CANADA'S PROPOSED REGULATIONS TO CONTROL CHLORINATED DIBENZO-PARA-DIOXINS AND Furans in Effluents from Pulp and Paper Mills

E.F. Muller and D. Halliburton, Environment Canada, Ottawa, Ontario K1A OH3

ABSTRACT

Canada is in the process of proposing regulatory requirements designed to eliminate the formation of polychlorinated dioxins and furans in pulp mills and to control 2,3,7,8-T4CDD and 2,3,7,8-T4CDF in their effluents to non-measurable levels. The proposed regulations will take effect on Jan 1, 1991 and 1994.

INTRODUCTION

In 1988, after the presence of chlorinated dioxins and furans in the aquatic environment near several pulp mills using chlorine in their bleaching processes was documented, Canada launched a major program to determine the extent and degree of contamination and the magnitude of dioxin and furan discharges to the aquatic environment. This program was a cooperative effort by the federal and provincial governments and the Canadian pulp and paper industry. Based on the results of this national program the federal government decided that stringent controls for chlorinated dioxins and furans were warranted.

SOURCES

Studies by the Pulp and Paper Research Institute of Canada indicated that there were two major sources of chlorinated dioxins and furans (reference 1).

(i) Wood chips obtained by pulp mills as a by-product of the manufacture of lumber which had been treated with pentachlorophenol as an anti-sapstain agent. After pulping, pulp made from PCP contaminated chips was found to contain polychlorinated dioxins consisting of predominantly hexachlorodioxins, and some hepta- and octachlorodioxins.

(ii) Formation by chlorine bleaching of pulp. Chlorinated dioxins and furans formed in this process are the results of chlorination of the precursor molecules dibenzodioxin and dibenzofuran which have both been identified in traces in unbleached pulp. In particular 2,3,7,8-TCDD, 2,3,7,8-TCDF and 1,2,7,8-TCDF were identified as the predominant species.

The profile of the chlorinated dioxin and furan congeners found in discharges from pulp mills using chlorine bleaching indicated that the two sources described above account for the majority of the dioxins and furans found in pulp mill effluents (Tab. 1). The composite effluent toxicity from all mills investigated shows a similar profile, with over 93% of the total dioxin and furan toxicity originating from 2,3,7,8-TCDF, H6CDD and 2,3,7,8-TCDD. This profile reflects a snapshot-type picture based on effluent samples taken in late 1988 and early 1989. The profile of dioxins and furans in sediment samples collected near mill outfalls reflects their cumulative deposition from mill effluents (Fig. 1).

TABLE 1. DISCHARGES OF DIOXINS AND FURANS
BY CANADIAN PULP MILLS USING CHLORINE BLEACHING

	TEQ* (g/y)	% TEQ
Dioxins		
2,3,7,8-T4CDD	44.98	15.9
P5CDD	7.47	2.6
H6CDD	78.00	27.6
H7CDD	2.37	0.8
O8CDD	0.27	0.1
Subtotal:	133.09	47.0
Furans		
2,3,7,8-T4CDF	140.93	49.9
P5CDF	0.41	0.1
H6CDF	5.78	2.1
H7CDF	2.17	0.8
O8CDF	0.32	0.1
Subtotal:	149.61	53.0
TOTAL:	282.70	100.0

*TEQ = 2,3,7,8-TCDD Toxicity Equivalency

ACCUMULATION AND UPTAKE

Once discharged into the environment, dioxins and furans accumulate in sediments and are taken up by biota. Within a particular organism elevated concentrations of certain dioxin and furan congeners may be found in its various parts, as shown in Figure 2 for crab and crab hepatopancreas. Results of the national program revealed that several crustacean species of commercial importance in the vicinity of some pulp mills accumulated dioxins and furans to levels which necessitated several closures of crustacean fisheries. Figures 3 and 4 show dioxin and furan toxicity profiles in such species collected in the vicinity of two pulp mills on Canada's west coast. The profiles indicate that 2,3,7,8-TCDF, 2,3,7,8-T4CDD and H6CDD are the major contributors to toxicity.

CONTROLS

In order to be effective, controls were designed to eliminate the formation of toxic polychlorinated dioxins and furans in mill processes and operations. These controls are being developed as regulatory requirements under the Canadian Environmental Protection Act (Tab. 2).

TABLE 2. PROPOSED REGULATORY REQUIREMENTS

Control Stage	Proposed Limit	Regulation	Effective Date
Effluent: Combined pulp mill effluents	° Non-measurable 2,3,7,8-TCDD/F (Max 50 ppq 2,3,7,8-TCDF)	Pulp and Paper Mill Effluent Chlorinated Dioxins and Furans Regulations	Jan. 1, 1994
Production: - Defoamer Purity	° 10 ppb DBD ° 40 ppq DBF	Pulp and Paper Mill Defoamer and Wood Chips Regulations	Jan. 1, 1991
- Restrictions on use, import and sale of wood chips	° Prohibition of use of wood chips originating from facilities where PCP is used to treat wood	Pulp and Paper Mill Defoamer and Wood Chips Regulations	Jan. 1, 1991

Under the proposed regulations the industry will be required to cease the use of wood chips contaminated by PCP, and of defoamers containing high levels of dibenzodioxins and dibenzofuran. In addition, operators of pulp mills will have to modify the bleaching process, so that 2,3,7,8-TCDD and 2,3,7,8-TCDF are no longer measurable in pulp mill effluents using present state-of-the-art high resolution analytical techniques. As a result, the formation of 2,3,7,8-TCDD, 2,3,7,8-TCDF and of H6CDD in the pulping and bleaching processes will be virtually eliminated. The regulations will be strictly enforced.

Within the last two years industry has been making steady progress in reducing their chlorinated dioxin and furan discharges by having eliminated the use of PCP contaminated wood chips, and having switched to defoamers containing lower levels of dibenzodioxins and furans. In addition, several mills already installed technologies to reduce the amount of chlorine used their bleaching process. One mill completed its modifications and reported non-measurable concentrations of chlorinated dioxins in its effluents.

EFFECTIVENESS OF CONTROLS

In order to provide the information necessary for evaluation of the adequacy of the control measures to protect the environment and human health, and to determine the need for more stringent control measures, pulp mills will also be required to conduct comprehensive environmental effects monitoring programs once every three years. Parameters to be monitored in the receiving environment, sediments and biota include specific organochlorines such as chlorophenols, chloroguaiacols, chlorocatechols, and chlorinated dioxins and furans (reference 2). These periodic monitoring programs are expected to also provide information on trends towards improvements in environmental quality where dioxin and furan contamination did occur as a result of past pracices.

CONCLUSIONS

The Canadian regulatory measures are designed to focus control on those congeners responsible for most of the chlorinated dioxin and furan toxicity in pulp mill effluents. These measures will likely also reduce the presence of the other congeners.

Substantial progress has already been made by the industry in reducing dioxin and furan releases. Mills eliminated the use of defoamers high in DBD and DBF, and of PCP contaminated woodchips. In order to meet the 1994 deadline most mills are in the process of modifying their bleaching process to also eliminate the formation of chlorinated dioxins and furans at that stage.

Environmental monitoring programs will provide additional insurance that the environment is adequately protected.

REFERENCES

1. P.E. Wrist. Communication by the Pulp and Paper Research Institute of Canada, May 18, 1989.

   R.M. Berry, B.I. Fleming, R.H. Voss, C.E. Luthe and P.E. Wrist. Towards preventing the formation of dioxins during chemical pulp bleaching. Pulp and Paper Canada 90:8 (1989).

2. Guidelines for Environmental Effects Monitoring at Pulp and Paper Mills. In preparation. To be issued in 1991 as part of the Pulp and Paper Effluent Regulations under the Fisheries Act.

Fig.1 Distribution of Dioxin/Furan Contamination in Pulp Mill Effluents and Sediments

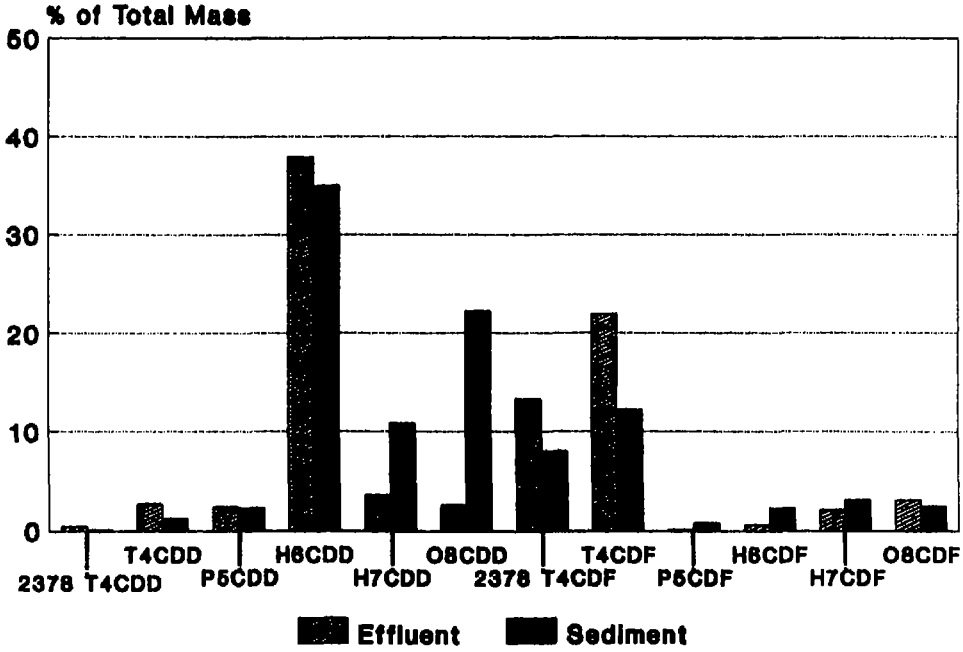

Fig.2 Concentration of 2,3,7,8 T4CDD/T4CDF in Mill Effluents, Sediments and Selected Biota Near Mill A

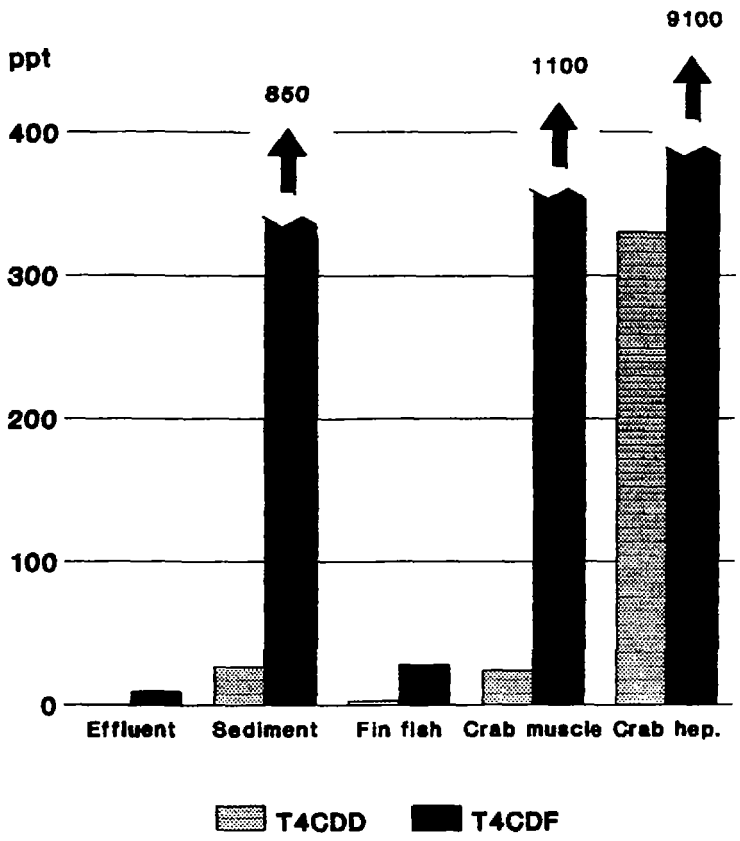

Fig.3 Distribution of TEQ from Dioxins and Furans in Selected Biota Near Mill A

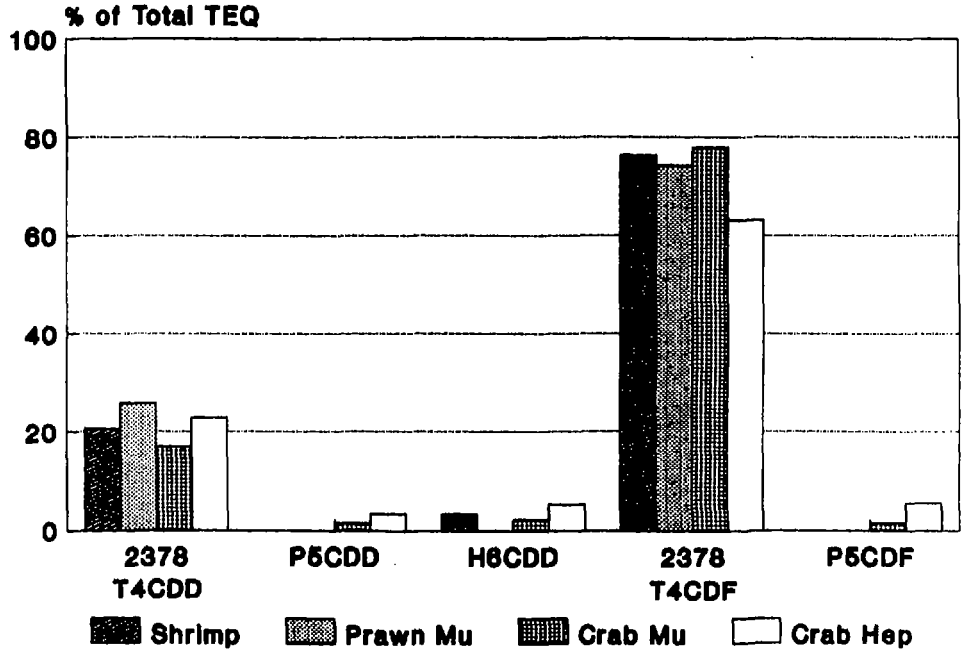

Fig.4 Distribution of TEQ from Dioxins and Furans in Selected Biota Near Mill B