**Dioxin, PCB and Waste Working Group**

c/o Arnika, Chlumova 17, CZ-130 00 Prague 3, Czech Republic
tel. + fax: +420.222 781 471, e-mail: petr.hrdina@arnika.org, http://www.ipen.org

# Comments on the Standardized Toolkit for Identification and Quantification of Dioxin and Furan Releases

The Standardized Toolkit for Identification and Quantification of Dioxin and Furan Releases, *“is a methodology to help countries just developing their inventories to estimate releases of PCDD/PCDF and also leads them through the process of how to enhance and refine these inventories.”* The authors of the Toolkit acknowledge that one of the Toolkit’s key elements is, *“an effective methodology for identifying the relevant industrial and non-industrial processes releasing PCDD and PCDF to air, water, land and with products and residues”*. However, the Toolkit still lacks a comprehensive strategy to identify PCDD/Fs sources as stated in previous NGOs comments.[1] The Toolkit should include a strategy for sources identification to support the objectives of the Stockholm Convention. We have included a list of sources which were not included in the Toolkit (see Table 1 below).

The Toolkit should be extended to include PCBs and HCB releases into the environment. Article 5 of the Stockholm Convention is not limited only to PCDD/PCDF, but also asks parties to evaluate, *“current and projected releases“* as well as,*“to address the releases of the chemicals listed in Annex C“*. The proposed Toolkit fails to address the releases of all the chemicals listed in Annex C, because it does not include PCBs or HCB sources. A large body of data documents both measurements and sources of PCBs and HCBs, which could be used as a basis for a comprehensive list and supply default emission factors, after critical evaluation of these information resources [2, 3, 4, 5, 6, 7, 8, 9, 10]. As clearly shown in some Regionally Based Assessment of Persistent Toxic Substances Reports, there exist country inventories of PCBs and HCB emissions as by-products in more cases[11] and we believe there are more data available in scientific reports. This raises the question why the Toolkit authors did not collect data from these inventories to set up a basic report that would help countries to prepare their own inventories of all by-products.

We have included some examples of emission factors for PCBs air releases used in the Czech National Implementation Plan Draft in Table 5 of these comments.[12]

The Toolkit must be revised to include a more comprehensive list of default emission factors that includes those that are appropriate not only for processes and activities in industrialized countries but also for those in developing countries and countries with economies in transition. Default emission factors in the Toolkit are often lower than those given in the byproducts inventories (including PCDD/Fs). In addition, the Toolkit often uses emission factors that are lower than actual measurements in industrialized regions as well as those reported in the scientific literature. Nonetheless, the Toolkit’s authors advise Parties that they need no monitoring data for any of the sources in their countries in order to estimate PCDD/Fs releases with sufficient accuracy to prioritize their sources. A summary of the default emission factors presented in section 8 (Annex 1) of the Toolkit shows that emission factors for many existing PCDD/Fs sources are missing.

The Toolkit should offer descriptions of both regulatory and affordable analytical means for obtaining monitoring data that can be used to estimate releases and/or derive emission factors.

## Sources Identification Strategy

Greenpeace International submitted a document at INC7 which is highly relevant to our comments on the Toolkit. [13] The following elements of their document are relevant to the current discussion:

Numerous dioxin sources have been identified in national and regional inventories, other government reports, industry reports, and the scientific literature. While many of these are addressed in the Toolkit, all of them are not. Meanwhile, new dioxin sources are still being discovered. In other words, the Toolkit does not have a comprehensive "check list" of all dioxin sources and such a list is unlikely to be compiled in the near future.

Why is a source identification strategy a matter of economic importance?

Equipped with the Toolkit's incomplete list but no source identification strategy, some countries will likely be unable to identify important dioxin sources. Sources that remain unidentified will not, of course, be included in dioxin inventories or, subsequently in national or regional action plans. Sources that are not included in action plans will not be eligible for funding being made available to support the implementation of the Stockholm Convention. In effect, unidentified dioxin sources represent the potential loss of economic assistance for countries and their public and industrial sectors. This loss of economic assistance is, at the same time, exacerbated by the economic losses associated with the impacts of unabated dioxin releases on public health and the environment.

Why is there no dioxin source identification strategy in UNEP's Dioxin Toolkit?

Greenpeace first recommended inclusion of a source identification strategy in preliminary comments on the draft Toolkit that were submitted to UNEP in June 2002, again in comments on the draft Toolkit that were submitted in January 2003, and yet again in comments on the revised draft Toolkit that were submitted in May 2003. The only acknowledgement given to this repeated recommendation was the following footnote, which appeared in the revised draft Toolkit that was circulated for comment in April 2003: *"[HF42] Greenpeace but I do not want to introduce "Strategy" as an own item within the inventory making."*

What is a dioxin source identification strategy?

A dioxin source identification strategy is neither complex nor lengthy. For example, in preparing its dioxin inventory, Denmark simply tracked the use of chlorine and chlorine-containing chemicals in its industrial sector. Industries that used chlorine in some form were given closer consideration as potential dioxin sources while those with no chlorine use were screened out.[14] Including this simple dioxin source identification strategy in UNEP's Dioxin Toolkit should be neither difficult nor costly. In addition, countries can follow this same strategy to evaluate proposals for industrial development and expansion, waste management projects, etc. for their potential as dioxin sources.

Primary[a] dioxin sources share one common feature – the availability of chlorine in elemental, organic or inorganic form. These sources fall into three general classes:

1) Processes and activities in which chlorine or chlorine-containing materials are essential. In almost all cases, these are chemical manufacturing processes. In some cases, the primary route of dioxin release to the environment is in products and materials (e.g., some organochlorine pesticides, such as pentachlorophenol). Most often, dioxins are concentrated in production wastes so that the wastes and/or the gaseous, liquid and solid residues from their treatment are the main routes of dioxin release.

2) Processes and activities in which chlorine or chlorine-containing materials are used for specific purposes that can be fulfilled by a non-chlorinated material (e.g., the use of elemental chlorine or chlorine dioxide for bleaching wood pulp); and

3) Processes and activities in which chlorine or chlorine-containing materials have no purpose but are only incidentally present, e.g., the burning of wastes that contain discarded goods made of polyvinyl chloride (PVC); metallurgical processes involving the recycling of discarded metal products that are, for example, PVC-clad; power generation in which municipal wastes that contain PVC- and other chlorine-containing materials are co-combusted, accidental fires involving vehicles with PVC plastic parts or homes that have pipes and appliances made of PVC; etc.[b]

We have included Table 3, part of Greenpeace comments on the Toolkit in January 2003, [15] with an indicative list of major chemical products from the uses of chlorine and/or chlorine-containing materials to support development of the Sources Identification Strategy. Information about production and producers of elemental chlorine and some of the important chlorine-containing chemicals would also be helpful to develop such strategy (see Table 2). [16] There are also two Annexes at the end of our Comments that list both "Commercial Chemicals Known or Suspected to be Accompanied by Dioxin Formation During Their Manufacture" and "Pesticides Known or Suspected to be Accompanied by PCDD/F Formation During Manufacture" (see Annex 1 and Annex 2).

## Emission Factors

Emission factors are a commonly used tool to construct inventories of different polluting substances and to fulfill the mission of pollutant release and transfer registers. This justifies their use in the Toolkit. An *emission factor* as defined by the Toolkit is the quantity of PCDD/Fs released to air, water, land, residues, and/or products when a specified quantity of material is processed or product is produced. In discussing the Toolkit's emission factors, the authors effectively acknowledge that the emission factors in their database are not universally applicable. In fact, the Toolkit uses information from industrialized countries. For example, the text of Toolkit indicates that, *"The "Toolkit" has been assembled using the accumulated experience of those who have compiled inventories. ... A review by UNEP Chemicals in 1999 identified only 15 [inventories], nearly all from developed Northern countries. ... Many are*

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[a] Primary dioxin sources are those processes and activities that actually generate dioxins, as opposed to secondary sources, which serve as points of release for dioxins generated by primary sources.

[b] This is an end of Greenpeace International document quotation.

**Table 1: Selection of Identified Dioxin Sources Not Included in the Toolkit's List of Sources**

| Source | Reference | Source | Reference |
|---|---|---|---|
| Tire combustion | [17] | Accidental fires involving stockpiles of PVC | [18] |
| Petroleum refining catalyst regenerators [c] | | Run-off from roads | [19] |
| Tetrachlorobisphenol-A manufacture | | Thermal stabilization of sewage sludge | [20] |
| Primary aluminum production | | Fireworks | [21] |
| Primary copper production | | Oil and gas exploration – well testing | [22] |
| Drum and barrel reclamation | | Hog fuel boilers [d] | [23] |
| Iron chloride manufacture | | Accidental fires involving stockpiles of tires | [24] |
| Aluminum chloride manufacture | | Thermal stabilization of sewage sludge | [25] |
| Copper chloride manufacture | | Rubber manufacture, vulcanization process | [26] |
| Phthalocyanine dyes and pigments manufacture | | Elemental chlorine manufacture, titanium electrodes [e] | [27] |
| Printing inks manufacture and/or formulation | | Trichloroethylene and perchloroethylene manufacture [f] | [28] |
| Carbon reactivation furnaces (industrial spent carbon and spent carbon from municipal water treatment) | | Caprolactam manufacture (intermediate for manufacture of nylon) | [29] |
| Alkylamine tetrachlorophenate manufacture | | Titanium dioxide manufacture | [30, 31] |
| Candle burning | | | |
| Municipal wastwater treatment | | | |

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[c] While it is acknowledged that this process has been otherwise identified as a dioxin source, it is not included in the Toolkit's list of sources and no data are given on dioxin releases.

[d] While this process may be assumed to be included in the subcategory, "Biomass Power Plants", it has been specifically identified in the scientific literature as well as in at least one national inventory as an important source due to high dioxin releases attributed to the high chlorine content of `hog fuel.'

[e] In the text of the Toolkit, manufacture of elemental chlorine using titanium electrodes is acknowledged to be a dioxin source. However, the Toolkit's list of sources includes only chlorine production with graphite anodes.

[f] Manufacture of these chemicals is acknowledged as a dioxin source in the Toolkit and an emission factor is given in the text. However, these are not included in the Toolkit's list of sources.

| **Table 2: Stanford Research Institute Reports on Production and Producers of Chlorine and Chlorinated Products**[32] | | | | | |
|---|---|---|---|---|---|
| **Title** | **Year** | **Authors** | **Cost** | **Production** | **Production Locations** |
| Chlorine/Sodium Hydroxide | Oct. 2002 | Eric Linak | $4,000 | | US, Canada, Mexico, Brazil, W. Europe, E. Europe, Middle East, Japan, ASEAN, China, India, Republic of Korea, Taiwan, Australia |
| Hydrochloric Acid | Nov 2001 | Eric Linak with Yashuhiko Sakuma | $2,500 | 16.6M tonnes (US, W. Europe, Japan) | US, Canada, Mexico, W. Europe, Japan |
| Ethylene Dichloride | Jan 2001 | Aida Jebens with Katherine Shariq | $1,500 | 32M tones(consumption) | North America, W. Europe, Japan, Taiwan, Republic of Korea, Other Asia, Other Regions |
| Vinyl Chloride Monomer (VCM) | Dec. 2000 | Aida Jebens with Akihiro Kishi | $2,000 | 25M tones | North America, W. Europe, Japan, Republic of Korea, Taiwan, Other Asia, Other Regions |
| Polyvinyl Chloride Resins | Jan 2001 | Aida Jebens with Akihiro Kishi | $2,000 | 25M tones | North America, Latin America, W. Europe, Japan, Republic of Korea, Other Asia, Other Regions |
| Chlorinated Methanes | Dec 2001 | Eric Linak and Goro Toki | $4,000 | ($1B global value) | US, Canada, Mexico, South America, W. Europe, E. Europe, Japan, China, Asia Pacific |
| Phosgene | July 2000 | Jamie Lacson | $1,500 | | US, Canada, Mexico, South America, W. Europe, Japan, Other Asia, China, Republic of Korea, |
| C2 Chlorinated Solvents | Jan 2002 | Eric Linak and Goro Toki | $2,500 | | US, Canada, Mexico, Brazil, W. Europe, E. Europe, Japan, China, Southeast Asia and Oceania |
| Monochloroacetic acid | Jan 2002 | Jamie Lacson with Kazuo Yahi | $1,500 | | US, W. Europe, E. Europe, Japan |
| Epichlorohydrin | Dec 2000 | Elvira Greiner with Thomas Kaelin and Mashiro Yoneyama | $1,800 | 640T tonnes (US, W. Europe and Japan) | US, W. Europe, E. Europe, Japan, China, Republic of Korea, Taiwan, Thailand |
| Chlorobenzenes | Dec 1999 | Jamie Lacson with Chiara Cornetta and Masahiro Yoneyama | $1,500 | 336T tonnes (US, W. Europe and Japan) | US, Canada, Mexico, Brazil, W. Europe, E. Europe, |
| Benzyl Chloride | July 2001 | Elvira Greiner with John Bottomley and Goro Toki | $2,000 | 128T tonnes (US and W. Europe) | US, Canada, Mexico, W. Europe, E. Europe, Japan, Other Asian Countries |

## Table 3: Indicative List of Uses of Chlorine and Chlorine-containing Products

| **Product** | **Uses** |
|---|---|
| **Elemental chlorine** | • Industrial processes (e.g., pulp and paper bleaching)<br>• Water and wastewater treatment<br>• Production of hydrogen chloride |
| **Hydrogen chloride** | Many |
| **C1 Derivatives** | |
| Monochloromethane | Manufacture of<br>• Methyl cellulose<br>• Silicones<br>• Tetramethyl lead |
| Dichloromethane | |
| Trichloromethane | Manufacture of HCFCs → PTFE |
| Tetrachloromethane | Industrial processes |
| Phosgene | Manufacture of<br>• Diisocyanates → Polyurethanes<br>• Polycarbonates |
| **C2 Derivatives** | |
| Monochloroethane | Manufacture of tetraethyl lead |
| 1,2-Dichloroethane (EDC) | Manufacture of<br>• Vinyl chloride → Polyvinyl chloride<br>• PVDC<br>• PVDF<br>• Perchloroethylene → HFC<br>• Trichloroethylene → HFC |
| Trichloroethylene | Manufacture of HFC |
| 1,1,1-Trichloroethane | Manufacture of<br>• HFC<br>• HCFC |
| Monochloroacetic acid | Manufacture of Carboxymethyl cellulose → Foods, cosmetics |
| Trichloroacetic acid | Manufacture of pharmaceuticals |
| **C3 Derivatives** | |
| Allyl chloride | Manufacture of<br>• Epichlorohydrin Epoxy resins & Glycerols<br>• Flocculants<br>• Propylene oxide<br>→ Propylene glycol → Glycol ethers<br>→ Polyols → Polyurethanes |
| Epichlorohydrin | |
| **C4 & Higher Derivatives** | Manufacture of Chloroparaffins → Linear alkyl benzene |
| Dichlorobutene | Manufacture of Chloroprene → Polychloroprene |
| **Aromatic Derivatives** | Manufacture of<br>• Pesticides, Anti-bacterials, etc.<br>• Dyes and dyestuffs<br>• Aramide fibers |
| **Inorganic Derivatives** | |
| Aluminum chlorides | |
| Iron chlorides | |
| Silicon tetrachloride | Manufacture of<br>• Silicon dioxide<br>• Silicon |
| Sulfur chlorides | Manufacture of<br>• Pesticides, etc.<br>• S-resins |
| Sodium hypochlorite | |
| Titanium tetrachloride | Manufacture of titanium dioxide |
| Phosphorus chlorides | Manufacture of pesticides, etc. |

*incomplete, out of date or lack uniform structure. ...Further, only a few inventories address releases other than to air."*

Analysis of how the default emission factors for all main source categories and subcategories have been derived and noting that they been determined mostly in the industrialized countries shows the limitations of their use because they are not equally applicable in various countries, especially in developing countries and countries with economies in transition.

Having acknowledged the marked limitations of the Toolkit's emission factors, particularly with respect to developing countries and countries with economies in transition, the authors nevertheless advise that: *"No emission testing is necessary to apply the Toolkit and to compile an inventory."*

In addition, the authors state that one of key elements of the Toolkit is, *"A detailed database of emission factors, which provides suitable default data to be applied which is representative of the class into which processes are grouped. ..."*

In addition the Toolkit authors state that, "*This database [of emission factors] can be updated in the future as new data becomes available."* The Toolkit in effect ignores already available data from measurements and scientific literature to define emission factors in the range closer to real releases of PCDD/Fs.

Inventories vary widely from year to year or even within the same year (for example in Holoubek, I. et al. 2004[33]) because they use emission factors commonly based on a limited number of measurements from a relatively small number of sources that are assumed to be representative for all sources of the same type. This "top down" approach probably underestimates PCDD/F releases since it does not take into account the variability in releases from individual sources or the variability among individual sources of nominally similar types. In turn, such underestimations can result in inappropriate ranking of PCDD/F sources so that national action plans do not target the most important PCDD/F sources.

In addition, default emission factors used in Toolkit are derived almost entirely from sampling and analysis carried out in a small number of industrialized countries. Such default emission factors do not yield useful results even when applied to similar facilities in the same industrialized country. For example, Webster and Connett (1998) estimated PCDD/F releases to air from US incinerators for which monitoring data were available. They compared these estimated annual air releases with estimates calculated using default emission factors. They generally found that estimates of air releases based on default emission factors were considerably smaller than those based on actual monitoring data. In fact, they found that the measurement-based estimate of annual air releases from two particular incinerators was as large or larger than 9 of 11 emission factor-based estimates for all incinerators combined.[34] A similar situation occurred during the preparation of a PCDD/PCDF inventory for releases to air for a National Implementation Plan. Data calculated for incinerators with using old emission factors originally underestimated value of waste incineration in whole PCDD/Fs releases into air.[35] A similar development occurred in the case of PCDD/PCDF inventory for releases to air prepared as a part of National Implementation Plan for the Stockholm Convention in the Czech Republic. Data calculated for incinerators using old emission factors originally underestimated value of waste incineration in whole PCDD/Fs releases into air. But not only the value for waste incineration releases into the air changed in the Czech case.[36]

The examples presented in Table 4, some of which are discussed below, further illustrate the severe limitations of default emission factors, particularly those derived from PCDD/F-generating processes and activities in industrialized countries. Using such emission factors to estimate PCDD/F releases from processes and activities can result in large under-estimations of PCDD/F releases in any country.

**Table 4: Comparison of Selected Emission Factors**

| | **UNEP Toolkit** | **Other** |
|---|---|---|
| **Emission FactorAIR, µg I-TEQ/ton** | | |
| Cement kilns, all | 0.15 - 5 | 0.15 [g]<br>OSPAR Guidance[37] |
| Cement kilns, hazardous waste | No factor given | 20.91 U.S.[38] |
| Cement kilns, no hazardous waste | No factor given | 0.27 U.S.[39]<br>202231 Russia [40] [h] |
| Municipal waste incinerator, high quality pollution control | 0.5 | 1.5<br>OSPAR Guidance[41] |
| Aluminum Production, Primary | None or insignificant<br>No factor given | 11169 Russia [42] |
| EDC/VCM/PVC *"Modern plants"* | 0.015 [i] | 0.1 – 33<br>Germany [43] |
| Thermal metal reclamation | 3.3 | 17<br>OSPAR Guidance[44] |
| **Emission FactorWATER, µg I-TEQ/ton** | | |
| EDC/VCM/PVC *"Modern plants"* | 2 [b] | 400 Germany[45]<br>0.5 OSPAR Guidance[46] |
| Municipal waste incinerators | *"minor importance"*<br>no factor given | 0.09 – 1.87 _g TEQ/L<br>OSPAR Guidance[47] |
| Hazardous waste incinerators | *"not… important"*<br>no factor given | 0.15<br>OSPAR Guidance[48] |
| **Emission FactorRESIDUE, µg I-TEQ/ton** | | |
| Aluminum Production, Primary | None or insignificant<br>No factor given | 141.1 Russia [49] |

Comments to data in Table 4 taken from Greenpeace comments presented in January 2003: [50]

- **PVC Production:** The Toolkit's emission factors for the production chain for polyvinyl chloride – ethylene dichloride (EDC)/vinyl chloride monomer (VCM)/polyvinyl chloride (PVC) – are those put forward by the U.S. industry. However, as shown in Table 4, German emission factors for releases to water and in residues are, respectively 100 and 200 times greater than those presented in the Toolkit. PCDD/F concentrations in treated wastewater from a Russian facility also support an emission factor for releases to water that is some 100 times greater than the Toolkit emission factor. However, the Toolkit's emission factor for releases to air is similar to that reported for German facilities. [51]

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[g] "Measurements recommended at some plants incinerating wastes"

[h] Value confirmed by N. Klyuev via personal communication, 11 June 2002.

[i] This value is based on data from the U.S. PVC industry, according to the Toolkit's authors.

- **Cement Kilns:** As shown in Table 4, the Toolkit's air emission factor for the most well controlled cement kilns is quite close to the U.S. factor for cement kilns fired with conventional fuels. However, while the Toolkit presents the same air emission factors for all cement kilns regardless of the materials used to fuel the kilns, air emission factors for U.S. cement kilns burning hazardous waste are some 77 times greater than those for cement kilns fired with conventional fuels. [52] The air emission factor reported for a coal-fired cement kiln in Russia is more than 40,000 times greater than the Toolkit's highest air emission factor for cement kilns

- **Aluminum Production:** In their discussion of PCDD/F formation in aluminum production, the Toolkit's authors note that, in primary aluminum production, PCDD/F levels *"are generally thought to be low and the main interest is in the thermal processing of secondary materials,"* i.e., secondary aluminum production. With that, primary aluminum production is not listed as a PCDD/F source and no emission factors are presented for this industry. However, as shown in Table 4, monitoring data at a primary aluminum production facility in Russia resulted in high emission factors for releases to air and in residues.

**Table 5: Examples of Air Emission factors for PCBs releases used in the Czech POPs emissions inventory [53]**

| Release source category | SNAP | PCBs emission factors for air releases [mg.t$^{-1}$] |
|---|---|---|
| Ore sintering plants | 30301 | 1.18280 |
| Steel smelting | 40203 | 0.00000 |
| Steelworks | 40207 | 0 |
| Cast iron production | 30303 | 0.13590 |
| Coke production | 40201 | 0 |
| Cement production | 30311 | 0 |
| Leaded glass production | 30317 | 0 |
| Municipal waste incineration | 90201 | 5.8000 |
| Hazardous waste incineration | 90202 | 331.3050 |
| Medical waste incineration | 90207 | 15.0250 |
| Sewage sludge incineration | 90205 | 5.4000 |

## Releases to Land, Residues and Products

EU inventories of PCDD/PCDF releases have been prepared in the form of PRTR databases. One addresses releases to air [54] and the other addresses releases to water and land. [55] The decision to research and divide releases into these three sectors of the global environment is quite clear if we look at the routes of pollution in the environment. The databases are based on geographical or environmental classification of the sectors belonging to environment – atmosphere (air), hydrosphere (water) and lithosphere or geosphere (land). Following the releases this way creates no confusion. Land is counted as surface, soil and "underground" (including underground mines for example).

The Toolkit's authors decided that releases of PCDD/F inventories should be configured to address five,*"compartments and/or media: air, water, land, wastes (residues), and products…"* This causes confusion. For the purposes of the inventories, the environmental compartment *"land"* consists only of *"soils"*, as in surface soils according to Toolkit. In other words, they decided that *"landfills"* are not a part of this or any other environmental compartment as well as underground mines. As a consequence, releases to landfills do not constitute releases to the environment according to the Toolkit. For example, in their discussion in Section 6.9 Disposal/Landfill, the Toolkit authors describe the fate of PCDD/F-contaminated residues as *"containment in secure landfills, destruction (thermally or chemical decontamination) or release into the environment."*

By defining surface soils as the sole components of the environmental compartment *"land"*, the authors of the Toolkit have created a circumstance for municipal solid waste incinerators, in which they state that, *"No release to land is expected unless untreated residue is directly placed onto or mixed with soil."* In contrast, ashes from municipal waste incinerators accounted for approximately 20 percent of total PCDD/F releases to land in the EU based on the EU inventory. [56]

According to the Toolkit, even when disposed of in landfills, PCDD/F-contaminated ashes from hazardous waste incinerators, medical waste incinerators, shredder waste incinerators, medical waste incinerators, waste wood and waste biomass incinerators, etc. are not acknowledged as PCDD/F releases to land or, consequently, to the environment. Presumably, if the Toolkit were to address deep-well injection of PCDD/F-contaminated wastes, (which it ignores even though this method of disposal is practiced in some countries) injection of PCDD/F-contaminated wastes down deep-wells would not be considered to be a release to the environment.

## Legislative tools to collect data and PRTRs

An international consensus on inventories was reached at the Aarhus Convention in May 2003 in Kiev with the "Protocol on Pollutant Release and Transfer Registers" (PRTRs) during the 5th Ministerial meeting, "Environment for Europe." This Protocol includes the requirement to follow releases of all chemicals listed in Stockholm Convention. It would be helpful even to say in the introduction of the Toolkit, that as soon as the Protocol enters into force it can help Parties collect data for their own inventories and show examples from existing PRTR systems in the world. With PRTRs and related mechanisms, Parties can require point sources of by-product POPs, such as manufacturing facilities, waste disposal facilities, etc., to monitor and report their releases of by-product POPs as well as intentionally produced POPs.

In support of this addition to the Toolkit, the Stockholm Convention states that each Party must give sympathetic consideration to PRTRs. [57] Many countries are already moving towards the use of data collected through PRTR programs for the compilation of national inventories. [58]

To help with collection of data from industry it is necessary in designing the national PRTR systems to pay attention to thresholds. To get any data for HCB releases into air would be not possible by establishing a threshold on the level of 10 kg per annum and one facility for releases into air for example. [59]

The Toolkit should help Parties to explain different possible legislative tools or best practices, which can help to collect data like including the duty to measure or calculate releases in different parts of legislation such as state decrees. A specific part dedicated to providing a collection of examples of legislation or environmental policies which helped to collect data about byproducts' releases would be helpful.

See also further specific comments on this topic in our detailed comments which follow.

## Detailed comments on Standardized Toolkit for Identification and Quantification of Dioxin and Furan Releases

| Page number | Selected excerpts from the Toolkit with comments and suggestions for changes |
|---|---|
| 1 | *"Therefore, sources of unintentionally generated POPs must be quantified and the methodology used to address sources must be consistent in order to follow or monitor dioxin releases over time and between countries."*<br>Comment: There term "dioxin" in this sentence is often used for PCDD/PCDF by the public or journalists. But without explaining it includes both PCDDs and PCDFs it should be not used, especially when other parts of the Toolkit most use "PCDD/PCDF."<br>Suggestion: **To use "PCDD/PCDF" instead of "dioxin."** |
| 3 | *"The final country inventories will clearly show that all potential sources have been addressed, even if the activity does not exist or is insignificant in that country."*<br>Comment: The Toolkit's list of sources does not include all PCDD/F sources that have been identified in various inventories, studies, etc., and new sources are still being discovered. Given this circumstance, the above statement is not accurate. However, when the Toolkit is modified to include a strategy for identifying PCDD/F sources, a somewhat parallel statement can be made.<br>Suggestion: ***The final country inventories will show that all sources listed in the Toolkit have been addressed, even if the activity does not exist or is insignificant in that country.*** |
| 9 | ***"2.3 Further Reading***<br>*This Toolkit is for the preparation of a release inventory for polychlorinated dibenzo-pdioxins (PCDD) and polychlorinated dibenzofurans (PCDF) ... respective Web Pages:"*<br>Comment: For further reading, a certain, but limited number of examples is provided. This part should be supplemented with some more useful sources of information<br>Suggestion: to add further text with references after first paragraph with references:<br>"***The United Nations Economic Commission for Europe web pages on the PRTR Protocol include the text of the Protocol (so far in English, Russian and*** |

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| | ***French). Unofficial translations into other languages are also likely to become available. http://www.unece.org/env/pp/prtr.htm***<br>***UNITAR (United Nations Institute for Training and Research) (2003). National Pollutant Release and Transfer Register Capacity Building Library: A Compilation of Resource Documents (2nd Edition, 2003). This is an extensive collection of documents on PRTRs, and links to other relevant websites are also provided. It is available on CD or on-line. http://www.unitar.org/cwm/prtrcd/index.htm***<br>***OECD (1996).: Pollutant Release and Transfer Registers: Guidance Manual for Governments (OCDE/GD(96)32). This is a key document which was produced in conjunction with a series of international multi-stakeholder meetings, including representatives of government, industry and NGOs. OECD has also produced a number of other documents. The guidance manual is available at:***<br>***http://www.olis.oecd.org/olis/1996doc.nsf/LinkTo/ocde-gd(96)32 (English)***<br>***http://www.oecd.org/dataoecd/18/30/1901146.pdf (Russian)”*** |
| 10 | *“Pollutant Release and Transfer Registers (PRTR): They will be established following recommendations contained in UNCED Agenda 21, Chapter 19. Governments and relevant international organizations with the cooperation of industry should [among others] “Improve data bases and information systems on toxic chemicals, such as emission inventory programmes…”*<br>*URL of a clearinghouse: http://www.chem.unep.ch/prtr/Default.htm”*<br>Comment: This paragraph is very general and does not make it clear that the suggested website contains valuable information on national PRTRs and activities of International organizations.<br>Suggestion: to change and enlarge this paragraph as follow:<br>***“Pollutant Release and Transfer Registers (PRTR): They will be established following recommendations contained in UNCED Agenda 21, Chapter 19. Governments and relevant international organizations with the cooperation of industry should [among others] “Improve data bases and information systems on toxic chemicals, such as emission inventory programmes…”***<br>***The following website http://www.chem.unep.ch/prtr/Default.htm contains valuable information on PRTR activities of national and international organizations. Below are direct links to some well developed national PRTR:***<br>***Australia: National Pollutant Inventory***<br>***http://www.npi.ea.gov.au***<br>***Canada: National Pollutant Release Inventory***<br>***http://www.ec.gc.ca/pdb/npri/npri_home_e.cfm***<br>***England and Wales: Pollution Inventory***<br>***http://216.31.193.171/asp/1_introduction.asp***<br>***Japan:***<br>***http://www.prtr.nite.go.jp/english/summary2001.html***<br>***The Netherlands: Datawarehouse Emission Inventory***<br>***http://dm.milieumonitor.net/en/index.htm*** |

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|  | ***Norway:***<br>***http://www.sft.no/bmi/ [which has a link to pages in English]***<br>***Scotland:***<br>***http://www.sepa.org.uk/data/eper/mainpage.htm***<br>***Sweden:***<br>***http://www.naturvardsverket.se/prtr/***<br>***United States: Toxics Release Inventory***<br>***http://www.epa.gov/tri/***<br>***North America - Commission for Environmental Cooperation (CEC). Their "Taking Stock" report is a compilation of comparable PRTR data from Mexico, the United States and Canada:***<br>***http://www.cec.org"*** |
| 10 | *"The IPPC Directive - Integrated Pollution Prevention and Control of the European Union: This directive is about minimizing pollution from various point sources throughout the European Union. All installations covered by an Annex of the Directive are required to obtain an authorization (permit) from the authorities in the EU countries. The permits must be based on the concept of Best Available Techniques (BAT). It has also been decided that policy-makers as well as the public at large need better information about the. The Directive provides for the setting up of a European Pollutant Emission Register (EPER) to inform about the amount of pollution that different installations are responsible for.*<br>*URL for IPPC Directive: http://europa.eu.int/comm/environment/ippc/*<br>*URL for BAT documents: http://eippcb.jrc.es/*<br>*URL for EPER: http://europa.eu.int/comm/environment/ippc/eper/index.htm"*<br><br>Comments: This paragraph in the Toolkit has to be updated based on the information already available. We think it is useful to clearly differentiate between the term BAT used here and "BAT" used as a term in the Stockholm Convention by including the URL for EPER: http://europa.eu.int/comm/environment/ippc/eper/index.htm was substituted by: : http://www.eper.cec.eu.int<br><br>Also it looks like there is a missing word at the end of the 4th sentence in this paragraph.<br><br>As we didn't find notice about the UN ECE PRTR Protocol to Aarhus Convention we propose to add the information about this important tool after the text on EPER.<br><br>Suggestion: To update this paragraph by adding the text before the reference to the websites: ***"The IPPC Directive - Integrated Pollution Prevention and Control of the European Union: This directive is about minimizing pollution from various point sources throughout the European Union. All installations covered by an Annex of the Directive are required to obtain an authorization (permit) from the authorities in the EU countries. The permits must be based on the concept of Best Available Techniques (BAT).[j] It has also been decided that policy-makers as well as the public at large need better information about the*** |

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[j] *BAT according to EU legislation has different meaning compared to the Best Available Technique term used in Stockholm Convention.*

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|  | ***facility specific pollution. The Directive provides for the setting up of a European Pollutant Emission Register (EPER) to inform about the amount of pollution that different installations are responsible for.***<br>***EPER lists 50 chemicals and industries caught by the scope of EPER have to report their releases to water and/or to air, but not to land. This means that the EPER inventory is not totally integrated across the media. Transfers are not included. The register became publicly available in February, 2004. It contains detailed information on pollution from 10 000 industries and enterprises in the EU and Norway. In March, 2004, additional information from Hungary will be incorporated. Next reporting year under EPER is 2006. For purpose of POPs by-products inventories it is important that EPER includes data on PCDD/F and hexachlorobenzene.***<br>***URL for IPPC Directive: http://europa.eu.int/comm/environment/ippc/***<br>***URL for BAT documents: http://eippcb.jrc.es/***<br>***URL for EPER: http://www.eper.cec.eu.int/eper***<br>***All the chemicals that are listed under EPER are incorporated into the UN ECE Protocol on Pollutant Release and Transfer Registers to the Aarhus Convention on Access to Information, Public Participation in Decision-Making and Access to Justice in Environmental Matters. The new Protocol was adopted at the 2003 "Environment for Europe" Ministerial Conference in Ukraine. As of the end of 2003, 36 countries and the European Community have signed the Protocol, but it will take several years to enter into force. Any country in the world can become a Party, opening up the possibility for the PRTR Protocol to set a global standard for pollution reporting and transparency. Given that all the EU countries and the European Community have signed the Protocol, EPER should develop into a proper PRTR in line with the Protocol in the future. The full text of the Protocol (in English, French and Russian) can be found at the UNECE web site: http://www.unece.org/env/pp/prtr.htm "*** |
| 9 - 10 | Because PRTR data are publicly available and widely used, many types of non-governmental and public organisations have been interested and involved in the design, implementation, and use of PRTR systems. The Toolkit does not incorporate any links or information about the activities of non-governmental organisations. Thus, we suggest including the following paragraph:<br>Suggestion: ***"Because PRTR data are publicly available and widely used, many types of non-governmental organizations have been interested and involved in the design, implementation, and use of PRTR systems. The following sites provide information on PRTR related activities implemented by non-governmental organizations:***<br>***The "Scorecard" web site of the NGO Environmental Defense allows a great range of queries of US Toxics Release Inventory data and other databases. It has an extensive database of information on specific chemicals: http://www.scorecard.org***<br>***The Working Group on Community Right-to-Know supports a network of right-to-know advocates with an inspiring record of community activism in the US.*** |

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| | ***http://crtk.org/index.cfm***<br>***Silicon Valley Toxics Coalition and Clary-Meuser Research Network web site has many links to PRTRs, related data and research projects. http://www.mapcruzin.com/globalchem.htm***<br>***The Regional Environmental Centre for Central and Eastern Europe (REC-CEE) have a Public Participation Programme which has made substantial contributions to the discussion on PRTRs in the CEE region. http://www.rec.org/REC/Programs/PublicParticipation.html***<br>***The European coalition of non-governmental organizations ECO-Forum prepared a Guidance Your right to know about sources of pollution, which is a brief introduction to the Protocol on Pollutant Release and Transfer Registers. The Guidance is available at: http://www.eeb.org and http://www.participate.org"*** |
| 11 | *"PCDD/PCDF are formed as unintentional by-products in certain processes and activities, Annex C of the Stockholm Convention provides two lists for several of these. Besides being formed as unintentional by-products of manufacturing or disposal processes, PCDD/PCDF may also be introduced into processes as contaminants in raw materials. Consequently, releases or transfers of PCDD/Fs can occur even where the PCDD/Fs are not formed in the process under consideration."*<br>Comment: With regard to the first sentence, it is critical that Parties are given at least the most important facts of PCDD/Fs formation. But the most important condition for PCDD/Fs formation is not introduced. It seems that authors are somehow afraid to say that the presence of chlorine is necessary for PCDD/Fs formation.<br>Suggestion: ***PCDD/PCDF are formed as unintentional by-products in certain processes and activities, all of which share one common feature: the availability of chlorine and/or chlorine-containing materials. Besides being formed as unintentional by-products of manufacturing or disposal processes, PCDD/PCDF may also be introduced into processes as contaminants in raw materials.*** |
| 11 | *"Four conditions, present either individually or in combination, favor generation of PCDD/PCDF in thermal processes:*<br>*• High temperature processes (during cool-down of combustion gases in a temperature range of ca. 200-450 °C) and/or incomplete combustion;*<br>*• Organic carbon;*<br>*• Chlorine;*<br>*• PCDD/PCDF containing products"*<br>Comment: It is not accurate that any of these "four conditions either individually or in combination" may cause PCDD/Fs formation. For example, not one of these conditions individually will lead to PCDD/F formation. Moreover, high temperature and organic carbon in combination will not lead to PCDD/F formation. "PCDD/PCDF containing products" do not "cause generation of PCDD/PCDF", although they may cause "release to air.' Indeed, the first three |

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| | “conditions” – high temperature, organic carbon, and chlorine – do not result in PCDD/Fs formation unless oxygen is present.<br>Suggestion: Correct this text segment as indicated below:<br>***“PCDD/F formation can take place only when the following four elements are available and brought into contact under appropriate conditions:***<br>***• Chlorine***<br>***• Carbon***<br>***• Oxygen***<br>***• Hydrogen***<br>***PCDD/F formation is known to take place at temperatures ranging from ambient to those of high-temperature combustion. For example, PCDD/F formation has occurred during composting of materials contaminated with pentachlorophenol[60] and through photolysis at ambient temperature of pentachlorophenol-contaminated soils[61]. PCDD/F formation is also known to occur as furnace gases from high-temperature incinerators cool through a temperature range of 900 to 240 °C.”[62]*** |
| 12 | *“The Toolkit addresses* ***direct*** *releases of PCDD/PCDF to the following five release vectors to the following compartments and/or media (Figure 1).*<br>*• Air*<br>*• Water (fresh, ocean, estuarine; then subsequently into sediments)*<br>*• Land*<br>*• Residue (including certain liquid wastes, sludge, and solid residues, which are handled and disposed of as waste or may by recycled)*<br>*• Products (such as chemical formulations or consumer goods such as paper, textiles, etc.).”*<br>Comment: Freshwater is sometimes taken in narrow meaning as only surface water. The same problem might be with explaining the term “Land” as only surface. But in many cases there are releases of PCDD/Fs below the surface of the earth. With regard to the bullet point “Residue”, the meaning and purpose of the phrase “or may be recycled” is not obvious. If the authors are suggesting that dioxin-containing wastes are mainly recycled, this is not an accurate reflection of the fate of such materials. For example, fly ash and bottom ash containing dioxins may be used as a raw material for road cover or as a part of other materials used in building industries, making them available for environmental release. Inventories should note this potentially important route of PCDD/Fs releases into the environment.<br>Suggestion: ***“The Toolkit addresses direct releases of PCDD/PCDF to the following five release vectors to the following compartments and/or media (Figure 1).***<br>***• Air***<br>***• Water [freshwater (surface water and groundwater), ocean, and estuarine]***<br>***• Land (both surface and below surface)***<br>***• Residues (including certain liquid wastes, sludge and other solid residues, that are handled and disposed of as wastes)***<br>***• Products (such as chemical formulations or consumer goods such as paper,*** |

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| | ***textiles, waste declared as product or raw material like bottom ash for example etc.).”*** |
| 13 | *“Thermal and combustion processes – including incineration of wastes, the combustion of solid and liquid fuels and the thermal processing of metals;”*<br>Comment: Thermal and combustion processes in which there is no available chlorine cannot be PCDD/F sources.<br>Suggestion: ***“Thermal and combustion processes involving chlorine and/or chlorine-containing materials – including incineration of wastes, combustion of solid and liquid fuels and the thermal processing of metals;”*** |
| 13 | *“Biogenic processes, which may form PCDD/PCDF from precursors such as pentachlorophenol.”*<br>Comment: Pentachlorophenol is not the only precursor of PCDD/Fs formation. Many chlorinated compounds could serve as precursors.<br>Suggestion: ***“Biogenic and phototransformation processes, which may form PCDD/PCDF from chlorinated precursors, such as pentachlorophenol.”*** |
| 14 | *“Actual dioxin formation potential and actual release will depend on process conditions and air pollution controls applied. Technologies have been developed to reduce formation of PCDD/PCDF and to control emissions to very low levels for many processes. ”*<br>Comment: Consistency in terminology will minimize confusion. “PCDD/PCDF”, rather than “dioxin” is the term most commonly used in the draft Toolkit. Also, to avoid confusion, the word “air” should be used in conjunction with the word “emissions”, or preferably, the term used should be “air releases”. Also, if means for reducing PCDD/F formation are to be addressed in this draft report, this should be done with greater thoroughness, accuracy and consistency.<br>Suggestion: ***“Actual PCDD/PCDF formation and subsequent release to air will depend on process conditions and the type and mode of operation of air pollution controls. Various techniques and technologies exist whereby PCDD/PCDF formation can be reduced and/or eliminated. For example, elimination or reduction of chlorine and chlorine-containing materials from process inputs is a recognized technique for reducing or eliminating PCDD/PCDF formation in a variety of processes.”*** [63, 64] |
| 14 | *“PCDD/PCDF may be present in a discharge if the PCDD/PCDF formed in the industrial production process, entered the industrial process with the feed material, or leached from a repository. Examples are:*<br>*• Wastewater discharge from pulp and paper production especially when elemental chlorine is used;*<br>*• Wastewater discharge from chemical production processes, production especially when elemental chlorine is used;”*<br>Comment: Naming only elemental chlorine could lead to confusion when assembling national inventories that PCDD/F formation is an issue only when “elemental chlorine” is used. This is not the case since PCDD/F formation also takes place during pulp and paper bleaching with chlorine derivatives such as chlorine dioxide.[65] Likewise PCDD/F are also formed and released in the |

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|  | wastewater discharges from industrial processes that involve not only elemental chlorine but also other inorganic and organic chlorine derivatives, e.g., scrubber water from incinerators [66] and aluminum production involving the use of hexachloroethane. [67]<br><br>Suggestion: ***„PCDD/PCDF may be present in a discharge if the PCDD/PCDF formed in the industrial production process, entered the industrial process with the feed material, or leached from landfill or other repository. Examples are:***<br>***• Wastewater discharge from pulp and paper production using elemental chlorine or chlorine derivatives, such as chlorine dioxide;***<br>***• Wastewater discharge from chemical production processes that involve elemental chlorine or chlorine derivatives;"*** |
| 14 | *"Leaching occurs when rainwater is allowed to migrate through inadequately stored repositories of PCDD/PCDF-containing products, residues and/or wastes. Additional mobilization will occur if co-disposal of organic solvents has taken place. However, it has been shown that phenolic structure in "normal" landfill leachates are capable of mobilizing PCDD/PCDF from wastes. Examples are:*<br><br>*• PCDD/PCDF-contaminated areas such as production or handling sites of chlorophenol herbicides;*<br><br>*• Timber industry sites where pentachlorophenol or other chlorinated aromatic pesticides were used as wood preservatives;*<br><br>*• Waste dumps and junk yards, especially when PCDD/PCDF-contaminated production residues or waste oils have been disposed."*<br><br>Comment: It is important that users know that landfills are potential sources of PCDD/F-containing leachates and that leaching occurs in landfills, regardless of their design, construction and operation. [68] Not only rainwater can migrate through the landfills, but also underground streams. [69] Concerning the additional mobilization of PCDD/Fs, a more user friendly term would be humic acids with additional information about its presence in all soils.[70]<br><br>Suggestion: ***"Leaching of PCDD/PCDF occurs when rain- and/or underground water is allowed to migrate through landfills and/or inadequately stored repositories of PCDD/PCDF-containing products, residues and/or wastes. Leaching of PCDD/PCDFs from landfills is enhanced by the presence of humic acids, which are present in all soils, and by co-disposal of solvents. Examples are:***<br><br>***• PCDD/PCDF-contaminated areas such as production or handling sites of chlorophenol herbicides;***<br><br>***• Timber industry sites where pentachlorophenol or other chlorinated aromatic pesticides were used as wood preservatives;***<br><br>***• Landfills and similar repositories of waste, especially when PCDD/PCDF-contaminated production residues such as incinerator ash or waste oils have been disposed."*** |
| 14 | *"Consequently, the criteria used to identify potential releases of PCDD/PCDF to* |

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| | *water include:*<br>*1. Wastewater discharge from processes involving chlorine and/or PCDD/PCDF Contaminated products or combustion, incineration and other thermal processes where wet scrubbers are used to clean flue gases;*<br>*2. Use of PCDD/PCDF contaminated pesticides (especially PCP and 2,4,5-T) and other chemicals (especially PCB);*<br>*3. Leachate from storage and/or disposal sites of PCDD/PCDF contaminated materials."*<br><br>Comment: The items listed above do not constitute "criteria"; rather, they are examples. Items in this list seem to be repetitive of those in the other two lists in this section. Also, as discussed earlier, it is important to avoid the impression that only processes involving (elemental) chlorine are relevant to PCDD/F formation.<br><br>Suggestion: Combine all three lists into one, avoiding repetition of individual items. Otherwise, modify the text of this portion as follows:<br>***"Other examples of sources of potential releases of PCDD/Fs to water include:***<br>***1. Wastewater discharge from processes involving chlorine and/or chlorinated materials and/or PCDD/F-contaminated products or combustion, incineration and other thermal processes where chlorine or chlorine-containing materials are involved and where wet scrubbers are used to clean flue gases;***<br>***2. Use of PCDD/F-contaminated pesticides (especially PCP and 2,4,5-T) and other chemicals (especially PCB);***<br>***3. Leachate from storage, landfills and/or disposal sites of PCDD/F-contaminated materials."*** |
| 15 | *"3.2.3 Release to Land*<br>*Sources releasing PCDD/PCDF to land can be divided into three classes: PCDD/PCDF contaminated product "applied" to land directly, residues from a process left on or applied to land or PCDD/PCDF deposited onto land via environmental processes. In all cases, land serves as a sink for the PCDD/PCDF from which they can be released into the food-chain through uptake by plants and/or animals.*<br><br>*Examples include:*<br><br>*• PCDD/PCDF contaminated product or waste use, e.g. pesticides, wood preservatives;*<br><br>*• Application of sewage sludge on farm land or compost in gardens;*<br><br>*• Direct disposal of PCDD/PCDF containing wastes on land; an example would be the ashes that are left from combustion, e.g., open burning on the ground;*<br><br>*Deposition of PCDD/PCDF to land via the atmosphere is not addressed in the Toolkit."*<br><br>Comment: The decision by the Toolkit's authors to consider the environmental compartment *"land"* to consist only of surface soils potentially ignores some of the largest releases of PCDD/Fs to the environment that occur in landfills/ |

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|  | Suggestion: **The Toolkit should be revised so that the environmental compartment *“land”* consists, as is commonly accepted, of all land so that PCDD/F-containing materials that are sent to landfills, deep well injection, mines, quarries, etc. do not escape consideration as environmental releases.** |
| 15 | *“The highest concentrations of PCDD/PCDF have been found in chlorinated phenols and their derivatives, e.g., pentachlorophenol (PCP and its sodium salt), 2,4,5-trichlorophenoxyacetic acid (2,4,5-T) or polychlorinated biphenyls (PCB). Wastes and residues from production of these and other chlorinated chemicals are also contaminated with PCDD/PCDF (see release vector “Residue”).”*<br><br>Comment: This part requires both qualification and documentation, since wastes from production of these and other organochlorines contain far higher concentrations of PCDD/Fs than the products.<br><br>Suggestion: ***“Among products, some of the highest concentrations of PCDD/Fs have been found in chlorinated phenols and their derivatives, e.g., pentachlorophenol (PCP and its sodium salt), 2,4,5-trichlorophenoxyacetic acid (2,4,5-T) or polychlorinated biphenyls (PCB). However, far higher levels of PCDD/PCDF have been found in residues from production. For example, wastes from the manufacture of vinyl chloride, the monomer of polyvinyl chloride, have been found to contain some of the highest PCDD/PCDF concentrations ever reported.”*** [71, 72] |
| 15 - 16 | *“PCDD/PCDF elimination or reduction comes through*<br><br>*(a) Product substitution through ban of production and use of a product known to be highly contaminated with PCDD/PCDF, so that the process that generates PCDD/PCDF is no longer realized in a country;*<br><br>*(b) Modification of the problematic step of the process, changing of the process conditions or moving to other feed materials so that PCDD/Fs are no longer generated or at least minimized.*<br><br>*Source controls such as the above mentioned affects the PCDD/PCDF at all points in the product life-cycle, including consumer waste. Effective control of the PCDD/PCDF source to the product leads to benefits in several other environmental compartments and media at the same time.”*<br><br>Comment: This part should address material substitution as a means of reducing PCDD/Fs formation. The ultimate goal of the Stockholm Convention is not only the reduction of by-products (including PCDD/Fs), but their elimination. It means to prevent formation of even low levels of PCDD/PCDF or prevent all processes and their steps where PCDD/PCDF formation occurs. The last sentence is not true in all cases, depending on the meaning given to the word “effective,” since some commonly used methods of reducing PCDD/Fs in products simply shift the PCDD/Fs from the products to a waste stream.<br><br>Suggestion: ***“PCDD/PCDF elimination or reduction comes through***<br><br>***(a) Product substitution through a ban on the production and use of a product known to be contaminated with PCDD/PCDF, so that the process that generates*** |

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|  | ***PCDD/PCDF is no longer realized in a country;***<br>***(b) Modification of the problematic step of the process, changing of the process conditions or moving to other feed materials so that PCDD/PCDF are no longer generated.***<br>***Eliminating or reducing PCDD/PCDF formation so that products contain no PCDD/PCDF also reduces associated releases to the environment.”*** |
| 16 | *“3.2.5 Release in Residues*<br>*An almost infinite number of processes can transfer PCDD/PCDF to wastes or (mostly solid) residues. However, the most likely types of wastes can be classified according to their origin, since PCDD/PCDF are always a by-product. Examples include:*<br>*• Garbage, trash, and rubbish (municipal, industrial, hazardous, medical, etc.);*<br>*• By-product waste from combustion and thermal processes (fly ash from flue gas cleaning equipment, bottom ash, soot, etc.);*<br>*• Production residues and residual products (sludge and residues from chemical production, sewage sludge from wastewater treatment, waste pesticides, waste transformer oil, etc.).”*<br>Comment: The first sentence is inaccurate: the processes that transfer PCDD/Fs to residues are not infinite but are, indeed, limited to those processes that involve some form of chlorine. The meaning of the second sentence is not clear. The terms used in the bullet points are repetitious, needlessly confusing and fail to make the important distinction between primary and secondary sources of PCDD/Fs. Not only fly ash from flue gas cleaning equipment includes PCDD/Fs, but also washed fly ash as well as fly ash from boilers that in some countries is classified simply as fly ash.<br>Suggestion: ***“Processes in which PCDD/Fs are formed and incorporated into process residues are those that involve chlorine and/or chlorine-containing materials. Residues that contain PCDD/Fs include, for example:***<br>***• Residues from incineration and other thermal processes in which materials containing some form of chlorine are burned, e.g., fly ash, bottom ash or slag, soot, etc. from incinerators, thermal power generators, etc.***<br>***• Residues from the production of chlorine-containing chemicals or chemicals that are produced through the use of chlorine-containing intermediates, e.g., process sludge, heavy bottoms, distillation residues, etc.;***<br>***• Discarded products, e.g., off-specification or unused pesticides, banned or discarded PCB transformer oils***<br>***• Untreated wastes from households, municipalities, healthcare facilities, etc. containing discarded products that are contaminated with PCDD/Fs formed*** |

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| 17 | ***during their manufacture or transferred during their treatment with other PCDD/F-contaminated products;***<br><br>***• Municipal wastewater treatment sludge which contain PCDD/Fs due to the use of PCDD/F-contaminated cleaning products (detergents, toilet paper, etc.), laundering of contaminated clothing and other textiles, washing of contaminated vegetables, etc.”*** |
| 16 | *“Chemical production involving especially elemental chlorine leads to wastes containing PCDD/PCDF. Whether it is the production of chlorine containing pesticides or the chlorine bleaching during paper production, chemical production processes with or around elemental chlorine produce waste streams. This waste usually contains PCDD/PCDF to some extent. Chapter 6.7 details what causes the PCDD/PCDF to be concentrated in the waste stream.”*<br><br>Comment: The fact that PCDD/Fs formation is not limited to chemical production involving only elemental chlorine should be more visible in this part. PCDD/Fs formation takes place in processes involving both organic and inorganic forms of chlorine.<br><br>Suggestion: ***“Chemical production involving chlorine and/or inorganic and organic forms of chlorine variously leads to wastes containing PCDD/PCDF, e.g., the production of chlorine-containing industrial chemicals and pesticides, chemicals for which chlorine or chlorine-containing intermediates are used during their manufacture, such as titanium dioxide.”*** [73] |
| 17 | *“For example whereas contaminated wastes from the chemical industry may be incinerated and effectively destroy any PCDD/PCDF present, dumping of such residue may result in the creation of a reservoir source. Further, residues from one process may be used as a raw material in another process and without adequate controls, PCDD/PCDF releases to air, water or product can occur.”*<br><br>Comment: The destruction efficiencies achieved by modern incinerators with PCDD/Fs and other POPs has not been shown to be high. According to available data, the actual destruction efficiencies of incinerators are relatively low.[74] It is also worthy of note that not only “dumping”, which is a term commonly used to refer to uncontained surface disposal, but also landfills can be important reservoir sources. In addition, the second sentence raises an important issue: PCDD/F-containing wastes are necessarily POPs wastes. This means that PCDD/F-containing wastes must be managed according to the requirements of the Stockholm Convention, e.g., POPs waste are *“[n]ot permitted to be subjected to disposal operations that may lead to recovery, recycling, reclamation, direct reuse or alternative uses of persistent organic pollutants.”* This suggests that the reuse of some PCDD/F-containing residues is contrary to the Treaty.<br><br>Suggestion: ***“While contaminated residues from, for example, a chemical process may be effectively destroyed by an appropriate destruction technology, dumping or landfilling such residues will result in the creation of a reservoir source. Moreover, the transfer of contaminated residues for destruction or further processing can result in PCDD/PCDF releases to air, water, land, products and residues.”*** |
| 17 | *“3.2.6 Potential Hot Spots* |

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| | *Potential Hot Spots are included as a category for assessment (see Section 4.1). This category 10 differs from the other nine categories as Hot Spots from former operations known to be related to PCDD/PCDF. Hot spots have the potential to become sources in the future."*<br><br>Comment: This paragraph does not include hot spots formed in relation to current activities like mines with untreated fly ash containing PCDD/Fs. [75] In addition, the word "potential" used with respect to "hot spots" is unnecessary. Either a "hot spot" is a "hot spot" or it is not and so it is or is not included in the inventory. In addition, it would seem that "hot spots" are "hot spots" because they do have immediate or ongoing releases of PCDD/Fs or the strong probability for such releases. The same reasoning applies to legacy contamination.<br><br>Suggestion:<br>***"3.2.6 Hot Spots***<br>***Hot Spots are included as a category for assessment (see Section 4.1). This category 10 differs from the other nine categories in that there is or should not be ongoing, deliberate additions to the amount of PCDD/Fs at the hot spot. Included in this category are pits, piles, ponds, landfills, etc. in which PCDD/F wastes from former as well as ongoing operations have accumulated or been deposited."*** |
| 17 | *"Although the concentrations of PCDD/PCDF in these Hot Spots can be very high, present releases may be negligible or small."*<br><br>Comment: The issues of insignificance have yet to be resolved by the Parties to the Stockholm Convention.<br><br>Suggestion: ***"While the concentrations of PCDD/Fs in these Hot Spots may be very high, present releases may be relatively small, depending on the circumstances of each individual Hot Spot."*** |
| 19 | *"The Toolkit is designed to assemble the necessary activity data and to provide a means of classifying processes and activities into classes for which appropriate average emission factors are provided."*<br><br>Comment: The Toolkit is not "designed to assemble the necessary activity data." Instead, it offers limited advice on possible means for obtaining such data. Also as discussed earlier, it is important to define as explicitly as possible the uncertainties of release estimates. Consequently, it is necessary for the Toolkit to present and advise users to apply a range of emission factors.<br><br>Suggestion: ***"The Toolkit offers advice on assembling the necessary activity data, provides a list of source categories and sub-categories and, for each source, presents a range of emission factors for each type of releases vector."*** |
| 19 | *"First, a coarse screening matrix is used to identify the Main PCDD/PCDF Source Categories present in a country. The second step details these Main Source Categories further into Subcategories to identify individual activities, which potentially release PCDD/PCDF."*<br><br>Comment: Please refer to the earlier discussion of the need for a **Source Identification Strategy**. |

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| | Suggestion: Insert in this section, a detailed description of the **Source Identification Strategy** that will enable users to identify those sources of PCDD/F and other by-product POPs that are not addressed in the Toolkit. |
| 20 | *"1. Apply Screening Matrix to identify Main Source Categories*<br>*2. Check subcategories to identify existing activities and sources in the country*<br>*3. Gather detailed information on the processes and classify processes into similar groups by applying the Standard Questionnaire*<br>*4. Quantify identified sources with default/measured emission factors*<br>*5. Apply nation-wide to establish full inventory and report results using guidance given in the standard format*<br>*Figure 2: The recommended five-step approach to establish a national PCDD/PCDF release inventory using the Toolkit"*<br><br>Comment: Please refer to the earlier discussion of the need for a **Source Identification Strategy**.<br><br>Suggestion:<br>***"1. Apply Screening Matrix to identify Main Source Categories***<br>***2. Follow Source Identification Strategy to identify any sources that are not addressed in the Main Source Categories.***<br>***3. Check subcategories and results of Source Identification Strategy to identify existing activities and sources in the country***<br>***4. Gather detailed information on the processes and classify processes into similar groups by applying the Standard Questionnaire***<br>***5. Quantify identified sources with default/measured emission factors***<br>***6. Apply nation-wide to establish full inventory and report results using guidance given in the standard format***<br><br>***Figure 2: The recommended six-step approach to establish a national PCDD/F release inventory using the Toolkit"*** |
| 20 | *"Table 1: Screening Matrix - Main Source Categories*<br>......"<br><br>Comments: The compartment "land" does not include landfills and similar environmental repositories, causing confusion in this table. This confusion is exacerbated by Main Source Category 9, which is actually entitled "Disposal/Landfill" at Section 6.9 and is described as including landfills and waste dumps; sewage and sewage treatment; open water dumping; composting; and waste oil treatment (non-thermal).<br><br>Inclusion of the term "subcategories" in the third column is confusing, because this is a list of main categories.<br><br>Further, while the attempt to identify "main release routes for each category" is admirable, there are far too many missing emission factors in the Toolkit's database to support this effort. Even in those relatively few cases where all necessary emission factors are presented, the resulting prioritization of releases is potentially appropriate only for certain processes and activities in the industrialized countries. In some countries, industries are known to dump their process wastes along roadsides and discharge untreated wastes directly into |

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| | surface or underground waters.<br>Suggestion: **Delete the term "and Subcategories" in column 3. Reconfigure the main source categories into a more rational format. Delete columns 4 through 8. Change the text following the table accordingly**. |
| 21 | **A new subsection should be inserted between 4.1 Step 1 and 4.1 Step 2 that describes the source identification strategy, advises users on following this strategy and includes sources identified in the appropriate subcategories. Subsequently, the text in the remaining sections of the report should be modified to reflect the use and results of the source identification strategy.** |
| 21 | *"Columns identify the five compartments or media into which significant amounts of PCDD/PCDF are potentially released. The large "X" denotes the release route expected to be predominant, and the small "x" shows additional release routes to be considered."*<br>Comment: Refer to earlier discussions of compartments/media, the designation of release routes and the determination of the quantity or quantities of PCDD/F that are to be regarded as significant.<br>Suggestion: Delete these sentences or modify the text as follows: ***"Columns identify the five compartments or media into which PCDD/Fs can be released. In this regard, the large "X" denotes the release route that is often regarded as predominant, and the small "x" denotes additional release routes that have also been identified in the industrialized countries."*** |
| 21 | *"Incineration in this context means destruction in a technological furnace of some sort; open burning and domestic burning in barrels and boxes does not belong to these subcategories; they are addressed in Section 4.2.6 – Uncontrolled Combustion."*<br>Comment: The term "destruction" is inappropriate in this context, since all material input to waste incinerators is not necessarily destroyed.<br>Suggestion: ***"Incineration in this context means treatment in a combustion furnace of some sort …"*** |
| 22 | *"Wastes differ in composition and combustion characteristics and the combustion equipment typically differs for each of the waste incineration subcategories."*<br>Comment: There are also many variations in combustion equipment within subcategories (see our comments below).<br>Suggestion: ***"Wastes differ in content, e.g., presence of chlorine, chlorine derivatives and metals, and combustion characteristics. Combustion equipment also typically varies both between and within the waste incineration subcategories."*** |
| 22 | *"However, releases to air are of greatest importance as they may undergo long-range transport and subsequently contaminate the food-chain."*<br>Comment: It seems that the importance of secondary releases from residues (mainly fly ash) for food-chain contamination was not considered by Toolkit authors. Particles including PCDD/Fs were considered as important source of food-chain contamination.[76] This would be a serious route of contamination in |

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| | waste incinerators which are not equipped with appropriate fly ash collection for example.<br><br>Suggestion: ***“However, releases to air including dust burden from inadequately handled fly ash (primary and secondary as well) are of greatest importance as they may undergo long-range transport and subsequently contaminate the food-chain.”*** |
| 23 | *“Table 4: Subcategories of the Inventory Matrix – Main Category 2”*<br><br>Comment: Several sources can be added to this subcategory.<br><br>Suggestion: **Include the following in this subcategory: titanium [77], magnesium and nickel. [78]** |
| 23 | *“In large, well-controlled fossil fuel power plants, the formation of PCDD/PCDF is low since the combustion efficiency is usually fairly high, typically they use fuel that contain more sulphur than chlorine and thus inhibit the formation of PCDD/PCDF, and the fuels used are homogeneous. However, significant mass emissions are still possible as large volumes of flue gases are emitted with small concentrations of PCDD/F.”*<br><br>Comment: Since, according to the Toolkit, there are no data describing PCDD/F levels in fossil fuel power plant residues, there is insufficient information to support the first statement above. As noted in one PCDD/F inventory, *“The combustion of oil and coal emits dioxin* [PCDD/F] *because these fuels contain both chlorine and organic precursors.”*[79] Moreover, studies of power generating facilities, such as that by Kopponen et al. (1992), have shown that PCDD/F releases increased with increasing chlorine content in the fuel.[80] Other studies, such as that by Manninen et al. (1996) have shown that “chlorine content of the fuel correlated with PCDFs and there was an inverse correlation between the S/Cl ratio and PCDFs.” [81] Gullette and Raghunathan (1997) concluded that, for coal combustion processes, low or no PCDD/F formation *“may be due to a number of factors including lack of appropriate catalysts, lack of organic products of incomplete combustion, insufficient chlorine, and the presence of catalyst-poisoning sulfur as SO2.”* [82]<br><br>Suggestion: Modify wording as follows: ***“In large, well-controlled fossil fuel power plants, the formation of PCDD/PCDF is not well documented since there are no data describing releases in residues. However, PCDD/PCDF formation is known to vary with the chlorine content of the fuel and, based on available information, PCDD/F releases to air can be substantial.”*** |
| 23 | *“Where smaller plants or biomass are used, the fuel may be less homogeneous and burned at lower temperatures or with decreased combustion efficiency. These conditions can result in increased formation of PCDD/PCDF.”*<br><br>Comment: There is insufficient evidence to support the conclusion that large fossil fuel burning power plants have markedly reduced PCDD/F generation rates in general. Also, as attested to by the emission factors presented in the Toolkit and documented in Costner (2001) [83], the highest PCDD/F formation occurs when the fuel burned is wood contaminated with pentachlorophenol or contains polyvinyl chloride (PVC) cladding or some other source of chlorine. |

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| | Suggestion: ***"Where smaller plants are used, the fuel may contain more chlorine and metal catalysts and such facilities may operate at lower temperatures and with poorer combustion efficiency. However, the Toolkit's emission factors are not adequate for estimating total PCDD/F releases from such facilities."*** |
| 23 | *"The same may occur when landfill and/or biogas is used as a fuel due to the presence of unwanted and undefined additional constituents."*<br>Comment: Refer to Costner (2001) for a compilation of studies that address the issue of chlorine content and PCDD/F release. [84]<br>Suggestion: ***"PCDD/F formation and release may occur when landfill or biogas is used due to the presence of chlorinated species in the gases burned."*** |
| 23 - 24 | *"In the cases of domestic and/or household heating/cooking the quality of the fuel used is often poor and the combustion efficiency very low, resulting in increased formation of PCDD/PCDF. The predominant release vectors are to air (flue gas emissions) and with residues, fly-ashes and bottom ashes."*<br>Comment: There are sufficient data presented in the Toolkit to estimate PCDD/F releases for household heating and cooking with contaminated wood/biomass, virgin wood/biomass, and coal-fired stoves but not domestic stoves fired with oil and natural gas. In those cases where sufficient data are available, contaminated wood/biomass and coal appear to be the fuels with the high potential PCDD/F formation and releases. The last sentence is not fully supported by the release data presented in the Toolkit. See earlier discussion of the lack of sufficient data in the Toolkit. Also the chlorine content of the fuel is an important factor in PCDD/F formation [see Costner (2001)][85].<br>Suggestion: ***"In the cases of domestic and/or household heating/cooking, the highest potential for PCDD/F formation and release occurs during the burning of contaminated wood/biomass and coal, both of which may contain relatively high levels of chlorine. Where sufficient data are available, PCDD/F releases in residues are greatest."*** |
| 24 | *"These are high-temperature processes for melting (glass, asphalt), baking (brick, ceramics), or thermally induced chemical transformation (lime, cement). In them, fuel combustion generates PCCD/PCDF as unwanted byproducts. Additional, formation of PCDD/PCDF may be linked to the process raw materials used. Cement and lime kilns are large volume processes which often add wastes as a low/no cost fuel. Where effective controls are in place, use of waste materials like tires, waste oil, sludges, etc. is not problematic; low emissions have been found."*<br>Comment: Concerning these processes data is lacking that describes PCDD/F releases to land, products or residues in the Toolkit (except for cement kilns and certain asphalt mixing plants). Without this data, it is not possible to estimate PCDD/F releases. Also in the Toolkit's emission factors, there is no distinction between cement kilns and other facilities that burn waste (e.g., tires, municipal waste, medical waste, hazardous waste, etc.) and those that do not, although important differences have been documented. PCDD/Fs formation should differ according to fuel source for these facilities as well, a point that is not reflected in the Toolkit. |

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| | In the U.S. inventory, the average emission factors for air releases from cement kilns that burn hazardous waste were as much as 100 times higher than those for cement kilns burning conventional fuels. In addition, PCDD/F levels in the cement kiln dust of cement kilns burning hazardous waste were some 1000 times higher than that from conventionally fired cement kilns.[86 97]<br><br>In the absence of emission factors for releases to land and products, the Toolkit does not present satisfactory information to support the last sentence above. The last sentence goes against two principles of the Stockholm Convention in such a case: precautionary principle and the elimination of byproducts releases as an ultimate goal.<br><br>Suggestion: ***"These are high-temperature processes for melting (glass, asphalt), baking (brick, ceramics), or thermally induced chemical transformation (lime, cement). Within these processes, combustion of fuel and/or wastes generates PCCD/PCDF as unwanted byproducts when the fuel or waste contains chlorine in some form. Additional, formation of PCDD/PCDF may be linked to the process raw materials used if they contain chlorine in some form. Cement and lime kilns are large volume processes, which often use various wastes as a low/no cost fuel. There is not sufficient information to estimate total PCDD/PCDF releases from these facilities."*** |
| 25 | *"Table 8: Subcategories of the Inventory Matrix – Main Category 6*<br>*(a) (Clean) Biomass burning*<br>*(b) Waste burning and accidental fires "*<br><br>Comment: It would be useful to separate accidental fires into one subcategory and to look at the chlorine and chlorine compounds containing products presence during such fires.<br><br>Suggestion:<br>***"Table 7: Subcategories of the Inventory Matrix – Main Category 6***<br>***(a) (Clean) Biomass burning***<br>***(b) Waste burning***<br>***(c) Accidental fires (buildings, vehicles, landfills, warehouses, trains, etc.)"*** |
| 25 | *"Indicators of high probability to form PCDD/PCDF in chemical manufacturing processes are' high temperature', 'alkaline media', 'the presence of UV-light as an energy source', and 'the presence of radicals in the reaction mixture/chemical process' (see Section 3.1).*<br><br>Comment: Refer to earlier discussions of this issue: chlorine or its derivatives has to be present to form PCDD/PCDFs.<br><br>Suggestion: ***"Indicators of high probability to form PCDD/PCDFs in chemical manufacturing processes are the presence of chlorine in some form and conditions such as `high temperature', 'alkaline media', 'the presence of UV-light as an energy source', and/or 'the presence of radicals in the reaction mixture/chemical process' (see Section 3.1)."*** |
| 26 | *"Table 8: Subcategories of the Inventory Matrix – Main Category 7*<br>*..."*<br><br>Comment: This table could include more uses. |

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| | Suggestion: Add the following in the table:<br>***“(f) Application of certain biocides (crops, textiles, buildings, etc.)***<br>***(g) Use of certain personal care products (e.g., toothpastes, etc. that contain certain bactericides)”*** |
| 26 | *“The use of elemental chlorine for bleaching and the use of certain biocides such as PCP and certain dyestuffs (chloranil-based) have been contributors to direct releases of PCDD/PCDF to water. Thus, strong emphasis should be put on the detailed investigation of these few potential sources of major overall significance of contribution to the overall PCDD/PCDF problem.*<br><br>Comment: The second sentence would include both chlorine derivatives as well as elemental chlorine use in processes (see earlier discussions, e.g., PCDD/F formation in bleaching occurs when any form of chlorine is used). There is no reason or given evidence to suggest that chemical production facilities are “few”.<br><br>Suggestion: ***“The use of chlorine or chlorine derivatives for bleaching and the use of certain chlorine-containing biocides and dyestuffs, e.g., pentachlorophenol and chloranil-based dyes, have been contributors to direct releases of PCDD/PCDFs to water. Thus, strong emphasis should be given to detailed investigation of chemical production facilities that use or manufacture chlorine and/or chlorine-containing materials, since they are of major significance to the overall PCDD/PCDF problem.”*** |
| 26 | *“Formation of PCDD/PCDF occurs mostly when contaminated fuels are being used and due to reaction of the hot gases with the organic matter of the materials to be dried. In case of biomass drying and smoke-houses, wastes such as used/treated wood, textiles, leather or other contaminated materials have been used as fuels.”*<br><br>Comment: This paragraph should include basic information that the presence of chlorine in the fuel is needed to for PCDD/Fs formation.<br><br>Suggestion: ***“Formation of PCDD/Fs occurs due to reactions of the hot gases with sources of chlorine (mostly when contaminated fuels are being used). In case of biomass drying and smoke-houses these chlorine sources are mostly chlorophenols and other chlorinated hydrocarbons in used/treated wood, textiles etc.”*** |
| 27 | *“Table 12”*<br><br>See our comment on page 20 above. |
| 28 | *“Within one subcategory to produce the same product, the emissions of PCDD/PCDF can vary considerably depending on technology, performance, etc. and in many cases only an estimate is possible. Estimation methods chosen will differ and should reflect local conditions and the available resources. Key parameters used to distinguish high emitting processes from low emitting processes are given in Section 6.”*<br><br>Comment: The term “releases” rather than “emissions” better reflects the philosophy of the Stockholm Convention.<br><br>Suggestion: ***“Within one subcategory to produce the same product, the releases*** |

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|  | ***of PCDD/Fs …. Key parameters used to distinguish processes releasing large amounts of PCDD/Fs from those releasing smaller quantities are given in Section 6.”*** |
| 33 | *“ For each process within a subcategory, releases are calculated by multiplying the activity rate for the given class by the emission factor provided in the Toolkit for all release vectors, namely air, water, land, product, and residue (see Chapter 6).”*<br>Comment: The term “total releases” instead of “releases” would clearly signal that all releases have to be addressed in PCDD/Fs inventories.<br>Suggestion: ***“For each process within a subcategory, total releases are calculated by multiplying the activity rate for .....”*** |
| 33 | *“Default emission factors provided represent average PCDD/PCDF emissions for each class.”*<br>Comment: The Toolkit should provide a range of emission factors, rather than an average, for each source or source category.<br>Suggestion: ***“The Toolkit provides high, low and average emission factors for each source or source category where such factors are available or can be derived.”*** |
| 33 | *“Although these default emission factors are based on best available information from literature or other sources they will be amended or classification expanded as new data becomes available.”*<br>Comment: This version of the Toolkit lacks data from the scientific literature. In addition, many of the default emission factors are based only experiences gained in developed countries. This leaves a question about who will evaluate which information is the most appropriate.<br>Suggestion: ***“Although these default emission factors are based on the largest possible range of available information from literature or other sources based on scientific data they will be amended or classification expanded as new data becomes available.”*** |
| 35 | *“An interim inventory will contain the following information:*<br>*• a listing of all subcategories that are carried out in the country; ...”*<br>Comment: The first bullet point should be modified to include both sources identified via the Toolkit’s list and those identified via the Source Identification Strategy.<br>Suggestion: ***“An interim inventory will contain the following information:***<br>***• a listing of all sources – those in the Toolkit as well as those identified through the Source Identification Strategy -- that are known to exist within the country.***<br>***• …”*** |
| 36 | *“The final country inventory of releases of PCDD/PCDF from all activities listed in the Toolkit to all media will result from the application of the full Toolkit methodology.”*<br>Comment: As written, the statement suggests that the Toolkit’s default emission |

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| | factors give users sufficient information to prepare complete estimates of releases to all environmental media/compartments. This is not the case, since there are many potential release routes for which no emission factors are given or the emission factors are unrealistic. The final country inventory should go further than the current version of the Toolkit by using a comprehensive Sources Identification Strategy.<br>Suggestion: Delete this sentence or change as follows: ***"The final country inventory of releases of PCDD/PCDF from all activities listed in the Toolkit and from sources identified as PCDD/PCDF sources based on use of chlorine-containing materials presence in the processes together with other conditions needed to form PCDD/PCDF in all media will result from the application of both the full Toolkit methodology and Source Identification Strategy."*** |
| 36 | *"An example of result within subcategories is shown in Section 10.1 and summary tables of national inventories made with the Toolkit in 10.2."*<br>Comment: See our comments to both Section 10.1 and Table 75 (pp 201 and 203) below. |
| 41 | *" High PCDD/PCDF formation is associated with poor combustion conditions (batch operation, high CO, etc.), problematic input materials and dust collectors operated at high temperatures."*<br>Comment: The contribution of chlorine and chlorine-containing materials to PCDD/F formation should be acknowledged here (see Costner (2001) [87]).<br>Suggestion: ***"High PCDD/PCDF formation is associated with poor combustion (batch operation, high CO, etc.) dust collectors operated at high temperatures, and waste composition, such as a high chlorine content and the presence of metals such as copper."*** |
| 41 | *"The PCDD/PCDF emissions to land are negligible and there is no product. Relevant releases to water occur only if wet scrubbers are used for the removal of particulate matter and the water is not recirculated within the process. Releases to water will occur when the effluent is not adequately treated, e.g., to filter out the particles with the PCDD/PCDF adsorbed onto them or water is used to cool down the ashes and the water is not caught. Thus, the most significant release routes are to air and residue. Typically, higher concentrations are found in the fly ash, bottom ash has lower concentrations but the larger volume. If both ashes are mixed, the combined residues will be more contaminated as the bottom ashes alone. In countries with waste management plans in force, fly ashes are typically sent to landfills."*<br>Comments: The statements in this segment attest to the very important misconceptions created by defining "land" as only surface soils and excluding landfills. Also, in some European countries e.g. Germany, the Netherlands, France and Denmark about 50% of the stockpiled municipal waste incinerator bottom ash is used as secondary building material, in road construction or as raw material for the ceramic industry inter alia.[88, 89, 90, 91, 92, 93,94] In some countries fly ash and bottom ash alone and/or in mixture are declared as "product" and are not sent to landfill even these countries have waste management plans in force. [95] According to this practice it is not true that, "there is no product". |

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| | With regard to the second sentence, the designation of PCDD/F releases as "relevant" or not is a decision that rests with the Parties of the Stockholm Convention, not the authors of the Toolkit. This same comment applies to the use of the word "negligible" in the first sentence.<br><br>Referring to earlier comments on the need for terminology that is consistent within the Toolkit as well as with the Stockholm Convention, "releases to land" is preferable to "emissions to land".<br><br>Suggestion: Delete last sentence and to change the paragraph wording as follows: ***"MSW incinerators release PCDD/PCDF into the air via stack gases. However, MSW incinerator ashes carry the largest share of the PCDD/PCDFs formed. The ashes are commonly sent to land (landfills) or, in some countries, used as secondary building material and declared as product. Releases to water may occur 1) if wet scrubbers are used for the removal of particulate matter, in which case the amount of PCDD/PCDFs released to water depends on the efficiency of scrubber water treatment in which PCDD/PCDFs is captured in the filter cake of the treatment process; and 2) water is used to cool down or "quench" the ashes and the water is not caught. Thus, the most significant release routes are to residue and air. Typically, higher concentrations are found in the fly ash. Bottom ash has lower concentrations but a larger volume. If both ashes are mixed, the combined residues will be more contaminated as the bottom ashes alone."*** |
| 42 | *"Table 16: Emission factors for municipal solid waste incineration"*<br><br>Comments: The heading for column 4 should be "Bottom ash or slag", since many incinerators are operated in a slagging mode. The EU inventory acknowledges the following types of incinerator residues: boiler ash, grate ash (bottom ash or slag), fly ash, sludge from the treatment of scrubber water, water used for quenching bottom ash, wash water and surface runoff and presents emission factors for bottom ashes, fly ash, and scrubber water sludge. [96]<br><br>The Toolkit's Emission Factors are, in many cases, very different from the emission factors in other inventories and in the scientific literature. For example, in the U.S. inventory, the seven types of incinerators, all equipped with various combinations of air pollution control devices, had emission factors to air ranging from 0.025 to 1,492 µg I-TEQ/ton,[97] as compared to the Toolkit's range of 0.5 to 350 µg I-TEQ/ton. In the EU inventory, the "typical" emission factor to air for MSW incinerators equipped with "high quality" air pollution control systems was 1.5 µg I-TEQ/ton, in comparison to the Toolkit's 0.5 µg TEQ/ton.[98] The Toolkit's Emission Factors of 1.5 to 15 µg TEQ/ton for bottom ash of incinerators with at least some air pollution control devices are also far lower than the 12 to 72 µg TEQ/ton used in the EU inventory or, for old plants with electrostatic precipitators, 6,600 to 31,100 µg TEQ/ton.[99] As another example, a recent PCDD/F mass balance study of a MSW incinerator *"equipped with a best available technology flue gas treatment line"* reported a PCDD/F release factor for slag of 7.59 µg I-TEQ/ton,[100] as compared to the value of 1.5 µg TEQ/ton used by the Toolkit's authors for bottom ash.<br><br>Since the Toolkit does not include citations for its emission factors, it is not |

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|  | possible to determine their origins.<br>Suggestion: **Any emission factors presented in the Toolkit should be identified as to their sources. Some rationale should be given for their selection and some indication should be given of their uncertainty. Also, all of the emission factors presented in the Toolkit should be reassessed and adjusted so as to be more compatible with existing data.** |
| 42 | *"These default emission factors are based on the assumption that the waste burned leads to about 1–2 % of fly ash and 10–25 % bottom ash."*<br>Comment: The estimated percentage of fly and bottom ash generated by burning solid waste are quite different from real figures. Based on the values above, the Toolkit's authors have assumed that the incineration of one ton of waste is accompanied by the generation of 10 to 20 kg of fly ash and 100 to 250 kg of bottom ash. This is significantly different from rates reported in other sources; for example, the EU inventory notes that the incineration of one ton of waste is accompanied by the generation of 30 to 38 kg of fly ash and 300 kg of bottom ash.[101] Another (second) example should be production of ashes in the Czech MSW in 2002. These incinerators generated 40 kg fly ash by burning 1 ton of waste (4% value).[102] A third example is a smaller incinerator burning mixed solid and liquid waste (municipal, medical and hazardous) in the Czech Republic which produced 19 tons of fly ash per year by burning over 600 tons mixed waste giving a value of more than 3% fly ash generated. [103] One possible result of these non-conservative assumptions by the Toolkit's authors is substantial underestimation of PCDD/PCDF releases in incinerator residues.<br>Suggestion: **Revise the Toolkit values so that they are compatible with those used elsewhere.** |
| 42 | *"Emission to air is the vector of most concern for MSW combustion."*<br>Comment: Releases to residues are the predominant pathways for PCDD/PCDF releases from MSW incinerators, which means they should be also of a great concern. Referring to the earlier discussions of the importance of consistency in terminology "air" is a vector but "emission to air" is not a vector, it is a pathway. Also refer to previous comments concerning the use of the term "emission" which should be replaced with the term "release."<br>Suggestion: ***"The greatest share of PCDD/PCDFs formed by incinerators is released in residues, e.g., fly ash and bottom ash or slag, but releases to air are of great concern as well especially when waste incinerators work with no APC systems."*** |
| 42 | *"Class 2 assumes a reduction in the specific flue gas volume to 7,000 Nm³/t MSW due to better combustion controls and lower excess air. The PCDD/PCDF concentration drops to 50 ng TEQ/Nm³ (@11% $O_2$). Plants of this type may be equipped with an ESP, multi-cyclone and/or a simple scrubber. In class 3, the combustion efficiency improves further and the efficiency of the APC system improves (e.g., ESP and multiple scrubbers, spray-dryer and baghouse or similar combinations) resulting in a drop of the PCDD/PCDF concentration to about 5 ng TEQ/Nm³ (@11% $O_2$). Also, the specific flue gas volume is reduced to 6,000 Nm³/t MSW. Class 4 represents the current state-of-the-art in MSW incineration and APC technology (e.g., activated carbon adsorption units or* |

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| | *SCR/DeDiox). Thus, only 5,000* $Nm^3/t$ *MSW and a concentration of less than 0.1 ng TEQ/*$Nm^3$ *(@11%* $O_2$*) will be the norm (LUA 1997, IFEU 1998).”*<br><br>Comment: This paragraph is irrelevant to practice even with the further explanation concerning the Thai municipal solid waste incinerator. While the results of these extrapolations are interesting, estimated releases are more valid when based on a range of emission factors that are derived from measurements of some number of existing systems. It is interesting to note that, although the EU inventory is cited as one of the two sources of the information presented in the above segment, the inventory’s emission factors were not used in the Toolkit. Refer also to earlier discussion on Table 16. Both this and its following paragraphs show the need to use a range of default emission factors and not just one figure per subcategory and level of technology plus APC system.<br>Suggestion: **Delete this segment**. |
| 43 | *“Releases to water occur only when scrubbers are employed for the removal of particulate matter or to cool down ashes. In this case the amount of PCDD/PCDF released through this vector, can best be estimated using the default emission factors supplied for residue. Normally, concentrations are in the range of a few pg I-TEQ/L and the highest PCDD/PCDF concentration reported in a scrubber effluent before removal of particulate matter was below 200 pg/L. Most of the PCDD/PCDF is associated with the particulate matter and consequently removed during wastewater treatment. Additionally, most of the APC equipment installed at MSW incineration plants operates wastewater free. Presently, such releases cannot be quantified.”*<br><br>Comment: As described in the discussion above on Table 16, the European Inventory also identifies the following potential carriers of PCDD/PCDFs from incinerators: water used for quenching bottom ash, wash water, and surface runoff. It would also be helpful if the recommended default emission factors were specified more clearly than as those “supplied for residues.” If the Toolkit’s authors have data describing PCDD/PCDF concentrations in scrubber water, it would be most helpful if they provided the exact data and its source. Also the unit used after figure given on concentration of PCDD/PCDFs in scrubber effluent (200) is not clear whether it is in units of TEQ.<br><br>Suggestion: ***“Releases to water may occur when wet scrubbers are used, when water is used for quenching bottom ash, and through wash water and surface runoff. There are no emission factors for such releases.”*** |
| 43 | *“No release to land is expected unless untreated residue is directly placed onto or mixed with soil. The concentration released in such cases will be covered under “Release in Residues”, Chapter 6.1.2.5.”*<br><br>Comment: Referring to several previous comments concerning the definition of “land” to include only surface soil, this definition presents an unnecessary and avoidable obstacle to understanding total PCDD/F releases.<br><br>Suggestion: **See general comments.** |
| 43 | *“The process has no product, thus there will be no emission factor.”*<br><br>Comment: This statement is incorrect. See earlier comment to the text on page 41: |

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|  | In some European countries e.g. Germany, the Netherlands, France and Denmark about 50% of the stockpiled municipal waste incinerator bottom ash is used as secondary building material, in road construction or as raw material for the ceramic industry inter al.[104, 105, 106, 107, 108, 109,110] In the Czech Republic both bottom and fly ashes are used as raw material and declared as "product". [111]<br>Suggestion: ***"About 50 percent of stockpiled bottom ash is used as a secondary building material, in road construction or as raw material for the ceramic industry in Germany, The Netherlands, France and Denmark. In some countries both bottom and fly ashes are used as a raw material and declared as product."*** |
| 43 - 44 | *"PCDD/PCDF concentrations in the fly ash are substantial, even though the total mass generated per ton of MSW is typically only around 1–2 %. PCDD/PCDF concentrations in the bottom ash are rather low, however, the amount of bottom ash generated per ton of MSW is around 10–20 %* [k]*. Fly ash and bottom ash also contain unburned carbon from 1 % (class 4) up to 30 % (class 1). Since unburned carbon in the ash greatly enhances the adsorption of PCDD/PCDF, the concentration is greatest in class 1; here, 500 ng TEQ/kg were chosen for bottom ash*[l]*. As these types of incinerators do not have a collection system for fly ash, there will be no emission factor for fly ash. In class 2 the concentration is assumed to be 30,000 ng TEQ/kg in fly ash and 100 ng TEQ/kg in bottom ash due to greatly improved combustion efficiency resulting in a much lower LOI of the ash. Class 3 cuts these values in half based on further improvements. Class 4 assumes not only high combustion efficiency but also a very high collection efficiency, especially of the very small fly ash particles. These small particles supply a large adsorption surface for PCDD/PCDF and therefore the overall concentration does not decrease further. Thus, the value for the fly ash is set at 1,000 ng I-TEQ/kg and the concentration for the bottom ash drops to 5 ng TEQ/kg."*<br>Comments: See earlier comments on the generation of fly ash and bottom ash. In contrast to the footnote comment under c), the scientists who prepared the EU inventory regarded this as a valid ash generation rate. [112] Also, in contrast to the statement that unburned carbon in ash enhances adsorption of PCDD/F, scientists have been reporting for almost twenty years that unburned carbon in fly ash enhances PCDD/F formation by serving as a source of complex carbon. [113, 114, 115, 116] The emission factors used in the Toolkit for MSW incinerator fly ash and bottom ash are based on ash generation rates and PCDD/F concentrations that are substantially lower than those that have been reported in the scientific literature and used in various inventories. This may lead to a substantial underestimation of PCDD/F releases in MSW incinerator bottom ash. For example, calculations using the data presented in the Toolkit - a PCDD/F concentration in bottom ash of 500 ng TEQ/kg and a bottom ash generation rate of 100-200 kg ash/ton of waste burned – result in PCDD/F release in bottom ash at a rate of 50-100 µg TEQ/ton. The average of this range, 75 µg TEQ/ton, is the emission factor for bottom ash |

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[k] Remark from the Toolkit text: *"In some Western European countries, 300 kg of bottom ash per ton of municipal solid waste burned (30%) were generated when the share of in inert and glass was higher in the 1960s and 1970s."*

[l] Remark from the Toolkit text: *"Extrapolated value: assumed 10-fold above the average measured concentrations from European plants of the 1980s.*

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| | given in the Toolkit for class 1 MSWs. Using this same PCDD/F concentration given in the Toolkit, 500 ng TEQ/kg, and the bottom ash generation rate given in the European inventory, 300 kg/ton of waste burned, the emission factor for bottom ash can be calculated to be 150 µg/ton, which is two times higher than that given in the Toolkit.<br>The emission factor for fly ash from new MSW incinerators is given as a range, 810 to 1,800 µg I-TEQ/ton in the European inventory. [117] The Toolkit's emission factor for the most advanced incinerators is far lower, 15 µg TEQ/ton. Indeed, the Toolkit's emission factor for fly ash from MSW incinerators with the most primitive air pollution control systems, 500 µg TEQ/ton, is markedly lower than the lower end of the range given in the European inventory. As mentioned earlier, the Toolkit uses a fly ash generation rate of 10 to 20 kg/ton of waste burned, which is substantially lower than the range reported in the European inventory (30 - 38 kg/ton of waste burned). [118] Using the Toolkit's values, an advanced MSW incinerator that burned 100,000 tons per year of waste would generate 10 to 20 tons of fly ash with a PCDD/F content of 150 to 300 µg TEQ. Using the values from the European inventory, this incinerator would generate 30 to 38 tons of fly ash with a PCDD/F content of 24,300 to 68,400 µg TEQ. In summary, the estimated PCDD/F releases in fly ash from this incinerator are, when prepared according to the Toolkit, from 81 to 456 times smaller than the releases estimated using the values in the European inventory.<br>For the most advanced MSW incinerator, the Toolkit assumes a PCDD/F concentration of 1,000 ng I-TEQ/kg in fly ash and 5 ng TEQ/kg in bottom ash. In contrast, a recent study of a fully modernized MSW incinerator reported 1,580 ng TEQ/kg in fly ash and 60 ng TEQ/kg in bottom ash or slag. [119] In another study of a smaller incinerator in France that had recently been equipped to meet the EU air emission standards, the PCDD/F concentrations in fly ash were 10,700 ng TEQ/kg and, in slag, 43 ng TEQ/kg. [120]<br>Suggestion: **All of the emission factors and residue generation rates presented in the Toolkit should be reassessed and, where appropriate, adjusted so as to be more compatible with existing data. Also any emission factors and supporting data, such as residue generation rates, presented in the Toolkit should be identified as to their sources. In addition, some rationale should be given for the selection of emission factors and some indication should be given of their uncertainty.** |
| 44 | *"Hazardous waste (HW) refers to residues and wastes, which contain hazardous materials in significant quantities. Generally spoken, all materials including consumer goods, which require special precautions and restrictions during handling and use belong to this group. Any consumer goods, which are labeled to such an extent and have entered the waste stream, must be considered hazardous waste. These include solvents and other volatile hydrocarbons, paints and dyes, chemicals including pesticides, herbicides, and other halogenated chemicals, pharmaceutical products, batteries, fuels, oils and other lubricants, as well as goods containing heavy metals. Also, all materials contaminated with these materials such as soaked rags or paper, treated wood, production residues etc. must be considered hazardous waste."*<br>Comment: The majority of hazardous waste sent to hazardous waste incinerators |

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| | is a waste from industrial processes. The information describing the hazardous contents of consumer goods is interesting, but it is irrelevant in the context of a discussion of dedicated hazardous waste incinerators.<br>Suggestion: ***"Hazardous waste (HW) refers to residues and wastes, which consist of or contain hazardous materials in significant quantities."*** Delete remaining text in paragraph. |
| 44 | *"Also, other technologies such as supercritical water oxidation, electric arc vitrification, etc., which treat hazardous waste can be included in this group (although they are not necessarily classified as "incineration")."*<br>Comment: There is no specific classification of releases from these technologies in the Toolkit. Why they can not be a special subcategory even under "Waste incineration" category. To put them under hazardous waste incineration without specification of their emission factors is not systematic.<br>Suggestion: Delete **this sentence and make a new subcategory under "h".** |
| 45 | *"Table 17 Emission factors for hazardous waste incineration"*<br>Comment: While Table 17 presents only an emission factor for fly ash, the EU inventory noted as follows with regard to hazardous waste incinerators: *"Solid wastes include bottom ash from the furnace, fly ash and residues from gas cleaning operations, and filter cakes and collected dusts from flue gas cleaning. We assume a solid waste production rate of 20% of throughput. … Releases to water arise mainly from the use of wet scrubbers, which are common on hazardous waste incinerators. Data from one UK plant indicate that the discharge is about 6.2 m³ per tonne of waste. … The range of levels in bottom ash and composite solid wastes is 0.1 - 34 ng I-TEQ/kg. The range of levels for liquid discharges is 0.01 - 0.6 ng I-TEQ / l."*[121] PCDD/PCDF concentrations in a range 0.0029 – 0.0036 ng I-TEQ/kg[122] were measured in the slag of the high technology Czech waste incinerator (class 4 according to Toolkit classification) burning mostly liquid hazardous waste including PCBs.<br>Suggestion: **Table 17 should include columns for emission factors for bottom ash/slag, scrubber water and scrubber water treatment sludge.** |
| 45 | *"These default emission factors are based on the assumption that the waste burned leads to about 3 % of fly ash and the PCDD/PCDF release associated with the disposal of bottom ash is negligible in classes 3 and 4. No data exist for classes 1 and 2 for bottom ash concentrations."*<br>Comment: As noted above, those who prepared the European inventory assumed hazardous waste incinerators generated solid residues, including fly ash, bottom ash, etc. at the rate of 200 kg/ton of waste burned. This suggests that the Toolkit needs to provide more detailed, documented information describing the rates at which fly ash and bottom ash are generated by hazardous waste incinerators. Also, as discussed earlier, the decision as to the negligibility of PCDD/F releases lies with the Stockholm Convention, not with the authors of the Toolkit. Moreover, the information presented in the preceding comment indicates that hazardous waste incinerator residues are potentially significant in quantity and PCDD/F content. |

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| | Suggestion: **Either substantiate the information in these sentences or delete them.** |
| 46 | *"The default emission factor for class 1 was derived from a specific flue gas volume flow rate of about 17,500 $Nm^3/t$ of hazardous waste and a concentration of about 2,000 ng TEQ/$Nm^3$. Class 2 assumes a reduction in the specific flue gas volume flow rate to 15,000 $Nm^3/t$ of hazardous waste due to better combustion controls and lower excess air. The PCDD/PCDF concentration drops to 20 ng TEQ/$Nm^3$ (@11% $O_2$) in this case. In class 3, the combustion efficiency improves further and the efficiency of the APC system improves resulting in a drop of the PCDD/PCDF concentration to about 1 ng TEQ/$Nm^3$(@11% $O_2$). Also, the specific flue gas volume flow rate is reduced to 10,000 $Nm^3/t$ HW. Class 4 represents the current state-of-the-art in HW incineration and APC technology. Thus, only 7,500 $Nm^3/t$ HW and a concentration of significantly less than 0.1 ng TEQ/$Nm^3$ (@11% $O_2$) is realistic (LUA 1997, IFEU 1998, Environment Canada 1999)."*<br><br>Comment: The information in this paragraph is probably based only on the few countries' experience. The EU inventory gives the following emission factors for air for hazardous waste incinerators: 2 µg TEQ/ton, minimum; 20 µg TEQ/ton, typical; and 200 µg TEQ/ton, maximum.[123] Hazardous Waste Incinerators belonging almost to the class 3 according to Toolkit explanation in the Czech Republic generated emissions with PCDD/PCDF concentrations measured in range between 0.026 - 18.285 ng TEQ/$Nm^3$ (@11% $O_2$).[124] In many cases hazardous waste was burned in these furnaces mixed with medical waste.The values and data used in the Toolkit undermine its credibility.<br><br>Suggestion: **Delete the segment above and replace it with well-substantiated information.** |
| 46 | *"The maximum actual PCDD/PCDF concentration found in wet scrubber effluent was below 0.15 mg TEQ/t (LUA 1997). Overall, this release vector is not considered to be important for this source type."*<br><br>Comment: The Stockholm Convention's ultimate goal is to eliminate byproducts release. From this point of view, all byproduct sources are important and should be considered in PCDD/PCDF inventories. The last sentence above is not consistent within this goal of the Stockholm Convention. In addition, the source given for this information "LUA 1997" is cited in these comments as "Quass, U., Fermann, M., 1997. Identification of Relevant Industrial Sources of Dioxins and Furans in Europe (The European Dioxin Inventory). Final Report No. 43, Essen, Germany: Landesumweltamt Nordrhein-Westfalen" and is, as the title indicates, the European Dioxin Inventory. This inventory addresses only PCDD/F releases to air and, as such, contains no information on PCDD/F concentrations in wet scrubber effluent of hazardous waste incinerators. The other European inventory, cited in these comments as "Wenborn, M., King, K., Buckley-Golder, D., Gascon, J., 1999. Releases of Dioxins and Furans to Land and Water in Europe. Final Report. Report produced for Landesumwaltamt Nordrhein-Westfalen, Germany on behalf of European Commission DG Environment. September 1999," reported scrubber water from hazardous waste incinerators to have PCDD/F concentrations of 0.01 - 0.6 ng I-TEQ per liter. [125] |

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| | Suggestions: **Delete this segment of text and replace it with the information given in the EU inventory of PCDD/PCDF releases to land and water.** |
| 46 | *"No release to land is expected unless untreated residue is directly placed onto or mixed with soil."*<br>Comment: See our earlier comments on this topic and discussion concerning the land releases in general comments.<br>Suggestion: See **earlier suggestions on this topic.** |
| 46 - 47 | *"To generate emission factors only fly ash has been taken into account for the residue, since no data for bottom ash is available for classes 1 and 2. For classes 3 and 4, in which it must be assumed, that the bottom ash is extracted from the furnace, no substantial contribution to the overall release of PCDD/PCDF occurs. Consequently, only PCDD/PCDF concentrations in the fly ash residue are substantial and will be considered further. The amount of fly ash in hazardous waste is typically around 3 %. Fly ash also contains unburned carbon of 0.5 % (class 4) up to 20 % (class 1). Since unburned carbon in the fly ash greatly enhances the adsorption of PCDD/PCDF, the concentration is greatest in class 1. In class 1 the PCDD/PCDF was assumed to be around 300,000 ng TEQ/kg residue. In class 2 the concentration drops to 30,000 ng TEQ/kg residue due to greatly improved combustion efficiency resulting in a much lower LOI of the fly ash. Class 3 cuts this value down to 15,000 ng TEQ/kg residue based on further improvements. Class 4 assumes not only high combustion efficiency but also very high collection efficiency, especially of the very small fly ash particles. These small particles supply a large adsorption surface for PCDD/PCDF and therefore the overall concentration decreases to about 1,000 ng TEQ/kg residue. If absolutely no fly ash data is available but actual stack emission data exists, it is fair to assume the PCDD/PCDF emissions through the residue vector to be similar and roughly in the same order of magnitude when compared to the air. Thus, the overall emissions can roughly be split equally between the air and the residue vector. However, this provides a much less accurate estimate of the overall PCDD/PCDF emissions due to the different nature and composition of hazardous waste fly ash."*<br>Comment: Refer to previous comments on similar estimations about the residues from MSW incineration (p 42, 43-44). Again, defining those levels of PCDD/Fs in incinerator residues that need not be considered in estimating PCDD/F releases is a matter to be resolved jointly by the Parties. This decision does not fall within the purview of the Toolkit's authors.<br>In addition to our comments to the text on pages 42, 43-44 we refer to measurement for the Czech hazardous waste incinerator (at least class 2 or 3) fly ash where 82,400 ng TEQ/kg of PCDD/PCDF residue were found.[126]<br>Again, in contrast to the statement that unburned carbon in ash enhances adsorption of PCDD/F, scientists have been reporting for almost twenty years that unburned carbon in fly ash enhances PCDD/F formation by serving as a source of complex carbon. [127, 128, 129, 130] Also, there is missing word, "incineration", in the last sentence after "hazardous waste".<br>Suggestion: **Delete this text and replace it with well-substantiated data and,** |

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| | **where appropriate, acknowledgement of the absence of data.** |
| 47 | *“To reliably destroy viruses, bacteria, and pathogens his waste is often thermally treated (by incineration or pyrolysis). Further, due to its origin and its composition, medical waste can contain toxic chemicals, e.g., heavy metals or precursors, which may form dioxins and furans. In many countries medical waste is a waste that requires special surveillance and it was found that incineration of all wastes generated within a hospital would be the most efficient way to get rid of these wastes.”*<br>Comment: This segment erroneously implies that incineration is the only method for reliable destruction of pathogens, such as viruses and bacteria. In fact, it is not even the “most efficient way to get rid of” medical waste as stated in a report prepared by World Bank.[131] There are many other technologies which destroy pathogens effectively without generating large amounts of PCDD/PCDF as waste as incineration does.[132, 133, 134]<br>The second sentence erroneously implies that toxic chemicals in medical waste are the major constituents in medical waste that form PCDD/Fs. As stated many times, the presence of PVC in medical waste is one of main reasons (along with poor conditions under which medical waste incinerators operate) that medical waste incineration belongs to one of the main PCDD/PCDF sources.<br>Suggestion: “***Incineration has been frequently relied on for the destruction of the pathogens, such as viruses and bacteria, in medical waste. However, a substantial fraction of medical waste commonly consists of chlorinated materials, such as polyvinyl chloride (PVC) blood bags, tubing, etc., that act as precursors for PCDD/PCDF formation.”*** |
| 48 | *“The major release vectors of concern are air and residue (here fly ash only due to the lack of data for bottom ash). Water releases are less important since APC equipment, if present at all, is almost wastewater free.”*<br>Comment: For medical waste incinerators, the European inventory gives a bottom ash generation rate of 150 kg/ton of waste burned; a fly ash generation rate of 80 kg/ton; and the generation of wet scrubber treatment residue at the rate of 40 kg/ton.[135] In the Czech Republic are wet scrubbers often used for both medical and hazardous waste incinerators too. Ekotermex Vyškov can be taken as example of such incinerator with maximum capacity 2.900 tons per annum. There was generated 1510 tons of wet scrubber soluble residue in 2000[136], what is unlikely per one year generated waste water. Important is fact, that waste water from this incinerator is sent to city waste water treatment, which shows that water releases of PCDD/PCDF can be important in some cases and in some countries.<br>In addition, this use of the word “vector” is incompatible with the definition given earlier in the Toolkit.<br>Suggestion: ***“The major releases of concern are air and residues. Water releases have to be considered as well.”*** |
| 48 | *“Table 18: Emission factors for medical waste incineration”*<br>Comment: The emission factors given in this table do not correlate well with those |

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|  | used in the European inventory, which are shown below (grate ash is equivalent to bottom ash or slag; and dry scrubber residue, to fly ash): [137]<br><br>Concentration ranges for the various solid wastes arising are as follows:<br>grate ash 15-300 ng I-TEQ/kg<br>dry scrubber residue 1800-4500 ng I-TEQ/kg<br>wet scrubber residue 680 ng I-TEQ/kg<br><br>Even higher figures are reported for Poland for residues from medical waste incinerators ranging from 8000 - 45000 ng I-TEQ/kg. [138]<br><br>Suggestion: **Modify Table 18 to include bottom ash and scrubber water residues, and modify the emission factors to be more compatible with those used in other inventories and reported in the scientific literature** |
| 48 | *“These default emission factors are based on the assumption that the medical waste burned leads to about 3 % of fly ash and the PCDD/PCDF release associated with the disposal of bottom ash is currently unknown, since no measured data are available presently.”*<br><br>Comment: As discussed and documented in an earlier comment, the fly ash generation rate for medical waste incinerators that is used in the European inventory is 80 kg/ton, or 8 percent. This is 2.7 times higher than the Toolkit’s value. In addition, the European inventory contains the citations for the sources of the emission factors for the various outputs of medical waste incinerators.<br><br>Suggestion: **Modify this statement to comply with the available information.** |
| 48 - 49 | *“Release to air is the predominant vector for medical waste incineration. The default emission factor for class 1 was derived from a specific flue gas volume flow rate of about 20,000 Nm$^3$/t medical waste and a concentration of about 2,000 ng TEQ/Nm$^3$ (@11% $O_2$). Class 2 assumes a reduction in the specific flue gas volume flow rate to 15,000 Nm$^3$/t medical waste due to better combustion controls and lower excess air. The PCDD/PCDF concentration drops to 200 ng TEQ/Nm$^3$ (@11% $O_2$) in this case. Class 3 is based on European data where a concentration of 35 ng I-TEQ/Nm$^3$ (@11% $O_2$) with 15,000 Nm$^3$/t has been determined. Class 4 represents the current state-of-the-art in medical waste incineration and good APC technology. In these cases, only 10,000 Nm$^3$/t of medical waste was generated and a concentration of less than 0.1 ng TEQ/Nm$^3$ (@11% $O_2$) was measured (LUA 1997, IFEU 1998, Environment Canada 1999).”*<br><br>Comment: Sufficient data are not presented to support the first statement. The air emission factors presented in Table 18 are somewhat larger than those of the European inventory. [139] However, in the absence of sufficient documentation for the stack gas flow-rates, it is not possible to verify the air emission factors presented in the Toolkit. See also our comment on hazardous waste incinerators measurements in the Czech Republic - comment on page 46 of the Toolkit. Also the second stage of the European inventory states that *“there still exist an unknown number of health care waste incinerators with flue gas PCDD/F concentrations above 100 ng I-TEQ/m3 which must be considered as important local sources;“*. [140]<br><br>Suggestion: **Delete the first sentence and provide sufficient documentation for** |

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|  | **the remaining data in this paragraph.** |
| 49 | *"Releases to water occur when wet scrubbers are employed for the removal of particulate matter and quench water is used to cool ashes. This is hardly ever the case except in Western Europe where wet scrubbers are occasionally used for acid gas absorption. This would only be applicable to class 4. Measured concentrations of PCDD/PCDF in scrubber water after medical waste incinerators are not available. Where wet scrubbers are identified the water treatment should be noted."*<br>Comment: In the absence of well-documented information describing the extent to which wet scrubbers are used in the rest of the world, the second and third sentences cannot be considered as correct.<br>Suggestion: ***"Releases to water occur when wet scrubbers are employed for the removal of particulate matter and quench water is used to cool ashes. Measured concentrations of PCDD/F in these effluents are not available. Where wet scrubbers are identified the water treatment should be noted."*** |
| 49 | *"6.1.3.3 Release to Land*<br>*No release to land is expected unless untreated residue is directly placed onto or mixed with soil."*<br>Comment: Refer to earlier comments, both general as well as detailed on the same topic under previous subcategories.<br>Suggestion: **Refer to earlier suggestions.** |
| 49 - 50 | *"PCDD/PCDF concentrations in the fly ash are substantial. Due to a lack of data for PCDD/PCDF concentration in bottom ash, default emission factors provided in the residue category only relate to PCDD/PCDF releases via fly ash PCDD/PCDF concentrations in the residues can be high, especially where combustion is poor (e.g., in a simple batch-type incinerator). Classes 1 and 2 medical waste incinerators will not generate fly ash due to the lack of dust removal equipment. In these cases, all residues will consist of the residue left in the combustion chamber. The class 1 emission factor is based on the assumption that the 200 kg of residue per ton of medical waste burned is left in the combustion chamber with a concentration of 1,000 ng TEQ/kg. For class 2, combustion is improved, so the bottom ash residue should contain only 100 ng TEQ/kg; resulting in an emission factor of 20 mg TEQ/t of waste.*<br>*For classes 3 and 4, fly ash is being collected and mixed with grate ash; the amount of fly ash in medical waste typically is around 3 %. Classes 3 assumes 30,000 ng TEQ/kg in the fly ash and 100 ng TEQ/kg in the grate ash (same as class 2). Class 4 incinerators have high combustion efficiency, resulting in an organic carbon content of about 1 % of unburned carbon but also a very high collection efficiency of the very small fly ash particles. Fly ash is collected (30 kg/t of waste) with a concentration of 5,000 ng TEQ/kg and 10 ng TEQ/kg of grate ash is chosen. These small particles supply a large adsorption surface for PCDD/PCDF and therefore the overall concentration does not decrease any further."*<br>Comment: As described and presented in earlier comments, data describing PCDD/F concentrations in both fly ash and bottom ash as well as the generation |

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|  | rates for these ashes are presented in the European inventory. The Toolkit's values for both PCDD/F concentrations in fly ash and bottom ash and the generation rates for these two kinds of ashes are considerably lower than the values in the European inventory. [141] Other data suggest that some of the Toolkit's values for PCDD/F concentrations in ashes are too low. In the UNEP inventory of PCDD/F releases in Thailand, PCDD/F concentrations in bottom ash of a hospital waste incinerator were reported as 1,410 and 2,300 ng I-TEQ/kg and described as *"about the highest ever reported in the literature."*[142] This is obviously not the case given the study of 18 hospital waste incinerators in Poland, eight of which had stack gas concentrations below 0.1 ng TEQ/m3, and that found bottom ash to contain PCDD/F concentrations in the range of 8,000 to 45,000 ng TEQ/kg.[143]<br><br>Suggestion: **Delete these two paragraphs and replace them with more appropriate, well-documented data.** |
| 51 | *"Releases to air are the most important release vector for LWSF combustion. There are not many measured data from this type of activity. The default emission factor for class 1 was derived based on a emission factor of 1,000 ng TEQ/kg as determined by the US EPA during a barrel burn study of selected combustible household waste which closely resembles the composition of fluff. Class 2 uses various emission data from a series of Western European and North American RDF facilities including Japanese fluidized bed combustors with minimal APC equipment. An emission factor of 50 µg TEQ/t was determined. Class 3 represents the current state-of-the-art in LFSW incineration and APC technology. Thus, only 10,000 Nm³/t light-shredder waste and a concentration of less than 0.1 ng TEQ/Nm³ (@11% $O_2$) is taken (US EPA 1999, LUA 1997, IFEU 1998, Environment Canada 1999)."*<br><br>Comment: In the absence of data describing the PCDD/F content of residues from the incineration of LWSF, this statement cannot be made. Justification should be given for the selection of each of the various substitute concentrations and emission factors presented here.<br><br>Suggestion: **Delete the first sentence. Craft and present well-documented justifications for the use of the information in the remainder of the paragraph.** |
| 51 | *"6.1.4.3 Release to Land*<br>*No release to land is expected unless untreated residue is directly placed onto or mixed with soil."*<br><br>Comment and Suggestion: See previous comments and suggestions on the definition of "land" and the resulting exclusion of landfills. |
| 51 - 52 | *"The amount of fly ash in LFSW is typically around 1 %. Fly ash also contains unburned carbon of 5 % (class 3) up to presumably 30 % (class 1). In class 1, no APC equipment is used and consequently no fly ash is collected but rather most of it is emitted to the atmosphere with the flue gas. Even though no specific collection device for fly ash is installed and the majority of the fly ash is discharged through the stack, some fly ash is expected to collect in the furnace and the ductwork leading to the stack as well as in the stack itself. Since unburned carbon in the fly ash greatly enhances the adsorption of PCDD/PCDF, the concentration is greatest in class 1. However, no accurate data is available. Class* |

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|  | *3 assumes not only a high combustion efficiency but also a very high collection efficiency, especially for the very small fly ash particles. Thus, a value of 15,000 ng TEQ/kg is chosen. These small particles supply a large adsorption surface for PCDD/PCDF and therefore the overall concentration does not decrease any further (US EPA 1999, LUA 1997, IFEU 1998).”*<br>Comment: The sources of these data, e.g., the rate of generation of LFSW incineration fly ash, etc., should be given. (It is not found in the sources that appear at the end of the paragraph).<br>Suggestion: **Either thoroughly and precisely document the information in this paragraph or delete it.** |
| 52 | *“Since PCDD/PCDF are virtually insoluble in water, the bulk of the PCDD/PCDF adsorbs to the solids present in the wastewater. If the solids are not removed, the PCDD/PCDF will be discharged with the wastewater.”*<br>Comment: While this statement may be true for pure water, it is not necessarily true for municipal and industrial wastewater that commonly contains substances that are or act as surfactants, such as linear alkylbenzene sulphonates, common ingredients of detergents and cleaning agents;[144] humic acids, ubiquitous soil components;[145] etc.<br>Suggestion: ***“PCDD/F are virtually insoluble in pure water. However, municipal and industrial wastewater may contain substances that are or act as surfactants, such as humic acids and linear alkylbenzene sulphonates, and increase PCDD/F solubility. However, the bulk of PCDD/Fs present will adsorb to solids present in wastewater, which can be removed by filtration or flocculation so that the PCDD/Fs are collected in the wastewater treatment sludges.”*** |
| 52 | *“… Another option for the disposal of sewage sludge is co-incineration in boilers, e.g., fossil fuel power plants (see Main Source Category 3 - Section 6.3.1) or in cement kilns (see Main Source Category 4 - Section 6.4.1).*<br>*Sewage sludge is incinerated in either bubbling or circulating fluidized bed furnaces where the formation of PCDD/PCDF is limited due to good combustion conditions. Also, high removal efficiencies of particulate matter, which are critical for the operation of circulating fluidized bed furnaces, reduce PCDD/PCDF emissions. Other furnace types commonly used are vertical rotary stage or open hearth-type furnaces, grate-type furnaces or muffle-type furnaces. All furnace types lead to reasonably low PCDD/PCDF formation depending, however, on the composition of the sludge burned. Incineration of sludge with a high content of halogenated hydrocarbons and/or other organic contaminants as well as heavy metals such as copper can increase the PCDD/PCDF emissions.”*<br>Comment: The sentence appears to resemble a manual on what to do with sludge. We suggest reorganizing the text and not hiding chlorine as the root for PCDD/Fs formation.<br>Suggestion: ***“Sewage sludge is incinerated in bubbling or circulating fluidized bed furnaces, vertical rotary stage or open-hearth-type furnaces, grate-type furnaces and muffle-type furnaces. Sewage sludge is also co-incinerated in boilers, e.g., fossil fuel power plants (see Main Source Category 3 - Section*** |

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| | ***6.3.1) or in cement kilns (see Main Source Category 4 - Section 6.4.1). The extent of PCDD/F formation depends on the composition of the sludge. Incineration of sludge with a higher content of chlorinated hydrocarbons and/or other sources of chlorine [146] and carbon as well as metals such as copper can be expected to have greater PCDD/F formation, while increased sulfur content in the sludge has been associated with reduced PCDD/F formation." [147]*** |
| 53 | *"Table 20: Emission factors for sewage sludge incineration"*<br><br>Comment: This table presents emission factors only for releases to air and residues. According to a recent European Commission report on sewage sludge disposal, *"incineration generates emissions to air, soil and water …"*[148]<br><br>Suggestion: **Include a column for Emission Factor WATER.** |
| 53 | *"Releases to air represent the most important vector for sewage sludge combustion. The default emission factor for class 1 was determined based on an average emission concentration of 4 ng TEQ/$Nm^3$ (@11% $O_2$) and a specific flue gas volume flow rate of about 12,500 $Nm^3$/t of sewage sludge burned based on a Belgian study as well as value of 77 ng TEQ/kg reported from the UK for a multiple hearth furnace with ESP. Class 2 is an emission factor determined in The Netherlands from fluidized bed plants with scrubbers and ESP. Class 3 is for fluidized bed plants with optimized air pollution control systems consistently meeting the emission limits equivalent to 0.1 ng I-TEQ/$Nm^3$ (@11% $O_2$) (from Canadian, German and Swiss measurements) (LUA 1997, IFEU 1998, Environment Canada 1999)."*<br><br>Comment: Again, it is not possible to verify this information due to the absence of cited sources. The three classes of sludge incinerators and their respective Emission Factors AIR do not coincide well with those presented by the U.S. Environmental Protection Agency: *"The average TEQ emission factor based on the data for the 11 AMSA facilities and the two facilities reported in U.S. EPA (1990f) is 6.94 ng I-TEQ DF /kg of dry sludge combusted (or 7.04 ng TEQ DF - WHO98 /kg of dry sludge), assuming nondetected values are zero. Other countries have reported similar results. Bremmer et al. (1994) reported an emission rate of 5 ng ITEQ/kg for a fluidized-bed sewage sludge incinerator, equipped with a cyclone and wet scrubber, in The Netherlands. Cains and Dyke (1994) measured CDD/CDF emissions at two sewage sludge incinerators in the United Kingdom. The emission rate at an incinerator equipped with an electrostatic precipitator and wet scrubber ranged from 2.75 ng I-TEQ /kg to 28.0 ng I-TEQ /kg. The emission rate measured at a facility equipped with only an electrostatic precipitator was 43.0 ng I-TEQ /kg."* [149]<br><br>Suggestion: **Provide source citations for each value as well as each statement of fact.** |
| 53 | *"6.1.5.3 Release to Land*<br>*No release to land is expected unless untreated residue is directly placed onto or mixed with soil."*<br><br>Comment: See our previous comments on this topic.<br><br>Suggestion: **See previous suggestions on this issue.** |

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| 54 | *"UK testing (Dyke et al 1997) of multiple hearth furnaces showed PCDD/PCDF in the grate ash at concentrations of 39 ng TEQ/kg and 470 ng TEQ/kg in fly ash from the ESP. Rates of ash production were 430 kg per ton of grate ash and 13 kg per ton of ESP ash for the multiple hearth plant. Levels in ash (all the ash was collected in the ESP) from fluidized bed combustion were much lower (<1 ng TEQ/kg). 373 kg of ESP ash was produced per ton of sludge combusted in the fluidized bed.*<br>*Class 1 releases to residues (combined) are therefore 23 µg TEQ/ton of waste. Class 2 releases are 0.5 µg TEQ/ton of waste. Class 3 releases are estimated the same as class 2."*<br>Comment: See earlier comment on the classification of incinerators and the lack of documentation.<br>Suggestion: **Reevaluate the incinerator classes and provide more appropriate, well-documented data.** |
| 54 | *"6.1.6 Waste Wood and Waste Biomass Incineration"*<br>[including accompanying introductory text]<br>Comment: First, the use of the terms "waste wood" and "waste biomass" do not convey clearly the important distinction that needs to be made between wood or biomass contaminated with pentachlorophenol, chlorine-containing paints, PVC cladding or scraps, chlorinated pesticides, etc. and wood and biomass that are simply excess materials.<br>Suggestion:<br>***"6.16 Contaminated Wood/Biomass Incineration***<br>***This subcategory addresses the combustion of contaminated wood/biomass in furnaces under conditions ranging from no control to highly controlled. Combustion of clean wood/biomass for generating energy is addressed in Section 6.3.2, and open burning of clean wood/biomass is addressed in Section 6.6 – Uncontrolled Combustion Processes.***<br>***Contaminated wood/biomass may contain materials that support or contribute to PCDD/F formation, e.g., paints, coatings, pesticides, preservatives, anti-fouling agents and many other substances that contain chlorine or chlorinated chemicals as well as metals. Higher levels in the contaminated wood/biomass of chlorine-containing materials and metals, such as copper, are commonly associated with greater PCDD/F formation. While PCDD/F formation may be enhanced by poor combustion conditions, it can be reduced, but not prevented, by good combustion in well-controlled furnaces equipped with effective, properly operated air pollution control systems. Three classes of combustion systems, together with their emissions factors for PCDD/F releases to air and residues."*** |
| 67 - 68 | *"Table 26: Emission factors for the steel industry and iron foundries"*<br>&<br>*"For electric arc furnaces, most measured emission data relate to plants using* |

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| | *relatively clean scrap and virgin iron and which are fitted with some after-burners and fabric filters for gas cleaning. Emission factors derived from plants in Sweden, Germany, and Denmark gave emission factors between 0.07 and 9 μg I-TEQ/t LS. For the Toolkit, an emission factor of 3 μg I-TEQ/t LS is applied (Bremmer et al. 1994, SCEP 1994, Charles Napier 1998).”*<br><br>Comment: Netherlands reports a much higher emission factor for electric arc furnaces of 35 μg I-TEQ/t LS.[150]<br><br>Suggestion: **State a larger ranger of emission factors that reflect a larger range of possible releases into the air.** |
| 74 | *“Older technology furnaces fitted with fabric filters had emissions of 146 to 233 ug TEQ/t of product. Concentrations and volumes of flue gas vary considerably; up to 10 ng I-TEQ/$m^3$ were reported (SCEP 1994). ...“*<br><br>Comment: There were measured higher emissions in the furnace even with some APC systems up to 13.7 ng TEQ/$m^3$ in Germany.[151]<br><br>Suggestion: Give emission factors in the larger range reflecting larger differences. ***“Older technology furnaces fitted with fabric filters had emissions of 146 to 233 ug TEQ/t of product. Concentrations and volumes of flue gas vary considerably; up to 10 ng I-TEQ/$m^3$ (SCEP 1994) or 13.7 ng TEQ/$m^3$ [152] were reported..”*** |
| 119 | *“Accidental fires are very variable and the emissions will depend strongly on the materials burned and on the nature of the fire. ... PCDD/PCDF will be present in residues that may be disposed of or left on the ground.”*<br><br>Comment: Even though it is mentioned later in the text, there should be a remark included about the need for the presence of chlorine and/or chlorinated substances for a fire to become a source of PCDD/PCDF. In cases where PVC is present, high concentrations of PCDD/PCDF in residues have been found ranging from 0.13 - 2,060 ng/g, [153] suggesting that leaving its residue on the ground is not suitable. Residue from accidental fires is hazardous waste according to its PCDD/PCDF content in many cases and it should be processed to avoid further soil, water and air (by dust particles) contamination.<br><br>Suggestion: ***“Accidental fires are very variable and the emissions will depend strongly on the materials burned and on the nature of the fire. Presence of elemental chlorine and/or chlorinated substances creates PCDD/PCDF in air emissions, water and residues during fire. ... PCDD/PCDF will be present in residues that should be handled as hazardous waste for its content of PCDD/PCDF to avoid further pollution caused by PCDD/PCDF.”*** |
| 121 | *“Residues from all types of fires considered in this Section are likely to contain PCDD/PCDF. The amounts will vary depending on the conditions in the fire and the nature of the materials. The residues may remain in place or be removed.”*<br><br>Comment: See our comment to page 119 on measurements of PCDD/PCDF in residues and handling with residues.<br><br>Suggestion: ***“Residues from all types of fires considered in this Section are likely*** |

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| | ***to contain PCDD/PCDF. The amounts will vary depending on the conditions in the fire and the nature of the materials such as those containing chlorine and/or chlorine substances. PCDD/PCDF will be present in residues in cases where chlorine and its substances are present during the fire so these residues should be handled as hazardous waste for its content of PCDD/PCDF to avoid further pollution caused by PCDD/PCDF.”*** |
| 121 | *“A wide range of concentrations has been measured but there is often insufficient information to estimate an emission factor since the amounts of ash produced are not known. In Germany, an estimate was made that gave emission factors in residues (including deposited soot) of 1,000 μg TEQ/t for industrial fires and 350 μg TEQ/t for residential fires (LUA 1997). As an approximation and to make an initial estimate, an emission factor of 400 μg TEQ/t is used giving equal PCDD/PCDF in air emission and in residues on average from the fires considered.”*<br><br>Comment: PCDD/PCDF concentrations in soot were measured up to 2,060 ng/g from three fires in the Czech Republic where PVC materials were involved. These levels are much higher than those measured in Germany. The lowest measured concentration in residues from these fires was 0.13 ng/g in the plaster. [154]<br><br>Suggestion: **To give wider ranges of default emission factors for residues that better reflect real PCDD/PCDF releases in residues.** |
| 161 | *“Table 71: Emission factors for sewage sludge”*<br><br>Comment: As Toolkit’s authors refer there were measured different levels of PCDD/PCDFs in sewage sludge in a range of 6 - 4.100 ng TEQ/kg. It is not clear how the authors derived emission default factors from these figures. The reality is very different from treatment to treatment and the emission factor for “Urban environments” on level of 100 ug TEQ/t d. m. for residue = product should be underestimated. Adding to the references on Toolkit page 161 there were four samples of sewage sludge in the Czech Republic with measured results in a range from 21.2 – 280.2 ug TEQ/t d.m. (data for year 2001). [155] Sewage sludge can be indirectly contaminated by PCDD/PCDFs releases from fly ash put on landfills which use municipalities waste water treatment plants to clean up waste water as well. [156]<br><br>Refer to our general and previous comments regarding a preference for a range of emission factors rather than a single number.<br><br>Suggestion: **Set emission factors using a range rather than a single number.** |
| 201 | *“The major release vectors are to air with a total of 150 g TEQ per year and with residues, which account for 552 g TEQ per year. The majority of PCDD/PCDF in the residues is due to contamination in the fly ashes.” ... “This incinerator emitted 87,5 g TEQ in the reference year whereas the state-of-the-art incinerator that applies BAT burns twice the mass (500,000 t/a), only releases 0,25 g TEQ in the reference year.”*<br><br>Comment: These comments given in the Example Tables for the Inventory in Toolkit Section 10.1 appear to be a promotion of state-of-the-art incineration and are simply confusing. The major release vector is clearly into the residues, so it |

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| | should be given first place. The last sentence in paragraph shows a narrow focus on air emissions/releases, but this is inconsistent with the Stockholm Convention. The incinerator in the chosen country did not emit (release) only 87.5 g TEQ PCDD/PCDF, but 212.5 g TEQ according to table 75 and the state-of-the-art incinerator would release more g TEQ PCDD/PCDF as well if residues or products release were taken into account. The last sentence does not help to explain the PCDD/PCDF country inventory as it appears to be promoting state-of-the-art incinerators. Also using different terms such as "emitted" and "only releases" is not consistent within the Toolkit as well as with the Stockholm Convention terminology. Another problem is that the last sentence focuses on air releases and neglects releases to other media as specified by the Stockholm Convention.<br>Suggestion: Change first phrase and delete last sentence about releases from state-of-the-art incinerator:<br>***"The major release vectors are to residues with a total of 552 g TEQ per year and with air, which account for 150 g TEQ per year. The majority of PCDD/PCDF in the residues is due to contamination in the fly ashes."*** |
| 203 | *"Table 75: Copy of an example ....."*<br>Comment: This example seems to be misleading by showing a releases inventory from waste incinerators. There are no figures on releases to water and there is no data on releases into product despite the fact that both of these occur in many countries. If we take into account previous comments, this example may be confusing in that it implies that countries have to focus mainly on releases into air, which is inconsistent with the Stockholm Convention, because all releases have to be reported.<br>Suggestion: **Improve the example by including release data into water and other media, or delete the table.** |

# Annexes:

## ANNEX 1: Commercial Chemicals Known or Suspected to be Accompanied by Dioxin Formation During Their Manufacture

| **Chemical** | **Reference** |
|---|---|
| **Dioxins are Known By-Products During Manufacture** | |
| Chlorine | [157] |
| Sodium hypochlorite (bleach) | [158] |
| Ethylene dichloride (1,2-dichloroethane; vinyl chloride monomer) | [159] |
| Epichlorohydrin | [160] |
| Trichloroethylene | [161] |
| Perchloroethylene (tetrachloroethylene) | |
| Hexachlorobutadiene | [162] |
| Chlorobenzenes | |
| Dichlorobenzene | |
| Trichlorobenzene | |
| 1,2,4,5-Tetrachlorobenzene | |
| Pentachlorobenzene | |

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| Hexachlorobenzene | |
| Chlorophenols | |
| 2,4,5-Trichlorophenol | [163] |
| 2,4,5-Trichlorophenol, sodium salt | [164] |
| 2,4,6-Trichlorophenol | [165] |
| 2,4,6-Trichlorophenol, sodium salt | [166] |
| 2,3,4,6-Tetrachlorophenol | [167] |
| 2,3,4,6-Tetrachlorophenol, sodium salt | [168] |
| Pentachlorophenol | [169] |
| Polychlorinated biphenyls (PCBs) | [170] |
| 4-Chlorotoluene | [171] |
| Chloranil (2,3,5,6-tetrachloro-2,5-cyclohexadiene-1,4-dione) | [172] |
| Dioxazine dyes (Direct Blue 106, Direct Blue 108, and Violet 23) | [173] |
| Ni-phthalocyanine dye | [174] |
| Printing inks (unidentified) | [175] |
| Metal Chlorides | |
| Aluminum chloride | [176] |
| Ferric chloride | |
| Cuprous chloride | |
| Cupric chloride | |
| **High Probability of Dioxin Formation During Manufacture** | |
| Chlorophenols | |
| o-Chlorophenol | [177] |
| 2,3-Dichlorophenol | |
| 2,4-Dichlorophenol | |
| 2,5-Dichlorophenol | |
| 2,6-Dichlorophenol | |
| 3,4-Dichlorophenol | |
| 4-Chlororesorcinol | |
| 4-Bromo-2,5-dichlorophenol | |
| 2-Chloro-4-fluorophenol | |
| 2-Chloro-4-phenylphenol | |
| Chlorohydroquinone | |
| 2-Chloro-1,4-diethoxy-5-nitrobenzene | |
| 5-Chloro-2,4-dimethoxyaniline | |
| 3,5-Dichlorosalicylic acid | |
| **Possible or Likely Dioxin Formation During Manufacture** | |
| Chlorobenzenes | |
| o-Dichlorobenzene | [178] |
| 1,2,4-Trichlorobenzene | |
| 1,2,4,5-Tetrachlorobenzene | |
| Hexachlorobenzene | |
| o-Chlorofluorobenzene | |
| 3-Chloro-4-fluoronitrobenzene | |
| Chloropentafluorobenzene | |
| 1,2-Dichloro-4-nitrobenzene | |
| Chlorophenols | |
| 3-Chloro-4-fluorophenol | [179] |
| 4-Chloro-2-nitrophenol | |
| o-Benzyl-p-chlorophenol | [180] |
| 2,3,6-Trichlorobenzoic acid | |

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| 2,3,6-Trichlorophenylacetic acid, and sodium salt | |
| 3,4-Dichloroaniline | [181] |
| 3,4-Dichlorobenzaldehyde | [182] |
| 3,4-Dichlorobenzotrichloride | |
| 3,4-Dichlorobenzotrifluoride | |
| 3,4-Dichlorophenylisocyanate | |
| Pentachlorocyclohexane | |
| Pentachloroaniline | |
| Pentabromochlorocyclohexane | |
| Tetrachlorophthalic anhydride | |
| *Phenol (from chlorobenzene) | |
| *1,2-Dihydroxybenzene-3,5-disulfonic acid, disodium salt | |
| *2,5-Dihydroxybenzenesulfonic acid | |
| *2,5-Dihydroxybenzenesulfonic acid, potassium salt | |
| *2,4-Dinitrophenol | |
| *2,4-Dinitrophenoxyethanol | |
| *3,5-Dinitrosalicylic acid | |
| *o-Nitroanisole | |
| *2-Nitro-p-cresol | |
| *o-Nitrophenol | |
| *2,4,6-Trinitroresorcinol | |
| *Fumaric acid | |
| *Maleic acid | |
| *Maleic anhydride | |
| *o-Phenetidine | |
| *Phenyl ether | |
| *Phthalic anhydride | |
| *Picric acid | |
| *Sodium picrate | [183] |

*Non-chlorinated chemicals produced via routes involving chlorinated chemicals.

## ANNEX 2: Pesticides Known or Suspected to be Accompanied by PCDD/F Formation During Manufacture

Sources: 1. U.S. Environmental Protection Agency. 1998. The Inventory of Sources of Dioxin in the United States. EPA/600/P-98/002Aa, Washington, D.C., April 1998.
2. Bretthauer, E., Kraus, H., di Domenico, A. 1991. Dioxin Perspectives: A Pilot Study on International Exchange on Dioxins and Related Compounds. New York: Plenum Press.

| Common Name | Pesticide | Chemical Abstract Service Number | Source |
|---|---|---|---|
| | Dichlorodifluoromethane | 75-71-8 1 | 1 |
| Bromophos | O-( 4- Bromo- 2,5- dichlorophenyl) O, O- dimethyl phosphorothioate | 2104-96-3 | 1 |
| | Dimethylamine 2,3,5- triiodobenzoate | 17601-49-9 | 1 |
| Neburon | | 555-37-3 | 1 |
| Crufomate | | 299-86-5 | 1 |
| | MCPB, 4- butyric acid [4-( 2- Methyl- 4- chlorophenoxy) butyric acid] | 94-81-5 | 1 |
| | MCPB, Na salt [Sodium 4-( 2- methyl- 4- chlorophenoxy) butyrate] | 6062- 26- 6 | 1 |
| | 4- Chlorophenoxyacetic acid | 122- 88- 3 | 1 |
| Chloroxuron | | 1982- 47- 4 | 1 |

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| Dichlobenil | | 1194- 65- 6 | 1 |
| Propanil | 3', 4'- Dichloropropionanilide | 709- 98- 8 | 1 |
| Dichlofenthion | O-( 2,4- Dichlorophenyl) O, O- diethyl phosphorothioate) | 97- 17- 6 | 1 |
| DDT | Dichloro diphenyl trichloroethane | 50- 29- 3 | 1 |
| Dichlone | 2,3- dichloro- 1,4- naphthoquinone | 117- 80- 6 | 1 |
| Ammonium chloramben | 3- amino- 2,5- dichlorobenzoic acid | 1076- 46- 6 | 1 |
| Sodium chloramben | 3- amino- 2,5- dichlorobenzoic acid | 1954- 81- 0 | 1 |
| Disul | Sodium 2-( 2,4-dichlorophenoxy) ethyl sulfate | 136- 78- 7 | 1 |
| DCNA | 2,6- Dichloro- 4- nitroaniline | 99- 30- 9 | 1 |
| | Potassium 2-( 2- methyl-4-chlorophenoxy) propionate | 1929- 86- 8 | 1 |
| MCPP, DEA Salt | Diethanolamine 2-( 2- methyl- 4- chlorophenoxy) propionate | 1432- 14- 0 | 1 |
| MCPP, IOE | Isooctyl 2-( 2- methyl- 4- chlorophenoxy) propionate | 28473- 03- 2 | 1 |
| Dicapthon | O-( 2- chloro- 4- nitrophenyl) O, O- dimethyl phosphorothioate | 2463- 84- 5 | 1 |
| Monuron trichloroacetate | 3-( 4- chlorophenyl)- 1,1- dimethylurea trichloroacetate | 140- 41- 0 | 1 |
| Diuron | 3-( 3,4- dichlorophenyl)- 1,1- dimethylurea | 330- 54- 1 | 1 |
| Linuron | 3-( 3,4- dichlorophenyl)- 1- methoxy- 1- methylurea | 330- 55- 2 | 1 |
| Metobromuron | 3-( p- bromophenyl)- 1- methoxy- 1- methylurea | 3060- 89- 7 | 1 |
| Methyl parathion | O, O- Dimethyl O- p- nitrophenyl phosphorothioate | 298- 00- 0 | 1 |
| Dichlorophene | Sodium 2,2'- methylenebis( 4- chlorophenate) | 97- 23- 4 | 1 |
| Dichlorophene, sodium salt | Sodium 2,2'- methylenebis( 4- chlorophenate) | 10254- 48- 5 | 1 |
| | 1,2,4,5- Tetrachloro- 3- nitrobenzene | 117- 18- 0 | 1 |
| Ethyl parathion | O, O- diethyl O- p- nitrophenyl phosphorothioate | 56- 38- 2 | 1 |
| Carbophenothion | S-((( p- chlorophenyl) thio) methyl) O, O- diethyl phosphorodithioate | 786- 19- 6 | 1 |
| Ronnel | O, O- dimethyl O-( 2,4,5- trichlorophenyl) phosphorothioate | 229- 84- 3 | 1 |
| Mitin FF | Sodium 5- chloro- 2-( 4- chloro- 2-( 3-( 3,4- dichlorophenyl) ureido) phenoxy) benzenesulfonate | 3567- 25- 7 | 1 |
| | Orthodichlorobenzene | 95- 50- 1 | 1 |
| | Paradichlorobenzene | 106- 46- 7 | 1 |
| Chlorophene | 2- Benzyl- 4- chlorophenol | 120- 32- 1 | 1 |
| | Potassium 2- benzyl- 4- chlorophenate | 35471- 49- 9 | 1 |
| | Sodium 2- benzyl- 4- chlorophenate | 3184- 65- 4 | 1 |
| | Chlorophenol | 95- 57- 8 | 1 |
| | 2- Chloro- 4- phenylphenol | 92- 04- 6 | 1 |
| | Potassium 2- chloro- 4- phenylphenate | 18128- 16- 0 | 1 |
| | 4- Chloro- 2- phenylphenol | not available | 1 |
| | 4- Chloro- 2- phenylphenol, potassium salt | 53404- 21 | 1 |
| | 6- Chloro- 2- phenylphenol | 85- 97- 2 | 1 |
| | 6- Chloro- 2- phenylphenol, potassium salt | 18128- 17- 1 | 1 |
| | 4- Chloro- 2- phenylphenol, sodium salt | 10605- 10- 4 | 1 |
| | 6- Chloro- 2- phenylphenol, sodium salt | 10605- 11- 5 | 1 |
| | 4 and 6- Chloro- 2- phenylphenol, diethanolamine salt | 53537- 63- 6 | 1 |

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|  | 2- Chloro- 4- phenylphenol, sodium salt | 31366- 97- 9 | 1 |
|  | 4- Chloro- 2- cyclopentylphenol | 13347- 42- 7 | 1 |
| Fentichlor | 2,2'- Thiobis( 4- chloro- 6- methylphenol) | 4418- 66- 0 | 1 |
| Fentichlor | 2,2'- Thiobis( 4- chlorophenol)] 5 | 97- 24- | 1 |
|  | 4- Chloro- 2- cyclopentylphenol, potassium salt of | 35471- 38- 6 | 1 |
|  | 4- Chloro- 2- cyclopentylphenol, sodium salt | 53404- 20- 9 | 1 |
| Chlorophacinone |  | 3691- 35- 8 | 1 |
| ADBAC | Alkyl* dimethyl benzyl ammonium chloride *( 50% C14, 40% C12, 10% C16) | 68424- 85- 1 | 1 |
| ADBAC | Alkyl* dimethyl 3,4- dichlorobenzyl ammonium chloride *( 61% C12, 23% C14, 11% C16, 5% C18) | not available | 1 |
| Niclosamide | 2- Aminoethanol salt of 2', 5- dichloro- 4'- nitrosalicylanilide | 1420- 04- 8 | 1 |
|  | 5- Chlorosalicylanilide | 4638- 48- 6 | 1 |
|  | 2- Methyl- 4- isothiazolin- 3- one | not available | 1 |
| Tetradifon | 4- chlorophenyl 2,4,5- trichlorophenyl sulfone | 116- 29- 0 | 1 |
| Chloranil | tetrachloro- p- benzoquinone | 118- 75- 2 | 1 |
|  | 6- Chlorothymol | 89- 68- 9 | 1 |
| Anilazine | 2,4- Dichloro- 6-( o- chloroanilino)- s- triazine | 101- 05- 3 | 1 |
| Chlorothalonil | Tetrachloroisophthalonitrile | 1897- 45- 6 | 1 |
| Fenac, Chlorfenac | Sodium 2,3,6- Trichlorophenylacetate | 2439- 00- 1 | 1 |
| Chlorfenvinphos |  | 470- 90- 6 | 1 |
|  | O-( 2- Chloro- 1-( 2,5- dichlorophenyl) vinyl) O, O- diethyl phosphorothioate | 1757- 18- 2 | 1 |
| PCMX | 4- Chloro- 3,5- xylenol | 88- 04- 0 | 1 |
| Piperalin | 3-( 2- Methylpiperidino) propyl 3,4- dichlorobenzoate | 3478- 94- 2 | 1 |
| Fenamiphos |  | not available | 1 |
|  | p- Chlorophenyl diiodomethyl sulfone | 20018- 12- 6 | 1 |
| Metribuzin |  | 21087- 64- 9 | 1 |
| Bifenox | methyl 5-( 2,4- dichlorophenoxy)- 2- nitrobenzoate | 42576- 02- 3 | 1 |
| Methazole | 2-( 3,4- dichlorophenyl)- 4- methyl- 1,2,4- oxadiazolidine- 3,5- dione | 20354- 26- 1 | 1 |
| Diflubenzuron | N-((( 4- chlorophenyl) amino) carbonyl)- 2,6- difluorobenzamide | 35367- 38- 5 | 1 |
| Oxadiazon | 2-Tert- butyl- 4-( 2,4- dichloro- 5- isopropoxyphenyl)- delta 2 -1,3,4- oxadiazoline- 5- one] | 19666- 30- 9 | 1 |
| Fenvalerate |  | 51630- 58- 1 | 1 |
| Fluvalinate | N- 2- Chloro- 4- trifluoromethyl) phenyl- DL- valine (+-)- cyano( 3- phenoxy- phenyl) methyl ester | 69409- 94- 5 | 1 |
| Iprodione | 3-( 3,5- Dichlorophenyl)- N-( 1- methylethyl)- 2,4- dioxo- 1- imidazolidinecarboxamide (9CA) | 36734- 19- 7 | 1 |
| Triadimefon | 1-( 4- Chlorophenoxy)-3,3-dimethyl-1-( 1H-1,2,4- triazol-1-yl)- 2- butanone | 43121- 43- 3 | 1 |
| Diclofop - methyl | Methyl 2-( 4-( 2,4- dichlorophenoxy) phenoxy) propanoate | 51338- 27- 3 | 1 |
| Profenofos | O-( 4- Bromo- 2- chlorophenyl)- O- ethyl S- propyl phosphorothioate | 41198- 08- 7 | 1 |
| Oxyfluorfen | 2- chloro- 1-( 3- ethoxy- 4- nitrophenoxy)- 4-( trifluoromethyl) benzene | 42874- 03- 3 | 1 |

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| Imazalil | 1-( 2-( 2,4- Dichlorophenyl)- 2-( 2- propenyloxy) ethyl)- 1H- imidazole | 35554- 44- 0 | 1 |
| Bromothalin | N- Methyl- 2,4- dinitro- n-( 2,4,6- tribromophenyl)- 6-<br>(trifuloromethyl) benzenamine | 63333- 35- 7 | 1 |
| Vinclozolin | 3-( 3,5- Dichlorophenyl)- 5- ethenyl- 5- methyl- 2,4- oxazolidinedione (9CA) | 50471- 44- 8 | 1 |
| Fenridazon | Potassium 1-( p- chlorophenyl)- 1,4- dihydro- 6- methyl- 4- oxo- pyridazine- 3- carboxylate | 83588- 43- 6 | 1 |
| Tridiphane | 2-( 3,5- Dichlorophenyl)- 2-( 2,2,2- trichloroethyl) oxirane | 58138- 08- 2 | 1 |
| Paclobutrazol | | 76738- 62- 0 | 1 |
| Linalool | | 78- 70- 6 | 1 |
| | [a-( 2- chlorophenyl)- a-( 4- chlorophenyl)- 5- pyrimidinemethanol] | 60168- 88- 9 | 1 |
| Dicamba dimethylamine | [3,6- dichloro- o- anisic acid] | 2300- 66- 5 | 1 |
| Diethanolamine dicamba | [3,6- dichloro- 2- anisic acid] | 25059- 78- 3 | 1 |
| 2,4-D | 2,4- Dichlorophenoxyacetic acid | 94- 75- 7 | 1 |
| | Lithium 2,4- dichlorophenoxyacetate | 3766- 27- 6 | 1 |
| | Potassium 2,4- dichlorophenoxyacetate | 14214- 89- 2 | 1 |
| | Sodium 2,4- dichlorophenoxyacetate | 2702- 72- 9 | 1 |
| | Ammonium 2,4- dichlorophenoxyacetate | 2307- 55- 3 | 1 |
| | Alkanol* amine 2,4- dichlorophenoxyacetate *( salts of the ethanol and ispropanol series) | not available | 1 |
| | Alkyl* amine 2,4- dichlorophenoxyacetate *( 100% C12) | 2212- 54- 6 | 1 |
| | Alkyl* amine 2,4- dichlorophenoxyacetate *( 100% C14) | 28685- 18- 9 | 1 |
| | Alkyl* amine 2,4- dichlorophenoxyacetate *( as in fatty acids of tall oil) | not available | 1 |
| | Diethanolamine 2,4- dichlorophenoxyacetate | 5742- 19- 8 | 1 |
| | Diethylamine 2,4- dichlorophenoxyacetate | 20940- 37- 8 | 1 |
| | Dimethylamine 2,4- dichlorophenoxyacetate | 2008- 39- 1 | 1 |
| | N, N- Dimethyloleylamine 2,4- dichlorophenoxyacetate | 53535- 36- 7 | 1 |
| | Ethanolamine 2,4- dichlorophenoxyacetate | 3599- 58- 4 | 1 |
| | Heptylamine 2,4- dichlorophenoxyacetate | 37102- 63- 9 | 1 |
| | Isopropanolamine 2,4- dichlorophenoxyacetate | 6365- 72- 6 | 1 |
| | Isopropylamine 2,4- dichlorophenoxyacetate | 5742- 17- 6 | 1 |
| | Morpholine 2,4- dichlorophenoxyacetate | 6365- 73- 7 | 1 |
| | N- Oleyl- 1,3- propylenediamine 2,4- dichlorophenoxyacetate | 2212- 59- 1 | 1 |
| | Octylamine 2,4- dichlorophenoxyacetate | 2212- 53- 5 | 1 |
| | Triethanolamine 2,4- dichlorophenoxyacetate | 2569- 01- 9 | 1 |
| | Triethylamine 2,4- dichlorophenoxyacetate | 2646- 78- 8 | 1 |
| | Triisopropanolamine 2,4- dichlorophenoxyacetate | 32341- 80- 3 | 1 |
| | N, N- Dimethyl oleyl- linoleyl amine 2,4- dichlorophenoxyacetate | 55256- 32- 1 | 1 |
| | Butoxyethoxypropyl 2,4- dichlorophenoxyacetate | 1928- 57- 0 | 1 |
| | Butoxyethyl 2,4- dichlorophenoxyacetate | 1929- 73- 3 | 1 |
| | Butoxypropyl 2,4- dichlorophenoxyacetate | 1928- 45- 6 | 1 |

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| | Butyl 2,4- dichlorophenoxyacetate | 94- 80- 4 | 1 |
| | Isobutyl 2,4- dichlorophenoxyacetate | 1713- 15- 1 | 1 |
| | Isooctyl( 2- ethylhexyl) 2,4- dichlorophenoxyacetate | 1928- 43- 4 | 1 |
| | Isooctyl( 2- ethyl- 4- methylpentyl) 2,4- dichlorophenoxyacetate | 25168- 26- 7 | 1 |
| | Isooctyl( 2- octyl) 2,4- dichlorophenoxyacetate | 1917- 97- 1 | 1 |
| | Isopropyl 2,4- dichlorophenoxyacetate | 94- 11- 1 | 1 |
| | Propylene glycol butyl ether 2,4- dichlorophenoxyacetate | 1320- 18- 9 | 1 |
| | 4-( 2,4- Dichlorophenoxy) butyric acid | 94- 82- 6 | 1 |
| | Sodium 4-( 2,4- dichlorophenoxy) butyrate | 10433- 59- 7 | 1 |
| | Dimethylamine 4-( 2,4- dichlorophenoxy) butyrate | 2758- 42- 1 | 1 |
| | Butoxyethanol 4-( 2,4- dichlorophenoxy) butyrate | 32357- 46- 3 | 1 |
| | Butyl 4-( 2,4- dichlorophenoxy) butyrate | 6753- 24- 8 | 1 |
| | Isooctyl 4-( 2,4- dichlorophenoxy) butyrate | 1320- 15- 6 | 1 |
| | 2-( 2,4- Dichlorophenoxy) propionic acid (Dichlorprop, 2,4-DP) | 120- 36- 5 | 1 |
| | Dimethylamine 2-( 2,4- dichlorophenoxy) propionate | 53404- 32- 3 | 1 |
| | Butoxyethyl 2-( 2,4- dichlorophenoxy) propionate | 53404- 31- 2 | 1 |
| | Isooctyl 2-( 2,4- dichlorophenoxy) propionate | 28631- 35- 8 | 1 |
| | [2-( 2- Methyl- 4- chlorophenoxy) propionic acid] | 7085- 19- 0 | 1 |
| MCPP, DMA | Dimethylamine 2-( 2- methyl- 4- chlorophenoxy) propionate | 32351- 70- 5 | 1 |
| Bromoxynil | 3,5- Dibromo- 4- hydroxybenzonitrile | 1689- 84- 5 | 1 |
| Hexachlorophene | 2,2'- Methylenebis( 3,4,6- trichlorophenol) | 70- 30- 4 | 1 |
| Hexachlorophene, sodium salt | Monosodium 2,2'- methylenebis( 3,4,6- trichlorophenate) | 5736- 15- 2 | 1 |
| Hexachlorophene, potassium salt | Potassium 2,2'- methylenebis( 3,4,6- trichlorophenate) | 67923- 62- 0 | 1 |
| Irgasan | 5- Chloro- 2-( 2,4- dichlorophenoxy) phenol | 3380- 34- 5 | 1 |
| | Tetrachlorophenols | 25167- 83- 3 | 1 |
| | Tetrachlorophenols, sodium salt | 25567- 55- 9 | 1 |
| | Tetrachlorophenols, alkyl* amine salt*( as in fatty acids of coconut oil) | not available | 1 |
| | Tetrachlorophenols, potassium salt | 53535- 27- 6 | 1 |
| Bithionolate sodium | Disodium 2,2'- thiobis( 4,6- dichlorophenate) | 6385- 58- 6 | 1 |
| Phenachlor | 2,4,6- Trichlorophenol | 88- 06- 2 | 1 |
| | Potassium 2,4,6- trichlorophenate | 2591- 21- 1 | 1 |
| | 2,4,6- Trichlorophenol, sodium salt | 3784- 03- 0 | 1 |
| Phenothiazine | | 92- 84- 2 | 1 |
| Dacthal- DCPA | Dimethyl tetrachloroterephthalate | 1861- 32- 1 | 1 |
| Endosulfan | Hexachlorohexahydromethano- 2,4,3- benzodioxathiepin- 3- oxide | 115- 29- 7 | 1 |
| Silvex | 2-( 2,4,5-Trichlorophenoxy) propionic acid | 93- 72- 1 | 1 |
| Tetrachlorvinphos | 2- Chloro- 1-( 2,4,5- trichlorophenyl) vinyl dimethyl phosphate | 961- 11- 5 | 1 |
| Edolan | Sodium 1,4', 5'- trichloro- 2'-( 2,4,5- trichlorophenoxy) methanesulfonanilide | 69462- 14- 2 | 1 |
| 2,4-DB | 4-(2,4-Dichlorophenoxy)butanoic acid and its salts | | 2 |
| 2,4,5-T | 2,4,5-Trichlorophenoxyacetic acid, its esters and | | 2 |

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|---|---|---|---|
| | salts | | |
| | Dimethyl-(2,3,5,6-tetrachloro-1,4-benzodicarbonate) | | 2 |
| MCPA | 4-Chloro-2-methylphenoxy acetic acid | | 2 |
| Chloroneb | 1,4-Dichloro-2,5-dimethoxybenzene | | 2 |
| Erbone | 2(2,4,5-Trichlorophenoxy)-ethyl-2,2,-dichloropropionate | | 2 |
| Daconil | 1,3-dicyano-2,4,5,6-tetrachlorobenzene | | 2 |

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