituminous or oil shale and tar sands
 - 9000 - Other
- 27.15 0000 Bituminous mixtures based on natural asphalt, on natural bitumen, on petroleum bitumen, on mineral tar or on mineral tar pitch (for example, bituminous mastics, cut-backs)

CHAPTER 28 INORGANIC CHEMICALS; ORGANIC OR INORGANIC COMPOUNDS OF PRECIOUS METALS, OF RARE-EARTH METALS, OF RADIOACTIVE ELEMENTS OR OF ISOTOPES

I. CHEMICAL ELEMENTS

- 28.04 Hydrogen, rare gases and other non-metals:
7000 - Phosphorus

V. SALTS AND PEROXYSALTS, OF INORGANIC ACIDS AND METALS

- 28.30 Sulphides; polysulphides:
3000 - Cadmium sulphide
- 28.35 Phosphinates (hypophosphites), phosphonates (phosphites), phosphates and polyphosphates:
- Phosphates:
- 2200 -- Of mono- or disodium
 - 2300 -- Of trisodium
 - 2400 -- Of potassium
 - 2500 -- Calcium hydrogenorthophosphate ("dicalcium phosphate")
 - 2600 -- Other phosphates of calcium
 - 2900 -- Other
- Polyphosphates:
3100 -- Sodium triphosphate (sodium tripolyphosphate)
3900 -- Other

VI. MISCELLANEOUS

- 28.48 0000 Phosphides, whether or not chemically defined, excluding ferrophosphorus

CHAPTER 31 FERTILISERS

- 31.03 Mineral or chemical fertilisers, phosphatic:
- 1000 - Superphosphates
 - 2000 - Basic slag
 - 9000 - Other
- 31.05 Mineral or chemical fertilisers containing two or three of the fertilising elements nitrogen, phosphorus and potassium; other fertilisers; goods of this chapter in tablets or similar forms or in packages of a gross weight not exceeding 10 kg:
- 1000 - Goods of this chapter in tablets or similar forms or in packages of a gross weight not exceeding 10 kg
 - 2000 - Mineral or chemical fertilisers containing the three fertilising elements nitrogen, phosphorus and potassium
 - 3000 - Diammonium hydrogenorthophosphate (diammonium phosphate)
 - 4000 - Ammonium dihydrogenorthophosphate (monoammonium phosphate) and mixtures thereof with diammonium hydrogenorthophosphate (diammonium phosphate)
 - Other mineral or chemical fertilisers containing the two fertilising elements nitrogen and phosphorus:
 - 5100 -- Containing nitrates and phosphates
 - 5900 -- Other
 - 6000 - Mineral or chemical fertilisers containing the two fertilising elements phosphorus and potassium
 - 9000 - Other

CHAPTER 32 TANNING OR DYEING EXTRACTS; TANNINS AND THEIR DERIVATIVES; DYES, PIGMENTS AND OTHER COLOURING MATTER; PAINTS AND VARNISHES; PUTTY AND OTHER MASTICS; INKS

- 32.06 Other colouring matter; preparations other than those of heading nos. 32.03, 32.04 or 32.05; inorganic products of a kind used as luminophores, whether or not chemically defined:
3000 - Pigments and preparations based on cadmium compounds

CHAPTER 34	SOAP, ORGANIC SURFACE-ACTIVE AGENTS, WASHING PREPARATIONS, LUBRICATING PREPARATIONS, ARTIFICIAL WAXES, PREPARED WAXES, POLISHING OR SCOURING PREPARATIONS, CANDLES AND SIMILAR ARTICLES, MODELLING PASTES, "DENTAL WAXES" AND DENTAL PREPARATIONS WITH A BASIS OF PLASTER
34.03	Lubricating preparations (including cutting-oil preparations, bolt or nut release preparations, anti-rust or anti-corrosion preparations and mould release preparations, based on lubricants) and preparations of a kind used for the oil or grease treatment of textile materials, leather, furskins or other materials, but excluding preparations containing, as basic constituents, 70% or more by weight of petroleum oils or of oils obtained from bituminous minerals: - Containing petroleum oils or oils obtained from bituminous minerals: 1100 -- Preparations for the treatment of textile materials, leather, furskins or other materials 1900 -- Other
CHAPTER 38	MISCELLANEOUS CHEMICAL PRODUCTS
38.10	Pickling preparations for metal surfaces; fluxes and other auxiliary preparations for soldering, brazing or welding; soldering, brazing or welding powders and pastes consisting of metal and other materials; preparations of a kind used as cores or coatings for welding electrodes or rods: - Pickling preparations for metal surfaces; soldering, brazing or welding powders and pastes consisting of metal and other materials: 1010 -- Pickling preparations for metal surfaces 1020 -- Welding or brazing powders and pastes, consisting of metals or other materials
CHAPTER 39	PLASTICS AND ARTICLES THEREOF
I. PRIMARY FORMS	
39.01	Polymers of ethylene, in primary forms: 1000 - Polyethylene having a specific gravity of less than 0.94 - Polyethylene having a specific gravity of 0.94 or more: 2010 -- Containing regulated chlorofluorocarbons 2090 -- Other 3000 - Ethylene-vinyl acetate copolymers 9000 - Other
39.02	Polymers of propylene or of other olefins, in primary forms: - Polypropylene: 1001 -- Containing regulated chlorofluorocarbons 1009 -- Other 2000 - Polyisobutylene 3000 - Propylene copolymers 9000 - Other
39.04	Polymers of vinyl chloride or of other halogenated olefins, in primary forms: 1000 - Polyvinyl chloride, not mixed with any other substances - Other polyvinyl chloride: 2100 -- Non-plasticised 2200 -- Plasticised 3000 - Vinyl chloride-vinyl acetate copolymers 4000 - Other vinyl chloride polymers 5000 - Vinylidene chloride polymers - Fluoro-polymers: 6100 -- Polytetrafluoroethylene 6900 -- Other 9000 - Other
II. WASTE, PARINGS AND SCRAP; SEMIMANUFACTURES; ARTICLES	
39.15	Waste, parings and scrap, of plastics: 3000 - Of polymers of vinyl chloride
39.16	Monofilament of which any cross sectional dimension exceeds 1 mm, rods, sticks and profile shapes, whether or not surfaceworked but not otherwise worked, of plastics: 2000 - Of polymers of vinyl chloride
39.17	Tubes, pipes and hoses, and fittings therefor (for example, joints, elbows, flanges), of plastics: - Tubes, pipes and hoses, rigid: 2300 -- Of polymers of vinyl chloride - Other tubes, pipes and hoses: -- Flexible tubes, pipes and hoses, having a minimum burst pressure of 27.6 MPa: 3110 --- Of condensation, polycondensation and polyaddition products 3120 --- Of other addition polymerisation products 3190 --- Other -- Other, not reinforced or otherwise combined with other materials, without fittings: 3210 --- Of condensation, polycondensation and polyaddition products 3220 --- Of other addition polymerisation products 3290 --- Other 3300 -- Other, not reinforced or otherwise combined with other materials, with fittings 3900 -- Other 4000 - Fittings
39.18	Floor coverings of plastics, whether or not self-adhesive, in rolls or in the form of tiles; wall or ceiling coverings of plastics: - Of polymers of vinyl chloride: 1001 -- With a thickness of less than 1.5 mm

	1009	-- Other
39.20		Other plates, sheets, film, foil and strip, of plastics, non-cellular and not reinforced, laminated, supported or similarly combined with other materials:
		- Of polymers of vinyl chloride:
	4100	-- Rigid
39.25		Builders' ware of plastics, not elsewhere specified or included:
	1000	- Reservoirs, tanks, vats and similar containers, of a capacity exceeding 300 litres
		- Doors, windows and their frames and thresholds for doors:
	2001	-- Doors containing regulated chlorofluorocarbons
	2009	-- Other
	3000	- Shutters, blinds (including Venetian blinds) and similar articles and parts thereof
		- Other:
		-- Construction parts for floors, walls or ceiling:
	9001	--- Containing regulated chlorofluorocarbons
	9002	-- Other
		-- Gates:
	9003	--- Containing regulated chlorofluorocarbons
	9004	--- Other
	9009	-- Other
39.26		Other articles of plastics and articles of other materials of headings nos. 39.01 to 39.14:
	1000	- Office or school supplies
	2000	- Articles of apparel and clothing accessories (including gloves)
	3000	- Fittings for furniture, coachwork or the like
	4000	- Statuettes and other ornamental articles
		- Other:
	9010	-- Shoe trees and lasts
	9020	-- Machines joints and gaskets
	9030	-- Transmission, conveyor or elevator belts or belting
		-- Other:
	9091	--- Fishing net floats
	9092	--- Sponges (other than rectangular or square) whether or not containing soap
		--- Stuffing materials, foamed, in finished forms (for example chips, angles, flakes):
	9093	---- Containing regulated chlorofluorocarbons
	9094	---- Other
	9098	--- Other
CHAPTER 68		ARTICLES OF STONE, PLASTER, CEMENT, ASBESTOS, MICA OR SIMILAR MATERIALS
68.07		Articles of asphalt or of similar material (for example, petroleum bitumen or coal tar pitch):
	1000	- In rolls
	9000	- Other
CHAPTER 71		NATURAL OR CULTURED PEARLS, PRECIOUS OR SEMIPRECIOUS STONES, PRECIOUS METALS, METALS CLAD WITH PRECIOUS METAL, AND ARTICLES THEREOF; IMITATION JEWELLERY; COIN
II. PRECIOUS METALS AND METALS CLAD WITH PRECIOUS METAL		
71.06		Silver (including silver plated with gold or platinum), unwrought or in semi-manufactured forms, or in powder form:
	1000	- Powder
		- Other:
	9100	-- Unwrought
	9200	-- Semi-manufactured
71.07 0000		Base metals clad with silver, not further worked than semi-manufactured
71.09 0000		Base metals or silver, clad with gold, not further worked than semi-manufactured
71.11 0000		Base metals, silver or gold, clad with platinum, not further worked than semi-manufactured
71.12		Waste and scrap of precious metal or of metal clad with precious metal; other waste and scrap containing precious metal or precious metal compounds, of a kind used principally for the recovery of precious metal:
	1000	- Of gold, including metal clad with gold but excluding sweepings containing other precious metals
	2000	- Of platinum, including metal clad with platinum but excluding sweepings containing other precious metals
	9000	- Other
III. JEWELLERY, GOLDSMITHS' AND SILVERSMITHS' WARES AND OTHER ARTICLES		
71.13		Articles of jewellery and parts thereof, of precious metal or of metal clad with precious metal:
		- Of precious metal whether or not plated or clad with precious metal:
	1100	-- Of silver, whether or not plated or clad with other precious metal
	1900	-- Of other precious metal, whether or not plated or clad with precious metal
	2000	- Of base metal clad with precious metal
71.14		Articles of goldsmiths' or silversmiths' wares and parts thereof, of precious metal or of metal clad with precious metal:
		- Of precious metal whether or not plated or clad with precious metal:
		-- Of silver, whether or not plated or clad with other precious metal:
	1101	--- Table cutlery
	1109	--- Other
	1900	-- Of other precious metal, whether or not plated or clad with precious metal
	2000	- Of base metal clad with precious metal
71.15		Other articles of precious metal or of metal clad with precious metal:
	1000	- Catalysts in the form of wire cloth or grill, of platinum
	9000	- Other

71.18		Coin:
	1000	- Coin (other than gold coin), not being legal tender
	9000	- Other
CHAPTER 79		ZINC AND ARTICLES THEREOF
79.07	0000	Other articles of zinc
CHAPTER 81		OTHER BASE METALS; CERMETS; ARTICLES THEREOF
81.07		Cadmium and articles thereof, including waste and scrap:
	1000	- Unwrought cadmium; waste and scrap; powders
	9000	- Other
CHAPTER 83		MISCELLANEOUS ARTICLES OF BASE METAL
83.11		Wire, rods, tubes, plates, electrodes and similar products, of base metal or of metal carbides, coated or cored with flux material, of a kind used for soldering, brazing, welding or deposition of metal or metal carbides; wire and rods, of agglomerated base metal powder, used for metal spraying:
	1000	- Coated electrodes of base metal, for electric arc welding
	2000	- Cored wire of base metal, for electric arcwelding
	3000	- Coated rods and cored wire, of base metal, for soldering, brazing or welding by flame
	9000	- Other, including parts
CHAPTER 84		NUCLEAR REACTORS, BOILERS, MACHINERY AND MECHANICAL APPLIANCES; PARTS THEREOF
84.07		Spark-ignition reciprocating or rotary internal combustion piston engines:
	1000	- Aircraft engines
CHAPTER 85		ELECTRICAL MACHINERY AND EQUIPMENT AND PARTS THEREOF; SOUND RECORDERS AND REPRODUCERS, TELEVISION IMAGE AND SOUND RECORDERS AND REPRODUCERS, AND PARTS AND ACCESSORIES OF SUCH ARTICLES
85.07		Electric accumulators, including separators therefore, whether or not rectangular (including square):
	3000	- Nickel-cadmium
85.41		Diodes, transistors and similar semi-conductor devices; photosensitive semi-conductor devices, including photovoltaic cells whether or not assembled in modules or made up into panels; light emitting diodes; mounted piezo-electric crystals:
		- Photosensitive semi-conductor devices, including photovoltaic cells whether or not assembled in modules or made up into panels; light emitting diodes:
	4009	-- Other
CHAPTER 87		VEHICLES OTHER THAN RAILWAY OR TRAMWAY ROLLING-STOCK, AND PARTS AND ACCESSORIES THEREOF
87.01		Tractors (other than tractors of heading no. 87.09):
87.02		Motor vehicles for the transport of ten or more persons, including the driver:
87.03		Motor cars and other motor vehicles principally designed for the transport of persons (other than those of heading no.
87.04		Motor vehicles for the transport of goods:
87.05		Special purpose motor vehicles, other than those principally designed for the transport of persons or goods (for example, breakdown lorries, crane lorries, fire fighting vehicles, concrete-mixer lorries, road sweeper lorries, spraying lorries, mobile workshops, mobile radiological units):
87.06		Chassis fitted with engines, for the motor vehicles of headings nos. 87.01 to 87.05:
87.07		Bodies (including cabs), for the motor vehicles of headings nos. 87.01 to 87.05:
87.08		Parts and accessories of the motor vehicles of headings nos. 87.01 to 87.05:
87.09		Works trucks, self-propelled, not fitted with lifting or handling equipment, of the type used in factories, warehouses, dock areas or airports for short distance transport of goods; tractors of the type used on railway station platforms; parts of the foregoing vehicles:
87.10	0000	Tanks and other armoured fighting vehicles, motorised, whether or not fitted with weapons, and parts of such vehicles
87.11		Motorcycles (including mopeds) and cycles fitted with an auxiliary motor, with or without side-cars; side-cars:
87.12	0000	Bicycles and other cycles (including delivery tricycles), not motorised
87.14		Parts and accessories of vehicles of headings nos. 87.11 to 87.13:
87.16		Trailers and semi-trailers; other vehicles, not mechanically propellers; parts thereof:
CHAPTER 88		AIRCRAFT, SPACECRAFT, AND PARTS THEREOF
88.02		Other aircraft (for example, helicopters, aeroplanes); spacecraft (including satellites) and suborbital and spacecraft launch
88.03		Parts of goods of heading no. 88.01 or 88.02:
CHAPTER 89		SHIPS, BOATS AND FLOATING STRUCTURES

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