PART I GENERAL GUIDANCE

Chapter 1 Introduction and Overview

Under the Stockholm Convention on Persistent Organic Pollutants (POPs), Parties are required to reduce total releases from anthropogenic sources of the chemicals listed in Annex C with the goal of continually minimizing and, where feasible, ultimately eliminating releases of these unintentionally produced chemicals. Toward this end, Parties must develop action plans as part of their National Implementation Plans (NIP) to identify, characterize and address the releases of unintentional POPs listed in Annex C. Action plans to be developed according to Article 5 of the Convention shall include evaluations of current and projected releases that are derived through the development and maintenance of source inventories and release estimates, taking into consideration the source categories listed in Annex C.

To achieve the goal of the Convention, Parties are required to implement or promote best available techniques (BAT) and best environmental practices (BEP), as described in the "Guidelines on Best Available Techniques and Provisional Guidance on Best Environmental Practices relevant to Article 5 and Annex C of the Stockholm Convention on Persistent Organic Pollutants".

Five years after developing their action plan, Parties are required to review their adopted strategies, including the extent to which their unintentional POPs releases have been reduced, and to incorporate such reviews in national reports pursuant to Article 15.

1.1 Chemicals Listed in Annex C

Pursuant to Article 5 of the Convention, the following unintentional POPs are listed in Annex C:

- Polychlorinated dibenzo-*p*-dioxins (PCDD)
- Polychlorinated dibenzofurans (PCDF),
- Polychlorinated biphenyls (PCB),
- Hexachlorobenzene (HCB), and
- Pentachlorobenzene (PeCBz).[1]

Among these, PCDD and PCDF (also collectively referred to as PCDD/PCDF) have never been used as commercial products, nor were intentionally manufactured for any reason other than laboratory purposes. PCB, HCB and PeCBz are also unintentionally formed, usually from the same sources that produce PCDD/PCDF. However, unlike PCDD/PCDF, they have also been manufactured and used for specific purposes, their intentional production and use being by far higher than the unintentional formation and release.

PCDD/PCDF releases are accompanied by releases of other unintentional POPs, which can be minimized or eliminated by the same measures that are used to address PCDD/PCDF releases. When a

[1] Annex C was amended to include pentachlorobenzene at the fourth meeting of the Conference of Parties, held from 4 to 8 May 2009, by decision SC-4/16.

comprehensive inventory of PCDD/PCDF is elaborated, it allows to identify priority sources, set measures and develop action plans to minimize releases **of all unintentional POPs**.

It is thus recommended, for practical reasons, that inventory activities be focused on PCDD/PCDF, as these substances are **indicative of the presence of other unintentional POPs**. They are considered to constitute a sufficient basis for **identifying** and **prioritizing** sources of all such substances as well as for **devising applicable control measures for all Annex C POPs** and for **evaluating their efficacy**.

Only in the context of research or other projects it is advisable to analyze emissions of all unintentional POPs listed in Annex C in order to produce useful information for the purpose of deriving emission factors.

In addition to emission factors for PCDD/PCDF, the Toolkit also contains emission factors for other POPs when such information is available. Typically, emission factors are provided for the five release vectors, *i.e.*, air (EF_{Air}), water (EF_{Water}), land (EF_{Land}), product ($EF_{Product}$), and residue ($EF_{Residue}$).

1.2 Purpose

The purpose of the "Toolkit for Identification and Quantification of Releases of Dioxins, Furans, and Other Unintentional POPs" is to support Parties in preparing PCDD/PCDF inventories[2] that are consistent in format and content, ensuring that it is possible to compare results, identify priorities, mark progress and follow changes over time at the country level, and at the regional and global levels. Towards this end, the Toolkit provides the following "tools":

- A simple but comprehensive procedure for identifying sources of PCDD/PCDF, including but not limited to the source categories listed in Annex C, Parts II and III;
- Guidance on gathering basic information on the design, operation and/or expected performance of sources that supports their classification and the assignment of appropriate default emission factors;
- Default emission factors – values for the quantity of PCDD/PCDF, expressed as TEQ, released to each vector per unit of activity (*e.g.*, µg TEQ per ton of material produced, per ton of fuel burned, etc.) that have been assigned for each class within the source categories. For the other unintentional POPs, mass concentrations will be assigned as appropriate;
- Guidance on acquiring data and related information to estimate national values for annual activity rates for source categories and/or classes within source categories*, e.g.,* tons per year of waste burned, tons per year of feed material processed, tons per year of product produced, etc.*;* and
- A spreadsheet to list all source groups, source categories and their associated classes and emission factors, for the five release vectors. This spreadsheet will automatically calculate annual PCDD/PCDF releases from all source categories in a given country or region where national activity data are entered.

[2] In this document, the terms "inventory" and "inventories" are used to include both source inventories and the associated release estimates.

The emission factors can be modified in the spreadsheet, *i.e.*, countries may use their own emission factors instead of the default ones, preferably using the same units to ensure comparability of results. Countries can also insert new source categories or classes by adding extra lines into the worksheet to better reflect national circumstances.

1.3 Structure and Use of the Toolkit

The Toolkit is divided into three parts: Part I contains four chapters providing general guidance for inventory development, Part II contains default emission factors for nine of the ten source groups, and Part III provides complementary information, including 53 annexes and 11 example inventories.

Part I

Chapter 1- Introduction and Overview summarizes the obligations of Parties under Article 5 and Annex C of the Stockholm Convention, describes the purpose and structure of the Toolkit and the chemicals listed in Annex C, including a brief overview of their formation and sources.

Chapter 2- Identification of PCDD/PCDF Sources and Estimation of Releases addresses the identification of sources and provides general guidance on gathering information that will allow for 1) sources to be identified and catalogued according to the source category and class to facilitate the selection of the most appropriate default emission factors, and 2) guidance to determine activity rates for each of the classes within each source category.

Chapter 3- Reporting of releases explains how to undertake inventory updates and revisions as well as projections of future releases. Finally, the reporting format under Article 15 of the Convention is described.

Chapter 4- Data quality provides information on the inventory data quality criteria along with guidance on possible quality assurance and quality control measures and a simple approach to characterize the quality of the inventory results.

Part II

1 – Waste Incineration addresses seven source categories of waste incinerators, the classes within each category and the default emission factors for each class.

2 – Ferrous and Non-Ferrous Metal Production addresses twelve source categories for the production of metals and metal alloys including recycling operations, the classes within each category and the default emission factors for each class.

3 – Heat and Power Generation addresses five source categories of large and small installations using fossil fuels, biomass or gas, the classes within each category and the default emission factors for each class.

4 – Production of Mineral Products addresses seven source categories of processes to manufacture mineral products, the classes within each category and the default emission factors for each class.

5 – Transport addresses four source categories including road and ship transport, the classes within each category and the default emission factors for each class.

6 – Open Burning Processes addresses two source categories of burning biomass or waste without technical equipment, the classes within each category and the default emission factors for each class.

7 – Production and Use of Chemicals and Consumer Goods addresses eight source categories of various industrial activities, the classes within each category and the default emission factors for each class.

8 – Miscellaneous addresses an array of five source categories that do not match the description of any other source group, the classes within each category and the default emission factors for each class.

9 – Disposal and Landfill addresses five source categories related to waste disposal, the classes within each category and the default emission factors for each class.

10 – Contaminated Sites and Hotspots addresses thirteen source categories that should only be noted in the inventory, where possible, since these categories cannot be further classified and no default emission factors can be provided.

Part III

The following annexes provide complementary information:

Annex 1 - Table of TEFs

Annex 2 - Guidance on identifying sources of PCDD/PCDF

Annex 3 - Questionnaires

Annex 4 - Compilation of all emission factors

Annex 5 - Reporting of releases

Annex 6 - Usage of units in air emissions

Annex 7 - Per capita/GDP emissions

Annex 8 - Data quality

Annexes 9 to 53 provide complementary information to source groups 1-10 and the source categories included in the respective groups.

Eleven **example inventories** are also included in Part III to illustrate the process of update and revision of inventories, as well as specific examples of inventories for source groups 1-10.

The Toolkit (current version updating and amending edition 2, which was published in 2005) is presented in an electronic version (web-based and CD-ROM). The electronic version of the Toolkit has been developed to increase the availability, portability and storage of the information. It delivers the Toolkit's content in an interactive and dynamic manner. The information is organized in a user-friendly multi-layer structure according to the level of complexity, where information elements are arranged according to the relevance for the inventory process:

- The first layer contains key elements of the Toolkit and essential information for the development of the inventory;
- The second layer of complementary information or additional explanatory material is included in annexes and example inventories accessible via hyperlinks;
- Further complementary information is accessible via pop-up windows;
- Cross-referencing within the Toolkit sections is done via internal links; and
- External links are used to reference outside resources.

Among other features, the web-based tool also offers access to interactive features including a search tool and access to Excel files for calculating releases. The user is therefore given flexibility in accessing the content of the Toolkit to meet specific information requirements.

1.4 POPs Releases from Sources

The Toolkit has been assembled for the purpose of assisting each country in identifying and quantifying sources of unintentional POPs that are located within the country's borders and estimating releases from those sources.

Sources of POPs releases are of four general types, three of which are active, ongoing processes, and one is a legacy of historic activities:

- Chemical production processes, *e.g*., facilities or production units that produce chlorinated phenols or in which certain other chlorinated chemicals are manufactured, or that produce pulp and paper using elemental chlorine for chemical bleaching;
- Thermal and combustion processes, *e.g.,* waste incineration, combustion of solid and liquid fuels, or production of metals in thermal processes;
- Biogenic processes in which PCDD/PCDF may be formed from precursors – manufactured chemicals such as pentachlorophenol that are structurally closely related precursors of PCDD/PCDF.
- Reservoir sources such as historic dumps containing PCDD/PCDF and other POPs-contaminated wastes, and soils and sediments in which POPs have accumulated over time.

The Toolkit presents information on each of the unintentional POPs source categories listed in Annex C, some additional source categories, and a strategy for identifying new source categories. It describes a step-by-step process to estimate PCDD/PCDF releases from each source category to the following environmental media:

- Air,
- Water (surface and ground water, including marine and estuarine water), and
- Land (surface soils),

and to these process outputs:

- Products (such as chemical formulations, including pesticides or consumer goods such as paper, textiles, etc.);
- Residues (including certain liquid wastes, sludge, and solid residues, which are handled and disposed of as waste or may be recycled).

Combustion Processes

PCDD/PCDF and other unintentional POPs can be formed in combustion processes when their component elements – carbon, oxygen, hydrogen, and chlorine – are present and combustion temperatures range between 200°C and 900°C (De Fre and Rymen 1989). Two primary mechanisms for PCDD/PCDF formation during combustion have been proposed:

- *De novo* formation, in which non-extractable carbon-based structures that fundamentally differ from the PCDD/PCDF undergo transformations and reactions to form PCDD/PCDF; and
- Precursor formation/reactions in which hydrocarbon fragments undergo cyclization or incomplete oxidation to form chemicals that share structural similarities with PCDD/PCDF and that undergo further reactions to finally form PCDD/PCDF.

PCDD/PCDF formation *via* these mechanisms can take place homogeneously (molecules react entirely in the gas phase or in the solid phase) or heterogeneously (the reactions take place between gas phase molecules and surfaces).

PCDD/PCDF can also be destroyed during combustion when temperatures are sufficiently high, residence times are adequate and mixing in the combustion zone is sufficiently thorough.[3] However, combustion gases must also be rapidly cooled in the post-combustion zone in order to minimize the formation of new PCDD/PCDF in this phase. Variables known to influence PCDD/PCDF formation in combustion processes include the following:

- Technology: Poor combustion, poor mixing in the combustion chamber, poorly designed and managed post-combustion chambers, and inadequate air pollution control devices are associated with increased PCDD/PCDF formation.
- Temperature: Formation has been reported in post-combustion zones and air pollution control devices at temperatures ranging from 200°C to 650°C, with the greatest formation occurring between 200°C and 450°C and peaking at about 300°C;
- Metals: Formation is catalyzed by metals including copper, iron, zinc, aluminum, chromium, and manganese;
- Sulphur and nitrogen: Chemicals containing sulphur and nitrogen have the potential to inhibit the formation of PCDD/PCDF in certain conditions, but may give rise to other undesirable by-products;

[3] Good combustion practices include presence of the "3 Ts" – temperature, turbulence, and time of residence.

- Chlorine: Chlorine must be present. Whether chlorine is present as organic, inorganic or elemental in the materials combusted is relatively negligible. However, its presence in fly ash or in its elemental form in the gas phase may be especially important.

Other variables and combinations of conditions also affect PCDD/PCDF formation. For example, while simulating the burning of household waste in a metal barrel inside a burn hut, Gullet *et al*. (1999) reported greater PCDD/PCDF formation with 1) increased chlorine in the waste, independent of the original form of the chlorine – organic or inorganic; 2) higher humidity; 3) increased waste load; and 4) higher levels of catalytic metals.

Industrial-Chemical Processes

As with combustion processes, carbon, hydrogen, oxygen, and chlorine must also be present for PCDD/PCDF to form in industrial-chemical processes. In chemical manufacturing processes, PCDD/PCDF formation may be favored if one or more of the following conditions apply (NATO/CCMS 1992, Hutzinger and Fiedler 1988):

- Elevated temperatures (>150°C);
- Alkaline conditions (especially during purification);
- Metal catalysis;
- Ultraviolet radiation or substances that generate radicals.

Among chlorine-containing chemicals, the following groups have been associated with the formation of PCDD/PCDF as byproducts during their production:

- Chlorinated phenols and their derivatives,
- Chlorinated aromatics and their derivatives,
- Chlorinated aliphatic chemicals,
- Chlorinated catalysts and inorganic chemicals.

PCDD/PCDF can be also formed as byproducts of some chemicals that do not contain chlorine when some form of chlorine is present or used during their production.

Application of Toxic Equivalents (TEQ)

Taken as a whole, PCDD and PCDF are a group of 210 tricyclic, chlorine-containing aromatic chemicals; there are 75 congeners of PCDD and 135 congeners of PCDF possible. PCDD and PCDF typically occur as mixtures. The most toxic compounds have chlorines in the 2, 3, 7 and 8 positions; they have been assigned a toxicity equivalency factor (TEF) based on the relative potency of each congener in comparison to the most toxic congener, 2,3,7,8-tetrachlorodibenzo-*p*-dioxin. In total, there are 17 congeners in which chlorine atoms occur at the 2, 3, 7, and 8 positions. Mixtures of these congeners are often evaluated and reported as a single number called toxic equivalent (TEQ). To determine the TEQ of a mixture, the mass concentration of each congener is analytically determined, multiplied with the assigned TEF, and the products summed. The first scheme, derived by the Committee on the Challenges of Modern Society of the North Atlantic Treaty Organization in 1988 and called I-TEFs, covered 17

PCDD/PCDF. Subsequent revisions of TEFs have been coordinated by the World Health Organization (WHO) in 1997 and 2005. These revisions also included 12 dioxin-like polychlorinated biphenyls (dl-PCB). For PCB, the compounds having the highest toxicity are those in which the molecule can assume a planar configuration, analogous to that of PCDD/PCDF.

To estimate PCDD/PCDF releases in inventories, the Convention requires that the most advanced TEFs are used. These are, at present, the WHO-TEFs established by a WHO/IPCS expert meeting in 2005 (van den Berg *et al*. 2006) (see Annex 1). However, these have not yet been recognized or adopted by the Conference of the Parties. For the purpose of the Toolkit and its "order-of-magnitude" estimates of emission factors, the differences between the WHO-TEFs (either from 1998 or 2005) and the international TEFs (I-TEFs) previously established by the Committee on the Challenges of Modern Society of the North Atlantic Treaty Organization in 1988 are negligible. Therefore, the TEF-scheme accompanying the emission factors is not specified in the Toolkit. When reference is made to measured values, the TEF scheme used should be included.

1.5 Limitations

An inventory can provide valuable information on the magnitude of releases to each environmental medium and in products and residues. It can highlight sources for possible impacts but it cannot provide an accurate guide to the relative impact of these releases on human or ecosystem exposure since the fate of PCDD/PCDF varies considerably from one release source to another. The main purpose is to identify sources of unintentional POPs, prioritize them and undertake measures to prevent the formation and reduce or eliminate releases of unintentional POPs. Furthermore, measures taken to address PCDD/PCDF releases are equally suitable for other unintentional POPs.

The default emission factors presented in the Toolkit are best estimates derived from experimental results at well-documented sources (*i.e*., taking into account technology, process characteristics and operating practices) or otherwise based on expert judgment. The results obtained for processes with similar characteristics are then aggregated into one emission factor representing "order of magnitude" release estimates, which do not describe accurately PCDD/PCDF releases from individual plants/facilities.

The default emission factors are assigned data quality ranks to enable an informed approach to estimating PCDD/PCDF releases. They should be applied with the specified level of confidence only when matching a specific situation in certain national circumstances. Annex 8 provides more information on data quality issues related to both emission factors and activity rates.

Most importantly, the Toolkit offers focused guidance on inventorying sources and releases of unintentional POPs. The Toolkit is based on systematic expert consultation, and can thus be considered as the most comprehensive and up-to-date compilation of emission factors for unintentional POPs.

Chapter 2 Identifying Sources and Estimating Releases of PCDD/PCDF

The PCDD/PCDF inventory includes these five steps:

- Identify sources[4];
- Select emission factors for the sources;
- Assign activity rates for each of the sources;
- Multiply the emission factor with the activity rate;
- Compile the inventory.

2.1 Identifying Sources

To assist Parties in identifying PCDD/PCDF sources at the national level, the Toolkit includes source categories as described in Annex C of the Stockholm Convention, Parts II and III. Since the list in Part III is indicative and open for additions, the Toolkit also contains further source categories that have been identified in existing inventories, national assessments, scientific studies, etc. In addition, it provides a simple screening process for identifying other sources not yet listed in the Toolkit.

Sources listed in the Toolkit

A country or region can begin identifying its PCDD/PCDF sources by determining the presence or absence within its borders of the PCDD/PCDF sources currently listed in the Toolkit. The Toolkit lists the source categories identified in Annex C as well as those identified by other means, such as national PCDD/PCDF inventories, scientific studies and reports.

The source categories listed in the Toolkit are divided into ten source groups. Table I.2.1 presents these ten source groups and the source categories currently listed in the Toolkit.

Table I.2.1 – Source Groups and Associated Source Categories

Source Group	1. Waste Incineration		2. Ferrous and Non-Ferrous Metal Production	3. Heat and Power Generation	4. Production of Mineral Products	5. Transport
Source Categories	a	Municipal solid waste incineration	Iron ore sintering	Fossil fuel power plants	Cement production	4-Stroke engines
	b	Hazardous waste incineration	Coke production	Biomass power plants	Lime production	2-Stroke engines
	c	Medical waste incineration	Iron and steel production and foundries	Landfill, biogas combustion	Brick production	Diesel engines
	d	Light-fraction shredder waste incineration	Copper production	Household heating and cooking (biomass)	Glass production	Heavy oil fired engines
	e	Sewage sludge	Aluminum	Domestic heating	Ceramics production	

[4] A source that has been determined not to be present in the country is assigned the value "0" in the national inventory

		incineration	production	(fossil fuels)		
	f	Waste wood and waste biomass incineration	Lead production		Asphalt mixing	
	g	Destruction of animal carcasses	Zinc production		Oil Shale Processing	
	h		Brass and bronze production			
	i		Magnesium production			
	j		Other non-ferrous metal production			
	k		Shredders			
	l		Thermal wire reclamation			
Source Group	**6. Open Burning Processes**		**7. Production and Use of Chemicals and Consumer Goods**	**8. Miscellaneous**	**9. Disposal and Landfill**	**10. Contaminated Sites and Hotspots**
Source Categories	a	Biomass burning	Pulp and paper production	Drying of biomass	Landfills, Waste Dumps and Landfill Mining	Sites used for the production of chlorine
	b	Waste burning and accidental fires	Chlorinated inorganic chemicals	Crematoria	Sewage and sewage treatment	Production sites of chlorinated organics and related deposits
	c		Chlorinated aliphatic chemicals	Smoke houses	Open water dumping	Application sites of PCDD/PCDF containing pesticides and chemicals
	d		Chlorinated aromatic chemicals	Dry cleaning	Composting	Timber manufacture and treatment sites
	e		Other chlorinated and non-chlorinated chemicals	Tobacco smoking	Waste oil treatment (non-thermal)	Textile and leather factories
	f		Petroleum refining			Use of PCB
	g		Textile production			Use of chlorine for production of metals and inorganic chemicals
	h		Leather refining			Waste incinerators
	i					Metal industries
	j					Fire Accidents
	K					Dredging of sediments; contaminated flood

						plains
	L					Other dumps/landfills of wastes from source groups 1-9
	m					Kaolin or ball clay sites

When an activity or process is identified but not described or not exactly matching the description provided in the Toolkit, the respective estimate of PCDD/PCDF releases can be included in the national inventory. The additional source will be inserted into the national inventory by adding extra lines into the respective source group (in the EXCEL spreadsheet). Such additions should be highlighted accordingly.[5]

Sources not listed in the Toolkit

To identify PCDD/PCDF sources not currently listed in the Toolkit, it is necessary to determine whether chlorine (in elemental, organic or inorganic forms) is or was present in the processes or activities of interest. PCDD/PCDF formation is influenced by many factors. However, when chlorine is not present, PCDD/PCDF formation cannot occur; when chlorine is present, even as a trace element, PCDD/PCDF formation may occur.

When Parties have identified processes or activities that are potential PCDD/PCDF sources due to the presence or use of chlorine in some form, those potential sources should be thoroughly evaluated. Evaluations can begin by investigating existing inventories, the scientific literature, government reports, *etc.,* to determine if the processes of interest or very similar processes have already been reported to release PCDD/PCDF. Additional guidance, including lists of processes and activities for which evidence of PCDD/PCDF formation and/or release exists but which are not addressed elsewhere in the Toolkit, is given in Annex 2.

2.2 Emission Factors

For each source category and/or source, it is necessary to obtain basic information about the design, operation, and other related factors that can substantially influence the magnitude of PCDD/PCDF releases. Based on this information, each source will be classified and placed in one of the several classes to which default emission factors are assigned.

Example questionnaires provided in Annex 3 may be useful in obtaining the information needed to classify source categories and so select appropriate emission factors. More specific suggestions on the information needed and potential avenues for obtaining such information for a source category may be found in Part II, in the chapters concerning source groups 1 through 10.

The default emission factors presented in the Toolkit are drawn from a variety of data sources, ranging from laboratory experiments, peer reviewed literature, dedicated experimental projects, to governmental or institutional reports. The emission factors for each class are best estimates based

[5] For example, if cremation of humans or animals is done in a way that neither reflects crematoria as described in category 8(b) for crematoria nor 1(g) for animal carcass incineration nor 6(b) for open burning of waste.

where possible on data measured at well-documented sources taking into account technology, process characteristics and operating practices, or otherwise estimates based on expert judgment. For the purpose of defining a default emission factor, results/processes with similar characteristics are aggregated into one emission factor. As such, the Toolkit's default emission factors are approximations intended to represent order of magnitude release estimates. They are suitable to derive national release inventories, set priorities, develop action plans and evaluate their efficacy; however, they should not be taken as accurately describing releases from individual plants/facilities.

The Toolkit methodology is designed so that both country-derived emission factors and the default emission factors presented in the Toolkit can be used. Default emission factors are recommended to be used for comparison or in cases where country-specific emission factors are not available.

2.3 Activity Rates

Activity rates are values in unit per year of product manufactured (*e.g.,* steel, sinter, cement, pulp, compost, *etc.*) or feed material processed (*e.g.,* municipal waste, hazardous waste, coal, diesel fuel, bodies cremated, *etc.*), or annual quantities of material released (*e.g.,* m^3 of flue gas, liters of wastewater, kilograms or tons of sludge generated, *etc.*).

Values for activity rates may be found in centralized statistical information assembled by state, provincial, national or international agencies, and they may be obtained from trade associations and owner/operators of facilities. Potential sources of information on activity rates include the following:

- National statistics;
- National energy balance;
- Regional economic activity records including national production and import/export data;
- International statistics such as EUROSTAT, OECD, FAO, World Bank etc.
- Local operating and permitting records of industrial facilities;
- Industry association data;
- Historical production and industry data;
- Other release inventories such as the inventory of criteria pollutants and or greenhouse gases;
- Questionnaires;
- Pollution Release and Transfer Registers (PRTRs).

When the activity rate for an industrial source category is not available but the nameplate capacity is known, an activity rate can be estimated by multiplying capacity by the domestic capacity utilization factor (CUF). If no domestic CUF is available, a regional or global CUF may be used and, if neither regional nor global CUF is available, the Toolkit Expert Group may provide an appropriate value.

Activity rates for diffuse source categories, such as traffic, open burning of domestic waste, agricultural residues, etc., are best characterized by drawing from centrally available data.

2.4 Release Estimates

Once PCDD/PCDF sources are identified and classified, emission factors selected and national or regional activity rates determined, the estimation of the total annual releases by source group, source category and class is relatively simple and straightforward.

For a source class, PCDD/PCDF releases per year are calculated according to the equation below. The activity rate is multiplied by each of the five emission factors and the sum of the five resulting values represents the quantity of PCDD/PCDF released annually from the source class.

PCDD/PCDF released, grams TEQ/year = Activity Rate x Emission Factor$_{Air}$
+ Activity Rate x Emission Factor$_{Water}$
+ Activity Rate x Emission Factor$_{Land}$
+ Activity Rate x Emission Factor$_{Product}$
+ Activity Rate x Emission Factor$_{Residue}$

For a source category, the annual PCDD/PCDF release is calculated as the sum of the total annual releases for each class within the category.

For each source group, the annual PCDD/PCDF release is the sum of the annual releases calculated for each source category in the source group.

For a country or region, the total annual PCDD/PCDF release is the sum of the annual releases from all source groups.

The spreadsheet will be used to determine annual releases according to source groups and the year of reporting.

2.5 Compilation of PCDD/PCDF Inventory

The Toolkit simplifies and expedites the calculations described above by providing an Excel spreadsheet that includes a list of the source categories addressed in the Toolkit, along with their associated classes and accompanying default emission factors. Once the activity rates for all classes within the source categories that have been determined to be present within a country or region are entered into the spreadsheet, annual PCDD/PCDF releases are automatically calculated for each source category. A summarizing worksheet provides an overview of all releases according to vectors (air, water, land, product, residue) and source groups.

Newly identified sources can also be included in the spreadsheet, along with their associated emission factors and activity rates. Their releases are also automatically calculated and included in the final results. If desired, a country can replace the Toolkit's default emission factors with their own emission factors that have been otherwise derived.

These and other issues related to the preparation of inventories and reporting of releases are discussed in greater detail in Chapter 3 Reporting of Releases.

Chapter 3 Reporting of Releases

3.1 Categorization of Sources

Source categories of unintentional POPs releases under the Stockholm Convention are listed in Annex C Part II and Part III to the Convention. These source categories are also among those considered in the Toolkit, where they are placed into ten source groups to facilitate the development of national release inventories and reporting of POPs releases.

The standard format to report PCDD/PCDF releases through national reports under Article 15 is included in Annex 5, Table III.5.1.

Some countries also report POPs releases to air and a number of other pollutants under the UNECE Convention on Long-Range Transboundary Air Pollution (CLRTAP). For these countries, a brief explanation of source categorization under CLRTAP, including a list of source categories under the Stockholm Convention and their equivalent designations under CLRTAP, is presented in Annex 5, Table III.5.2.

Parties are encouraged to report releases of unintentional POPs in national reports submitted pursuant to Article 15 of the Convention, according to the source categories listed in Annex C of the Convention, grouped into the source groups specified in the Toolkit. By complying with this approach, Parties will ensure that the following conditions are met:

- Estimates of unintentional POPs releases are readily comparable;
- Regional and global release summaries can be easily prepared; and
- Time trends can be readily elaborated for the purpose of effectiveness evaluation under Article 16 of the Convention.

3.2 Baseline Release Estimates, Updating, Revisions, and Projections

Article 5, paragraph (a) (i) of the Stockholm Convention requires that Parties evaluate current and projected releases, including the development and maintenance of source inventories and release estimates of chemicals listed in Annex C, Part I, taking into consideration the source categories identified in Annex C, Part II and III, of the Convention.

In practice, this means that Parties must prepare their initial release estimates and update these estimates at regular intervals (*e.g*. every five years). Parties may also find it necessary to revise their initial and subsequent estimates in order to establish and maintain the consistency necessary for discerning meaningful trends in releases over time.

The **baseline release estimate** is the first inventory of sources and releases of Annex C POPs elaborated by a Party, usually as part of the National Implementation Plan developed under Article 7. This first inventory serves as a baseline against which subsequent updated release estimates are assessed in order to establish trends in releases over time and evaluate the efficacy of the adopted strategies for minimizing and/or eliminating PCDD/PCDF and other unintentional POPs releases.

As schematized in Figure I.3.1, **updating of the inventory begins** with an examination of the previous/baseline inventory to identify the approach used, including:

- The classification of sources and emission factors used
- Information sources based on which activity rates were estimated
- Assumptions and expert judgment applied to fill the gaps

In a second step, the developer of the inventory should **review changes in data since the baseline inventory**, in particular by checking for factors that may influence changes in releases over time. These include: economic and/or demographic growth, changes in technologies in particular through phasing in BAT and BEP, building, reconstruction or close down of production facilities, substitution of fuels, introduction of abatement techniques, identification of new sources, and others.

It is also important to **check whether new or revised emission factors have become available or new source categories or classes have been included in the Toolkit**. Once these data and information are collected, the developer of the inventory will proceed with the reclassification of sources to reflect the current situation in the particular reference year and with the establishment of activity rates for the reference year.

Once the information is assessed and the inventory is updated to reflect economic, demographic and technical changes, the **need to revise the previous inventories**, including the baseline, may arise. Revising previous inventories so that new or revised emission factors and new source categories and classes are incorporated is especially important.

Besides such changes in the Toolkit methodology, some **specific national factors may also trigger the need for revision.** These are usually related to the availability at the country level of **new or corrected information/knowledge,** *e.g*. correction of past activity estimates or the discovery of sources that existed in the past but were not considered in previous inventories due to lack of adequate information at that time.

The revision of the previous inventories aims to correct the estimates therein, by including missing information, filling gaps, using the same set of emission factors, applying the same assumptions, expert judgment as in the updated inventory.

Only after this stage, the developer of the inventory will be able to calculate updated releases **and establish consistent trends in releases over time**. If sources are reclassified and/or emission factors have been revised, new factors must be assigned accordingly; if the source classification has not changed, nor the emission factors, the same factors are applied; releases are finally estimated by multiplying the emission factors with the corresponding activity rates.

Maintaining all these stages in the inventory updating and revision process is essential to ensure that coherent trends over time can be computed based on comparable and consistent results over time. The same approach needs to be applied consistently in all release estimates to ensure consistency of results over time and to enable the assessment of trends over time.

If the approach changes over time, if new or corrected information or knowledge becomes available at the country level, **previous inventories need to be revised accordingly and <u>one single approach used for all inventories</u>**. Otherwise it would not be possible to compare data from the different reference years and establish consistent trends over time.

Projections of future release estimates may be elaborated by Parties using the same methodology, by considering:

- Appropriate emission factors based on planned or expected changes in technologies, raw materials, fuels, abatement techniques or other key parameters which could influence release estimates (*e.g*. triggered by the action plan developed under Article 5 of the Convention).
- Projections of future activity rates for certain source categories based on *e.g*. - expected socio-economic development, production plans for a particular source category or source group, etc.

The example inventory 1 shows an illustration of the inventories' update and revision process.

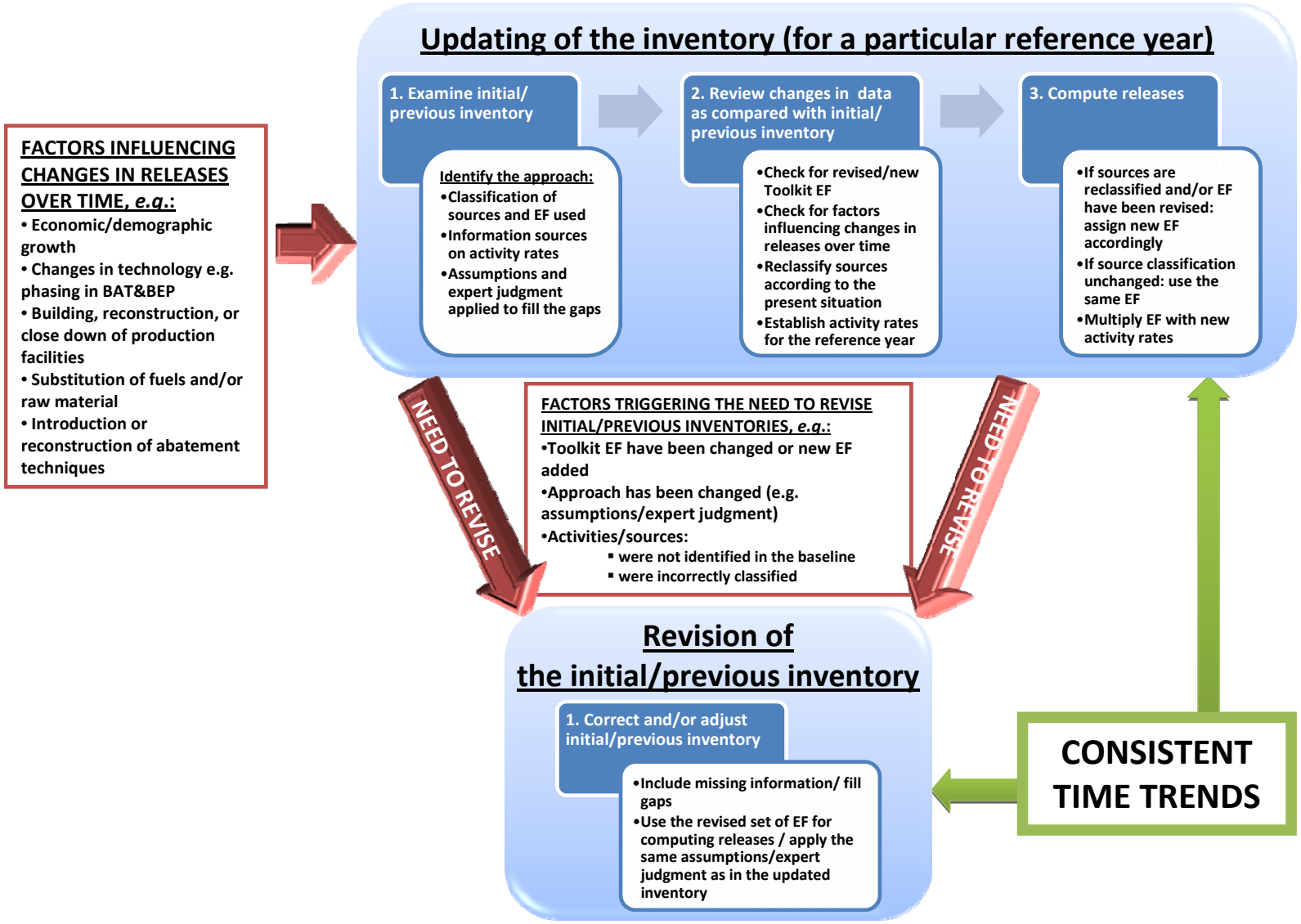

Figure I.3.1 Establishing trends in POPs releases over time

Chapter 4 Data Quality

Source inventories and release estimates reported under Article 15 should be:

- Reliable,
- Consistent over time,
- Comparable between countries,
- Transparent, and
- Complete.

Reliable inventories entail coherent application of internationally acknowledged methodologies such as the Toolkit and the use of best available national information.

To achieve **consistency** over time, the same approach should be used over time to establish consistent time trends. To ensure **comparability between countries,** all countries should report according to the same source groups and source categorization.

For **transparent** estimates, the approach, methodology, information, and assumptions used should be clearly described, documented and archived to facilitate inventory updates in the future.

For **complete** release inventories, all relevant source categories, all sources within those categories and all relevant release vectors have to be considered in the whole country. The inventory should also include information on source categories that do not exist or are not operational in the country during the reference year.

4.1 Quality Assurance and Quality Control (QA/QC)

The following quality assurance and quality control measures (QA/QC) should be applied to ensure that the source inventory and release estimates meet the quality criteria described above:

Activity Rates

- Align the unit of the activity rate with the unit of the emission factor.
- Pay attention to orders of magnitude while recalculating the activity rates and applying the emission factors.
- Explain clearly and completely all assumptions made in filling gaps in activity rates (see also “completeness”).
- Explain clearly and completely the process of classification of sources and the way activity rates were derived.

Emission Factors

- The Toolkit expert group is mandated to evaluate all emission factors that are or will be included in the Toolkit to determine that they are scientifically sound.
- National emission factors should only be derived from measured data of adequate quality *e.g*. the application of standard sampling and analytical methods; proven laboratory experience and good documentation are pre-requisites of high quality data.

- The classification of sources and choice of emission factors have to be explained, documented and archived.
- Consideration has to be given to units and orders of magnitude.

Completeness of Data

- Whenever practical and appropriate, individual plant questionnaires may be used to gather information for large point sources[6].
- Questionnaires provide useful information for the classification of plants and selection of emission factors. Since the return rate of the questionnaires is likely to be low, incomplete information-data gaps- will need to be covered by making assumptions about certain sources, where no specific information can be collected. Approaches will vary, but all assumptions should be clearly described in order to facilitate inventory updates in the following years or revisions in light of improved information.
- To determine complete activity rates, a combination of questionnaires (for large point sources) and national statistics should be used.
- When reporting the inventory results, it should be distinguished between "not applicable" *e.g*. the source category does not exist or is not operational in the country, and "not estimated" *e.g*. the source category is relevant but there was no sufficient information to estimate the releases.

Additional Considerations for Assessment of Inventory Results

- Compare national inventory results with results from other countries (see Annex 7).
- Compare national inventory results across different time periods: differences have to be justified, documented and logically explainable.

4.2 Data quality

Possibilities of indicating the confidence in the data used to generate emissions estimates may be as follows:

- Reporting of ranges (gives a good indication of confidence in data, however it may create problems while summarizing releases from more countries, therefore suitable only for reporting at the national level);
- Simple qualifiers, *i.e*., data quality codes "high", "medium", "low" as outlined in Annex 8.

[6] Large point sources include major industrial emitters, and the collection of information on their activity rates should be given priority. Definition of the large point sources as described for different industrial sectors in Annex 1 of the Directive 2008/1/EC on Integrated Pollution Prevention and Control (IPPC) may be used for orientation. As an example, emission from the following large point sources are regulated by the IPPC directive:

- combustion installations with a rated thermal input exceeding 50 MW;
- installations for the production of iron or steel with a capacity exceeding 2,5 tons per hour;
- installations for the production of cement with a capacity exceeding 500 tons per day, etc.

More details can be found at http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:32008L0001:EN:NOT

Qualifiers may be applied to both emission factors and activity data to discern the overall confidence in the inventory's results. Quality ranks are assigned to default emission factors by the Toolkit expert group to enable informed use of the methodology to assess PCDD/PCDF releases. Technical annexes provide complementary information on how default emission factors were derived to ensure that they are applied with the specified level of confidence only when matching a specific situation. Furthermore, guidance on assessing data quality criteria for calculating activity rates is provided in Annex 8.

More details on data quality and inventory QA/QC can be found in Part II Default Emission Factors.