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Committee for Administering the Mechanism for Promoting the Implementation and Compliance of the Basel Convention
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Item 4 (a) (ii) of the provisional agenda**

Review of general issues of compliance and implementation under the Convention: national reporting: guidance on the development of inventories

Guidance on the development of inventories

Note by the Secretariat

I. Introduction

1. By its decision BC-10/11, the tenth meeting of the Conference of the Parties adopted the work programme for the biennium 2012–2013 of the Committee administering the mechanism for promoting implementation and compliance of the Basel Convention (hereinafter "the Committee"), attached to that decision. Within its mandate to review general issues of compliance and implementation under the Convention, the Committee was requested to undertake several activities with the objective of improving timely and complete national reporting under paragraph 3 of Article 13 of the Convention.

2. Among the activities listed in the 2012–2013 work programme is the development of guidance on the development of inventories.

3. The Committee considered the guidance on the development of inventories during its ninth meeting from 8–9 November 2012 on the basis of document UNEP/CHW/CC.9/8 including the annex setting out a methodological guide for hazardous waste inventories (October 2012 draft). In its conclusions, the Committee requested the Secretariat to circulate the draft guidance to all parties and Basel Convention Regional Centers (hereinafter, "BCRCs") and to invite parties, the BCRCs and others to comment thereon by 31 July 2013. The Committee also developed some recommendations for the consideration of the eleventh meeting of the Conference of the Parties[1].

4. A revised version of the methodological guide was prepared in order to take into account the outcome of the Committee's deliberations during its ninth meeting. The methodological guide for the development of inventories of hazardous wastes and others wastes under the Basel Convention (February 2013 preliminary draft) was published on the website of the Convention and, on 7 March 2013, sent to all parties and BCRCs with an invitation to comment by 31 July 2013.

* Reissued for technical reasons on 3 December 2013.
** UNEP/CHW/CC.10/1.
[1] Documents UNEP/CHW/CC.9/16 and UNEP/CHW.11/10.

5. By its decision BC-11/8, and based on the recommendations of the Committee, the eleventh meeting of the Conference of the Parties adopted the work programme for the biennium 2014-2015 of the Committee, contained in annex II to that decision, whereby the Committee was requested to finalize, taking into account comments received by parties and Basel Convention regional centres by 31 July 2013, and including through consultations with the Open-ended Working Group, the development of guidance on the development of inventories for the consideration and possible adoption by the Conference of the Parties at its twelfth meeting.

6. By its decision BC-11/19, and based on the recommendations of the Committee, the eleventh meeting of the Conference of the Parties adopted the work programme of the Open-ended working group for the biennium 2014–2015 whereby it requested the group to consult with the Committee on the following activities of the Committee's 2014–2015 work programme:

(a) Developing guidance on the development of inventories;

(b) Developing guidance on the take-back provision;

(c) Updating the guide to the control system;

(d) Reviewing and updating the manual for the implementation of the Basel Convention to ensure consistency between the manual and the guide to the control system and, as far as possible, to avoid duplication between the two documents.

II. Implementation

7. As at 16 September 2013, the Secretariat has received comments from Canada, the European Union and its member States as well as the United States of America on the February 2013 preliminary draft Methodological guide for the development of inventories of hazardous wastes and others wastes under the Basel Convention. These comments are set out in document UNEP/CHW/CC.10/INF/2. As at that same date, one Committee member has shared with all Committee members his comments on the draft, in accordance with previous practice.

8. With the support of a financial contribution from the European Union, the Secretariat has hired a consultant to assist with the further development of the guidance on the development of inventories.

9. The annex to this note sets out draft guidance on the development of inventories that takes into account comments referred to in paragraph 7 above.

III. Proposed action

10. The Committee may wish to request the Secretariat to prepare by 31 March 2014 revised draft guidance on the development of inventories reflecting the outcome of the discussions during the tenth meeting of the Committee, for the consideration of the Open-ended Working Group at its ninth meeting and the consideration of the Committee at its eleventh meeting.

Annex

Methodological guide for the development of inventories of hazardous wastes and other wastes under the Basel Convention

(Draft, October 2013)

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LIST OF ACRONYMS

BC	Basel Convention
BAT	Best Available Techniques
COP	Conference of Parties to BC
CPCB	Central Pollution Control Board of India
EPA	Environmental Protection Agency
E-PRTR	The European Pollutant Release and Transfer Register
ESM	Environmentally Sound Management of Hazardous Wastes
e-waste	waste from electronic and electrical waste
fg	femtogram, 10^{-15} g
GDP	Gross Domestic Product
GHS	The Globally Harmonized System of Classification and Labeling of Chemicals
HS	Harmonized Commodity Description and Coding System
HoW	Hazardous and other wastes
ICC	Committee for Administering the Mechanism for Promoting Implementation and Compliance with the Basel Convention
ICT	Information and Communication Technology
MAP	Mediterranean Action Plan
MSW	Municipal Solid Waste
OECD	Organization for Economical Co-operation and Development
OEWG	Open-ended Working Group of BC
PRTR	Pollution Release and Transfer Register
PVC	Polyvinyl chloride.
SBC	Secretariat of the Basel Convention
SDS	Safety Data Sheets for hazardous chemicals
SEA	South-East Asia
t	metric ton
WCO	World Customs Organization
WHO	World Health Organization

1. Introduction

The tenth meeting of the conference of the Parties to the Basel Convention requested the Committee for Administering the Mechanism for Promoting Implementation and Compliance with the Basel Convention (ICC) to improve timely and complete national reporting of the Convention, by developing guidance on the development of inventories of hazardous waste and other wastes (hereinafter “HoW”) under the framework of the Basel Convention. This guidance document is the output of this task. It is intended to be a substitute to the Methodological Guide for Undertaking National Inventories under the Basel Convention which was published in draft version in May 2000[1].

This document takes into consideration the Framework Document 1994 on the Preparation of Technical Guidelines for the Environmentally Sound Management of Wastes Subject to the Basel Convention[2]. The guide at hand was prepared utilizing experiences from the Basel Convention Regional Centers (hereinafter “BCRC”), especially the pilot project conducted by the BCRC-Indonesia in 2005[3], recommendations given by this pilot project[4] and a methodological guide produced for Arab countries by the BCRC-Egypt[5]. Comments from parties, the Secretariat of the Basel Convention (hereinafter “SBC”), ICC members and some representatives of the BCRCs were received and utilized in developing this guide.

The ICC has earlier developed a Guidance Document on Improving National Reporting by Parties to the Basel Convention[6]. That document outlines the elements needed for a Party to be in a position to fulfill its national reporting obligation. Conducting the national HoW inventory is a core element of that strategy. According to that guidance document an inventory of hazardous and other wastes should cover generators, disposal sites and all handlers of such wastes. In addition the national reporting questionnaire requires that Parties report information on the export and import of HoW.

HoW inventories should be seen as a tool for implementing the objectives of the Basel Convention through a national or a regional HoW strategy. The conducting of inventories should be streamlined with the process of developing national policies, legislation, planning and implementation of environmentally sound management of HoW and hazardous chemicals.

[1] Basel Convention, 2000.
[2] Basel Convention, 1994.
[3] Ambika consultants, 2005.
[4] Amar Binaya Karsa, Ambika Consultants, 2005.
[5] Basel Convention Regional Centre For the Arab States (BCRC-Egypt), 2007.
[6] Basel Convention, Conference of Parties, 2009.

2. Objective of the guidelines and document structure

The main objective of these guidelines is to assist countries where no statistical data are collected in fulfilling their reporting obligations under the Basel Convention, as regards national inventories of hazardous waste. This guide focuses on the actions required nationally to develop the national information systems that produce the information needed to fulfill the national reporting obligations.

Conducting HoW inventories requires interplay with developing legislation, monitoring and enforcement of compliance and with the planning and implementation of HoW disposal capacity to fulfill the principles of environmentally sound waste management. The officials, consultants or academics who are conducting the practical work of compiling and interpreting the inventories are expected to benefit from the guidelines. Furthermore the document intends to promote the exchange of good methodological practices and the benchmarking of specific generation of HoW of prioritized sectors between all Parties.

Those Parties to the BC that have not been able to report their HoW inventory to the SBC can use this Guide to develop the elements that are needed to submit the first national report on HoW generation.

Chapter 3 of this document summarizes the annual reporting requirements under the Basel Convention. Chapter 4 describes different types of HoW inventories and suggests roles that the inventory findings can play in developing a national HoW policy. The chapter discusses the elements of HoW policy that should be in place to enable credible inventories. Chapter 5 provides a road map for conducting the first national HoW inventory. It discusses some of the challenges commonly faced during each step, presents case stories from several countries and provides guidance and proposes good practices in overcoming the common obstacles. Chapter 6 goes deeper into the process of conducting a first generation inventory of industrial wastes and chapter 7 deals with hazardous wastes other than industrial waste streams and briefly covers also the inventory and reporting of “other wastes” under the BC. Chapters 8 and 9 dip into the challenges of field work of HoW inventories. Chapter 8 provides guidance in conducting waste audits in industrial facilities and chapter 9 focuses on compliance monitoring which is the basis of regularly updated inventories.

3. National reporting under the Basel Convention

In order to enable monitoring of the implementation of the Basel Convention by its Parties Article 13, paragraph 3 of the Basel Convention establishes that the Parties shall transmit, through the Secretariat, before the end of each calendar year, to the Conference of the Parties, a report on the previous calendar year containing the following information:

(a) Competent authorities and focal points that have been designated by them pursuant to Article 5;

(b) Information regarding transboundary movements of hazardous wastes or other wastes in which they have been involved, including:

(i) The amount of hazardous wastes and other wastes exported, their category, characteristics, destination, any transit country and disposal method as stated on the response to notification;

(ii) The amount of hazardous wastes and other wastes imported their category, characteristics, origin, and disposal methods;

(iii) Disposals which did not proceed as intended;

(iv) Efforts to achieve a reduction of the amount of hazardous wastes or other wastes subject to transboundary movement;

(c) Information on the measures adopted by them in implementation of this Convention;

(d) Information on available qualified statistics which have been compiled by them on the effects on human health and the environment of the generation, transportation and disposal of hazardous wastes or other wastes;

(e) Information concerning bilateral, multilateral and regional agreements and arrangements entered into pursuant to Article 11 of this Convention;

(f) Information on accidents occurring during the transboundary movement and disposal of hazardous wastes and other wastes and on the measures undertaken to deal with them;

(g) Information on disposal options operated within the area of their national jurisdiction;

(h) Information on measures undertaken for development of technologies for the reduction and/or elimination of production of hazardous wastes and other wastes; and

(i) Such other matters as the Conference of the Parties shall deem relevant.

To facilitate the transmission of such information, at its sixth meeting, the Conference of the Parties, by its decision VI/27, adopted a revised questionnaire on transmission of information (UNEP/CHW.6/29) and a manual providing guidance to Parties on how to complete the questionnaire[7].

Part I of the revised questionnaire deals mainly with qualitative issues such as competent authorities, agreements, information about disposal options, effects of hazardous waste and policies for waste minimization. Part II deals with quantitative information on HoW generation and transboundary movements as well as disposals that did not proceed as intended and accidents that occurred during the transboundary movement and disposal of HoW. More specifically, tables 6 and 7 of the questionnaire deal with exported and imported HoW. Table 8B consists of the annual sum of the national inventory of all hazardous wastes and other wastes by Y-categories. Table 8A is a summary of the waste data in table 8B. These tables are attached to this guide as annex 4. This guide aims to assist parties in building the information needed to fill in these tables.

[7] Available at http://www.basel.int/Countries/NationalReporting/Guidance/tabid/1498/Default.aspx

As national reporting has been a major concern by Parties in fulfilling the obligations of the Basel Convention, following its seventh session, and under the mandate provided by decision VIII/32, the ICC adopted the “Guidance Document on Improving National Reporting”[8] aimed at assisting with the preparation of the national reports that are to be submitted annually to the Secretariat of the Basel Convention. Subsequently, the ICC developed a "benchmark report"[9] to demonstrate what a national report submitted in accordance with Article 13, paragraph 3, might ideally look like, and to give some advice on what to avoid when preparing the national report. The Conference of the Parties, during its tenth meeting, took note of the “benchmark report” and encouraged Parties to use it (decision BC-10/11).

Cases of illegal trafficking of HoW should be reported following a distinct reporting procedure[10].

4. Roles and types of HoW inventories

4.1. First generation HoW inventories

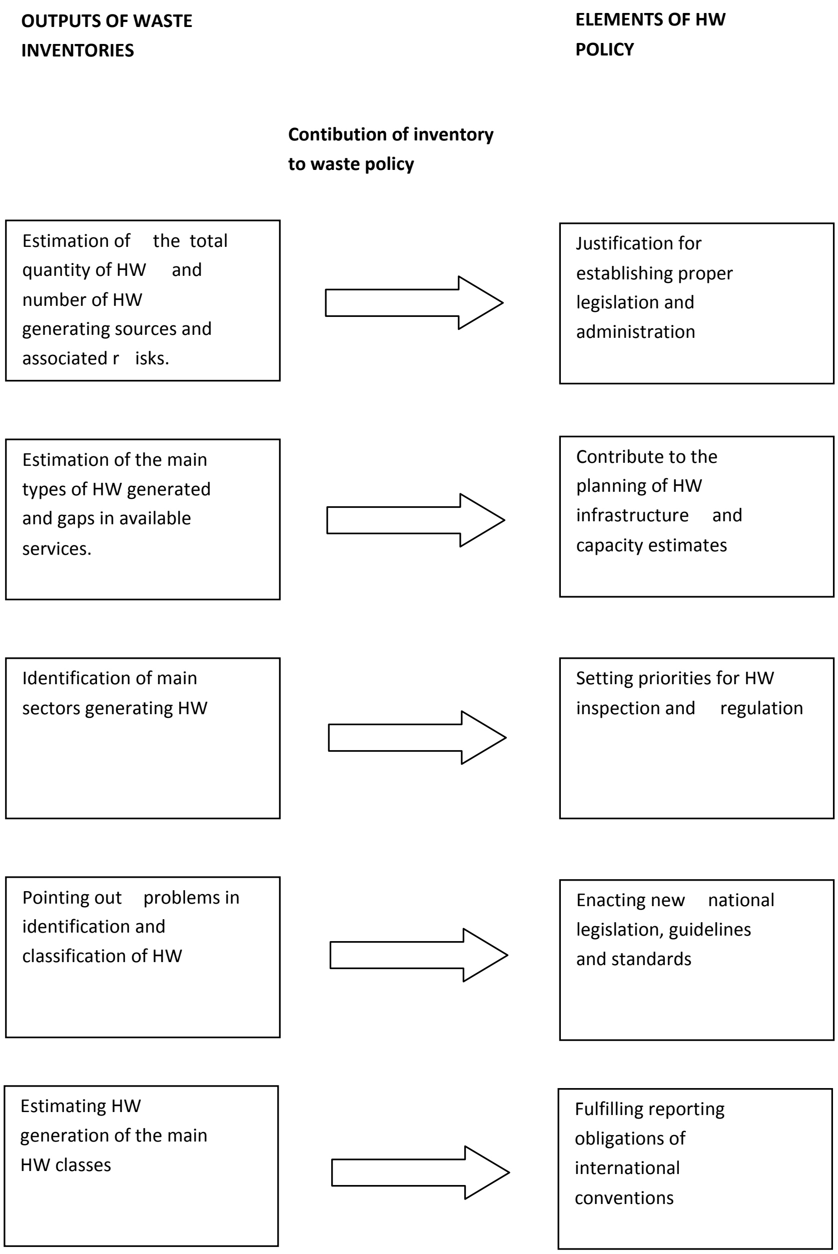
The role of a national HoW inventory depends on the stage of development of the national HoW and chemical policy. In the early stages of development, HoW inventories are often created using basic calculations of HoW generation and a review of management practices aiming at identifying priority waste streams and sources, main risks, main players, service and investment needs etc. Such inventories are named *first generation* inventories in this document.

Before a system for collecting site specific data from the main HoW generators is in place, such ad hoc studies and engineering calculations may be the only way of producing the information basis for setting priorities for HoW policy and for the planning of the HoW management infrastructure.

Experiences from the first generation inventories should be used to identify development needs in the different elements of the national HoW strategy. Figure 1 demonstrates how the outputs of HoW inventories can feed into the development of national HoW policy.

[8] Available at http://www.basel.int/TheConvention/Publications/GuidanceManuals/tabid/2364/Default.aspx
[9] Available at http://www.basel.int/Portals/4/download.aspx?d=UNEP-CHW-NREP-REP-BenchmarkNationalReporting-1.English.pdf
[10] Basel Convention, http://www.basel.int/Procedures/ReportingonIllegalTraffic/tabid/1544/Default.aspx.

Figure 1 Roles of first generation inventories in HoW policy



4.2. Second generation HoW inventories

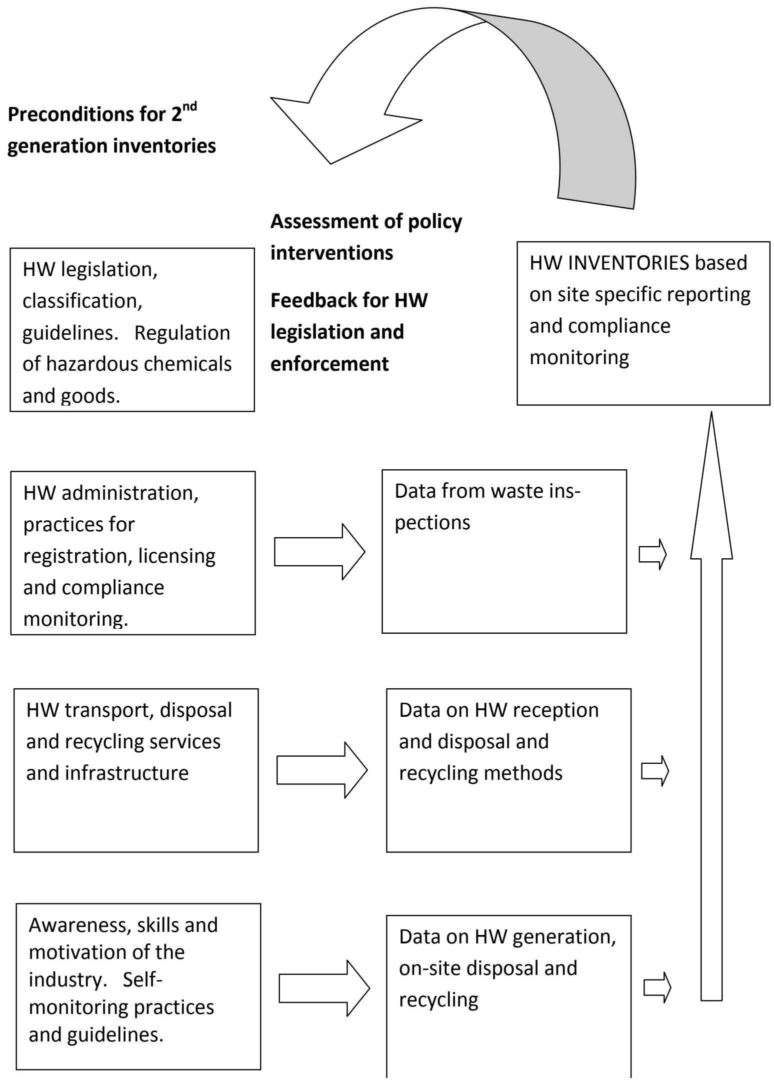
In a more advanced stage when a national system is in place with detailed HoW legislation, licensing and enforcement it is the self-monitoring and compliance monitoring system that produces data for annual HoW inventories. These *second generation* inventories could be updated annually or compiled to answer specific questions. The basis for annually updated inventories could be the monitoring obligation of the nationally regulated stakeholders.

For example in the EU, waste installations are required to obtain permits for their operations (with certain possibilities for exemptions regarding non-hazardous waste and waste recovery). These waste installations as well as the generators, collectors, transporters, dealers and brokers of hazardous waste must keep chronological records of, *inter alia*, the quantity, nature and origin of the waste and make this information available on request to the competent authorities (Articles 23-26 and 35 of the EU Waste Framework Directive 2008/98/EC, OJ L 312, 22.11.2008, p. 3). For hazardous waste, the records shall be preserved for at least three years except in the case of establishments and undertakings transporting hazardous waste which must keep such records for at least 12 months. Documentary evidence that the management operations have been carried out shall be supplied at the request of the competent authorities or of a previous holder. Specific requirements for inventories of equipment containing PCBs and PCTs are laid down in EU Directive 96/59/EC, OJ L 243, 24.9.1996, p. 31, including simplified inventories for equipment slightly contaminated by PCBs and PCTs.[11]

Chapter 5 presents the steps for second generation HoW inventories. Certain elements of HoW policy have to be in place to enable relevant inventories. On the other hand the findings of inventories can be used for the evaluation of policy interventions and to identify compliance gaps as shown in the following figure.

[11] See submission of the EU and its member States, 13 August 2013, available at: http://www.basel.int/Implementation/LegalMatters/Compliance/GeneralIssuesActivities/Activities201213/GuidanceonInventories/tabid/3194/Default.aspx

Figure 2 Interaction of second generation inventories with HoW policy elements



In the intermediate phase, when moving from first to second generation inventories, a combination of both methodologies are used. In addition, project type surveys are needed to analyze specific waste streams or product chains.

The methodology, scope, degree of detail and the format of presenting the results of a waste inventory depend on the intended use. This is reflected in table 1 with examples of typical motivations for commissioning HoW inventories. The order of presentation also represents the typical evolutionary course of different types of inventories. The permanently updated database of annual HoW reports, verified by regular inspections is the ultimate stage that is most detailed and can be used for multiple purposes, including enforcement actions.

Table 1 Examples of types of inventories

Purpose of an inventory	Characteristics of the inventory	Note
Justifying policy action on a general level	Order of magnitude estimates to verify that the problem exists and should be addressed	Classification of wastes can be on a very general level and estimates based on rough emission factors or only identifying the major waste groups.
Identifying priorities and policy gaps during the life cycle of hazardous materials. Planning of economic instruments e.g. polluter pays principle.	Screening of most significant waste streams and disposal sites. Identify waste groups imposing the most urgent risks. Tentative listing of the biggest HoW generators in each sector. Identify key stakeholders in the relevant sectors.	The inventory can reveal gaps in the legislation, in the classification of wastes as hazardous, management capacity, awareness of waste generators etc. Quantitative accuracy is not so relevant.
Planning of service and investment needs	Order of magnitude estimates of main HoW groups. Rough geographical breakdown of generated HoW quantities. Grouping of HoW types by main disposal options (e.g. potentially treatable at landfills, incinerators, recyclable).	Inventories can be conducted in phases starting from regions with big or large numbers of waste generators or starting with wastes applicable for disposal or disposal of a specific type.
Planning of services for specific waste types	Inventories can be based on the consumption of products generating the specific waste type, such as e-waste, batteries, vehicles, PVC products, lubricating oil etc.	Import and export statistics are an important part of such inventories.
Evaluating the effectiveness of waste prevention policies	Inventories focusing on tracking the change in consumption of the hazardous substance and generation of HoW from the target sector or activity.	Growth of the target sector can easily override the reduction of specific waste generation. Results can be verified by repeated waste audits using the same sample of waste generators.
Identifying risks of non-compliance and potential for waste recycling, prevention or improving cost efficiency.	Waste audits based on self-monitoring or using external consultants. Inventories based on detailed fieldwork and analysis of samples.	High cost, but usually best reliability.

Purpose of an inventory	Characteristics of the inventory	Note
Compliance monitoring of individual waste generators	Inventories based on regularly updated databases of HoW generators, self-monitoring and periodical verification by inspection.	Results can be used for identifying anomalies, tracking trends, planning inspection. Identifying illegal transfers or export of hazardous wastes.

4.3. Using inventory data for national reporting

The first generation inventory can be built on national databases and statistics on industrial production and can utilize waste factors from other studies.

In the interim period, before the HoW policy elements are in place to enable second generation inventories, the national reporting can be based on calculations of national HoW generation, *if* they are based on primary data from actual field work covering a representative sample of real cases.

The road map for conducting HoW inventories **-** especially of industrial HoW streams **-** is presented in Chapter 6. Inventories of other HoW sources are discussed in Chapter 7. Using actual data from pilot areas and then calculating the national HoW generation by extrapolation is the only realistic way of reporting HoW from scattered sources, such as agricultural use of pesticides, households or services, where annual collection of waste data from each individual source is impossible.

Also regarding the waste streams related to waste disposal, import and export and for waste generation from major industrial source a certain level of environmental legislation, administration, management and control must be in place to produce the site and waste typed specific data that is necessary to fulfill the reporting requirements.

5. Steps towards a national HoW inventory

The following steps are intended to assist Parties in preparing an inventory of HoW for the purpose of preparing national reports under BC. Conducting a study of hazardous waste generation may sound as a simple task of preparing a questionnaire, sending it to the industrial companies and compiling the results into graphics. Sometimes HoW inventories are expected to be conducted as the first step before even establishing national definitions or legislation for hazardous waste. This means that the entity/ies assigned for the job will have to make assumptions that will influence the outcome of the inventory much more than the actual field work. It is advised that the development of the inventory be undertaken by an interagency task force bringing together representatives of key stakeholders. In addition survey teams will need to be established for the purpose of organizing the collection of primary data from generators. These teams should have a good level of understanding of BC waste classification system and, if one is place, of its relationship with the national waste classification system.

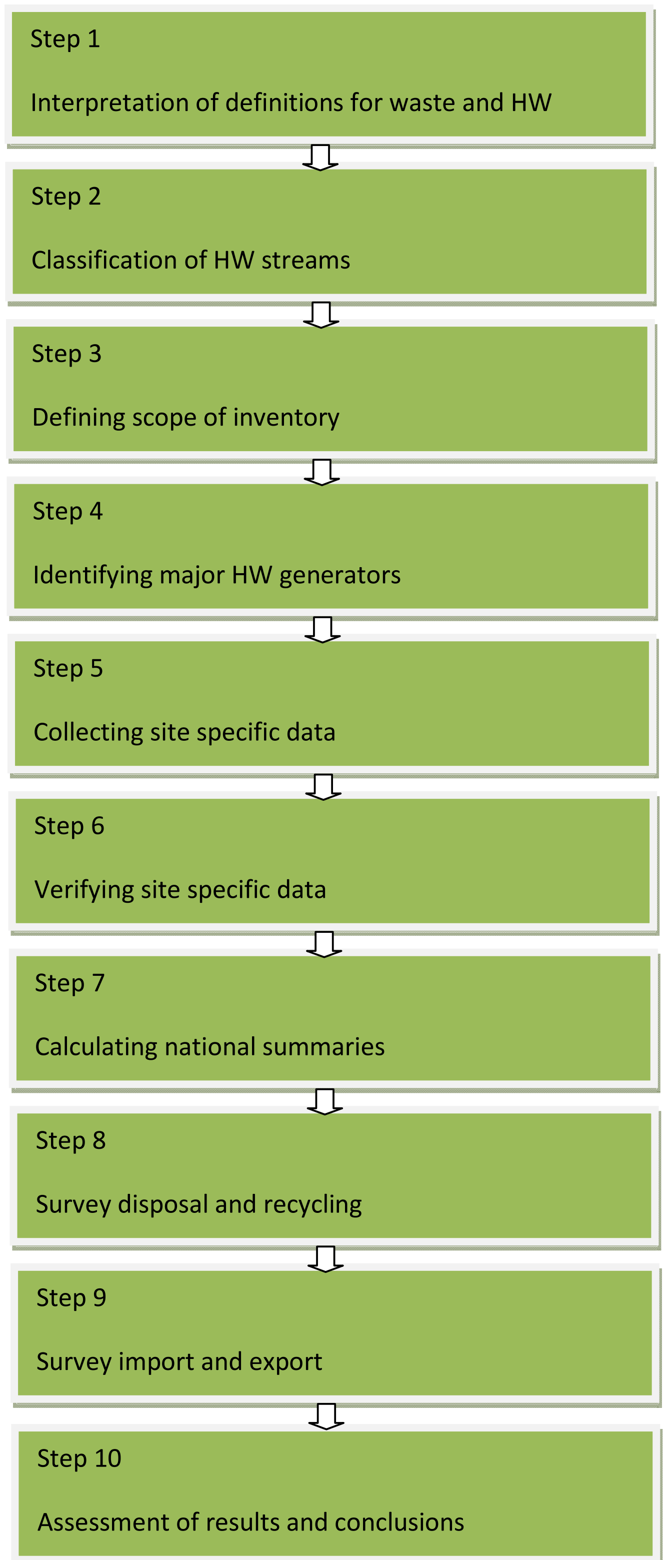
This chapter walks the reader through the typical challenges of a national or regional HoW inventory and proposes some solutions to the problems that will be encountered. In each national context the steps (see figure 3) will be to some extent different depending on the level and performance of the existing environmental legislation, institutional capacity and information management. This section is mainly oriented towards an inventory of industrial HoW, which is usually the dominant HoW stream. Many of the steps can be applied to other HoW streams as well.

5.1. Interpretation of definitions

As part of the planning process for a national HoW inventory the inventory task force should clarify the national interpretations of the key definitions related to HoW. As will be seen in the case stories, the interpretations can have a dramatic impact on the results of an inventory. At least the following questions must be answered before the survey can be launched:

- what substances or objects will be defined as wastes?
- how to decide in practice if a waste is hazardous or not?
- when to consider emissions to the wastewater as HoW?

Figure 3 Ten steps towards a national HoW inventory



5.1.1 Definition of waste

The definition of waste is stated in the Basel Convention paragraph 1 of Article 2:

> *"Wastes" are substances or objects which are disposed of or are intended to be disposed of or are required to be disposed of by the provisions of national law*

Disposal in the Convention text (annex IV) means a) operations which do not lead to the possibility of resource recovery, recycling, reclamation, direct re-use or alternative uses, and b) operations which may lead to resource recovery, recycling, reclamation , direct re-use or alternative uses.

Determining whether a substance or object is or not "waste" within the meaning of the Basel Convention and national legislation implementing this treaty may not always be straightforward. Ultimately it is the mandate of the waste authority (e.g. inspector) to decide, in which instance a substance or good is defined as "waste" or not. Metal scrap, slag, ash, used lubricating oil etc. are examples of materials that can have a commercial value. Still they can be defined as wastes. Further work on clarifying such matters is in progress under the Basel Convention[12]. Unless otherwise specified in the domestic legal framework, the following criteria for instance can be used to assess the waste/non-waste status:

- is there an existing market or demand for the waste constituents?
- does the substance or object fulfill the technical requirements for the specific purposes and meet the existing legislation and standards applicable to products (does the generator of the material provide the buyer with quality control data)?
- does the use lead to risks of adverse environmental or human health impacts?

The principles governing the definition of "waste" at the national level should be known and communicated before the field work towards the development of an HoW is initiated

5.1.2 Definition of hazardous waste

Basel Convention paragraph 1 of Article 1 defines "hazardous wastes" for the purposes of that Convention:

> *a) Wastes that belong to any category contained in Annex I,* ***unless they do not possess*** *any of the characteristics contained in Annex III; and*

[12] Reference is made to the work undertaken under the Basel Convention on the development of technical guidelines on transboundary movements of e-waste and used electrical and electronic equipment, in particular regarding the distinction between waste and non-waste under the Basel Convention (http://www.basel.int/Implementation/TechnicalMatters/DevelopmentofTechnicalGuidelines/Ewaste/tabid/2377/Default.aspx) and on improving legal clarity (http://www.basel.int/Implementation/LegalMatters/CountryLedInitiative/OutcomeofCOP10/Providingfurtherlegalclarity/tabid/2673/Default.aspx).

b) Wastes that are not covered under paragraph (a) but are defined as, or are considered to be, hazardous wastes by the domestic legislation of the Party of export, import or transit.

This definition reveals important challenges for conducting the inventory.

Annex 1 lists categories of wastes that **are** considered as hazardous wastes, ***except*** if it can be verified that they do not possess any of the hazardous characteristic in Annex III e.g. acutely toxic, flammable, corrosive, or infectious. Annex VIII (list A) classifies, in more practical terms, wastes that typically belong to the different hazardous wastes categories. In many cases the hazardousness assumption should be verified by testing. Such detailed analysis is usually not possible in inventories based on questionnaires or statistical data. This means that the inventory findings may overestimate (or underestimate) the true amount of hazardous wastes.

Annex IX lists materials (list B) that are typically **not** hazardous wastes; however contamination with wastes or substances of list A can render these materials hazardous waste as well. This may need to be verified later by analysis and quality control measures. List A and B include so called mirror entries (e.g. fly-ash from coal powered plants A 2060, B 2050), which can be hazardous or not depending on the heavy metal content or other contaminants in the specific case.

In addition to issues pertaining to the definition of hazardous wastes, the classification of hazardous wastes used in the national legislation may differ from the classification used in the Basel Convention; unless a correlation is established, this may lead to complications in reporting data, in comparing data that are reported and in having a comprehensive overview of Parties' generation and TBM of BC wastes In addition, some wastes that are not classified as hazardous in one country can be classified as such in another Party of the Convention. In such cases some figures in the national inventory may differ from the figures reported for trans-boundary movements. This issue is further discussed in 5.2. below.

One challenge in collecting data about hazardous wastes from waste generators is that they may not familiar with the hazardous wastes definition and classification. One way to overcome this challenge is for the authorities to provide waste generators with greater clarity and information about what is expected from them. Another option could be for the authorities to collect data on "waste" and then for these authorities to classify the waste as "hazardous" or "other" based on the criteria embedded in the national legislation.

5.1.3 Border line between wastes and other releases

The definition of waste implies that waste can be solid, sludge (semi-solid), liquid or even gaseous. In designing a HoW inventory the border line between waste and other releases to the environment should be clarified.

Case story 1

> *An inventory was conducted in 2006 in Greater Cairo area, Egypt based on a sample of 23 industrial establishments was extrapolated to cover all establishments in the area. The estimate concluded that 50,000 t/yr of solid hazardous wastes, 550,000 m^3/yr of liquid hazardous wastes and 450,000 t/yr o hazardous wastes sludge are generated in the area[13]. The result of the inventory regarding pharmaceutical industry implied that 546,000 tons of hazardous wastes was generated while 99.95% of this was wastewater. This was because the Ministry of Health at that time had decided in a ministerial decree that "all waste from pharmaceutical industry is hazardous wastes*"

This case study emphasizes th**e linkage between HoW generation and integrated pollution control[14].** If toxic emissions into the sewer, surface water or soil are not controlled, only little hazardous waste is accumulated at the site and consequently, no demand for HoW services is created. Ideally, HoW inventories should be part of an integrated approach of tracking the distribution of hazardous material flows between air, water, land, waste and on-site disposal. Such an approach is promoted by the Pollution Release and Transfer Register (PRTR) scheme that is facilitated by the OECD[15]. The PRTR databases from industrialized countries can be used to identify industrial sectors that use and release selected hazardous chemicals or substances.

[13] Ramadan,A., Afifi,R., 2006.

[14] Defining wastewater as HW is not conducive to the development of HW management, because wastewater emissions cannot be solved by providing external HW disposal capacity. The amount of hazardous waste arising from the disposal of industrial wastewater is usually not more than 2…10 weight-% of the quantity of wastewater - depending on the technology and the degree of dewatering of the sludge. Some wastewater can be totally neutralized on site, e.g. mixing acid wastewater with alkaline wastewater and the result can be zero emission of HW. In plant specific HW audits liquid HW that can be contained from the process (e.g. batches of acid baths or used lubricating fluids) should be quantified as HW, even if they presently are diluted and discharged into the sewer. In some cases it is possible to estimate the quantity of "hazardous sludge" that would arise after implementing non-hazardous wastewater segregation and precipitation of the hazardous wastewater flow. In first generation inventories it may be realistic to exclude hazardous wastewater issues entirely from the scope

[15] OECD, 2012.

5.2. Step 2. Classification of HoW streams

The classification and grouping of HoW types in conducting and presenting the results of inventories must also be carefully designed to maximize the benefits of the results. The value of a hazardous waste inventory is increased if it leads to progress towards the environmentally sound management (ESM) of wastes. Thus a characterization of wastes that enables the grouping of the results according to disposal option is recommended.

The Basel Convention classifies hazardous wastes using two types of categories. The A-list consists of two groups of waste classes. Group I (classes Y1-18) categorized based on the **origin** of the waste streams (e.g. Y4 Wastes from the production, formulation and use of biocides and phytopharmaceuticals). The second group (Y19-Y45) is based on the **hazardous constituent**, regardless of the waste stream (e.g. Y42 Organic solvents excluding halogenated solvents). The annex contains useful proposals of concentration limits for some contaminants, which can be used in national legislation and guidelines. Annex VIII provides a classification of list A substances by a 4-digit code that represents typical wastes covering all the Y-codes and combining the waste-stream and the hazardous-constituent approaches.

Examples of potentially hazardous wastes from various sources are provided in annex 3 of this document, using the categories of wastes from Annex I of the Basel Convention.

The Basel Convention, EU-legislation and individual national classification systems use different systems in the classification of wastes and hazardous wastes. Most of the classes can find matching classes in the BC system, but in many cases a full match cannot be achieved. This is the reason why only few countries can report their hazardous wastes generation by Y-classes in table 8B. For example, in the EU system, the two and four digit level categories are based on the economic sectors that generate the waste. The hazardous wastes are distinguished from non-hazardous “mirror” wastes at the six digit level. Many of these hazardous wastes classes could match with at least two BC classes (Y-codes): one matching with the class categorized by source and one with the matching hazardous constituent. Each Party should establish its practice of harmonizing its waste classification with the classification required in the BC reporting. There may be alternative ways of matching a national waste class with the BC system, but the main principle is to be consistent in using the same interpretation from year to year. Justified changes in the interpretation should be mentioned in the accompanying letter or in the remarks of the national reporting table 8A.

If the inventory is planned before the national classification is enacted, the task force has to choose which international system to follow. The benefit of using a classification based on the economical sector is that emission factors can be calculated by combining the inventory results with economical statistics. This will provide an indicator of “waste intensity” (kg of waste per $ of GDP of the selected sector) that can be monitored as an indication of progress in waste prevention. Interventions are often most effective when targeting specific waste streams one at a time. On the other hand, if wastes are classified only by the source sector then it would be difficult to group the results in a way that supports the planning of disposal capacity. For example a specific waste type (e.g. mineral waste, acid, oily waste or solvent) can arise from several industrial sectors, but can be disposed of or recycled together. Classification criteria should promote grouping the results into pragmatic groups. The difference is illustrated by comparing case stories 2 and 3.

Case story 2

A national inventory conducted in Egypt classified the hazardous wastes into three groups: solid hazardous wastes, sludge hazardous wastes and liquid hazardous wastes. Also the quantity of hazardous wastes packaging was estimated separately. The results could not be used for any estimation of the needed disposal capacity, because no distinction was made on whether the waste was mainly organic (usually suitable for incineration) or inorganic (mostly suitable for landfill disposal).

Case story 3

The national inventory in India routinely uses grouping into three groups: "land disposable hazardous wastes", "incinerable hazardous wastes" and "recyclable hazardous wastes". In 2007-2008 49.55% of all hazardous wastes was recyclable according to the inventory, 6.67% was incinerable and 43.78% land disposable[16]*. Such a grouping is useful in estimating the regional need of hazardous wastes landfills and incineration capacity. The classification into the landfill disposable class is determined by analysis of the total organic content or volatile substance content. In practice it is not easy to assess if it is feasible to recycle a waste or not without conducting detailed analysis and market studies. Still this approach to classification is useful because it encourages conclusions and action about disposal capacity.*

The BC classification system includes many cross-references to the list B wastes. All international and national classification systems require trained users. When collecting primary data from the industry it may be too challenging to require them to use the BC classification in reporting their wastes. As suggested earlier, it may be advisable that the experts in the inventory task force would be responsible of the classification, based on primary information provided by the informants. Any questionnaire for collecting waste data from generators should direct the respondents to provide enough information for the classification, e.g. by asking about the source of the waste and the hazardous substances in the waste. Unfortunately the questionnaires cannot be very detailed and specific to different waste types. The degree of detail is always a compromise

[16] Verma N.K., 2009.

between the need to be accurate and the need to be practical in terms of work load and knowhow required from the respondent. It is good practice to keep the questionnaires relatively simple and to amend the information through more detailed interviews of a sample of respondents.

When classifying waste generators according to their economic activities sector, the national statistical system is used. In the reporting to the SBC the use of the International Standard Industrial Classification (ISIC) of All Economic Activities latest revision is recommended[17]. 4-digit classes should be used when possible because at this level there is some similarity in the industrial processes that generate waste (e.g. 2422 Manufacture of paints, varnishes and similar coatings, printing ink and mastics).

On the other hand the number of waste factors needed to cover all 4-digit classes is easily overwhelming. In order-of-magnitude inventories the use of 2-digit or 3-digit classes (e.g. 241 Manufacture of basic chemicals or 24 Manufacture of chemicals and chemical products) may have to be used for pragmatic reasons.

In the classification of the disposal and recycling methods the classification in Annex IV to the BC should be applied. In addition, national interpretations and sub-classes may be needed.

5.3. Step 3. Defining the scope of the inventory

Under BC, Parties must report on all wastes generated. The scoping and implementation plan for the inventory should answer at least the following questions:

- HoW streams to be covered
- geographical area to be covered
- specific exclusions from the scope
- level of classification of waste generating facilities (level of ISIC code or corresponding)
- the system and the level of classification of HoW and harmonization between the national and Basel codes.

In a worst case scenario, the budget of the inventory project will be decisive in deciding the scope and depth of the survey. The existing information base and the support available from the compliance monitoring authorities are other major factors.

5.4. Step 4. Identifying major HoW generating facilities

A database of industrial establishments and other generators of waste streams is the core of the HoW inventory development. In countries with advanced environmental administration the environmental license

[17] Unistats, 2012.

and inspection databases provide the natural starting point for establishing hazardous wastes. In less developed countries other information systems can be utilized. The Ministry of Industry and its regional branches usually have lists of industrial establishments based on their mandate to register or issue licenses to these. The databases of sector ministries can be used to identify probable major sources of hazardous wastes which then can be targeted for environmental permitting procedures or waste inventory surveys. These databases can offer some basic data for hazardous wastes inventories such as location, industrial sector, the year of establishment, production capacity and number of employees. The information can be obsolete if it has not been updated since the first registration. Production capacity figures are often far from actual production rates.

The large scale use of hazardous chemicals is usually regulated and monitored and these same facilities of course are candidates for being big hazardous wastes generators. Often several ministries have to be consulted, because mining, pharmaceutical industry, petroleum, energy sector, military industry and sometimes food processing may be under the jurisdiction of the corresponding sector ministries or agencies. Information about the quantities of imported chemicals can provide a reference value for estimating the quantity of waste arising from the use of this substance. For example the quantity of perchlorethylene imported can be used to estimate the quantity of hazardous sludge generated by the dry cleaning shops.

Industrial associations can be valuable partners in hazardous wastes inventories by providing lists of their member companies and possibly also production data. Industrial associations, for example industrial chambers can also be considered as partners in distributing questionnaires and encouraging their members to participate in the survey. Such cooperation is likely in cases where the member companies can be offered some incentives such as government sponsored waste prevention consulting.

It is good practice to start up a waste generator database by listing the biggest establishments of those industrial sectors that are typically major hazardous wastes generators, such as chemical industry, mining and ore processing, basic metal industry, petroleum industry, fertilizer and pesticide production, chemical wood preservation, galvanic industry and waste or industrial wastewater processing. The next step is to proceed by sector, working from the biggest companies towards the medium scale industry. Small scale and cottage industry should be approached at a later stage. It is a common mistake that environmental authorities attempt to target all sizes of industry and all types of industry in one phase. The administration is then easily overwhelmed with the paperwork and practical interventions and priorities will be lost in the mass of data.

Another option is to start working in a geographically limited area, preferable some of the most densely industrialized corridors to create the technical capacity for hazardous wastes inventories and then to gradually widen the geographical scope.

5.5. Step 5. Collecting site specific data

This is the point where first and second generation inventories differ radically. The second generation is mainly based on reporting obligations mandated by the law whereas the first generation inventory has to convince the target facilities to collaborate in providing the data or, following a less time consuming and less costly approach, estimate the amount of waste generated based on other factors or data (such as production, sales, etc), as explained in Chapter 6.

For second generation inventories, data can be collected using a questionnaire sent to the target stakeholders. An example of a template for HoW data collection is provided as annex 4 to this report. A low reply percentage, missing data and wrong interpretations of the survey questions, definitions and classifications are obvious risks in this approach. Also, although facility-level inventories can serve different purposes, their compilation to build a national inventory is not always possible because of issues such as differing metrics, confidential business information and waste categorization.

Data collected from environmental permits, applications, environmental impact assessment (EIA) reports, self-monitoring reports and from inspection reports is more reliable as these documents have passed the processing by environmental inspectors who are aware of the legal background and have training and authority in the subject. Specific guidance on the collection of data from industrial sectors is provided in Chapter 6, while chapter 7 provides guidance on the collection of data from other specific hazardous wastes streams as well as “other wastes”. Challenges concerning information collection from compliance monitoring sources, for instance challenges associated with weak enforcement, low quality of environmental licensing documents or insufficient information about waste classification, are discussed in chapter 8.

5.6. Step 6. Verifying site specific data

Verifying the data collected from questionnaires or monitoring reports is often the most resource intensive part of an inventory survey. Guidance is provided for conducting a waste audit in an industrial facility in chapter 8. Even in first generation inventories field, verification can be helpful to validate the assumptions used in the calculations and can be made through visits to a number of facilities, comparisons to results historical calculations, or comparisons to information from other countries. Questionnaires, if used, should always be tested in the field before being used in large scale. Waste data provided by the waste generator should be critically assessed, compared with production data, data from previous years and with data from other facilities from the same sector. Suspicious and abnormal data should be confirmed through direct contact with the respondent.

5.7. Step 7. Calculating national summaries

Compiling a national inventory from the data collected from the field is a complex task. Incomplete coverage of the waste generating sources may be the rule, not the exception. In first generation inventories national summaries are calculated using waste factors derived from a limited sample of real cases and extrapolated to correspond to the entire community of waste generators. For the extrapolation step national statistics from the concerned sector are needed. It may be noted that in many countries the statistics are more focused on the monetary value of production than on the physical volume of production, which would be more useful for calculating waste streams. Different options for calculating national summaries using waste factors are presented in Chapter 6.

Also second generation inventories may be incomplete, because mandatory reporting requirements cannot be extended to very small units, such as small enterprises, households and individual farms, construction and demolition projects etc. In later revisions of national inventories these small generators can be included in the national summary by extrapolating findings from pilot projects.

5.8. Step 8. Data on HoW disposal and recycling

In countries where the government has not taken appropriate measures to ensure the availability of adequate HoW disposal facilities as required by the Convention and as further elaborated in other documents for instance in the Framework for the environmentally sound management of hazardous wastes and other wastes[18], much of the HoW disposal business is operated by the informal sector. HoW with a market value, such as used oil, lead batteries, empty containers, scrap cable and contaminated metal scrap is intensively recycled. However it is very difficult to collect relevant statistics from the informal sector.

If waste recycling facilities are registered and regulated, the records kept by these companies are a valuable source of HoW data, because there the real world information of waste from numerous waste generators is accumulated. The waste input to the disposal facilities is usually categorized, weighed or otherwise measured, and also some quality indicators are analyzed. Waste authorities should always ensure that commercial waste disposal and final disposal plants are obliged to submit annual reports that can be utilized in compiling national inventories. The plant owners should be instructed to use appropriate waste classification systems that are compatible with national HoW inventory methods. It is important to avoid

[18] The Framework for the environmentally sound management of hazardous wastes and other wastes is set out in document UNEP/CHW.11/3/Add.1/Rev.1 and was adopted by decision BC-11/1. See also the Non-exhaustive list of actions that may be considered for the implementation of the framework for the environmentally sound management of hazardous wastes and other wastes in the short and medium term by parties, regional centres and other stakeholders, set out in the Annex I to decision BC-11/1

double booking of wastes. If a disposal plant acts only as a transfer station for some wastes, these should not be registered as "wastes from waste disposal plants" when transported to the final destination. In addition to solid waste facilities also wastewater disposal plants can generate HoW. The quantities of wastewater disposal sludge can be quite massive because sludge often contains 50…90% water depending on the dewatering technology. National standards for concentration limits of contaminants in wastewater sludge should be established to determine whether the sludge is actually hazardous waste or not.

In comparing the national sum of "generated HoW" with the sum of "disposed HoW" it is common to observe a considerable gap. This is due to numerous sources of inaccuracy, such as missing data, unreliable estimation methods or conversion factors, HoW managed on site, illegal disposal, differences in classification, exclusion of data on imports and exports of HoW etc. Gradually the gap will be narrowed when the quality and coverage of data improves.

According to the BC national reporting requirements the generation of different waste streams should be reported (table 8A and 8B). Table 8A is mandatory and 8B is optional. The fate of each waste stream (i.e. type of disposal or recycling) is not reported in these. Disposal options available in the country must be reported to the SBC according to point (g) in article 13, which is reflected in tables 2 and 3 of part I of the national reporting questionnaire. Therefore, the list of disposal sites should be regularly updated.

5.9. Step 9. Data on HoW import and export

The Basel Convention controls transoundary movements of HoW: their import, transit and export. Each Party has the obligation to designate one or more authorities for approving each trans-boundary movement – named the "Competent Authority", and a control system is in place to ensure the prior consent to and traceability of such movements, including confirmation that the waste is, ultimately, disposed of in an environmental sound manner.

A summary of HoW imported and exported is to be reported annually to the SBC under tables 6 and 7 of the questionnaire (Annex 5). In this system, the BC classification for wastes and disposal/recycling codes is used. In particular, with respect to the classification of waste, and although the revised questionnaire to be used to submit a national report was adopted subsequently to the adoption of Annexes VIII and IX[19], Parties are to report imports and exports using the Y codes set out in Annexes I (hazardous wastes) and II (other wastes) or, if none is applicable, the waste streams/wastes having as constituents. Instances in which no Y code is applicable may result for instance from the fact that the Party has a national definition of hazardous wastes under paragraph 1 (b) of Article 1 of the Convention.

[19] Annexes VIII (List A) and IX (List B) of the Basel Convention were adopted by COP-4 (decision IV/9) and further amended subsequently.

The applicant seeking permission for export or import of HoW regulated by BC is required to fill in the classification of the waste in question using both the BC Y classification and the national classification (e.g. the EWC code in the EU countries). The intended disposal or recycling method for each waste type must be reported using the Basel Convention codes.

The classification established by Annexes I and II of the Convention is not the only classification system for waste that is relevant. Also customs use a classification for goods that is, in general, useful for the purposes of transboundary movement of waste.
The international trade uses the Harmonized Commodity Description and Coding System (HS) which is an internationally standardized system of names and numbers for classifying traded products developed and maintained by the World Customs Organization (WCO). The Parties to BC and the WCO are cooperating in transposing the BC list of wastes into the WCO HS codes so as to ensure harmonization of tariffs and control of trade in hazardous waste.[20].

Because of their central role in controlling transboundary movements of HoW, Competent Authorities are the source of information on the import and export of HoW. The customs authority is also a source of data on imported and exported goods which contain or can contain hazardous substances or wastes. In addition to customs, data provided by waste generators on waste that is intended to be exported and data provided by waste disposers on wastes that has been received as a result of an import should be used as a secondary source of information.

5.10. Step 10. Assessment of results and conclusions

The inventory report should include a section on the reliability of the results. The report should point out the major changes compared to previous inventories and discuss the probable reasons for these changes. Findings regarding challenges related to the national legislation, classification and compliance monitoring should also be documented and communicated to the policy makers.

Remarks regarding the coverage of the inventory or major gaps should be incorporated in the national reporting to SBC (footnotes in table 8A).

[20] Basel Convention, www.basel.int/Portals/4/Basel%20Convention/docs/techmatters/wco_hsc/NC1189E1a.pdf.

6. Methods for calculating industrial hazardous wastes generation

In most countries the bulk of the volume of hazardous wastes is generated by the industry. Information is more easily collected from industrial production than from the more dispersed users of hazardous chemicals such as agriculture and households. Industry should be seen as a partner for the waste authorities in providing expertise and technology for hazardous wastes disposal services. Moreover, bilateral or regional cooperation could be considered as a means to obtain information and data that can be used to produce estimates. While there may be cases where some assumptions are case-specific, there may be other cases that are similar and assumptions can be made based on waste production values used in other countries.

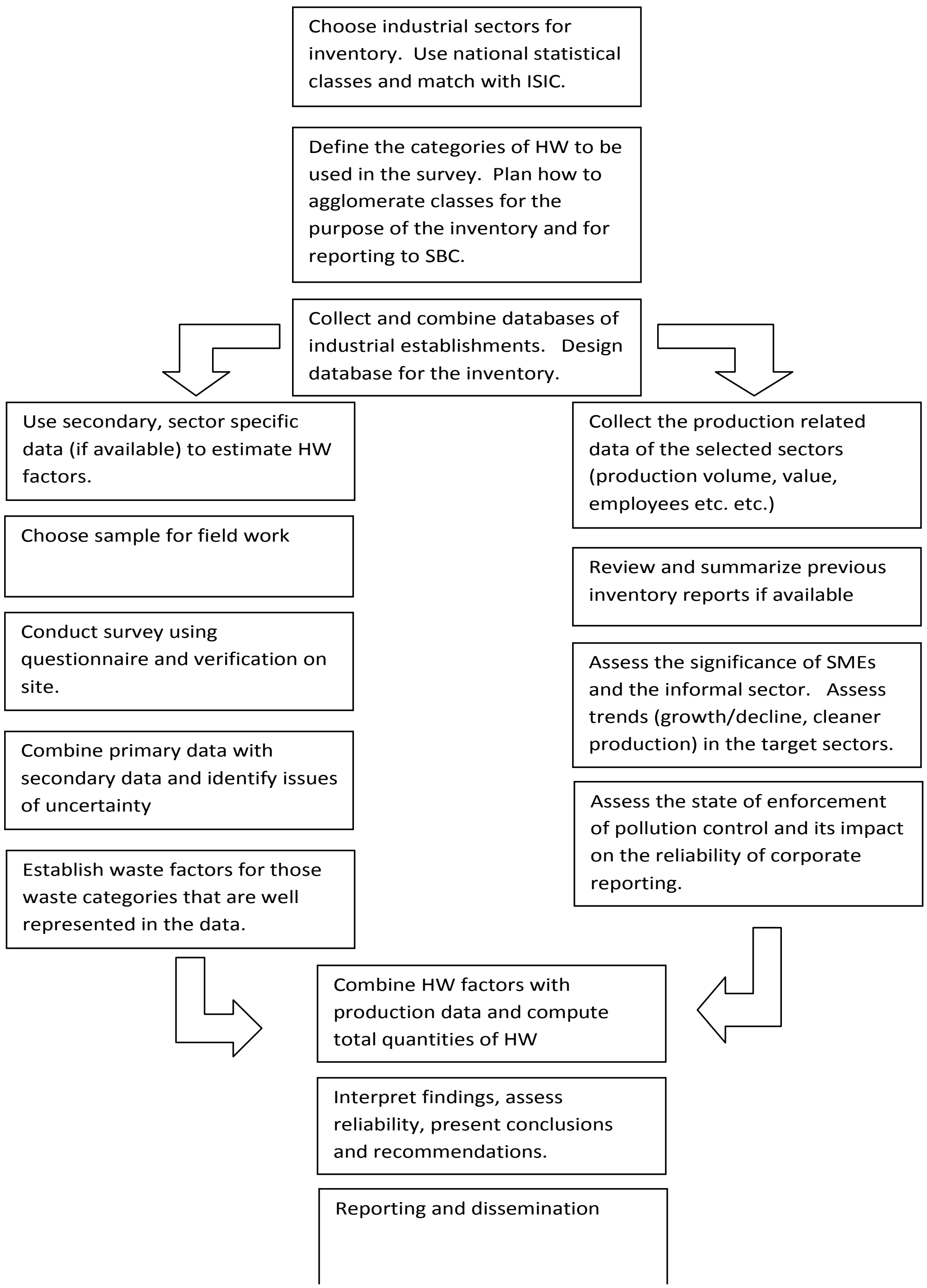
Hazardous wastes surveys commonly follow an evolutionary history of estimations that gradually become more and more detailed, analytical and reliable. The first generation of hazardous wastesinventories can be described as calculations based on statistics of industrial production multiplied by the specific waste generation of each sector or process. The first version of the BC methodological guide for hazardous wastesinventories introduced this method and it has been used in several countries and by some BCRCs. The methodology uses **waste factors** derived from field work and uses industrial statistics in interpolating the results from a sample of industrial establishments into national or sub-national estimates. The waste factors are usually based either on the **number of employees** or the **annual production rate** or the consumption of the main raw material input. Often it is easier to acquire the data on production capacity than the actual production rate. Information of the value of production may be more easily acquired than the mass of production, because the added value of various sectors can usually be found from national statistics. In the service sectors other units can be used (number of beds, production area etc.).

The waste factor i.e. the quantity of hazardous wastes generated per unit (employee, ton of product, net sales etc.) should be surveyed in a sample of companies from each target sector. The national inventory can then be computed by multiplying the waste factor with total number of units (of employees, production volume, value of production). In developing countries the figure that is most easily accessible is the number of employees, so this has been used in several case studies.

The road map for conducting such a survey project is presented in the figure 4[21].

[21] The diagram is partly based on the report of the BCRC SEA pilot project (AmbikA 2005).

Figure 4 Road map for 1st generation inventories of industrial hazardous wastes



As with any methodology, there are limitations to this one. The first problem is the variety of hazardous wastes generated in any industrial sector. If only the average for all wastes types is used in the waste factor, the results of the inventory cannot be used to assess the total quantities of different types of wastes to be managed (e.g. if organic and inorganic wastes are added up into one figure). Secondly, if waste factors need to be determined for every class of wastes generated in each industrial branch this means an enormous task. International databanks are not available for extracting waste factors, but some factors are can be found from national inventory reports. For example the Central Pollution Control Board (CPCB) of India has studied the petrochemical, dye, drugs & pharmaceutical and pesticide sectors and calculated hazardous waste factors for a long list of products and processes[22].

Case story 4

> *According to a study by CPCB India waste generation factors in the pesticide production vary between 1,5 kg and 436 kg of hazardous waste per ton of product. Using the waste factor derived from one process may give a mistake up to 290 fold if used for a company producing another pesticide.*

In the petrochemical industry the range of products and hazardous wastes is somewhat more limited. The following table 3 gives examples of hazardous waste factors derived from the survey in India. This table demonstrates the complexity of the classification of hazardous wastes even in one industrial branch and the huge variation of the emission factors. The overall estimate will depend heavily on the choices of agglomerating different waste categories for calculating the waste factor.

The PRTR global portal managed by the OECD provides a gateway to public national databases of pollutant releases from the major emission sources[23]. It includes information about disposal of wastes containing hazardous chemicals to landfills and transfers of hazardous wastes for recycling. The PRTR databases can be used in designing inventories to identify industrial sectors generating certain hazardous wastes classes (e.g. mercury containing wastes). Unfortunately the information about hazardous wastes is scarce compared to air emissions and the waste classification is not compatible with the BC typology. The European Pollutant Release and Transfer Register (E-PRTR) is an important example of PRTR information sources. The production rate is usually not available in the PRTR data so the specific waste generation can be calculated only if the production rate can be found from other sources. Another source of information about waste factors are the BAT-reference documents for specific industrial sectors produced by the European Integrated Pollution and Prevention Control Bureau.[24] These BAT documents provide an in-depth description of each industrial sector including some information about specific emissions. The information about specific waste

[22] CPCB, Central Pollution Control Board of India 2012.
[23] OECD, 2012.
[24] EIPPCB, 2012.

generation from selected processes is scarcer than for water and air emissions, but this is expected to be gradually improved.

Table 2 Examples of waste factors for some petrochemicals and plastic materials[25].

Product	Waste stream	waste factor (kg/t)
Xylene	spent clay	0.500
ethylene/propylene	oil soaked carbonaceous coke	0.017
	spent caustic	0.056
	spent palladium catalyst	0.007
Butadiene	butadiene polymer waste	0.058
	solvent regeneration residue	0.39
Benzene	spent nickel catalyst	0.025
	spent nickel molybdenum catalyst	0.0025
	spent cobalt molybdenum catalyst	0.007
Polypropylene	spent activated carbon	0.062
	spent activated alumina	0.007
	spent molecular sieve	0.031
	powder waste	3.93
	polymeric oil	1.10
vinyl chloride monomer and PVC	reactor waste	0.014
	EDC bottom viscous	3.59
	carbon waste	0.021
	surge pond sludge	0.43
	PVC wet resin	3.48
Acetone	distillation byproduct (tar waste)	7.83
Phenol	solvent waste	4.77

Case story 5

The BCRC for South-East Asia commissioned a demonstration project in the Philippines for conducting national hazardous wastes inventories[26]. This inventory focused on three major hazardous wastes streams: acids, alkalis and wastewater sludge from the chemicals industry, metal finishing industry (electroplating) and semi-conductor industry. Hazardous wastes factors were compiled from the annual reports of the regulated companies. Both kg/year/employee and kg/year/ton of production indicators were calculated. For electroplating and semiconductor industry the indicator kg/year per 1000 pieces of product was used.

The following problems were encountered in this first generation hazardous wastes inventory exercise:

[25] CPCB, Central Pollution Control Board of India,2002.

[26] AmbikA consultants, 2005.

- *The number of employees could mean the number of permanent employees or the total number of actually operating employees. The difference between the two choices can significantly affect the accuracy of the hazardous waste estimate factors*
- *Statistical calculations to determine a systematic correlation between the number of employees and the annual production quantities failed*
- *Some data on production capacity are expressed in quantity units per day and there is no information on the number of workdays in a week and the number of work week per year.*
- *Significant difference between production rate and production capacity.*
- *Some data on production quantity unit and waste stream generation unit may be incorrectly used or incorrectly written, e.g. weight unit is written as kg while actually intended as metric ton. Production is expressed as pieces or units, not tons.*
- *Variations of manufacturing process. Despite classified under the same group of manufacturing industrial sub-sector, different process technology and operations affect the generation of hazardous waste in terms of either type or quantities.*
- *There is also a high possibility that some companies do not monitor or record their hazardous waste streams generation.*

Waste factors from other countries should be used with caution, because many products can be produced using different processes with widely differing waste intensities. For this reason good practice is to use waste factors in national inventories only after conducting actual national fieldwork where waste factors are derived from real cases. A minimum of three establishments from each target industrial branch is recommended to reveal differences between company practices. The reliability of national waste factors will eventually grow if the regulated industry is obliged to report their specific waste generation in their annual reports.

Case story 6

In Finland the Waste Act was amended in 2011 by obliging all generators of hazardous wastes to perform book-keeping of the generated wastes including the calculation of the specific waste generation in relation to the volume of the activity. The ministry can give sector specific guidance on the calculation methods.

Case story 7

The Helsinki Regional Waste Management Authority in Finland has established a benchmarking service for various industrial and service sectors. The company can voluntarily upload its waste generation and compare its waste factor with the average of other companies in the sector.

When attempting to compile national waste factors for industrial waste it is advisable to limit the work to those industrial sectors where the number of plants is too large compared to the available resources to allow site visits to each of them. It is not practical to attempt to compute waste factors for every hazardous wastes type. It is more efficient to focus on the 3-5 main waste types in each sector. The classification of wastes should recognize the terminology used in the specific industry. Each waste type should also be classified using the national classification codes. The survey team should then translate these into BC waste codes.

There are alternative strategies that can lead step-wise to a national estimate of industrial hazardous wastes generation that can be reported to SBC. One strategy is to report the quantities of hazardous wastes streams that are received and reported by registered hazardous wastes disposal facilities. Another strategy is to conduct a field study in a limited geographical area and then extrapolate the national figures using waste factors as described in this chapter. A third approach is to focus on the relevant industrial sectors one at a time. The inventory can start with the major facilities and use waste factors derived from these to extrapolate the national figures. A sector specific approach generates more reliable waste factors than a geographical approach. A sector specific approach is more useful in building up the technical knowhow in the environmental administration by providing practical information about the range of waste streams and waste factors, good and bad practices and typical problems in each sector.

7. Inventories of the generation of other HoW streams

7.1. Introduction

In addition to the industry the following sectors of the national economy are typical sources of HoW:

Table 3 Other sectors generating HoW with examples

Sector	**Examples of** HoW
Mining	Tailings containing heavy metals or other hazardous constituents, mineral leaching or processing chemicals, drilling chemicals etc.
Transport sector	Used oils, brake fluids, cooling chemicals, batteries, used catalytic convertors, etc. Asbestos, corrosion prevention coatings from ships.
Energy sector	Fuel tank bottoms, PCB transformers and capacitors, boiler chemicals, asbestos insulation, some types of fly ash and slag etc
Cottage industry and the informal sector	Solvents, paints, pesticides, heavy metal waste etc. depending on the branch and raw material
Health care	Drugs, contagious biological waste, chemicals, mercury appliances, radioactive waste etc.
Agriculture, horticulture, animal husbandry	Obsolete or off-specs pesticides and fertilizers, their contaminated packages, drugs for animals etc
Households and service sector	cleaning chemicals, paint and solvent waste, drugs, batteries, e-waste, mercury lamps

The inventories of these special types of waste are usually performed as separate studies aiming to prepare specific interventions. Experiences from other countries can more often be applicable to such specific HoW types than to industrial inventories. Generation of HoW can in some cases be estimated quite well as desk work based on consumption, sales and import statistics. In this chapter methodological aspects of some of the specific HoW issues are highlighted.

7.2. E-waste

Waste of end-of-life electric and electronic appliances (e-waste) is one of the priority issues in implementing the Basel Convention because of the logarithmic growth of the generation of this waste.. Inventories of e-waste have been conducted by many of the Parties and BCRCs.

The BCRC for South-East Asia (BCRC-SEA) has published guidelines for conducting e-waste inventories[27]. The guide and its annexes provide useful information for conducting e-waste inventories, including product group specific waste factors. The contents of this guide will not be replicated here.

The quantity of e-waste generated from households in the EU countries has been estimated as 15 kg/capita per year. Of this amount about 50% or 7.5 kg consisted of large household appliances, 10% or 1.5 kg small household appliances, 20% or 3 kg ICT appliances and 20% or 3 kg other consumer electronic waste[28].

PCB containing capacitors and transformers is a special kind of e-waste. PCB waste is also covered by the Stockholm Convention. An example of an inventory of PCB containing waste streams is given in annex 2.

7.3. Waste mineral oil and oily wastes

Used mineral oil and other types of oily wastes (oily water, oily sludge, solid oily wastes such as oil filters) is a waste group that can be found in every country and is generated from numerous industrial and service sectors. It is one of the best candidates for early action, because the volumes are big, the disposal technology is fairly simple and there is opportunity for feasible business because of the value of oily wastes as fuel or reuse.

Used oil from the transport sector can be calculated based on waste factors specific to each vehicle type and national statistics of registered vehicles. The same can be applied to transformer oil. In developing countries, some used oils are recycled directly as lubricant in motor engines. The volatile hazardous constituents in the waste oil are transformed into air emissions.

Yilmaz (2006)[29] provides a demonstration of this methodology in his inventory from Turkey. He presented the following waste factors for vehicles:

[27] BCRC-SEA, 2007.
[28] Zoeteman, B.C.J., Krikke, H.R. & Venselaar, J. 2009.
[29] Özge, Y., 2006.

Table 4 Waste factors for used oil from vehicles

Type of vehicle	**waste factor (liter/yr/vehicle)**
personal car	4.25
Minibus	31.5
Bus	425
Truck	92.5
Tractor	31

BRCR-Bratislava has conducted a study of used lubricating oils in Bosnia-Herzegovina (2006)[30]. It demonstrates the elements of conducting the inventory and the use of inventory results in preparing a master plan for used oil management. They used an average of 18-20 kg for oil consumption per vehicle and assumed a 40% collection rate for engine oils and 75% for gear and hydraulic vehicle oils.
Oily wastewater generated from degreasing processes, oil separators from workshops etc. are more dependent on local practices and has to be studied using other methods of assessment. The demand for oily waste management depends on the practices and enforcement of pollution control of oil emissions to the sewer and discharges to the environment.

7.4. Household waste and residues from incineration

7.4.1. Household wastes in the context of the Basel Convention

In addition to hazardous wastes the Basel Convention also deals with "other wastes". Wastes that belong to any category contained in Annex II that are subject to trans-boundary movement shall be "other wastes" for the purposes of this Convention. Annex II lists wastes that are not classified as hazardous, but require "special consideration", namely:

- Y46 Wastes collected from households, and
- Y47 Residues arising from the incineration of household wastes.

These wastes are included in the annual reporting requirements of the Convention.

A challenge in determining which figures to report under Y46 and Y47 is that in many countries the solid waste statistics do not distinguish household waste from other municipal solid wastes (MSW from services, government institutions, schools, markets, green areas). The share of household waste in MSW varies greatly depending on the pattern of settlement and housing. In urban core areas the share of services and institutions is high. In semi-urban and rural areas the share of wastes from services is low. On the other hand in rural settlements much of the organic household waste is used as animal feed or as organic fertilizer.

[30] Bosna-S Consulting, 2006.

In most countries an estimate of household waste generation is available from other studies and can be used for the first generation inventory. Per capita waste factors from other countries can be used for computing rough estimates. The World Bank´s report, *"A Global Review of Solid Waste Management"* [31], provides useful consolidated data on MSW generation, collection, composition and disposal by country and by region. The report also makes projections on MSW generation and composition for 2025 in order for decision makers to prepare plans and budgets for solid waste management in the coming years. Municipal Solid Waste factors from The World Bank´s Report by region and by income level are listed in the following tables 5 and 6.

Table 5 Municipal solid waste generation by region in 2010

Region	MSW generation (kg/capita/day)
Africa	0,65
East Asia & Pacific	0,95
Eastern & Central Asia	1,1
Latin America & the Caribbean	1,1
Middle Asia & North America	1,1
OECD	2,2
South Asia	0,45

Table 6 Municipal solid waste generation by income level in 2010

Income Level	MSW generation (kg/capita/day)
High	2,1
Upper Middle	1,2
Lower Middle	0,79
Lower	0,60

Usually the reported quantity of MSW generation is based on the quantity that is actually collected.
An example of a field survey of household waste is given in annex 1.

7.4.2.Residues from the incineration of household waste

Residues from the incineration of household waste are relatively easy to quantify, because the number of commercial incinerators is usually limited in a country and they are usually under strict environmental control because of the major air pollution risks. The quantity of residues arising from the incineration of household waste can be calculated quite reliably by using waste factors, as the percentage of non-combustible material in waste is relatively constant.

[31] Hoornweg, D, Bhada-Tata, P., 2012.

The quantity of bottom ash or “slag” from MSW incineration in grate furnaces is between 20-30% of the quantity of waste feed and the quantity of fly ash is between 1 to 5% [32],[33], [34]. The percentage differs depending on the flue gas disposal method. Fly ash is in many cases mixed with the reaction products of dry or semidry flue gas disposal processes. Fly ash from incineration of MSW is usually classified nationally as hazardous waste because of the heavy metal content and the content of persistent organic pollutants. For the bottom ash the classification depends on the practices and efficiency of source separation and pre-treatment at the facility (e.g. magnetic separation of metals).

7.4.3. Hazardous wastes in household waste streams

The generation of household HoW is usually estimated based on the quantities actually collected at household waste designated collection points in industrialized countries. The typical waste factor for household HoW is in the range of 3…5 kg/capita/year. The share of actually collected HoW depends on the general environmental awareness and the service level of HoW reception. For example in Finland collection rates are about 4.5 kg/capita and 0.5 kg/capita remains in the mixed waste deposited on landfills[35].

Mercury lamps are one example of a hazardous waste stream typically found in municipal waste.

7.5. Medical waste

Clinical wastes from medical care in hospitals, medical centers and clinics are classified as Hazardous waste class Y1 in the BC annex I. It is important to recognize that clinical wastes are hazardous only if they possess one or more of the hazardous characteristics in Annex III. The hazard class specific to clinical waste is H6.2 Substances or wastes containing viable micro organisms or their toxins which are known or suspected to cause disease in animals or humans. It is not uncommon for first generation inventories to classify all waste generated in hospitals and clinics as hazardous. In fact if proper isolation of truly infectious patients and processes and proper waste segregation and packaging is conducted then only a small fraction of hospital waste is hazardous. Clinical waste not classified as hazardous waste can still be regulated with sector specific waste management standards and guidelines. For example human tissue is generally not hazardous wastes, but it should not be disposed of together with other organic wastes due to ethical and religious reasons. World Health Organization (WHO) estimates that 80% of the total waste generated by health-care activities is general waste and the remaining 20% may be infectious, toxic or radioactive[36]. Infectious and anatomic wastes represent up to 15% of total waste, sharps (needles etc.) represent about 1% and toxic wastes can contribute 3-4% of total waste. WHO estimated that high-income countries generate on average up to 0.5 kg

[32] Defra, 2007.
[33] Petrlik, J.M.S., Ryder R.A.,2005.
[34] World Bank, 1999.
[35] Helsinki Region Environmental Services Authority, 2007.
[36] WHO, 2012.

of hazardous waste per bed per day (180 kg/year/bed) and low-income countries generate 0.2 kg per day (70 kg/year/bed).

Infectious waste is typically waste contaminated with blood, microbiological cultures, discarded diagnostic samples, infected animals from laboratories and contaminated materials and equipment. Syringes can be an important vehicle of infection as they create a risk of injury and infection for hospital workers, cleaners, waste management workers and scavengers. Syringes may be deliberately reused without proper disinfection or by drug addicts.

Other hazardous waste generated in hospitals and clinics are:

- expired or unused drugs
- mutagenic or carcinogenic drugs (e.g. cytotoxic drugs for cancer treatment)
- radioactive waste such as glassware contaminated with radioactive diagnostic material or radiotherapeutic materials
- heavy metal waste such as broken mercury thermometers
- toxic laboratory chemicals, solvents etc.

Technical guidelines on the environmentally sound management of biomedical and healthcare wastes have been developed by the Conference of the Parties to the Basel Convention[37] WHO has also published guidance for the transport of infectious substances[38]. Indicative examples of infectious substances that are included in risk category UN 2814 are listed in annex 1 of this guide. Extremely dangerous pathogens such as *variola*, Ebola, Lassa and Marburg virus are listed in addition to laboratory cultures of other infectious diseases such as polio, rabies, yellow fever, HIV, hepatitis B, anthrax etc. Another list is provided for extremely infectious organisms affecting domestic animals.

The WHO guide on Safe management of wastes from health-care activities provides additional guidance on defining hazardous infections waste and managing it safely. Concentrated cultures of pathogens and contaminated sharps (particularly hypodermic needles) are probably the waste items that represent the most acute potential hazards to health[39].

Case story 8

The Helsinki University Hospital in Helsinki, Finland is a frontrunner in environmental management. Through effective waste prevention and segregation practices it had reached a

[37] See http://www.basel.int/TheConvention/Publications/TechnicalGuidelines/tabid/2362/Default.aspx
[38] WHO, 2007.
[39] WHO, 1999.

situation where only 6 % of the generated waste was classified as infectious or otherwise hazardous[40]*. The results of a case study from this hospital are presented in table 8.*

Table 7 Health care waste streams from a case study in Finland

Waste type	***ton/year***	***%***	***kg/bed***	***kg/employee***
Hazardous health care waste	*289*	*4*	*79*	*14*
Other hazardous waste	*139*	*2*	*38*	*7*
Recycled waste	*3548*	*51*	*966*	*174*
Non-hazardous waste for disposal	*3033*	*43*	*826*	*149*
TOTAL WASTE	*7009*	*100*	*1908*	*344*

7.6. Small scale industry and the informal sector

Small scale industry or so called cottage industry is a crucial part of the economy in most developing countries. It is very challenging to assess HoW generation from these enterprises, because often no public information is available of their generation. A high percentage of these workshops are unregistered, their raw materials, production and labor force fluctuate annually.

On the other hand inventories and interventions in the SME and informal sector are important as their HoW practices can be especially harmful because they are often located within residential areas and they don't have access or they cannot afford organized HoW services.

In first generation HoW inventories it is probably not realistic to target small scale industry because of the very high work input required. Waste factors derived from bigger companies may not be applicable to the small workshops. Often the informal sector plays a significant role in the disposal of hazardous waste. At some later stage it is feasible to launch separate surveys or campaigns for the inclusion of these enterprises. Providing easy access to HoW auditing, transport and disposal services and using financial incentives to reduce the cost of these services may be the only way to acquire real information of their HoW streams. Gradually also the small scale industry and workshops should be registered to facilitate data collection. It is good practice to implement this in a step-wise mode by designing the HoW licensing and reporting requirements so that they distinguish "small HoW generators" from large ones.

[40] Kaski, A.i, 2008.

7.7. Hazardous wastes from chemical spills and accidents

Contamination of soil and buildings caused by chemical spills or accidents can be a source of huge volumes of hazardous waste. Excavated soil and debris from such sites can constitute a high portion of the hazardous waste that needs disposal capacity so it is good practice to include available information about contaminated sites in HoW inventories. Quantitative data is based on site specific surveys and waste factors cannot be used to estimate HoW quantities. The volume of contaminated soil that requires off-site disposal is highly dependent on the national legislation and guidelines for site remediation and the site specific environmental and land use conditions.

In developing countries and countries with economies in transition storages of obsolete pesticides and abandoned industrial plants are typical sources of contaminated soil. Other examples of risk sectors are chemical wood preservation facilities, scrap yards, the waste recycling industry, oil and chemical storage sites, industrial dumping sites etc. Contaminated site surveys provide information for the HoW inventory regarding this waste type.

7.8. High volume low toxic wastes

Wastes that arise in massive quantities from large scale industry, mining or other large scale operations may require special attention in HoW inventories and HoW policy. In many cases such wastes can be classified either as hazardous waste or non-hazardous waste depending on the actual concentration of a minor but hazardous constituent. Thus it can belong to list A or the "mirror" list B of the Basel Convention depending on the case. Fly ash, phosphogypsum sludge, ore tailing waste, ferro-chrome sludge, lime sludge from paper mill, industrial sewage sludge and excavated contaminated soil are typical examples. If all such waste is classified as HoW "to be on the safe side" this interpretation can distort the conclusions of the inventory. Sector specific surveys are recommended to assess the range of hazardous concentrations. The national legal framework should clarify the threshold for such wastes to be considered as "hazardous" first.

Case story 9

> *A manual for conducting hazardous waste inventories for India recommended the exclusion of wastes with high volume and low effect wastes like fly-ash, red mud, phosphor-gypsum from the list of hazardous wastes was recommended. Instead specific guidelines for the management of each specific waste are proposed*[41].

[41] Verma N.K., 2009.

Case story 10

Yilmaz (2006)[42] collected hazardous wastes factors from literature for several industrial sectors including mining and applied them to a national hazardous wastes inventory in Turkey. Some examples of waste factors from mining of metal ores are presented in table 8. A wide fluctuation of annual production is common in the mining sector due to changes in the market price of metals.

Table 8 Waste generation factors for mining waste

Metal containing ore	*Tailing waste ton per ton of input of ore*	*Tailing waste ton per ton of end product*
Copper	*0.46*	*191.4*
Silver	*0.99*	*1568*
Gold	*0.46*	*752380*
Iron	*0.33*	*1.4*
Lead	*0.94*	*16*
Zinc	*0.89*	*8*

In some countries mining waste is excluded from the scope of the Waste Act regulation and is instead regulated by the Mining Act only.

[42] Özge, Y., 2006.

8. Hazardous waste audits and case studies

Waste auditing is one of the useful and reliable sources of waste data. Primary data for HoW inventories is often collected by conducting waste audits. By waste audit we mean systematic surveys in an individual waste generating facility, conducted by either an in-house team or a consultant team in cooperation with the management of the facility. A waste audit is normally commissioned by the company as a voluntary activity aiming at identifying opportunities for cost efficiency, waste minimization and pointing out risks of non-compliance and damage liabilities. The objective of a waste audit differs from a waste inspection that is conducted by authorized inspectors with the sole objective of verifying compliance and which may lead to sanctions for non-compliance. The systematic methodology of waste audits can be used also in waste inspections, but the scope of waste audits is wider because the latter is concerned of cost impacts in addition to environmental impacts.

Ideally, waste audits are part of integrated environmental audits, performed by either internal or external experts. Some basic principles of conducting HoW audits in individual industrial facilities are presented in this chapter. Waste prevention audits also follow these principles. The degree of detail in these audits can vary depending on the time and human resource allocation per site and the scope of the inventory (e.g. focusing on specified waste types only).

8.1 Basic information

The basic information gathered from each case includes location, ownership, year of establishment, industrial sector, main products and main raw materials, production rates, working days per year, number of workers and contact information. Annex 4 to this Guide can be used as a model for designing a template for collecting waste inventory data at an industrial plant level. It is to some extent based on the template used by BCRC-SEA in its pilot project[43]. The annex should be adapted to the specific scope of the inventory, avoiding too ambitious and complex information requirements.

Using of GIS equipment in registering the location of the facility is good practice. Taking photos of the establishment is also very useful if it is allowed by the company. Operating licenses, environmental permits and maps of the location are important sources of information.

8.2. Input-output balances

A simple flow chart of the industrial process should be requested or sketched with the company representatives.

For the main production steps rough mass balances are compiled. If some of the raw materials can be considered as waste this is recognized as a risk. It is essential to study wastewater discharges, because it is common that hazardous wastes are discharged deliberately into the sewer to avoid generating hazardous wastes in situations where the regulation and compliance monitoring of wastewater emissions is poor. Also

[43] Amar Binaya Karsa, Ambika Consultants, 2005.

this is understandable in countries where no services for hazardous wastes transport and disposal are available.

The hazardous chemicals used in each main process are listed (excluding minor use, for example if annual consumption is less than 200 liters). In classifying the hazardous chemicals The Globally Harmonized System (GHS) of Classification and Labeling of Chemicals is recommended. The GHS is a system for standardizing and harmonizing the classification and labeling of chemicals[44].

8.3. Waste data

The types of waste generated on a daily basis are listed based on interviews of the responsible plant manager. Verification from the company's own waste records and the waste transport and delivery reporting from the receivers of the waste is used if available. Companies implementing a formal environmental management system according to an internationally recognized standard such as ISO 14001 regularly monitor their waste generation so that they are usually more ready to provide reliable data.

Hazardousness of the wastes can be estimated based on the chemical safety fact sheets that should be available for every hazardous chemical regularly used in the factory. Waste quantities monitored in volumes (m^3 of waste containers multiplied by number of transports per year) are converted to metric tons using conversion factors if available, or by estimation. Providers of waste transport and disposal services often have a better knowledge of waste quantities than the plant managers.

In the next step it is important to interview the plant representatives about periodical or intermittent procedures that generate wastes. End of shift, end of batch, change of product, end of day or week clean-up operations are typical examples. Wastes arising from the auxiliary processes such as wastewater disposal, oil separator clean-up, flue-gas disposal and on-site waste management processes are often forgotten in superficial waste audits. Questions about obsolete chemicals, off-specs products and past chemical spills may give further hints of waste generation.

During the site tour observations are made on waste segregation, accumulated waste, dumping sites, storage of large numbers of chemical drums etc. Interviews of process workers, if allowed by the company management can reveal relevant practical issues and the general awareness level.

It is good practice to collect data of all wastes, not only hazardous waste, because the plant representative can provide wrong interpretations (unintentional or deliberate) about the classification of their waste.

8.4. Waste samples

In cases where the hazardousness of the waste is unclear or controversial it may be necessary to take and analyze waste samples. Taking of waste samples requires a trained person and adequate protective measures.

[44] UNECE, 2012.

The factors affecting the hazardous constituents of the waste must be understood when determining the time of sampling. Representative samples from waste piles should be composite samples consisting of at least 10 sub-samples. Environmental inspectors normally have the right to take waste samples as needed for ensuring compliance, but consultants need authorization and cooperation of the plant management.

Classification of a waste as hazardous is not only a matter of verifying the existence of a hazardous constituent. National standards on concentration limits for the relevant chemical elements and compounds are necessary to ensure clarity. Not only that, standards also needed for determining the ability of the toxic component to be released. Standard tests are used to simulate the potential of the hazardous constituent of a waste sample to be leached into water or acid or to be evaporated.

8.5. Access to plant specific information

The authority commissioning the inventory must take decisions regarding the means of obtaining information and the confidentiality of the data. A consultant team cannot access industrial establishments or acquire company specific information without the voluntary participation of the plant management. Lack of cooperation may prevent the task force to enter plants even if it would be crucial to the goals of the inventory. On the other hand, environmental inspectors normally do have the mandate to access sites where wastes or other emissions are generated. It is good practice to engage environmental inspectors in the inventory, because the ultimate goal of conducting inventories is to identify problems and to take action to ensure environmentally safe management of hazardous wastes. Inventories can promote interaction between consultants, authorities and industrialists and should lead to a learning process. Inventories very often reveal gaps in the existing legislations and official guidelines and standards.

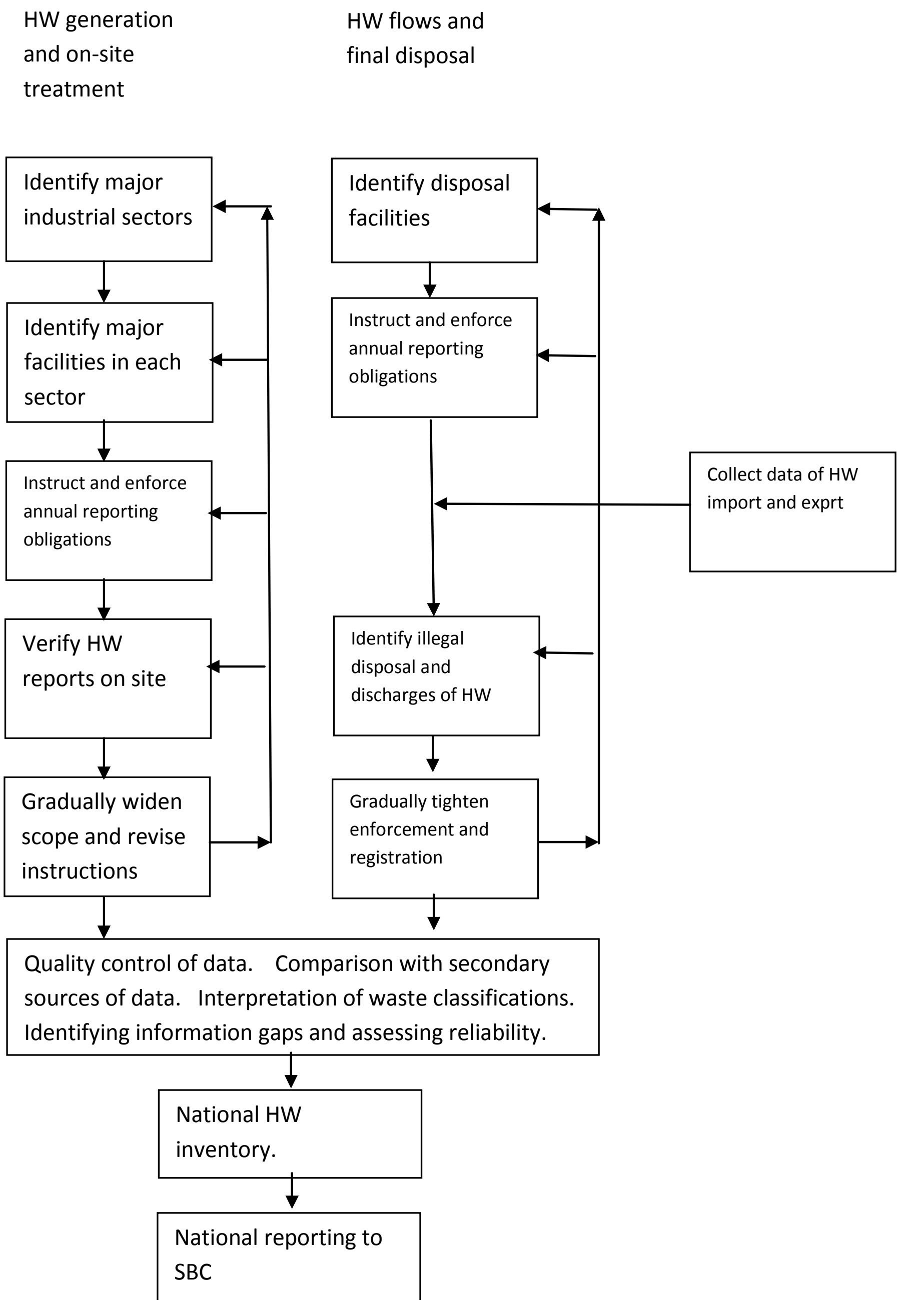
9. Inventories of HoW generation based on compliance monitoring

When compiling first generation HoW inventories the intention is to justify action and to identify priorities for HoW policy and to collect basic data for planning of HoW disposal investments. At this point HOW legislation may still be incomplete, the HOW infrastructure may be missing and institutional capacity is weak.

At a more advanced stage of implementing a HoW strategy the constellation should be turned around: HoW generators are registered, they are delivering their HoW waste to licensed disposal facilities and both the generating industry and the HoW disposal facilities are regularly reporting their HoW output and input to the regulating authority. In this setup inventories will be based on the annual reports of the waste generators with periodical verification by site inspections or by comparing output reports with input reports of the waste receiving facilities.

The transition from the first stage to the advanced stage is a long process; it may take ten to twenty years to establish a reliable system of inventories based on self-monitoring and compliance monitoring. The road map for conducting regularly updated HoW inventories is presented in figure 5.

Figure 5 Road map for 2nd generation HoW inventories



It is good practice to build this system in phases, starting from the biggest waste generators of the relevant industrial sectors and the disposal facilities. Gradually the compliance monitoring is extended to medium sized and finally to small waste generators. Industrial sectors can be classified into priority groups based on their environmental risks (e.g. red-amber-green).

For the sake of speeding up the transition and at the same time for fulfilling the reporting obligations of the Basel Convention it is possible to couple 1st and 2nd generation HoW inventories in the transition stage. In this approach the inspection resources are focused on one geographic location known to have a variation of industrial activities. Supported by *ad hoc* expert teams with project type funding all significant industrial establishments are inspected in this area, wastes are categorized and estimated, annual production and employment figures are collected and current waste management practices assessed. The outputs of this intervention are a relatively reliable inventory of wastes in this geographical area and a boost for the institutional capacity that can be disseminated to other administrative districts. But also the national HoW inventory can be built on this geographically limited data by extrapolating the result using rough waste factors such as the value of industrial production and number of industrial workers. The result is not very reliable because of differences in the distribution of different industrial sectors in different regions, but the result and the development impact is still likely to be better than from using only waste factors derived from other countries.

9.1. Challenges in inventories based on compliance monitoring

The obligation for book-keeping and submitting information to the authorities should be enacted in the waste legislation, not forgetting sanctions for negligence. The mandate for defining the details of reporting should be left to the regulating authority. It is important to balance reporting obligations with the actual capacity of the administration to handle the incoming reports. A multi-tiered approach is again recommended. Reporting forms should not be too ambitious and detailed if they are to be used in all industrial sectors and both large and small establishments. It is good practice to define different levels of obligations for “large generator” and “small generator”.

Case story 11

In the USA[45] *a generator is defined as a large quantity generator if:*

- *the generator generated in any single month 1,000 kg or more of hazardous waste; or*
- *the generator generated in any single month or accumulated at any time, 1 kg of so called* ***acute hazardous*** *waste; or*
- *the generator generated, or accumulated at any time, more than 100 kg of spill cleanup material contaminated with acute hazardous waste.*

Countries are increasingly turning towards electronic data management in environmental reporting. On-line registration of hazardous waste generators and reporting of annual hazardous waste generation can significantly increase the efficiency of compliance monitoring and allows many types of data searches that are not realistic in manual systems. It is important to recognize that computerized databases are as good as the data that is fed into the system. The coverage of the database of registered hazardous waste generators is one of the main bottlenecks. The quality and reliability of the reported data is the other main hurdle, because of the complexity of the definition and classification of hazardous waste.

[45] US EPA, 2010.

Electronic databases and on-line reporting will have their downsides. ICT experts need to interact efficiently with the waste experts. The database should be easily upgradable. Often the database plans are too ambitious and fail to be maintained. The database programs should be transparent and simple to manage by the administration itself after the demonstration and training phase without relying on costly external service. On-line connections in the country may be unreliable and data transmission too slow to provide reasonable service. Smaller companies may not have access to the internet.

Electronic reporting forms can alleviate data recording errors to some extent. Using menu bars with waste classes to select, providing links to explanation of terms and to additional guidelines and using alarms to indicate missing or illogical data can alleviate some of the quality assurance problems. For example the quantity of waste should not normally exceed the quantity of production in tons.

Case story 12

The hazardous waste inventory in the Philippines has been based on compliance monitoring since 2006. The following problems were encountered in compiling and using the hazardous waste database[46]:

- *Sharp increase or decrease in hazardous waste generation which may be attributed to error in encoding data with different units (tons instead of kilograms or pieces)*
- *Waste generated does not equal waste treated plus waste disposed plus waste stored*
- *Different interpretations of "treated" and "disposed"*
- *Present hazardous waste generation data does not reflect specific waste class but a lump sum of hazardous waste series.*

Data exchange between the environmental administration and the national bureau of statistics is crucial and can avoid duplication of information gathering and controversies between reported data.

Even if it will take years before the hazardous waste generator database has reached full coverage it is possible to use the incomplete database to extract waste factors and to compile national summaries by combining the primary data from the HoW database with statistical data on industrial production by sector. Also the HoW contribution of the small scale industry that may be excluded from the database can be estimated based on surveys of their market share. Year by year the reliability of the database will improve and the need for extrapolation and estimation will diminish.

Changes in the classification of wastes are a source of complications in hazardous waste databases as the data from previous years is no longer comparable with the figures after the new classification. Such events

[46] Ruiz, M.L.L.H , 2012.

are quite common due to changes in national or international guidelines. These must be observed when making conclusions on trends in the inventory results.

9.2. Challenges in quality control of hazardous waste databases

The number of registered hazardous waste generators in industrialized countries can easily be thousands or tens of thousands. It is obvious that it is not possible to verify all annual reports on site. It is still essential that site visits of a sample of establishments are regularly performed to maintain a threat for revealing fraud and for the quality control of the self-monitoring reports submitted by the regulated companies or their consultants.

The data reported by the hazardous waste generators should pass a quality control before being fed into the national database. Comparing the production figures with waste quantities can reveal errors in units. Comparison with the previous year’s figures can also reveal anomalies that need to be checked. Major deviations from sector specific waste factors and gaps in the reporting can be criteria for choosing targets for site visits.

Case story 13

> *A study in Finland[47] verified that there were data quality problems in the Finnish waste information system. Most of the exceptional peaks in the trend of selected hazardous waste groups were explained by errors in the classification or recording of the hazardous waste amounts reported by one or few individual companies. The data of some waste generators was recorded twice or even three times.*

A common problem in using the results from hazardous waste databases is the double-booking of waste flows received at registered waste treatment facilities. Many facilities act as pre-treatment sites, where the received batches of hazardous waste are collected, merged, sorted, crushed or compacted and then delivered for further resource recovery or disposal. Outputs from storage or pre-treatment facilities should not be reported as waste generated from this facility. .

[47] Lilja, R., Liukkonen S., 2008.

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ANNEX 1

CASE: HOUSEHOLD SURVEY AND WASTE CHARACTERISATION FOR NUKUHETULU, TONGA

This annex is a summary of a simple household waste inventory conducted in Tonga in 2007[49].

Methodology
The survey was a combined qualitative and quantitative data collection. It was carried out in the Tongan language. Face-to-face interviews and on-site weighing of waste by the survey team were the survey methods adopted. All answers and observations by the survey team were recorded immediately on the survey questionnaires. Most of the qualitative data collected was from the waste characterization component of the survey, generated through an on-site weighing of waste generated by each household. Each household was given empty 25-kg bags for waste collection, and instructions for classifying the waste for each (seven) day surveyed. All waste collected was emptied onto a tarpaulin sheet and weighed and recorded after confirming the type of waste (according to the classification table provided in the questionnaire).

All households in Nukuhetulu were surveyed, giving a response rate of 100% (391 people).
The data collected were entered and stored in an MS Excel spreadsheet for analysis and interpretation. A basic statistical program (used with MS Excel) was used for data analysis.
Percentages (both in the socioeconomic survey and waste quantities generated), were also calculated.

Results
The total quantity of waste being generated in Nukuhetulu daily is approximately half a ton (502.4 kg), which equals 183 tons annually. The generation rate was calculated to be **1.29 kg of waste produced per person per day**. Of 63 households in Nukuhetulu, 63% disposed of their waste by burning. About 20% disposed of their waste by throwing into the lagoon or the bush, and 16% buried their waste. Only 1% was recorded as recycling or reusing waste.

Conclusions
The half a ton of waste generated each day in Nukuhetulu is high and almost twice the quantity indicated by two previous studies conducted at the landfill site. The difference is most likely due to the high quantity of biodegradable garden and kitchen waste, however, much of which would not have been recorded by the earlier landfill-based.

The implication of the survey results for IWP is clear. There is a fair amount of organic rubbish that is disposed of by each household into the environment, including the lagoon and mangrove areas. The majority of households in Nukuhetulu disposed of their waste by burning, although it creates further environmental problems. Persistent organic pollutants (POPs) such as dioxin and furan are formed by incomplete combustion and burning of plastics; burning also produces methane, carbon monoxide and carbon dioxide. Recycling is not a common practice in Nukuhetulu, and households are probably unaware of recycling methods.

[49] Prescott, N., Palaki, A., Tongia, S. & Niu, L., 2007

ANNEX 2

CASE: PCB INVENTORY FROM ELECTRIC APPLIANCES

This annex is a summary of a study conducted in the Russian Federation in 2000[50]. In addition waste factors for estimating PCB loads in typical appliances are given based on guidance material published in the USA.

Methodology

To ensure maximum completeness and reliability in assessing the total amount of PCB, and preparing the inventory of PCB containing equipment and waste in Russia, two independent sources of data collection were employed. The first were the territorial environmental protection authorities (covering the 89 administrative territories of Russian Federation) which collected information on a regional basis and submitted this to the State Committee for Environmental Protection. The second source of information was data collected by relevant ministries from industrial enterprises located throughout Russia in which inventory activities were conducted.

These requests for information on production, use and storage of PCB, were sent to the following ministries and organizations connected with various industrial activities: the State Committee for Statistics, Ministry of Economy, Ministry of Fuel and Energy, Ministry of Defence, the electric power network and several other companies. The electric power sector in Russia is divided into a number of enterprises responsible for production of electricity and the distribution networks. These are again divided into both federal and regional levels of subordination. The electric power network consists of the 'Russian joint-stock company of joint electric energy systems' (RAO 'ES of Russia') and 76 regional energy systems, all of whom were sent the request for information on PCBs. For technical reasons, equipment with PCB is not used in electricity production (only transformers filled with mineral transformer oil are used in electricity production). In the distribution network, however, capacitors containing PCB are used. The following industrial branches (according to the State Committee for Statistics classification) were excluded as not being users of equipment containing significant amounts of PCB:

- Food industry;
- Light industry;
- Production of building materials.

The Ministry of Defence officially replied that it would not take part in the inventory of PCB or PCB containing equipment because PCB containing equipment and materials are not in use anymore. For this reason, the use and disposal of PCB in the military sector was not assessed in the present project. In the major industrial sectors: chemical and petro-chemical sector, ferrous and non-ferrous metallurgical industries, mechanical engineering, and timber (including pulp and paper) industry, some 300 enterprises, which may utilize high power capacitors and transformers were selected by the Ministry of Economy of the Russian Federation. The same number of enterprises was selected in the electric energy sector. According to the State Committee for Statistics, the number of large enterprises in Russia in 1997 was 265, and the total number of enterprises included in the inventory (600) is approximately twice this number.

As of December 1999, data were submitted by 79 administrative territories of the Russian Federation to the State Committee for Environmental Protection, and information for the inventory was supplied to the ministries by a total of 950 large- and medium-sized enterprises. This, according to expert estimation, covered approximately 80% of the total number of enterprises which may have PCB or PCB containing equipment. The inventory conducted by territorial environmental protection authorities incorporates information concerning presence of capacitors and transformers in all enterprises, also including the food industry, light industry and the building industry. (s. 3)

[50] AMAP, 2000.

Realization

The State Committee of the Russian Federation for Environmental Protection prepared and issued a "*Guide to conduct of the inventory of production, equipment and materials, using and containing PCB, and PCB-contaminated wastes in the territory of the Russian Federation*" for use by the territorial environmental protection authorities and experts in the various industries. This 'Guide' contained information on the basic physic-chemical and toxic properties of PCBs, trademarks of PCB-containing materials manufactured in the former USSR, fields of use of PCB, and also possible items and materials containing PCB. This information facilitated identification of PCB and PCB-containing equipment for inclusion in the responses to the distributed questionnaire. Official information submitted by governmental and economic organizations at federal and regional levels was used during project implementation. The complete project was subdivided into 6 tasks covering:

1. Information on production of PCB;
2. Information on production of PCB-containing equipment;
3. Information on use of PCB-containing equipment;
4. Information on PCB-contaminated industrial waste;
5. Information on releases of PCB from industrial waste;
6. Recommendations. (s. 3-4)

Data were collected by employees of the relevant ministries and territorial environmental protection authorities. Data were then submitted to the State Committee of the Russian Federation for Environmental Protection, for processing by the Russian experts group that was established by order of the State Committee to carry out the project. The Center for International Projects of the State Committee of the Russian Federation for Environmental Protection (CIP) provided logistical support and prepared the reporting documentation for each task. This documentation was then submitted to the AMAP Secretariat and to the project International Steering Group for review and eventual approval.

Use of PCB-containing equipment

The questionnaires returned from industries where equipment containing PCB is used, included information on the numbers of transformers and capacitors (the major PCB sources) in use or held in reserve at the enterprises. From industrial enterprises 167 responses were received as of December 1999 (56% return of the distributed questionnaires). According to this information base, the amount of transformer and capacitor PCB fluids totals some 11,700 tons. The responses from the energy and fuel sectors (168 responses, 56% return) showed that the energy network accounts for the major part of the PCB containing equipment, and the major amount of PCB. The total amount of PCB contained in equipment in use or in reserve in the fuel and electric energy enterprises is approximately 3,140 tons, of which only approximately 100 tons is in the coal and petroleum industries. As of December 1999, data had been submitted from 79 of the 89 territorial environmental protection authorities (ca. 90% response rate). Of these, 19 answered that no PCB containing equipment was used in their regions. This concerned primarily the Siberian regions. The information received from the territorial environmental protection authorities includes additional data from smaller enterprises and non-industrial uses, which are not taken into account in the industrial sector based inventories. These uses add some 6,700 tons PCB.

Transformers and capacitors

The amount of PCB in transformers (if not stated explicitly in the questionnaire response) was estimated from data obtained from the Chirchik transformer plant. **Ten types of PCB containing transformers were produced with a Sovtol[*)] content ranging from 160 to 2,980 kg**. The average amount (1,746 kg) was used to estimate PCB contained in transformers. An average amount of PCB in capacitors was estimated from questionnaire responses where this information was provided. These **capacitors had an average TCB[*)] content of 17.2 kg**. This value was used to estimate TCB in capacitors in cases where questionnaire response only included information on the number of capacitors held.

Combined results

According to results of the inventory of PCB in PCB-containing equipment in the territory of Russia, the total amount of PCB was 20,000 tons (see Table 2). The identified PCB, in PCB-containing equipment, is

equivalent to about 11% of the total PCB production of the former USSR and the Russian Federation that took place between 1939 and 1993 (when production ceased).
When the identified PCB in PCB-containing equipment is grouped according to regional distribution, a non-uniform distribution is observed. The largest amounts of PCB are located in the North-, Central-, Volga- and Ural regions; these regions account for approximately 65% of the total identified amount of PCB in Russia.

*) Three brand-names in PCB production:

- Sovol: A mixture of tetra- and pentachlorinated PCBs (used as a plasticizer in paints and varnishes);
- **Sovtol**: Sovol mixed with 1,2,4 trichlorobenzene; especially in the ratio 9:1, named Sovtol-10 (**used in transformers**);
- Trichlorobiphenyl (**TCB**): Mixed isomers of trichlorobiphenyl **(used in capacitors**).

Guidance on calculating PCB loads in typical appliances[51]

Transformers
PCB Transformer means any transformer that contains 500 ppm PCBs in the dielectric fluid. PCB-Contaminated Transformer means a transformer containing a concentration of PCBs in the range of 50 ppm and < 500 ppm PCBs**.** PCB Contaminated Transformer is a subset of PCB Contaminated Electrical Equipment.

Capacitors
Capacitor means a device for accumulating and holding an electrical charge and consists of conducting surfaces separated by a dielectric. The PCB concentration and size of the capacitor determine which regulations apply. The provisions at 40 CFR 761.2(a)(4) specify the following assumptions about PCB concentration if the PCB concentration has not been tested or documentation from the manufacturer is lacking:

- You must assume PCBs 500 ppm in a capacitor of unknown concentration made prior to July 2, 1979, or whose date of manufacture and concentration are unknown. (s. 2-3)
- You may assume PCBs < 50 ppm in a capacitor made after July 2, 1979 (i.e., a non-PCB capacitor).
- You may assume a capacitor is non-PCB if it is marked “No PCBs” at the time of manufacture.

PCB Capacitor means any capacitor that contains 500 ppm PCBs. A PCB capacitor, as opposed to a PCB Capacitor, is a capacitor with detectable PCBs.

Small capacitor means a capacitor which contains less than 1.36 kg (3 lbs) of dielectric fluid. If the weight of dielectric fluid is unknown, use Exhibit 2-4 to determine the size of a capacitor. **A large capacitor is a capacitor which contains 1.36 kg (3 lbs) or more of dielectric fluid**.

PCB-Contaminated Electrical Equipment
PCB-Contaminated Electrical Equipment means any electrical equipment (such as transformers, capacitors, and circuit breakers, including those in railroad locomotives and self-propelled cars) which contains 50 ppm and < 500 ppm PCBs in the dielectric fluid. In the less frequently encountered case of dry electrical equipment, the electrical equipment is PCB-Contaminated if it has PCBs > 10 fg/100 cm2 and < 100 fg/100 cm2 as measured by a standard wipe test.

[51] US EPA, 1999.

Annex 3

Annex I wastes		Examples of potentially hazardous waste streams from various sources
Y1	Clinical wastes from medical care in hospitals, medical centers and clinics	Waste contaminated with blood and other body fluids; laboratory cultures and microbiological stocks; waste including excreta and other materials that have been in contact with patients infected with highly infectious diseases. Human pathological waste, including tissues, organs, and body parts and body fluids that are removed during surgery or autopsy, or other medical procedures, and specimens of body fluids and their containers. Sharps that have been used in patient care or treatment, including hypodermic needles, syringes, Pasteur pipettes, scalpel blades, blood vials, needles with attached tubing, and culture dishes. Pharmaceuticals that are expired or no longer needed; items contaminated by or containing pharmaceuticals. Cytotoxic waste containing substances with genotoxic properties (for example, waste containing cytostatic drugs; genotoxic chemicals). Waste containing chemical substances such as laboratory reagents; film developer; disinfectants that are expired or no longer needed; solvents (for example methanol, acetone, and methylene chloride); waste with high content of heavy metals, such as batteries; broken thermometers and blood-pressure gauges.
Y2	Wastes from the production and preparation of pharmaceutical products	Off-specification or obsolete raw materials or products. Spent separation and purification solvents (for example, methanol, toluene, hexanes, acetone, etc.). Still bottoms and reaction residues (solvents, catalysts, and reactants; for example, benzene, chloroform, methylene chloride, toluene, methanol, ethylene glycol, methyl isobutyl ketone, xylenes, hydrochloric acid, etc.). Used filter media. Used chemical reagents. Dusts from filtration or air pollution control equipment. Raw material packaging wastes. Laboratory wastes. Spills, as well as wastes generated during packaging of the formulated product. Equipment cleaning washing liquids and mother liquors. Sludges from on-site wastewater treatment. Filter cakes from fermentation processes.
Y3	Waste pharmaceuticals, drugs and medicines	Potential hazardous waste pharmaceuticals include prescription drugs, chemotherapy agents (including cytotoxic, antineoplastic and cytostatic waste), controlled substances or over the counter items that are either expired, damaged or otherwise not usable for their intended purpose.
Y4	Wastes from the production, formulation and use of biocides and	Equipment washing liquids (aqueous or solvent) and mother liquors. Still bottoms and reaction residues. Filter cakes and spent absorbents. Sludges from on-site wastewater treatment.

Annex I wastes		Examples of potentially hazardous waste streams from various sources
	phytopharmaceuticals	Containers and container liners potentially contaminated with biocides and phytopharmaceuticals. Off-specification products. Dust collected from emission control equipment, and product spills. Contaminated laboratory equipment and protective workers clothing.
Y5	Wastes from the manufacture, formulation and use of wood preserving chemicals	Equipment washing liquids and mother liquors. Still bottoms and reaction residues. Filter cakes and spent absorbents. Sludges from on-site wastewater treatment. Containers and container liners potentially contaminated with chemicals. Off-specification products. Wastewaters, process residuals, preservative drippage, and spent formulations from wood preserving processes at facilities that use chlorophenolic formulations, creosote formulations, and inorganic preservatives containing arsenic or chromium.
Y6	Wastes from the production, formulation and use of organic solvents	Degreasing wastes containing solvents from the leather and fur industry. Cloth finishing wastes from the textile industry (halogenated solvents, usually perchloroethylene, is used in the scouring of fabrics and yarns). Washing liquids (halogenated and non-halogenated organic solvents) and mother liquors from organic chemical processes (manufacture of: basic organic chemicals; plastics, synthetic rubber and man-made fibres; organic dyes and pigments; organic plant protection products, wood preserving agents and other biocides; pharmaceuticals; fats, grease, soaps, detergents, disinfectants and cosmetics). Wastes from the manufacture, formulation and use of paint, varnish and ink (solvents used include hexane, cyclohexane, toluene and xylene). Waste paint or varnish remover (often contains dichloromethane). Waste adhesives and sealants containing organic solvents. Solvent-based developer solutions from the photographic industry. Waste crack-indicating agent from casting of ferrous pieces. Degreasing wastes from chemical surface treatment and coating of metals and other materials. Perchloroethylene wastes from dry cleaning facilities (cooked powder residues, still bottom residues, spent cartridges, and button/lint trap wastes). Wastes from solvent recovery.
Y7	Wastes from heat treatment and tempering operations containing cyanides	Spent cyanide solutions, quenching bath residues from oil baths and quenching wastewater treatment sludges from metal heat treating operations where cyanides are used in the process.
Y8	Waste mineral oils unfit for their originally	Waste engine, gear and lubricating oils. Waste insulating and heat transmission oils. Waste hydraulic oils. Mineral oil based

Annex I wastes		Examples of potentially hazardous waste streams from various sources
	intended use	brake fluid. Oil filters.
Y9	Waste oils/water, hydrocarbons/water mixtures, emulsions	Bilge oils. Oil, oily water and sludges from oil/water separators. Vehicle washwaters. Boiler blowdown sludge. Cooling tower washwaters. Cutting oils, soluble oils.
Y10	Waste substances and articles containing or contaminated with polychlorinated biphenyls (PCBs) and/or polychlorinated terphenyls (PCTs) and/or polybrominated biphenyls (PBBs)	Waste components containing PCBs from dismantling of end-of-life vehicles and vehicle maintenance. Transformers, capacitors and discarded equipment containing or contaminated by PCBs. Construction and demolition wastes containing PCB-containing sealants, resin-based floorings, or sealed glazing units. Waste hydraulic, insulating or heat transmission oils containing PCBs.
Y11	Waste tarry residues arising from refining, distillation and any pyrolytic treatment	Waste tarry residues.
Y12	Wastes from production, formulation and use of inks, dyes, pigments, paints, lacquers, varnish	Sludges, waste paint and varnish containing organic solvents (solvents used include hexane, cyclohexane, toluene and xylene), potentially hazardous metals (antimony, cadmium, chromium, lead, zinc) in the pigments or other dangerous substances. Waste paint or varnish remover (often contains dichloromethane). Waste printing toner. Waste etching solutions. Disperse oil. Waste isocyanates from the production of polyurethane paints. Waste ink and solvents from printing processes.
Y13	Wastes from production, formulation and use of resins, latex, plasticizers, glues/adhesives	Sludges, waste adhesives and sealants containing organic solvents or other dangerous substances (for example, urea formaldehyde resin)
Y14	Waste chemical substances arising from research and development or teaching activities which are not identified and/or are new and whose effects on man and/or the environment are not known	Laboratory chemicals, consisting of or containing dangerous substances, including mixtures of laboratory chemicals. Discarded chemicals consisting of or containing dangerous substances.

Annex I wastes		Examples of potentially hazardous waste streams from various sources
Y15	Wastes of an explosive nature not subject to other legislation	Wastes that contain, consist of or are contaminated with organic peroxides. Nitrocellulose waste. Picric acid waste from histology and forensic laboratories.
Y16	Wastes from production, formulation and use of photographic chemicals and processing materials	Water-based developer and activator solutions. Water-based offset plate developer solutions. Solvent-based developer solutions. Fixer solutions. Bleach solutions and bleach fixer solutions. Wastes from on-site treatment of photographic wastes.
Y17	Wastes resulting from surface treatment of metals and plastics	Pickling acids and bases. Phosphatizing sludges. Saturated or spent ion exchange resins. Sludges and filter cakes, aqueous rinsing liquids and degreasing wastes containing dangerous substances. Eluate and sludges from membrane systems or ion exchange systems containing dangerous substances. Sludges and solids from tempering processes. Wastes from hot galvanizing processes. Sludges, machining oils and emulsions from shaping and physical and mechanical surface treatment of metals and plastics. Spent waxes and fats. Spent grinding bodies, grinding materials and waste blasting material containing dangerous substances. Aqueous washing liquids. Steam degreasing wastes.
Y18	Residues arising from industrial waste disposal operations	Slag, ashes and gas cleaning wastes from incineration or pyrolysis of waste. Wastes from physico/chemical treatments of hazardous waste (for example, dechromatation, decyanidation, neutralisation). Solidified or partly stabilized hazardous wastes. Fly ash and other flue-gas treatment wastes from vitrification. Wastes from shredding of metal-containing wastes. Wastes from oil regeneration (spent filter clays, acid tars, aqueous liquid wastes, wastes from cleaning of fuel with bases, wastes from flue-gas cleaning). Wastes from the mechanical treatment of hazardous waste (for example sorting, crushing, compacting, pelletizing). Saturated or spent ion exchange resins. Grease and oil mixture from oil/water separation.
Y19	Metal carbonyls	Wastes from nickel ore refining using nickel carbonyl as intermediate.
Y20	Beryllium; beryllium	Discarded beryllium powder, container residue and spill residue. Beryllium sulfate is used primarily for the production

Annex I wastes		Examples of potentially hazardous waste streams from various sources
	compounds	of beryllium oxide powder for ceramics.
Y21	Hexavalent chromium compounds	Wastes from hot galvanizing processes. Spent catalysts. Wastewater treatment sludges from electroplating operations. Wastewater treatment sludges from the chemical conversion coating of aluminum. Wastewaters, process residuals, preservative drippage, and spent formulations from wood preserving processes. Wastewater treatment sludge from the production of inorganic pigments (chrome yellow and orange pigments, molybdate orange pigments, zinc yellow pigments, chrome green pigments, chrome oxide green pigments, and iron blue pigments). Oven residue from the production of chrome oxide green pigments. Waste paint, varnish and ink containing potentially hazardous metals in the pigments (for example, lead chromate, strontium chromate). Wastes from manufacture of coloring glass and glass products. Glazing wastes from manufacture of ceramic goods, bricks, tiles and construction products.
Y22	Copper compounds	Wastes from physical and chemical processing of metalliferous and non-metalliferous minerals. Gas cleaning wastes from copper thermal metallurgy. Wastes from copper hydrometallurgical processes. Glazing wastes from manufacture of ceramic goods, bricks, tiles and construction products. Wastes from the manufacture, formulation, supply and use of salts and their solutions and metallic oxides. Waste etching solutions from the manufacture, formulation, supply and use of printing inks. Wastes from chemical surface treatment and coating of metals and other materials. Sludges and gas cleaning wastes from power stations and other combustion plants. Batteries and accumulators. Spent catalysts. Wastes from incineration or pyrolysis of waste. Wastes from vitrification of waste. Membrane system waste from wastewater treatment plants. Wastes from shredding of metal-containing wastes. Wastewaters, process residuals, preservative drippage, and spent formulations from wood preserving processes.
Y23	Zinc compounds	Wastes from physical and chemical processing of metalliferous and non-metalliferous minerals. Glazing wastes from manufacture of ceramic goods, bricks, tiles and construction products. Wastes from the manufacture, formulation, supply and use of salts and their solutions and metallic oxides. Sludges and gas cleaning wastes from power stations and other combustion plants. Wastes from chemical surface treatment and coating of metals and other materials. Spent catalysts. Wastes from incineration or pyrolysis of waste. Wastes from

Annex I wastes		Examples of potentially hazardous waste streams from various sources
		vitrification of waste. Membrane system waste from wastewater treatment plants. Wastes from shredding of metal-containing wastes. Aqueous washing liquids and mother liquors from the manufacture of pharmaceuticals. Waste paint, varnish and ink containing potentially hazardous metals in the pigments. Wastes from zinc and other non-ferrous thermal metallurgy. Sludges from zinc hydrometallurgy (including jarosite, goethite). Wastes from hot galvanizing processes.
Y24	Arsenic; arsenic compounds	Wastes from physical and chemical processing of metalliferous and non-metalliferous minerals. Glazing wastes from manufacture of ceramic goods, bricks, tiles and construction products. Wastes from the manufacture, formulation, supply and use of salts and their solutions and metallic oxides. Sludges and gas cleaning wastes from power stations and other combustion plants. Wastes from chemical surface treatment and coating of metals and other materials. Batteries and accumulators. Wastes from incineration or pyrolysis of waste. Wastes from vitrification of waste. Membrane system waste from wastewater treatment plants. Wastes from shredding of metal-containing wastes. Wastes from lead, zinc and other non-ferrous thermal metallurgy. Wastewaters, process residuals, preservative drippage, and spent formulations from wood preserving processes. Spent catalysts. Antimony oxide production wastes
Y25	Selenium; selenium compounds	Coal combustion residues (fly ash, bottom ash, coal slag, and flue gas desulfurization residue).
Y26	Cadmium; cadmium compounds	Wastes from physical and chemical processing of metalliferous and non-metalliferous minerals. Wastes from manufacture of coloring glass and glass products. Glazing wastes from manufacture of ceramic goods, bricks, tiles and construction products. Wastes from the manufacture, formulation, supply and use of salts and their solutions and metallic oxides. Sludges and gas cleaning wastes from power stations and other combustion plants. Wastes from chemical surface treatment and coating of metals and other materials. Batteries and accumulators. Wastes from incineration or pyrolysis of waste. Wastes from vitrification of waste. Membrane system waste from wastewater treatment plants. Wastes from shredding of metal-containing wastes. Waste paint, varnish and ink containing potentially hazardous metals in the pigments. Wastes from lead, zinc and other non-ferrous thermal

Annex I wastes		Examples of potentially hazardous waste streams from various sources
		metallurgy. Wastes from on-site treatment of photographic wastes.
Y27	Antimony; antimony compounds	Wastes from physical and chemical processing of metalliferous and non-metalliferous minerals. Wastes from the manufacture, formulation, supply and use of salts and their solutions and metallic oxides. Metal-containing wastes from inorganic chemical processes. Waste paint, varnish and ink containing potentially hazardous metals in the pigments (for example, antimony trioxide). Discarded electrical and electronic equipment. Sludges and gas cleaning wastes from power stations and other combustion plants. Oil and tar containing wastes from non-ferrous thermal metallurgy. Glazing wastes from manufacture of ceramic goods, bricks, tiles and construction products. Batteries and accumulators. Spent catalysts (for example from fluoromethanes production). Wastes from incineration or pyrolysis of waste. Wastes from vitrification of waste. Membrane system waste from wastewater treatment plants. Wastes from shredding of metal-containing wastes. Antimony oxide production wastes. Purification solids, bag house dust and floor sweepings from the production of dithiocarbamate acids and their salts.
Y28	Tellurium; tellurium compounds	Wastes from physical and chemical processing of metalliferous and non-metalliferous minerals. Wastes from the manufacture, formulation, supply and use of salts and their solutions and metallic oxides. Sludges and gas cleaning wastes from power stations and other combustion plants. Wastes from incineration or pyrolysis of waste. Wastes from vitrification of waste. Membrane system waste from wastewater treatment plants. Wastes from shredding of metal-containing wastes. Wastes from non-ferrous thermal metallurgy. Spent catalysts.
Y29	Mercury; mercury compounds	Wastes from physical and chemical processing of metalliferous and non-metalliferous minerals. Wastes from the manufacture, formulation, supply and use of salts and their solutions and metallic oxides. Sludges and gas cleaning wastes from power stations and other combustion plants. Batteries and accumulators. Wastes from incineration or pyrolysis of waste. Wastes from vitrification of waste. Membrane system waste from wastewater treatment plants. Wastes from shredding of metal-containing wastes. Wastes from non-ferrous thermal metallurgy. Wastes from natural gas purification. Barium sulphate sludge from halogen chemical processes. Gas cleaning waste from crematoria. Mercury switches. Amalgam waste

Annex I wastes		Examples of potentially hazardous waste streams from various sources
		from dental care. Fluorescent tubes.
Y30	Thallium; thallium compounds	Wastes from the production of titanium dioxide using the chloride-ilmenite process. Wastes from the manufacture of thallium-based high-temperature superconductors. Wastes from the processing of sulfide-bearing mineral deposits.
Y31	Lead; lead compounds	Batteries and accumulators. Wastes from physical and chemical processing of metalliferous and non-metalliferous minerals. Waste paint, varnish and ink containing potentially hazardous metals in the pigments (for example, lead chromate). Glazing wastes from manufacture of ceramic goods, bricks, tiles and construction products. Wastes from the manufacture, formulation, supply and use of salts and their solutions and metallic oxides. Fly ash, sludges and gas cleaning wastes from power stations and other combustion plants. Gas cleaning wastes from copper thermal metallurgy. Wastes from chemical surface treatment and coating of metals and other materials. Wastes from incineration or pyrolysis of waste. Wastes from vitrification of waste. Membrane system waste from wastewater treatment plants. Wastes from shredding of metal-containing wastes. Wastes from lead, zinc and other non-ferrous thermal metallurgy. Spent catalysts. Wastes from on-site treatment of photographic wastes. Cathode ray tubes. Antimony oxide production wastes.
Y32	Inorganic fluorine compounds excluding calcium fluoride	Wastewater sludge from semiconductor plants.
Y33	Inorganic cyanides	Wastewater treatment sludges from electroplating operations. Spent cyanide plating bath solutions from electroplating operations. Plating bath residues, and spent stripping and cleaning bath solutions from the bottom of plating baths from electroplating operations where cyanides are used in the process. Spent cyanide solutions from salt bath pot cleaning from metal heat treating operations. Quenching bath residues from oil baths, and quenching wastewater treatment sludges from metal heat treating operations where cyanides are used in the process. Wastewater treatment sludge from the production of iron blue pigments.
Y34	Acidic solutions or acids in solid form	Acetic Acid. Chromic Acid. Hydrobromic Acid. Hydrochloric Acid. Hydrofluoric Acid. Nitric Acid. Perchloric Acid. Phosphoric Acid. Sulfuric Acid. Pickle liquor.

Annex I wastes		Examples of potentially hazardous waste streams from various sources
Y35	Basic solutions or bases in solid form	Potassium Hydroxide. Sodium Hydroxide. Ammonium Hydroxide. Alkaline cleaners.
Y36	Asbestos (dust and fibres)	Wastes containing asbestos from the manufacture of chlorine. Wastes from asbestos-cement manufacture containing asbestos. Metallic waste packaging containing asbestos. Brake pads containing asbestos. Discarded electrical and electronic equipment containing free asbestos. Insulation materials and asbestos-containing construction materials. Wastes from shredding of metal-containing wastes.
Y37	Organic phosphorus compounds	Waste of organophosphorous pesticides, including: azinphos methyl; bolstar; chlorpyrifos; coumaphos; demeton-O; demeton-S; diazinon; dichlorous, disulfoton; ethoprop; fensulfothion; fenthion; merphos; mevinphos; parathion methyl; phorate; ronnel; stirophos (tetrachloryinphos); tokuthion (prothiofos); trichloronate.
Y38	Organic cyanides	Spent pot linings from aluminium smelting containing inorganic cyanides. Aqueous and aqueous-alcoholic acetonitrile wastes from liquid chromatography. Wastes from the production of acrylonitrile.
Y39	Phenols; phenol compounds including chlorophenols	Wastes from cleaning of fuels with bases (from petroleum refining). Wastes from the production of or manufacturing use of tri- or tetrachlorophenol, or of intermediates used to produce their pesticide derivatives. Wastes from the production of materials on equipment previously used for the production or manufacturing use of tri-and tetrachlorophenols. Separated aqueous stream from the reactor product washing step in the production of chlorobenzene. Waste from the production or manufacturing use of pentachlorophenol, or of intermediates used to produce its derivatives. Discarded formulations containing tri-, tetra-, pentachlorophenol or compounds derived from these chlorophenols. Residues resulting from the incineration or thermal treatment of soil contaminated with tri-, tetra-, or pentachlorophenol. Bottom sediment sludge from the treatment of wastewaters from wood preserving processes that use creosote and/or pentachlorophenol.
Y40	Ethers	Brake fluids. Wastes from the production of or manufacturing use of tri- or tetrachlorophenol, or of intermediates used to produce their pesticide derivatives. Wastes from the production of materials on equipment previously used for the production or manufacturing useof tri-and tetrachlorophenols. Discarded unused formulations containing tri-, tetra- or pentachlorophenol

Annex I wastes		Examples of potentially hazardous waste streams from various sources
		or discarded unused formulation containing compounds derived from these chlorophenols. Still bottoms from the purification column in the production of epichlorohydrin.
Y41	Halogenated organic solvents	Solvent degreasers, vapor degreasers, dry cleaning solvents, brake cleaners, paint removers. Spent halogenated solvents: tetrachloroethylene, trichloroethylene, methylene chloride, 1,1,1-trichloroethane, carbon tetrachloride, chlorinated fluorocarbons, chlorobenzene, 1,1,2-trichloro-1,2,2-trifluoroethane, ortho-dichlorobenzene, trichlorofluoromethane, and 1,1,2-trichloroethane. Still bottoms from the recovery of these spent solvents and spent solvent mixtures.
Y42	Organic solvents excluding halogenated solvents	Paint thinners, lacquer thinners, alcohol cleaners. Spent non-halogenated solvents: xylene, acetone, ethyl acetate, ethyl benzene, ethyl ether, methyl isobutyl ketone, n-butyl alcohol, cyclohexanone, methanol, cresols, cresylic acid, nitrobenzene, toluene, methyl ethyl ketone, carbon disulfide, isobutanol, pyridine, benzene, 2-ethoxyethanol, and 2-nitropropane. Still bottoms from the recovery of these spent solvents and spent solvent mixtures.
Y43	Any congenor of polychlorinated dibenzo-furan	Waste from the production or manufacturing use of pentachlorophenol, or of intermediates used to produce its derivatives. Wastes from the production of or manufacturing use of tri- or tetrachlorophenol, or of intermediates used to produce their pesticide derivatives. Wastes from the manufacturing use of tetra-, penta, or hexachlorobenzenes under alkaline conditions. Discarded formulations containing tri-, tetra- or pentachlorophenol or discarded formulations containing compounds derived from these chlorophenols. Wastewaters, process residuals, preservative drippage, and spent formulations from wood preserving processes generated at plants that currently use or have previously used chlorophenolic formulations. Wastewater treatment sludges from the production of ethylene dichloride or vinyl chloride monomer.
Y44	Any congenor of polychlorinated dibenzo-p-dioxin	By-products of various industrial processes (for example, bleaching paper pulp, and chemical and pesticide manufacture) and combustion activities (for example, burning household trash, forest fires, and waste incineration). Waste from the production or manufacturing use of pentachlorophenol, or of intermediates used to produce its derivatives. Wastes from the production of or manufacturing use of tri- or tetrachlorophenol, or of intermediates used to produce their pesticide derivatives.

Annex I wastes		Examples of potentially hazardous waste streams from various sources
		Wastes from the manufacturing use of tetra-, penta, or hexachlorobenzenes under alkaline conditions. Discarded formulations containing tri-, tetra- or pentachlorophenol or discarded formulations containing compounds derived from these chlorophenols. Wastewaters, process residuals, preservative drippage, and spent formulations from wood preserving processes generated at plants that currently use or have previously used chlorophenolic formulations. Wastewater treatment sludges from the production of ethylene dichloride or vinyl chloride monomer.
Y45	Organohalogen compounds other than substances referred to in this Annex (e.g. Y39, Y41, Y42, Y43, Y44)	Chlorofluorocarbons and halons. Discarded equipment containing chlorofluorocarbons, HCFC, HFC. Gases in pressure containers containing CFCs and derivatives, including halons, as propellants.

Annex 4

Annex 4: Template for collecting waste data from generators in the industrial sector

Identification of Enterprise Surveyed					
Company name					
Address, Plant site	Street				
	Town				
	State/ Province				
	GIS Coordinates	Longitude		Latitude	
Post Address					
Responsible Person	Name				
	Position				
	Telephone				
	E-mail				
Industrial Sector			ISIC Code (if applicable)		
Number of Employees	Full time		Part time		
Date of Information					
Collector of information					

Other Production Information				
Department of Factory				
Main Products or Intermediate Products	Unit	Production per Year	Note[1]	
Hazardous Chemicals Used in Production Process	Commercial Name[2]	Quantity	Unit	Effective Chemicals CAS Name

[1] e.g. months per year

[2] A commercial product can contain many hazardous substancies

Auxiliary Functions			
Process Flow Diagram	☐		
Use of Fuels	Type of Fuel	Unit	Per Year
Waste Generated from Wastewater Treatment			
Waste Generated from Treatment of Off-gases			
Current Storage of Hazardous Waste, tons[1]			

[1] only hazardous waste that are stored longer than 1 year, exceptional storage

Specific Hazardous Waste Management Information				
Year of Data				
Department				
Type, Name of Waste				
Source of Waste				
Code of Waste	National[1]		Basel Convention, Y-Code	
Hazard Class[2]				
Physical State				
Dry Solid Content				
Quantity Generated per Year **Tons**				
Quantity Recycled per Year **Tons**	R-Code	Recipient of Waste		
Quantity Disposed per Year **Tons**	D-Code	Recipient of Waste		

[1] for example EWC, used in EU-Countries

[2] for example hazardous/ very hazardous classification in some countries

Liquid
Semi-Liquid
Solid

R01
R02
R03
R04
R05
R06
R07
R08
R09
R10
R11
R12
R13

D01
D02
D03
D04
D05
D06
D07
D08
D09
D10
D11
D12
D13
D14
D15

Annex 5

PART II: ANNUAL REPORTING
SECTION A
TABLE 6
Export of hazardous wastes and other wastes in 2011

Total amounts exported:

Total amount of hazardous wastes under Art. 1 (1)a (Annex I: Y1 - Y45) exported............... in metric tons.
Total amount of hazardous wastes under Art. 1 (1)b exported.. in metric tons.
Total amount of other wastes exported (Annex II: Y46 - Y47). .... in metric tons.
Total amount of hazardous wastes and other wastes exported... in metric tons.

Category of waste			Hazardous characteristics [3] (Annex III)							
Annexes I and II [1]		Annex VIII [3]	UN class [3]	H' code [3]	Characteristics [3]	Amount exported (metric tons)	Country/countries of transit[4]	Country of destination[4]	Final disposal operation (Annex IV A) D code	Recovery operation (Annex IV B) R code
Y code	Waste Streams/ wastes having as constituents [2]									

1 Crucial to fill in the Y code or, if none is applicable, the waste streams/wastes having as constituents.
2 Not required to fill in, if you have provided the Y-code.
3 Optional to fill in.
4 Use ISO codes as in the attached list.

PART II: ANNUAL REPORTING
SECTION A
TABLE 7
Import of hazardous wastes and other wastes in 2011

Total amounts imported:

Total amount of hazardous wastes under Art. 1 1(a) (Annex I: Y1 - Y45) imported................ in metric tons.
Total amount of hazardous wastes under Art. 1 1(b) imported.. in metric tons.
Total amount of other wastes imported (Annex II: Y46 - Y47). .... in metric tons.
Total amount of hazardous wastes and other wastes imported.. in metric tons.

Category of waste			Hazardous characteristics [3] (Annex III)							
Annexes I and II [1]		Annex VIII [3]	UN class [3]	H' code [3]	Characteristics [3]	Amount imported (metric tons)	Country/countries of transit[4]	Country of origin[4]	Final disposal operation (Annex IV A) D code	Recovery operation (Annex IV B) R code
Y code	Waste Streams/ wastes having as constituents [2]									

1 Crucial to fill in the Y code or, if none is applicable, the waste streams/wastes having as constituents.
2 Not required to fill in, if you have provided the Y-code.
3 Optional to fill in.
4 Use ISO codes as in the attached list.

PART II: ANNUAL REPORTING
SECTION A
TABLE 8A
Total Amount of Generation of hazardous wastes and other wastes in 2011

TOTAL amount of hazardous wastes and other wastes generated (metric tons)												
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Total amount of hazardous wastes under Art. 1 (1)a (Annex I: Y1-Y45) generated												
Total amount of hazardous wastes under Art. 1 (1)b generated												
Total amount of other wastes generated (Annex II: Y46-Y47)												
Remarks:												

PART II: ANNUAL REPORTING
SECTION A
TABLE 8B
Generation of hazardous wastes and other wastes by Y-categories in 2011

If possible, please fill in the quantities for the categories Y1 - Y47

CATEGORIES													
Waste streams (Annex I to Basel Convention)		2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Y1	Clinical wastes from medical care in hospitals, medical centres and clinics												
Y2	Wastes from the production and preparation of pharmaceutical products												
Y3	Waste pharmaceuticals, drugs and medicines												
Y4	Wastes from the production…... of biocides and phytopharmaceuticals												
Y5	Wastes from the manufacture…... of wood preserving chemicals												
Y6	Wastes from the production, formulation and use of organic solvent												
Y7	Wastes from heat treatment and tempering operations containing cyanides												
Y8	Waste mineral oils unfit for their originally intended use												
Y9	Waste oils/water, hydrocarbons/water mixtures, emulsion												
Y10	Waste substances ….containing or contaminated with PCBs, PCTs, PBBs												
Y11	Waste tarry residues … from refining, distillation and any pyrolytic treatment												
Y12	Wastes from production…... of inks, dyes, pigments, paints, etc												
Y13	Wastes from production……resins, latex, plasticizers, glues, etc												
Y14	Waste chemical substances arising ….. environment are not known												
Y15	Wastes of an explosive nature not subject to other legislation												
Y16	Wastes from production, formulation and use of photographic chemicals…												
Y17	Wastes resulting from surface treatment of metals and plastics												
Y18	Residues arising from industrial waste disposal operations												

CATEGORIES													
Wastes having as constituents (Annex I to Basel Convention)		2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Y19	Metal carbonyls												
Y20	Beryllium; beryllium compounds												
Y21	Hexavalent chromium compounds												
Y22	Copper compounds												
Y23	Zinc compounds												
Y24	Arsenic; arsenic compounds												
Y25	Selenium; selenium compounds												
Y26	Cadmium; cadmium compounds												
Y27	Antimony; antimony compounds												
Y28	Tellurium; tellurium compounds												
Y29	Mercury; mercury compounds												
Y30	Thallium; thallium compounds												
Y31	Lead; lead compounds												
Y32	Inorganic fluorine compounds excluding calcium fluoride												
Y33	Inorganic cyanides												
Y34	Acidic solutions or acids in solid form												
Y35	Basic solutions or bases in solid form												
Y36	Asbestos (dust and fibres)												
Y37	Organic phosphorus compounds												
Y38	Organic cyanides												
Y39	Phenols; phenol compounds including chlorophenols												
Y40	Ethers												
Y41	Halogenated organic solvents												
Y42	Organic solvents excluding halogenated solvents												
Y43	Any congenor of polychlorinated dibenzo-furan												
Y44	Any congenor of polychlorinated dibenzo-p-dioxin												
Y45	Organohalogen compounds other than …(e.g. Y39, Y41, Y42, Y43, Y44)												
Categories of wastes requiring special consideration (Annex II to Basel Convention)		2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Y46	Wastes collected from households												
Y47	Residues arising from the incineration of household wastes												