Compilation of Comments on the draft guidelines on BAT and guidance on BEP received by the Secretariat of the Stockholm Convention

COMMENTS SUBMITTED BY NGOS

COMMENTS SUBMITTED BY THE AMERICAN FOREST & PAPER ASSOCIATION

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Comments of the American Forest & Paper Association on:

Section V.C.
Guidance by source category: Annex C, Part II Source Categories
"Production of pulp using elemental chlorine or chemicals generating elemental chlorine for bleaching"
Draft of April 15, 2004

Preamble

These comments are provided by the American Paper & Forest Association to assist the Expert Group in the development of Best Available Techniques and Best Environmental Practices for the elimination of specific polychlorinated dibenzo-*p*-dioxins and polychlorinated dibenzofurans that may be formed during the bleaching of chemical pulp and emitted to waterways. (AF&PA contact: Dr. John L. Festa).

General Comments on "Draft Guidelines on BAT for production of pulp using elemental chlorine"

The current, "Draft Guidelines on BAT for production of pulp using elemental chlorine" accurately identifies the relevant UPOPs that have the potential for formation when pulp is produced with elemental chlorine.

The draft guidelines, with some exceptions noted below, describe the internationally recognized, scientifically sound, and widely implemented, Best Available Techniques for their reduction and elimination. Furthermore, the success of these Best Available Techniques has been well documented. Relevant international regulatory standards are also provided to guide Parties to the Stockholm Convention on Persistent Organic Pollutants toward implementation of the Convention.

Section 1.3 Other sources of UPOPs in pulp mills

Section 1.3 (1.3.1 – 1.3.5) is deficient in a number of respects:

- The descriptions of the releases are general in nature;
- There is no description of the relevant UPOPs for each potential release;
- There is no discussion of mechanisms of formation or sources of contamination of the relevant UPOPs;

- There is no discussion of appropriate and demonstrated Best Available Techniques for reduction or elimination of relevant UPOPs;

- There is no documentation of successful implementation of Best Available Techniques; and
- There is no guidance provided to the Parties of relevant regulatory standards and the background upon which such standards are based.

For these reasons AF&PA recommends this chapter be removed until each of the above noted issues has been fully addressed and supported by additional information, and/or required research, technology development and economical implementation.

Section 2.2.1 Upstream and downstream aspects

Section 2.2.1 while emphasizing bleaching processes where chlorine is still practiced, for the most part, discusses technology options for elimination of chlorinated organic compounds in general. Development of BAT/BET for elimination of chlorinated organic chemicals is clearly outside the scope of the treaty. For this reason alone, AF&PA recommends this chapter be removed from the guidelines.

In addition, AF&PA believes this section should be removed based on the following summary. Since the late 1980s, the international scientific community has rigorously examined and rejected the hypothesis that the presence of and the amount of chlorinated organic substances is a measure of potential adverse environmental effects. More importantly, the scientific community has rejected the hypothesis that decreased chlorinated organic emissions will result in improved effluent quality and environmental protection. Overwhelming scientific evidence indicates these hypotheses are flawed for the following reasons:

- Chlorinated organic compounds, as measured by the amount of chlorine attached to organic substances, is not a predictor of bioassay responses for either primary or secondary treated effluents[1].
- There are no established causal relationships between ecological effects and the concentration of chlorinated organic substances[2].
- Factors other than the presence or absence of chlorine containing organic substances determine ecological responses. Natural compounds extracted from wood in pulping processes and released to the environment have been identified as one likely cause.
- Ecological responses to fish have been found downstream of mills with and without chlorine- and/or chlorine dioxide-based bleaching[3].
- Model ecosystem studies have shown no relationship between the concentration of chlorinated organic substance and observed environmental effects[4].

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[1] O'Connor, B.I., Kovacs, T.G., Voss, R.H. and Martel, P.H. *A Study of the Relationship Between Laboratory Bioassay Response and AOX Content for Pulp Mill Effluents.* Journal of Pulp and Paper Science: Vol. 19. No. 1. January 1993

[2] Priha, M. *Ecotoxicological Impacts of Pulp Mill Effluents in Finland.* 1994 Proceedings International Fate and Effects of Pulp and Paper Mill Effluents Conference, Vancouver B.C. St. Lucie Press, Florida, (1996)

[3] Williams, T.G., Carey, J.H., Burnison, B.K., Dixon, D.G., and Lee, H.-B. *Rainbow Trout Mixed Function Oxygenase Responses Caused by Unbleached and Bleached Pulp Mill Effluents: A Laboratory Study.* 1994 Proceedings International Fate and Effects of Pulp and Paper Mill Effluents Conference. Vancouver B.C. St. Lucie Press, Florida, (1996)

[4] Tana, J. and Lehtinen, K-J., *The Aquatic Environmental Impact of Pulping and Bleaching Operations - An Overview.* Finnish Environmental Agency, Helsinki, (1996).

- Environmental effects assessed by field studies in receiving waters do not correlate with the concentration of chlorinated organic substances[5].

Finally, the discussion of technologies minimizing bleach plant effluent volume, delignification, enzyme pretreatment, chemical substitution, effluent treatment, sludge disposal and combustion processes while relevant in the development of overall environmental regulations for protection of the ecosystem, are not relevant in this BAT guideline for elimination of UPOPs.

Specific Comments on "Draft Guidelines on BAT for production of pulp using elemental chlorine"

Summary
The last line of the second paragraph should be amended as follows:

"… have been identified **as potentially** being produced ..."

The next sentence should be amended as follows:

"… can be **taken** for decreasing **and/or eliminating** …"

The summary would benefit by adding the following to the measures that can taken for decreasing and/or elimination the formation of 2378-TCDD and 2378-TCDF:

- Maximize knot removal;
- Eliminate pulping of wood chips contaminated with polychlorinated phenol; and
- Reduce application of molecular chlorine by decreasing active chlorine multiple.

Section 1.2.1 Process Steps in general

The third line should be amended as follows:

"… residue cleaning and **de-knotting** …"

Section 1.2.2 Pulping Methods Applied

Something is missing at the end of the second paragraph; see the following:

"… in the case of **?** are continuous processes **?** are vertical tower constant flow digesters …"

The last line of the last paragraph should be amended as follows:

"… it is achieved using ~~non-chlorinated~~ compounds such as dithionite or peroxides …"

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[5] Munkittrick, K.R., Servos, M.R., Carey, J.H. and Van Der Kraak, G.J. *Environmental Impacts of Pulp and Paper Wastewater: Evidence for a Reduction in Environmental Effects at North American Pulp Mills Since 1992*. IAWQ, 1996 Proceedings of the 5th Forest Industries Waste Water Symposium.Vancouver, B.C., June 1996.

The use of the term "non-chlorinated" is unnecessary, as chlorine was never used for mechanical pulp bleaching.

Section 1.2.2.3 Sulphite Pulping Processes

The last sentence could be amended as follows:

"… **Sulphite pulps are** relatively bright **compared to kraft pulps and are also relatively easy to bleach with oxygen based chemicals such as peroxides …"**

The comment that they are easy to bleach without chlorine chemicals is not necessary.

Section 1.2.3 Bleaching

The first sentence of the third paragraph should be amended as follows:

"… ECF pulp bleached with chlorine dioxide accounts for the predominant share of roughly **three-quarters**[6] of the bleached pulp produced worldwide …"

The last sentence of the third paragraph should be amended as follows:

"… Roughly **20%** of the bleached pulp produced world-wide is still bleached with **some** elemental chlorine…"

In the preceding sentence, "some" need not be underlined. The emphasis is not necessary.

Section 1.2.3.3 Elimination mechanisms for 2378-TCDD/F

This section should be amended as follows:

- The title of Figure 2 should be: "… **2378-TCDF** formation with different chlorine dioxide substitution level"
- The next sentence should be "… 2378-TCDD**/F** formation will be reduced **and ultimately eliminated** by increasing chlorine dioxide substitution …"
- The next paragraph should be amended as follows: "… The summary effect of active chlorine multiple **and** chlorine dioxide substitution ~~**and precursor concentration**~~ can be seen in the figure 3. The level of ~~**the**~~ dioxin **formation under these conditions, i.e., high active chlorine multiple and low chlorine dioxide substitution,** is expected to vary depending on the DBD content of the brownstock …"
- The title of Figure 3 should be: "… Effect of ~~**precursor content,**~~ active chlorine multiple and chlorine dioxide substitution level on 2378-TCDD formation …". The figure does not show the effect of precursor content.
- The last sentence of the next paragraph should be removed. The fact that ECF bleaching leads to the formation of a relatively small amount of chlorinated compounds is true but not relevant to the discussion of the elimination of 2378-TCDD/F. The latter half of the sentence discussing 85% substitution is unclear and confusing.

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[6] Trends in World Bleached Chemical Pulp Production: 1990-2002. *Alliance for Environmental Technology*. December, 2002.

Section 1.3 Other sources of UPOS in pulp mills

The title should be amended to "… Other sources of **UPOPs** in pulp mills …"

Section 1.3 (1.3.1 – 1.3.5) is deficient in a number of respects:

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- There is no documentation of successful implementation of Best Available Techniques; and
- There is no guidance provided to the Parties of relevant regulatory standards and the background upon which such standards are based.

For these reasons AF&PA recommends this chapter be removed until each of the above noted issues has been fully addressed and supported by additional information, and/or required research, technology development and economical implementation.

Section 2.2.1 Upstream and downstream aspects

Section 2.2.1 while emphasizing bleaching processes where chlorine is still practiced, for the most part, discusses technology options for elimination of chlorinated organic compounds in general. Development of BAT/BET for elimination of chlorinated organic chemicals is clearly outside the scope of the treaty. For this reason alone, AF&PA is of the opinion that this chapter should be removed from the guidelines.

In addition, AF&PA recommends this section be removed based on the following summary. Since the late 1980s, the international scientific community has rigorously examined and rejected the hypothesis that the presence of and the amount of chlorinated organic substances is a measure of potential adverse environmental effects. More importantly, the scientific community has rejected the hypothesis that decreased chlorinated organic emissions will result in improved effluent quality and environmental protection. Overwhelming scientific evidence indicates these hypotheses are flawed for the following reasons:

- Chlorinated organic compounds, as measured by the amount of chlorine attached to organic substances, is not a predictor of bioassay responses for either primary or secondary treated effluents[7].
- There are no established causal relationships between ecological effects and the concentration of chlorinated organic substances[8].
- Factors other than the presence or absence of chlorine containing organic substances determine ecological responses. Natural compounds extracted from wood in

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[7] O'Connor, B.I., Kovacs, T.G., Voss, R.H. and Martel, P.H. *A Study of the Relationship Between Laboratory Bioassay Response and AOX Content for Pulp Mill Effluents.* Journal of Pulp and Paper Science: Vol. 19. No. 1. January 1993

[8] Priha, M. *Ecotoxicological Impacts of Pulp Mill Effluents in Finland.* 1994 Proceedings International Fate and Effects of Pulp and Paper Mill Effluents Conference, Vancouver B.C. St. Lucie Press, Florida, (1996)

pulping processes and released to the environment have been identified as one likely cause.

- Ecological responses to fish have been found downstream of mills with and without chlorine- and/or chlorine dioxide-based bleaching[9].
- Model ecosystem studies have shown no relationship between the concentration of chlorinated organic substance and observed environmental effects[10].
- Environmental effects assessed by field studies in receiving waters do not correlate with the concentration of chlorinated organic substances[11].

- Finally, the discussion of technologies minimizing bleach plant effluent volume, delignification, enzyme pretreatment, chemical substitution, effluent treatment, sludge disposal and combustion processes while relevant in the development of overall environmental regulations for protection of the ecosystem, are not relevant in this BAT guideline for elimination of UPOPs.

Section 3 Performance standards

Under 2378-TCDD/2378-TCDF ppq To Water and the USA Ammonium based and specialty sulphite, the measurement point is: "… **in bleach plant effluent**…"

Section 4 Performance Reporting

The final sentence of the first full paragraph should be amended as follows:

"… The testing period reverts back to monthly testing if either a quarterly test or an annual test ~~detects dioxins or furans~~ exceeds the level of quantitation (LOQ) … "

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[9] Williams, T.G., Carey, J.H., Burnison, B.K., Dixon, D.G., and Lee, H.-B. *Rainbow Trout Mixed Function Oxygenase Responses Caused by Unbleached and Bleached Pulp Mill Effluents: A Laboratory Study.* 1994 Proceedings International Fate and Effects of Pulp and Paper Mill Effluents Conference. Vancouver B.C. St. Lucie Press, Florida, (1996)

[10] Tana, J. and Lehtinen, K-J., *The Aquatic Environmental Impact of Pulping and Bleaching Operations - An Overview*. Finnish Environmental Agency, Helsinki, (1996).

[11] Munkittrick, K.R., Servos, M.R., Carey, J.H. and Van Der Kraak, G.J. *Environmental Impacts of Pulp and Paper Wastewater: Evidence for a Reduction in Environmental Effects at North American Pulp Mills Since 1992*. IAWQ, 1996 Proceedings of the 5th Forest Industries Waste Water Symposium.Vancouver, B.C., June 1996.

COMMENTS SUBMITTED BY ARNIKA ASSOCIATION –TOXICS AND WASTE PROGRAMME

Comments on „Draft guidelines and guidance on BAT and BEP for the sources of dioxins and other unintentionally produced POPs identified in Annex C of the Stockholm Convention"

The submitted „Draft guidelines and guidance on BAT and BEP for the sources of dioxins and other unintentionally produced POPs identified in Annex C of the Stockholm Convention" (quoted as „Draft guidelines and guidance on BAT and BEP" further) will undoubtedly represent an important document for parties of the Stockholm Convention. This document should serve in particular to fulfilment of the requirements of the Stockholm Convention which requires: „*...each country to reduce the total releases derived from anthropogenic sources of [POPs], with the goal of their continuing minimization and, where feasible, ultimate elimination.*"

Annex C of the Stockholm Convention further states: *"When considering proposals to construct new facilities or significantly modify existing facilities using processes that release chemicals listed in this Annex* [i.e. dioxins, furans, PCBs and HCB], *priority consideration should be given to alternative processes, techniques or practices that have similar usefulness but which avoid the formation and release of such chemicals."* (Annex C, Part V (B)(b))

When reviewing the „Draft guidelines and guidance on BAT and BEP" from the point of view of the two above-mentioned quotations of the text of the Convention, it has to be stated that the Draft is not in accordance with them or it does not fulfil even a half of them. For this reason, we require revision of the Draft. Specifically, in the case of incineration of wastes, either in incinerators or in cement kilns, an important part is avoidance of these practices. The description of the Best Environmental Practice should contain also a description of the specific sources included into Part V. Therefore, in the case of incineration of municipal wastes, we lack description of methods used in the cities and states which adopted „Zero waste" policy as their waste management policy. The Australian city Canberra could serve as an example for a description of such method. Similarly, in the case of description of medical waste incineration, we lack a more detailed description of alternative methods of medical waste treatment. The comprehensive report prepared by Health Care Without Harm network „Non-Incineration Medical Waste Treatment Technologies" can be used as a source for such description. We recommend to do this when revising the „Draft guidelines and guidance on BAT and BEP".

One of the important methods resulting in reduction of POPs releases is, for example, elimination of PVC, as a material comprising chlorine, from the waste which is incinerated or deposited into landfills. Incineration of PVC and other chlorinated substances results in higher likelihood of POPs formation, as proved by numerous studies. Therefore, we hope that recommendation to eliminate PVC, and, optionally, further materials, from the flow of wastes into incinerators and landfills, will be incorporated into the „Draft guidelines and guidance on BAT and BEP". From our point of view, BEP in the case of PVC is reduction of its use with the goal of its total replacement.

In the countries which have experience with introduction of full informing of the public about flows of toxic chemicals through publicly available Pollutant Release and Transfer Register, reduction of all toxic chemicals releases is evident. For this reason, we believe that the list of BEP in the „Draft guidelines and guidance on BAT and BEP" should include also establishment of PRTRs. From this point of view, recommendation to the parties of the Convention to adopt PRTR Protocol to Aarhus Convention should be considered.

The „Draft guidelines and guidance on BAT and BEP" reflect, to a certain extent, loopholes in „The Standardized Toolkit for Identification and Quantification of Dioxin and Furan Releases", or more precisely, its shortcomings concerning releases of other unwanted by-products (PCBs and HCB), and in the field of assessment of the content of unwanted by-products in solid and liquid residues. We lack such assessment in the part dealing with incineration of wastes in cement kilns. If HCB is formed during incineration of hazardous wastes in incinerators, then certain emissions of this chemical can be expected also during incineration of wastes in cement kilns as it was measured in Poland (see further detail comments). It is not possible to be satisfied with the statement that the emissions of HCB and PCB are not subject to regulatory monitoring in cement plants.

All technologies, including incineration of hazardous wastes (both in incinerators and in cement kilns), plasma arc, pyrolysis and others should be compared according to their Destruction Efficiencies in full TEQs scale, in the „Draft guidelines and guidance on BAT and BEP“. Therefore the following part is specifically focused on POPs waste destruction.

Criteria for destruction of POPs waste

Parties are to take measures according to the Stockholm Convention so that POPs wastes are:

- *Disposed of in such a way that the persistent organic pollutant content is destroyed or irreversibly transformed so that they do not exhibit the characteristics of persistent organic pollutants...*

- *...not permitted to be subject to disposal operations that may lead to recovery, recycling, reclamation, direct reuse or alternative uses for POPs.*

Criteria from Stockholm Convention:

A suitable destruction process/technology therefore should:

- Prevent the formation of dioxins, furans and other by-product POPs.
- Prevent the release of dioxins/furans and other by-product POPs.
- Not generate any wastes with POPs characteristics.
- Not utilise any POPs disposal methods which are non-destructive, such as landfilling or recycling in any form.

By undersigned NGOs endorsed criteria for destruction of (historical) POPs waste originally prepared by Greenpeace:

- An effective destruction efficiency of 100% - taking into account all inputs and releases;
- Complete containment of all process streams to enable testing and reprocessing if necessary to ensure;
- No uncontrolled releases from the process.

Further Considerations when evaluating technologies:

- Eliminate inappropriate technologies (based on guidance/criteria)
  - E.g. formation of POPs/releases of POPs/POPs wastes/landfill etc
- Destruction Efficiency (based on inputs vs. all outputs)
- Ability to contain all process streams
- Ability to reprocess materials, residues, gases, liquids if required

- Availability of complete process information (analytical data)
- Track record/commercial availability
- Safety/OH&S
- Hazardous materials use
- Community acceptability

We prefer to use a concept of Destruction Efficiency rather than Destruction and Removal Efficiency commonly used during the evaluation of technologies for POPs destruction. Difference between these two concepts is quite clear from paper prepared by D. Luscombe as Greenpeace factsheet (Non-Incineration Technology Fact Sheet #2).

Few detail comments

In Section V.B. "Cement kilns firing hazardous waste", Table 1: "Summary of PCDD/PCDF measurements data" is contained. This Table attempts to summarise the measured concentrations of PCDD/PCDF in flue gases. There were done measurements on cement kilns co-burning waste as fuel in the Czech Republic in 2002 - 2003. Only in one case a level of 0.005 ng I-TEQ/m^3 was measured. The rest of results (12 measurements together) were in a range of 0.023 - 2.3 ng I-TEQ/m^3. In three cases, the results exceeded the limit of 0.1 ng I-TEQ/m^3.

Measurements done in Poland in a cement kiln co-incinerating non-hazardous waste found that emissions of PCBs and HCB rose many times in comparison with a cement kiln burning coal only, what is contrary to statement in chapter 3.4 of Section V.B. of the „Draft guidelines and guidance on BAT and BEP": "*However, some measurements have revealed that HCB could not be detected, i. e. HCB emissions is most probably not an issue for the cement industry.*"

Cement kiln	**PCDD/F ng-TEQ/m^3**	**PCBs ng-TEQ/m^3**	**HCB ng-TEQ/m^3**
Co-incinerating waste	0.070	8.95	44.2
Burning coal	0.055	4.45	2.90

Ref.: Grochowalski A., Sprawozdanie z przeprowadzonych pomiarow i oznaczania stezenia PCDDs/PCDFs, HCB i PCBs, 30.09.2002; http://ks.ios.edu.pl/gef/doc/GF-POL-INV-R1.PDF

Comment to Section V.B., chapter 3. Process Outputs: Recycling cement kiln dust (CKD) directly to the kiln generally results in a gradual increase in alkali content of generated dust that may damage cement kiln linings, produce inferior cement, and increase particle emissions.[i] In Europe, CKD is commonly added directly to the product cement.[ii] This practice may well explain the PCDD/PCDF levels of 5.1 to 17.8 ng I-TEQ/kg in clinker that has been reported by Denmark,[iii] since PCDD/PCDF levels as high as 297 ng I-TEQ/kg are known to occur in CKD.[iv]

Elevated PCDD/PCDF levels in CKD suggest that fugitive emissions of CKD may constitute significant releases of PCDD/PCDF. Fugitive emissions of CKD and associated PCDD/PCDF occur not only with operation of kilns but also with subsequent handling, storage and disposal of CKD. For example, the U.S. Environmental Protection Agency offered the following evaluation:[v]

> *Additionally, particulate emissions of fugitive dust are the major contributor of CKD to EPA's indirect foodchain pathway model. The Agency's quantitative modeling of ``indirect'' food chain pathways, both aquatic and agricultural, indicates potential human health effects, both cancer and non-cancer. A wide range of chemical constituents, including arsenic, cadmium, chromium, barium, thallium, lead, and dioxins, were indicated as constituents of concern at various plants. Because some CKD disposal units are located near, and in some instances immediately adjacent to, farm fields, rural residences with gardens, or surface waters containing fish, there is potential*

for indirect risk from the consumption of CKD-contaminated beef, vegetables and fish, as well as ingestion of CKD-contaminated water during recreational swimming.

In Section V.A.1. "Municipal and hazardous waste, and sewage sludge", there is stated in Table 6.3 that by incinerating 1 tonne of MSW, 210 kg of bottom ash is produced. In the Czech MSWI it is up to 370 kg according to records from the MSWI Termizo Liberec.

You can find more detailed data from Poland useful for medical waste incineration guidelines in section V.A.2. in Annex to our Comments.

Conclusions

As follows from the previous text, we require completion, or, optionally, revision of the „Draft guidelines and guidance on BAT and BEP" in order to contain:

- „Zero waste" policy examples as realistic alternative to municipal waste incineration avoiding new POPs releases generated by waste incineration and/or by fires on landfills;
- more detailed description of alternatives to incineration of medical wastes;
- more detailed description of alternatives to incineration of hazardous wastes;
- separate dealing with incineration of hazardous wastes in the „Draft guidelines and guidance on BAT and BEP", because this is a waste different in many aspects from municipal waste;
- more detailed description of chemical treatment of fly and boiler ashes, resulting in decomposition of POPs;
- comparison of all technologies by means of Destruction Efficiencies based on full TEQ and/or all POPs releases assessment;
- reduction of PVC and other substances, incinerating of which, or, optionally, firing of which on landfills, or in the case of which household and/or open burning of waste leads to POPs releases;
- establishment of publicly available PRTRs incorporating full information on POPs in all recorded flows, as information systems which, in its consequence, result in reduction of releases of toxic chemicals in general.

These comments were endorsed by following NGOs and experts:

Ing. Milan Havel, Ing. Petr Hrdina and RNDr. Jindrich Petrlik, Arnika Association, Czech Republic

Dr. Mahmood A. Khwaja, Sustainable Development Policy Institute (SDPI), Islamabad. Pakistan

Pawel Gluszynski, Waste Prevention Association - 3R, Krakow, Poland

Boryana Hrissimova, independent environmental expert, Sofia, Bulgaria

Ralph Ryder, Communities Against Toxics, United Kingdom

Dr. Paul Connett, Professor of Chemistry, St. Lawrence University, Canton, NY, USA

Ellen Connett, Editor, Waste Not, Canton, NY, USA

Huub Scheele, Both ENDS, Amsterdam, The Netherlands

Ing. Cestmir Hrdinka, Executive director, Health Care Without Harm Europe, Prague, Czech Republic (undersigning the comments related to medical waste)

Donald L. Hassig, Director, Cancer Action NY, USA

Eugeniy Lobanov, Foundation for Realization of Ideas (FRI), Belarus

Igor Hadjamberdiev "PAN Central Asia network" Kyrgyzstan-Uzbekistan-Tadjikistan

Miroslav Beranek, Czech Ecological Society, Czech Republic

Sonia S. Mendoza, President, Mother Earth Foundation, Philippines

Vratislav Bina, Civic Association Suchomasty, Czech Republic

Any reactions please send to:

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ANNEX:

Table 1. Non-incineration medical waste treatment technologies certified for the Polish market:

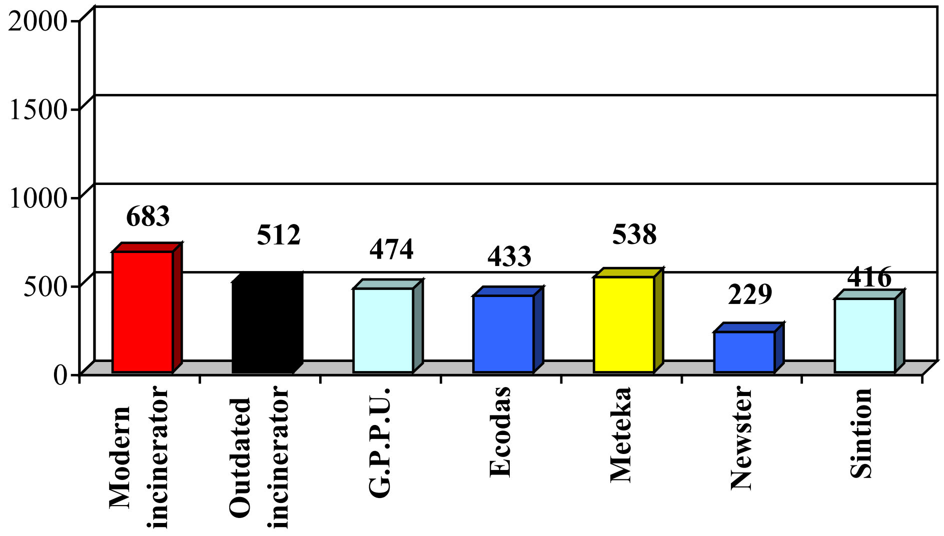
	G.P.P.U. (Polish)	**Ecodas (French)**	**Meteka (Austrian)**	**Newster (Italian)**	**Sintion (Austrian)**
Installation	Autoclave TSO 150	Autoclave T.300	Microwave Medister 360	Chemical Thermal Treatment Newster 10	Autoclave + Microwave Sintion 1.1.
Level	sterilisation	sterilisation	sterilisation	sterilisation	sterilisation
Maximum quantity [TPA] *	350	300	130	370	**120
Capacity [kg/cycle]	70	35	12 – 18	10 – 25	12
Chamber capacity [m^3]	0,93	0,35	0,06	0,13	0,103
Installation dimension L x W x H [m]	2,4x1,5x2,7	1,85x2,1x3	1,7x1,05x0,8	1,2x0,8x1,4	0,84x1,2x1,1
Installation mass [kg]	3150	2000	480	1100	430
Power supply type [V]	3 x 380	380	3 x 380	3 x 380	3 x 400
Power [kW]	11,2	17	no data	30	no data
Price net [excluding VAT]	**166 000 €**	**130 000 €**	**70 000 €**	**85 000 €**	**50 000 €**

	G.P.P.U. (Polish)	**Ecodas (French)**	**Meteka (Austrian)**	**Newster (Italian)**	**Sintion (Austrian)**
The price includes all equipment	without steam generator	without steam generator	yes	yes	yes
Term of guarantee [month]	24 – 36	12	12	12	12 - 18
Water use per cycle [m^3]	0,25	0,1	0,05	0,15 – 0,3	no data
Steam use per cycle [kg]	30	15	–	–	–
Energy use per cycle [kWh]	5	3	8,5	0,6	1
Chemical use per cycle [kg]	none	none	none	0,3 – 0,5 {14 – 15% NaClO}	none
Cycle time [minute]	40 – 90	40 – 60	55	15 – 25	10 – 30
Shredder	yes	yes	no	yes	no
Chamber unload	automatic	gravitational	gravitational	automatic	manual
Waste temperature right after process [^{o}C]	80 - 100	80	50	~ 90	< 50

* Maximum cycle time, and full load; operational for 7466 hours per year (85%).

** Sintion requires 8 hours break per twenty-four hours.

Investment costs
recalculated for maximum capacity
[€ net/tonne]



Modern incinerator: **equipped with secondary chamber; filters and scrubber, and automatic monitoring control system as required by Directive 2000/76/EC. [Average price based on three proposed installations, in 2002/2003.]**

Outdated incinerator: equipped with secondary chamber; filters and scrubber, without automatic monitoring control system as required by Directive 2000/76/EC, and [possibly] not meeting the EU emission standard. [Average price based on seven installations built in late 90's.]

All incinerators have average capacity 300 kg/h.

Source:
Urządzenia do unieszkodliwiania zakaźnych odpadów medycznych i weterynaryjnych dostępne na rynku krajowym [Medical waste treatment technologies available on the Polish market], OTZO/WPA, Kraków, March 2003.

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[i] U.S. Environmental Protection Agency, 1998. Technical Background Document on Ground Water Controls at CKD Landfills. Draft. Washington, D.C.: Office of Solid Waste, U.S. Environmental Protection Agency.

[ii] Lohse, J., Wulf-Schnabel, J., 1996. Expertise on the Environmental Risks Associated with the Co-Incineration of Wastes in the Cement Kiln "Four E" of CBR Usine de Lixhe, Belgium. Hamburg, Germany: Okopol. http://www.oekopol.de/Archiv/Anlagen/CBRBelgien.htm

[iii] Hansen, E., 2000. Substance Flow Analysis for dioxins in Denmark. Environmental project No. 570. Copenhagen, Denmark: Danish Environmental Protection Agency.

[iv] U.S. Environmental Protection Agency, 1998. Draft Risk Assessment for Cement Kiln Dust Used as an Agricultural Soil Amendment. Draft Report. Washington, D.C.: Office of Solid Waste, U.S. Environmental Protection Agency, 16 June 1998.

[v] U.S. Environmental Protection Agency, Standards for the Management of Cement Kiln Dust; Proposed Rule. 40 CFR Parts 259, 261, 266, and 270. Federal Register: August 20, 1999 (Volume 64, No. 161, pp. 45631-456971.

COMMENTS SUBMITTED BY CANADIAN STEEL PRODUCERS ASSOCIATION

Comments on the *Draft Guidelines on Best Available Techniques (BAT) Relevant to Article Five and Annex C of the Stockholm POPs Convention*
Submitted by the Canadian Steel Producers Association

- Draft guidelines have been prepared on a number of sources not identified in Annex C to the Stockholm Convention. This includes secondary lead production, primary aluminiun production, magnesium production, secondary steel and primary metals. No rationale is presented as to why they have been included, nor was there any consultation before the documents for these sources were prepared. Only those sources cited in Annex C of the Convention should be included in the preparation of draft Guidance on BAT/BEP.
- The table of contents lists sections on how to use the guidelines and guidance with the indication that they are yet to be developed. This content of this section is an important part of the guidelines and it should clearly indicate that these documents are "guidance" that offers a range of approaches for jurisdictions and industrial sectors. The fact that the documents represent guidance should be clear in the language and tone of the Guidelines. It would be appropriate to indicate at the beginning of the discussion for each source that the techniques and practices most appropriate to a specific industrial source will be affected by considerations specific to an industry and jurisdiction, and will be affected by competitive and cost considerations.
- The language used in a number of the guidance documents dealing with the various metals sectors goes beyond guidance in dealing with areas such as achievable levels and monitoring and reporting. It is appropriate to indicate an achievable level of emissions based on experience from a range of countries, but schedules for reaching them should be the decision of the appropriate jurisdiction. Again, it is appropriate to recommend a monitoring program that meets accepted criteria and reporting of results, but the frequency of testing and details related to any program should again be the decision of the responsible jurisdiction. This is the approach adopted in the guidance document for Chemical Production Processes.
- In best *available* techniques, available is clarified to mean "those techniques that are accessible to the operator and that are developed on a scale that allow implementation in the relevant industrial sector, under economically and technical viable conditions, taking into consideration the costs and advantages". This is not reflected in certain statements in the draft guidelines, for example on page 12 of the Draft Guidance for Secondary steel production, which states that "it should be feasible for all plants to implement some or all of the pollution prevention practices identified below", without any discussion of the costs of implementing the measures.
- All guides should be reviewed to ensure consistency from the perspective of what is covered and how specific items are handled (see third bullet above).

COMMENTS SUBMITTED BY CANCER ACTION

CANCER ACTION NY
www.canceractionny.org
Cancer Prevention by Pollution Minimization

5/27/04

James B. Willis, Executive Secretary
Stockholm Convention
United Nations Environment Programme
11-13 chemin des Anemones
CH-1219, Chatelaine, Geneva, Switzerland

Dear Executive Secretary Willis,

Cancer Action NY submits the following comments upon the Expert Group on BAT/BEP guidance on open burning of waste.

In Section 1.0 of the guidance, it is stated: "Countries should work diligently to establish and implement sound practices including resource reduction, reuse, recycling, composting, modern sanitary landfilling, and BAT incineration."

Comment No.1. BAT incineration should not be included as an alternative to open burning of wastes due to the fact that environmentally significant levels of dioxins and dioxin-like compounds are created and released by the most carefully regulated incineration. Non-combustion disposal techniques and technologies should be the only recommended alternatives to open burning.

In Section 1.1, it is stated: "In the short term, where there are not realistic alternatives to open burning, practical process modifications that are likely to reduce unintentional POPs generation include:[4]

- Reduction in the amount of material discarded via open burning. Consistent with the convention, this is the first line of improvement.
- Removal of non-combustibles, including glass and bulk metals, and materials of low fuel value.
- Supply of sufficient air
- Steady burning or rate of mass loss
- Minimization of smoldering, possibly with direct extinguishments"

Comment No. 2. Removal of PVC plastics from the waste to be disposed of by open burning should also be recommended. PVC plastic smolders in an open fire. Smoldering, sooty combustion is a significant source of dioxins and dioxin-like compounds.

In the following sections: 3.1.2, 3.1.3, and 4.1.3, BAT incineration is recommended as an alternative to the open burning of wastes.

Comment No. 3. Please see Comment No. 1.

In Section 4.2.4, it is stated that efficient combustion of shredded tires has been demonstrated in cement kilns, wood and coal combustors.

Comment No. 4. Regardless of how efficient the combustion of shredded tires is for producing heat energy, emissions from this fuel use are relatively high in particulates. The most environmentally sound disposal method for waste tires is incorporation into road surfacing materials.

General Comments

Comment No. 5. No mention is made in the guidance of the importance of public health education to the elimination of open waste burning. In many areas where open waste fire disposal takes place there exist numerous public health entities, including: local, regional and national public health departments. Residents are more inclined to change behaviors based upon warnings of adverse health effects, which come directly from government health agencies rather than from other sources such as environmental groups or government planning offices.

Elimination of the open burning of wastes is the responsibility of government as a matter of public health protection. Dioxin exposure, which takes place by way of consumption of animal fat foods, imposes a significant cancer risk upon the residents of industrialized nations. The US Environmental Protection Agency (US EPA) has published a dioxin reassessment, which includes, "Part III: Integrated Summary and Risk Characterization for 2,3,7,8-Tetrachlorodibenzo-p-dioxin (TCDD) and Related Compounds". This document provides a quantification of dioxin exposure cancer risk. Epidemiologic studies of several exposed groups: workers who manufactured or applied dioxin contaminated pesticides, including pentachlorophenol, and 2,4,5-T; victims of an industrial accident in Seveso, Italy, which released kilogram quantities of dioxin; and US Air Force personnel engaged in Project Ranch Hand, the spraying of Agent Orange during the Vietnam War, demonstrate a linear relationship between dioxin exposure and increased cancer risk. According to US EPA, the average American consumes a quantity of animal fat sufficient to impose a dioxin and dioxin-like compound exposure of 1 pg dioxin TEQ/kg bw/day. This level of exposure is associated with a 1 in 1000 excess risk of developing cancer. Doubling one's intake of animal fat food results in a doubled cancer risk. During the 1970s and 1980s, dioxin and dioxin-like compound levels in animal fat foods were considerably higher than current levels. Those who consumed animal fat produced over that time period have a significantly higher lifetime cancer risk; 1 in 100 represents a reasonable estimate of cancer risk for this group.

Comment No. 6. Labeling of animal fat foods for dioxin and dioxin-like compound content constitutes a powerful educational tool for increasing public awareness of the need to eliminate the burning of waste in open fires. The consumer will seek out information on the source of this contamination. A public thus informed will support governmental policies implemented for the establishment of environmentally sound waste disposal practices.

Thank you for this opportunity to contribute to the development of BAT/BEP guidance that will lead to the elimination of open waste burning as a source of the releases of dioxins and dioxin-like compounds to the environment.

Respectfully submitted,

Donald L. Hassig, Director
Cancer Action NY

CANCER ACTION NY
www.canceractionny.org
Cancer Prevention by Pollution Minimization

June 10th, 2004

James B. Willis, Executive Secretary
Stockholm Convention
United Nations Environment Programme
11-13 chemin des Anemones
CH-1219, Chatelaine, Geneva, Switzerland

Re: Comments upon the Expert Group on BAT/BEP guidance on Waste Incinerators: Municipal and Hazardous Waste, and Sewage Sludge

Dear Executive Secretary Willis,

Cancer Action NY submits the following comments upon the Expert Group on BAT/BEP guidance on Waste Incinerators: Municipal and Hazardous Waste, and Sewage Sludge.

This guidance needs to include a fully developed protocol for guarding against illegal fuel use. Unauthorized fuels can lead to significant increases in dioxin and dioxin-like compound formation. Inspection of waste, which is addressed in the guidance, is an important part of obtaining information about what is actually being burned. Records of all inspections should be maintained at the facility, and also provided to the government regulatory entity responsible for environmental protection. The public should have full access to these records. Due to the fact that inspection yields only sporadic snapshots of waste composition, additional means for determining what materials are being incinerated must be incorporated into the protocol. Testing of bottom ash for metals concentration will provide necessary information about fuel use.

If fuel usage changes to include materials with a higher copper and/or iron content, dioxin emissions will increase due to the catalytic effect of these metals on dioxin formation. Such a change in fuel can be readily detected by ash testing. Incinerator bottom ash should be tested regularly for copper and iron concentrations. If it is discovered that these metals are present in the fuel over a considerable range of concentrations, it will be necessary to stack test when the higher metal content fuel is in use to determine how great an impact this fuel has on dioxin emissions. An ash testing protocol can serve as a deterrent to the burning of unauthorized waste materials.

Only by following the protocol described above is it possible to accumulate the data that would be necessary to enforce fuel use restrictions. Without fuel use restrictions, dioxin and dioxin-like compound emissions will vary significantly from stack test results, thereby making the true emissions of the facility greater than what stack testing would indicate.

Thank you for this opportunity to provide input on the development of the incineration guidance.

Respectfully submitted,

Donald L. Hassig, Director
Cancer Action NY

Board of Directors: Frederick E. Biggs, Patricia M. Biggs, and Lewis M. Shepard
Director, Donald L. Hassig
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canceraction@hotmail.com

COMMENTS SUBMITTED BY THE FINNISH FOREST INDUSTRIES

From: Luukko Kari [mailto:Kari.Luukko@forestindustries.fi]
Sent: Wednesday, June 23, 2004 11:54 AM
To: Cristina Cardenas
Cc: Hille.Hyytia@ymparisto.fi
Subject: comments to the 2nd draft

Dear receiver,

Enclosed please find the Finnish forest industries' comments to the UNEP draft document "Guidelines on BAT for production of pulp using elemental chlorinE".
Best Regards,
<<Draft2 Comments 11.6.2004.doc>>
Kari Luukko

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2 nd DRAFT

GUIDELINES ON BAT FOR PRODUCTION OF PULP USING ELEMENTAL CHLORINE OR CHEMICALS GENERATING ELEMENTAL CHLORINE FOR BLEACHING

Draft Guidelines on BAT for production of pulp using elemental chlorine or chemicals generating elemental chlorine for bleaching

Summary

Annex C Part II (c) of the Convention identifies ”production of pulp using elemental chlorine or chemicals generating elemental chlorine” as an industrial source category having ”the potential for comparatively high formation and release of polychlorinated dibenzo-*p*-dioxins and polychlorinated dibenzofurans (PCDD/PCDF), hexachlorobenzene (HCB), and polychlorinated biphenyls (PCB).”

Of these compounds HCB and PCB are not formed during pulp bleaching. Only polychlorinated dibenzo-*p*-dioxins and polychlorinated dibenzofurans (PCDD/PCDF) have been identified as being unintentionally produced during the production of pulp using elemental chlorine. Of the 17 PCDD/PCDF congeners with chlorine in the 2,3,7 and 8 positions, only two congeners, namely 2,3,7,8-tetrachlorodibenzo-p-dioxin (2378-TCDD) and 2,3,7,8-tetrachlorodibenzofuran (2378-TCDF), have been identified as potentially being produced during chemical pulp bleaching using chlorine.

As a summary, the following primary measures can be taken ~~made~~ for eliminating or decreasing ~~or elimination~~ the formation of 2378-TCDD and 2378-TCDF:

- Eliminate elemental chlorine via replacing with chlorine dioxide (ECF bleaching), or with chlorine free chemicals (TCF bleaching)
- Reduce application of elemental chlorine via decreasing chlorine multiple or increasing substitution of chlorine dioxide for molecular chlorine

- ~~Minimize precursors like DBD and DBF entering the bleach plant by using precursor-free additives and good washing~~

- ~~Decrease the chlorine multiple~~

- ~~Increase the level of chlorine dioxide substitution employed in the chlorination stage or completely replace chlorine with chlorine dioxide (Elemental Chlorine-Free bleaching)~~

~~1~~Introduction

~~1.1~~General information about pulp and paper production

Pulp and paper are manufactured from wood, recycled paper and many types of agricultural residue. Wood and the main non-wood materials used in papermaking are a complex mixture of the same substances – cellulose (40-45%), hemicelluloses (25-35%), lignin (20-30%) and extractives (2-15%). Most ligno-cellulosic and cellulosic materials of fibrous structure may be processed into various grades of papers and paperboard. Fibres from different raw materials are, however, not alike. They differ considerably in their morphological and chemical characteristics, which make them more or less suitable for papermaking.

Pulping and bleaching technology must be matched to the quality and characteristics of the pulp and paper grades to be produced. No single pulping or bleaching process can produce pulp suitable for all uses. For instance, newsprint is a high volume product of moderate strength, opacity and printability and a relatively short life. Therefore, a high yield of pulp at the expense of maximum achievable strength and brightness can be manufactured from the raw materials and there is a lower bleaching requirement due to natural brightness of the pulps. On the other hand packaging papers need strength if they are to be fit for use and here it is necessary to accept a lower yield via a different manufacturing route in order to obtain this strength but again the bleaching requirement may be low if this is a middle layer board . Further characteristics such as the brightness and its durability as required by outer packaging layers and printing and writing papers that may need to last for many years without yellowing, mean that and here the level of delignification and bleaching applied may need to be high. The amount of effort needed in bleaching can therefore vary widely.

Apart from hardwood and softwood species normally used in pulping, in some parts of the world a very high proportion of primary cellulose fibres originate from non-wood raw materials such as bagasse, cereal straw, bamboo, reeds, grasses, jute, kenaf, flax and sisal **[TAPPI, 1987]**. Over 10% of world pulp production is made from these non-wood fibres and in some countries it is the dominant fibre source, for instance in China and India.

Pulp and paper mills may be integrated or non-integrated. Non-integrated pulp mills (market pulp) are only manufacturing pulp that is then sold on the open market. Non-integrated paper mills use purchased pulp for their paper production. In integrated pulp and paper mills, the activities of pulp and paper making are undertaken on the same site. With recovered paper manufacturing the level of integration is high; nearly all recovered paper mills include recovered paper processing, some of them adding purchased pulp.

Compared to pulp production a relatively high number of small and medium-sized paper manufacturing facilities are in operation in many countries. A difference in relation to the scale of production is seen in different parts of the world with the capacities ranging from small mills of a few tens of tonnes per day through to major industrial complexes processing 1,000 to 1,500 tonnes per day.

~~1.2~~Process Description

~~1.2.1~~Process Steps in general

The main processes involved in making pulp, cellulose and paper products are: raw material handling and preparation, such as transport, storage, wood debarking, chipping and agricultural residue cleaning and de-noding; then pulping; pulp processing and bleaching and finally paper or paperboard making. Cellulose rich pulp products are also manufactured as raw material for other industrial processes, the manufacture of rayon, cellophane and some products in the chemical industry for example.

The industry is a divergent production process and so there is a wide range of techniques, using different pulping chemicals and process conditions as well as different bleaching sequences, that deliver the desired fibre product characteristics from a range of available raw fibre types and mixtures. The methods employed vary across the world both in relation to the characteristics of the fibre types available, the products to be made from them and the local pollution control restrictions that apply.

~~1.2.2~~Pulping Methods Applied

The manufacture of pulp uses mechanical, thermomechanical, chemimechanical and chemical methods. Mechanical and thermomechanical methods are used in integrated mills to make naturally bright, high yield pulps mainly used for newsprint manufacture. Chemical pulping methods are used in integrated and non integrated pulping mills. Pulps produced in different ways have different properties that make them suited to particular products.

Pulping is the process of converting the virgin fibre into a form suitable for making paper and paperboard grades. In chemical pulping the fibres are broken down chemically: chemicals are used in a cooking process to enter the fibre lumen and dissolve lignin in the cell walls to gain access to the compound middle lamella (CML). Lignin has to be removed from the CML to free the fibres. The lignin and many other organic substances are thus put into solution. This happens in pressure vessels, called digesters, which in the case of batch processes are heated, pressurissed vertical stationary vessels for wood and often spherical ones arranged to rotate to unload the contents, for non-woods, or in the case of ~~are~~ continuous processes are vertical tower constant flow digesters.

Mechanical pulping processes use grinding for logs and disc refiners for chips. In ~~this~~ these processes, mechanical shear forces are used to pull the fibres apart and the majority of the lignin remains with the fibres, although there is still some significant dissolution of organics. The first step is followed by secondary disc refining and direct supply to a paper machine. Mechanical pulps can often be used without bleaching, but where brightening is done it is achieved using non chlorinated compounds such as dithionite or peroxides.

The main chemical semi-chemical and chemimechanical pulping techniques are:

- **Lime, lime-soda** especially non-wood fibres;
- **Cold soda** uses sodium hydroxide pre treatment at ambient temperatures, alone or with sodium carbonate; especially hardwood and non-wood fibres; (semi chemical).
- **Soda AQ** sodium hydroxide alone or with sodium carbonate and a catalyst anthraquinone, hardwood and non-wood fibres; (chemical, similar to kraft but without sulphur), reduced odour.
- **Sulphate (kraft)** uses a mixture of sodium hydroxide and sodium sulphide under alkaline conditions to dissolve the lignin~~,~~from wood and most non-wood fibres; (chemical method).
- **Sulphite - acid bisulphite, bisulphite, alkaline and neutral sulphite methods,** (Ca, Mg, NH_4, Na) different bases, including anthraquinone, under

a range of pH, to dissolve the lignins, most wood fibres; (chemical and semi-chemical methods).

- **Organosolv** methods, wood and non-wood applications, some proven on mill scale:
  - **Alcohol** as a solvent (not in commercial use), **organic acids** as solvent;
  - **Hybrid processes.**

~~1.2.2.1~~The Kraft (Sulphate) Pulping Process

The kraft or sulphate process is an alkaline cooking liquor process and it is the dominating pulping process world wide (84 % of the world chemical pulp production and 63% of total chemical and mechanical pulp production). The kraft process uses a sodium based alkaline pulping solution consisting of sodium sulphide (Na_2S) and sodium hydroxide ($NaOH$). Used cooking liquor (black liquor) is recovered to generate white liquor for the first pulping step. At mills with chemical recovery, most of the dissolved wood substances are combusted and the wastewater mainly contains the organics in condensates plus, at bleached mills, the substances dissolved during bleaching and the residues of the bleaching chemicals. Many small mills do not recover the liquor.

The recovery of non-wood fibre liquors is problematic due to the high silica content of fibre materials, the rapid increase of the liquor viscosity during evaporation and difficulties in achieving high solids content in the concentrated liquor fed to the recovery system. However, this area of recovery technology is currently receiving much attention with some claims for viable processes.

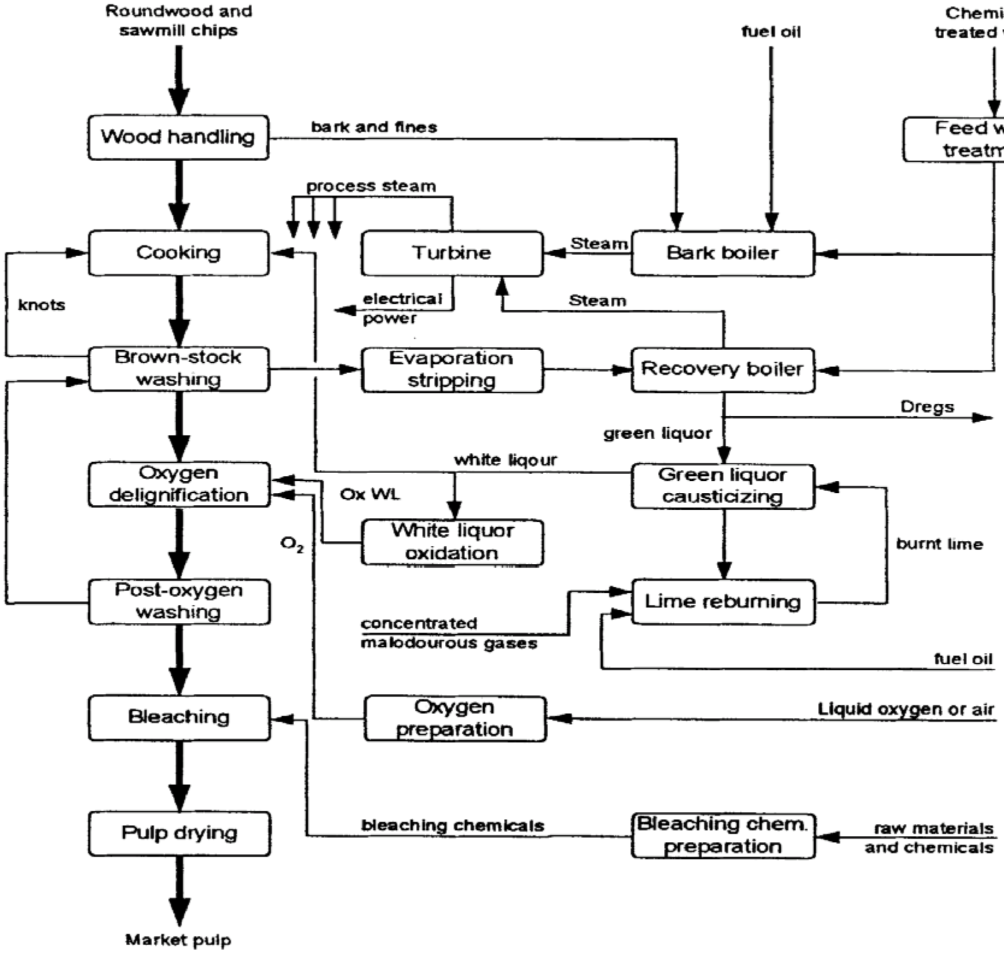

Figure 1. Pulping process flows - kraft pulping example (EIPPCB BREF, 2001)

~~1.2.2.2~~Lime and Soda processes

These are processes using simple alkaline cooking liquors in a similar process to kraft pulping but without the use of sulphur compounds. At mills with no chemical recovery, all the dissolved wood substances and pulping/bleaching chemicals remain in the wastewater apart from the volatiles incidentally released to atmosphere. The de-lignification ability is inadequate for low yield, high white, wood pulping. Its application to non-wood pulps is widespread and it is also used with oxygen for straw pulping. In the soda process, the chemistry is simplified as there is no added sulphur to form undesirable by-products and the hydroxide can be recovered by lime causticization of the sodium carbonate smelt. After cooking, pulps that are not to be bleached are refined to separate the fibres.

~~1.2.2.3~~Sulphite Pulping Processes

The sulphite pulping process is based on aqueous sulphur dioxide (SO_2) and a base, calcium, sodium, magnesium or ammonium. This method is losing its importance and only 10% of the world pulp is produced by this method. Alkaline sulphite mills for non-wood fibres are often operated as a batch process and chemical recovery is generally not practised at such mills due to their small size and the complexity of chemical recovery from what is normally a sodium based process. Compared to kraft pulps sulphite pulps are ~~R~~ relatively bright and are also relative easy to bleach with oxygen based chemicals such as peroxides. ~~and easily bleached pulps. Easy to bleach without chlorine chemicals.~~

~~1.2.3~~Bleaching

The objective of bleaching is to further remove the small quantity of residual lignin left after cooking. All lignin cannot be removed selectively enough in a single bleaching stage, but pulp is usually bleached in three to five stages, using combinations of oxygen, hydrogen peroxide, ozone, peracetic acid, Caro's acid, sodium hypochlorite, chlorine dioxide, chlorine and other chemicals or treatments. The first two stages primarily release and extracts lignin and the subsequent stages removes the lignin residues and finishes the product. These bleaching sequences are applied to maximise the bleaching effect of each component. Water is used to perform intermediate washes to remove extracted wastes from the pulp.

Bleaching sequences where chlorine based chemicals are used are called Chlorine Chemical Bleaching (CCB). If molecular chlorine and hypochlorite are excluded, the abbreviation is Chlorine Dioxide Bleaching (CDB), or Elemental Chlorine Free Bleaching (ECF). If the sequence uses only oxygen based chemicals like oxygen, ozone, alkaline or acidic peroxide the term Oxygen Chemical Bleaching (OCB), or Totally Chlorine Free (TCF) can be used.

ECF pulp bleached with chlorine dioxide accounts for the predominant share of roughly three-quarters ~~two-thirds~~ of the bleached pulp produced worldwide. TCF pulp only accounts for about 6% and is primarily produced in mills in Northern and Central Europe. Roughly 20% ~~25%~~ of the bleached pulp produced world-wide is still bleached with ~~some~~ some elemental chlorine.

Hardwood and straw pulps are easier to bleach by non chlorine methods due to their lower lignin content to begin with and the bleaching effort required for sulphite pulps is less due to their higher pre bleach brightness.

~~1.2.3.1~~Bleaching with chlorine and hypohlorous acid

Electrophilic bleaching chemical agents such as chlorine and hypochlorous acid may be used to achieve further delignification after pulping. These electrophilic bleaching agents react with all unsaturated structures, namely lignin structures, polysaccharide degradation products such as hexenuronic acid and extractive stuctures that contain carbon-carbon double bonds. These electrophilic bleaching agents are able to react with different unsubstituted aromatic carbon atoms in lignin to either:

a) chlorinate (when the carbon is not bonded with an oxygen atom), b) chlorinate and depolymerize (via displacement of an α-hydroxyl group), or c) just depolymerize without chlorination (via hydroxylation) .

These chlorination or depolymerization reactions make lignin alkaline soluble and it can be removed from pulp in the alkaline bleaching stages of the bleaching sequence.

The chlorination of non-aromatic structures, such as hexenuronic acid, does not lead to the formation of polychlorinated aromatic degradation products.

Some examples of bleaching sequences when chlorine is used:

CEH (non-woods)
CEHD
CEHDED (higher brightness)
CEDED
(CD)EDED

With an oxygen de-lignification stage or reinforced extraction stage then:
OCEH (non-woods)
(D+C)(EO)D (non-woods)

With oxygen de-lignification and reinforced extraction then:
O(D+C)(EO)D (non-woods)
O-(CD)EDED
O-(CD)(EO)DED

Bleaching sequence letters :
C is elemental chlorine Cl_2
E is alkaline extraction NaOH
H is hypochlorite
D is chlorine dioxide ClO_2
(CD) is mixtures of chlorine and chlorine dioxide
O is oxygen
(EO) is alkaline extraction with oxygen

~~1.2.3.2~~Formation of 2378-TCDD/F

Dioxins and furans (only 2378-TCDD and 2378-TCDF) may be formed in the bleaching process in which chlorine is used. Most of the formation of the 2378-TCDD and 2378-TCDF are generated in the C-stage via the reaction of chlorine with precursors of TCDD namely dibenzo-p-dioxin (DBD) and precursor of TCDF which is unchlorinated dibenzofuran (DBF). When these precursors are chlorinated, the key reaction is electrophilic aromatic substitution. ~~This type of reaction requires a positive-charged chlorine species and the~~ The rate of this reaction will be dependent both on the concentration of the precursor and the concentration of chlorine~~ which is in the electrophilic form~~. The levels of 2378-TCDD and 2378-TCDF are not determined by the content of the lignin in the pulp /R.M.Berry, B.I.Fleming et. al/ .

The unchlorinated dioxin precursors are prevalent in certain mineral oils which are part of some defoamer formulations used in the pulp and paper industry and are the major source of precursors. Wood itself may be source of dioxin precursor. In particular compression wood contains higher concentrations of precursors than normal wood. Compression of wood also contains higher levels of coumaryl-type lignin which may be a source of DBD- and DBF-like precursors.

~~1.2.3.3~~Elimination mechanisms for 2378-TCDD/F

Preventing formation of 2378-TCDD and 2378-TCDF in the bleaching will be achieved mainly by decreasing the amount of chlorine used in the first bleaching stage. This can be done by reducing atomic chlorine multiple through use of oxygen and peroxide reinforced extraction stage and increased chlorine dioxide substitution. Figure 2. shows how formation 2378-TCDF will be reduced by increasing ClO_2 substitution: when ClO_2 substitution level is more than 85 % 2378-TCDF is not detectable in waste waters coming from the mill.

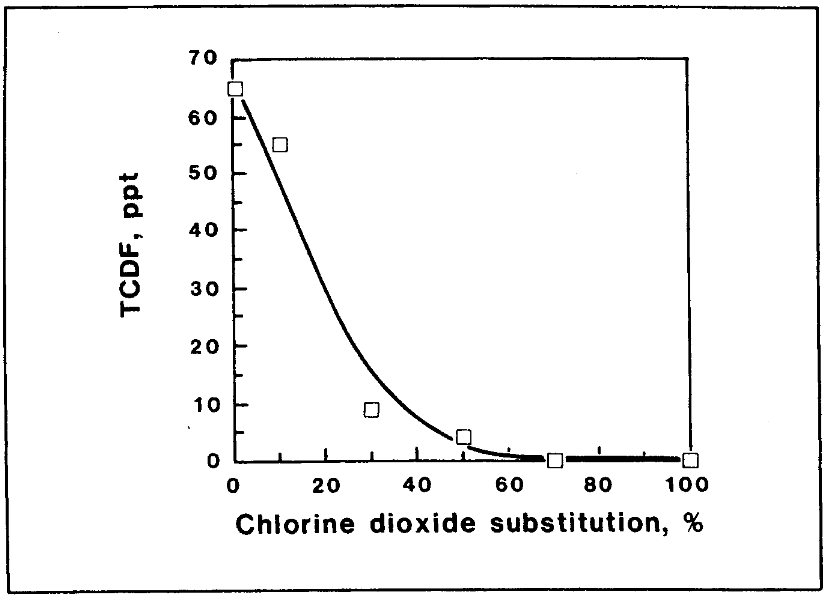

Figure 2. 2378-TCDF~~D~~ formation with different chlorine dioxide substitution level~~.~~ ~~2378-TCDD formation will be reduced by increasing ClO$_2$ substitution.~~

The summary effect of active chlorine multiple~~,~~ and chlorine dioxide substitution level ~~and precursor concentration~~ can be see in the figure 3. The level of dioxin formation under these conditions, i.e., high active chlorine multiple and low chlorine dioxide substitution, ~~Maximum level of dioxin corresponds to a high chlorine multiple and low ClO$_2$ substitution. The level of the dioxin~~ is expected to vary depending on the DBD precursor content of the brownstock.

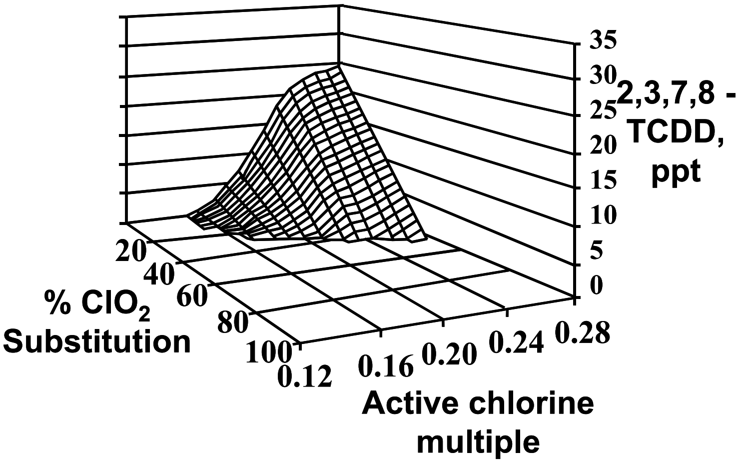

Figure 3. Effect of ~~precursor content, ~~active chlorine multiple and chlorine dioxide substitution level on 2378-TCDD formation.

Elemental ~~C~~chlorine can ~~be ~~completely be replaced by chlorine dioxide (Elemental Chlorine-Free bleaching ECF). In comparison ~~to~~with~~ ~~chlorine bleaching, ECF bleaching using chlorine dioxide leads to the formation of a relatively small amount of chlorinated compounds, but ~~even others ~~does not lead to the formation of 2378-TCDD/F~~ as the substitution is >85 %~~.

~~In most chlorine dioxide manufacturing methods, chlorine is not produced and only such chlorine by-product free generation methods should be used (Mathieson, Solvay, R8/R10 or SVP-lite to be mentioned as an examples).~~

Chlorine is produced as a side product in some chlorine dioxide manufacturing methods, but in all cases this amount is too small for the unintentional production of 2378-TCDD/F.

As a summary, the following measures can be made for eliminating or decreasing the formation of 2378-TCDD and 2378-TCDF:

- Eliminate elemental chlorine via replacing with chlorine dioxide (ECF bleaching), or with chlorine free chemicals (TCF bleaching)
- Reduce application of elemental chlorine via decreasing chlorine multiple or increasing substitution of chlorine dioxide for molecular chlorine

- Minimize precursors like DBD and DBF entering the bleach plant by using precursor-free additives and good washing such

~~□Decrease the chlorine multiple and use more chemicals in the later stages~~

~~□Increase the level of chlorine dioxide substitution employed in the chlorination stage or completely replace chlorine with chlorine dioxide (Elemental Chlorine-Free bleaching)~~

~~1.3Other sources of UPOS in pulp mills~~

~~To be taken in to consideration: should this chapter be removed or should the content of this chapter be supplemented with detailed information?~~

~~1.3.1Releases to water from recycled fibre processing.~~

~~The use of recycled fibre introduces contamination UPOPs contained in the fibre supply. These travel through the process are concentrated in the process sludges if de-inking is applied.~~

~~1.3.2Releases from process sludges.~~

~~There is also the potential for UPOP releases from process sludges such as de-inking sludges and those from process water and final effluent treatment sludges,~~

~~where UPOPs may be concentrated and which may be applied on land, be incinerated or landfilled.~~

~~1.3.3Releases to air from burning of organic materials in the recovery cycle to generate energy and recover inorganic process chemicals~~

~~With any such combustion process feedstock, attention has to be paid in all cases to good combustion conditions in order to minimise the formation of UPOPs.~~

~~1.3.4Releases to air from burning wood and biomass to generate energy~~

~~Coastal pulp and paper mills using saltwater transport modes for logs can generate dioxins and furans which are created through the burning of salt contaminated hogged fuel. The material is then used as boiler fuel to produce heat and electrical energy for the pulp and paper process. Again, with any such combustion process feedstock, attention has to be paid in all cases to good combustion conditions in order to minimise the formation of UPOPs.~~

~~1.3.5Releases / Transfer into products (pulp or paper)~~

~~There is also the potential for releases from products themselves (pulp or paper). The final paper products may contain UPOPs and other chlorinated organic contaminants from elemental chlorine bleaching, chemical usage on the papermachine such as chlorinated wet end additives.~~

~~2~~Best Available Techniques (BAT) for production of pulp using elemental chlorine

~~2.1~~Primary measurements

The principal Best Available Techniques to minimization or elimination of formation of 2378-TCDD/F are as follows and they are independent of the raw material (wood or non-wood) used in the process:

- Eliminate molecular chlorine via replacing with chlorine dioxide (ECF bleaching), or with chlorine free chemicals (TCF bleaching)
- Reduce application of molecular chlorine via decreasing chlorine multiple or increasing substitution of chlorine dioxide for molecular chlorine
- Utiliz~~ation ~~e ~~of ~~DBD and DBF-free defoamers
- Effective brown stock washing to enable the reduction of chlorine multiple
- Maximize knot and dirt removal to enable the reduction of chlorine multiple
- Eliminate pulping of wood chips contaminated with polychlorinated phenol
- ~~Reduce application of molecular chlorine via decreasing chlorine multiple~~
- ~~Increase substitution of chlorine dioxide for molecular chlorine~~
- ~~Eliminate molecular chlorine and replace with chlorine dioxide - ECF bleaching (or use totally chlorine free bleaching TCF)~~

~~2.2~~Secondary measurements

The following general measures are suggested:

- Substitution. The identification and substitution of potentially harmful substances with less harmful alternatives. Use of a detailed inventory of raw materials used, chemical composition, quantities, fate and environmental impact.

- Investment planning/cycles, co-ordination of process improvements to reduce technical bottleneck delays to the introduction of better techniques.

- Training, education and motivation of personnel. Training, education and motivation of staff and operators. People operate pulp and paper mills. Therefore, training of staff can be a very cost-effective way of reducing discharges of harmful substances.

- Process control monitoring and optimisation. To be able to reduce different pollutants simultaneously and to maintain low releases, improved process control is required. Raw materials specification and monitoring of raw materials for precursor materials.

- Adequate maintenance. To maintain the efficiency of the process and the associated abatement techniques at a high level, sufficient maintenance has to be ensured.

- Environmental management system. A system which clearly defines the responsibilities for environmentally relevant aspects in a mill. It raises awareness and includes goals and measures, process and job instructions, check lists and other relevant documentation. Incorporation of environmental issues in process change controls.

- Development of environmental monitoring and standard monitoring protocols.

- Release monitoring for new facilities. Demonstrate performance of combustion processes and releases to water.

~~2.2.1Upstream and downstream aspects~~

~~*To be taken in to consideration: should this chapter be removed or should the content of this chapter be supplemented with detailed information?*~~

~~There are also other steps that can be taken both upstream and downstream of the bleaching process~~ ~~**particularly where chlorine bleaching is still practiced.**~~

~~Lignin removal in the cooking stage is more advantageous than bleaching both economically and environmentally. The reduction of chlorinated organic substances in the effluents of pulp mills can therefore be achieved to a large extent by in-process measures, such as increased delignification before the bleach plant; by extended or modified cooking, additional oxygen stages and efficient washing to reduce carry over to the bleach plant.~~

~~Further contributing factors that will decrease the releases of chlorinated organics other non-chlorinated toxic organic compounds into receiving waters, are the installation of end of pipe abatement measures such as effective external treatment plants of different designs.~~

~~In some parts of the world the trend within the industry is toward increased closure of the bleach plants either by using ECF (Elemental Chlorine Free) or TCF (Totally Chlorine Free) bleaching of pulps, and the increased reuse of treated process waters by implementing production-integrated advanced wastewater treatment systems.~~

~~Further steps are, therefore:~~

- ~~Promote the degree of delignification in cooking processes via:~~
    - ~~Use of cooking catalysts;~~
    - ~~Extended (modified) cooking, Kraft;~~
    - ~~Extended cooking, Sulphite;~~
    - ~~Hot alkali extraction;~~
- ~~Continue the delignification process using oxygen techniques;~~
- ~~Use pre treatments to enhance bleaching effects, where applicable:~~
    - ~~Enzyme pretreatment;~~
- ~~Use chlorine dioxide generation methods with low by-product chlorine;~~
- ~~Reduce use of chlorine compounds by the introduction of oxygen chemical bleaching;~~
- ~~Use effective primary and biological effluent treatment;~~
- ~~Control sludge disposal;~~
- ~~Control combustion processes.~~

~~3~~Performance standards(Is this chapter necessary?)

The following table summarises this information as it is applied to bleached kraft pulp mills:

New Plant	**2378-TCDD / 2378-TCDF ppq To Water**	**2378-TCDD / 2378-TCDF ng/kg To Sludge**	**PCDD / PCDF ng/m^3 STP TEQ To Air**	**Defoamers DBD and DBF ppb**
EU			0.1	
Canada - Federal	Non-measurable[1] – In treated final effluent		0.1	DBD <10 DBF <40
USA Kraft and Soda	2378-TCDD <10 2378-TCDF 31.9 - In bleach plant effluent	10 / 100		
USA Ammonium based and speciality	2378-TCDD <10 2378-TCDF <10 -In bleach plant effluent			

sulphite				
Australia	2378-TCDD <15 2378-TCDF none – In treated final effluent			

1. Non measurable - means a concentration less than the level of quantification as defined in the Reference Method. The current level of quantification is 15 ppq.

4Performance Reporting

Performance reporting is recommended as follows:

For dioxin and furan releases to water – a monthly testing period. A mill may adopt quarterly sampling if it has had no measurable concentrations in its last three consecutive monthly samples, a mill may adopt annual sampling if it has had no measurable concentrations in its last three consecutive quarterly samples. The testing period reverts back to monthly testing if either a quarterly test or an annual test ~~detects dioxins or furans~~ exceeds the level of quantitation (LOQ).

Treatment sludges used for agricultural benefit may also need to be tested before use.

Where emissions testing is not possible (e.g., analytical capacity is not readily available), the use of PCDD/PCDF release factors associated with a similar mill type and operation is suggested as an interim performance reporting requirement until such time as annual emissions testing and analysis is available. Emission factors for releases of PCDD/PCDFs from mills are presented at page 184 in the UNEP Standardized Toolkit for Identification and Quantification of Dioxin and Furan Releases, May 2003 (URL:www.pops.int).

The commonality of this issue across all sector guides would indicate that it needs to be covered as a separate report and draw on the information on performance levels and testing methods contained in each of the individual sector guides.

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DEFINITIONS

ADt & ODt	Air dried tonne of paper (paper contains around 7% water under ambient conditions). ODt oven dried.
AOX	Adsorbable Organic Halogen
APP	Alkaline peroxide process
BAT	Best Available Techniques
Bleaching Sequence letters :	
C	is elemental chlorine Cl_2
E	is alkaline extraction NaOH
H	is hypochlorite
D	is chlorine dioxide ClO_2
(CD)	is mixtures of chlorine and chlorine dioxide
O	is oxygen
(EO)	is alkaline extraction with oxygen
P	is hydrogen peroxide
(EOP)	is alkaline extraction with oxygen and hydrogen peroxide
aP	is hydrogen peroxide in acidic conditions
(PO)	is peroxide pressurised with oxygen
(DN)	is chlorine dioxide with subsequent neutralisation
Z	is ozone
Paa	is peracetic acid
Ca	is Caro's acid (sulphuric acid and hydrogen peroxide)
Pxa	is mixed peracids
Q	is chelation stage
X	is enzyme treatment
BOD	Biochemical Oxygen Demand
COD	Chemical Oxygen Demand
CTMP	Chemi-thermo-mechanical-pulping processes (using sulphite or APP)
DAF	Dissolved air flotation
DBD	Dibenzodioxin
DBF	Dibenzofuran
DTPA	Diethylene triamino pentaacetic acid
ECF	Elemental chlorine free (pulp bleached without elemental chlorine)
EDTA	Ethylene diamine tetra-acetic acid
EMS	Environmental Management System
Kappa No	The Kappa number is an indirect measure of the residual lignin content in a pulp measured via the consumption of an oxidant chemical (e.g. potassium permanganate). Measure used for process control.
Integrated-mill	A mill in which both pulping and papermaking take place
I-TEQ	International Toxicity Equivalents or TEQ (Toxic Equivalents)
I-TEF	International Toxicity Equivalency Factor or TEF (Toxicity Equivalence Factor)
NTA	Nitrilo triacetic acid
PAE	Polyamidoamine-epichlorhydrin resins
PAM	Polyacrylamides
PCDDs	Polychlorinated dibenzo-para-dioxins
PCDFs	Polychlorinated dibenzofurans
PCP	Pentachlorophenol
PCB	Polychlorinated biphenyls
PEI	Polyethyleneimines

RCF	Recycled fibre
TCDD	2,3,7,8 –tetrachloro-para-dibenzodioxin
TCDF	2,3,7,8 – tetrachloro dibenzofuran
TCF	Totally chlorine free (pulp bleached without any chlorine compounds)
TOC	Total Organic Carbon
Wood-free	Paper made from pulp from which the lignin has been largely dissolved by chemical mean

COMMENTS SUBMITTED BY GREENPEACE INTERNATIONAL

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Comments on draft guidelines on best available techniques and guidance on best environmental practices relevant to Article 5 and Annex C of the Stockholm Convention on Persistent Organic Pollutants

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We appreciate this opportunity to comment on the latest draft guidelines and guidance.

It was agreed at EGB-2 that a section on alternatives would included in the draft guideline/guidance document. Reflecting that agreement, "Consideration of Alternatives" is listed as the second chapter in the table of contents of this document. It was also agreed to include similar, appropriately specific alternatives chapters in each of the guidance/guidelines for individual source categories. However, as is evident, all of the latter documents do not include an alternatives chapter and, consequently, require revision to correct this oversight.

Below are brief comments, both specific and general, on the guidelines/guidance document as a whole as well as on guidance/guidelines for several of the individual source categories.

Chapter/Section	Comment
1.A. Purpose	Despite its title, there is no mention in this segment of the actual purpose of the guidelines and guidance. • The purpose of the guidelines and guidance can be broadly described as providing Parties with information that will help them to achieve the goal of the Stockholm Convention with respect to unintentionally produced POPs (UPOPs) – the *"continuing minimization and, where feasible, ultimate elimination"* of UPOPs. • The purpose of the guidelines and guidance can be described more specifically as providing Parties with information that will help them to meet their obligations to promote and in some cases require the use of best available techniques (BAT) and to promote the use of BEP in order to achieve the goal of the Stockholm Convention with respect to UPOPs – the *"continuing minimization and, where feasible, ultimate elimination"* of UPOPs. We suggest that this segment is revised so that it begins with one or both of the above statements, or reasonably similar text.

II. Consideration of alternatives	The title of this section –*"Consideration of alternatives"* as it is listed in the table of contents – is so vague that many readers are likely to skip past it and go directly to the apparent "meat" of the document, *"V. Guidance/guidelines by source category: Annex C, Part II Source Categories,"* and *"VI. Guidance/guidelines by source category: Annex C, Part III Source Categories."* A more meaningful title – "Consideration of alternative processes, activities and chemicals" – can be taken from the text of the Convention, e.g., in the preamble – *"**Recognizing** the importance of developing and using environmentally sound alternative processes and chemicals"* -- and in Annex C, Part V.A – *"When considering proposals to construct new waste disposal facilities, consideration should be given to alternatives such as activities to minimize the generation of municipal and medical waste, including resource recovery, reuse, recycling, waste separation and promoting products that generate less waste."* With several types of suggested text distinguished by color, this section is difficult to read and the meaning of the text is hard to discern. However, the general approach -- a "checklist" methodology -- has considerable merit and should be retained. In addition, this section requires substantial revision if it is to serve as the overarching discussion of alternatives to be included in this guidance/guideline as agreed at EGB-2.
V.A. Waste incinerators: 1. Municipal and hazardous waste and sewage sludge	This draft guidance/guideline includes a large mass of information. However, a significant share of that information is repetitive. For example, flue gas treatment is addressed in great detail both in section 4.0 and yet again in sub-section 6.2. At the same time, important information is lacking. For example, while the widespread use of waste incinerators in developed nations as well as some developing nations is noted, there is no accompanying description of the contribution of waste incinerators to UPOPs releases to air, water, land, products and residues in some of these same countries, although such data are readily available. Similarly, there is no mention of the relatively numerous studies and reviews that have examined the association between impacts on public health and the environment and waste incinerators. While the details of incinerator designs can be appreciated, the size of this document could be markedly reduced, its organization improved and its contents simplified by referring readers who desire a high level of detail to the EU BREF. In addition to the agreement at EGB-2 to include an overarching discussion of alternatives, it was also agreed to include guidance on alternatives in the guideline/guidance for each source category. Following the model of the overall guideline/guidance document, based on its table of contents, the alternatives sub-section of this guideline/guidance for waste incinerators should follow the introduction or, as it is called here, *"1.0 Background."*

However, as this guideline/guidance is currently organized, the one section that might be construed as addressing alternatives occurs near the end of the report. It is listed in the table of contents as *"9.0 Alternative and Emerging Technologies"* and titled in the text as *"9.0 Emerging Technologies."* The information in this sub-section consists only of brief discussions of pyrolysis and gasification, thermal depolymerization, plasma technologies, and high temperature melting. Some of these are considered to be incineration technologies by some authorities, such as the European Commission, and all are potential sources of UPOPs.

The purpose of this guidance/guideline is described in "1.0 Background" as follows:

> *The environmentally sound design and operation of waste incinerators requires the use of best environmental practices and best available techniques to prevent or minimize the formation and release of the unintentional POPs. The purpose of this guidance is to identify such practices and techniques, summarize their effectiveness, and estimate their relative cost, for consideration by the Parties in the development of national action plans under the Stockholm Convention on Persistent Organic Pollutants".*

We suggest revising the above purpose so that it is compatible with the obligations defined by the Convention with respect to UPOPs and UPOPs sources. For example, the Convention clearly recognizes that "*alternatives such as activities to minimize the generation of municipal and medical waste, including resource recovery, reuse, recycling, waste separation and promoting products that generate less waste, including resource recovery, reuse, recycling, waste separation and promoting products that generate less waste"* (see Annex C, Part V.A) as BAT/BEP for UPOPs sources including waste incinerators.

It is interesting to note that this guidance states that *"poorly designed or operated incinerators can lead to the unintentional formation and release of persistent organic pollutants (dioxins and furans [PCDD/F], and unintentionally produced polychlorinated biphenyls [PCBs] and hexachlorobenzene [HCB]."* There is no argument that UPOPs formation and releases may be much higher with poorly designed and operated incinerators. However, the formation and release of UPOPs from even the most modern, well-designed and operated waste incinerators is well-documented. Similarly inaccurate statements are made with respect to hazardous waste incinerators and sewage sludge incinerators.

The notion of folding together of BAT/BEP for municipal waste incinerators, hazardous waste incinerators and sewage sludge incinerators can be seen to have merit in that it potentially avoids the repetition of certain types of information, such as flue gas cleaning techniques. However, in this document, it has also created a circumstance in which the section on BEP for waste incineration offers information on waste minimization for municipal waste only.

Since this guidance/guidelines is intended for use by Parties that are developing countries, the information presented that can be expected to be relevant predominantly to industrialized countries should be clearly identified. For example, the contents of municipal wastes differ greatly, depending on levels of development, as indicated by gross national product. For example, in developing countries, municipal waste commonly has a higher moisture content and higher levels of inert materials such as dirt and sand so that volume and weight reductions achieved by incineration may be considerably less, the mass of bottom ash may be larger, energy recovery may be considerably reduced, etc. Such factors should be presented and discussed in this guidance/guideline. Many developing countries have no hazardous waste or lined, monitored landfills for the disposal of incinerator ash and no municipal wastewater treatment systems that can appropriately treat incinerator scrubber water. The economic implications of such factors should also be addressed in this document.

It is also interesting to note that there is no mention of chlorine in Section “2.0 Formation and Release of Unintentional POPs,” while it is mentioned in Section “3.2.1 Delivery, Storage and Pre-Treatment of MSW” -- *“Recycling paper, cardboard, and plastics will reduce the energy value of the waste but may also reduce available chlorine”* – with no explanation of why reducing available chlorine is relevant to UPOPs formation and release. We suggest revising Section 2.0 so that the role of chlorine in UPOPs formation is explained. Toward that end, we offer the following explanation of PCDD/F formation which can be suitably simplified:

> The prerequisites for PCDD/F formation in thermal processes are the following:
>
> - Chlorine in the form of gaseous, elemental chlorine; as organic chlorine, such as chlorobenzene, polyvinyl chloride (PVC), etc.; or as inorganic chloride, such as hydrogen chloride, sodium chloride (table salt), etc.;
> - Carbon in the form of macromolecular carbon in fly ash, soot , and/or the activated carbon that is used to reduce releases in flue gases, or in the form of organically-bound carbon in compounds that have escaped combustion or formed as products of incomplete combustion;
> - Oxygen as gaseous, elemental oxygen or as oxygen in organic or inorganic forms e.g., PCDD/PCDF formation can take place in a nitrogen atmosphere[i]; and
> - Hydrogen in any form..
>
> PCDD/PCDF formation in thermal processes is thought to occur primarily through these pathways:
>
> 1. High-temperature, gas-phase formation in homogeneous[12] reactions of chlorine, either in elemental form or as hydrogen chloride, and gaseous precursors[13];

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[12] In this context, the term “homogeneous’ means that all reactants are in the same physical state (gaseous, liquid or solid), while in “heterogeneous” reactions, reactants differ in their physical states.

	2. Relatively low-temperature formation from the reaction of macromolecular[14] carbon, which occurs in fly ash, soot and activated carbon, with organic or inorganic chlorine present in the fly ash, (often referred to as *de novo* formation); and 3. Formation in heterogeneous reactions of gas-phase organic precursors with metal oxides, metal chlorides or other catalytically active constituents on fly ash, other particulates or solid surfaces. . The relative importance of these pathways varies, depending on conditions. However, the two latter pathways are thought to be most important in modern, well-operated incinerators. Conditions that favour PCDD/PCDF formation in thermal processes are as follows: • Elevated temperatures: Formation of PCDD/PCDF in the combustion zones of lab- and full-scale combustion systems has been reported to occur in the range of 500-1000 °C . [ii, iii, iv] Formation in post-combustion zones, including air pollution control devices, of full-scale incinerators via *de novo* synthesis or another heterogeneous pathway has been found to occur at temperatures as low as 150 °C. [v] However, the optimum temperature for PCDD/PCDF formation in the post-combustion zone has been reported to range between 650 and 250 °C, with maximum formation at approximately 300 °C. [vi] • Metals (for example, copper and iron, [vii] zinc,[viii] and manganese[ix]) can serve as catalysts that increase and expedite PCDD/PCDF formation. However, some studies have shown that metals may not be required.[x] .
VI.A Open burning of wastes	In "1.1 General Process Consideration", we suggest the following revised text: In the short term, where there are no realistic alternatives to open burning, practical techniques that are likely to reduce UPOPs generation include: • Reduce as much as possible the amount of material burned, O Remove non-combustibles such as glass and bulk metals O Remove other materials of low fuel value; O Remove wet materials;

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[13] A precursor is a substance from which another substance is formed, for example, chlorobenzenes and chlorophenols are precursors of PCDD/PCDF formation in combustion processes. A precursor is commonly regarded as being somewhat similar in chemical structure to the substance for which it is a precursor.

[14] Macromolecular carbon is carbon that possesses a structure in which all of the carbons are linked by chemical bonds.

    - Remove chlorine-containing materials such as PVC, salty food scraps, etc.;
    - Remove metal-containing materials such as scrap wire, cans, etc.
- Supply sufficient air, e.g., do not compact wastes;
- Burn in piles rather than confined spaces such as barrels;
- Maintain a steady rate of combustion; and
- Minimize smoldering by, if needed, extinguishing the fire.

We note that there are numerous studies, including open burning of various materials, that have found increased chlorine content in the materials burned to correlate with increased PCDD/PCDF formation. An annotated bibliography of such studies has been prepared by Costner (2001).[xi]

In section 3.1.2, we suggest deletion of the following sentence: "*The preferred combustion alternative is BAT incineration with energy recovery, however combustors run the gamut from BAT incineration through a continuum of decreasing technology and efficiency to open pile or pit or "barrel" burning.*"

In section 3.2.1 Material Composition, we suggest including PVC among the materials in "Construction waste" as well as "Demolition waste.'

In section 3.1.3 Strategies and Policy Instruments to Avoid, Reduce or Divert Waste, we suggest including policies that reduce and/or change the character of consumer products and materials that, upon becoming wastes, contribute to the formation and release of UPOPs when subjected to open burning. Such products and materials include those that are made of or contain chlorinated materials, such as PVC plastic.

In section 3.2.3 Strategies and Policy Instruments to Avoid, Reduce or Divert Waste, we suggest including policies that reduce and/or change the character of construction products and materials that, upon becoming wastes, contribute to the formation and release of UPOPs when subjected to open burning. Such products and materials include those that are made of or contain chlorinated materials, such as PVC siding, PVC pipe, etc.

In section 4.1.3 Strategies and Policy Instruments to Avoid, Reduce or Divert Waste, we suggest including policies that reduce and/or change the character of agricultural film which, upon becoming a waste, contributes to the formation and release of UPOPs when subjected to open burning. Such agricultural films include those that are made of or contain chlorinated materials, such as PVC plastic.

In section 4.2.4 Alternatives, Barriers to Use and Policy Instruments to Remove Barriers, we suggest including the following in the text:

> Dedicated tire incinerators have been identified as UPOPs sources,[xii] while co-combustion tires and coal is associated with increased

	PAH emissions.[xiii]
VI.F. Chemical production processes	We suggest that the following is included as the introductory section of this document; The World Chlorine Council describes chemical production processes in which formation of PCDD/PCDF occurs as follows:[xiv] "Dioxins can be formed in chemical processes, where the element chlorine is involved." The other basic prerequisites for PCDD/PCDF formation in industrial-chemical processes are the presence of carbon, oxygen and hydrogen. For example, PCDD/PCDF formation takes place during the manufacture of elemental chlorine when graphite electrodes are used, as is commonly the case in China.[xv] USEPA (1997) described the factors that influence PCDD/PCDF formation in the manufacture of organic chemicals as follows: [xvi] "*A number of factors influence the amount of dioxins and furans that may be formed in a given manufacturing process, including temperature, pH, catalyst, and reaction kinetics. ... Four major mechanisms have been postulated for the formation of halogenated dioxins and furans in the manufacture of halogenated organic chemicals: (1) direct halogenation of dioxins or furans ...); (2) reaction of an ortho halogen with a phenate...; (3) loss of the halogen (e.g., chlorine or bromine) from a halogenated phenate to form halogenated furans ... ; and (4) reactions between ortho- and meta-substituted halogens ....*" With regard to PCDD/PCDF formation in the manufacture of organic chemicals, Fiedler et al. (2000) noted as follows: [xvii] "In wet-chemical processes the propensity to generate PCDD/PCDF during synthesis of chemical compounds decreases in the following order: *Chlorophenols < Chlorobenzenes < Aliphatic chlorinated compounds < Inorganic chlorinated compounds*"

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