ASSESSMENT OF THE VIRTUAL ELIMINATION OF PERSISTENT, BIOACCUMULATIVE TOXIC SUBSTANCES

1993 - 1998

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SUMMARY

The objective of the Protection component of St Lawrence Vision 2000 is the long-term virtual elimination of persistent, bioaccumulative toxic substances. Since this cannot be fully realized within the confines of the agreement, means have been taken to complete the intermediate steps. The Protection component has adopted an action plan based on compliance with environmental objectives that emphasize the protect on of the receiving environment.

In 1993, the reference year of the agreement, five of the eleven targeted substances were found in the effluents of 47 of the 106 priority plants encompassed by the agreement. Since then, seventeen of the industries have succeeded in virtually eliminating one of these substances and two others have eliminated two of these substances through clean-up measures or changes to their production processes. In 1998, mercury was found in the effluents of 17 industries in the metallurgy, mining and inorganic chemical sectors; benzo(a)pyrene at five aluminum smelters and one metallurgy plant; and dioxins and furans at eleven pulp and paper mills and inorganic chemical plants. PCBs were not detected at any of the industries. Between 1993 and 1998, PCBs, dioxins and furans, mercury and BaP were reduced by 28 g/d, 5797 g/d, 320 µg/d and 2 g/d respectively, which translates into decreases of 100%, 89% 88% and 14%. Finally, although hexachlorobenzene appears in the results, it was not found in the efflluents. Thus, the goal of reducing these substances below the environmental discharge objectives has been partially achieved.

RÉSUMÉ

Le volet Protection de l'entente Saint-Laurent Vision 2000 poursuit un objectif d'élimination virtuelle à long terme de substances toxiques persistantes et bioaccumulables. Puisque que cette élimination ne peut être complètement réalisée à l'intérieur des limites de l'entente SLV 2000, des moyens ont été pris pour franchir des étapes intermédiaires. Le volet Protection a adopté un plan d'action reposant sur le respect d'objectifs environnementaux basés sur la protection du milieu récepteur.

En 1993, année de référence de l'entente, cinq des onze substances visées ont été retrouvées dans les effluents de 47 des 106 établissements industriels associés à l'entente. Depuis, dix-sept établissements ont réussi à éliminer virtuellement une de ces substances et deux autres à éliminer deux substances, par des mesures d'assainissement ou par des modifications à leurs procédés. En 1998, le mercure se retrouve dans les effluents de 17 établissements des secteurs de la métallurgie, des mines et de la chimie inorganique; le benzo(a)pyrène, dans cinq alumineries et dans un établissement du secteur de la métallurgie; les dioxines et furanes, dans onze établissements des secteurs des pâtes et papiers et de la chimie et les BPC, dans aucun des établissements. De 1993 à 1998, les BPC, les dioxines et furanes, le mercure et le BaP ont été réduits de 28g/d, 5797g/d, 320µg/d et de 2g/d pour des réductions de 100%, 89%, 88 % et 14% respectivement. Enfin, l'hexachlobenzène figure dans les résultats, mais il n'a pas été retrouvé dans les effluents. En conclusion, l'objectif de réduire ces substances en deçà des objectifs environnementaux de rejets a été atteint partiellement.

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1. INTRODUCTION

On June 3, 1988, the Canadian and Quebec governments signed a co-operative agreement to harmonize their efforts to save the St Lawrence River. The five-year St Lawrence Action Plan (SLAP) was signed in June 1989. Phase two of SLAP, St Lawrence Vision 2000 (SLV 2000), was signed in April 1994. The second phase of the plan (1994-1998) took a more ecosystemic approach.

One of the seven components under SLV 2000, Protection, continued the efforts made by SLAP to reduce toxic effluent discharges into the environment. The Protection component of SLV 2000 added 56 new priority plants, for a total of 106. Its objective is the long-term virtual elimination of eleven persistent, bioaccumulative toxic substances.

This assessment looks at the progress made by St Lawrence Vision 2000 towards the virtual elimination of these eleven substances. It begins with a list of the eleven targeted substances and their sources as well as definitions of the terms *persistence* and *bioaccumulation*. To achieve virtual elimination, the Protection component has to first accomplish another step: compliance with environmental objectives in the mid term. There are two other approaches taken to virtual elimination, those of Environment Canada and those of Canadian Council of Ministers of the Environment (CCME), which will not be discussed here. The last chapter will present the results obtained, by substance and industrial plant.

2. BACKGROUND

To meet the requirements of the Great Lakes Water Quality Agreement, a binational strategy was developed under which Environment Canada, the United States Environmental Protection Agency (USEPA) and all stakeholders along the Great Lakes were called upon to co-operate in virtually eliminating persistent, bioaccumulative toxic substances in the Great Lakes basin.

In 1985, the International Joint Commission's Great Lakes Water Quality Board established a list of eleven critical persistent, bioaccumulative substances that are harmful to human health and the environmentet .

The persistence of a substance depends on the specific environment in which it is found. Persistence is generally defined in terms of half-life, which is the time required for a substance to diminish to one-half of its original value when broken down by chemical, biochemical or photochemical processes. The International Joint Commission (IJC) considers a substance to be persistent when its half-life in water is more than eight weeks.

Bioaccumulation is a general term that describes the phenomenon by which chemical substances accumulate in living organisms, either directly through the environment or indirectly through the food chain. Bioaccumulation can be expressed in different ways: in the form of a bioaccumulation factor, a bioconcentration factor or an octanol/water partition coefficient. In 1995, the IJC did not select any numerical criteria for bioaccumulation.

Of the eleven persistent, bioaccumulative toxic substances on the list, seven are no longer sold or used in Canada: dieldrin/aldrin, Mirex, DDT (+DDD+DDE), toxaphene, hexachlorobenzene, lead alkyls and polychlorinated biphenyls (PCBs). The pesticides dieldrin/aldrin, DDT (+DDD+DDE), toxaphene and hexachlorobenzene are no longer licensed in Canada. Mirex, which is a fire retardant, can no longer be used in accordance with the *Canadian Environmental Protection Act* (CEPA). Lead alkyls, which are gasoline additives, are banned under the Gasoline Regulations but are still permitted in propeller-driven aircraft engines and race cars.

Table 1 lists the eleven persistent, bioaccumulative toxic substances and identifies the most common sources of discharges in the 106 priority industries:

Table 1

List of eleven Persistent, Bioaccumulative Toxic Substances and Their Usual Sources

Toxic Substances	**Sources**
Lead alkyls	gasoline additives
Dieldrin/Aldrin	pesticides
DDT (+DDD+DDE)	pesticides
Mirex	fire retardants
Toxaphene	pesticides
Sources identified by SLV 2000	
Hexachlorobenzene	pesticides and by-products
Dioxins	chlorine bleaching by-products (pulp and paper mills)
Furans	chlorine bleaching by-products (pulp and paper mills)
Polychlorinated biphenyls	paper recycling, dyes
Benzo(a)pyrene	*Söderberg* horizontal stud process (aluminum smelters)
Mercury	metallurgy and inorganic chemicals

On June 2, 1995, the Minister of the Environment, Sheila Copps, made public the federal government's new *Toxic Substances Management Policy*. The goal of the policy is to guide federal activities in order to protect the environment and human health from toxic substances; it favours a preventive, cautious approach to managing toxic substances.

3. APPROACH

3.1 Environmental Discharge Objectives (EDOs)

One of the mandates of the Ministère de l'Environnement du Québec is to protect human health and biological resources in view of maintaining and recovering the waterways for various uses. To do so, the Ministère de l'Environnement du Québec has developed a method to assess contaminant loads that may be discharged into rivers and streams without negatively affecting their use. This method involves EDOs.

An EDO is the maximum quantity of contaminants that a receiving environment can accept from an effluent without harm to the users of the aquatic environment.

Thus for a given contaminant, a numerical value that ensures the protection of a use is calculated. This value is called a quality criterion and is the basis of the approach to protecting the aquatic environment. We have to be able to calculate the quantity of contaminants that a source (industrial, for example) may discharge into an aquatic environment without exceeding the quality criterion at sites where the water is used. The result of this calculation is called an EDO and is expressed in the form of a concentration and load for each contaminant. An EDO, using the quality criterion for surface water takes into account toxic effects, the risks associated with a contaminant and the exposure of living organisms to the contaminant. It also incorporates the quality of the watercourse at the source point of a contaminant and the characteristics of the discharge mixture in the watercourse. A criterion is a numerical value that is based on the effects measured at known concentrations. These concentrations can be used to determine the values that would have deleterious effects but are still low enough to be considered tolerable. When mathematical models are used to calculate "no effect" concentrations using known concentrations, the calculations may produce values much lower than normal analytical thresholds. This situation is even more likely to occur if the substance is persistent, very bioaccumulative and very toxic, as is the case for eleven of the substances targeted for virtual elimination. Thus, it is not surprising that it is often impossible to demonstrate compliance with the EDO and thus virtual elimination.

The EDO approach should not be taken in this document to be the Ministère de l'Environnement du Québec response to the problem of virtually eliminating persistent, bioaccumulative toxic substances. The Department has used this method for several years, even before the concept of virtual elimination became a recognized approach. However, for comparison purposes, the EDO method can be combined with the *Great Lakes Binational Toxics Strategy* and its attempt to define virtual elimination based on the absence of effects rather than on the absence of substances.

3.2 Position of Partners

The partners in the Protection component (Environment Canada and the ministère de l'Environnement du Québec) seek the long-term virtual elimination of persistent, bioaccumulative toxic substances, in particular the eleven substances specified in the SLV 2000 agreement. Without taking sides in the debate over the definition of virtual elimination, the Protection component considered a substance's "virtual elimination" to be its "quasi elimination." Because of the component's scope, the target was limited to the virtual elimination of discharges in the effluent of the SLV 2000 priority industries. The Environmental Discharge Objectives (EDOs) calculated by the ministère de l'Environnement du Québec were used to achieve this goal.

Under SLV 2000, it was decided that the best applicable analytical protocols would be used to verify and demonstrate the fulfillment of Environmental Discharge Objectives and virtual elimination. Methods whose detection limits achieve, at the very least, the analytical performance levels specified in the SLV 2000 characterization guide (*Guide général de caractérisation SLV 2000* [Section 4, Exigences liées aux travaux analytiques]) were to constitute the minimum requirements.

If an investigation into a specific substance does not allow us to say for certain whether its Environmental Discharge Objective has been achieved (for example, if the detection limit of the method chosen is higher than the environmental objective), this step towards the virtual elimination of that substance is not considered to have been completed. In order to definitively demonstrate that the objective has been fulfilled, a more extensive investigation would be required, involving either more powerful analytical methods, a more extensive characterization (that is, over a period of more than three days), etc. For the purposes of SLV 2000, this demonstration, although not mandatory, was the responsibility of the industry concerned.

Environmental Discharge Objectives were chosen under the Protection component of SLV2000 to provide a solid, consistent and effective basis for achieving the virtual elimination of persistent, bioaccumulative toxic substances. From an environmental point of view, the promotion of and compliance with the Environmental Discharge Objectives by the end of SLV 2000 can be considered an enormous step towards the acceptance and implementation of the virtual elimination of substances of concern. From a strictly administrative point of view, the strategy advocated under the Protection component is compatible and consistent with the federal government's *Toxic Substances Management Policy*.

4. RESULTS

The eleven substances targeted by the Protection component of SLV2000 are also the subject of international negotiations in an effort to reduce atmospheric emissions of these substances. They can travel over large distances and contaminate the environment in countries where they are not used.

However, the results of this study only apply to six of the eleven substances identified by SLV 2000. The other substances (three pesticides, a gasoline additive and a fire retardant) are no longer manufactured, used or discharged by industry into the environment. For this reason, analyses were not conducted to detect them in effluents.

4.1 PCBs

Characterizations carried out under the St Lawrence Action Plan and those conducted by the Association des Industries forestières du Québec (AIFQ) [Quebec association of forestry industries] only found PCBs (congener homologous control group method) in the effluent of only four pulp and paper mills that recycle paper. They were formerly used in printing inks and are still used today in some countries where they are not banned. PCB congeners are also found in various dyes and could be a point source of PCBs.

In 1993, the four pulp and paper mills discharged 28 g/d of PCBs. In 1996, according to data provided by the pulp and paper mills in accordance with provincial regulations, PCBs were not detected at any of the 38 mills on the SLV 2000 priority list (using the same analysis method).

However, the detection limit of the method used was not adequate to verify compliance with the EDOs so we do not know whether the first step towards the virtual elimination of PCBs in pulp and paper mills was completed. In the future, PCB analyses using congeners should be used to validate compliance with EDOs.

4.2 Benzo*(a)*pyrene

Benzo(a)pyrene (BaP) is a member of the family of polycyclic aromatic hydrocarbons (PAHs) and is found mainly in the discharge of aluminum smelters using the *Söderberg* horizontal stud process. Most of the BaP is released into the atmosphere, although some is also found in liquid effluent in very low concentrations.

During the characterizations carried out under the St Lawrence Action Plan and St Lawrence Vision 2000, benzo(a)pyrene was measured at five aluminum smelters, one metallurgy plant and one pulp and paper mill. One distinctive feature of BaP is that an environmental discharge objective is not calculated for BaP alone but for all the priority PAHs in group 1, which is defined in the ministère de l'Environnement du Québec document on water quality criteria entitled "Critères de qualité de l'eau" (Appendix 1).

Table 2

Loads and Environmental Discharge Objectives for BaP Discharged in 1998 by Industrial Plants Targeted by SLAP and SLV 2000

Industrial Plants	Load (g/d)	EDO* (g/d)	EDO* (mg/L)
Alcan Smelters and Chemicals Ltd. (Beauharnois)	0.19	1.49	0.0003
Canadian Reynolds Metals Company (Baie Comeau)	3.28	3.5	
Alcan Smelters and Chemicals Ltd. (Jonquière)	5	13.5	
Alcan Smelters and Chemicals Ltd. (Grande Baie)	0.00183	0.052	0.06
Norton Advanced Ceramics of Canada Inc (Shawinigan)	0.4	20 (1)	3.1 µg/L
Alcan Smelters and Chemicals Ltd. (Shawinigan)	3	17.4 (2)	3.1 µg/L

*EDO for all group 1 PAHs
Detection limit for BaP = 0.0004 mg/L
(1) The load is equivalent to 20g/d for a flowrate corresponding to the characterization flowrate in 1995
(2) The load is equivalent to 17,4g/d for a flowrate corresponding to the characterization flowrate in 1995

According to Table 2, six of the 106 SLV 2000 industrial plants discharged BaP in 1988, although none discharged loads exceeding acceptable amounts as calculated by the EDO method. Between 1993 and 1998 BaP was reduced by 14%.

4.3 Mercury

Between 1993 and 1998, according to the characterizations carried out under SLAP, SLV 2000 and by the AIFQ on some pulp and paper mills, 23 industrial plants in the metallurgy, inorganic chemical and pulp and paper sectors discharged a total of 364 g/d of mercury. Mercury is often found in the raw materials used by these sectors, in mineral ore for example.

In 1998, 17 of the industries (Table 3) were still discharging a total of 44 g/d of mercury. Of this number, eleven were discharging loads exceeding the acceptable limits as calculated using the EDO method while six were discharging effluent into municipal sewer systems, for which EDOs were not calculated.

Table 3

Loads and Environmental Discharge Objectives for Mercury Discharged in 1998 by Industrial Plants Targeted by SLAP and SLV 2000

Industrial Plants	Load (g/d)	EDO (g/d)	EDO (mg/L)
Noranda Metallurgy Inc., CCR Refinery (Montreal East)	2	closed system	closed system
Expro Chemical Products Inc. (St Timothée)	0.33	closed system	closed system
PPG Canada Inc. (Beauharnois)	3.8	0.103	0.00016
Solutia Inc. (LaSalle)	0.585	closed system	closed system
Pratt & Whitney Inc. (Longueuil)	0.1259	closed system	closed system
Nacan Products Ltd. (Boucherville)	0.0183	closed system	closed system
Tioxide Canada Inc. (Tracy)	1	0.34	0.0003
ICI Canada Forest Products (Bécancour)	3	0.03	0.006
Ultramar Canada Inc. (St Romuald)	3	2.84	0.0003
Alcan Smelters and Chemicals Ltd. (Jonquière)	23	8.09	0.0001
Wabush Mine (Sept Îles)	2	0.042	0.000013
Chemprox Chemicals Inc. (Bécancour)	0.14	0.053	0.00017
Les Emballages Knowlton inc. (Brome Lake)	2	closed system	closed system
General Motors du Canada ltée (Boisbriand)	0.04	0.00508	0.0001
Albright & Wilson Americas Ltd. (Buckingham)	2.7	0.96	0.0003
Le Manufacturier Granford inc. (St Alphonse-de-Granby)	0.0059	0.0012	0.000013
Sivaco Quebec, Division of Ivaco Inc (Marieville)	0.2	0.0031	9.3E-6

Detection limit for mercury = 0.0002 mg/L

Between 1993 and 1998, mercury was reduced by 88%. However, the lack of mercury monitoring under federal and provincial pulp and paper mill regulations prevents us from updating the mercury data, gathered during the initial SLAP and SLV 2000 characterizations, where mercury was detected in the effluent of one pulp and paper mill.

4.4 Dioxins and Furans

Dioxins and furans were mainly found in the effluent of pulp and paper mills that use a chlorine bleaching process. In May 1992, the federal government adopted the *Pulp and Paper Mill Effluent Chlorinated Dioxins and Furans Regulations*. Under these Regulations, as of July 1, 1992 or January 1, 1994 (depending on the start-up date), pulp and paper mills were prohibited from operating a chlorine bleaching plant, discharging or authorizing the discharge into the environment of a final effluent containing a measurable concentration of 2,3,7,8-TCDD (dioxin) or 2,3,7,8-TCDF (furan). In September 1992, the Quebec government adopted the *Regulations Respecting Pulp and Paper Mills*, by virtue of which no effluent may contain a total concentration of chlorinated dioxins and furans greater than 15 picograms per litre expressed as a toxic equivalent of 2,3,7,8-TCDD.

Dioxins and furans were detected in 13 industrial plants in the pulp and paper, metallurgy and inorganic chemistry sectors during SLAP and SLV 2000 characterizations.

Although the official SLV 2000 list refers only to 2,3,7,8-TCDD and 2,3,7,8-TCDF, the Protection component has chosen to study all chlorinated dioxins and furans, as is done by the other major players concerned with this matter. Table 4 provides the results for chlorinated dioxins and furans expressed as toxic equivalents of 2,3,7,8-TCDD. Of the 210 known dioxins and furans, 17 contribute particularly the toxicity of a complex mixture and are of major concern. These substances and their equivalency factors can be found in Appendix 2.

Table 4

Loads and Environmental Discharge Objectives for Chlorinated Dioxins and Furans Discharged in 1998 by Industrial Plants Targeted by SLAP and SLV 2000

Industrial Plants	Load (µg/d)	EDO (µg/d)	EDO (pg/L)
Petromont and Company Ltd. Partnership (Montreal East)	3.85	closed system	closed system
Spexel Inc (Beauharnois)	0.43	4.8	0.48
Perkins Papers Ltd.(Candiac)	94.0	closed system	closed system
Wood Preservation Industries Ltd. (Tracy)	0.133	8.4	0.7
Abitibi-Consolidated Inc.(Trois Rivières)	97.0	29	2
Sterling Pulp Chemicals (Buckingham)	13.0	0.49	1.4
Domtar Paper, Windsor business Center (Windsor)	45.0	9.8	0.15
Stone Container (Canada) Inc. Division (Portage du Fort)	138.0	39	0.68
James Maclaren Industries Inc. (Thurso)	78.8	12	0.27
E B Eddy Forest Products Ltd. (Hull)	2.08	13	0.5
Tembec Inc. (Témiscaming)	250.0	12	0.24

Between 1993 and 1995, 13 industries discharged a total of 6519 µg/d of dioxins and furans. In 1998, eleven industries were discharging only 722 µg/d of dioxins and furans, a 89% reduction. Of the eleven industries that were still discharging these substances, eight were pulp and paper mills.

Among these eleven plants, three had discharges below the EDOs and six had discharges greater than the EDOs. The two remaining plants did not have EDOs since they run on a closed system.

4.5 Hexachlorobenzene

Hexachlorobenzene is an organic compound that was once used as a pesticide but whose manufacture and use are now prohibited. It may still be found in industrial effluent as a by-product of a chemical reaction or as a product impurity. Hexachlorobenzene has never been detected in industrial effluent during SLAP and SLV 2000 characterizations.

5. SUMMARY OF RESULTS

Nineteen industries have succeeded in virtually eliminating targeted substances through clean-up measures or process changes:

Table 5

Industries That Have Virtually Eliminated at Least One Substance

Industry	Substances
Spexel Inc. (Beauharnois)	Dioxins and Furans
Alcan Smelters and Chemicals Ltd. (Beauharnois)	Benzo(a)pyrene
Albright & Wilson America Ltd. (Varennes)	Mercury
KRONOS Canada, Inc. (Varennes)	Dioxins and Furans
Wood Preservation Industries Ltd. (Tracy)	Dioxins and Furans
QIT-Fer et Titane Inc (Tracy)	Mercury
Daishowa Inc. (Quebec)	PCBs
Donohue Forest Products Inc. (Clermont)	Benzo(a)pyrene
Canadian Reynolds Metals Compagny (Baie-Comeau)	Benzo(a)pyrene
Abitibi-Consolidated Inc., Port Alfred Division (La Baie)	PCBs
FjordCell Inc. (Jonquière)	Dioxins and Furans, PCBs
Alcan Smelters and Chemicals Ltd. (Grande-Baie)	Benzo(a)pyrene
Alcan Smelters and Chemicals Ltd. (Jonquiere)	Benzo(a)pyrene
Les Services T.M.G. Inc, Niobec mine (St Honoré)	Mercury
Norton Céramiques avancées du Canada inc. (Shawinigan)	Benzo(a)pyrene
Alcan Smelters and Chemicals Ltd. (Shawinigan)	Benzo(a)pyrene
IBM Canada Ltd. (Bromont)	Mercury
Scott Papers Ltd. (Lennoxville)	Mercury, PCBs
E.B.Eddy Forest Products Ltd. (Hull)	Dioxins and Furans

Four industries have succeeded in reducing the discharge of targeted substances to below detection limits:

Table 6

Industries That Have Reduced Discharge of Substances to Below Detection Limits

Industrial Plants	Substances
Daishowa Inc. (Québec)	PCBs
Abitibi-Consolidated Inc, Port Alfred Division (La Baie)	PCBs
FjordCell Inc (Jonquière)	PCBs
Scott Papers Ltd. (Lennoxville)	PCBs

The following table illustrates the progress made towards reducing the discharge of persistent, bioaccumulative toxic substances between 1993 and 1998:

Table 7

Percentage Reduction of Persistent, Bioaccumulative Toxic Substances Between 1993 and 1998

	1993		1998		% reduction
	Number of Industries	Quantity Discharged	Number of Industries	Quantity Discharged	
PCBs[(1)]	4	28g/d	4	0	100
Dioxins and furans	13	6519µg/d	11	722µg/d	89
Mercury	23	364g/d	18	44g/d	88
Benzo(a)pyrene	7	14g/d	6	12g/d	14

(1) below detection limit

6. CONCLUSIONS

The results show that between 1993 and 1998, progress was made in reducing substances targeted for virtual elimination, particularly PCBs, dioxins and furans and mercury. Nineteen industries have succeeded in meeting the EDOs, through clean-up measures and process changes (see Table 5). This is the first step towards virtual elimination. Others have decreased the loads discharged but could not demonstrate compliance with the EDOs due to the poor performance of analytical methods (see Table 6).

At the end of the SLV 2000 mandate in March 1998, despite the efforts made by the targeted industries, the Protection component was unable to fully achieve its objective to reduce discharges to levels comparable to the environmental objectives.

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APPENDIX 1

Polycyclic Aromatic Hydrocarbons (PAHs)
Targeted by Water Quality Criteria

GROUP 1: PAHs included in total PAH critera for raw water and the contamination of aquatic organisms

Benzo(a) anthracene
Benzo(b) fluranthene
Benzo(j) fluranthene
Benzo(k) fluranthene
Benzo(a) pyrene
Dibenzo(a,h)acridine
Dibenzo(a,j)acridine
Dibenzo(a,h)anthracene
7H-dibenzo(c,g)carbazole
Dibenzo(a,e)pyrene
Dibenzo(a,h)pyrene
Dibenzo(a,i)pyrene
Dibenzo(a,l)pyrene
Indeno(1,2,3-cd)pyrene
5-methylchrysene

APPENDIX 2

International Toxicity Equivalency Factors (TEFs)
for Dioxins and Furans

Congeners	TEF
2,3,7,8-TCDD	1
1,2,3,7,8-P_5CDD	0.5
1,2,3,4,7,8-H_6CDD	0.1
1,2,3,7,8,9-H_6CDD	0.1
1,2,3,6,7,8-H_6CDD	0.1
1,2,3,4,6,7,8-H_7CDD	0.01
OCDD	0.001
2,3,7,8-TCDF	0.1
2,3,4,7,8-P_5CDF	0.5
1,2,3, 7,8-P_5CDF	0.05
1,2,3,4,7,8-H_6CDF	0.1
1,2,3,7,8,9-H_6CDF	0.1
1,2,3,6,7,8-H_6CDF	0.1
2,3,4,6,7,8-H_6CDF	0.1
1,2,3,4,6,7,8-H_7CDF	0.01
1,2,3,4, 7,8,9-H_7CDF	0.01
OCDFF	0.001

(After NATO/CCMS, 1988)

Of the 210 dioxins and furans, 17 make the greatest contribution to the toxicity of a complex mixture and are of the greatest concern. However, this should not be interpreted to mean that the other 193 dioxins and furans are not toxic; rather, it is an indication that the other products make a comparatively small contribution to the toxicity of a complex mixture.