1ER COLLOQUE SUR LES SUBSTANCES TOXIQUES

Les 4 et 5 avril 1984

Hôtel le Reine Elizabeth, Montréal

1ST CONFERENCE ON TOXIC SUBSTANCES

April 4-5, 1984

The Queen Elizabeth Hotel, Montreal

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APCA - Association pour la prévention de la contamination atmosphérique

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(résumé)

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(abstract)

CONFERENCE D'OUVERTURE

MERCREDI, 4 AVRIL 1984, 9:10

M. Louis Berlinguet

Secrétaire et premier conseiller scientifique
Ministère d'Etat chargé des sciences et de la technologie

La solution au problème que posent les substances toxiques représente un défi de taille et par le biais de sa politique technologique, le gouvernement fédéral a démontré qu'il croit fermement que les sciences et la technologie ont un rôle essentiel à jouer à cet égard.

Où sont les solutions idéales? Comment faire pour que l'industrie demeure productive tout en assurant que le Canada demeure concurrentiel sur les marchés internationaux et tout en protégeant la santé des Canadiens? Faudra-t-il interdire l'utilisation de certains produits, les enfouir sous terre ou les transporter ailleurs? Quels moyens devront-nous prendre pour mieux informer la population en général des faits réels concernant les substances toxiques? Comment orienter les recherches dans ce domaine? Voilà autant de questions auxquelles nous devons apporter le plus rapidement possible les réponses pratiques.

Le Canada a déjà acquis certaines compétences dans le domaine de la prévention, de la détection et du traitement. Il faudra désormais orienter nos efforts futurs de recherche et de développement de manière que le Canada améliore sa situation économique tout en assurant que les générations futures n'auront pas à payer de leur santé les progrès dont nous tirons avantage aujourd'hui.

OPENING CONFERENCE

WEDNESDAY, APRIL 4th, 1984 (9 h 10)

Mr. Louis Berlinguet
Secretary and First Scientific Advisor
Ministry of State for Science & Technology

The solution to the problem created by toxic substances represents quite a chalenge. The Federal Government demonstrated with its technological policy its conviction that science and technology have an important role to play in the solution to the problem.

Where are the ideal solutions? How will we manage to maintain a productive industry, the competitiveness of Canada on international markets and the health of Canadians at the same time? Should we ban the use of some products, should we burry them or carry them elsewhere? How should we inform the public on facts related to toxic substances? How should we orient research? We must answer these questions as soon as possible.

Canada already has some competence in prevention, detection and treatment. Future research and development must be oriented in such a way that Canada improves its economic situation while ensuring that future generations will not have to pay at the cost of their health the progress that beneficiates us today.

SESSION I

La problématique et ses priorités

Toxic substances: Problems and priorities

A Consultative Approach
to Priority-Setting
in Toxic Chemicals Management Program

Carolyn T. Miller, PhD
Senior Manager
Toxic Chemicals Management Program (TCMP)
Environment Canada

A CONSULTATIVE APPROACH TO PRIORITY SETTING IN TCMP

Introduction

It is one thing to know (and care) about environmental problems: acid rain, tree shortages, the greenhouse effect, agricultural practices with a negative energy balance, the contamination of drinking water. It is quite another thing to actually convince people to change their ways of living and thinking in order to preserve the integrity of our environment. Difficult as it may be, this is the strategic objective - the dream - of the Toxic Chemicals Management Program: to convince people, individually and corporately that it really is worthwhile to espouse an environmental ethic and look for better ways to do business.

The Toxic Chemicals Management Program is an integrated program within the federal Department of the Environment. All of the Services* - EPS, ECS, AES, CFS and Parks contribute to the program under the guidance of a steering committee composed of Service ADM's* and Regional Directors General. Our group - the Priority Issues Directorate - provides staff support to the steering committee. The chairman of this committee is Environment Canada's representative (and currently also chairman) of the Interdepartmental Committee on Toxic Chemicals. This provides a forum for the coordination of the chemical control efforts of a range of federal departments.

Environmental Economics

Federal priority has been given to the intergrated management of the vast array of human activities that involve chemicals. This priority is not based on any sort of esoteric environmentalism. Rather, is has a hard-noted economic rationale.

Humans do not live in a vacuum. We are an integral part of our environment. In Canada we depend on a healthy natural environment not only individually for clean air, food, water, recreation and sheer beauty but also collectively for our economic status. We depend on forestry, agriculture and fisheries. In Canada the environment is a fundamental component of our economy. Yet, there are already fish we cannot eat, water that has to be charcoal filtered and the prediction that pulp mills will have to lay people off for the lack of trees to process. Why have we been so slow to halt detrimental activities and meet the environmental challenges that confront us?

Frequently, our society defines economic interest too narrowly. Short term interests like immediate productivity of forest and grasslands, or control of a current insect infestation take precedent over the sustainability of resources and ecological stability. Immediacy subverts reason.

* EPS - Environmental Protection Service
ECS - Environmental Conservation Service
AES - Atmospheric Environment Service
CFS - Canadian Forestry Service
Parks - Parks Canada

* ADM - Assistant Deputy Minister

Reason, on the other hand, does not mean the abolition of chemicals. We cannot allow prudence to become fear, and prevent us from enjoying the maximum attainable quality of life - a quality that depends in part on modern chemical technology. In other words, we have to get our priorities straight.

For example, some communities depend on pulp mills for jobs. Management says clear-cutting is necessary to get enough trees to keep mill capacity up and avoid lay-offs. But clear-cutting now means a period with no trees in the future because there aren't enough existing stands to last the twenty-five years it takes for trees to mature - assuming of course that we do plant new trees. Now reforestation with no residual forest canopy means a brush problem and greater use of herbicides. So both future unemployment and chemical loading of the environment are built in to current practices. We need to find a better way. It is by recognizing and addressing such problems, as in the consultative process and the new Quebec forest policy being developed by M. Duhaime (Minister of Energy and Resources) that we will find that better way.

Social Values

Before we can set priorities and choose which of our commercial, industrial or personal activities to study, analyse and where appropriate modify, we must stop to consider the quality of life that we as a society wish to sustain into the future. We need to think carefully about social values - health, standard of living, self-sufficiency, jobs, convenience, comfort, recreation potential - all are social values of importance to us, and all interact in one way or another on the state of our environment. Only when the long range objectives are understood and accepted can we attempt to adjust our corporate and civilian lifestyles and sustain the priorities we most value.

Defining Environmental Issues

The dimensions of the Toxic Chemicals Management Program are huge. Indeed, the scope and diversity of the component issues has been one of the stumbling blocks to program integration. First the cause dimension. Environmental problems arise from a range of human activities that may alter the sources, environmental pathways, fate and effects of chemicals. In very broad terms, the types of human activities with the potential for environmental pollution include:

- industrial sectors
- waste management
- commerce in chemicals
- urbanization
- consumerism
- preservation of goods etc.
- renewable resource management
    - . forest
    - . agriculture
    - . fisheries

I have chosen classes of human activities rather than classes of chemicals as the primary descriptor of the cause dimension, because it is human activity that is subject to influence and amenable to modification. While these human activities may generally be associated with certain classes of chemicals, there are big overlaps. Dioxins for example may arise for waste leaching or incineration, wood preservation, forest fires and the use of contaminated pesticides in agriculture and forestry. The reduction of dioxin loading to the environment must be addressed differently for the different sources: improved technology for incineration, codes of good practice for wood preservation and alternative forest management strategies to reduce fire hazards and pesticide inputs. In the past, we have tended to set priorities on a chemical by chemical basis. Now we are recognizing that the human activity approach provides a more rational and efficient framework. This approach leads us to think not just in terms of cutting down on sources - inputs to the environment - but encourages analysis of the stages of the environmental life cycle to search for effective options for control.

The priority to be assigned to environmental issues is strongly influenced by a second dimension - the environmental effect of the causal activities. In the past, we have tended to assess effects in terms of the concentration of contaminants in soil, water, air or biota. Then, through laboratory research on test organisms we attempted to discover levels of contaminant that could be considered negligible or to have a very low probability of adverse effect. These derived environmental quality criteria have become the basis for many occupational safety standards, water quality quidelines and so on.

However, the level of contaminant in an environmental medium is in reality only a surrogate for actual environmental damage. While we predict that the level is likely to be "safe" or otherwise we must remain fully aware of the scientific uncertainties. We are now beginning to develop the capacity to actually sense and measure effects on the environment to achieve a more direct, more reliable estimate of environmental impact. Initiatives in environmental sensing with respect to effects on man, species and ecosystems will form a second major thrust of the program.

To complete the effects dimension consideration must be given to renewable resource objectives. Both productivity and sustainability should be optimized. However, sustainability is surely the dominant consideration.

Analysis of Priorities

These two dimensions - the causal human activities and the resultant environmental effects provide a framework for describing, analysing and setting priorities among candidate environmental issues. An "issue" may be defined as the impact of some particular human activity on a selected aspect of environmental quality represented by one block in a matrix which describes our program. Our objective is to so conduct our chemical affairs that we optimize environmental quality.

This matrix of environmental issues provides the basis for program analysis and priority-setting. First, we will construct a "map" of our present departmental activities, by simply locating each actvity on the matrix. This will indicate both the areas of current activity and the gaps - issues that for one reason or another we are not addressing. Explicit identification of these gaps will lead us to ask the question "why not?" In some cases, the reason may be satisfying. In others we will have derived a first indication of changes needed in our priorities.

The second stage in program analysis will be to construct, using the same cause/effect coordinates, "maps" of the concerns expressed by various segments of society. Three basic areas of concern will be considered:

. potential adverse effects on environmental quality
. potential socio-economic impact
. public/political profile

The consultations required to determine the existence of concern associated wth the issues in the matrix will differ for each of the three maps or overviews. Environmental scientists would contribute largely to the first, economists and sociologists to the second, and a range of publics to the third. Having constructed these overviews of concern, we will then compare the structure of our actual program to the pattern of concerns expressed. Hopefully, there should be some reasonable concordance between concerns and activities. Areas of significant discord would again indicate the need for adjustment to priorities.

Further insight could be gained by comparing the distribution of concerns expressed by different groups. If, for example, there is very high public concern in areas where the scientists indicate low risk potential, then this discrepancy is in itself a problem needing attention. Deliberate steps should be taken to assess the root of the disagreement which might involve access to information, different interpretations, or different value systems. Appropriate steps should be taken to generate consensus.

The first of these critieria (environmental impact) involves the kind of hazard ranking that has generally been applied in the past. For example, under the Environmental Contaminants Act, chemicals are rated on three factors: toxic effects, persistence, and use pattern. A compound that gets two "black balls" is designated for one of the development of controls, investigation of potential risks, or further information gathering. The rating is done by regulatory agencies with opportunity to consult as they see fit. This kind of hazard ranking will continue, and provides a first "score" by which to derive relative priority. Consideration of all chemicals associated with the human activity of concern could contribute to the priority of the overall issue. In this manner, we can use the information base developed in support of chemical by chemical standard setting as one component of the broader picture.

Social and economic factors such as the effect of shifting the number or location of jobs should be included in the design of a better way to conduct our chemical affairs. It is the members of the affected community, with their natural commitment to its prosperity, who will provide the ingenuity to find that better way. We need to mobilize this ingenuity. All of the involved publics - industry, professional, community - should have opportunity to express their perspectives of the issue and influence the priority assigned to it. In this way the taxpayers' money will be spent resolving issues of acknowledged social significance, and stand a better chance of leading to acceptable solutions.

To help us access this talent a new component has recently been added to DOE's semi-annual "Regulatory Agenda". In addition to its "Regulatory Initiatives", the Environmental Protection Sevice now publishes a list of "Problem Assessments" underway. Before selection of issues for future intervention, a problem assessment report is published and opportunity is provided for public consultation. At present 12 problem assessments are listed, ranging from the fertilizer industry, paint and pigment manufacturing to wood preservation.

Environmental Risk Management (See Figure)

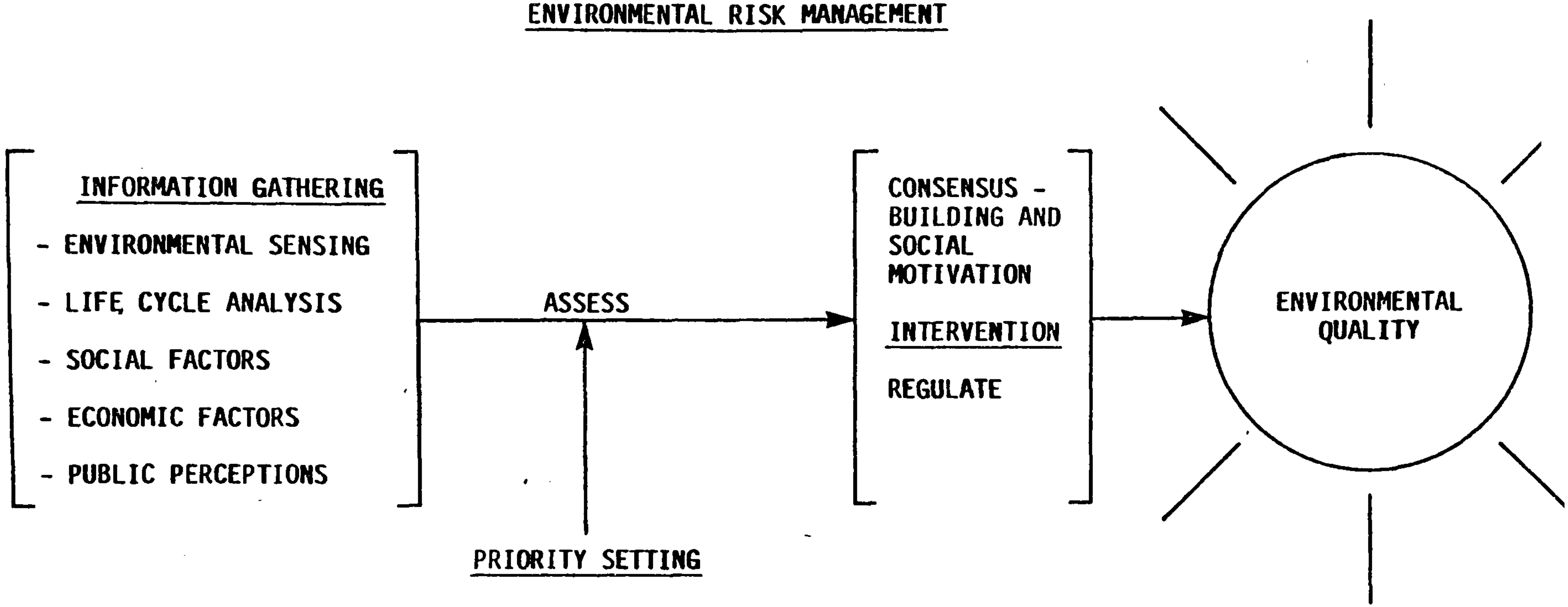
The initial identification of a candidate issue generally arises from the scientific knowledge base: both "old-fashioned" inventory of the amounts of chemicals, measurements of environmental contamination, and laboratory studies of the characteristics of toxicity, and the "new-fangled" environmental sensing approach. The observations made may trigger a concern and precipitate further exploration of the chemical life cycle - the human activities involved, environmental pathways, fate and effects. Once the root cause human activities have been identified, we begin to appreciate the potential social and economic impact of either changing our ways, or failing to change our ways.

Someone, however, must take the responsibility to pull all this together, and analyse the environmental threat. However, knowledge base development and assessment are iterative processes. We learn a little, ask questions, learn more. But all too often we have allowed it to become a treadmill - a trap from which we cannot escape, because full knowledge and absolute truth belong only to the angels. There must come a point, where in spite of scientific uncertainty and ethical dilemmas we make the decision to intervene, or not intervene and stop spending money on information that will not contribute to any decision. It is before this decision point that government must seek out the perspectives of various publics and ensure that decisions reflect a consensus with respect to social values. This is a tall order, and an area where policies and practices still have much growing up to do. In the past, socio-economic analysis (really heavily economic) has only come into play much further into the issue management process, when proposed interventions appear to have a potential $10 M kidney punch to deliver.

Once the decision is made to assign priority to an issue, a plan of action can be developed along the lines spelled out in the regulatory agenda. However, the term "regulatory agenda" is itself misleading for we in PID do not regard regulation in the legal sense as the only or even the most important tool by which to motivate adjustment to our chemical affairs and implement better ways of doing business. Intervention can often be achieved not only by the hammer of the law, but by working together with the various sectors of society to define objectives, explore strategies and derive solutions that will lead to improved enviromental quality. For it is this - enviromental quality -

which inevitably provides common ground - ground that is essential to economic health and human wellbeing. With a healthy environment we can enjoy "participaction" - a healthy, satisfying lifestyle based on a decent standard of living. Without a clean Canada, these fundamental social values cannot be sustained. In TCMP we have at least made a start at getting our priorities straight.

ENVIRONMENTAL RISK MANAGEMENT



RECOMMEND 1. INTERVENE

2. STOP (FOR NOW)

3. FURTHER STUDY (SPECIFIC)

Research in a Regulatory Environment

Dr. Scott R. Baker

U.S. Environment Protection AGency

Washington, as the center of the U.S. government, is a remarkable place - where the laws of physics do not apply, where sound travels faster than light, and where two armed scientists (issues resting on one hand and then the other) abound. The Environmental Protection Agency is equally remarkable in its efforts to bridge the gaps that exist between the public, the scientific community, and the political community. This is readily apparent in many of its issues, including acid rain. While the public refers to it as acid rain, the scientific community cälls it acid precipitation, and the political community calls it acidic deposition.

Each version of such semantic juggling is important to individuals using it, as it is indicative of their understanding, their interpretation of chemical effects, their opinions, awareness, their need for assuming posture, and their need to be mindful of certain sensitivities in relation to their position in society.

Under the leadership of William Ruckelshaus, the present Administrator of the EPA, risk assessment and risk management have been introduced into the Agency's decision-making process. Risk assessment is a quantitative scientific process that provides a predicted measure of health impacts based on available scientific information. Risk management includes not only a consideration of risk assessment, but also other significant elements in the entire range of societal impacts. While all of the tools of policy analysis in the decision-making process influence the shape of regulations and standards at EPA, it is still the science and the risk assessment that form the underpinning --the justification--for regulations and standards in the first place, and which plays an important role in the values that are promulgated into law. I would like to spend the next few minutes explaining how the EPA moves forward from a preliminary concern, through the scientific considerations, to the point of drafting policy. The development of the science that is used in the regulatory processs belongs to, and is the domain of, the Office of Research and Development at EPA. It is this office, run by Assistant Administrator Bernard Goldstein, that must interface with the public and the policymaker on issues of scientific interpretation. This office's organizational and procedural structures are critical elements in its ability to be effective.

The Agency

The mission of the Environmental Protection Agency is to protect the environment and human health. It does this through many statutes legislated by the U.S. Congress. The main laws are: the Toxic Substances Control Act, the Comprehensive Environmental Response, Compensation and Liability Act, the Resource Conservation and Recovery Act, the Federal Insecticide, Fungicide, and Rodenticide Act, the Clean Air Act, the Clean Water Act, the Safe Drinking Water Act, the Marine Protection Research and Sanctuaries Act, and the Federal Water Pollution Control Act. These nine statues form the broad basis for the Agency's regulatory authority. The Agency administers these various statutes, all of which require it to collect and evaluate scientific data for eventual use in developing and implementing regulations. Each law, however, imposes a distinctive set of data management requirements and a unique information burden upon EPA regulatory offices. The Toxic Substances Control Act, for example, requires the use of quantitative risk assessments in evaluating the potential health hazards of new chemicals and provides for consideration of economic factors in determining whether identifiable risks are unreasonable risks. The Clean Air Act, on the other hand, does not allow economics to play any role in setting National Ambient Air Quality Standards and, in fact, requires that the standards be based on an adequate margin of safety. This interpretation assumes that there will be no residual risk to populations at air pollution concentrations below the standard.

The Agency contains various regulatory offices that are, for the most part, aligned along media or class of pollutant, such as the Office of Air and Radiation, the Office of Water, the Office of Pesticides and Toxic Substances, and the Office of Solid Waste and Emergency Response. While there are other offices, it is these four with which the Office of Research and Development must seriously interact on a continuing basis.

THE OFFICE OF RESEARCH AND DEVELOPMENT

The mission of the Office of Research and Development is to provide a wide range of research and development support to the setting of regulations and standards, and to the enforcement functions of the Agency. This includes the development and implementation of control measures to reduce or mitigate risks to human health. It therefore must furnish the

Agency's regulatory offices with a very wide array of scientific technical information (that frequently it must generate) and scientific assessment for health hazard and risk. It does this by an interfacing mechanism described in Figure 1.

The main point of contact is the research committee, which consists of representatives of the regulatory, regional, and policy offices of the Agency, as well as representatives of the Office of Research and Development. In this committee forum, the groundwork for future scientific needs is laid, and the basis for the Agency's research program is pieced together. There are five such research committees in the Agency as indicated in Figure 2, whose outcomes collectively form the Agency's research program.

With the regulatory issues, policy issues, and questions spelled out, the Office of Research and Development proposes scientific programs to resolve them. The representatives of the research committees define the priorities ultimately leading to implementation of the research program within the structural framework of the Office of Research and Development, according to the description in Figure 3. The defined scientific information and assessment needs are distributed among the Agency's 14 laboratories and assessment offices. The needs are then fulfilled extramurally through funding of universities, research centers, and private contractors, or intramurally in the Agency's laboratories. In the end, the overall process is conducted in concert with the requesting regulatory office. While the various operations depicted in Figure 4 appear sequential and logically in order, the process is far from simple and it frequently results in problems of scientific interpretation that are difficult to resolve.

EPA's interest in toluene, a widely-used chemical with commercial applications, illustrates how science plays a role in the regulatory environment.

In its 1983 review of the literature on toluene, the Office of Research and Development concluded that, although it is improbable that toluene is a strong carcinogen, the possibility that it is a weak one cannot be excluded on the basis of information that was available at the time. The available published literature gave no reasonable expectation of adverse health consequences from exposure to ambient concentrations. As a result of this conclusion, the regulatory office of concern proposed that toluene not be regulated as a carcinogen. In the process, new information was and still is unfolding to suggest that toluene indeed has nonspecific carcinogenic properties in animals. This finding is unexpected since toluene is negative in all of the usual short-term tests for mutagenicity, and there is no known mechanism for toluene carcinogenicity.

In this case, the science is clearly driving the need (or lack of need) to regulate toluene. However, the issue is difficult because there is not enough scientific information to decide one way or the other about its carcinogenicity. For most chemicals, there is seldom enough evidence to be absolutely certain of a substance's ability to cause an adverse health effect in actual settings. Instead, we take the best-available information, subject it to criteria for determining the weight-of-evidence, and make a decision. At this juncture, an important question arises: Who makes the decision? Where is the line of distinction drawn between risk assessment (the domain of scientists) and risk management (the domain of policymakers)? In cases where the science results in a clearly defined determination of effect or no effect, the division of responsibility is more straightforward. Such cases, however, are the exception, not the rule. More commonly, the science/policy interface is murky. Ultimately, in a regulatory environment, the policymaker (in this case the EPA Administrator) makes all decisions. It is the scientist's responsibility to make sure that the policymakers' interpretations accurately reflect the status of the science.

Science in a regulatory environment is made complex by a wide variety of circumstances impinging on it. Nevertheless, science is the underlying basis for environmental regulation, and it will always be in the interfacing zone between public opinion and public policy.

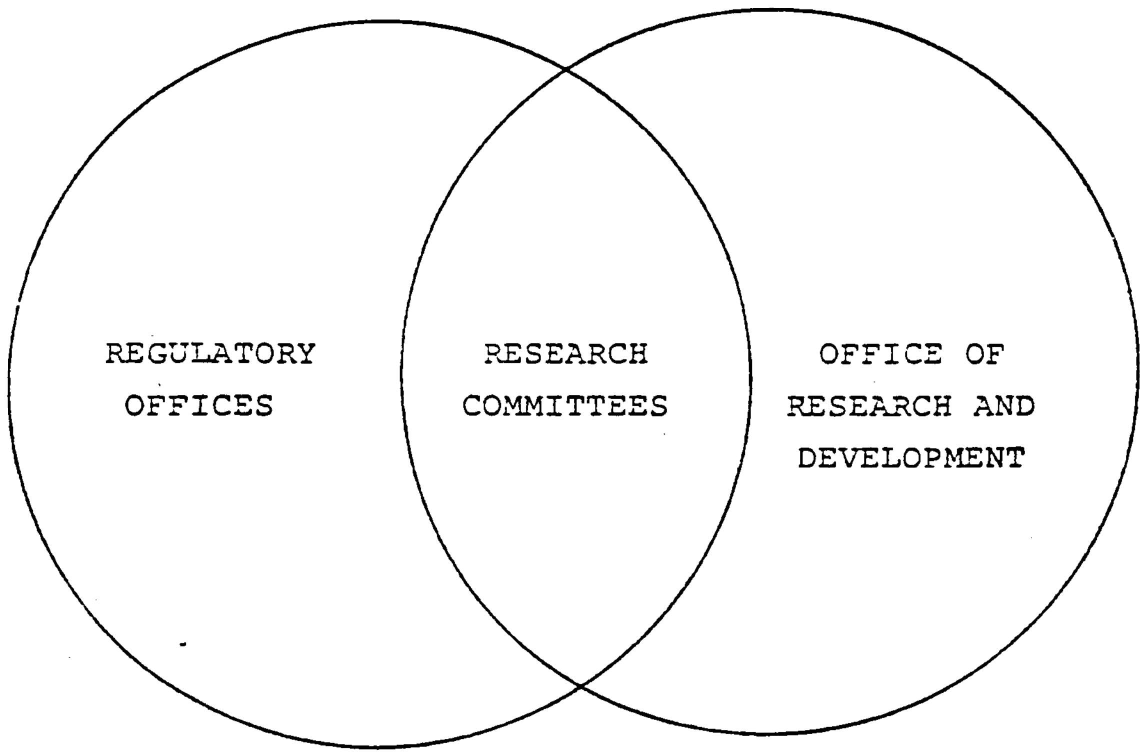


Figure 1. Interrelation between the Office of Research and Development and the regulatory offices of the EPA.

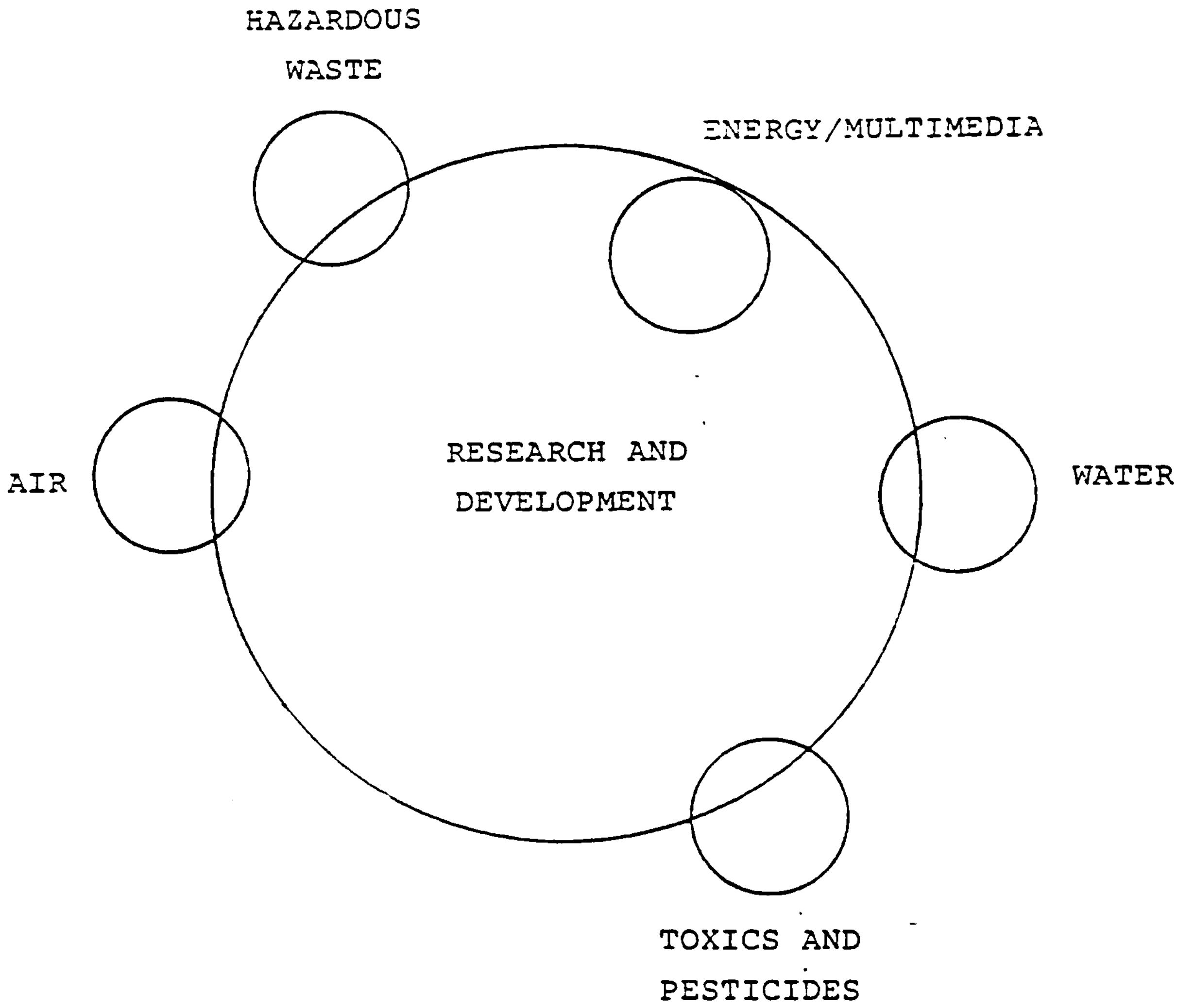
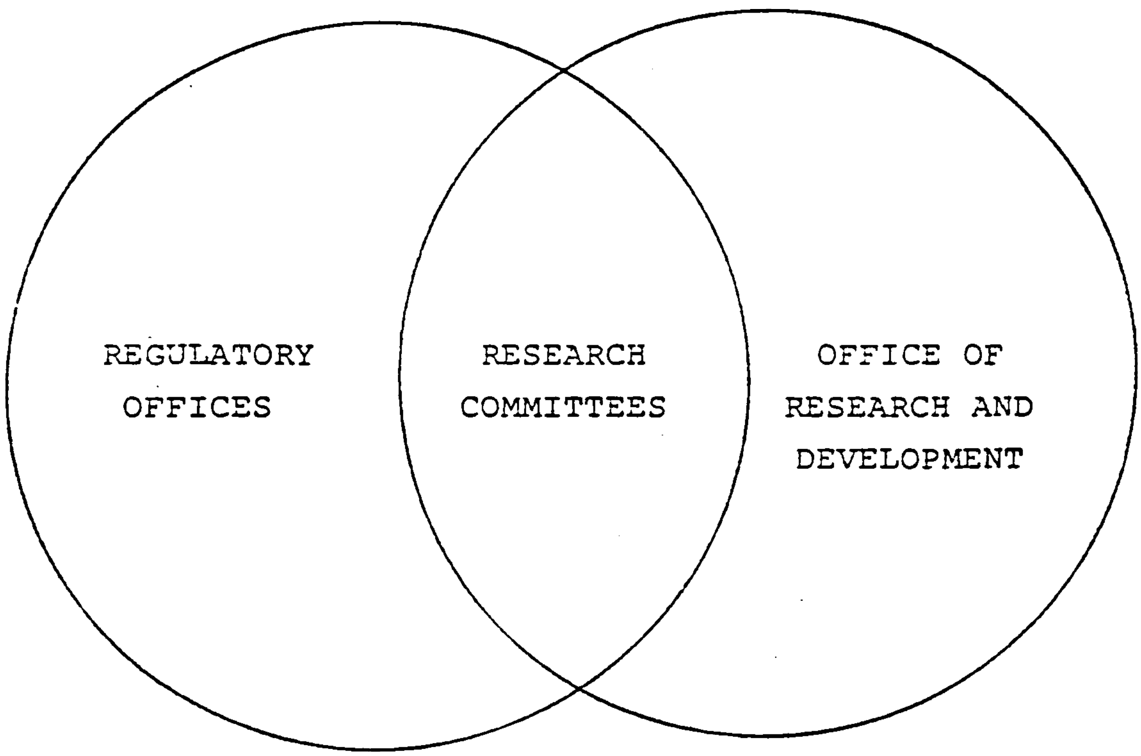


Figure 2. Research program to fulfill regulatory needs for information.



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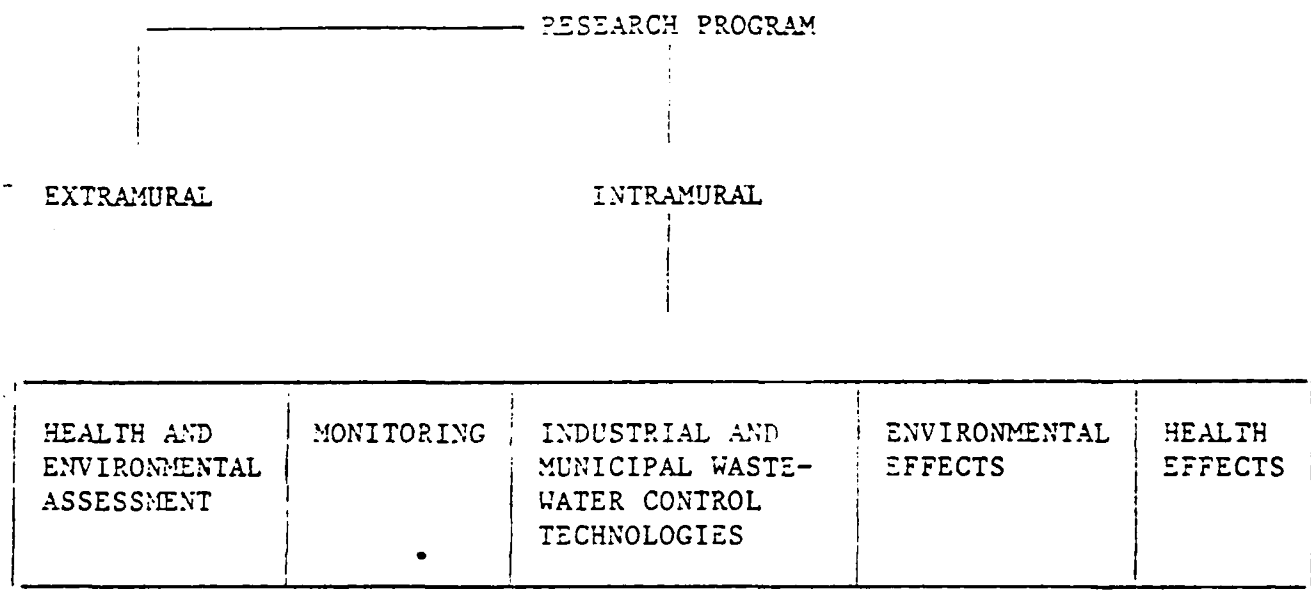

Figure 3. Distribution of research needs in the various sections of EPA's Office of Research and Development.

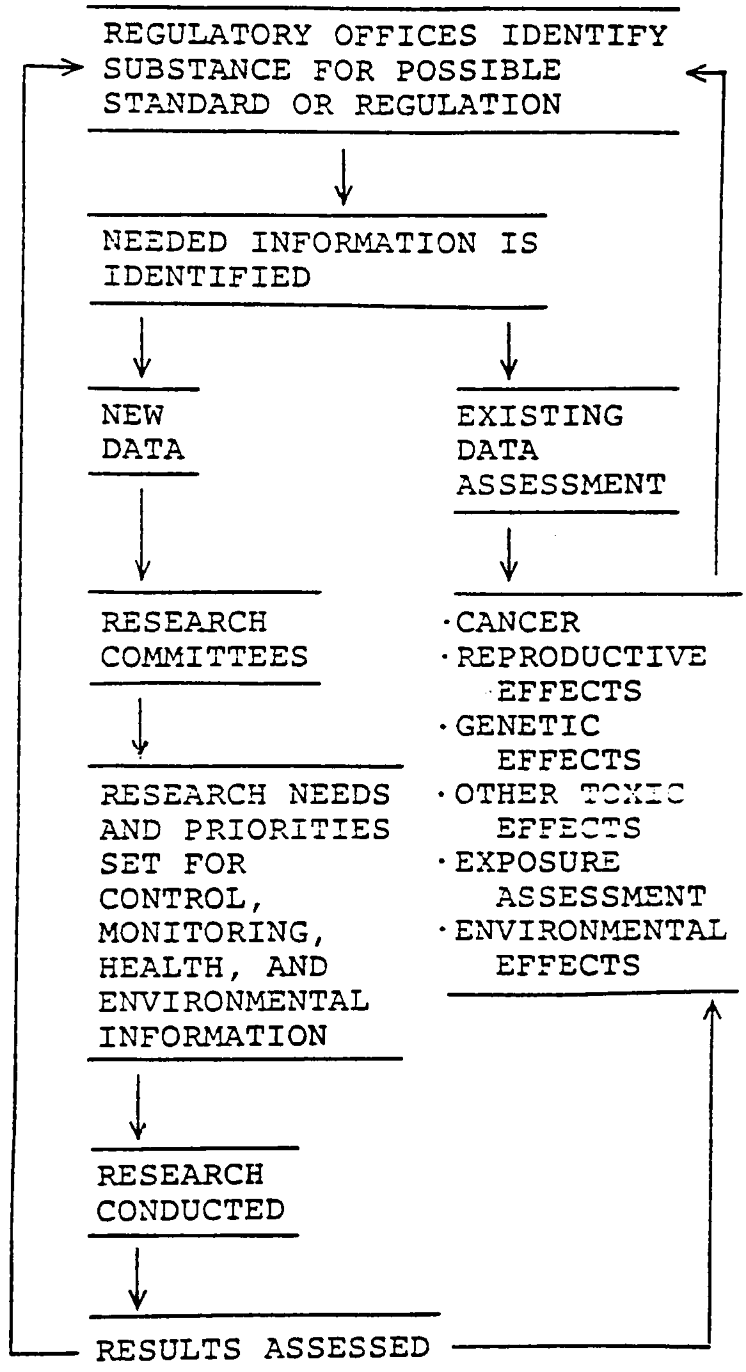

Figure 4. Sequence of events in the process of developing scientific information needed for regulatory considerations.

Prévention:

Une base pour le choix des priorités en santé et sécurité du travail relativement aux contaminants

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Permettez-moi, avant d'aborder le sujet de mon exposé, de remercier les organisateurs de ce colloque sur les substances toxiques pour leur invitation. Signe de l'acceptation de valeurs nouvelles dans la société québécoise et canadienne, les luttes entreprises pour contrôler et améliorer notre environnement ont besoin pour se poursuivre et s'intensifier, de lieux de réflexions sur les connaissances acquises et les actions entreprises. Ce colloque en est un.

Le thème de cet atelier portant sur la problématique des substances toxiques, les organisateurs m'ont demandé de traiter plus spécifiquement des méthodes de détermination des priorités pratiquées par la Commission de la santé et de la sécurité du travail du Québec.

Comme vous le savez, la Commission a été créée le 13 mars 1980 par l'entremise de la Loi sur la santé et la sécurité du travail, adoptée par l'Assemblée nationale du Québec le 21 décembre 1979. La Commission est responsable de deux mandats principaux. D'une part, elle a pour objectif, avec la participation des travailleurs et des employeurs, l'élimination à la source même des dangers pour la santé, la sécurité et l'intégrité physique des travailleurs. D'autre part, elle doit, en cotisant les employeurs, réparer les conséquences des accidents de travail et des maladies professionnelles.

Pour exécuter ses mandats, la Commission dispose de plusieurs moyens d'action: règlements, normes, programmes, guides, formation, information et recherche.

Préalablement au choix des meilleurs moyens pour atteindre des objectifs aussi vastes, il importe de déterminer au mieux les cibles visées, c'est-à-dire quel secteur industriel, quel groupe professionnel, quel problème de santé et de sécurité ou encore quel agent causal fera l'objet de l'intervention. Cette sélection s'impose pour éviter la dispersion des ressources humaines et monétaires et s'assurer du meilleur impact possible des actions entreprises.

Les clientèles spécifiques et les moyens d'action choisis, l'organisme se doit périodiquement de faire le point sur les efforts et progrès réalisés dans le but de poursuivre, renforcer ou même d'interrompre l'action entreprise pour toujours s'assurer qu'il progresse dans la réalisation des mandats confiés.

La Commission s'est donc au départ fixée des priorités d'intervention en matière de santé et de sécurité du travail. Ces priorités sont axées vers la prévention des lésions professionnelles puisque tout résultat positif en prévention tend à éliminer la nécessité d'indemniser et de réadapter les travailleurs, second mandat de la Commission.

Ce choix de prioriser la prévention peut vous sembler évident. Pourtant ce n'est pas encore le cas dans notre société et la grande majorité de nos ressources humaines, matérielles et financières est toujours investie dans le domaine curatif.

Une étude récente du Conseil des affaires sociales et de la famille (1) nous indique qu'en 1980-1981, environ 3% des budgets alloués dans le domaine de la santé au Québec étaient alloués à la prévention, soit 134 millions sur un total de plus de 4 milliards 350 millions.

La Commission, en 1981, consacrait près de 4% de son budget, soit 35 millions sur 878 millions, à des activités de prévention. Cette portion en 1983 est passée à 53 millions sur 950 millions, soit plus de 5%. Pour la présente année, cet effort sera de 10% du budget, soit environ 100 millions. Ces sommes ne comprennent pas les efforts consentis directement par les employeurs, les travailleurs et leurs associations.

La Commission et ses partenaires ont donc consenti un effort considérable pour non seulement accepter le principe de la prévention, mais aussi pour y consacrer les ressources nécessaires.

Mais pour bien canaliser ces ressources et s'assurer de l'efficacité des actions entreprises, comment fixer nos priorités d'intervention? Suffit-il, pour être en mesure d'effectuer un choix parmi l'ensemble des problèmes connus ou suspectés, de se baser sur les informations statistiques ou même sur l'ordre obtenu dans une démarche synthétique? Il faut, je pense, répondre non à cette question. Outre les éléments de connaissances scientifiques et statistiques,

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(1) Camirand, F., Coûts de la prévention en santé, Québec, 1980-1981: Document de travail, Québec, Conseil des affaires sociales et de la famille 1982, 16 p., annexes.

nous devons tenir compte des éléments de pertinence pour la clientèle visée, soit les employeurs, les travailleurs et leurs associations. Alors que les statistiques ne font que quantifier certaines données prédéfinies d'un problème, le choix des priorités repose sur l'analyse des données et des connaissances et sur la perception de l'importance des problèmes pour les partenaires sociaux.

Il est quand même fondamental pour réaliser l'établissement de priorités, d'évaluer la situation dans son ensemble à l'aide de données brutes pour être en mesure dans un second temps de fixer la priorité relative qui sera accordée à chaque problème en fonction, comme nous venons de le mentionner, tant des critères de connaissance que de pertinence. Pour améliorer sa performance dans la sélection de ses priorités d'action, la permanence de la Commission expérimente présentement une démarche de sélection. Cette démarche se concentre sur les résultats à atteindre en terme de santé et d'intégrité physique des travailleurs, puisque la question à aborder en priorité est le pourquoi de l'intervention avant celle du comment.

Elle s'appuie sur une approche multidimensionnelle et multidisciplinaire: il est excessivement rare qu'un problème de santé et de sécurité en milieu de travail puisse être imputé à une cause unique. L'examen des dimensions humaines, individuelles et collectives, organisationnelles, financières, technologiques et la contribution des travailleurs, des employeurs et des spécialistes de plusieurs disciplines est donc obligatoire pour effectuer le diagnoctic des causes. De plus, le choix et la conception des moyens d'intervention nécessite la même approche multidimensionnelle et multidisciplinaire si nous voulons obtenir un impact durable en santé et sécurité du travail.

La démarche expérimentée présentement comprend cinq étapes soit: le diagnostic social, le diagnostic épidémiologique, le diagnostic étiologique, le diagnostic administratif et une dernière phase d'évaluation. Pourquoi en phase I, avoir un diagnostic social? En soi, la considération de la qualité de vie individuelle et sociale est une préoccupation qui excède les objectifs spécifiques de la Commission. Pour nous, cet élément constitue cependant le point de départ puisqu'il est en rapport avec les avantages à long terme qui peuvent découler d'actions spécifiques en santé et en sécurité du travail. De plus, sur le plan de la pertinence, des préoccupations sociales autres que sanitaires préoccupent nos partenaires.

La Loi elle-même d'ailleurs repose sur un diagnostic social: l'atteinte des objectifs de prévention ne peut se réaliser sans la participation des employeurs et des travailleurs. Il s'agit là d'un choix fondamental qui marque toutes les actions de la Commission.

Comme vous le savez, le conseil d'administration est composé de quinze membres, soit sept représentants des travailleurs, sept représentants des employeurs et un président-directeur général désigné par le Gouvernement du Québec. Cette composition favorise le diagnostic social. C'est ainsi que le conseil a opté pour le choix de secteurs d'activités économiques prioritaires plutôt que le choix de métiers ou de problèmes de santé ou de sécurité prioritaires. Pourquoi? Pour insérer la gestion de la prévention à l'intérieur des structures organisées de production soit le chantier ou l'établissement.

Le conseil a aussi opté pour l'application progressive des principales dispositions de la Loi: programme de prévention, services de santé au travail, comité de santé et de sécurité, en commençant par des groupes de secteurs prioritaires. Le choix des secteurs prioritaires s'est établi à l'aide des données disponibles en 1980 concernant les lésions professionnelles et en établissant une pondération de pertinence sur la sous-estimation statistique des maladies professionnelles. C'est ainsi que le secteur des produits chimiques se retrouve dans le premier groupe de secteurs prioritaires.

Ce choix «social» draine les investissements en prévention vers ces secteurs, je pense particulièrement à la mise en place des services de santé. Il n'a pu s'effectuer que grâce à un consensus établi entre les partenaires et maintenu depuis lors.

En phase II, le diagnostic épidémiologique permet d'identifier les problèmes de santé et de sécurité spécifiques qui semblent contribuer aux problèmes sociaux observés en phase I. Il va de soi que la Commission se doit de documenter scientifiquement de la façon la plus complète possible les problèmes de santé et de sécurité relatifs au milieu de travail ainsi que leurs conséquences directes, individuelles, sociales et économiques. Déjà, la Commission tant par l'entremise de ses permanents et ceux de l'Institut de recherche en santé et sécurité du travail, que par des commandites auprès de spécialistes, a procédé à l'identification des problèmes spécifiques pour les deux premiers groupes de secteurs prioritaires, c'est-à-dire dix secteurs sur les trente-deux que compte le Québec: industries des bâtiments et travaux publics, des produits chimiques, de la forêt et des scieries, des mines et des carrières, des produits en métal, du bois ouvré et des meubles, du caoutchouc et des matières plastiques, des équipements de transport, de première transformation des métaux, des produits minéraux non métalliques.

Ces deux étapes visent à obtenir une bonne vision des facteurs sanitaires qui peuvent influencer sur la qualité de la santé et de la sécurité dans le milieu de travail. Il m'apparaît important de s'astreindre à recueillir et analyser ces données.

En effet, certains facteurs sont étroitement reliés aux problèmes de santé au travail comme l'âge et le sexe. D'autres facteurs comme l'organisation du travail, la technologie utilisée, les modes de rémunération, la situation économique ont toujours une certaine répercussion sur la santé et la sécurité des travailleurs. Nous constatons aussi que lorsqu'un facteur non sanitaire joue, du point de vue de la clientèle, un rôle prédominant comme élément de la qualité de vie, toute intervention ayant pour résultat d'affecter négativement ce facteur et par le fait même cette qualité de vie sera rejetée comme non pertinente. Nous ne pouvons donc isoler les questions de santé et de sécurité de l'ensemble des préoccupations présentes dans le milieu de travail.

C'est ainsi que pour sélectionner les problèmes prioritaires à l'intérieur des dix secteurs choisis par le conseil, nous avons documenté l'ensemble des données disponibles, soit les données sociodémographiques, les données sur les procédés, les contaminants présents, les données de réparation de la C.S.S.T. et les données sur le contenu des clauses en santé et sécurité dans les conventions collectives de travail.

Plus spécifiquement par rapport aux dangers et notamment aux substances toxiques présentes, la permanence de la Commission a examiné la littérature scientifique et les solutions retenues par la réglementation au Québec et à l'extérieur du Québec. Ces études nous ont permis de mettre en évidence la gravité des lésions et leur incidence, l'uniformité ou non des conclusions scientifiques, la capacité éprouvée d'intervention et, si possible, l'état actuel de la recherche.

Croisant l'ensemble des dix secteurs, une analyse de la généralisation des problèmes à travers tous les secteurs, de la gravité du danger, de la population exposée et des niveaux d'exposition nous permet de retenir des problèmes et des métiers pour lesquels les interventions de prévention sont prioritaires.

Si dans les deux phases précédentes de la démarche nous sommes restés au niveau de la planification générale avec la phase III, c'est-à-dire le diagnostic étiologique, nous abordons la planification stratégique. Chaque problème doit être étudié de façon particulière et approfondie avant d'arrêter dans une étape subséquente la conception et la mise en oeuvre du ou des moyens d'intervention destinés à contrer les causes de ce problème de santé et de sécurité. Comme l'indique le mot «étiologique», nous recherchons l'ensemble des causes responsables de la manifestation du problème.

Pour chaque problème retenu comme prioritaire, la permanence prépare une analyse détaillée des causes et de la pertinence des diagnostics disponibles. C'est ainsi que le bruit, les vibrations, l'amiante, la silice, le plomb, le benzène, le travail en milieu hyperbare, les chutes en hauteur, le travail à boni pour ne citer que quelques exemples ont fait l'objet d'études plus approfondies.

Les causes circonscrites, nous abordons la quatrième phase soit le diagnostic administratif: parmi les moyens d'actions disponibles, quel est celui ou ceux qui, tout en contrant le risque visé, assurent la meilleure rentabilité des ressources qui seront affectées à sa mise en oeuvre et l'atteinte du bénéfice escompté. Ce diagnostic se traduit en mode d'intervention: programme, règlement, norme, guide, etc.

Quant à la phase d'évaluation, soit le retour critique sur l'action entreprise, bien que nous l'ayons distinguée ici, elle n'apparaît pas normalement dans ce type de profil. Elle doit être intégrée à chacune des phases préalablement discutées.

En effet, même si l'évaluation ne s'effectue qu'après une certaine période de fonctionnement du moyen d'intervention retenu, elle doit être prise en compte à chaque étape de planification puisqu'il est très difficile d'évaluer une intervention dont les objectifs généraux et spécifiques et les bénéfices attendus sont peu ou mal définis.

Comme vous le constatez, la démarche testée à la Commission dans le choix de ses priorités s'appuie sur de grands principes de base. Le premier étant l'équité c'est-à-dire s'assurer que les choix seront faits grâce à des méthodes et procédures reconnues qui permettent à ceux qui le désirent, d'intervenir et d'influencer par leur contribution le choix des priorités.

Le second principe en cause c'est la participation. Nous devons à toutes les étapes favoriser et susciter s'il y a lieu, la participation active des employeurs, des travailleurs et de leurs associations, de même que celle des autres intervenants en santé et sécurité du travail.

Le dernier principe que j'aimerais vous souligner à nouveau concerne le processus même de détermination des priorités. Ce dernier doit nous permettre de relier en osmose d'une part les données statistiques et scientifiques et d'autre part les données de pertinence, telles que perçues par le milieu.

Dans ce processus de détermination, si la décision est de s'assujettir à cet exercice, nous pouvons identifier six étapes: le choix d'une méthode de détermination des priorités, l'établissement des règles de participation des personnes impliquées et d'obtention objective de consensus, le rassemblement et l'examen des données, la définition et la sélection des critères de choix.

la détermination du poids relatif des critères retenus de même que des catégories de classement et finalement l'appréciation des problèmes et des solutions par les groupes directement visés.

Ces principes, la Commission tend à les respecter de plus en plus. Les règles de fonctionnement du conseil d'administration et particulièrement la création de comités ad hoc permettent d'élargir la participation et les consensus. La création de l'Institut de recherche en santé et sécurité du travail, de son conseil scientifique, des axes de recherche et développement qui y sont choisis s'appuient sur les mêmes principes.

La création des associations sectorielles et le développement de leurs services et programmes s'appuient aussi sur les mêmes principes. La création de comités consultatifs régionaux et la mise sur pied de tables de concertation tant sur le plan national avec le ministère des affaires sociales et le ministère de l'éducation que sur le plan régional avec les centres hospitaliers ayant un département de santé communautaire et les autres intervenants régionaux poursuivent les mêmes fins: assurer un apport constant du milieu pour documenter les problématiques, influencer positivement les choix et assurer une participation à l'atteinte des objectifs.

Nous pouvons donc nous servir du processus de détermination des priorités pour indiquer aux décideurs les situations problèmes qui dans chaque catégorie doivent faire l'objet d'interventions immédiates ou encore leur indiquer celles qui ne doivent recevoir aucune ou peu de considérations. Il sert de plus à identifier les situations problèmes qui dans chaque catégorie recevront la plus grande part des ressources et à déterminer s'il faut attendre d'établir de façon solide les interventions axées sur la réduction des problèmes les plus prioritaires dans chaque catégorie avant d'en amorcer d'autres. Enfin le processus peut servir à indiquer lesquelles parmi les questions classées en tête de liste dans toutes les catégories doivent recevoir le feu vert pour des interventions, et ce, selon quel calendrier et avec quelle proportion de ressource. De telles utilisations montrent que la sélection des situations et des problèmes prioritaires se fait habituellement selon un ensemble de critères comme l'importance d'un taux d'accroissement du problème, l'irréversibilité des dommages sanitaires ou l'ampleur des coûts générés. Cependant, lorsqu'il faut choisir les interventions appropriées aux différents problèmes, l'ordre dans lequel elles doivent être entreprises peut s'établir sur des critères différents comme la disponibilité technologique, l'acceptabilité socio-politique, la faisabilité des moyens d'intervention ainsi que la capacité globale en terme économique de pouvoir les réaliser.

Pour améliorer le résultat de cette démarche, nous nous efforçons de mettre à la disposition de nos partenaires les informations les plus exactes et les plus à date possible.

Actuellement deux principaux axes de connaissance sont à perfectionner, soit la couverture des champs d'activités en santé et sécurité du travail, et la spécificité des connaissances par rapport à un problème. Ces deux axes ont des conséquences importantes pour nous. Nous pouvons choisir un problème moins prioritaire parce qu'un autre est méconnu, et nous pouvons proposer des moyens qui ne résoudrons pas adéquatement un problème identifié par défaut des connaissances techniques requises.

La mise sur pied du répertoire toxicologique, la création d'un fichier des établissements, la collecte de données de base en prévention, l'établissement d'un dossier médical et environnemental, l'informatisation des données d'inspection et d'analyse de laboratoire, la création d'équipes associées de recherche, le suivi de projets pilotes génèrentdes bases de données nouvelles qui nous permettront de mieux compléter notre démarche.

Quels sont les résultats pour la Commission de l'application de cette démarche? Tout d'abord elle a permis au conseil d'administration, comme je vous l'ai indiqué, d'opter pour l'application, par secteurs d'activités prioritaires, des principales dispositions de la Loi sur la santé et la sécurité du travail. Ce choix effectué, la permanence de la Commission avec ses partenaires et des spécialistes, a produit pour chaque secteur des monographies descriptives de la problématique en santé et sécurité du travail. Des priorités d'actions ont été dégagées tant pour nos actions de prévention, de recherche, d'inspection, de mise en place de services de santé que de programmes de prévention. Des métiers à risque ont été mieux documentés et des problèmes mieux circonscrits, par exemple le bruit et le plomb. Ces problèmes dégagés, nous nous assurons que les programmes mis en place tendent à les réduire sinon à les éliminer tant par les programmes de prévention mis en place dans les établissements des secteurs prioritaires que par l'adoption de nouvelles mesures comme le retrait préventif des travailleurs exposés au plomb.

En terminant, je considère important de rappeler sommairement les principaux avantages ainsi que les exigences liées à cette approche de détermination des priorités. Tout d'abord, elle force les décideurs à procéder à partir d'une vue d'ensemble de la réalité vers une vue plus sélective au fur et à mesure que les diagnostics se précisent. La pondération des problèmes qui en résulte est donc plus fiable et mieux documentée. De plus, cette approche permet une meilleure validation de la perception et de l'importance accordée aux problèmes par les participants et les intervenants dès les premières étapes de planification générale. Ainsi, la volonté de reconnaître un problème, d'y trouver une solution et de l'appliquer n'intervient pas qu'en fin de processus, ce qui a souvent entraîné l'échec ou la mise à l'écart de projets, mais dès le début, ce qui offre de meilleures garanties quant à l'application réelle des solutions.

D'autre part, cette approche comporte une exigence majeure, soit celle d'accepter dès le départ que toute la démarche de choix de priorités et, par la suite, de recherche de solutions, ne peut se ramener à une formulation technique des problèmes, mais doit être resituée dans un contexte social et économique. Ceci exige entre autres des spécialistes des problèmes de santé et d'environnement qu'ils s'astreignent plus qu'auparavant à tenir compte dès le début de leurs démarches d'analyse, des réalités sociales, économiques et administratives.

J'espère avoir réussi à vous expliciter comment pas son processus de choix des priorités en santé et sécurité du travail, la Commission entend réaliser son mandat de prévention, soit éliminer à la source même les dangers pour la santé, la sécurité et l'intégrité physique des travailleurs grâce à la participation des employeurs, des travailleurs et de leurs associations.

Dioxins in Canada

Dr. Martin J. Boddington

Environment Canada

Dioxins is a subject of intense interest to the federal government resulting in the development of the National Research Council's criteria documents (1,2) and a federal government program to control dioxins under the aegis of the Interdepartmental Committee on Toxic Chemicals (3).

Dioxins could be used as an ideal example for all aspects of this conference. The difficulties of analysis and confirmation of dioxins in the 1970s resulted more changes in environmental chemistry than from investigations into any other compound. Dioxins have also been used as an example of managing an issue of these dimensions and complexity. Alternatively, there are various control options and regulatory initiatives have been taken or are required in the many related areas of dioxins. For this paper, I will dwell largely on the reasons for dioxins being a priority in Canada. There are several facets to the issue; dioxin-containing chemicals, such as 2,4,5-T, 2,4-D and pentachlorophenol, wastes, such as Love Canal and their impact on the Niagara River and combustion such as municipal incinerators. From the viewpoint of the Air Pollution Control Association, combustion and its priority within the dioxin issue will be of greatest interest.

The priority of dioxins results from a mixture of science, history and uncertainty. To start with there are 75 dioxins, the general structure of which is depicted in Figure 1 (1). Any or all of the numbered positions - 1 through 8 - can be substituted with chlorine giving mono-through octachlorodibenzo-p-dioxin. The most well known is where the 2,3,7,8 positions are substituted giving 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD). This is only one of 22 such TCDDs.

From the viewpoint of comparative toxicology, there are several reasons why dioxins should be a priority. In Figure 2 (4), the acute toxicity of 2,3,7,8-TCDD (in molar doses) is compared to other well known poisons. 2,3,7,8-TCDD is clearly orders of magnitude more toxic than cyanide, strychnine or curare, and only the biological toxins such as botulina, tetanus and diphteria are more toxic. There is, however, an enormous variability between the different dioxin isomers tested so far. This can be as much as a million fold between say 2,3,7,8-TCDD and such as 1,2,3,4-TCDD, 2,7-TCDD and octachlorodioxin (Figure 3). Additionally, different species react differently so the range of sensitivity between the guinea pig and hamster to 2,3,7,8-TCDD is 5,000 fold.

Even so, acute toxicity in the hamster at 5mg/kg-bw means we are dealing with a super toxic compound (Figure 4) (5). The values of the guinea pig are completely off the scale. A compound that is million fold less toxic than 2,3,7,8-TCDD in the guinea pig is still a slightly to moderately toxic compound.

While this kind of comparison raises concern, it is only a comparative tool. Even given the great potency of 2,3,7,8-TCDD, situations just do not exist where one could be exposed to such levels. For instance, the total lethal dose for man (using guinea pig equivalent sensitivity) that would have to be contained in a meal is 70 ugs. For a large meal of fish, say 0.25 kg, the concentration would have to be 280 ppb (Figure 5). When this concentration is compared to the federal guideline of 20 ppt then there is a 10,000 fold difference.

The concern is not lethality but carcinogenicity and the result of exposure to low levels over long periods of time. One of the often used, and often misused, predictors of toxicity is enzyme induction (Figure 6) (1). While there is quite a close correlation between acute toxicity and enzyme induction very few compounds have actually been tested for carcinogenicity. Thus, if a dioxin has a low enzyme induction potential, it is considered not very toxic and synonymously not very carcinogenic. This is indeed the case for 2,7-dichlorodibenzo-p-dioxin. Equally, the hexachlorodioxin tested for carcinogenicity is, as predicted, less carcinogenic than 2,3,7,8-TCDD. However, there is not much other evidence to say that the remaining 72 dioxins will follow these trends.

This is part of the scientific uncertainty. But the uncertainty goes much further. There is our ability to predict human effects from rat experiments and our ability to extrapolate from high dose animal experiments to low dose human exposures. The methods of risk analysis or safety factor analysis contribute to the confusion and uncertainty. Add to this unknowns such as promotor/initiator, threshold/no threshold, and the relative sensitivity of man, there is quite clearly room for considerable controversy.

This uncertainty has led to the search for effects in humans. The reality of actually finding any human effects is somewhat fallacious and we certainly hope that the scientific evidence will prevent major epideminologic catastrophes. But the philosophy of counting dead bodies is still persuasive in some quarters.

Attempts to document human effects, particularly carcinogenic effects, have not been successful. Highly exposed factory workers after an accident in Virginia in 1948 have shown chloracne - a boil-like eruption - that disappears after several years. The latest reports (6) show no increase in cancer. The recently released Ranch-Hand Study of Vietnam phenoxy- herbicide sprayers showed no cause and effect relationship. The Swedish study on herbicide sprayers did show a 5-fold increase risk factor (8) but this study has been so dogged with controversy that its status is just not conclusive at this time. In Seveso, another industrial accident, there was some evidence of chloracne and neurological disorders in children after high but short exposure (1).

Again, scientific uncertainty. But history has also had its role to play. The fact that Agent Orange was used in Vietnam and contained 2,3,7,8-TCDD at high levels has been pivotal in making dioxins a priority. Initially, it was probably more a reaction to Vietnam than dioxin per se, but the use of the phenoxy-herbicides in North America and the relative toxicity of 2,3,7,8-TCDD certainly added fuel to the fire.

There were many reports of a questionable scientific nature, both epidemicological and analytical, which helped create a climate of concern in the 1970s and in some cases damaged scientific credibility. There were the citizens' group studies at Alsea in Oregon, and Love Canal, both of which raised public concern but were later discounted scientifically. There were lots of reports of dioxin in anything from milk to fish, many of these results were never confirmed. Reports on incidents like Seveso and Times Beach, as well as residues in fish from Lake Ontario all raise public consciousness but do little to document either the relevance to Canadians in general or yet the solutions that are, or are not, available. It is then a combination of reports and events starting over a decade ago, to which we have consistently been unable to give adequate responses, that contributed as much, if not more, to dioxin being a priority than any of the scientific evidence.

More recently, the theory of combustion (9) as a source of dioxins has prompted consideration of more than just 2,3,7,8-TCDD. This has only succeeded in complicating the issue to quite enormous proportions. One of the ways that we can look at the priority of different sources is by their relative contribution of dioxins. Figure 7 depicts some of the rough estimates we currently believe to be the case for Canada as a whole. 2,4,5-T, the cause celebré, contributes only 0.5g of 2,3,7,8-TCDD. This contribution should not be underestimated, but it is a small amount sprayed over very large areas with very little human contact. When you look at these figures, one must question the ability of science to resolve, what seems to be, a very small issue. Even 2,4-D, where much less toxic dioxins are involved, has become controversial, even when the regulations have obviously reduced total inputs to very small amounts (Figure 7).

On the other hand, pentachlorophenol, a wood preservative, has received very little attention. The vast majority of the total 1,500 kg potential dioxins from pentachlorophenol is octachloro dibenzo-p-dioxin, which is considered relatively innocuous.

However, 430 kgs are hexa- and heptachloro dibenzo-p-dioxins which are considered relatively toxic. This is perhaps an over emphasis because a considerable portion of the dioxins will be retained in the wood that is preserved and not actually released to the environment.

In comparison, Environment Canada is currently upgrading the 1981 NRCC estimate (1) of 13 kg from combustion to something in the order of 300 kgs (10). Of this, possibly 250 kgs is released directly to the air. By comparison, the total amounts in the Niagara waste dumps, all 2,3,7,8-TCDD, is enormous. But again this is the amount contained and not the amount released annually to the environment.

It is incorrect to believe these source quantities are directly comparable because they are totals for different dioxins that have a variable toxicity. Ideally, if we were just starting out with this issue, these numbers should be weighted for their toxicological potential which would give a much better idea of priority.

There are, in fact, many combustion sources. Figure 8 gives a tentative set of source quantities which are currently under review and will be released later in the year(10). Perhaps the most controversial figure and the most interesting is the possible contribution from natural sources such as forest fires. Clearly, this is as much as for all other combustion sources.

This leads to the the possibility of a natural background level and so with the current analytical capability, we can expect, in the future, to find dioxins all over the place. Recently, Hites has demonstrated precisely that from sediment cores which can be dated back to the 1800's (11). However, the cores also show that there were dramatic increases in levels from the 1930-period onward.

It must be emphasized that combustion yields many, if not all, dioxin isomers. Very little isomer specific work has been completed but, for instance, the work of Lamparski and Nestrick (1980) (12) showed 19 of the 22 TCDD isomers in fly ash (Figure 9). In complex mixtures of this nature, with a variable content and a variable toxicity for each isomer, interpretation and meaning are obviously difficult. Ontario Ministry of the Environment has suggested 30 pg/m^3 for total dioxins in ambient air (13). This is equivalent to the 20 ppt value for fish. The value is really as good as any other at the present time and probably has a good safety margin. The only problem is whether one can measure dioxins in ambient air at that level.

The intent of this paper is to briefly outline some of the complexities of the dioxin issue and also some of the reasons why it is a priority. The reasons are partly scientific, partly the inability of science to resolve some uncertainties and partly historical perspective and circumstance.

In Canada, there is no doubt that combustion must be high on the list of dioxin priorities merely because of its source magnitude. But the meaning of the emissions, either toxicologically or in relation to a background level, are as yet not totally clear, and obviously we have a long way to go before we can give all the answers to all the questions.

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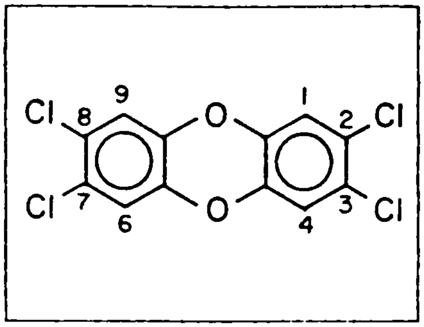
Figure 1. A list of polychlorinated dibenzo-p-dioxin congeners[α] by homologue[β] and isomer[γ]; (Number of isomers). (from NRCC, 1981)



Numbering system for congeners

MONOCHLORO-(2)

1; 2;

DICHLORO-(10)

1,2; 1,3; 1,4;
1,6; 1,7; 1,8;
1,9; 2,3; 2,7;
2,8;

TRICHLORO-(14)

1,2,3; 1,2,4;
1,2,6; 1,2,7;
1,2,8; 1,2,9;
1,3,6; 1,3,7;
1,3,8; 1,3,9;
1,4,6; 1,4,7;
1,7,8; 2,3,7;

TETRACHLORO-(22)

1,2,3,4; 1,2,3,6;
1,2,3,7; 1,2,3,8;
1,2,3,9; 1,2,4,6;
1,2,4,7; 1,2,4,8;
1,2,4,9; 1,2,6,8;
1,2,6,7; 1,2,7,8;
1,2,6,9; 1,2,8,9;
1,2,7,9; 1,3,6,9;
1,3,6,8; 1,3,7,9;
1,3,7,8; 1,4,7,8;
1,4,6,9; 2,3,7,8;

PENTACHLORO-(14)

1,2,3,4,6; 1,2,3,4,7;
1,2,3,6,7; 1,2,3,6,8;
1,2,3,6,9; 1,2,3,7,8;
1,2,3,7,9; 1,2,3,8,9;
1,2,4,6,7; 1,2,4,6,8;
1,2,4,6,9; 1,2,4,7,8;
1,2,4,7,9; 1,2,4,8,9;

HEXACHLORO-(10)

1,2,3,4,6,7;
1,2,3,4,6,8;
1,2,3,4,6,9;
1,2,3,4,7,8;
1,2,3,6,7,8;
1,2,3,6,7,9;
1,2,3,6,8,9;
1,2,3,7,8,9;
1,2,4,6,7,9;
1,2,4,6,8,9;

HEPTACHLORO-(2)

1,2,3,4,6,7,8;
1,2,3,4,6,7,9;

OCTACHLORO-(1)

1,2,3,4,6,7,8,9;

α Congener is a general term used to mean any isomer of any homologue; thus, there are a total of 75 PCDDs congeners.

β In the present document, homologue is defined as a group of isomers having a specified number of chlorine atoms; thus the tetrachloro homologue has 22 isomers.

γ An isomer is defined by the numerical arrangement of chlorine atoms within the homologue.

Figure 2. TOXICITIES OF SELECTED POISONS[a]
(from Esposito et al. 1980)

Substance	Molecular weight	Minimum lethal dose, moles/kg
Botulinum toxin A	9×10^5	3.3×10^{-17}
Tetanus toxin	1×10^5	1×10^{-15}
Diphtheria toxin	7.2×10^4	4.2×10^{-12}
2,3,7,8-TCDD	322	3.1×10^{-9}
Saxitoxin	372	2.4×10^{-8}
Tetrodotoxin	319	2.5×10^{-8}
Bufotoxin	757	5.2×10^{-7}
Curare	696	7.2×10^{-7}
Strychnine	334	1.5×10^{-6}
Muscarin	210	5.2×10^{-6}
Diisopropylfluorophosphate	184	1.6×10^{-5}
Sodium cyanide	49	2.0×10^{-4}

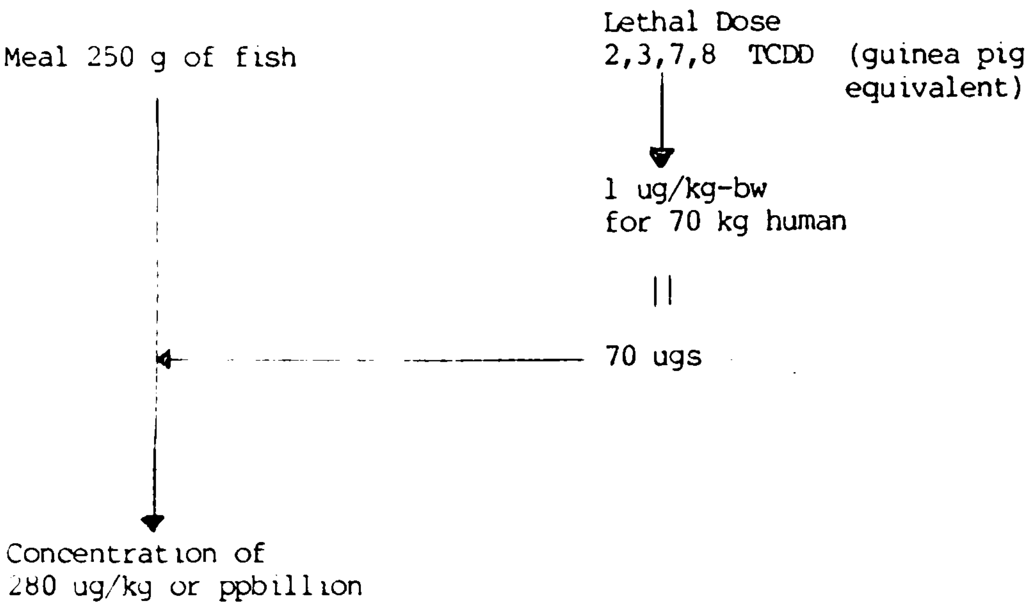
Figure 3. Acute Lethality (after NRCC; 1981)

Homologue	Isomer	Range of LD_{50} Vertebrates (ug/kg-bw)
D_2CDD	2,7-	2,000,000
	2,8-	300,000
T_3CDD	2,3,7-	30,000
T_4CDD	2,3,7,8-	1-5,000
	1,3,7,8-	
	1,2,3,8-	
	1,2,3,4-	1,000,000
P_5CDD	1,2,3,7,8-	3-338
	1,2,4,7,8-	1100-5000
H_6CDD	1,2,3,4,7,8-	70-800
	1,2,3,6,7,8-	70-1300
	1,2,3,7,8,9-	60-1400
H_7CDD	1,2,3,4,6,7,8-	600-
O_8CDD		1,000,000

Figure 4. Classification of toxicants into categories related to their relative toxicities (after Casarett and Doull 1975)

Toxicity Rating	Common Term	Probable Human Acute Lethal Dose (70 kg human)
6	supertoxic	less than 5 mg/kg-bw
5	extremely toxic	5 - 50 mg/kg-bw
4	very toxic	50 - 500 mg/kg-bw
3	moderately toxic	0.5 - 5 g/kg-bw
2	slightly toxic	5 - 15 g/kg-bw
1	practically non-toxic	greater than 15 g/kg-bw

Figure 5. The concentration of a lethal dose



Fish guideline = 20 pptrillion or 10000 times less.

Figure 6. AHH Induction and Carcinogenicity in Rats (after NRCC 1981)

Homologue	Isomer	AHH Induction Relative to 2,3,7,8-T_4CDD (rat hepatoma cells)	Carcinogenicity (rat) Minimum effect (ug/kg-bw/d)	No Observed effect (ug/kg-bw/d)
D_2CDD	2,7-	33,000		$7.5x10^5$
	2,8-	33,000		
T_4CDD	2,3,7-	3100		
T_4CDD	2,3,7,8-	1	$1x10^{-2}$	$1x10^{-3}$
	1,3,7,8-	240		
	1,2,3,8-	1700		
	1,2,3,4-	33,000		
P_5CDD	1,2,3,7,8-	15		
	1,2,4,7,8-	330,000		
H_6CDD	1,2,3,4,7,8-	21	$36x10^{-2}$	
	1,2,3,6,7,8-	85		
	1,2,3,7,8,9-	130		
	1,2,3,6,7,9-	220,000		
H_7CDD	1,2,3,4,6,7,8-	370		
	1,2,3,4,6,7,9-	10,000		
O_8CDD		53,000		

Figure 7. Total Dioxins - Estimates of Total Quantities by Source

SOURCE	DIOXINS (kg/a)	
a. Chemical		
2,4,5-T	0.0005	(50000 kg 2,4,5-T at 10 ppb, all 2,3,7,8-TCDD)
2,4,-D 1980	9.2	
1983 (post regulation)	0.14	(4500 tonnes, 3 dioxins at 10 ppb)
Pentachlorophenol (including tetrachlorophenol)	1500	(mainly retained in preserved wood)
	430	(hepta and hexachloro-dioxins)
b. Combustion		
1981 (NRC)	13.4	(all dioxins)
1984 (DOE)	300	
c. Niagara Waste Dumps	(kg)	
		(2,3,7,8-TCDD contained in dumps)
Love Canal	45	
Hyde Park	2230	
S area & 102nd	unknown	(but thought to be equivalent)

Figure 8. Total Dioxins Emitted by Combustion Sources[1]

SOURCE	EMISSIONS (g/a) PCDD
Combustion	
Municipal Incinerators	
A. Ontario data	9200-47900
B. Environment Canada data	80-600 (particulate)
	7-100 (gaseous)
Sewage Sludge Incinerators	4100-13200
Coal-Fired Utility Boilers	400
Fuelwood Combustion	1800
Fuel-Oil Fired Residential Sources	1
Wigwam Burners	1800
Forest Fires	159800
Slash Burning	1700
Cigarette Smoking	2-4.3
Motor Vehicles	200

1. Tentative figures under review, assumptions not discussed.

Figure 9. T_4CDD isomer concentrations detected in US fly ash (after Lamparski and Nestrick 1980).

Isomer	ng/kg
1,2,6,9-	190
1,4,6,9-	ND (50)[b]
1,2,6,7-/1,2,8,9-[a]	220
1,2,6,8-/1,2,7,9-[a]	500
1,3,6,9-/1,4,7,8-[c]	-
1,2,7,8-	ND (80)[b]
1,2,3,6-/1,2,3,9-[a]	430
1,2,3,7-/1,2,3,8-[a]	720[a]
1,2,4,6-/1,2,4,9-[a]	730[a]
1,2,4,7-/1,2,4,8-[a]	310
1,3,7,8-	1370
1,3,7,9-	1160
1,3,6,8-	1320
1,2,3,4-	370
2,3,7,8-	430
Total T_4CDDs	7750

a Summation of two retention times.

b Not detected (at detection limit).

c Not recovered.

d Possible isomer interference.

Point de vue journalistique

sur la problématique des substances toxiques

Yvon Leblanc

Journaliste

Radio-Canada

Point de vue journalistique sur la problématique des substances toxiques.

Ce point de vue tournera forcément autour de la notion de qualité de l'information sur ce sujet et vous devinez déjà peut-être que j'ai à ce propos des doléances à formuler.

Les hommes publics affirment souvent être mal compris des journalistes; le contraire est au moins aussi vrai.

En consultant la liste des invités et des communications du présent colloque, je me suis d'abord dit que j'allais détonner et paraître tout à fait incongru dans une pareille assemblée, dans une réunion de gens finalement assez homogènes qui, par la recherche de données ou solutions, ont une préoccupation quotidienne (professionnelle, pourrait-on dire) des problèmes d'environnement. Mais, cette méfiance un peu orgueilleuse, je l'avoue, a vite craqué devant la conviction que plusieurs d'entre vous partagent, je l'espère, qu'il y a sur ces questions de "menaces à l'environnement", par des sources de plus en plus nombreuses d'ailleurs, qu'il y a dis-je un problème sérieux d'information ou, plus justement, de manque d'information. Dans une société qui se veut démocratique, les carences d'information ou des entraves à la libre circulation de l'information sont des maux graves qui peuvent conduire les citoyens à adopter des attitudes défensives, en tout cas plus émotives que rationnelles. Il m'apparaît que, face à la pollution, ce mal qui vient de partout et qui répand la terreur, on réagit le plus souvent par la confiance exagérée envers les experts, ou par une méfiance systématique envers les écolo-alarmistes, ou encore par un fatalisme un peu désabusé. Dans tous les cas, on abdique un peu le sens critique. Quant à moi, c'est un cheminement à mon sens privilégié, mais par plusieurs aspects semblable à celui de milliers d'autres personnes, qui m'a conduit jusqu'à ces préoccupations, cet intérêt pour les questions environnementales, vitales et fondamentales.

Je travaille donc dans le secteur de l'information; je fais partie d'un groupe de privilégiés qui peut, comme tout citoyen normal, entretenir des inquiétudes et des interrogations, mais qui peut, en plus, être payé pour qu'on y réponde. C'est un privilège, mais aussi une responsabilité. Il y a six ans donc, un peu lassé du secteur actualités-politique où j'oeuvrais depuis autant d'années, j'ai voulu changer d'air, quitter un univers un peu superficiel où tout m'apparaissait centré sur le thème du pouvoir -- le pouvoir à acquérir, à conserver ou à augmenter -- pour diriger ma curiosité vers des valeurs, me semblait-il, humainement plus fondamentales.

J'ai voulu, en somme, opérer ma petite révolution culturelle à la chinoise, quitter les palais pour les champs, enfin presque...

Mais, il y a encore des périodes rassurantes en studio. Je me suis donc retrouvé à l'animation du magazine agricole et de ressources renouvelables "La semaine verte". Et, en même temps que je faisais mes classes, j'ai rapidement perdu quelques illusions : le monde rural n'avait plus rien de commun avec mes souvenirs littéraires, avec les films de l'Abbé Proulx, plus rien de commun non plus avec l'image idyllique qu'en faisaient les hippies des années 60 qui proposaient, vous vous en souvenez, un retour à la terre; ces tentatives ont d'ailleurs, la plupart du temps, lamentablement échoué. Non, le monde rural avait été rejoint par le progrès et, comme le monde industriel, malgré le calme trompeur des décors pastoraux, devait se soumettre, lui aussi, aux impératifs économiques, à la tyrannie de la productivité, de la croissance, "à tout prix".

Ce prix à payer a été, et est encore, peut-être moins évident à la ferme qu'à la ville. Mais, il faut se rappeler que, bien avant l'ère industrielle, l'agriculture a été responsable de quelques-unes des catastrophes écologiques les plus importantes de la planète. En réduisant de riches écosystèmes à des agro-écosystèmes, en les affaiblissant, on les rendait vulnérables. Il s'en est suivi souvent une désertification de grandes régions du globe dont, entre autres, une très large partie de ce qu'on nomme encore aujourd'hui sans sourire "le croissant fertile" (Proche-Orient). Les façons culturales d'antan ont donc, c'est certain, conduit à une certaine dégradation du milieu, de l'environnement, mais l'agriculture d'aujourd'hui est encore nettement plus agressante.

Si en ville c'est l'air qui est surtout vicié, à la campagne c'est le sol par sa structure même qui est menacé. Menacé de l'extérieur; dans la région de Noranda, par exemple, on a quelquefois vu des champs de céréales littéralement brûlés par les émanations de gaz sulfureux de l'usine de raffinage de Noranda, toute proche. Menacé aussi de l'intérieur, parce que la course folle à la productivité, toujours accrue, a entraîné le recours de plus en plus intensif aux engrais chimiques et aux pesticides de toutes sortes. On n'a pas le temps d'en faire ici la démonstration mais, sur le sujet, la documentation est assez accablante. L'agriculture est devenue, tout comme le secteur des industries lourdes ou chimiques, une source importante de pollution; pollution en amont des productions, par les engrais azotés, les fertilisants de toutes sortes, les herbicides, les fongicides, les insecticides... pollution aussi en aval, par les fumures, les purins, les résidus, la contamination fréquente de la nappe phréatique, l'azote nitrique en excès dans les tissus de certaines plantes, et qui conduisent à des problèmes au niveau de la consommation.

Les fertilisants eux-mêmes, paraît-il, ne sont pas polluants, mais la sur-fertilisation, fréquente, largement utilisée pour maintenir les rendements, laisse des accumulations de métalloïdes, entre autres, qui à la longue, diminuent la fertilité des sols et modifient leur structure pédologique; les matières organiques qui autrefois servaient à recycler l'humus du sol sont aujourd'hui le plus souvent évacuées du cycle de production.

L'utilisation massive et croissante des engrais chimiques en agriculture serait selon plusieurs scientifiques responsable en bonne partie aussi de la perturbation soupçonnée des cycles de l'azote et du phosphore. Quant aux pesticides, et bien, si quelques-uns sont disparus parce que leur nocivité ne faisait plus de doute pour personne, tel le DDT, on en retrouve encore près de un millier au États-Unis seulement, commercialisés sous 60 000 préparations différentes, et la consommation de ces pesticides augmenterait de 15 p. cent par année, notamment à cause des résistances aux traitements que développent les maladies, les insectes, les plantes nuisibles (celles qu'on veut éliminer).

De tous les produits phyto-sanitaires, ce sont les herbicides (les militaires diraient les défoliants, c'est toujours la même chose) qui enregistrent la plus forte croissance d'utilisation. Leur application entraîne beaucoup de gaspillage au niveau de la dispersion dans la nature par les vents, les conditions ne sont pas toujours favorables, et le problème plus grave encore de leur persistence dans les sols et dans les eaux n'a pas encore été résolu.

D'autre part, malgré les succès notoires obtenus dans le contrôle (et non l'éradication) d'insectes nuisibles par l'introduction d'insectes prédateurs (i.e. la lutte biologique), ce sont encore les insecticides chimiques qui sont massivement utilisés.

Leur emploi excessif a conduit à de véritables hécatombes de l'avifaune (des oiseaux insectivores surtout) en certains points d'Amérique; je pense notamment au combat contre la fourmi rouge, dans les années 50, dans le sud des États-Unis, et aussi à la lutte au scolyte de l'orme, qui causait la maladie hollandaise de l'orme dans le nord-est des États-Unis quelques années plus tard.

D'autre part, l'utilisation aussi croissante des fongicides serait responsable des taux élevés de mercure mesurés dans le foie et les reins des gallinacés et surtout des oiseaux rapaces, au sommet de la chaîne alimentaire. Ces accumulations dans la biomasse, à chaque niveau trophique, entraînent des désordres physiologiques assez graves. De véritables "Minamata" fauniques qui pourraient entraîner, selon plusieurs, la disparition de certaines espèces.

Je me suis laissé entraîner à une énumération de facteurs polluants en agriculture sans parler même des intoxications graves que subissent nos ressources dites "renouvelables" : forêt et pêcheries. Renouvelables... c'est de moins en moins certain. On s'en rend compte de plus en plus, ces ressources sont très vulnérables. Le mal n'est pas toujours irrémédiable; en tout cas, la nature a souvent donné des preuves de sa vitalité et de son pouvoir de récupération, mais pour le moment l'homme, dans ces deux secteurs, par la sylviculture et l'aquaculture, devra sans doute apprendre à corriger certaines erreurs commises dans l'exploitation des stocks.

Mais, de toutes les formes de pollution, celle qui m'apparaît encore la plus grave est la pollution des cerveaux. Pollution qui vise à atténuer les légitimes inquiétudes et à éviter les véritables questions. Ainsi, chez la très grande majorité des firmes industrielles génératrices de pollution, les budgets consacrés à la publicité dépassent de beaucoup ceux consacrés à la recherche technique et scientifique. Bien souvent d'ailleurs, la publicité d'une entreprise va carrément tenter de récupérer à son profit, pour remodeler son image, les préoccupations écologiques du public bien qu'elle ne s'en occupera pas, pour autant, vraiment.

Bon! j'arrive ici aux doléances journalistiques annoncées au début de mon intervention et dont vous me pardonnerez de m'être tant éloigné. Il devient, dans le contexte que j'ai un peu esquissé, difficile d'exercer avec objectivité la traditionnelle neutralité radio-canadienne dans l'information. Neutralité qui veut que l'on interroge surtout des gens sans se prononcer nous-mêmes, qu'on invite souvent les journalistes -- les journaliste invitent souvent d'autres journalistes à s'exprimer; neutralité qui veut qu'on donne tant de minutes à chaque invité; il y a des inégalités sur ces questions qu'on ne peut pas tolérer. Il est difficile d'exercer donc simplement un travail d'information sur des questions importantes comme celle-là, parce que le débat me semble, en plusieurs endroits, piégé. Parce qu'avec le silence ou l'attentisme des gouvernants et une certaine discrétion de la communauté scientifique, c'est l'argumentation intéressée de l'industrie qui prévaut le plus souvent. Confronté à ses responsabilité de pollueur, le discours industriel ira d'une négation pure et simple de cette responsabilité jusqu'à un aveu d'impuissance reposant sur une analyse des lois économiques. Qu'il soit à la ville ou à la campagne, la stratégie de défense du pollueur a jusqu'ici toujours consisté à opposer à l'écologie, l'économie.

Le plus étonnant, c'est que ça fonctionne encore malgré l'absence de fondement de la plupart des affirmations.

On connaît la rengaine; de mémoire, elle va à peu près comme ceci : "les mesures anti-polluantes ou dites de dépollution coûtent très cher, c'est une dépense improductive; si on nous contraint à les engager quand même, nos coûts de production monteront en flèche, nous ne seront plus compétitifs, concurrentiels, il faudra envisager la fermeture de l'usine. Préférez-vous le maintien de vos emplois à une usine propre, mais désaffectée? etc. etc." Souvent d'ailleurs, les syndicats, curieusement, se rangent à cette argumentation fallacieuse; les gouvernements aussi semblent prisonniers de cette logique économique bizarre. L'intervention surtout normative du gouvernement, appuyée de pénalités plutôt ridicules, semble encourager le statu quo. Malgré les risques d'une image publique un peu écorchée, d'autre part, les pollueurs ou le pollueur trouvera plus avantageux de tergiverser, d'attendre, de payer l'amende, ou d'en appeler, etc., plutôt que d'engager vraiment des efforts résolus dans des mesures d'assainissement.

Jean-Pierre Rogel, journaliste et rédacteur en chef de l'excellent magazine Québec Science, a pourtant brillamment démontré la gratuité des prémices qui fondent l'argumentation des industriels dans "Un paradis de la pollution", édition Québec Science, 1978.

On n'y reviendra pas, faute de temps. Mais, répétés quand même à satiété, ces mythes ont la vie dure, et le spectre des fermetures d'usines, la faillite d'entreprises, continuent à enfermer le problème dans une dualité tout aussi illogique qu'irréductible, écologie versus économie. Comme s'il fallait nécessairement choisir entre les deux, et non les deux, comme il me semble possible de le faire. Sur quelles bases l'économie fonctionnera-t-elle si on laisse le milieu se détériorer et les catastrophes écologiques se produire?

Il faut donc, selon moi, sortir de cette opposition artificielle qui retarde la solution de certains problèmes et fait se dresser les uns contre les autres les industriels et les travailleurs, d'une part, contre les écologistes et les journalistes alarmistes, d'autre part; d'un côté donc, les réalistes, les gens qui ont les pieds sur terre et de l'autre, les rêveurs, les utopistes, et les "écolos" en tout genre. Le journaliste, la plupart du temps, se retrouvera malgré lui souvent du côté des utopistes s'il accepte de poser avec obstination certaines questions impertinentes, interdites même, sur la gestion des déchets toxiques, par exemple, sur les risques d'accident important. Et, comme la plupart d'entre nous n'avons pas de formation scientifique comme telle (Ce qui est dommage... Remarquez, on pourrait aussi souhaiter que le milieu scientifique produise davantage de vulgarisateurs dans différents domaines) il ne sera pas, par conséquent, tellement difficile de miner insidueusement la crédibilité du journaliste, de le présenter comme un cassandre pessimiste, comme un sensationnaliste morose.

Notre société est, de toute évidence, maintenant capable de produire des catastrophes écologiques d'une ampleur qui dépasse les scénarios les plus pessimistes. Mais, justement, si ces scénarios existent, on a préféré le plus souvent les écarter jusqu'ici, ne pas les retenir vraiment, ne pas les considérer. Pourtant, on a eu de chaudes alertes : Seveso, Three-Miles Island, Mississauga.

Pourtant, la sensibilité répugne toujours à envisager l'inconcevable, à penser, comme a dit quelqu'un, "l'impensable". À propos des risque écologiques qu'introduit notre type de développement, qu'entraîne tout type de développement, il y a actuellement chez beaucoup de gens une insouciance jovialiste, puérile; ces risques sont pourtant, d'après moi, avoués en certains endroits, mais discrètement, et ils soulèvent d'angoissantes questions.

La première réponse à toute question, c'est d'abord de la bien poser. C'est la responsabilité du journaliste. Le scientifique a celle d'y répondre, sans éluder la question. Autrement, il ne peut rien subsister de son prestige d'impartial savant. Il est aisé de comprendre que certains peuvent avoir d'autres intérêts. Mais il faudrait en général, d'après moi, que diminue cette méfiance un peu commode qu'entretiennent beaucoup de scientifiques à l'égard de toute vulgarisation de leurs connaissances. Chez les industriels, devrait diminuer aussi cette presque paranoïa qui voit un complot visant à les affaiblir économiquement dans la moindre contrainte d'ordre écologique. Cela rend la cueillette d'information difficile; cela fait d'un secret d'industrie un presque secret d'état. Il faudrait observer d'ailleurs que les adversaires les plus compétitifs, dans ces mêmes industries, appartiennent souvent à des pays plus avancés que le nôtre au niveau de la protection de l'environnement. Je pense à l'Allemagne et à l'Autriche.

Certains scientifiques nous proposent des concepts lénifiants de "risques minimes" ou "risques acceptables". Quand on considère les installations, certaines installations -- leur importance, leur taille -- on constate que si les risques sont acceptables, il sont d'autre part "majeurs" dans leurs implications; et que nous n'avons collectivement à peu près aucune préparation pour affronter ces éventualités. Il faudrait aussi se donner les moyens de discuter sur la place publique certains choix de développement.

Il faudrait apprendre à apprivoiser le risque, apprendre à le gérer. Comme le soulignait le jeune ingénieur français, Patrick Lagadek, dans un livre qui a fait beaucoup de bruit l'an dernier "La civilation du risque", et je cite : "En période de crise, les sytèmes habituels de gestion deviennent encore plus complexes et parfois tout à fait non-opérationnels. À l'intérieur des grandes organisations, il y a des fuites de tous les côtés. Ça donne une grande vasière dans laquelle l'intelligence n'a plus de prise." Et plus loin "Il est fort risqué de gérer le risque; des gestionnaires spécialement formés seront nécessaires pour faire face aux catastrophes...", et plus loin encore "Il faut revoir les approches coutumières; il ne s'agit plus notamment qu'un système donne en gros satisfaction, il importe de viser la quasi-perfection, de traquer ensuite les failles résiduelles. Bref, l'aberrant doit devenir sujet d'étude." Enfin, et en terminant, il importe, me semble-t-il, de toute urgence de mondialiser la discussion sur ces problèms de pollution et sur les solutions envisagées. Si on est arrivé à se parler entre grands du désarmement pour que diminue, ce qui est très louable, la terreur nucléaire, la tension, on devrait pouvoir le faire pour un mal encore plus évident, plus présent, dont la nocivité saute aux yeux de plusieurs. Un mal déjà installé donc, et dont on n'a pas fini malheureusement encore de mesurer la malice et les séquelles.

La pollution n'a pas de frontières et on prête pour le moment peu d'intérêt à ces questions dans les pays de l'Est, c'est notoire.

Tandis que certains pays du Tiers-Monde paient très cher, en coût humain, un certain développement, leur sang pourrait bien un jour retomber sur nous. La Terre est bien petite; alors, cessons de la violenter et courtisons-la plutôt comme nous le proposait le grand écologiste, René Dubos, en 1980, dans un livre plein d'espoir.

The Problem of Toxic Substances from a Journalist's point of View

Yvon Leblanc

Journalist

Radio-Canada

The problem of toxic substances from a journalist's point of view.

This point of view will inevitably focus on the quality of information on this subject and, as you may have guessed, I have a few grievances to air in this regard. Public figures often contend that they are misinterpreted by journalists; however, the contrary is at least just as true.

When I consulted the list of guest speakers and the papers they were to give at this symposium, I first thought that I'd be like a fish out of water and stick out like a sore thumb at a meeting of such a homogeneous group of people who are involved on a day-to-day, professional basis in looking for facts on or solutions to the problems of the environment. Buy my admittedly rather base fears soon gave way to the conviction, hopefully shared by many of you, that on these issues of environmental threats - which are constantly multiplying - there is a serious problem of information, or rather, a lack of information. In a society which considers itself to be democratic, any lack of information or impediment to the free flow of information are terrible evils that may lead people to react defensively, more emotionally than rationally. It seems to me that, faced with the problem of pollution, a terrifying, all-pervasive evil, we tend to put all our faith in the experts and systematically distrust the dire warnings of environmentalists or we tend to be cynical fatalists. In any case, we tend to abdicate our critical faculties. Personally, I becamed concerned and interested in these vital, basic environmental issues in the same way as thousands of others, but through a rather special route.

As you already know, I work for the news media where I belong to a group of privileged people who, like any other citizens, may have worries and concerns but who, in addition, are paid for analysing them. This is mot only a privilege, it is a responsibility. Six years ago, rather weary of the political scene that I had been covering for the previous six years, I wanted a change of pace, to get away from this rather superficial world where everything seemed to be focussed on achieving, maintaining or accumulating power, to explore more basic human values. In a nutshell, I wanted to launch my own little Chinese-Style revolution and get back to the land, back to basics... Rest assured however, I still get to enjoy the comforts of the studio. I therefore found myself in charge of "La semaine verte", a magazine program concerned with agriculture and renewable resources. And as I was learning the tools of the trade, some of my illusions soon vanished: the country no longer corresponded with my schoolboy memories, Father Proulx's films or the idyllic image of the hippies of the 1960's who, as you may recall, wanted to get back to nature; however, most of these attempts failed miserably. Alas, the country had not remained untouched by progress and like the industrial world, despite the deceptive peace and quiet of rural life, it too had had to bow to economic imperatives and the tyranny of increasing productivity, at any price. Although the cities have traditionally had to pay a higher price for their development than the country, we must remember that well before the industrial era, agriculture was responsible for some of the worst ecological catastrophes on this planet. By reducing rich ecosystems to agro-ecosystems and by weakening them, we made them vulnerable. As a result, large areas of land in the world, including a very large part of what is still ironically called the "fertile crescent" (Near East), have often become deserts. The old ways of farming have therefore led to a certain deterioration of the environment, but agriculture today is still by far more damaging. If the air is polluted in the cities, in the country, the soil is threatened in its very structure by outside forces. For example, in the Noranda region. sometimes entire fields of grain have literally been burned by sulphur dioxide fumes from the nearby Noranda refinery. The soil is also threatened from within. because the mad race to increase productivity had led to the more intensive use of chemical fertilizers and pesticides of all kinds. We don't have time here to take a look at some examples, but the literature on this subject is overwhelming.

So, just like the heavy or chemical industries, agriculture has become a major source of pollution - pre-production pollution caused by the use of nitrates, fertilizers of all kinds, herbicides, fungicides and insecticides, ans post-production pollution resulting in liquid and other types of manure, waste products, the frequent contamination of the water table, and excessive amounts of nitrogen and other substances that are found in certain plants and that lead to problems on consumption. It would appear that fertilizers themselves are not pollutants; however, frequent overfertilization, used largely to maintain output, builds up accumulations of metalloids, among other things, which in the long run, reduce the fertility of the soil and modify its structure. Organic matter which was once used to replenish the soil is today generally eliminated from the production cycle. According to a number of scientists, the extensive and increasing use of chemical fertilizers in agriculture is also largely responsible for the suspected disturbance in the nitrogen and phosphorous cycles. As for pesticides, although some such as DDT have been withdrawn because of the blatant harm they caused, close to a thousand others are still in use in the United States alone, under 60 000 different combinations and names, and the use of these pesticides is increasing by 15% annually, mainly because diseases, pests and the weeds we're trying to eradicate develop a resistance to these substances. Of all the phytosanitary products, herbicides (referred to as defoliants by the military but meaning the same thing) are being used at the fastest growing rate. Their use causes a great deal of waste since they are dispersed by wind, conditions are not always favourable and the more serious problem of their persistence in the soil and in water has not yet been solved.

Moreover, despite the acknowledged success in biologically controlling pests (and not eradicating them, as is often the goal) through the introduction of predatory insects, chemical insecticides are still widely used. Their overuse has led to the sheer slaughter of birds, particularly of insectivorous birds, in certain parts of North America. I refer specifically to the control programs against the red ant in the 1950's in the southern United States, and against the elm scolytid (bark beetle), which caused Dutch elm disease in the northeastern States a few years later.

In addition, the growing use of fungicides is responsible for the high levels of mercury found in the livers and kidneys of gallinaceans, particularly of birds of prey, at the top of the food chain. These accumulations in the biomass at each point in the food web result in rather serious physiological disorders, a birds' version of Minamata disease which, according to many experts, could lead to the extinction of certain species one day.

Up to this point, I have listed some of the polluting agents in agriculture without even mentioning the serious poisoning to which our so-called "renewable" resources are subjected. I'm speaking about our forests and fisheries. Whether they are renewable is debatable. We're becoming more and more aware of the fact these resources are very vulnerable. However, damage done is not always irreparable. In any case, nature has often demonstrated her vitality and power to recover, but for the time being, man, through forestry management and aquaculture, must learn to make better use of these resources.

However, the worst form of pollution I can imagine is brainwashing. It is intended to allay our legitimate fears and evade the real issues. Thus, among the vast majority of manufacturing companies that generate pollution, budgets for advertising exceed by far those for technical and scientific research. Moreover, very often a company's advertising campaign will deliberately set out to capitalize on popular ecological concerns to enhance its image, although it doesn't really intend to do much about the problem of pollution.

Well, I'm finally getting around to the grievances I mentioned earlier and I hope you'll forgive me for my digression. In the circumstances I've outlined, it is difficult to be objective in observing the traditional CBC position of neutrality - neutrality that requires us to interview people and talk with fellow reporters without giving our own opinions; neutrality that requires us to give an equal amount of air time to each guest. But there are such intolerable disparities. It becomes difficult for us just to do our job with regard to such important issues as pollution because discussion of the matter often seems to be rigged: the government's silence or wait-and-see policy and the scientific community's discretion usually give industry's self-interested arguments the upper hand. When confronted with its responsibility for polluting the environment, industry will categorically deny any such thing and invoke economics for their inability to act. Whether in the city or the country, the polluter's strategy of defence has until now consisted of setting economy against ecology, and the amazing thing is that it still works despite the fact that most of the arguments are unfounded. It's always the same old story that goes something like this: "Antipollution measures are very costly and constitute an unproductive expense. If, however, we're forced to adopt such measures, our production costs will skyrocket, we'll no longer be competitive, and we'll have to consider closing down the plant. Now, what do you prefer? Job security or a clean but empty plant?" And so on, and so forth. As strange as it may seem, unions often side with these fallacious arguments. Government also seems to be a prisoner of this bizarre economic reasoning. Government intervention mostly of a regulatory nature, backed by token sanctions, seems to encourage the status quo. Faced with the risk of a slightly tarnished public image, polluters prefer to dodge the issue, use the wait-and-see approach, or pay or appeal fines rather than firmly commit themselves to cleaning up their act.

Jean-Pierre Rogel, journalist and chief editor of the excellent magazine Québec Science, brilliantly demonstrated the gratuitousness of the premise on which manufacturers base their arguments, in his article "Un paradis de la pollution", Québec Science, 1978. We won't dwell on it here, for lack of time. However, repeated ad nauseam, these myths die hard and the spectre of plant shutdowns and business failures perpetuates the illogical and yet inescapable dual nature of the problem: ecology versus economy. As if we had to choose one or other but not both, as I think is possible. On what basis will the economy work if we let the environment deteriorate and ecological catastrophes happen?

In my opinion, we need to put an end to this artificial conflict which is keeping us from solving certain problems and makes us pit manufacturers and workers on the one hand against ecologists of all stripes and vocal journalist on the other; hence, the realists, the down-to-earth people against the dreamers, the idealists, and every brand of ecologist. The journalist, in spite of himself, will usually find himself siding with the idealists if he is determined to concern himself with impertiment, taboo matters such as toxic waste management or the risk of serious accidents. And since most of us have no scientific background to speak of, which is a pity (mind you, perhaps the scientific community could produce more popularizers in different fields), as I was saying, since most of us have no scientific background, it won't be very difficult to insidiously undermine the credibility of the journalist, portray him as a prophet of doom and as a morbid sensationalist.

Clearly, today's society is capable of provoking ecological disasters the extent of which goes beyond the worst possible scenarios. Although these scenarios do in fact exist, we have until now chosen to dismiss them, ignore them. Yet, we've had a few close calls such as Seveso, Three-Mile Island and the Mississauga derailment. And yet human nature is always reluctant to conceive the inconceivable, think the unthinkable.

Many people have adopted a light-hearted, childish attitude toward the ecological risks presented by our or any other type of industrial development. However, these risks have been confirmed in several places, albeit discreetly and they raise a number of alarming questions.

Now then, to get the right answers, you first have to ask the right questions. That's the journalist's responsibility. The scientist's responsibility is to answer these questions without beating around the bush. Otherwise, his reputation as an impartial man of science is destroyed. It is easy to understand that certain people may have ulterior motives; but, generally speaking, I feel we should allay these suspicions, which I still frequently observe, a rather convenient excuse on the part of many scientists with regard to any popularization of their knowledge. Manufacturers should also strive to be less paranoid, seeing any ecological constraint as a plot to weaken them economically; this makes it difficult to collect information and, in turn, transforms an industrial secret into a virtual state secret. Moreover, it should be pointed out that often the toughest competitors, that these very industrial companies often come from countries that are more advanced than our own as far as protecting the environment is concerned. I'm referring here to Germany and Austria.

Some scientists downplay the situation with concepts of minimal or acceptable risks, but if you consider some of the existing facilities, their size and consequence, you can see that even though the risks may be acceptable, their implications are nevertheless far-reaching, and that we, as a society, are basecally unequipped to handle them and their consequences. We should also find a way to discuss openly the choices that we have. We must learn to cut risk down to size and learn to manage it. As the young French engineer, Patrick Lagadek, pointed out in La civilisation du risque, a book which created a stir last year:

> (Trans)
> In times of crisis, the usual management systems become even more complex and are sometimes altogether inoperative. Large organizations spring leaks. There's nothing solid to get hold of anymore. ...It is very risky to manage risk; specially trained managers will be needed to cope with disasters... Customary approaches must be reviewed. It is not enough for a system to basically sa-

tisfy our needs; we should aim for virtual perfection and then track down the residual flaws; in short, aberrations will become the subject of study.

Lastly, in concluding, I think we must act without delay to make discussion on the problems of pollution and proposed solutions an international issue. If the world powers can sit down and discuss disermament for the reduction of tension and nuclear terror, which is highly commendable, we should be able to do the same as regards an even more manifest and palpable evil whose harmfulness is clear to many. We're talking about an evil which is already with us and whose maliciousness and repercussions have not yet been fully determined. Pollution knows no bounds and it is common knowledge that, for the time being, the eastern bloc is paying little attention to these problems, whereas development in some Third World countries is being achieved at high human cost. One day, their blood could very well spill over onto us. It's a very small world; so let's stop violating it and start taking care of it as the great ecologist, René Dubos, proposed in 1980, in his optimistic book.

SESSION II

Les substances toxiques dans l'environnement: monitoring et analyses

Toxic Substances in the Environment: Monitoring and Analyses

Systems Concept for Real Time Toxic Monitoring

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CONTENTS

ABSTRACT

The New York State Department of Environmental Conservation is providing a lead role for controlling the emission of harmful material into the air, water and ground. Monitoring is recognized as an essential element in the comprehensive regulatory program. A systems concept has been developed to insure that monitoring goals and objectives can be met by application of proper technology. The framework must be designed to assure compliance with permit conditions, public acceptance that data is valid, and timely results which can provide an immediate response to a dangerous situation.

The comprehensive real time toxics monitoring system includes and utilizes several monitoring concepts. Site measurements are performed where instrumentation is needed to provide immediate results of process control and abatement. Field toxic monitoring stations containing dedicated laboratory techniques which can perform analysis for selected toxics provide data as soon as the sample is delivered. Mobile monitors housing computerized mass spectrometers and gas chromatographs are essential for tracking plumes, locating sources and determining background levels. Laboratory analysis involving highly specialized equipment and resource intensive facilities is utilized to perform the most challenging measurements.

For each of these concepts to be effective there are similar design factors which must be addressed and have been identified. These include selection of analytical procedures, methods of sampling, quality assurance, data acquisition, validation and reporting. To effectively manage a program of this scope, the Department has recognized that the enviro-chemical analysis sections of all environmental quality and wildlife divisions must be fundamentally involved in this task for proper input in the decision-making process. Utilizing collective expertise to properly direct resources into environmental protection from the effects of toxic materials with the above design criteria can provide the needed monitoring data. At this time the most effective manner to satisfy political or public perception of control of toxic substances is with proper monitoring.

INTRODUCTION TO SYSTEMS CONCEPT

The measurement and control of pollution in the environment continues to be the responsibility of both industry and government. In New York State the Department of Environmental Conservation has statewide authority for the regulation of discharges of hazardous materials into the air, water and ground. Monitoring has been found to be a key element of a regulatory system which sets discharges at levels necessary to protect the public's welfare and natural resources. Using a systems concept provides a framework for application of proper technology to insure that the monitoring goals and objectives can be met. To manage the problem of toxic waste requires an understanding and analysis of the entire system. Three important considerations are compliance with permit conditions, public acceptance that the data is valid and timely results which can provide an immediate response to a dangerous situation.

Real time measurements which could mean immediate results or even several days later are recognized as a very effective means of satisfying the above criteria when the monitoring system is designed for adequate feedback to control the problem. Source and ambient level monitoring can be coupled with transport parameters to determine both compliance with and validity of standards and limitations. In the area of common air pollutions, especially sulfur dioxide, monitoring systems have evolved sufficiently to provide feedback into environmental management decisions. By conducting both real time stack and ambient monitoring to control emission of sulfur dioxide, utilities have taken advantage of the economics of fuel switching and conversions.

Expanding this concept to satisfy all considerations mentioned above to include not only maintenance of sulfur dioxide air quality standards but also providing a monitoring system which assesses the environmental impact of all toxic substances released is the real goal. Although unknown factors such as hazardous wastes, toxic contamination, wind-transported fine particulate and their subsequent effects of morbidity, visibility reduction and acid precipitation were not established or included as an essential part in past monitoring systems, the need for a more comprehensive system is now recognized. Fossil fuel combustion, modern manufacturing methods, expanded use of petrochemicals and disposal of wastes have created materials when left unregulated could cause irreversible and cumulative environmental degredation and biological retention.

For the design of monitoring systems to be expanded to cover a program of the scope of toxic substances involvement with staff from environmental quality, public health, industrial hygiene, agricultural, biological and wildlife sciences may be needed. From an analysis of the individual goals and the analytical processes required, systems can be developed and designed to mesh with each disciplines requirements. Following the systems concept for monitoring provides reasonable assurance of successful implementation and that the final information obtained will be adequate because it can be predetermined from system design factors. In the past, omitting or neglecting important factors such as quality assurance provided data which may have been limited and questionable. Attempts to apply corrections, extrapolations, safety factors, modeling, etc. often lead to more confusion and possible duplication of work to verify results.

By considering the system design factors which will be described for implementation of a sampling project, an opportunity is provided to determine if adequate resources are available to produce the desired results. Awareness of obvious deficiencies will allow for formulation of an integrated plan which would draw from resources of other sectors. Depending on the complexity and the priority assigned, some projects may require pooled expertise to produce meaningful results.

To understand the mechanics of real time toxics monitoring systems which are presently being developed for use during the next decade, we must look first at where the sampling will take place. On-site monitoring is performed by dedicated, automated instrumentation which provides immediate results for process control and compliance determination. Field toxic monitoring stations containing specific laboratory techniques which can perform analysis for selected toxics and provide data as soon as the sample is delivered. Mobile monitors are most useful for tracking plumes, locating sources and determining background levels. Laboratory analysis involves highly specialized equipment and resource intensive facilities which can be utilized to perform the most complex measurements.

Both government and regulated industry must work together to maintain control of toxic and hazardous wastes to the same degree of quality control as is done with other commercial processes. Properly conducted monitoring provides good information no matter who is doing the sampling. Continuous emission monitoring techniques employed by the source owner must be comparable to and compliment ambient sampling and stack testing requirements now in existence. Monitoring conducted by the regulatory agency can also be used for auditing to verify self-monitoring by the source owner. The frequency and type of sampling conducted by the discharger as a requirement for permit conditions is specified with consideration for environmental significance or pollutant, its variability and the feasibility of monitoring. Opposition based on the feasibility of sample collection, analyses, and equipment operation is no longer a major obstacle as instrumentation vendors are responding to this market and industry cannot afford to ignore their liability to monitor toxic discharges. In the past the imposition of real time toxics monitoring has been restricted to very few parameters which are relatively easy to measure by discrete sampling.

One responsibility of the permitting authority is to provide an adequate mechanism to accomplish monitoring goals. Lack of information on acceptable techniques and background levels coupled with extremely complex analysis methods and trace amounts present make it impossible to specify the exact nature of the work to be done. This is why a total systems concept must be used to justify the level of resources required for the development, production and operation of real time monitoring methods for toxics and hazardous wastes.

SYSTEM DESIGN FACTORS

In developing an effective program for providing real time toxic monitoring identification knowledge of the design factors which must be addressed is essential. Methods of sampling, analytical procedures, quality assurance, data acquisition, validation, and reporting are all recognized as basic needs in any type of monitoring program. By looking at each of these and the special considerations imposed by toxics monitoring both individually and collectively, the decisions can be made to determine the best monitoring system. The following information presented describes how a system approach, utilizing realistic resources and technology, can be combined into a comprehensive effort which will accomplish present toxic monitoring goals.

A. Methods of Sampling and Analyses

Because of the complexity of analyses required for most toxic substances, the goal of providing routine field measurement methods which can be handled by technical field staff is a major challenge. The decision of taking either the laboratory to the sample or the sample to the laboratory must be made after a study of all factors involved. These include not only the chemistry of the techniques and instrumentation but also the considerations of resource utilization and environmental urgency. Application of the system concept requires knowledge of the advantages and limitations of all the modes of sampling which could be conducted.

On site measurements generally produce immediate results for a truly representative sample. This approach may be required if the sample presents some form of hazard, decomposes, reacts with the collection system, or may present an environmental emergency. Limitations are dependent on the complexity of operating the analysis equipment under field conditions.

Field toxic monitoring stations containing instrumentation that could be dedicated to a particular toxic or family of toxics of local interest can provide rapid analysis for a relatively extensive area. Chromatographic, chemical, spectrophotometric techniques with capability staff would allow for adequate coverage in major population areas.

Mobile monitoring is the most versatile but also the most resource intensive type of monitoring which can be conducted. Purchasing a state of the art mobile, computerized mass spectrometer system along with huge operation and support costs can only be justified in a few special cases. While few chemicals justify such measures in a scientific sense, public impact or awareness generated by mobile monitors may be of sufficient value to an overall program to justify such a measure.

Laboratory analysis is reserved for compounds which require highly specialized, complex or equipment intensive analyses. This approach is usually time consuming and requires a high degree of cross checking to insure a valid sample collection techniques is usually uncertain or removed from the laboratory protocol. Sample handling protocol must be established. Proper coordination requires oversight at a high involvement level to provide a forum between the sample analysis and collection groups.

The need for specialized source testing team with the knowledge of where and how to obtain a valid sample cannot be understated. The nature of toxics monitoring often requires identification of the sources and extent of the problem before routine monitoring can begin. This group will perform cursory measurements and take samples utilizing available resources and provide the basis for designing an adequate real time toxics monitoring system.

B. Analytical Procedures

Appreciation of the complexity of the analytical processes involved in discerning toxic substances in the environment can be obtained by examining the physiology of the natural procedure - the sense of smell. As an analytical system the olfactory sense utilizes many of the elements required for real-time toxics monitoring. Simultaneous location, separation, detection, and identification all occur in a most qualitative manner. Unfortunately, like any other analysis method, there are limitations which must be understood. These would include interferences, lack of sensitivity and the need for quantitative results and calibration for consistent recognization.

For most classical toxic substances optical detection methods which involve chemical color changes are available. The simplest apparatus used are glass tubes containing chemicals which progressively change in color as the sample is aspirated over the material. Additional refinements include collecting the sample in an absorbing media to improve sensitivity and using electronic detection to more quantitatively describe the color change produced. This process is known as electroptical determination and is the basis for many of the variable monitoring techniques which are now being used.

When circumstances at the monitoring site dictate that the analytical techniques cannot be carried to completion, laboratory analysis is needed. Because the equipment found in the laboratory is not intended to be dedicated to serve only one specific field sampling site, the analysis can be performed in a most uncompromising manner. If complex instrumentation requiring highly skilled operators is needed to determine the sampling results, there is a wide variety of state of the art equipment for high performance identification and detection of toxic substances in environmental samples available for laboratory use. In addition to the colorimeter which detects in the visible region, ultra-violet and infrared spectrophotometric equipment have been used for many years to detect substances which exhibit distinctive spectral responses. Use of specialized excitation techniques such as atomic absorption, atomic emission, and fluorescense extends the range of materials which can be detected via spectrophotometric methods. Further utilization of other parts of the electromagnetic spectrum is also possible. X-ray techniques, ionic detection, and mass spectrometry use various forms of electrical properties and magnetic beams which interact characteristically with the sample molecules.

Practical considerations for selecting and using equipment include the question of multipollutant capability. While the thought of analyzing for every component in a sample appears attractive the questions of sensitivity specificity, response time, cost of analysis, maintenance, reliability, and needed technical expertise will arise. Separation techniques used in gas an liquid chromatography have proved to be most useful in selective determination especially for organics.

The recent advances of using microprocessors to control analytical procedures and equipment have produced a new generation of laboratory equipment described by Emilio Sturino (1982). The concept of automatic programmed operation and calibration with fast access to information from previous analysis allows for unprecedented speed and flexibility in screening and detection from a complex sample. Packages are available with complete data processing providing tabulated, calculated data results with manipulations for any variables which can be detected. Because of this trend it is now possible to set up and use equipment in any area where a high powered analysis is needed with a minimum of laboratory resource support. Installing such equipment in field stations and mobile monitors can substantially reduce analysis time to provide almost immediate results.

A real time instrument is a device which can look at a sample for analysis from the immediate, surrounding environment (in situ) and rapidly report back information concerning the concentrations of parameters of interest. The use of real time analyzers eliminates the problems associated with obtaining a valid sample for laboratory analysis and provides a continuous record of actual concentrations for documentation and control purposes. For establishing an automatic feed back link to provide real time regulation and warnings concerning source strengths, the need for reliable, dedicated instruments has become firmly established.

In the last ten years there has been a rapid commercialization and marketing of instruments for environmental monitoring especially in common air pollutants. R.K. Stevens and W.F. Herget (1974) while working for the United States Environmental Protection Agency carried on an aggressive program from sensor development through field evaluation of prototype instruments. Their policy of requiring vendors to obtain formal government designation of their equipment by testing according to performance specifications resulted in a market for instrumentation which could be expected to provide valid results.

Although this concept has not emerged to cover other toxic substances, vendors have realized that customers are looking at the level of performance their new equipment will provide. The only limiting factor in providing real time equipment is if justification exists for the level of resources required for the development, production, and operation of an instrumental method versus the importance of the information obtained. In cases where environmental quality standards exist the instrumentation is designed to detect a range of levels within certain limits of precision and accuracy. Performance information is usually obtained from calibration data. Because there are many toxics substances that still will require additional background sampling and risk assessment in order to determine acceptable levels, the commercial availability of parameter specific, real time instrumentation will be delayed until standards are defined which in turn dictate monitoring performance. It will be mutually beneficial for both the regulatory agency and regulated sector to provide equipment vendors with information needed to stimulate this market. In many cases dedicated adaptations of multipurpose laboratory equipment are likely to be used for the present time. Again advances in portability and computerization are making it possible to dedicate techniques once found only in the laboratory for field monitoring purposes. Flexibility and adaptability to allow expansion to cover newly discovered important toxic substances should also be recognized.

In situations where real time sampling of a toxic substance is not feasible, the use of surrogate parameters and effects monitoring are important to consider. The surrogate approach concerns collecting information that can be correlated to define a consistent relationship with the substance of interest. An example would be the monitoring of stack temperature and carbon monoxide during incineration to determine the potential for formation of known toxic emissions. The monitoring for airborne particulates has been used as a major surrogate parameter for defining migration for toxics site cleanup activities on a real time basis. It is important with the type of monitoring to determine if the results are satisfactory to define the real issue.

Effects monitoring usually involves exposure of materials to integrated dosages with the results being indicated by noting changes between before and after readings. Personal dosimeters are used extensively in cases where industrial exposure records must be maintained. Effects monitoring on living organisms is coupled with analysis of specific parts which tend to accumulate certain toxic materials. Microscopic identification is extremely useful in determining the presence of toxic particulate material such as asbestos.

Selection of the proper analytical techniques and instrumentation should remain flexible enough to allow for pragmatic changes as technological developments occur. Specification of standard or reference methods usually stifles plans to explore alternative methods. Again by using a systems design approach it will still be possible to consider the feasibility of using any technique to obtain the desired results.

C. Quality Assurance

The principles of quality assurance are used to determine the degree of uncertainty when making a measurement. The function of quality control (QC) is to produce data within acceptable limits. A quality assurance (QA) plan is a series of actions designed to measure the effectiveness of quality control procedures and to mathematically report data quality assurance. No matter how well an analyzer has been calibrated if there is a high degree of uncertainty if a valid sample was collected, the data obtained will always be questionable. The purpose of quality assurance is to define all sources of error and provide improvement.

The best way to insure that sources of error are properly documented is to start out with a quality assurance system plan. Actually, by looking at the basic areas and elements to consider when preparing the plan, one can further refine the completed monitoring system before actual sampling takes place. In addition, the imposition of calibration audits will be required to further define data quality performance once the routine sampling begins. The elements which must be considered are described in detail by USEPA-600/9-76-005(1976) using the concept of the "Quality Assurance Wheel". The wheel arrangements identifies the entire quality assurance system and can be used to determine those quality control factors that are applicable to the toxics monitoring program. Elements include those items which are specified when performing a systems audit. The major ones are organization and planning, sample collection and analysis, calibration and maintenance, data reporting and validation, and preparation of quality assurance reports and recommendations.

At an organizational level coordination of quality assurance should be a separate staff function from line supervision and operation. Together the supervisor and quality assurance coordinator must use all elements to form a complete and integrated system which can achieve desired program objectives. From a management perspective the quality assurance report cannot only identify the effectiveness of resource utilization but also provide ongoing insight on shifting priorities to maintain cost effectiveness.

The need to dedicate sufficient resources to establish and maintain capability for accurate calibration standards is often initially overlooked as an essential system element. Often the costs of providing a worthy calibration program may meet or exceed those required for the actual analyses system.

Traceability of calibration from repositories for calibration standards to the final measurement site includes dedicated record keeping and cross checking at every level. Such protocols requiring trained staff and precise equipment may not prove feasible to implement in-house, but, unfortunately, contracts for adequately providing this type of service are difficult to obtain and administer. The only answer is to considered all of the alternatives when designing the system and decide what way will produce the most acceptable results.

D. Data Acquisition, Validation and Reporting

For any monitoring system the methods used to collect, validate, and report data are important factors to consider in obtaining adequate measurements. Today's technology allows computerization techniques which continue to change the role of the operator in generating the final report. Systems with automatic and unattended operational modes are now possible by utilization of telecommunications system which allow for detection of operational problems with real time access through remote data and status checks. Decisions on providing the right system depend on several design factors.

In cases where a large volume of data will be generated modern computer systems can be effectively used to reduce the volume of recorded data by performing calculations and reporting compressed information such as averages or means over selected time intervals and exceedances over certain values. The sampling rate and period which can be determined from the nature of the monitoring required are important to consider when designing a data acquisition system. Another important factor is the practicability or necessity of having an operator in attendance at the site and the degree of automation utilized in the analytical protocol.

The current trend among vendors is to provide analytical equipment containing dedicated microprocessors to substantially reduce routine manual operational and data processing work requirements. While this may prove most convenient for individual site measurements, for larger networks, questions concerning complexity, redundancy, and interface with other existing data retrieval and processing procedures must be answered. Experience indicates that strictly on-site data recording in an unattended mode often result in significantly more data loss due to unknown malfunctions. The need to automatically telemeter information to a central location and have additional remote access via terminals in an important consideration.

In the case of mobile monitors where an operator is in attendance at all times there is an additional requirement to identify sample location as well as date and time. For laboratory analysis access to a computer system provides excellent documentation when all sample data and information can be easily entered for statistical analysis, historical record, report generation, tabular and graphics summary output.

In all cases the data report should satisfy the needs of the end user. A quality assurance report should always be part of the final report to qualify the data and describe the protocol for data validation. Without proper documentation data should not be used legally to define and compare levels of toxics materials obtained by field sampling. Also included is the need to report actual background levels including limits of sensitivity, detectability, and interferences.

IMPLEMENTATION OF SYSTEM

In order to produce a working toxics monitoring program from the system design factors the protocol for implementation requires certain elements. Included are identification and risk analysis, a program plan, resource management, and assessment of results. Identification and risk analysis techniques are used to determine priorities and which toxics are to be monitored. A program plan outlines the steps needed from starting out to completion of monitoring goals. Resource management requires coordination of the work to be performed within program constraints. The final strategy is to evaluate and modify the system so the benefits of the information which is obtained meets actual needs.

The 1980 Register of Toxic Effects contains more than 150,000 entries for substances that are known to have some toxicity. Because there is no universal measurement method for this range of compounds, extensive measurements are the least desirable means of identification because of the time and expense involved. Use of records, process data,placards, shipping documents and other emission inventory techniques is preferable to categorize the types of monitoring which could be performed. In risk analysis, occupational standards and available toxicological data can be initially evaluated to define short and long term exposure levels safe for the general public. Appropriate measurement and analytical techniques can be identified once acceptable levels or standards are proposed to provide the design specifications which will be needed.

The challenge of providing analytical capability and monitoring instrumentation for a toxics monitoring system requires a comprehensive program plan to insure success. The following elements are also needed in the quality assurance plan and should be considered; with the goal being to establish routine procedures to be carried out by all involved staff:

1. Plan monitoring program by determining requirements, analyzing costs, justifying budget and scheduling implementation.

2. Acquire equipment by market surveillance, equipment evaluation, preparation of performance specifications and conducting acceptance testing.

3. Develop expertise by receiving factory training, preparation of operational guidelines and quality assurance manuals and cross instruction of staff.

4. Establish routine monitoring by developing and implementing set procedures and comparing with prior methods.

5. Maintain reliable operation with test and repair facilities, establishing a preventative maintenance program and revise procedures based on performance improvements.

6. Certify methods performance as per requirements via a quality assurance program with auditing procedures, provide documentation and determine if cost effective.

Using the systems approach requires assembly and integration of the resources which are available in order to collectively accomplish the goals. Preparation of a work plan is a key step in order to identify and schedule the specific tasks and duties involved. When making assignments it is important to keep in mind the advantages of utilizing existing resources over proposing and developing new ones. There is a real need to establish an enviro-chemical oversight group in situations where there will be a considerable interaction between various program groups. In this manner there is a forum for receiving individual program proposals and for channeling resources to avoid both duplication of effort and missing elements.

Management strategy should maintain the flexibility to make adjustments to the monitoring system with respect to problems which may arise. The cost of implementing a change should be related to the benefits obtained. Knowledge of how the entire system functions points out the specific areas which must be modified to produce the needed results.

In the field of environmental toxicology the success of implementing monitoring systems which are designed to provide feedback needed to effectively manage the situations which will be encountered in the next decade requires a vast understanding. The odds are overwhelming that we as environmentalists will obtain the resources to do enough. Recognition of the extent that mankind could use his wisdom to preserve rather than destroy what God has created could be the answer. There is the hope that the brilliant minds which have the ability to devise complex military and industrial systems could also be used to provide defense against the assault of toxic substances into our lives.

ACKNOWLEDGEMENTS

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Transport of Toxic Chemicals

in the Atmosphere

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ABSTRACT

The use of chemicals in every facet of our society has expanded greatly over the years. However, their dangers to various forms of life have not been fully realized. Their use has been promoted by society to improve the quality of life, but it has only been in recent years that attention has been drawn to their negative environmental impacts. Even though these chemicals are transported through and transformed in the atmospheric, aquatic and terrestrial environments, this paper will concentrate on those chemicals which are found in the atmosphere. Examples will be given of some of these toxic chemicals and their behaviour in ambient air. These atmospheric processes will be brought into focus by considering the short-range dispersion of a forest-spray pesticide such as fenitrothion and the long-range transportation of toxaphene.

TRANSPORT OF TOXIC CHEMICALS IN THE ATMOSPHERE

1. INTRODUCTION

The use of chemicals in every facet of our society has expanded considerably over the years with little realization of the dangers to animal, plant and human life. Despite an increased environmental consciousness dating from Rachel Carson's 1962 book "Silent Spring" and extending through the recent furor over Love Canal (Niagara Falls, N.Y.) and Times Beach, MO, substantial uncertainty remains regarding the behaviour of hazardous substances released into the environment. Indeed, a recent U.S. study on the potential health hazards of chemicals found that inadequate toxicity data are available for most chemical groups to assess this potential. As an example, it was estimated that approximately 60% of the pesticides in present day use were in this category. Similar uncertainty exists regarding the transport and transformations of these substances in the atmosphere.

Toxic chemicals can be divided into five general classes. Heavy metals (such as lead and mercury) and other inorganics (such as asbestos) are emitted from a variety of stationary and mobile sources such as mining, smelting and refining operations, and automobiles. Radionuclides are mobilized by mining and processing of radioactive ores. Polycyclic aromatic hydrocarbons (PAHs) are ubiquitous pollutants produced by the incomplete combustion of carbonaceous fuels. Organochlorine compounds include, for example, the polychlorinated biphenyls (PCBs) used in electrical transformers and capacitors and the polychlorinated dibenzo-p-dioxins (PCDDs) which occur as contaminants in certain pesticide formulations. Dioxins are also found in the emissions from municipal incinerators. The final class is the pesticides, some of which are also organochlorine compounds.

All of these toxic chemicals have an atmospheric pathway and are subject to the action of a variety of meteorological processes. This paper will focus on the important atmospheric linkages between sources and receptors which may involve transport over hundreds and even thousands of kilometers. This means that, very much as with the acid rain issue, effects of toxic chemical emissions can become inter-jurisdictional, thus posing difficult societal problems. The discussion of atmospheric transport processes will be illustrated by reference to two important pesticides, fenitrothion and toxaphene. Pesticides are particularly suitable for illustrating the importance of aerial transport as they are the only man-made toxic chemicals deliberately introduced into the atmosphere.

2. PESTICIDES

Pesticides exhibit to a greater or lesser extent all the characteristics usually associated with toxic substances, namely, environmental persistence, ability to bio-accumulate, mobility in the environment and use in large quantities. The environmental risks posed by their toxicity and these characteristics have to be weighed against the benefits in food production, disease control, health protection, and forestry and fisheries management. The attractiveness of these benefits has often led to their use without regard toward environmental impacts. Thirty years elapsed before the recognition of the harmful effects of DDT led to its prohibition in North America.

The presence of pesticides in the atmosphere is primarily a result of either aerial or ground-based spray applications in agriculture, horticulture or forestry. Secondary sources include resuspension and evaporation after the primary application as well as fugitive emissions during manufacture, transportation and disposal.

3. ATMOSPHERIC CYCLE

A simplified model of the major atmospheric processes and pathways for toxic chemicals is shown in Figure 1. The total air concentration is a key parameter. It reflects the interaction of atmospheric processes with emissions and also provides the input for the deposition processes to the receptors. Emissions are subject to initial mixing, transport and transformation processes that establish the total air concentration. Wet and dry deposition processes deplete

ATMOSPHERIC CYCLE

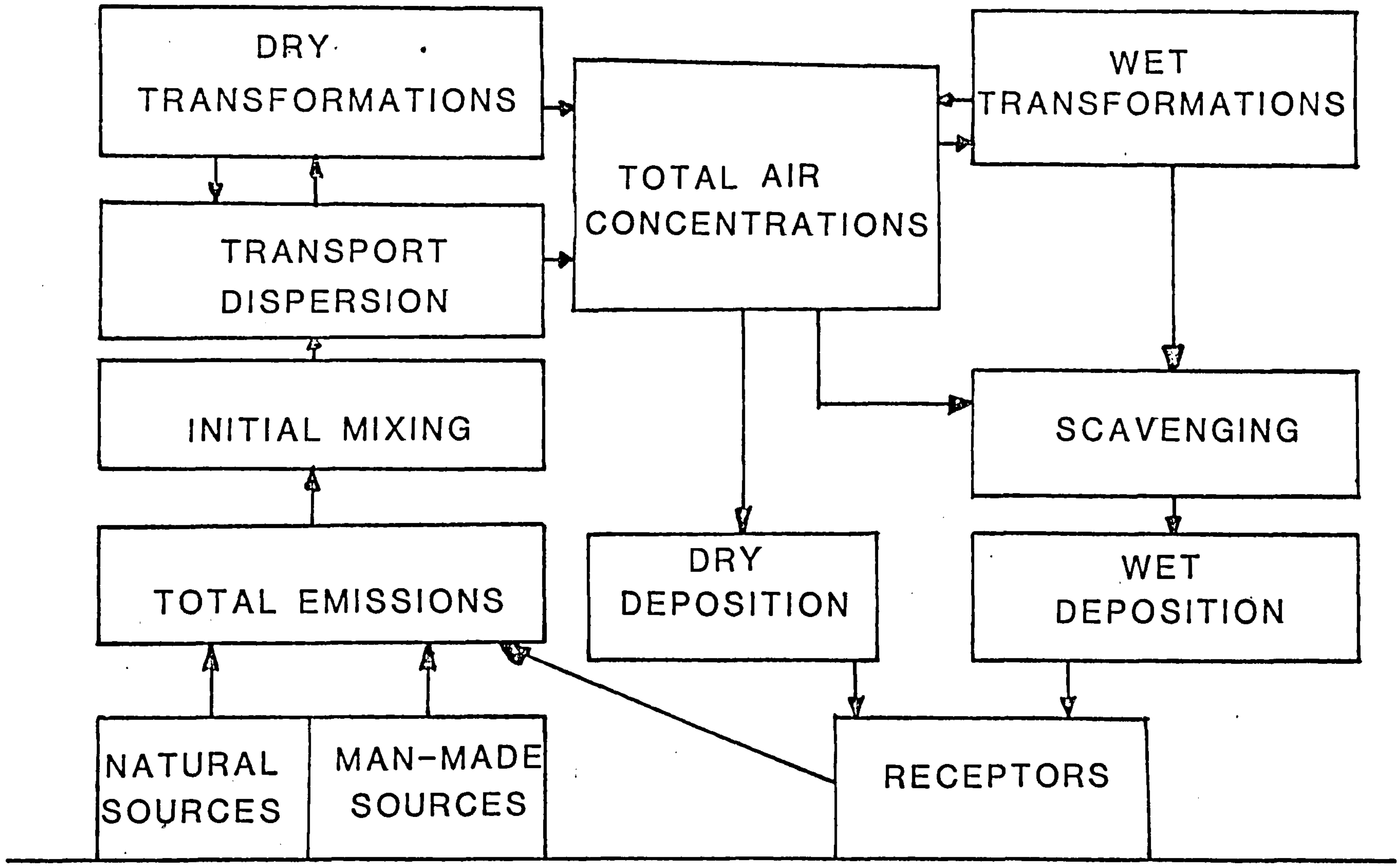

FIGURE 1

this air concentration by the transfer of the toxic substance to the earth's surface.

Although the sources of toxic substances are most often thought of as man-made, there are significant natural sources. Radon gas is a product of radioactive decay of radium and uranium ores. The burning of a forest fire produces PAHs. Whether the emissions are natural or man-made, their initial movement and dilution in the atmosphere will depend on the configuration of the source. An important factor in atmospheric transport is the effective height of the source. Generally, the greater the effective height, the greater is the residence time of a substance in the atmosphere. There are two reasons for this. The emission height influences whether deposition is more likely to occur due to wet deposition processes or to dry deposition processes. Also, at greater emission heights the toxic substances are subjected to greater wind speeds and, therefore, longer transport.

Transport and dispersion are the two key atmospheric processes that are due solely to the effects of wind and turbulence. The literature cites studies showing the importance of these mechanisms. Atlas and Giam (1981) found DDT over an isolated atoll in the North Pacific Ocean far from any source. Risebrough et al. (1968) found DDT in several species of Arctic and Antarctic birds. Related observations for other pollutants are also illustrative of the role of atmospheric transport. Smoke from Alberta forest fires has been seen in Europe and spores from African plants have been transported by the wind to the Caribbean.

Despite their reputation for chemical inertness and persistence, upon release into the environment some pesticides do undergo chemical or photochemical transformations. In general, they may degrade in the atmosphere via chemical or photochemical oxidation, hydrolysis or interaction with other reactive air pollutants. The actual degradation pathway is very much dependent on the chemical composition and molecular structure of the particular pesticide as well as the prevailing environmental conditions. Thus, aldrin, dieldrin, DDT and mirex, for example, are all known to be transformed through the action of sunlight. It has been shown that aldrin is converted to dieldrin which in turn is transformed into photodieldrin. This "offspring" is reported to be more toxic than either of its parents and is quite resistant to further degradation. As a rule, organophosphate pesticides tend to be more reactive and hence less persistent than their chlorinated organic counterparts, with the result that the former are generally not detected at remote locations.

The final link in the atmospheric chain is the deposition of the pesticides to the receptors, such as the lakes, forests and plants. Deposition can be achieved by two processes. The wet deposition process occurs during precipitation, events only. Toxic particles can act as nucleii for precipitation, while all airborne toxics can be washed out from the atmosphere by the action of precipitation. The dry deposition process is the attachment of the toxic chemical to the surface. This can result from simple settling of particulates under gravity, impaction as particulates are driven by the wind against surface elements, or attraction of chemicals to the surface by forces such as electrostatic forces.

The examples given here indicate the various processes that are relevant to particular pesticides. In the aerial pesticide spraying of forests, the emissions are known but the total resultant air concentration is dependent on the initial mixing with the air, the dispersion of the spray due to the effects of the aircraft flight and the meteorological conditions. The pesticide spray reaches the receptors, i.e. the forest canopy, through the dry deposition process as spraying is normally undertaken in periods of dry weather and the wet deposition process does not apply. For agricultural spraying the processes of interest relate not only to the primary application, but also the secondary emissions from the soil in subsequent cultivation, the transport through the atmosphere and the ultimate wet or dry deposition.

The relative importance of the individual atmospheric processes varies for each chemical or for each chemical use. Indeed, part of the intelligent use of a pesticide is to ensure that it is only applied under conditions that will lead to the desired impact while minimizing the undesirable non-target impacts. In the following sections selected examples of pesticide usage are given to show the specific implications of atmospheric processes for two different pesticides.

4. FOREST PESTICIDES - FENITROTHION

Even though the quantity of pesticide used in agriculture is 100 times the quantity used in forest aerial spraying, the latter has attracted more public attention. Over 95% of the forest pesticide used in Canada is to control the spruce budworm and is applied over approximately 3 million hectares each year. Over half the pesticide application occurs in New Brunswick, with the other major application area being the province of Québec. The major pesticide for the control of the spruce budworm is fenitrothion, an organophosphate insecticide.

The application of pesticides is governed by provincial regulations that are designed to minimize the pesticide drift to non-target areas to acceptable levels, while maintaining effective forest protection. The parameters that are taken into account in the regulation of aerial spraying are the setbacks (the distance between spraying and the nearest susceptible area) and the wind speed. Based on preliminary results for studies in New Brunswick (Mickle et al., 1984), the Atmospheric Environment Service is actively studying an improved definition of the optimum and desirable conditions for aerial spraying.

Forest pesticides are sprayed in either oil or water solutions from aircraft. This method of application produces a range of droplet sizes between 0 and 300 µm in diameter, but evaporation processes in the spray rapidly alter the droplet size distribution range. For a typical spray situation the mass distributions of the spray droplets at release and after evaporation are shown in Figure 2 (Reid, 1979). Typically these droplets are caught up in the trailing vortices of the spray aircraft and so their initial motion is governed by these vortices. Between the aircraft height and the forest floor, these vortices dissipate and release the droplets. Droplet trajectories are now governed by the wind speed, turbulence and the droplet fall speeds under gravity. The majority of the droplets deposit on the trees or the forest floor, but some droplets remain in the atmosphere and are transported beyond the target area by the wind.

For a typical spray scenario, the Atmospheric Environment Service has formulated a Monte Carlo model (Reid and Crabbe, 1980) which predicts the deposition spectrum for specific droplet sizes shown in Table 1. The deposition is for the area within 500 m of the spray line. It is important to have information on droplet sizes, larger droplets being important for dermal impact, smaller droplets being respirable.

Table 1: The deposition within 500 m of the spray line for specific droplet sizes

Droplet Diameter (μm)	0	16	25	35	50	64	94
% Deposited	44	49	54	62	78	89	99

Taking into account the relative frequency of the droplets in the evaporated spray distribution of Figure 2, this deposition spectrum indicates that about 80% of the pesticide is deposited within 500 m of the spray line. The model also predicts the percentage of drops that remain in the atmosphere out to 100 km from the spray line. The predictions for each droplet size are shown in Figure 3 (Reid, 1979). When these calculations are weighted for the fraction of drops in each size range, the results in Table 2 are obtained.

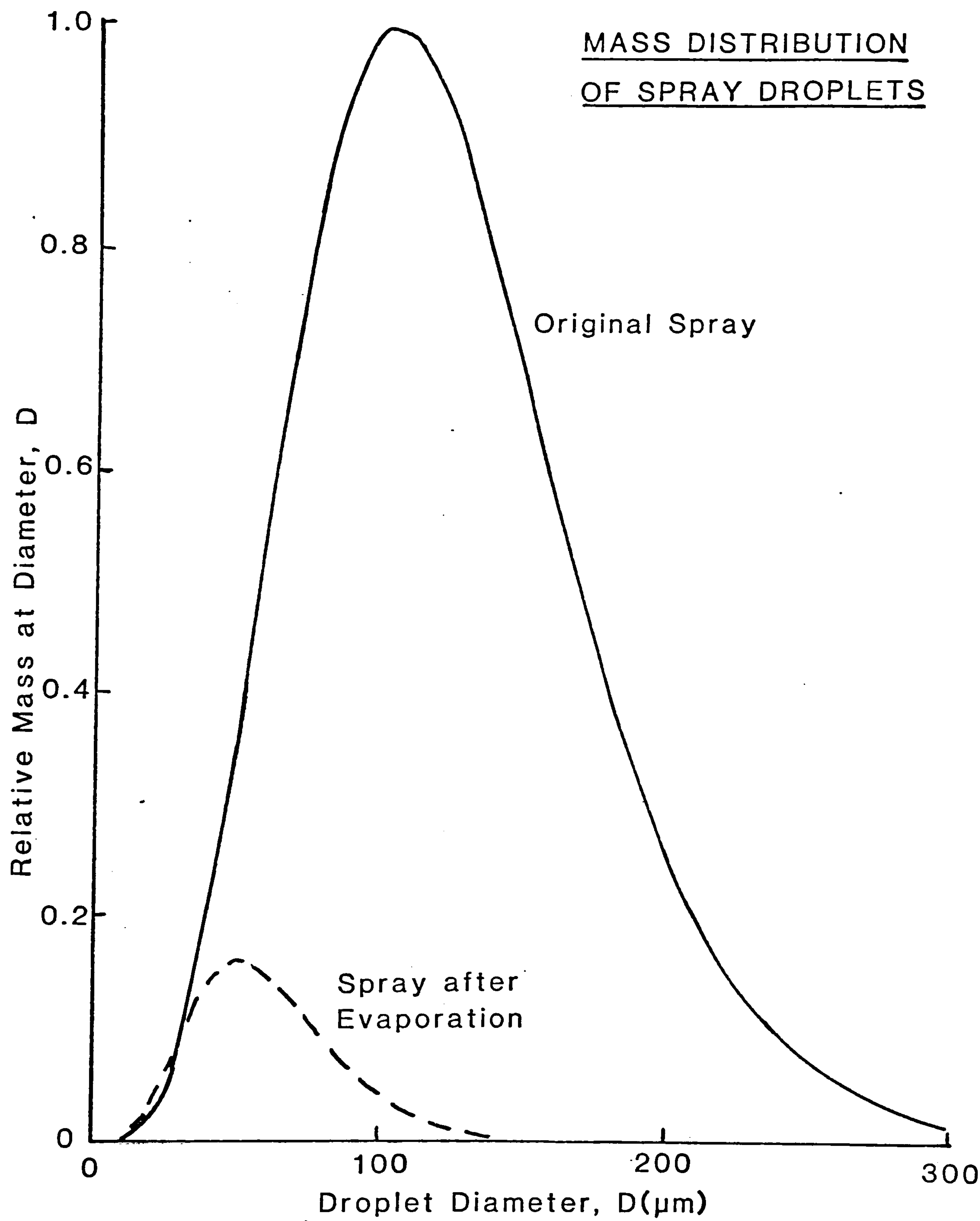
MASS DISTRIBUTION
OF SPRAY DROPLETS
Original Spray
Spray after
Evaporation
Relative Mass at Diameter, D
1.0
0.8
0.6
0.4
0.2
0
0
100
200
300
Droplet Diameter, D(μm)

FIGURE 2

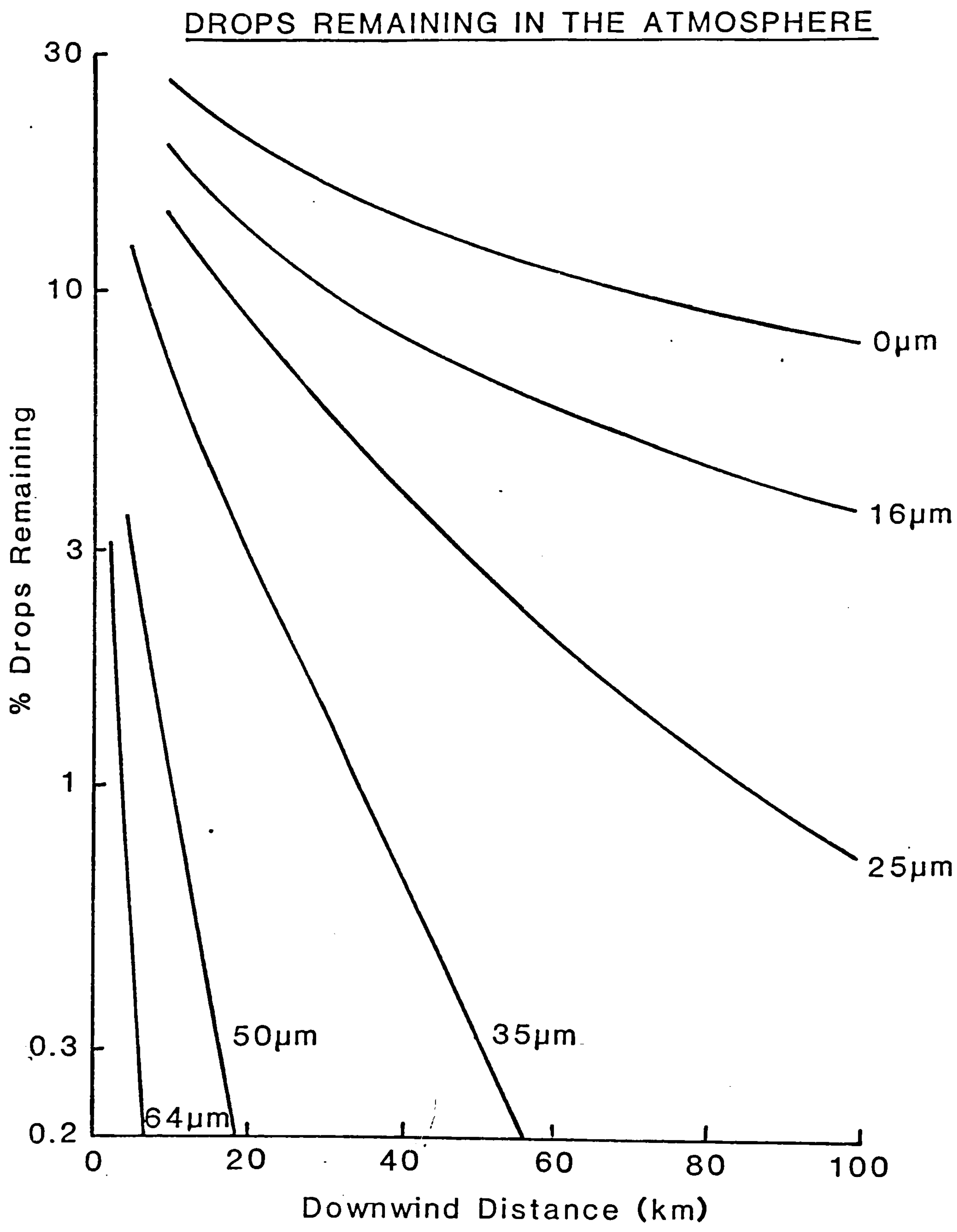
DROPS REMAINING IN THE ATMOSPHERE
30
10
3
1
0.3
0.2
% Drops Remaining
0μm
16μm
25μm
35μm
50μm
64μm
0
20
40
60
80
100
Downwind Distance (km)

FIGURE 3

Table 2: Airborne Mass Budget for New Brunswick Spray Scenario.

Diameter Range (μm)	Original Mass (kg)	After Evaporation Mass (kg)	Mass at 80 km (kg)
< 25	10.53	40.79	1.04
25 - 50	242.2	354.5	0.34
> 50	6765.0	737.5	-
All	7017.7	1132.8	1.38

Of the 1133 kg of pesticide that was sprayed, only about 1.4 kg (0.1%) remains in the atmosphere at 80 km from the spray line. At this distance the spray is also well distributed within the atmosphere and so the concentrations at 80 km are extremely low. Also seen in this table is the effect of evaporation and the shift in the distribution indicated in Figure 2.

In comparing these predictions with the five case studies undertaken in New Brunswick in 1983 (Mickle et al., 1984), there was an agreement between the average of the case studies and the prediction to within 5%. Similar calculations are now underway for a variety of meteorological and spray configuration conditions. When combined with information on environmental or human health impacts at different insult levels of pesticide, a natural scientific basis for regulatory decisions will be in place.

5. AGRICULTURAL PESTICIDES - TOXAPHENE

Toxaphene was first introduced as a pesticide in 1947 and was primarily applied to cotton and soybean crops in the southern part of the United States. With the banning of DDT in 1969, the use of toxaphene increased both in quantity and in area covered. Thus, in the mid-1970's the U.S. production rate was approximately 22,000 tonnes/year (Goldberg, 1983) and its use had been extended to crops such as alfalfa, corn, peanuts and wheat. Because toxaphene is highly persistent, bio-accumulative and toxic to fish, concern has been expressed in recent years that a potentially serious situation may be developing in the Great Lakes ecosystem as evidenced by the elevated toxaphene concentrations found in fish.

Residues of toxaphene have also been found in fish collected from a land-locked lake on Isle Royale in Lake Superior, clearly indicating aerial transport to this isolated location where toxaphene has never been used (Swain, 1978). In addition, toxaphene residues have been detected in the air over Bermuda and over the North Atlantic (Bidleman & Olney, 1975) at locations far removed from areas of its application. On the basis of an assessment of environmental contamination by toxaphene, Reinert et al. (1982) concluded that atmospheric transport is the predominant mechanism for its widespread dispersal throughout the environment.

Deposition of airborne pesticides to water surfaces occurs by wet and dry deposition processes. Wet deposition involves the scavenging and removal of pesticides from the air due to condensation and precipitation phenomena. For dry deposition, gases and aerosols are brought into contact with the receptor water surface by turbulent dispersion, molecular diffusion and gravitational settling. For many pesticides the relative importance of these two modes of removal remains undefined, but available data indicate that dry deposition to water surfaces such as the Great Lakes may exceed that by wet deposition. The following data will indicate this relationship with respect to toxaphene and other pesticidal chemicals.

Air and precipitation concentrations for some common pesticides found in the Great Lakes Basin are shown in Table 3. This table indicates that the mean air concentration for toxaphene measurements in the Great Lakes Basin exceeds that for dieldrin by a factor of 10 and is similar to that for aldrin. Of the 6 common pesticides in this table, only lindane exhibits a mean ambient air concentration higher than that for toxaphene. With respect to its concentration in precipitation, toxaphene shares the spotlight with DDT and lindane for highest mean value.

Table 3 Pesticide Concentrations in Air and Precipitation in the Great Lakes Basin (Eisenreich et al., 1980 & 1981)

Compound	Air (ng/m^3)		Precipitation (ng/L)	
	Range	Mean	Range	Mean
Aldrin	0.1 -1	0.5	0.5-3	2
Chlordane	0.01-0.5	0.1	1 -5	2
DDT(Total)	0.01-0.05	0.03	1 -10	5
Dieldrin	0.01-0.1	0.05	0.5-30	2
Lindane	1 -4	2	1 -15	5
Toxaphene	0.02-2	0.5	1 -10	5

These values can be used to estimate the wet and dry deposition fluxes by using the following relationships. The wet flux is the product of the pesticide concentration in precipitation, the mean annual precipitation and the receptor surface area. Here the mean annual precipitation is assumed to be 80 cm. The dry flux is the product of the pesticide ambient air concentration, the dry deposition velocity and the receptor surface area. The mean dry deposition velocity is assumed to be 0.3 cm/sec. The results of these calculations and the ratios of these fluxes are shown in Table 4. Inspection of Table 4 indicates that, for toxaphene, the contribution of dry deposition to the total flux of this pesticide to the Great Lakes Basin as a whole greatly exceeds the wet deposition flux i.e. the amount deposited with rain and snow.

Table 4 Fluxes of Airborne Pesticides to the Great Lakes (Eisenreich et al., 1980 & 1981)

Compound	Dry Flux	Wet Flux	Ratio Dry/Wet Flux
	($\mu g. m^{-2} y^{-1}$)		
Aldrin	48	2	24
Chlordane	9.5	2	4.8
DDT (Total)	3	4	0.75
Dieldrin	5	2	2.5
Lindane	190	4	48
Toxaphene	48	4	12

By combining the wet and dry deposition, an estimate of the total deposition to each lake can be calculated. The results are tabulated in Table 5. The amount of toxaphene (or any of the other pesticides included in Table 5) deposited to each of the 5 lakes is a direct function of the surface area of the individual lakes. For all of the Great Lakes combined, the total amount of toxaphene deposited via the atmosphere in a single year amounts to nearly 13 tonnes.

Table 5 Total Atmospheric Deposition to the Great Lakes (Eisenreich et al., 1980)

	Lake					Great
Compound	Superior	Michigan	Huron	Erie	Ontario	Lakes
		(tonnes/yr)				
Aldrin *	4.1	2.9	3.0	1.3	0.95	12.3
Chlordane *	0.94	0.66	0.69	0.30	0.22	2.8
DDT (Total)	0.58	0.40	0.43	0.19	0.14	1.7
Dieldrin	0.54	0.38	0.55	0.17	0.13	1.8
Lindane	15.9	11.2	11.6	5.0	3.7	47.4
Toxaphene *	4.3	3.0	3.1	1.3	0.99	12.7

* Estimates by authors

The Great Lakes Water Quality Board concluded in its 1982 report to the International Joint Commission that aerial long-range transport was clearly indicated as a pathway for toxaphene input into the Great Lakes. The Board noted that the use in Ontario is minimal and strictly controlled. Responding to their concern with toxaphene atmospheric transport, especially into the Great Lakes Basin, the United States Environmental Protection Agency withdrew the majority of the registered uses in 1982.

6. CONCLUSION

The preceding discussion showed that the atmosphere can have a major effect on a toxic substance in its path from source to receptor. To illustrate this point, pesticides (an important class of toxic substances) were chosen. A simplified conceptual model was used to indicate the various atmospheric processes that are active when a pollutant is emitted into the atmosphere. Specific examples of these processes were brought into focus by describing the different applications of two pesticides. In each case different atmospheric processes contributed to the dominant effects observed in the atmospheric pathway. In both cases atmospheric transport played a major role.

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Monitoring of Dioxin and Furan Emissions in Ontario

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In this paper a program on dioxin and furan emissions from two municipal refuse incinerators and one municipal sewage sludge incinerator in Ontario is discussed. All important events in the program are described in a chronological order with the main conclusions and results given in a summary form. The program established that dioxins and furans are generated and emitted from municipal incinerators and that these emissions vary, depending on the incinerator. Acceptability of air emissions of these compounds was found to depend on the incinerator and on the operational variables in the same incinerator. Ontario provisional guidelines on ambient air concentrations and point of impingement concentrations of dioxins and furans are also discussed as well as some candidate abatement alternatives for the removal of these compounds from stack emissions.

A concern among the environmental agencies in North America over dioxin emissions from combustion started in late seventies and early eighties. Experimental programs to measure dioxin emissions from combustion sources were initiated by at least three government agencies in the early eighties; U.S.-Environmental Protection Agency (EPA), Environment Canada, and the Ontario Ministries of the Environment and Energy. While the programs by the U.S.-EPA and Environment Canada were more exploratory in that a wide variety of sources were at least initially considered, the Ontario program was more limited in that it included only the combustion of municipal refuse, of municipal sewage sludge and of industrial waste liquids containing chlorinated organics. No other combustion sources such as power plants or hospital incinerators were planned for investigation because the available information at the time did not seem to warrant the effort. Also, the Ontario program was oriented mainly to problems in waste disposal and the energy from waste recovery programs in the province. Its main objective was to assess the air emissions of chlorinated dioxins and furans from the combustion of municipal refuse and to project the impact which these emissions may have on the province's plans for energy from waste programs. Another important objective of the program was to find out as much as possible about the conditions which give rise to dioxin and furan emissions from the combustion of waste and about the physical characteristics of these emissions, especially with regard to pollution abatement alternatives for their control.

The only two municipal refuse incinerators existing in the Province today were included in the study. One is in Toronto, where mass refuse as received is fired in conventional air cooled refractory furnaces; the other, a solid waste reduction unit (SWARU) in Hamilton, where refuse is first shredded and then separated from the ferrous metals prior to burning in the firing chambers of two Babcock and Willcox steam boilers. Both of these incinerators were built in the sixties. In terms of air emissions, the Toronto plant was found satisfactory on several occasions in the recent past. However, problems of intermittent nature were experienced with stack emissions from SWARU where incidences high stack plume opacities, of fallout of large particulates and of high total hydrocarbon emissions were recorded. The municipal sewage sludge incinerator in Toronto included in the study has been recently reconstructed, with no apparent air emission problems recorded at this plant after the reconstruction. A thermal oxidizer at the Dow Chemical Plant in Sarnia was the industrial chlorinated liquid incinerator planned for testing. Originally, the program was called Trace Organic Contaminants, which besides dioxins and furans included polychlorinated byphenyls (PCBs), chlorobenzenes and chlorophenols. PCBs, chlorobenzenes and chlorophenols were of interest because of their potential to synthetize or combine into dioxins and furans under pyrolytic conditions which could exist locally in the furnaces.

The compositions of refuses, sewage sludge and their trace chlorinated organic content were determined in every test in the program. Combustion conditions were monitored in as much detail as possible at each plant. Samples of all ash streams including the furnace bottom ashes and the electrostatic precipitator ashes were taken simultaneously with the stack emission samples to determine the relative contribution of various process streams to the total dioxin and furan discharges from the plants. Because the main objective of the program was to assess the environmental impact of dioxin and furan emissions from the combustion of refuse, an essential part of the program was to obtain a guideline for these compounds in both stack emissions and ambient air. Medical staff at the Ontario Ministry of Labour were approached for this purpose and asked to specify a guideline based on the health effects of these compounds.

The measurement technology for these compounds available at the time the program started was unproven, especially for stack emissions. The laboratory procedures and equipment available to the Ministry of the Environment Laboratory Services Branch at the beginning of the programs could not be termed as the best in analytical technology but this situation was improved as the program progressed. The problem was even more complicated due to complex chemical analysis and to lack of standards for all individual dioxin and furan compounds. In order to alleviate these problems and to secure confirmatory analyses of critical air emission samples, Dr. C. Rappe of the Swedish University of Umea was contracted as an expert consultant and analyst for part of the emission samples. Chemical analyses on all samples were performed by the Ministry of the Environment. All field sampling and laboratory extractions of samples were carried out by Ontario Research Foundation.

The sampling trains for stack emissions specified for this study were similar to the ones used in the measurement of PCB emissions from combustion sources (Figure 1). These PCB trains were modified in that additional florisil traps were added as back-up components to indicate the level of capture efficiencies of the sampling trains for chlorinated organics in each sampling test.

Approximately eight months after the first set of samples were taken and a preliminary research on laboratory extractions was completed, most of the samples collected at the Toronto incinerator were lost through an accident at the laboratories. Sampling at this incinerator was repeated in 1982.

The first set of emission results from municipal refuse and sewage sludge incinerators became available in the second half of 1982 and the beginning of 1983. By the end of 1982 a background document on ambient air guideline for dioxins and furans was completed in December of 1982(1). On the basis of this document, the Ontario provisional guideline criterion for ambient air concentrations and the provisional guideline on point of impingement concentrations of dioxins and furans were specified(2).

The provisional air guideline criterion is based on the toxicity of dioxins and furans in animals. Dioxins have been shown capable of bringing about the development of neoplasms in the liver, of interfering with reproduction and of disturbing the immune system in animals. By considering that dioxin has its effects according to classical toxicological principles, an ambient air guideline of 30 pg/m^3 for annual average was proposed for total dioxins using an uncertainty factor applied to the lowest no observed effect level. The corresponding point of impingement guideline applicable to stack emissions is 450 pg/m^3 (Figure 2). Because of the toxicological similarities between dioxins and furans, the proportions of both dioxins and furans were taken into consideration, and a special formula was proposed for this purpose. In the formula furans were assumed to be 50 times less toxic than dioxins. There is another formula where differences in the toxicity of various dioxins were taken into account; it was assumed that all dioxin and furan compounds which do not have at least three chlorines in the positions 2,3,7 and 8 and at least one hydrogen are 100 times less toxic. The main difficulty with this formula is its impracticability due to lack of chemical standards required for the quantification of individual dioxin and furan congeners. However, as the analytical techniques become more tuned for the determination of individual isomers and the chemical standards for individual dioxin and furan congeners become available, this formula can be expected to become more important and used in the assessment of dioxins and furans in the air.

One important feature of the provisional guideline for dioxin and furans is that it applies to average annual values. The guideline can be exceeded in short periods which are not expected to have a significant toxic effect, as long as the annual average limit is satisfied. This feature may be significant in the assessment of intermittent processes such as can be the case with municipal incinerators. Even if the emissions from these plants exceed the point of impingement provisional guideline in short periods, these emissions could still be acceptable as long as their annual average does not exceed the guideline. The provisional guideline for dioxins and furans is now undergoing an extensive review and detailed scientific criteria documents for dioxin and furan standards are being prepared by the Ministry of the Environment's Hazardous Contaminants and Standards Branch.

Insofar as the results of the trace organic contaminants survey are concerned, perhaps the most surprising was the discovery that the municipal refuses at both Toronto and Hamilton plants contained dioxins (Table 1). Moreover, the output of total dioxins and furans (the total included all species with four and more chlorines) varied proportionately with the input of dioxins into the incinerators in the three tests carried out at each plant. However, the homologue series distribution in the refuse and the discharge streams, were quite different (Figure 3). In comparison to heptachlorinated and octachlorinated dioxins in refuses, the discharge streams contained all dioxin and furan homologue series with four and more chlorines.

The refuses also contained significant quantities of PCBs, chlorobenzenes and chlorophenols, however, no correspondence between the input of these species and the ouput of total dioxins and furans was obtained. This lack of correspondence was possibly the result of incomplete chemical analyses which did not include dioxins and furans with less than four chlorines or PCBs, chlorobenzenes and chlorophenols with less than three chlorines in either the input or output samples.

Dioxin and furan emissions from the municipal refuse and sewage sludge incinerators in Toronto met the provisional guideline on point of impingement. In the interpretation of the analytical results on the emission samples some very conservative assumptions were made in that the instrument detection limits were used to estimate possible quantities of dioxins and furans whenever "none detected" was reported by the analytical laboratory. As a result the calculated and reported emission results were overestimates of what was actually emitted. Even so overestimated emissions from both Toronto incinerators complied with the point of impingement guideline.

The emissions of total dioxins and furans from SWARU, however, were found to exceed the provisional guideline on point of impingement. Consequently, the SWARU operators were asked to cut back on the refuse processing rate such that the annual provision of the guideline is met(3). The trace organic contaminants program was temporarily discontinued and sampling of the industrial incinerator postponed indefinitely. In its place, another more comprehensive sampling program at SWARU was initiated to examine and optimize operational variables and to specify conditions which would ensure compliance of stack emissions of total dioxins and furans with the guideline. This new program involved 13 stack emission tests for dioxins and furans and the collection of "new" process data such as combustion gas temperatures in the firing chamber which were previously unavailable. The results of this study are given in three technical reports issued in January of 1984(4,5,6).

In summary, the main conclusions from the new study were that the emissions of dioxins and furans were considerably lower in 1983 than in 1982 and that they could be acceptable at a higher refuse processing rate than that specified in the Ministry's restraint request which was based on the 1982 results, providing good operational and maintenance practices are in effect. However, there are still uncertainties as to whether the emissions of dioxins and furans would be acceptable at the design firing rates because such rates were not achieved in either of the 13 tests at SWARU last year and, hence, no information on this condition is available. Soil samples were also taken in locations where the SWARU plume reaches the ground and analyzed for dioxins and furans. Small quantities of these compounds were found in some of these samples(7).

The information on dioxin and furan emissions measured in three tests at each of the two Toronto incinerators and the first three tests at SWARU were reported for the first time at the public hearing on an application by Victoria Hospital Corporation for an energy from waste plant in London, Ontario(8). Presentations on the provisional guideline for dioxins and furans in air were also made at that meeting.

The results reported were very conservative in that they probably overestimated the actual emissions in effect during the tests (Table 2).

The results from all three incinerators were applicable to the Victoria Hospital project which, besides refuse, included sewage sludge incineration. The presentations dealing with trace organic contaminants project and projections of dioxin and furan emissions from the incineration of refuse and sewage sludge were accepted by the Hearing Board. A testimony on the provisional air guideline for dioxins and furans was also accepted(9).

In comparing the emissions of dioxins and furans from the two municipal refuse incinerators (shown in Table 2), it can be noted that the SWARU emissions were significantly higher in spite of lower refuse burning rates. Also, the chemistry of dioxins and furans in the emissions from the two plants were different. The SWARU emissions contained predominantly more volatile tetrachlorinated and pentachlorinated species while hexachlorinated dioxins and furans were the most significant homologues in the emissions from the Toronto incinerator (Figure 4). However, the total disharges of dioxins and furans in grams per day which include stack emissions and ash streams were more similar at both plants because of a considerably higher dioxin and furan content of the ash at the Toronto plant.

The distributions of dioxins and furans in the stack sampling trains in all tests were such that part of these species had to be in the vapour phase at the point of filtration. Considerable portion of these vapours were found in the impinger water which is during sampling kept at low temperatures. This suggested that condensation could be used to remove dioxins and furans from the stack emissions.

One of the commercially available technologies where cooling is effected by spraying water solution of lime into the stack gases (to remove acidic gases such as hydrogen chloride and sulfur dioxide) is a Teller scrubbing system. In that system the small particulates after the spraying tower are agglomerated into large particulates by injecting inert extraneus particulates into the gas stream as seeds. This agglomeration is supposed to facilitate an easier particulate removal by the baghouses installed downstream of the point of injection. It was speculated that the part of dioxins and furans which are in the vapour form in the combustion gases of the refuse incinerators could be condensed in the spray tower, then absorbed on the particulates and removed by the baghouses. The Ontario Ministries of the Environment and

Energy funded a program jointly with the California Air Resources Board to test such one facility in Japan last year. The results from the study are expected soon.

The Ministry of the Environment is also supporting research on stack sampling method for dioxins and furans to be carried out at the University of Waterloo. It is hoped that this research will also give a new insight into whether condensation combined with an effective removal of particulates is a viable alternative for the removal of dioxins and furans from the stack emissions at the municipal refuse incinerators.

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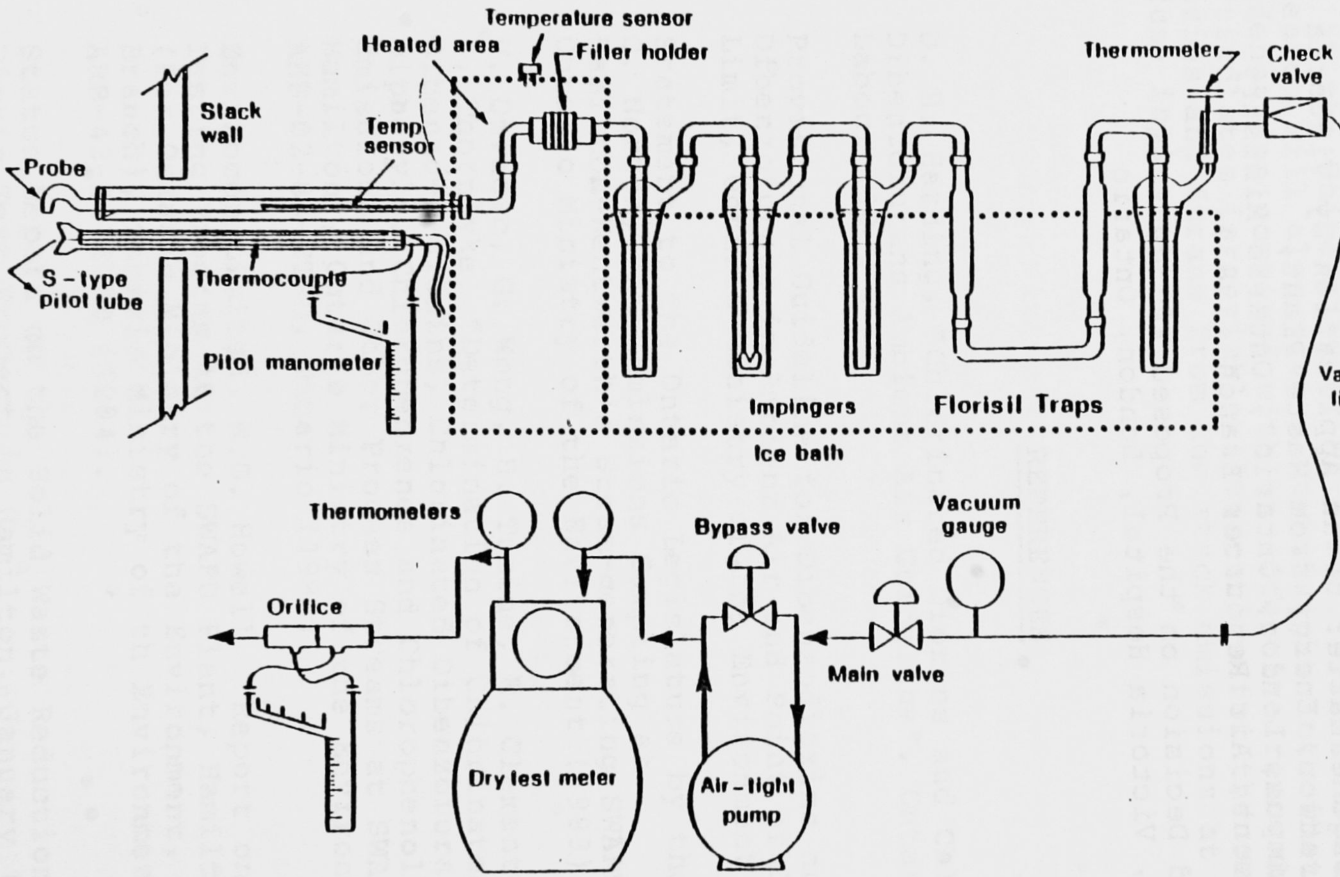


FIGURE 1; TRACE ORGANIC SAMPLING TRAIN

FIGURE 2.

POINT OF IMPINGEMENT PROVISIONAL GUIDELINE FOR PCDDs&PCDFs

1. $$\frac{PCDDs_{(pg/m^3)}}{450_{(pg/m^3)}} + \frac{PCDFs_{(pg/m^3)}}{450 \times 50_{(pg/m^3)}} = 1$$

2. $$\frac{PCDDs_{toxic(pg/m^3)}}{450_{(pg/m^3)}} + \frac{PCDDs_{less\text{-}toxic(pg/m^3)}}{450 \times 100_{(pg/m^3)}} + \frac{PCDFs_{toxic(pg/m^3)}}{450 \times 50_{(pg/m^3)}} + \frac{PCDFs_{less\text{-}toxic(pg/m^3)}}{450 \times 50 \times 100_{(pg/m^3)}} = 1$$

toxic; congeners with at least one hydrogen and at least three chlorine atoms in the lateral ring positions.

less-toxic; the remaining congeners.

TABLE 1.

DAILY FLOWRATES OF CHLORINATED ORGANICS IN g/d AT TWO ONTARIO MUNICIPAL REFUSE INCINERATORS

	TORONTO TEST			SWARU TEST		
	1	2	3	1	2	3
TOTAL PCDDs/PCDFs						
IN	5	6	14	17	86	14
OUT	27	37	44	40	70	27
TOTAL PCBs,CBs,CPs						
IN	150	954	454	101	141	131
OUT	94	54	na	51	17	78

FIGURE 3.

HOMOLOGUE SERIES DISTRIBUTION IN THE REFUSE AND EMISSIONS AT THE TORONTO PLANT

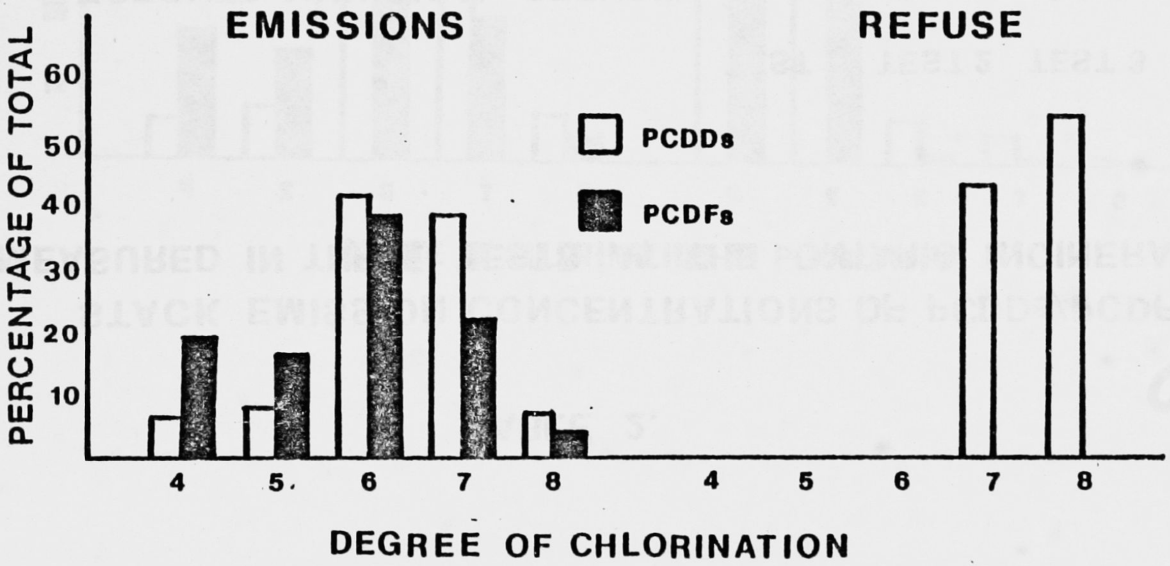


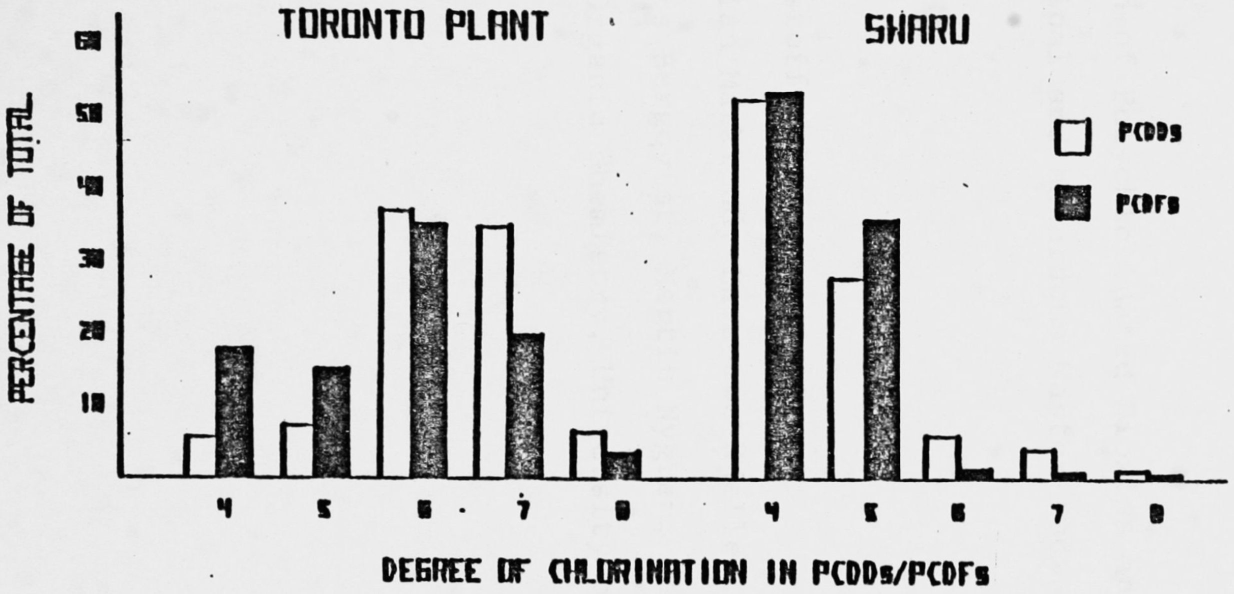
TABLE 2.

STACK EMISSION CONCENTRATIONS OF PCDDs/PCDFs (ug/m^3) MEASURED IN THREE TESTS AT THE ONTARIO INCINERATORS

	TEST 1	TEST 2	TEST 3
TORONTO MUNICIPAL REFUSE	0.6	2.5	3.1
SWARU	24.9	45.2	14.8
TORONTO SEWAGE SLUDGE	1.4	1.6	2.7

FIGURE 4.

PCDDs/PCDFs HOMOLOGUE DISTRIBUTION OF STACK EMISSIONS FROM SWARU AND TORONTO PLANT



Formation of Polychlorinated Dioxins and Dibenzofurans in Municipal and hazardous Wastes incinerators

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INTRODUCTION

Polychlorinated dibenzo-*p*-dioxins (PCDDs) and polychlorinated dibenzofurans (PCDFs) are two series of tricyclic almost planar aromatic compounds which exhibit similar physical, chemical and biological properties and have been the subject of much concern in recent years. They have been involved in accidents like that in Seveso, Italy in 1976, the fire in the Binghamton State Office Building in 1981, the Love Canal incident in Niagara Falls in 1979, the intoxications at horse arenas in Missouri in 1971 and Times Beach, Missouri in 1982-83, the Yusho accidents in Japan in 1968 and in Taiwan in 1979 and also in the herbicide spraying program in Vietnam in the late 1960s.

The chemical structures and numbering of these hazardous compounds are given in Figure 1. The number of chlorine atoms in these compounds can vary between one and eight producing up to 75 PCDD and 135 PCDF positional isomers as shown in Table 1.

Animal studies and *in vitro* experiments have indicated that there is a pronounced difference in toxic and biologic effects among different PCDD and PCDF isomers. A factor of 1 000 - 10 000 in difference can be found for so closely related isomers as 2,3,7,8- and 1,2,3,8-tetra-CDD and 1,2,3,7,8- and 1,2,4,7,8-penta-CDD (Bradlaw and Casterline, 1976; Poland *et al.*, 1976). The isomers with the highest activity and the highest acute toxicity are those having 4-6 chlorine atoms and all lateral (2,3,7 and 8) positions substituted for chlorine, see Table 2. The LD_{50}-values for guinea pigs for 2,3,7,8-tetra-CDD, 1,2,3,7,8-penta-CDD, 2,3,7,8-tetra-CDF and 2,3,4,7,8-penta-CDF are all below 10 µg/kg (Mc Connell *et al.*,, 1978; Moore *et al.*, 1979; Huff *et al.*, (1980). The chemical analytical technique used in this investigation is described elsewhere (Rappe, 1984; Rappe et al., 1984 a and b).

FORMATION OF PCDDs and PCDFs BY THERMAL REACTIONS

The formation of 2,3,7,8-tetra-CDD as a result of thermal reactions of 2,4,5-T and 2,4,5-T derivatives has been the subject of controversy. Heating 2,4,5-T salts at 400-450°C for 30 minutes or longer yields approximately 1 g of 2,3,7,8-tetra-CDD per kg of 2,4,5-T salt, while no dioxin was identified from the same treatment of 2,4,5-T acid or esters (Langer et al., 1973; Baughman, 1974). Using a more sensitive analytical method Ahling et al. (1977) reported that 0.2-3 mg of 2,3,7,8-tetra-CDD was formed per kg of 2,4,5-T esters during combustion at 500-850°C. Two reports (Stehl and Lamparski, 1977; Andersson et al., 1978) have shown that 2,3,7,8-tetra-CDD could not be found on burning samples of spiked or sprayed vegetation at 600°C. The combustion gases, soot, particles and ashes were analyzed and the detection limit was 4 mg/kg 2,4,5-T burned, or less.

Rappe et al. (1978) have studied the burning of material impregnated with various salts of chlorophenols. Very carefully purified 2,4,6-tri- and pentachlorophenate were studied in addition to a commercial formulation of 2,3,4,6-tetrachlorophenate. The analytical method used in this study was not isomer specific, but the following conclusions could be drawn concerning the formation of PCDDs by thermal reactions:

- the expected dimerization products and products formed in the "Smiles rearrangement" are the major PCDDs,
- no other thermal isomerization of the PCDDs formed can be observed;
- no formation of higher chlorinated PCDDs can be observed,
- octa-CDD and other higher chlorinated PCDDs yield lower chlorinated dioxins in a nonspecific dechlorination reaction. This is also a major reaction pathway,
- a series of PCDFs was also observed

It has been found that PCBs can be converted to PCDFs under pyrolytic conditions. The pyrolysis of commercial PCBs in sealed quartz ampoules in the presence of air yielded about 30 major and more than 30 minor PCDFs. The optimal yield of PCDFs was about 10% calculated on the amount of PCB decomposed. Thus uncontrolled burning of PCBs can be an important environmental source of hazardous PCDFs. Therefore, it was recommended (Buser et al., 1978 a; Buser et al., 1978 b) that all destruction of PCB contaminated waste using incinerators must be carefully controlled. In the temperature range 300-400^{o}C, the yield of conversion seems to be in the part-per-million range (Morita et al., 1978), but Nagayama et al. (1981) have reported a dramatic increase of PCDFs at these temperaturesin the presence of stainless steel and nickel.
Buser and Rappe (1979) studied the pyrolysis of 15 individual synthetic PCB isomers. This study showed that the formation of PCDFs can follow several competing reaction pathways. In another study, where a series of chlorobenzenes were pyrolyzed in the same way, Buser (1979) found that significant amounts (~ 1%) of PCDDs and PCDFs were formed. A complex mixture of isomers of PCDDs and PCDFs found suggesting several reaction routes.

Using the same technique as above Lindahl et al., (1980) studied the thermal decomposition of polychlorinated diphenyl ethers. Both PCDDs and PCDFs were formed involving several pathways. The temperature range was 500-600^{o}C and the yields varied from 0.1% to 4.5%. It has also been reported that pyrolysis of PVC yields higher chlorinated benzenes (Ahling et al., 1978).

The data discussed in this section is summarized in Table 3 (6).

MUNICIPAL INCINERATORS

Emissions from municipal incinerators, heating facilities and thermal power plants have for long time been the subject of much concern. Whereas previously, the emission of dust, smoke, toxic metals and noxious gases were of prime concern, the presence of potentially hazardous organic compounds from these emissions has been recognized only recently. In 1977 Lahaniatis et al. reported on the finding of chlorinated organic compounds in fly ash of a municipal incinerator. The compounds detected were chlorinated aliphatics, benzenes, PCBs and pesticides.

Also in 1977 Olie et al. reported on the occurrence of PCDDs and PCDFs in fly ash from three municipal incinerators in the Netherlands. Their results indicated the presence of up to 17 PCDD peaks, but not quantification or isomer identification was possible due to lack of synthetic standards. Buser and Bosshardt (1978) studied fly ash from a municipal incinerator and an industrial heating facility, both in Switzerland. In the former the levels of PCDDs was 0.2 µg/g and of PCDFs 0.1 µg/g. In the industrial incinerator the levels were 0.6 µg/g and 0.3 µg/g, res ec-

During the period 1978-1982 a series of papers, reports and reviews have been published confirming the original findings of Buser and Bosshardt. Up to now less data have been reported on the levels of PCDDs and PCDFs in other incineration products such as particulates and flue gas condensate, which are the true emissions.

As mentioned earlier a risk evaluation should be based on the levels of the highly toxic isomers found in isomer specific analyses. However, in most studies of fly ash the results are given in terms of total levels of tetra-, penta-, hexa-, hepta- and octa-CDDs and CDFs. The value of such studies is limited, especially in this case where the number of isomers is quite large. More than 30 PCDDs and 60 PCDFs have been found in fly ash samples. Other authors make the assumption of an equal distribution among the isomers. This seems to be an erroneous approach. Using the isomer specific analytical method described above, two samples from municipal waste incinerators were analyzed, see Figure 2. The Swedish Eksjö incinerator was operating by the fluidized bed technique, the Canadian by conventional technique.

The total levels of PCDDs and PCDFs were found to vary highly between different sampling periods for the same incinerator and were normally in the range 10 ng - 1 $\mu g/m^3$ which means grams a day or up to kilograms in a year. In both samples we could identify a series of PCDDs and PCDFs. The isomeric distribution did not vary much between samples from the same incinerator. Of special interest is the observation that all tetra-CDDs found in these two samples co-elutes with the isomers present in a mixture of all the 22 tetra-CDDs. A variation in the levels of the highly toxic 2,3,7,8-tetra-CDD was also observed. In the Swedish sample this isomer constitutes about 3% of the total level of a tenfold variation of this interesting isomer. Moreover, in these samples the ratio between the largest and the smallest peak is more than 100:1 (C. Rappe, S. Marklund, unpublished).

The fragmentograms of the penta- and hexa-CDDs from these two incinerators are given in Figure 3 and 4. It is interesting to notice that the highly toxic 1,2,3,7,8-penta-CDD is a middle/major constituent in these samples.

The fragmentograms of the tetra-CDFs are given in Figure 5, penta-CDFs in Figure 6 and hexa-CDFs in Figure 7. The toxic 2,3,7,8-substituted isomers are middle/major constituents in these samples, especially 2,3,4,7,8-penta-CDF and 1,2,3,6,7,8-hexa-CDF.

Another interesting parameter to investigate for various incinerators is the PCDF/PCDD ratio. At the Cl_4 and Cl_5 levels, the PCDFs are in general much more abundant than the PCDDs, while the situation is reversed at the Cl_7 and Cl_8 levels (Rappe _et al_., 1983).

In a report in 1978 it was proposed by scientists from Dow Chemical Company that PCDDs and especially 2,3,7,8-tetra-CDD are ubiquitous and formed as trace level byproducts of any normal combustion (Dow, 1978; Bumb _et al_., 1980). Consequently dioxins should have been present in the environment since the advent of fire ("The Trace Chemistries of Fire"). A recent survey of PCDD levels in particulate from residental wood combustion units is quoted in support of the above (Nestrick and Lamparski, 1982). The survey showed PCDD levels in the ppt-range. The major constituent was octa-CDD, but tetra-CDDs (including the 2,3,7,8-isomer) was also found. The occurrence of PCDFs is not discussed in these report

However, this hypothesis has been criticized (Anonymous, 1979, 1982). One of the main arguments is that coal-fired power plants are ruled out as a possible source of 2,3,7,8-tetra-CDD (Kimble and Gross, 1980; Junk and Richard, 1981). Another argument is that data are completely lacking in the Dow studies on levels of dioxin precursors (see Table 3) in the material being burned, including the air in the flames.

HAZARDOUS WASTES INCINERATORS

In this contribution we are discussing levels and isomer distribution of PCDDs and PCDFs in samples from the following hazardous wastes incinerators:

Komunekjemi, Nyborg, Denmark

SAKAB, Norrtorp, Sweden

Kema Nord, Stenungsund, Sweden

Norcem, Slemmestad, Norway

Cementa, Degerhamn, Sweden

Komunekjemi, Nyborg, Denmark

This incinerator is equipped with a 12 m long rotary kiln and an afterburner and has also been described by other contributions to this conference (Løvgren and Christiansen and Thousig Møller). We have analyzed two samples, one taken before (A) and the other taken during a PCB test burn (B). The thermal degradation efficiency was > 99.795 % during the complete test burn (Bergström, 1983). The temperature is given as > 800 °C with a total residence time of >5 sec. The quantitative results from this test burn (flue gas + particulate) are given in Table 4, and no obvious difference in the levels was observed between the samples taken before and during the PCB test burn.

The isomer specific fragmentograms from this incinerator is shown in the lower curves of Figure 2 (Tetra-CDDs), Figure 3 (Penta-CDDs), Figure 4 (Hexa-CDDs), Figure 5 (Tetra-CDFs), Figure 6 (Penta-CDFs) and Figure 7 (Hexa-CDFs). The isomer distributions in these samples are very similar to those found in samples from municipal incinerators (Eksjö, Sweden and Canada). The major chlorine source in the hazardous wastes is assumed to be chlorinated solvents like methylene chloride and perchloroethylene.

SAKAB, Norrtorp, Sweden

This hazardous wastes incinerator is constructed by von Roll; a rotary kiln with an afterburner. It was built in 1982-83 and started to operate in September 1983. The burning efficiency is > 99.995 % (Bergström 1984), the temperature is > 800 ^{o}C and the residence time > 5 sec (in kiln and afterburner). The isomeric distribution of PCDDs and PCDFs in the samples from this incinerator is quite constant and almost identical to the distribution found in the samples from the incinerator in Nyborg, Denmark (Figures 2-7).

Kema Nord, Stenungsund, Sweden

This incinerator is a small Lurgi incinerator operating at 1200 ^{o}C and a rather short residence time (~ 0.5 sec). The incinerator is burning various side-streams from the production of vinyl chloride monomer (VCM), mainly VCM and VCM tar. The VCM tar constitutes lower chlorinated aliphatic compounds like 1,2-dichloroethane (19 %) and trichlorobutanes (19 %), but also tetra- (0.2 %) penta- (0.1 %) and hexachlorobenzene (0.5 %).

We could only identify low levels of the higher chlorinated PCDFs and octa--CDD. The amounts of tetra-, penta-CDFs as well as tetra- through hepta-CDDs were below the detection level (1 ng/m^3) see Table 6 given as mean values from three sampling periods.

Norcem, Slemmestad, Norway

We have analyzed a series of samples taken during a test study of the thermal destruction of PCB in a rotary cement kiln in Slemmestad, Norway. The test kiln is 155 m long with a diameter of 4 m. It is a "wet" oven operating at 1200-1300 ^{o}C in the solid material and up to 2000 ^{o}C in the flems. Normal fuel consumption is 92 metric ton/day for a production of 850 ton/day of clinker. During the test period 4 m^3 of PCB was burned at a feeding rate of 50 kg/hr. The destruction efficiency of PCB was found to be > 99.9997 %. No PCDFs or PCDDs could be found in any of the samples, but in a few samples we found traces of Cl_4-PCB (Rappe *et al.*, 1983).

Cementa, Degerhamn, Sweden

A second series of PCB test burnings were performed at Cementa, Degerhamn, Sweden, Six samples were analyzed for PCDFs, and one for PCDFs and the results are collected in Table 7. Unfortunately the amount of gas collected in each sample is still not known to us.

The construction of this kiln is similar to that in Slemmestad, Norway, but it has been reported to us that it was operating under oxygen deficiency. The chromatogram of the hexa-CDFs is given in Figure 8.

CONCLUSIONS

PCDDs and PCDFs have been found in emissions and fly ash from all municipal incinerators we have analyzed and from most hazardous waste incinerators. The only exception was rotary cement kiln operating under optimal conditions. PCDDs and PCDFs seem to be normal products from every combustion or incineration of organochlorine compounds. Very specific conditions are required for the complete degradation.

The levels were found to vary highly and were founc to be in the range 1 ng/m^3 - - 3 μg/m^3. The levels of PCDFs were higher than the levels of PCDDs, especially for the tetrachloro compounds. The levels were comparable in samples of fly ash, particulates and flue gas.

In figures 2-4 we are comparing isomeric pattern of the PCDDs from a fire involving PCBs and chlorobenzenes in the Binghamton State Office Building with samples from a Swedish municipal incinerator (fluidized bed) a Canadian municipal incinerator and the Danish hazardous waste incinerator. The isomer pattern were almost the same for different samples from the same incinerator (fly ash, particulate and flue gas) and the differences between the various incinerators are not so dramatic. The PCB/chlorobenzene fire gave a quite different pattern.

Concerning the tetra-CDDs the 2,3,7,8-tetra-CDD is always in minor or very minor constituent but the 1,2,3,7,8-penta-CDD is a middle (see Figure 3). The toxic PCDFs are always middle or major constituents. Since the PCDFs are normally present at a much higher level, it is highly recommended that these constituents should not be neglected.

In Figures 5-7 we are comparing the isomeric pattern of the PCDFs in the incineration samples. The difference between the samples is marginal, the toxic 2,3,7,8-substituted isomers are middle or major constituents. This investigation illustrates the importance of an analytical technique differentiating between the toxic 2,3,7,8-tetra-CDF and the much less toxic 2,3,4,8-tetra-CDF.

We have an increasing amount of information indicating that the toxic 2,3,7,8-substituted PCDDs and PCDFs listed in Table 2 constitutes a low but general background in the environment and also in the general population in many parts of the world. In Figure 9 we have compared levels in human adipose tissue from N. Sweden with levels (on fat basis) found in mother's milk, mainly from Germany. The profiles are similar and the isomers the same.

Among the PCDDs we found an increasing amount with increasing number of chlorine atoms. The levels of octa-CDD were dominating. The PCDF profile is quite different. Here the highest values were found for 2,3,4,7,8-penta-CDF. and the levels of octa-CDF were always low. A series of fish, bird and seal fat samples from the Baltic Sea have similar PCDD and PCDF pattern (Rappe et al., 1984 c).

Of special interest is the observation of 1,2,3,7,8-penta-CDD, normally at slightly higher levels than 2,3,7,8-tetra-CDD. This particular isomer has never reported from any commercial product, but is always present in samples from incinerators, see Figure 3. At the present time it cannot be excluded that incineration, both hazardous wastes and municipal wastes contribute to the background levels of PCDDs and PCDFs found in the environment and the general population.

It is of fundamental importance to study the background levels of the highly toxic PCDDs and PCDFs in the environment and in the general population. Special attention must be given to the possible correlation between these background levels and the emissions from various incinerators.

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Table 1. Number of positionel PCDD and PCDF isomers

Level of chlorine substitution	Number of isomers PCDDs	PCDFs
Cl_1 (Mono)	2	4
Cl_2 (di)	10	16
Cl_3 (tri)	14	28
Cl_4 (tetra)	22	38
Cl_5 (penta)	14	28
Cl_6 (hexa)	10	16
Cl_7 (hepta)	2	4
Cl_8 (octa)	1	1
	75	135

Table 2. The most toxic PCDD and PCDF isomers

PCDDs	PCDFs
2,3,7,8-Tetra-CDD	2,3,7,8-Tetra-CDF
1,2,3,7,8-Penta-CDD	1,2,3,7,8-Penta-CDF
1,2,3,6,7,8-Hexa-CDD	2,3,4,7,8-Penta-CDF
1,2,3,7,8,9-Hexa-CDD	1,2,3,6,7,8-Hexa-CDF
1,2,3,4,7,8-Hexa-CDD	1,2,3,7,8,9-Hexa-CDF
	1,2,3,4,7,8-Hexa-CDF
	2,3,4,6,7,8-Hexa-CDF

Table 3. Formation of PCDDs and PCDFs by thermal processes

Precursor	Conditions	Products
2.4,5-T salt	Pyrolysis	2,3,7,8-TCDD
2,4,5-T (vegetation)	Pyrolysis	No TCDD
	Burning	-"-
Chloro phenate	Burning	PCDDs[x] + PCDFs
PCBs	Pyrolysis	PCDFs [xx]
Polychloro benzenes	Pyrolysis	PCDFs + PCDDs [xxx]
Chloro Diphenyl ethers	Pyrolysis	PCDFs + PCDDs
PVC	Pyrolysis	Polychlorobenzenes

x = PCDD formed by dimerization and a non-specific dechlorination

xx = other products: hexa- and penta-chlorobenzenes

xxx = other products: PCBs, polychlorinated naphthalenes

Table 4. Levels of PCDDs and PCDFs (ng/m^3) in samples from Nyborg, Denmark

	Sample A	Sample B
2,3,7,8-TCDD	0.02	0.03
Σ TCDDs	5.7	5
2,3,7,8-TCDF	36	8
Σ TCDF	108	40
Σ PeCDDs	25	5
Σ PeCDFs	26	5
Σ HxCDDs	10	1
Σ HxCDFs	22	4
Σ HpCDDs	15	1
Σ HpCDFs	23	3
OCDD	2	0.2
OCDF	6	0.6

Table 5. Levels of PCDDs and PCDFS in samples from SAKAB, Sweden

Isomer	1 9 8 3 Day number			
	328 ng/m^3	328 ng/m^3	347 ng/m^3	348 ng/m^3
2,3,7,8-Tetra-CDF	1.7	2.0		9
Σ Tetra-CDFs	42	55	3060	280
2,3,7,8-Tetra-CDD	0.08	0.4		1.5
Σ Tetra-CDDs	3.4	6.4	216	30
1,2,3,7,8/1,2,3,4,8-Penta-CDF	1.9	2.5		35
2,3,4,7,8-Penta-CDF	1.8	2.3		18
Σ Penta-CDFs	38	46		350
1,2,3,7,8-Penta-CDD	0.1	0.2		4.4
Σ Penta-CDDs	2.5	4.3		79
Σ Hexa-CDFs	11	10		128
Σ Hexa-CDDs	1.8	1.7		26
Σ Hepta-CDFs	1.1	0.9		43
Σ Hepta-CDDs	0.6	0.5		11
Octa-CDF	0.3	0.2		5.8
Octa-CDD	0.07	0.2		5.8

Table 6. Results from Kema Nord (ng/m^3)

Hexa-CDFs	1	-	3 ng/m^3
Hepta-CDFs	3	-	20 ng/m^3
Octa-CDF	3	-	400 ng/m^3
Octa-CDD	0.1	-	1 ng/m^3

Table 7. Results from Cementa, Degerhamn, Sweden (ng)

	1	2	3	Blank	4	5	6	Blank
2,3,7,8-TCDF	33	23	43	< 0.05	0.9	0.7	1.3	< 0.05
Σ TCDFs	330	230	430	< 0.5	9	7	13	< 0.5
Σ PeCDFs	12	12	24	< 0.1	2.6	2	2.6	< 0.1
Σ HxCDFs	< 0.8	< 0.8	< 0.8	< 0.1	1.9	0.6	< 1	< 0.1
Σ HpCDFs	< 0.3	< 0.3	< 0.3	< 0.1	1.9	0.6	< 0.3	< 0.1
OCDF	< 0.1	< 0.1	< 0.1	< 0.1	0.3	0.1	< 0.1	< 0.1
Σ HxCDDs	NA	NA	NA	NA	1.0	NA	NA	< 0.1
Σ HpCDDs	NA	NA	NA	NA	1.0	NA	NA	< 0.1
OCDD	NA	NA	NA	NA	0.5	NA	NA	< 0.1

NA = Not Analyzed

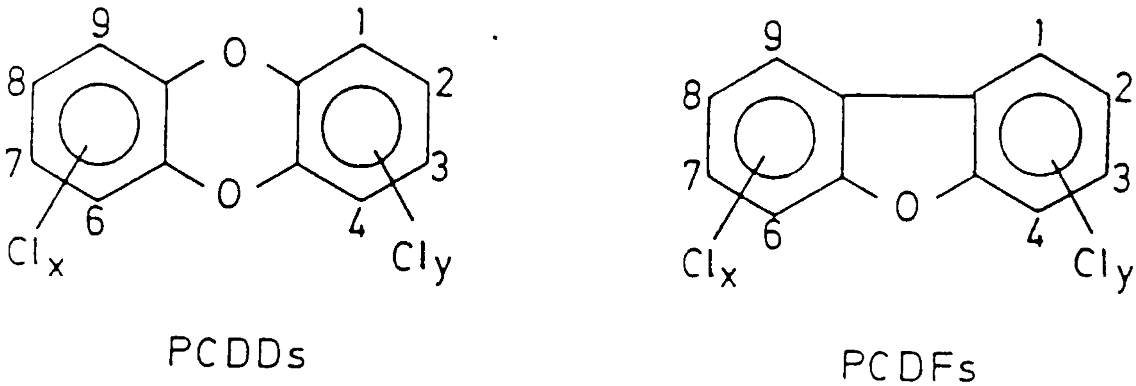

Figure 1. Formulaes for the compounds discussed.

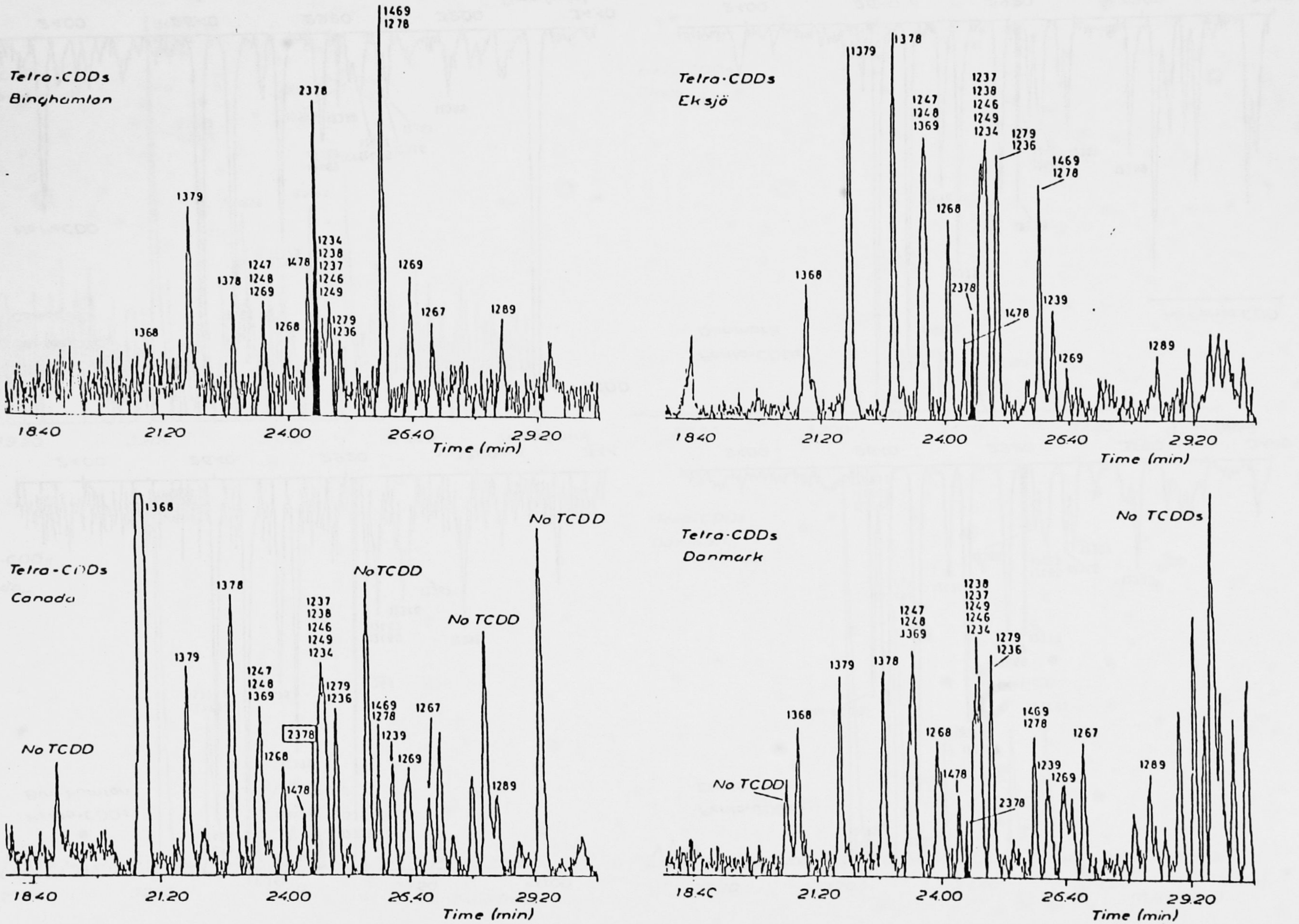

Figure 2. Separation of tetra-CDDs in samples from Binghamton and incinerators on a 60 m SP 2330 fused silica column.

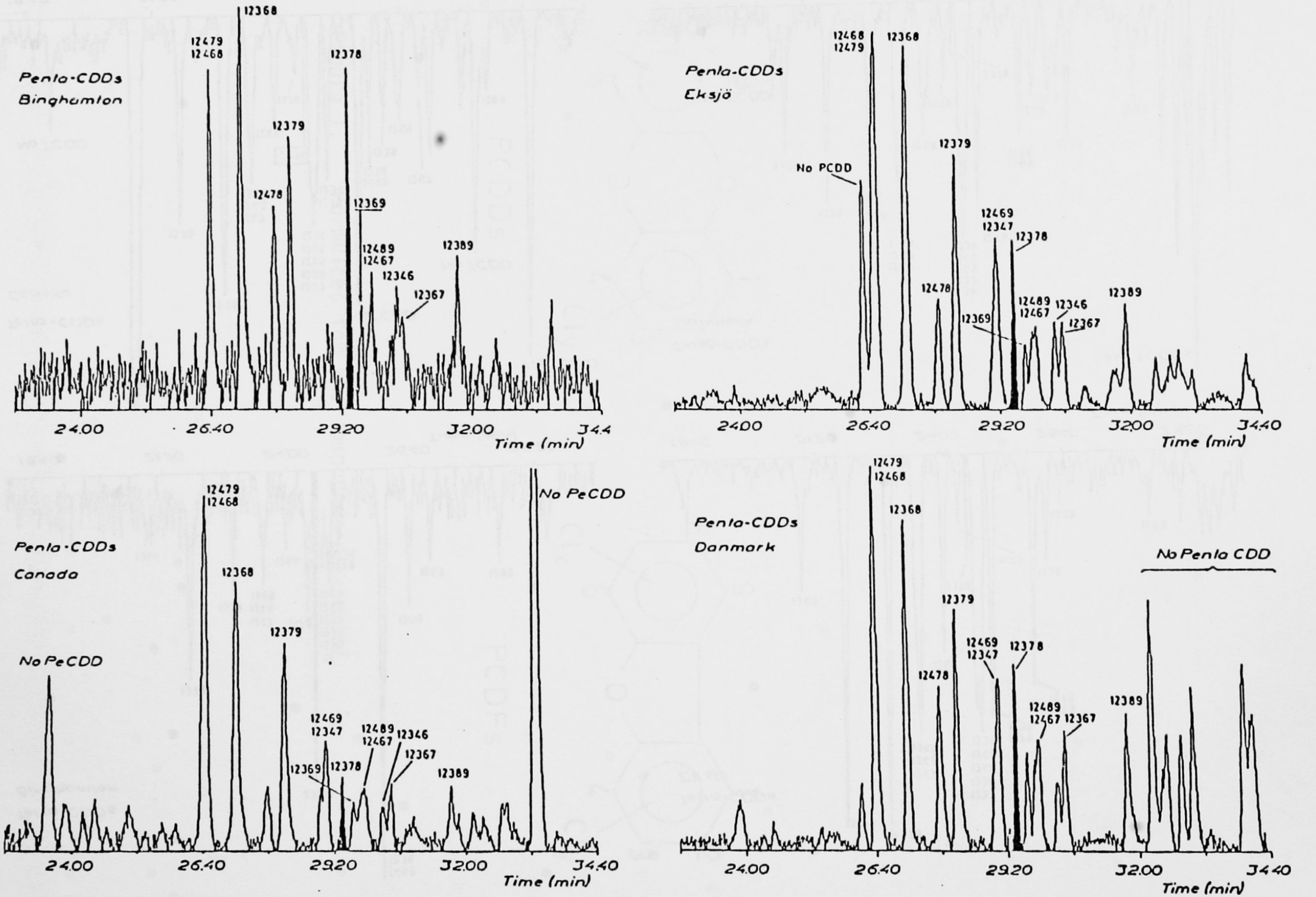

Figure 3. Separation of penta-CDDs in samples from Binghamton and incinerators on a 60 m SP 2330 fused silica column.

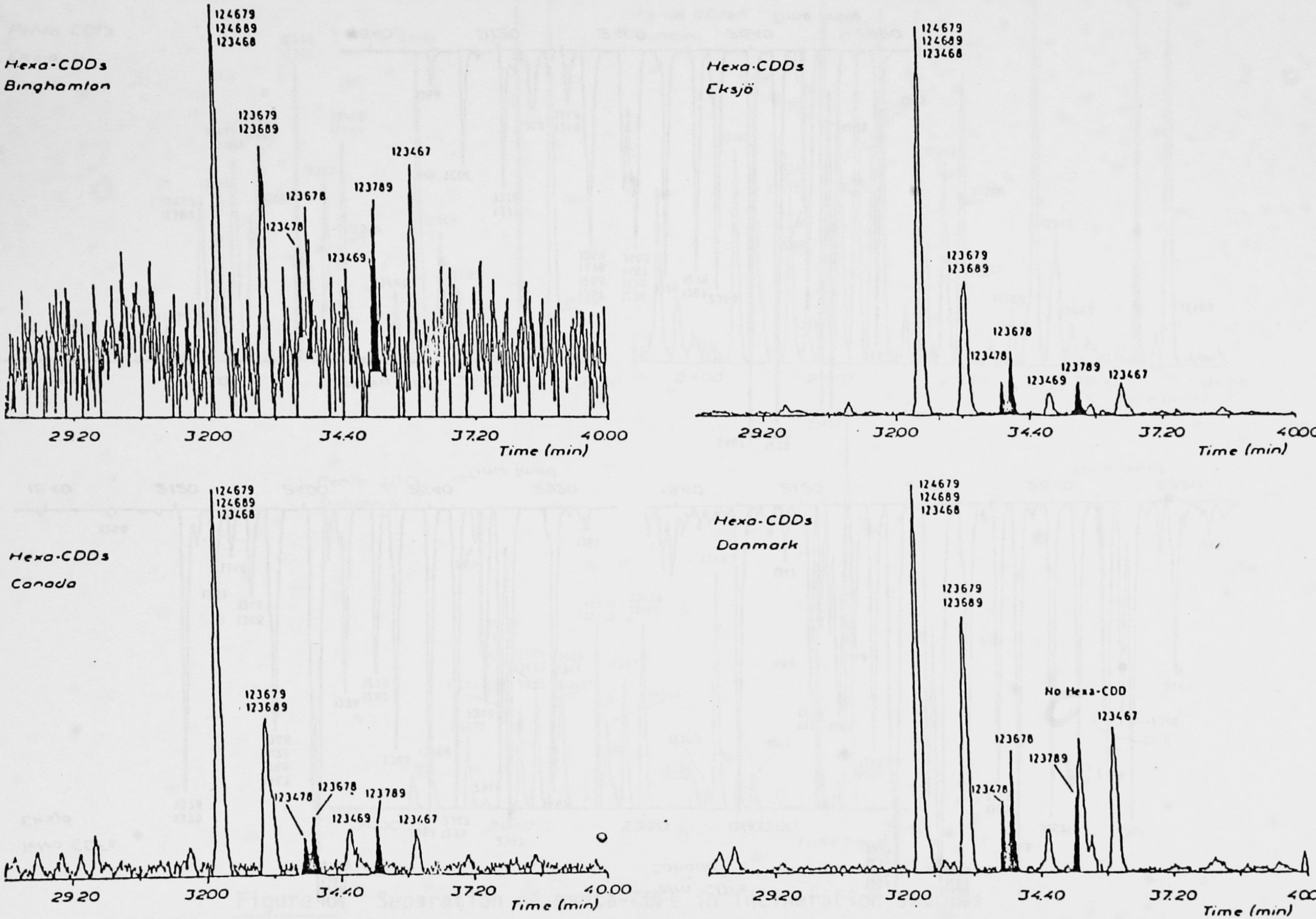

Figure 4. Separation of hexa-CDDs in samples from Binghamton and incinerators on a 60 m SP 2330 fused silica column.

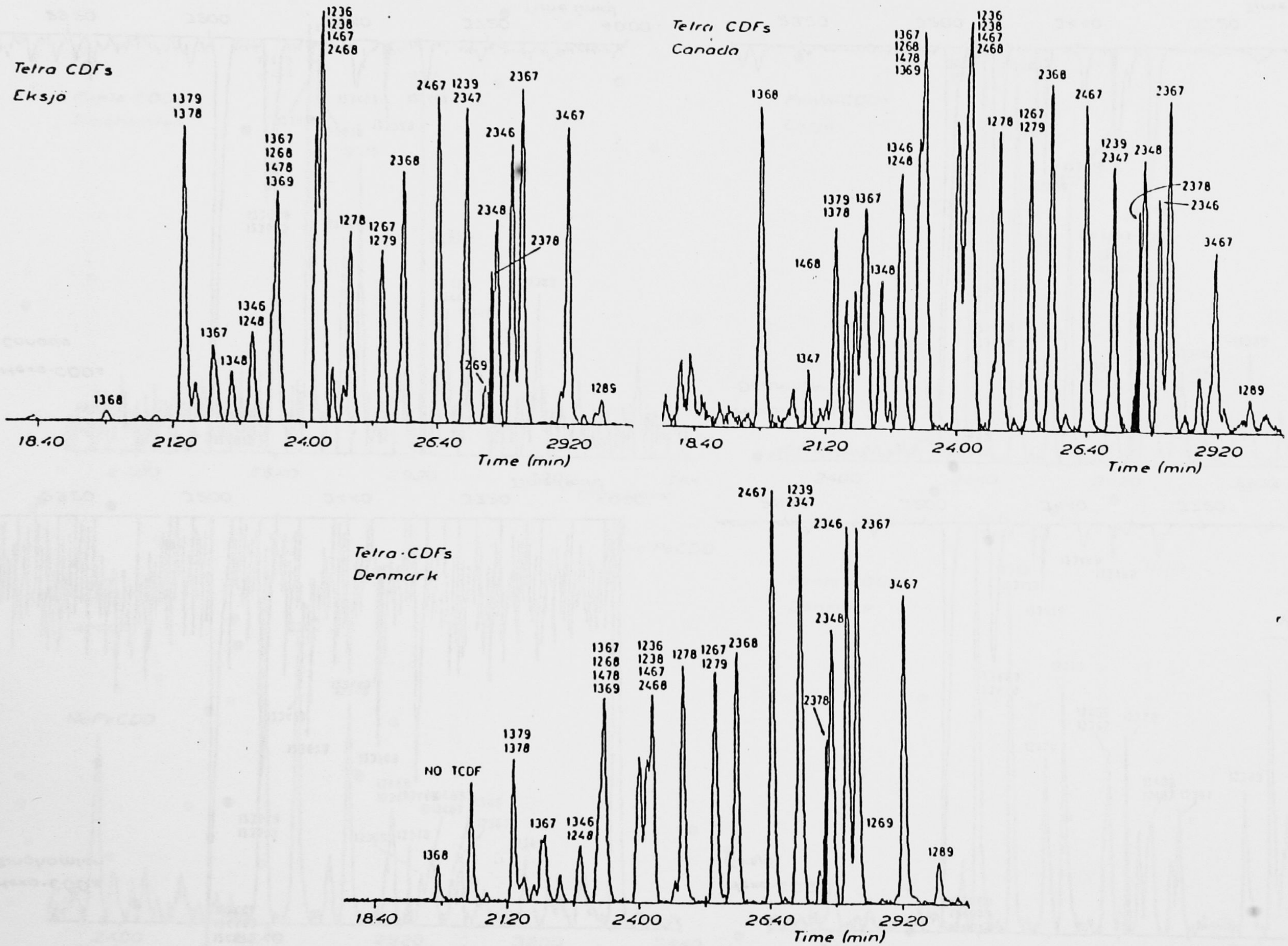

Figure 5. Separation of tetra-CDFs in incineration samples on a 60 m SP 2330 fused silica column.

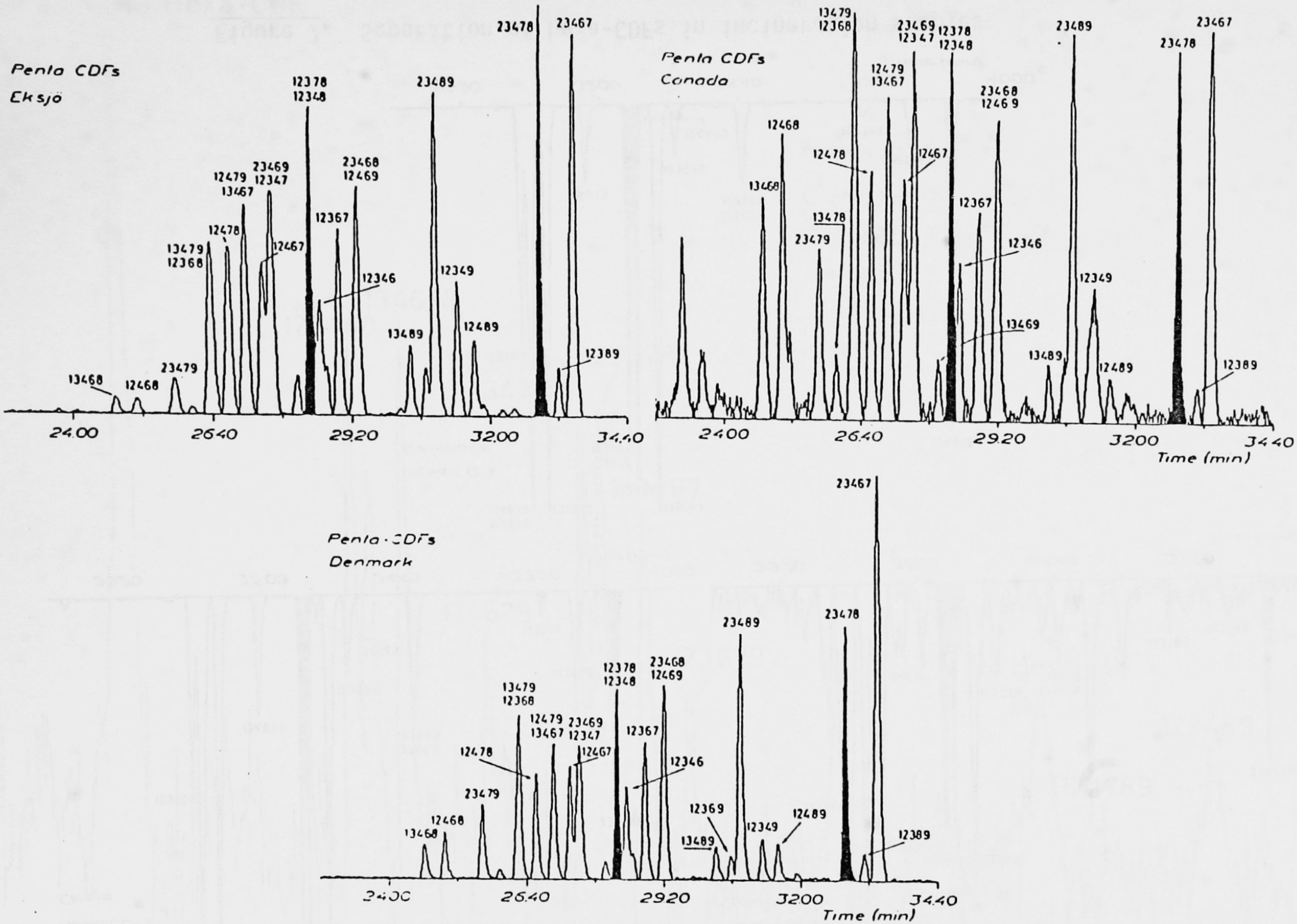

Figure 6. Separation of penta-CDFs in incineration samples on a 60 m SP 2330 fused silica column.

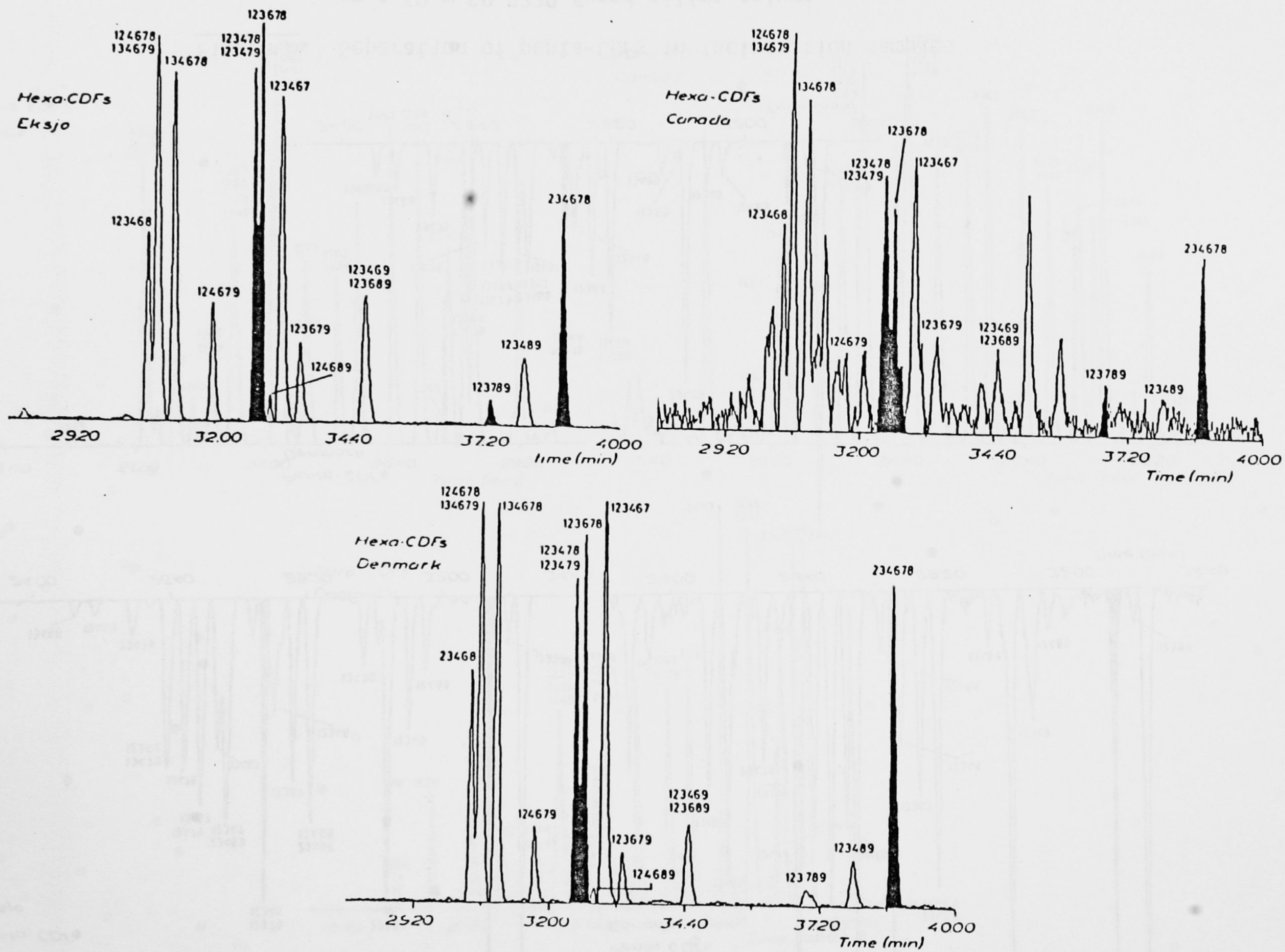

Figure 7. Separation of hexa-CDFs in incineration samples on a 60 m SP 2330 fused silica column.

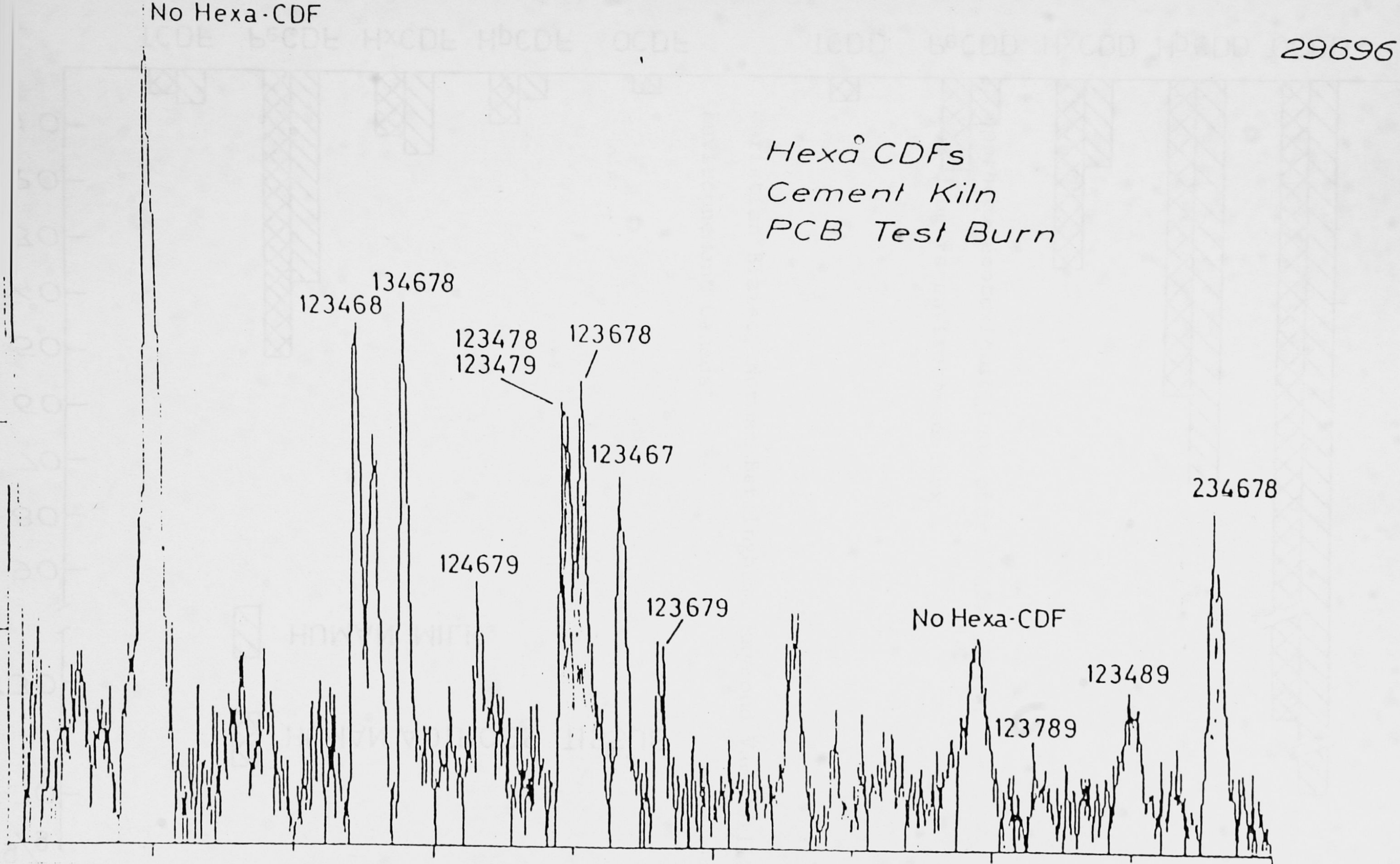

Figure 8. Separation of hexa-CDFs in cement kiln sample on a 60 m SP 2330 fused silica column.

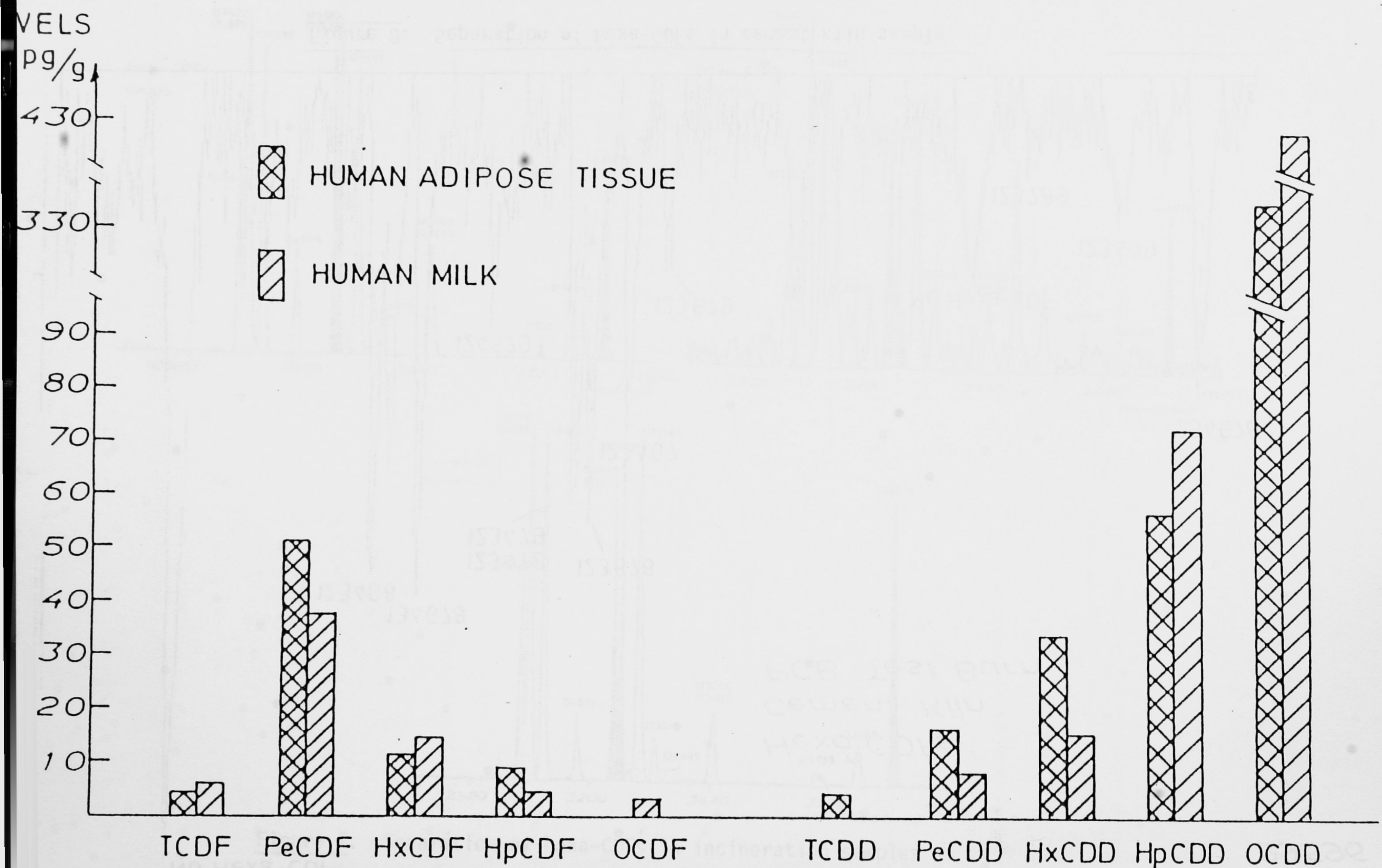

Figure 9. Profile of PCDDs and PCDFs in human samples.

Approche écotoxicologique pour l'évaluation des dangers environnementaux

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RESUME

L'accroîssement incessant des technologies n'est pas sans impositions environnementales et nécessite que soit fondamentalement repensée, sur le plan technique, la façon d'évaluer l'agression toxique. La spirale insidieuse de l'écotoxicité - progéniture indésirable du progrès humain - s'écartera davantage de son point de départ si sa marche n'est pas entravée. Plus que jamais, l'alliance de la biologie et de la chimie, par le biais de l'écotoxicologie, s'avère un outil indispensable pour mettre en évidence les <u>effets</u> d'une quelconque insulte et d'en identifier les <u>causes</u>. S'inspirant d'une conscientisation scientifique internationalement reconnue envers les problèmes de l'écotoxicité, le Service de la Protection de l'Environnement, Environnement Canada (Région du Québec) prône l'application d'une approche écotoxicologique intégrée afin de contribuer à la lutte contre les perturbations des milieux aquatique, tellurique et atmosphérique. Les objectifs, moyens ainsi que l'utilité de cette démarche écotoxicologique régionale font l'objet du présent exposé.

1. L'agression toxique et la conscientisation scientifique aux problèmes de l'écotoxicité

Parmi les principes qui s'appliquent à l'univers, un des plus fondamentaux est celui de la dualité. Ainsi, si toute action a une réaction et si le mal semble devoir coexister avec le bien, n'y a t-il pas également des résultantes négatives du progrès technologique humain? Il faut croîre que oui, hélas, puisque la société industrielle, née vers la fin du 19e siècle, a apporté avec elle les bienfaits et les méfaits de la science. Appelés à améliorer le sort humain, la production et l'utilisation de sources d'énergies et de produits chimiques, ainsi que l'accroîssement de l'agriculture ont cependant été les causes majeures contribuant à la venue de diverses pollutions au cours des décennies passées. Ce n'est que récemment que l'on commence à se rendre compte des menaces qui pèsent sur nos conditions de vie. Plusieurs drames de toxicité environnementale ont d'ailleurs sensibilisé le public aux rejets dans l'environnement: l'évocation de certains mots tristement célèbres tels que Minamata (mercure), Seveso (dioxines) et Love Canal (contaminations diverses) nous rappellent, d'ailleurs, à la réalité de ces faits. A nos dépens, nous avons constaté les effets endommageants de certains produits chimiques sur la végétation, les animaux et l'homme. Le passage de substances chimiques à l'eau, au sol et à l'atmosphère par l'entremise d'égouts, d'incinérateurs ou d'autres modes de dissémination a souvent contribué à perturber le milieu récepteur et à insulter ses composantes biotiques. Cette insidieuse infiltration massive de substances altéragènes à l'environnement est maintenant connue sous le nom d'écotoxicité. Ce phénomène, par lequel on entend la manifestation de tous les types d'agressions agissant collectivement sur la biosphère, résulte de causes multiples. Les effets de l'écotoxicité sont variés, et ses sites d'agression sont souvent sous la gouverne de facteurs aléatoires. Ainsi, une connaissance parfaite des conséquences globales de l'écotoxicité est difficilement saisissable. La triste réalité de l'écotoxicité est en partie imputable à l'imprécision scientifique du passé ainsi qu'au comportement trop souvent "Cigalien" de l'homme qui, à la façon de Louis XIV ("après moi le déluge!") considère surtout l'action de ses énergies en se souciant trop peu de la réaction. Toujours est-il que ce n'est vraiment qu'à compter des années 60's qu'une jeune discipline des sciences biologiques - la toxicologie - commençait à s'affirmer en lançant les premiers cris d'alarmes. Une spécialisation récemment issue de cette discipline est l'écotoxicologie, qui est l'étude des répercussions des substances toxiques sur l'environnement et qui tente d'expliciter les multiples effets et causes de l'écotoxicité.

2. Considérations sur la nécessité d'une approche écotoxicologique

Il n'est plus possible, à l'heure actuelle, de contester l'utilisation d'organismes biologiques afin d'évaluer l'ampleur des insultes environnementales. Le concept écotoxicologique repose principalement sur le fait que les organismes vivants constituent les outils essentiels permettant d'apprécier la qualité environnementale car ce sont eux qui sont exposés aux effets combinés de l'écotoxicité. Aussi sont-ils les mieux qualifiés pour indiquer des perturbations potentielles ou actuelles aux écosystèmes. Le devenir des molécules toxiques libérées à l'environnement est beaucoup trop complexe, de par les cinétiques et transformations diverses auxquelles elles sont aléatoirement assujetties, pour faire reposer la responsabilité de la protection environnementale dans les bras exclusifs de l'analyse chimique. Plus que jamais, au contraire, une alliance essentielle des sciences biologiques et chimiques s'avère indispensable pour mettre en évidence <u>les effets</u> déstabilisateurs de l'écotoxicité et pour en identifier <u>les causes</u>. En plus, il faut considérer que les facteurs permettant de cerner les problèmes écotoxiques sont fonction des caractéristiques chimiques des polluants, des indicateurs biologiques sélectionnés pour en faire l'évaluation, ainsi que du type et de la durée des bio-tests utilisés (tableau 1). L'intégration des connaissances obtenues déterminera ultimement le potentiel écotoxique final de la substance ou du rejet à l'étude, d'où l'importance capitale de l'approche écotoxicologique utilisée à cette fin.

Plusieurs stratégies environnementales, faisant appel à l'écotoxicologie, sont présentement considérées afin d'évaluer les dangers et risques posés par l'écotoxicité où l'on peut considérer l'application de tests _in situ_ et de laboratoires. Dans ce dernier cas, on peut utiliser des bio-tests faisant intervenir un seul organisme à la fois, mais réalisés, selon le besoin, à des niveaux trophiques différents. Des bio-tests multi-trophiques sont également réalisables ainsi que le sont ceux simulant des micro-écosystèmes. Assurément, les bio-tests _in situ_ et de laboratoire ont, individuellement, leurs points forts et faibles ainsi que leurs valeurs respectives d'emploi en écotoxicologie. Une utilisation rationnelle de ces essais permet une caractérisation écotoxique relativement complète de la substance, du rejet ou du biotope à l'étude. La valeur d'entreprendre des bio-analyses de laboratoire et de terrain en parallèle pour l'investigation environnementale est d'ailleurs reconnue sur le plan international, ainsi que l'a confirmé la tenue récente de symposiums internationaux en écotoxicologie (Leclerc et Dive, 1982; Persoone, 1984). L'intérêt d'une méthode d'analyse globale pour l'évaluation de décharges industrielles à l'environnement aquatique est à ce point élevé qu'un Workshop, sous le patronage de l'OCDE, sera exclusivement consacré à ce sujet en septembre prochain (1984) aux Etats-Unis (Duluth, Minnesota). Selon l'OCDE, la surveillance biologique des eaux résiduaires, pour en connaître les effets écotoxiques, constituerait une méthode plus efficace que celle faisant appel exclusivement aux analyses chimiques conventionnelles. Il est permis de penser que l'application d'une approche intégrée dans l'analyse de l'écotoxicité des rejets dans l'eau, à la fois efficace et économique, pourrait être par la suite adaptée à d'autres domaines, comme la gestion des déchets solides et l'assainissement de l'air.

En général, on procède à l'analyse d'une substance altéragène dans le but de déterminer sa nocivité et le danger qu'elle constitue pour l'environnement. Le système d'évaluation adopté précisera les effets létaux, sublétaux ou chroniques ainsi que les propriétés de bio-accumulation d'une substance. Il est encore impossible de prévoir toutes les conséquences, à court et à long termes, de l'introduction d'un polluant dans l'environnement. Toutefois, une méthode d'analyse intégrée permettra de réduire une grande part d'incertitude à cet égard. La structure et la marche à suivre des méthodes existantes d'analyse globale de toxicité diffèrent beaucoup (Lloyd, 1980; Cairns, 1983). Parmi les méthodes les plus intéressantes, l'une emprunte une démarche séquentielle, et l'autre préfère l'exécution simultanée de plusieurs types d'essais. La méthode dite "séquentielle" ou "par étapes" emploie au départ des essais de dépistage simples et peu coûteux, suivis, si nécessaire, d'essais biologiques de complexité croissante (Cairns, 1983). Il faut décider à chaque étape s'il est ou non nécessaire de poursuivre l'analyse par des essais additionnels (tableau 2). Malgré la valeur évidente d'une telle approche, particulièrement pour l'évaluation de la toxicité de substances pures, elle ne constitue pas la meilleure méthode d'analyse de l'écotoxicité de rejets contenant plusieurs substances différentes. Les principales failles de la méthode séquentielle sont les suivantes (Cairns, 1983):

a) On assume, sans preuve scientifique à l'appui, que les bio-tests placés au début de la séquence d'essai prédiront adéquatement les effets toxiques des bio-tests placés plus loin dans la séquence, lesquels sont représentatifs d'organismes à de plus hauts niveaux d'organisation biologique;

b) Les bio-tests initiaux, conçus principalement pour indiquer des effets toxiques létaux, ne peuvent tout simplement pas prédire la gamme des effets sublétaux et/ou chroniques capables de résulter d'une exposition au polluant étudié;

c) La conséquence des lacunes notées aux paragraphes a) et b) pourrait être une sous-estimation importante du potentiel écotoxique de la substance altéragène;

d) Le processus séquentiel peut avoir, sur le plan de la gestion, une basse rentabilité au niveau du temps et du coût total des opérations, surtout si la valeur de prédiction écotoxique n'augmente pas au fur et à mesure que progressent les étapes subséquentes:

e) L'approche séquentielle vise surtout à expliciter l'aspect toxique d'une quelconque agression environnementale. Or, l'écotoxicité entraîne également des problèmes qui peuvent n'être pas liés à la toxicité (par exemple, contamination microbienne, enrichissement, perturbation physico-chimique).

La deuxième méthode d'analyse intégrée, récemment considérée pour l'évaluation du potentiel écotoxique de substances altéragènes, est dite "simultanée" (tableau 3). Cette approche prône la réalisation concurrente de plusieurs bio-tests représentatifs de niveaux différents d'organisation biologique et tient compte de seuils de toxicité létale, sublétale et chronique ainsi que de problèmes environnementaux de catégorie autre que toxique. La mise en évidence des principaux problèmes comprenant l'écotoxicité caractérise ce système d'évaluation. Sa valeur repose sur un choix judicieux d'une batterie de bio-tests capable d'offrir la meilleure prédiction écotoxique possible et ce, de façon rentable (temps et argent). Bien structuré en fonction de besoins spécifiques, ce plan d'action peut être utile pour analyser diverses situations environnementales sans qu'il ne présente les faiblesses inhérentes à l'approche étapiste. Comme nous le verrons plus loin, nous avons adopté l'approche simultanée dans l'étude de problèmes de pollution de l'environnement.

3. Préoccupation du Service de la Protection de l'Environnement (Environnement Canada) envers l'écotoxicité

Avec le temps, la pollution prend de l'ampleur, ainsi que l'illustre la figure 1. Plusieurs des plus anciennes sources de pollution n'ont pas disparu mais se sont, au contraire, ajoutées aux plus récentes. Devant la possiblité d'interactions multiples de nature cumulative, synergique, antagoniste et/ou inconnue de ces mélanges polluants sur l'environnement, il va sans dire que cette menace a une importance capitale pour tout organisme s'occupant de protection du milieu. Quoiqu'il n'y ait pas encore de politique ferme établie par le Service de la Protection de l'Environnement (Environnement Canada) en matière d'évaluation de l'écotoxicité à l'heure actuelle, il existe, au sein du S.P.E., un support implicite encourageant fortement une telle initiative. Ainsi, en examinant certains textes récents sur les problèmes de dégradation de l'environnement, nous avons trouvé quelques citations justifiant l'action entreprise régionalement depuis 1981 pour mettre en oeuvre un programme d'évaluation écotoxicologique des répercussions des substances altéragènes sur l'environnement. Par exemple:

- "Le ministère de l'Environnement doit voir au développement de modes opératoires simples, rapides et peu coûteux destinés à déterminer les effets toxiques des contaminants de l'environnement..." (Chant et Hall, 1979).

- "L'émission de produits chimiques toxiques artificiels dans le milieu constitue l'une des plus graves préoccupations de notre époque..."Les initiatives d'Environnement Canada sont très simples. Nous essayons de prévoir le problème de la contamination toxique au lieu de nous livrer plus tard à des programmes coûteux de rattrapage." (SBSC et Env. canada, 1983).

- "Nous oeuvrons dans un contexte budgétaire difficile. Il nous faudra faire plus. Il nous faudra surtout faire mieux sans attendre des ressources de l'extérieur..." (Gérin, 1983).

- "Le ministère considère qu'il est essentiel de développer des outils d'interprétation conformes à l'approche de l'écotoxicologie." (Env. Canada, 1983).

- "...nos activités peuvent être divisées en trois grandes fonctions: une fonction cognitive, une fonction curative et une fonction préventive." (Slater, 1983).

En termes concis, ces écrits plaident, selon notre entendement, en faveur d'énergies devant être dirigées vers le développement et l'application de bio-tests capables de générer des données permettant de réaliser l'évaluation écotoxicologique au meilleur coût possible. C'est en tenant compte de cette optique que s'est orientée notre démarche.

4. La progression spiralée de l'écotoxicité

L'écotoxicité, lorsqu'elle n'est pas freinée, peut rapidement atteindre des proportions alarmantes et devenir presque impossible à éliminer. On peut prendre conscience plus facilement de son évolution en étudiant la figure 2 qui la représente par une spirale. Cette dernière, qui est caractérisée par cinq bandes de tons distincts représentant chacun des plus importants paliers trophiques de l'écosystème aquatique (i.e. transformateurs, producteurs, consommateurs primaires, consommateurs secondaires et consommateurs ultimes), traverse quatre secteurs adjacents, lesquels sont perpendiculairement séparés par deux axes qui s'entrecroîsent. L'axe vertical sépare les effets toxiques létaux des effets toxiques sublétaux, alors que l'axe horizontal sépare les effets toxiques stables (aigus) des effets toxiques chroniques (dynamiques). On remarquera que le secteur 1 fait allusion à un premier niveau de mesures de protection environnementale qui doit être envisagé afin d'évaluer les effets écotoxiques létaux lesquels ont un impact local flagrant. Le secteur 2 fait référence à un deuxième niveau de mesures de protection environnementale devant être considéré afin d'estimer l'écotoxicité sublétale aiguë à court ou à moyen terme: l'impact de ce potentiel écotoxique est souvent régional. Les secteurs 3SL et 3L comprennent l'évaluation des toxicités chroniques (sublétales et létales) dont l'impact est généralement de plus grande portée et qui nécessitent une étude exhaustive avant toute recommandation d'une action corrective. La toxicité sublétale chronique (secteur 3SL) peut se trans-de génotoxicité. Ainsi, on peut concevoir qu'en s'écartant davantage de son point de départ, la spirale de l'écotoxicité produira tout d'abord des effets létaux, lesquels produiront par dilution, différents effets sublétaux. Ensuite, alimentée par les mécanismes de bio-accumulation, de bioconcentration, de persistance et de génotoxicité, elle provoquera chez divers organismes des effets chroniques. Ce dernier type de toxicité pourra se transformer en toxicité létale (selon le degré de nocivité), complétant ainsi le cercle évolutif de la toxicité. Il est également possible d'obtenir une vision un peu plus concrète et pratique de ce que représente l'écotoxicité en considérant les précisions qui sont apportées au tableau 4. Les trois cas suivants de déversement en milieu aquatique vont faciliter la compréhension de l'évolution de la toxicité d'un milieu pollué.

a) Déversement de biphényles polychlorés (BPC)

Si le rejet initial a une forte teneur en BPC, il produira des effets létaux, sublétaux et également des effets chroniques, par le biais de la bio-accumulation agissant aux divers paliers d'un écosystème aquatique. La toxicité chronique se traduira tout d'abord par des effets sublétaux, lesquels pourront devenir létaux par la suite, selon les circonstances.

b) Déversement d'azote ammoniacal

Par contre, un polluant comme l'azote ammoniacal (NH_3) ne produira pas de toxicité dont les effets dépassent le niveau sublétal aigu, à cause des transformations biologiques qui ne lui permettront pas d'entraîner une toxicité chronique. Ses effets seront donc limités.

c) Déversement d'acide sulfurique

En principe, un tel rejet provoquera une toxicité létale localisée (premier niveau de toxicité), sans conséquences additionnelles. Toutefois, dans certains cas, des effets toxiques de second et même de troisième niveaux pourraient intervenir. Par exemple, une toxicité chronique pourrait résulter indirectement, particulièrement dans le cas de rejets acides non traités à débit continu. Ainsi, une bio-accumulation pourrait être produite due à la remise en solution de substances inorganiques dans le milieu récepteur.

Il est certain qu'une multitude de combinaisons d'effets létaux, sublétaux et chroniques est possible, et que leur manifestation dans l'environnement sera influencée par la nature des polluants, par la migration de ces derniers dans l'environnement ainsi que par leur capacité de transformation.

5. La démarche écotoxicologique du SPE, région du Québec

En étant conscient des dangers de l'écotoxicité qui ont été exposés par la spirale, il est nécessaire qu'une démarche écotoxicologique soit éventuellement expérimentée et appliquée afin de caractériser les différents aspects de ce fléau environnemental. Récemment, le Service de la Protection de l'Environnement (Environnement Canada), Région du Québec, a proposé l'élaboration d'un plan pratique d'évaluation écotoxicologique des dangers environnementaux (tableau 5). L'objectif ultime d'une telle initiative vise l'obtention d'un pouvoir bio-analytique à large spectre afin d'estimer les problèmes écotoxiques d'écosystèmes aquatique, terrestre et atmosphérique. Nous croyons que cet ambitieux programme est réalisable malgré les contraintes financières et en personnel, à condition que la caractérisation écotoxicologique fasse usage de bio-essais répondant à des critères de simplicité, de rapidité et de rentabilité. D'autres caractéristiques désirables, pour une telle approche, sont la miniaturisation et l'automatisation, lorsque cela est possible. La mise en application de tels bio-tests, qui devront en plus être sensibles, représentatifs et avoir une valeur réelle de prédiction écotoxique, afin d'être crédibles sur le plan scientifique, devraient, en principe, garantir le succès de cette méthode d'évaluation. Trois étapes de développement ont été prévues afin d'obtenir la capacité écotoxicologique désirée (tableau 6). Initiée depuis quelques temps au niveau de l'évaluation écotoxicologique intégrée du milieu aquatique, l'expérimentation de notre approche a déjà été menée de façon exhaustive sur des prélèvements liquides provenants de dépotoirs (Van Coillie et al., 1983). Les résultats de cette étude ont confirmé l'utilité de l'approche écotoxicologique simultanée et d'autres évaluations similaires sont présentement en cours sur une sélection d'effluents industriels. Ces études préliminaires permettent d'apporter des ajustements graduels à la méthode et de la mettre au point avec le temps.

6. Etapes à suivre pour l'évaluation des dangers de rejets liquides

Dans l'établissement d'une procédure d'application écotoxicologique pour l'évaluation des dangers de rejets liquides, il faut tenir compte de plusieurs considérations (Van Coillie et al., 1984). En premier lieu, il est nécessaire d'obtenir des résultats pour les trois niveaux de mesures de protection environnementale correspondant aux trois dimensions de l'écotoxicité, tels que conceptualisés par la figure 2. Il est également important de respecter un délai maximum entre l'échantillonnage et les analyses et bio-analyses ultérieures afin de maintenir la représentativité de l'évaluation entreprise. La réalisation de plusieurs types de bio-essais s'avère aussi essentielle en fonction de variables telles que le palier d'écotoxicité (i.e. létal,sublétal aigu, sublétal chronique), l'étape écologique (allant des transformateurs jusqu'aux consommateurs), la durée de l'exposition (bio-tests à court, moyen et long terme), ainsi que le choix des espèces et des paramètres de toxicité. Il y a en plus les particularités spécifiques aux prélèvements à analyser et les problèmes à prévoir à cet égard. D'autres éléments sont le coût des diverses analyses à effectuer ainsi que leur répétition minimale pour l'obtention de résultats fiables. Finalement, le degré de précision de l'évaluation demandé par les centres de décision influera nécessairement sur la portée ultime de l'estimation écotoxique.

Nous tentons présentement de réconcilier toutes ces considérations, avec un certain compromis, en faisant usage d'une méthodologie en trois étapes opérationnelles (tableau 7). Chacune comprend un certain nombre d'analyses et de bio-analyses à réaliser pour les trois niveaux de mesures de protection environnementale et les trois dimensions de l'écotoxicité. Dans un tel partage, les trois étapes opérationnelles ne correspondent pas entièrement aux trois niveaux et/ou aux trois dimensions considérés, chacune ayant été surtout élaborée afin de faciliter la gestion, plutôt que de répondre à une préoccupation scientifique exhaustive. La décision de passer d'une étape opérationnelle à la suivante dépendra de facteurs tels que:

- la nocivité constatée à une étape;
- le degré d'évaluation souhaité
- le coût en fonction des estimations de l'effort indiqué au tableau 7.

Nous évaluons, depuis plusieurs mois déjà, ce type de procédure avec divers effluents en l'ajustant graduellement et en y incorporant, autant que possible, des bio-tests miniaturisés et automatisés, ceci afin de simplifier davantage les opérations, de maximiser le rendement et de minimiser les coûts impliqués. Nous en arrivons donc au stade actuel de développement et d'utilisation de cette approche qui, comme nous l'avons déjà mentionné, subit en ce moment un rodage. L'interprétation éventuelle de la multitude de données générées par les études en cours confirmera bientôt la valeur de cette méthode pour l'évaluation écotoxicologique du milieu aquatique.

7. CONCLUSIONS

La méthode d'évaluation écotoxicologique intégrée est l'approche qui convient le mieux à l'étude de la toxicité de l'eau. L'examen de plusieurs méthodes a démontré l'efficacité d'une approche "simultanée", lorsqu'il faut analyser un effluent industriel qui contient plusieurs substances altéragènes. De plus, il est possible d'adapter la méthode à l'étude de la pollution du sol et de l'air. Il est d'ailleurs temps que l'étude de la pollution d'un milieu soit effectuée de façon plus réaliste, c'est-à-dire qu'elle comprenne l'analyse d'une gamme suffisamment étendue de paramètres chimiques, biologiques et écotoxiques, afin d'éviter que des perturbations ou des toxicités soient mal estimées. La méthode adoptée permet une identification assez complète des facteurs altéragènes parce qu'elle distingue non seulement les agents chimiques et biologiques de pollution, mais aussi les degrés de toxicité (létal, sublétal et chronique). Rappelons enfin que la méthode d'évaluation écotoxicologique intégrée est d'une utilité indéniable dans la lutte contre la pollution des rejets industriels:

a) parce qu'elle permet d'améliorer la qualité finale des rejets dans l'environnement en démontrant les effets des substances altéragènes a l'aide des essais biologiques et en identifiant clairement l'étape ou le procédé industriels pollueurs;

b) parce qu'elle permet d'obtenir des données précises sur l'impact réel d'une substance ou d'un facteur altéragènes sur l'environnement par la réalisation d'essais <u>in situ</u> qui confirment ou non les résultats initiaux des essais biologiques effectués en laboratoire.

Appliquée dans un tel but, l'évaluation écotoxicologique intégrée favoriserait davantage une politique environnementale de prévention plutôt que de rattrapage et devrait normalement contribuer à enrayer, ou tout au moins, à freiner cette pollution envahissante qui caractérise notre siècle et plus particulièrement notre génération.

En guise de récapitulation finale, les points suivants rappellent la problématique d'une évaluation adéquate des problèmes parfois complexes d'écotoxicité et plaident en faveur d'une méthode d'évaluation écotoxicologique intégrée afin de remédier à ces derniers:

a) D'importantes quantités de substances altéragènes s'infiltrent dans l'environnement par divers moyens;

b) On définit, par le terme écotoxicité, cette insulte globale à la biosphère;

c) Le devenir des substances chimiques libérées à l'environnement est une préoccupation première d'agences mandatées de protection environnementale à l'échelle mondiale;

d) L'évaluation intégrée de l'agression toxique se réalise à travers l'écotoxicologie, dont certaines stratégies sont retenues pour tenter d'élucider les effets et causes de l'écotoxicité afin d'améliorer la protection et la qualité du milieu;

e) Une alliance des sciences biologiques et chimiques est essentielle afin de solutionner les problèmes de l'écotoxicité;

f) La valeur de l'écotoxicologie intégrée devrait être reconnue dans les programmes de protection de l'environnement, et son utilisation devrait être considérée à l'avenir;

g) Les normes, règlements, lois environnementales ainsi que les technologies industrielles devraient être modifiées afin de tenir compte de l'écotoxicité.

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TABLEAUX

FIGURES

Tableau 1. FACTEURS LIES AU PORTRAIT ECOTOXIQUE D'UNE SUBSTANCE

1. SUBSTANCE

PHYSICO-CHIMIE	POTENTIEL DE DEGRADATION
- structure - volatilité - liposolubilité	- abiotique - biotique

↓

2. ORGANISMES - TEST

- sensibilité
- représentativité
- simplicité

rentabilité/efficacité

↓

3. EXPOSITION

- dose/concentration
- durée (court, moyen, long terme)
- niveau (aigu, subaigu, chronique)

↓

INTEGRATION DES EFFETS TOXIQUES

↓

EVALUATION ECOTOXICOLOGIQUE DES DANGERS

TABLEAU 2- APPROCHE SÉQUENTIELLE (ÉTAPISTE).

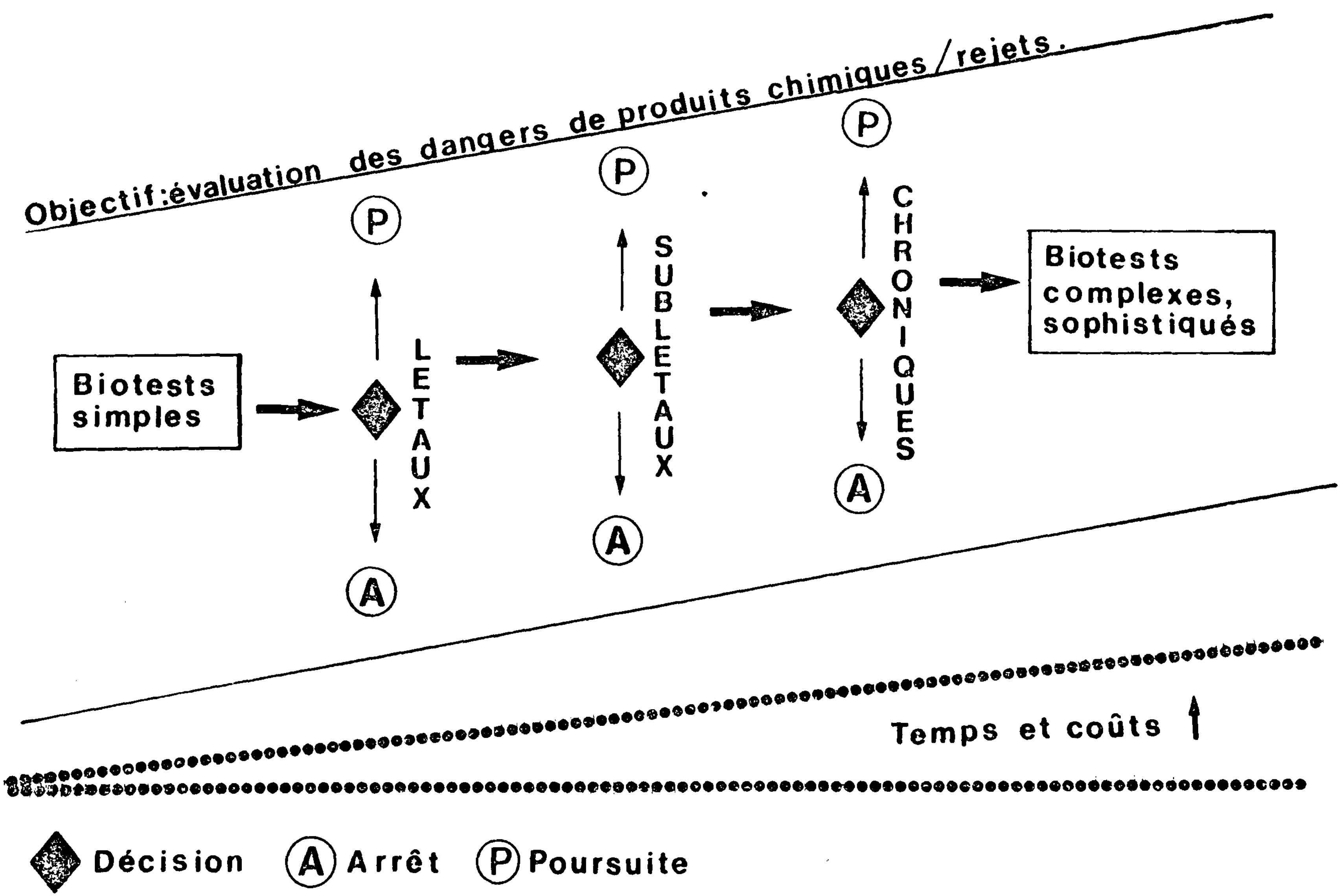


Tableau 3. APPROCHE SIMULTANEE

REALISATION SIMULTANEE DE BIO-TESTS REPRESENTATIFS DE DIFFERENTS NIVEAUX
1. ECOLOGIQUES (ESPECES VARIEES)
2. ECOTOXIQUES (LETAL, SUBLETAL, CHRONIQUE)

→ OBJECTIF →

MISE EN EVIDENCE DES PRINCIPAUX PROBLEMES ECOTOXIQUES

1. TOXICITE
   - LETALE, SUBLETALE, CHRONIQUE
   - CYTOTOXICITE
   - GENOTOXICITE

2. ENRICHISSEMENT
   - EUTROPHISATION
   - CHARGE ORGANIQUE

3. DEVENIR DES POLLUANTS
   - BIO-ACCUMULATION
   - BIOCONCENTRATION
   - BIODEGRADATION
   - PERSISTANCE

4. PROBLEMES MICROBIENS
   - CONTAMINATION FECALE
   - PATHOGENES HUMAINS, ICHTHYENS, ETC.
   - MULTIRESISTANCE AUX ANTIBIOTIQUES

Tableau 4. VUE D'ENSEMBLE DE L'EVALUATION ECOTOXICOLOGIQUE EN FONCTION DES TROIS NIVEAUX DE MESURES DE PROTECTION DE L'ENVIRONNEMENT

NIVEAU	REPERCUSSIONS ECOTOXIQUES		DEGRADATION DE L'ENVIRONNEMENT		
	Degré de toxicité	PORTEE	CAUSE	CONSEQUENCE	MESURE DE CORRECTION
Premier	Toxicité létale aiguë	Locale	Toxicité flagrante: Présence excessive de polluants (contaminants, agents pathogènes, conditions physico-chimiques perturbées, etc.) Exemple: Hg, *Salmonella*, pollution thermique, déversements d'acides.	Disparition quasi-totale (mortalité) des composantes biotiques du milieu à l'exception d'espèces ultra-tolérantes (certaines bactéries par exemple).	Traitement grossier (primaire) des rejets
Deuxième	Toxicité sublétale aiguë à court et moyen termes résultant d'effets stables facilement quantifiables	Régionale	Présence de polluants produisant une toxicité et entraînant une réaction possible de synergie, d'additivité et (ou) d'antagonisme, due au désordre (déséquilibre) physico-chimique engendré dans le milieu aquatique. Ce type de toxicité peut être, en plus, biodégradable, mais non bio-accumulable.	Effets mesurables de perturbation au niveau de la diversité biologique et conséquences de stress physiologique, biochimique et éthologique de durée précise.	Traitement secondaire (biologique) efficace des eaux de rejet garantissant leur innocuité optimale envers l'environnement récepteur. Dans certains cas, la capacité assimilatrice du milieu devra s'ajouter au traitement afin d'assurer l'innocuité du rejet.
Troisième	Toxicité chronique avec effet écotoxique à court, moyen ou long termes	Globale	Toxicité insidieuse, parfois difficilement interprétable quant aux dangers réels qu'elle représente, due à la dynamique de certaines manifestations écotoxiques. Les polluants ne sont pas assimilables par le milieu récepteur et s'infiltrent dans un biotope par des mécanismes de persistance, bio-accumulation et (ou) bioconcentration et (ou) en altérant les caractéristiques génétiques des composantes biotiques du milieu.	Réduction dans la fréquence de survie à long terme, dans le taux de croissance, dans la reproduction des espèces; déstabilisation des structures et fonctions des écosystèmes aquatiques avec possibilité de récurrence d'effets létaux; induction de problèmes génotoxiques.	L'élimination de ce type de danger peut être dispendieux et nécessitera bien souvent un traitement à la source du (des) polluant(s), après considérations d'ordre socio-économique et évaluation de risques et de dangers.

Tableau 5. PROGRAMME D'ÉCOTOXICOLOGIE PROPOSÉ POUR LES LABORATOIRES DU S.P.E., ENVIRONNEMENT CANADA, RÉGION DU QUÉBEC, LONGUEUIL

OBJECTIF : Offrir à la Région la capacité technique d'identifier, par le biais de l'approche écotoxicologique, les principaux problèmes environnementaux susceptibles d'avoir des répercussions néfastes sur la qualité de l'eau, de l'air et du sol.

MOYENS : 1. Développer un arsenal cohérent et intégré d'essais biologiques basé sur des principes de simplicité, rapidité, sensibilité, reproductibilité, représentativité et rentabilité (IDENTIFICATION DU PROBLEME).

2. Approfondir les données biologiques obtenues par une expertise chimique de support complémentaire (DEFINIR LA CAUSE DU PROBLEME).

UTILITE : Permettre l'évaluation des risques et des dangers courus par l'homme et l'environnement: la connaissance des différents problèmes (EFFETS) et des agents qui en sont responsables (CAUSES) offre la possibilité accrue de mieux connaître et d'interpréter les répercussions de déversements, de substances chimiques, etc. et facilite la tâche des gestionnaires dont la responsabilité est de faire des recommandations et de superviser l'application de mesures correctives visant à restaurer l'environnement ou, tout au moins, à minimiser les effets néfastes sur celui-ci.

Tableau 6. PRINCIPALES PHASES DE DÉVELOPPEMENT ÉCOTOXICOLOGIQUE

1. PHASE I : Développement d'un plan d'action pratique pour l'évaluation écotoxicologique intégrée du milieu aquatique:

   - eaux douces (action initiée)
   - eaux marines (action initiée)

2. PHASE II : Développement d'un plan d'action pratique pour l'évaluation écotoxicologique intégrée du milieu terrestre (à élaborer et à adopter).

3. PHASE III : Développement d'un plan d'action pratique pour l'évaluation écotoxicologique intégrée du milieu atmosphérique (à élaborer et à adopter).

Tableau 7. EVALUATION ECOTOXICOLOGIQUE SIMULTANEE DE REJETS AQUEUX
(efforts et coût basés sur l'appréciation de 10 échantillons)

ETAPES OPERATIONNELLES: PREMIER ECHANTILLONNAGE DES REJETS		
Première étape	**Deuxième étape**	**Troisième étape**
Opérations: - Echantillonnage; - Indicateurs microbiens classiques; - Analyses physico-chimiques (Type 1)[1]; - Bioessais de dépistage[5]; - Bioaccumulation autotrophique; - Biodégradation; - Potentiel mutagénique; - Evaluation. EFFORT TOTAL: 32 personnes-jours	Opérations: - Identification microbienne et multirésistance aux antibiotiques; - Analyses chimiques (Type 2)[2]; - Bioessais de dépistage[5] après biodégradation (selon le besoin); - Evaluation. EFFORT TOTAL: Peut varier de 3 à 34 personnes-jours plus 6K[4].	Opérations: - Evaluation et décision possible de procéder à une deuxième ronde d'échantillonnage et d'évaluation subséquentes de certains problèmes écotoxiques relevés.

ETAPES OPERATIONNELLES: DEUXIEME ECHANTILLONNAGE DES REJETS		
Première étape	**Deuxième étape**	**Troisième étape**
Opérations: réalisation partielle ou totale de l'exercice prévu ci-haut, en fonction du degré de nocivité constaté et du degré d'évaluation souhaité. EFFORT TOTAL: entre 9-34 personnes-jours.	Opérations: réalisation partielle ou totale de l'exercice prévu ci-haut, en fonction du degré de nocivité constaté et du degré d'évaluation souhaité. EFFORT TOTAL: entre 3-34 personnes-jours plus 6K[4].	Opérations: Exercices comme ci-haut, selon le besoin. En plus (et en option) - Analyses chimiques (Type 3)[3]; - Bioessais confirmatoires réalisés à de plus hauts niveaux d'organisation biologique; - Essais de cancérogénicité. EFFORT TOTAL: entre 5-99 personnes-jours plus 13K[4].

1. Paramètres essentiels permettant de mieux comprendre la présence d'effets écotoxiques.
2. Paramètres permettant d'identifier les causes potentielles écotoxiques, dont l'analyse peut être réalisée à partir d'échantillons faciles à conserver.
3. Remarque identique à l'annotation 2., mais pour des échantillons difficilement préservables.
4. Montants prévus pour analyses contractuelles.
5. Bioessais simples, rapides et peu coûteux réalisés avec bactéries, algues et protozoaires.

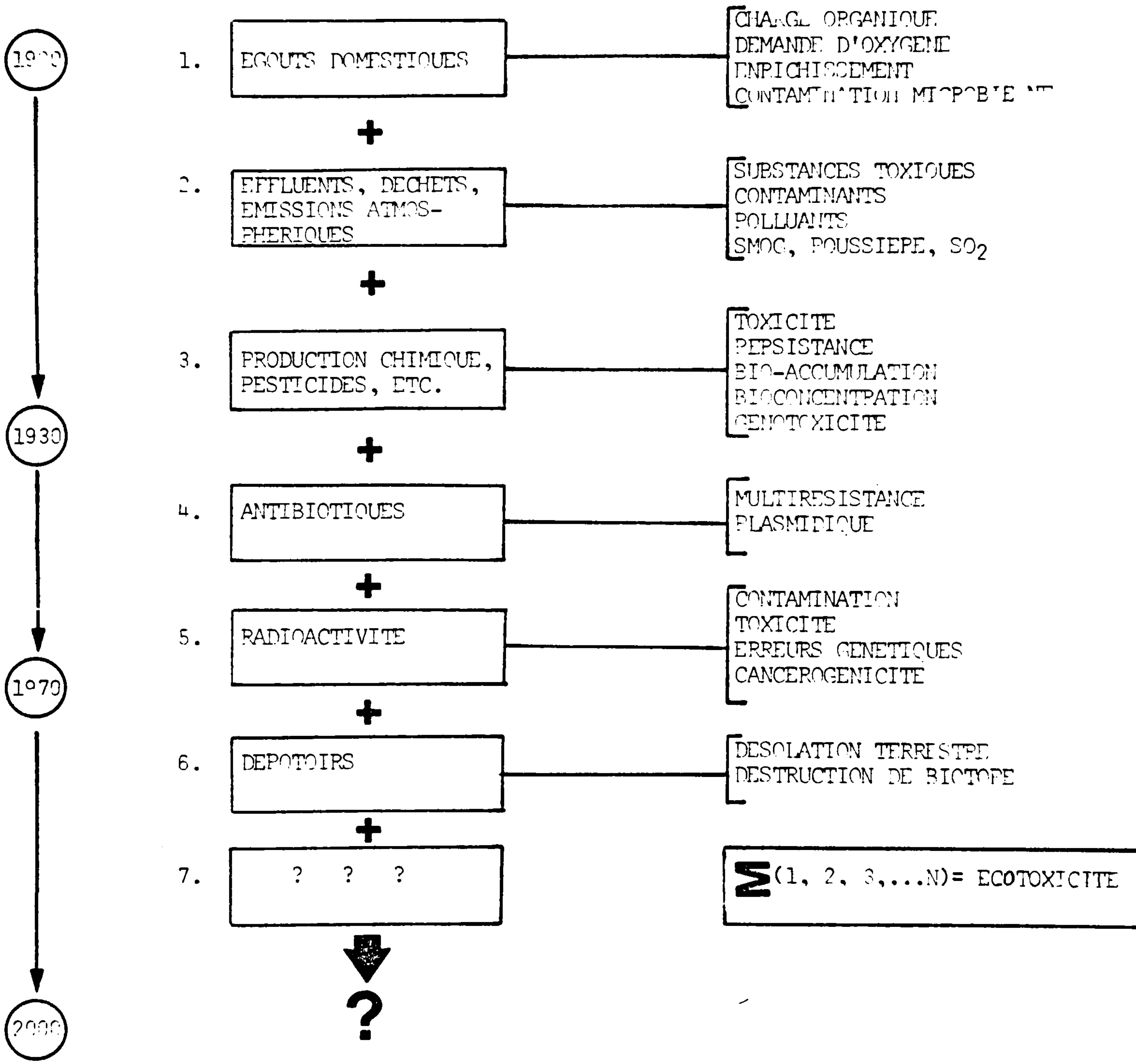


Figure 1. ADDITIVITE DES DIVERSES POLLUTIONS ENVIRONNEMENTALES.

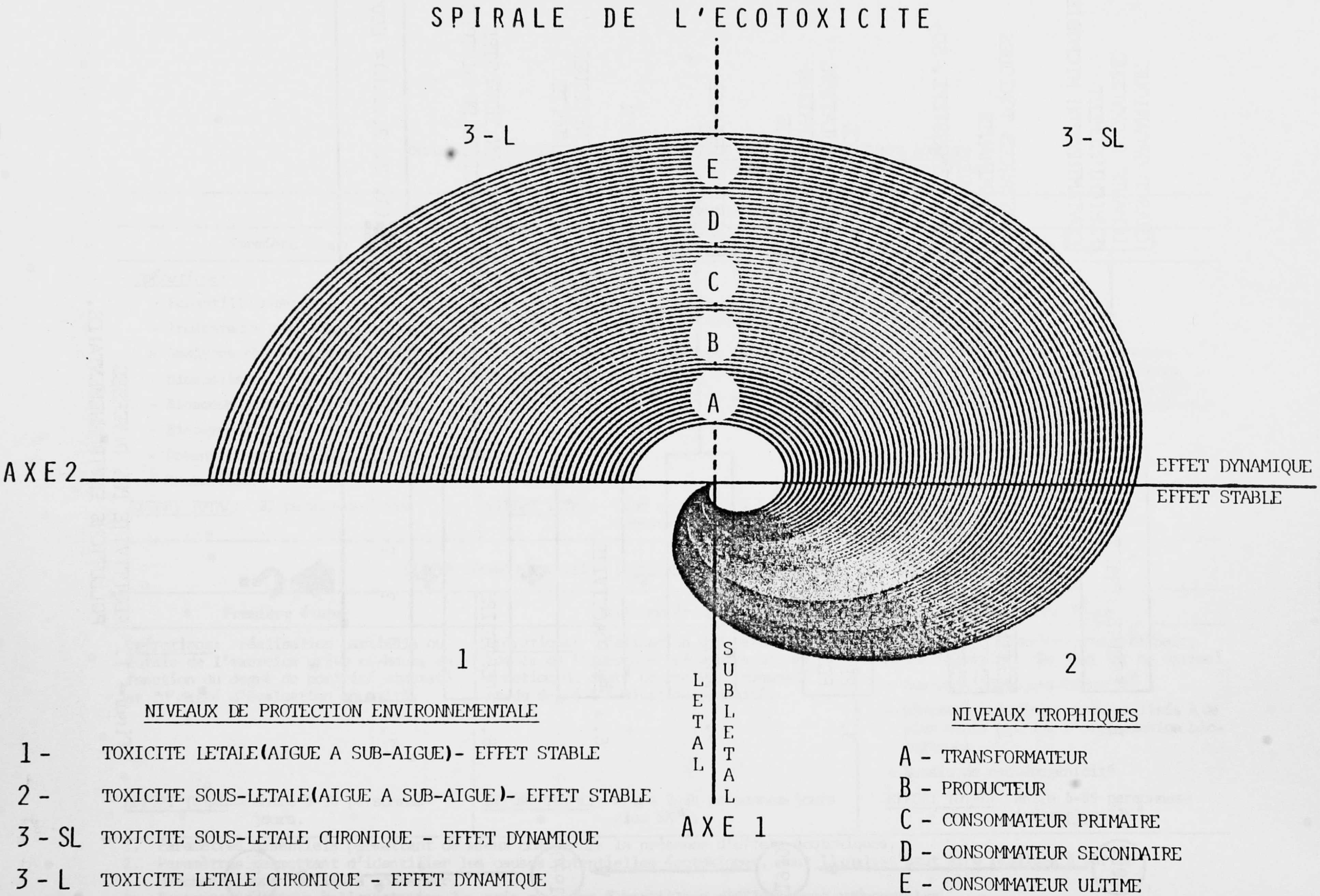


FIGURE 2 : SPIRALE DE L'ECOTOXICITE

SESSION III

Les mécanismes de gestion

Management of Toxic Substances

Ontario's Hazardous Contaminants Program

Ed Piche

Hazardous Contaminants and Standards Branch

Ontario Ministry of the Environment

GOOD MORNING, EVERYONE. I'M ED PICHE, ACTING DIRECTOR OF THE HAZARDOUS CONTAMINANTS AND STANDARDS BRANCH OF THE ONTARIO MINISTRY OF THE ENVIRONMENT. I APPRECIATE THE OPPORTUNITY TO SPEAK TO YOU TODAY ON A SUBJECT THAT IS BOTH TOPICAL AND IMPORTANT. (FIG. 1)

FIRST, I SHOULD POINT OUT THAT MANAGEMENT OF TOXIC SUBSTANCES IS A MINISTRY-WIDE CONCERN. VARIOUS BRANCHES IN THE ENVIRONMENTAL PLANNING DIVISION OF THE MINISTRY, AND OUR WORLD-CLASS MINISTRY LABORATORY ARE ALL DOING IMPORTANT AND PIONEERING WORK IN THIS AREA. I'LL TALK MORE ABOUT ALL THESE PROGRAMS LATER.

I ALSO WANT TO POINT OUT THAT ONTARIO IS THE FIRST PROVINCIAL GOVERNMENT IN CANADA TO ESTABLISH A SPECIAL BRANCH (IN THE MINISTRY OF THE ENVIRONMENT) TO DEAL EXCLUSIVELY WITH HAZARDOUS CONTAMINANTS--OR TOXIC SUBSTANCES. WE ARE PROUD OF OUR INITIATIVE IN THIS NEW AREA, AND JUSTIFIABLY I THINK, BECAUSE IN A SHORT TIME, WE HAVE ALREADY BEGUN TO PUT IN PLACE SOME PRETTY IMPORTANT PROGRAMS TO ADDRESS THE MANAGEMENT OF TOXIC SUBSTANCES IN THE ENVIRONMENT.

I FOUND A TIMELY LITTLE NEWSPAPER ARTICLE WHICH SHOWS THE DIMENSIONS OF OUR TOPIC, AND WHICH HAS A REVEALING QUOTATION.

THE HEADLINE ANNOUNCES, "RIVERS LACED WITH POISONS". THE ARTICLE SAYS THAT A PROVINCIAL GOVERNMENT STUDY SHOWED THAT AN AVERAGE KILOGRAM OF YELLOW PERCH TAKEN IN 1978 FROM VARIOUS RIVERS IN EASTERN CANADA CONTAINED:

°	ARSENIC	0.0225 MG
°	CADMIUM	0.0062 MG
°	CHROMIUM	2.07 MG
°	COPPER	1.55 MG
°	MERCURY	0.76 MG
°	NICKEL	1.05 MG
°	LEAD	0.47 MG
°	POLYCHLORINATED BIPHENYLS	95. MG
°	DDT	168. MG

(FIG. 2) HERE'S THE QUOTATION, FROM ONE OF THE AUTHORS: "THERE ARE SO MANY DIFFERENT PRODUCTS IN THE FISH WE ANALYSE THAT YOU WONDER HOW THEY STAY AFLOAT."

THE AUTHOR CONTINUES, "THERE IS A HOST OF OTHER PRODUCTS, <u>KNOWN AND UNKNOWN</u>, NOT YET MEASURED, WHICH ARE PROBABLY IN THE FISH." THAT'S NOT VERY REASSURING.

AND WE'RE NOT EVEN SURE ABOUT HOW THE SUBSTANCES WE <u>DO</u> KNOW ABOUT AFFECT US. I AM REMINDED OF A CARTOON ABOUT 2 SCIENTISTS. ONE IS TELLING THE OTHER ABOUT A POTION HE HAS DISCOVERED. "IT WILL GIVE US IMMORTALITY," HE SAYS, "BUT IT WILL TAKE FOREVER TO TEST IT."

I WANT TO TALK TODAY ABOUT THE KINDS OF THINGS WE HAVE TO DO TO BE IN A POSITION TO "MANAGE" TOXIC SUBSTANCES IN THE ENVIRONMENT. AND IN CONSIDERING THESE THINGS, WE ARE CONFRONTED AT EVERY STEP WITH THE NOTION OF <u>RISK</u>--THE RISK TO HUMAN HEALTH AND THE ENVIRONMENT

POSED BY TOXIC SUBSTANCES. THERE ARE DIFFERENT THINGS TO TAKE INTO CONSIDERATION AT EACH POINT.

WE HAVE TO CALCULATE, AS ACCURATELY AND REASONABLY AS POSSIBLE, THE NATURE AND EXTENT OF THE RISKS ASSOCIATED WITH SOME SUBSTANCES. WE'VE COME A LONG WAY IN THIS, BUT WE STILL HAVE MANY MILES TO GO. WE THEN HAVE TO DECIDE WHAT LEVEL OF RISK WE'RE PREPARED TO LIVE WITH. THIS PRESENTS A PROBLEM OF TRADING OFF THE RISKS, ON THE ONE HAND, AND THE COSTS (NOT JUST FINANCIAL) OF CONTROLLING THEM, ON THE OTHER. AND ONLY THEN CAN WE THINK ABOUT DEVELOPING EFFECTIVE MEASURES TO "MANAGE" RISKS.

I'VE TRIED TO SIMPLIFY THIS TASK INTO THREE MAIN SPHERES OF ACTIVITY: (FIG. 3)

SCIENCE - PURE AND SIMPLE, BUT OFTEN UNCERTAIN;

SYNTHESIS - OBJECTIVE, SUBJECTIVE AND COMPLEX;

STRATEGY - BITING THE BULLET AND TAKING A STAND.

BEFORE WE GET TO A POINT OF BEING ABLE TO "MANAGE" TOXIC SUBSTANCES, WE HAVE TO GO THROUGH A VARIETY OF STEPS, AND NONE OF THEM IS EASY. BUT IF WE TAKE EACH IN TURN, WE CAN TRY TO FIND:

- METHODS AND CONCLUSIONS OF SCIENCE THAT ARE AS RELIABLE AS POSSIBLE (OR AT LEAST A FAIRLY CLEAR INDICATION OF LIMITATIONS);

- FAIR AND EFFECTIVE WAYS OF CONSIDERING ALL FACTORS THAT ARE IMPORTANT IN A DECISION ON RISKS WE ARE PREPARED TO LIVE WITH; AND

- APPROPRIATE REGULATORY RESPONSES TO MAINTAINING AND NOT EXCEEDING THAT LEVEL OF RISK.

THE MINISTRY OF THE ENVIRONMENT ALREADY HAS A SOLID TRACK RECORD IN ADDRESSING RISKS ASSOCIATED WITH TOXIC SUBSTANCES, HAVING CARRIED ON THE WORK OF PREVIOUS ENVIRONMENTAL AGENCIES, SUCH AS THE ONTARIO WATER RESOURCES COMMISSION. THE MINISTRY HAS BEEN CONDUCTING RESPONSIBLE AND OFTEN PIONEERING WORK IN THIS FIELD IN A VARIETY OF WAYS AND IN SEVERAL BRANCHES.

I WANT TO GIVE YOU A QUICK OVERVIEW OF THE KINDS OF THINGS WE HAVE BEEN DOING TO DATE IN THE MINISTRY OF THE ENVIRONMENT. THEN I'LL GO ON TO THE LARGER CHALLENGES OF COMBINING SCIENCE, SYNTHESIS AND STRATEGY TO PROTECT OUR WELL-BEING. (FIG. 4)

THE AIR RESOURCES BRANCH OF THE MINISTRY IS DEVELOPING A "SUPER MODEL" FOR THE LONG-RANGE TRANSPORT OF AIR POLLUTANTS. THIS IS A CO-OPERATIVE EFFORT BY CANADA, ONTARIO AND WEST GERMANY.

THE WATER RESOURCES BRANCH HAS ESTABLISHED A NEW DRINKING WATER SECTION WITH THE RESPONSIBILITY FOR DEVELOPING PLANS, STRATEGIES, PROGRAMS AND POLICIES TO ENSURE THE PROTECTION OF DRINKING WATER QUALITY IN THE PROVINCE.

UNDER THE DIRECTION OF THE WASTE MANAGEMENT BRANCH, AN APPROVAL AND MANAGEMENT SYSTEM IS BEING IMPLEMENTED FOR MOBILE TECHNOLOGY FOR THE DESTRUCTION OF PCB'S. THIS IS A TIMELY AND SENSIBLE IDEA; WE'RE GOING TO TAKE THE TECHNOLOGICAL EQUIPMENT FOR DESTROYING PCB'S TO THE SITES WHERE THEY ARE FOUND. WHAT IS BEING WORKED OUT NOW ARE THE TERMS AND CONDITIONS UNDER WHICH THE EQUIPMENT WILL BE OPERATED.

AS WELL, WASTE MANAGEMENT BRANCH PRODUCED A "BLUEPRINT FOR WASTE MANAGEMENT" IN THE SUMMER OF 1983 WHICH PRESENTED A COMPREHENSIVE STRATEGY FOR DEALING WITH ALL KINDS OF WASTES IN THE PROVINCE. NOW THE BRANCH IS AT THE STAGE OF IMPLEMENTING THE BLUEPRINT.

AT MY OWN BRANCH, HAZARDOUS CONTAMINANTS AND STANDARDS, WE ARE CONDUCTING ENVIRONMENTAL FATE ANALYSIS STUDIES ON PESTICIDES, SPECIFICALLY, ALDICARB AND ATRAZINE. THIS IS A JOINT EFFORT BY OUR MINISTRY, THE ONTARIO MINISTRY OF AGRICULTURE AND FOOD, AND THE PROVINCIAL PESTICIDES ADVISORY COMMITTEE. (THE ADVISORY COMMITTEE IS A GROUP OF SCIENTIFIC EXPERTS ESTABLISHED IN THE LATE 1960'S TO ADVISE AND REPORT DIRECTLY TO THE MINISTER OF THE ENVIRONMENT ON MATTERS RELATED TO THE USE AND CONTROL OF PESTICIDES IN THE PROVINCE.)

THE MINISTRY'S LABORATORY SERVICES AND APPLIED RESEARCH BRANCH HAS PURSUED HIGH LEVELS OF EXCELLENCE IN THE DEVELOPMENT OF NEW ANALYTICAL METHODS AND SAMPLING PROTOCOLS, AND IN THE COMPUTERIZATION OF INFORMATION. FOR EXAMPLE, THE ACID RAIN DATA BASE AND MODEL PRODUCED BY THE LABORATORY WILL BE USED BY THE US NATIONAL AERONAUTICS AND SPACE ADMINISTRATION IN GROUND-PROOFING SATELLITE REMOTE-SENSING IMAGERY.

THE MINISTRY'S REGIONAL OPERATIONS DIVISION IS IMPORTANT TO THE OVERALL EFFORT BECAUSE IT IMPLEMENTS THE MINISTRY'S TOXIC SUBSTANCES CONTROL PROGRAMS THROUGH ENFORCEMENT MEASURES, MONITORING, AND ENSURING THAT ABATEMENT MEASURES ARE UNDERTAKEN AS REQUIRED. <u>THIS IS WHERE THINGS GET DONE</u>. FIELD OFFICERS WORK CLOSELY WITH INDUSTRY, MUNICIPALITIES AND PRIVATE CITIZENS IN CARRYING OUT THIS PROGRAM AT THE LOCAL LEVEL.

ALL THESE ACTIVITIES ARE IMPORTANT COMPONENTS OF THE MINISTRY'S RESPONSE TO THE NEED TO MANAGE TOXIC SUBSTANCES.

BUT THE SITUATION TO WHICH ALL THESE EFFORTS MUST RESPOND IS BECOMING MORE COMPLICATED ALL THE TIME. WE ARE NOW FACED WITH A CLASS OF SUBSTANCES THAT CAN PUT PEOPLE AT RISK IN A VARIETY OF WAYS. DIOXIN, FOR EXAMPLE, CAN BE FOUND IN WATER, AIR, LAND OR DIET.

OUR CHALLENGE IS TO MAKE OUR RESPONSE TO THIS COMPLEX SITUATION AS <u>EFFECTIVE AND EFFICIENT AS POSSIBLE</u>. ONE WAY TO DO THAT IS TO CO-ORDINATE WHAT WE ARE DOING IN

ORDER TO HAVE A MORE SHARPLY-FOCUSED EFFORT AND ULTIMATELY A BETTER-QUALITY PRODUCT.

THE HAZARDOUS CONTAMINANTS AND STANDARDS BRANCH WAS ESTABLISHED IN THE SUMMER OF 1982 TO FOCUS AND CO-ORDINATE THE IDENTIFICATION, EVALUATION AND MANAGEMENT OF TOXIC SUBSTANCES IN THE ENVIRONMENT. SPECIFICALLY, THE ROLE OF THE HAZARDOUS CONTAMINANTS AND STANDARDS BRANCH IS AS FOLLOWS: (FIG. 5)

A) TO ASSESS THE SIGNIFICANCE OF HAZARDOUS CONTAMINANTS AND COORDINATE MINISTRY ACTIVITIES FOR THEIR CONTROL.

B) TO ESTABLISH STANDARDS FOR THE PROTECTION OF PUBLIC HEALTH AND THE ENVIRONMENT.

IT'S A TOUGH JOB, BUT SOMEBODY'S GOT TO DO IT.

FIRST, WHAT IS MEANT BY A "STANDARD"? TO US, A STANDARD IS SIMPLY THE MEASURE WHICH RESULTS FROM A WEIGHING OF RISKS, BENEFITS AND COSTS. IN PRACTICAL TERMS IT CAN BE A "GUIDELINE", AN "OBJECTIVE", A "RECOMMENDATION", A LEGALLY- ENFORCEABLE NUMBER, (WHICH CAN BE CONTROLLED IN A CERTIFICATE OF APPROVAL, FOR EXAMPLE) OR A "REGULATION". IN SHORT, IT'S THE MEASURE OF RISK WE ARE PREPARED TO LIVE WITH.

WE CAN DEVELOP MORE EFFECTIVE STRATEGIES FOR MANAGING TOXIC SUBSTANCES IF WE DO KNOW THAT LEVEL. WHEN WE HAVE DECIDED ON SUCH A "STANDARD", WE CAN CHOOSE THE MOST APPROPRIATE MANAGEMENT OPTIONS, THAT IS, WHEN WE

KNOW HOW SERIOUS THE RISK IS, AND HOW MUCH DEVIATION THERE IS FROM THE "STANDARD".

THERE ARE OTHER BENEFITS TO ESTABLISHING "STANDARDS" FOR EXPOSURE TO TOXIC SUBSTANCES. THESE ARE SOME OF THE ONES WE SEE: (FIG. 6)

1. SETTING STANDARDS REFLECTS AN ATTEMPT TO PROTECT PEOPLE AND THE NATURAL ENVIRONMENT FROM UNACCEPTABLE HARM THROUGH A MULTI-MEDIA CONSIDERATION OF PUBLIC EXPOSURE TO HAZARDS--AND BY MULTI-MEDIA I MEAN FROM THE AIR, FROM THE WATER, FROM THE LAND, ETC.

2. STANDARDS CAN FOCUS AND ALLOW PRIORITIES TO BE SET FOR RESEARCH AND ABATEMENT EFFORTS.

3. STANDARDS CAN PROVIDE BENCHMARKS FOR MONITORING, FOR A REFINEMENT OF PROGRAMS THAT WE UNDERTAKE AS A MATTER OF COURSE.

4. STANDARDS ALLOW BUSINESS AND INDUSTRY TO KNOW THE TARGET, KNOW THE RULES. THIS CAN STABILIZE THEIR BUSINESS-PLANNING, AND CLARIFY AND SPEED UP THE APPROVAL PROCESS FOR INDUSTRIAL AND COMMERCIAL DEVELOPMENT.

ESTABLISHING STANDARDS IS A KEY ELEMENT OF EFFECTIVE MANAGEMENT OF TOXIC SUBSTANCES. HERE IS HOW WE SEE THE LOGICAL STEPS ON THE ROAD TO IT. (FIG. 7) WE HAVE CHOSEN TO CALL THESE STEPS RISK IDENTIFICATION, RISK ANALYSIS, RISK ASSESSMENT AND RISK MANAGEMENT. PEOPLE

WORKING IN THIS FIELD USE DIFFERENT WORDS TO MEAN THE SAME THINGS, FOR EXAMPLE, RISK ESTIMATION INSTEAD OF RISK ANALYSIS, RISK EVALUATION INSTEAD OF RISK ASSESSMENT. IN ANY CASE, YOU SEE THAT EVERYTHING INVOLVES RISK--THE OPERATIVE NOTION IN ALL OF THIS.

THE FIRST CATEGORY, RISK IDENTIFICATION, INVOLVES IDENTIFYING AND RANKING SUBSTANCES FOR PRIORITY AS HAZARDS; THE RANKING IS COMMONLY BASED ON THINGS LIKE TOXIC EFFECTS TO HUMAN HEALTH OR ENVIRONMENT, PERSISTENCE, AND QUANTITY AND USE.

AT A RISK ANALYSIS STAGE, SCIENTIFIC INFORMATION IS ASSEMBLED AND ANALYZED TO DETERMINE POTENTIAL ADVERSE HEALTH EFFECTS; THIS ANALYSIS SHOWS THE TYPE AND EXTENT OF SUCH EFFECTS AT CERTAIN LEVELS OF EXPOSURE.

RISK ASSESSMENT IS THE STAGE AT WHICH VARIOUS INTERESTS DETERMINE THE ACCEPTABILITY OF A CERTAIN LEVEL OF RISK IN COMPARISON WITH HOW REASONABLE THE COSTS OF CONTROLLING THE RISK ARE. THIS CAN RESULT IN THE SETTING OF A STANDARD FOR A PARTICULAR SUBSTANCE.

THE FINAL STAGE IS THAT OF MANAGING THESE RISKS BY SELECTING AN APPROPRIATE AND RESPONSIBLE REGULATORY OPTION TO ADDRESS A POTENTIAL HEALTH HAZARD.

NOW, LET ME TELL YOU ABOUT SOME OF THE GOOD THINGS WE ARE DOING IN MY BRANCH IN OUR CO-ORDINATING FUNCTION, FIRST IN THE AREA OF SCIENCE. THESE INVOLVE BOTH RISK IDENTIFICATION AND RISK ANALYSIS.

Last year, a Priority List Working Group was established to identify hazardous substances, screen them, and give them a priority ranking for further evaluation. Their terms of reference were as follows: (Fig. 8)

1. Develop a set of criteria (rules) for the selection of substances that are candidates for standard setting.

2. Develop a method of establishing priorities for the candidate substances.

3. Expand the existing list (HCO) of 209 substances to include pesticides and the more 'traditional' types of pollutants such as microorganisms, sulphur oxides, nitrogen oxides, etc.

The last item concerns a list of substances that was developed under the direction of the Ministry's Hazardous Contaminants Office (which was amalgamated when my Branch was set up). A working group conducted a literature search from sources all over the world to identify 209 substances requiring further evaluation by my Ministry. The information in this document, called "Chemical Identification", now forms the basis of the Priority List Working Group's efforts.

The group's task is to develop a method to estimate the environmental and health hazard posed by these substances, and of course, to add to and update the list.

THEY PROPOSE TO DO THIS IN THE FOLLOWING WAY. THEY INTEND TO CHECK TO SEE, FIRST, IF THERE IS AN EXISTING "STANDARD" (OR GUIDELINE OR REGULATION) FOR A PARTICULAR SUBSTANCE WHICH WOULD AFFECT THE RANKING PROCEDURE, AND SECOND, IF THE EXISTING STANDARD SHOULD BE UPDATED IN THE LIGHT OF NEW AND EVOLVING INFORMATION.

THE GROUP WILL CONDUCT AN "EXPOSURE ASSESSMENT" AS WELL AS AN "EFFECTS ASSESSMENT". (FIG. 9) THE INDUSTRIAL COMPONENT OF THE EXPOSURE ASSESSMENT WILL BE DONE ON THE BASIS OF DATA FROM A WIDE RANGE OF SOURCES, INCLUDING THE FEDERAL GOVERNMENT, OTHER PROVINCIAL AGENCIES, MOE'S OWN DATA, AND TWO OUTSIDE STUDIES. THE FIRST IS A SURVEY (DESIGNED BY MY BRANCH) CONDUCTED BY THE CANADIAN CHEMICAL PRODUCERS ASSOCIATION IN 1983 AT OUR REQUEST, AND THE OTHER IS A SURVEY OF 14 CHLORINATED AND AROMATIC HYDROCARBONS DONE FOR MOE BY ACRES CONSULTING IN 1979.

THE CCPA SURVEY PROVIDED AGGREGATE INFORMATION ON THE IMPORT, EXPORT, MANUFACTURE, STORAGE, EMISSIONS TO AIR, DISCHARGES OF WATER, WASTE DISPOSAL AND END USE FOR 254 SUBSTANCES OR CLASSES OF SUBSTANCES OF CONCERN TO MY MINISTRY. THE CCPA NOT ONLY CONDUCTED A SURVEY OF ITS OWN MEMBERS BUT ALSO CO-ORDINATED MEMBER SURVEYS BY OTHER INDUSTRIAL ORGANIZATIONS.

THIS IS A FINE EXAMPLE, BY THE WAY, OF INDUSTRY CO-OPERATING WITH GOVERNMENT, AND WE COMMEND IT. CCPA DELIVERED AN EXCELLENT PRODUCT WHICH WAS EXTREMELY USEFUL TO US AS THE BASIS FOR FURTHER WORK. THIS KIND

OF CO-OPERATION FORGES VALUABLE LINKS BETWEEN INDUSTRY AND GOVERNMENT IN AN AREA OF MUTUAL INTEREST AND RESPONSIBILITY. WE INTEND TO LOOK FOR FURTHER OPPORTUNITIES TO DO THIS IN THE FUTURE.

THE INFORMATION ASSEMBLED FOR THE EXPOSURE ASSESSMENT WILL BE CONSIDERED TOGETHER WITH OTHER INFORMATION ON MAN-MADE AND NATURAL SOURCES, ENVIRONMENTAL MONITORING DATA AND ENVIRONMENTAL TRANSPORT AND FATE. BUT EVEN BY ITSELF IT PROVIDES VALUABLE INSIGHTS FOR NARROWING THE LIST OF SUBSTANCES TO INCLUDE THOSE WITH A SIGNIFICANT PRESENCE IN ONTARIO; FOR EXAMPLE, SOME OF THE 140 "NOT REPORTED" SUBSTANCES WOULD BE CONSIDERED TO BE OF LESS IMPORTANCE THAN THE "REPORTED" ONES.

THIS EXPOSURE ASSESSMENT IS COMPLEMENTED BY AN "EFFECTS" ASSESSMENT. (FIG. 10) THIS WORK IS PROPOSED TO BE DONE ACCORDING TO THE HAZARD ASSESSMENT PROCESS DEVELOPED BY THE STATE OF MICHIGAN. THAT PROCESS IS A PRIORITY RANKING POINT ASSIGNMENT SYSTEM USED TO EVALUATE COMPOUNDS FOR THEIR SIGNIFICANCE IN THE FOLLOWING AREAS:

- ACUTE TOXICITY (ORAL, DERMAL, ACQUATIC, INHALATION)
- CARCINOGENICITY
- HEREDITARY MUTAGENICITY
- TERATOGENICITY
- ENVIRONMENTAL PERSISTENCE
- BIOACCUMULATION (BCF OR LOG P)
- OTHER ADVERSE EFFECTS - TERRESTRIAL ANIMALS

- AQUATIC ORGANISMS
- PLANTS
- AESTHETICS

THE SCORING SYSTEM IS FULLY EXPLAINED IN THE "CHEMICAL IDENTIFICATION" DOCUMENT.

I SHOULD POINT OUT THAT THIS IS NOT NEW RESEARCH; IT DRAWS ON A WIDE RANGE OF EXISTING SOURCES. BUT IT IS NEW WORK: THE REFINEMENT OF TECHNIQUES, CRITERIA AND EVALUATION THAT THIS GROUP WILL UNDERTAKE IS PIONEERING WORK IN ITSELF.

IN OUR WORK TOWARDS THE DEVELOPMENT OF STANDARDS, MY BRANCH HAS UNDERTAKEN THE PREPARATION OF SCIENTIFIC CRITERIA DOCUMENTS ON LEVELS OF RISK POSED BY CERTAIN SUBSTANCES. THIS WORK INVOLVES REVIEWING THE LATEST LITERATURE AND THEN ANALYSING THIS DATA TO DETERMINE EFFECTS ON HUMAN HEALTH AND THE NATURAL ENVIRONMENT, THINGS LIKE WHAT RISKS ARE ASSOCIATED WITH DIFFERENT LEVELS OF EXPOSURE TO A HAZARDOUS SUBSTANCE.

WORK IS UNDERWAY NOW ON A STUDY OF THE EFFECTS OF DIOXINS AND DIBENZOFURANS. ONLY IN RECENT YEARS HAS THE MINISTRY'S OWN LABORATORY DEVELOPED A WAY TO MEASURE THESE SUBSTANCES IN MINUTE AMOUNTS. THE LAB CAN NOW MEASURE DIOXIN IN PARTS PER QUADRILLION. THAT IS LIKE BEING ABLE TO FIND A DOLLAR BILL WITH YOUR NAME ON IT IF THE WHOLE CANADIAN CONTINENT WERE BLANKETED WITH DOLLAR BILLS LAID END TO END AND SIDE TO SIDE. NOW THAT SCIENCE HAS ALLOWED US TO DISCOVER SUSPECTED HAZARDS, WE ARE OBLIGED TO STUDY THEM.

THE FEDERAL GOVERNMENT IS LOOKING AT THE WHOLE SCOPE OF DIOXINS IN CANADA, AND WE IN ONTARIO HAVE BEEN WORKING CO-OPERATIVELY WITH THEM AND SHARING INFORMATION. THE FEDERAL GOVERNMENT HAS APPOINTED A SCIENTIFIC ADVISORY COMMITTEE ON DIOXINS UNDER THE ENVIRONMENTAL CONTAMINANTS ACT. THE GOVERNMENT HAS ALSO SET UP AN INTERNAL INTERDEPARTMENTAL COMMITTEE WHICH HAS DEVELOPED A FEDERAL APPROACH TO THE PROBLEM OF DIOXINS. BOTH GROUPS REPORTED THEIR FINDINGS IN DECEMBER 1983.

(FIG. 11) IN ONTARIO WE HAVE FOCUSED ON OUR OWN PRIORITIES RELATED TO DIOXIN-- ON ONTARIO SOURCES AND PROBLEMS, AND ON AREAS THAT ARE IN THE MINISTRY'S MANDATE TO CONTROL. THERE ARE FOUR SIGNIFICANT SOURCES OF IT IN THE PROVINCE: SITE-SPECIFIC CONTAMINATION OF THE NIAGARA RIVER (YOU'VE HEARD OF THE LOVE CANAL), VARIOUS KINDS OF INCINERATION, THE OPERATIONS OF THE WOOD PRESERVING INDUSTRY, AND ONE SITE WHERE PHENOXYHERBICIDE WAS FORMULATED MANY YEARS AGO. AS WELL, WE HAVE DATA ON SOURCES AND EXPOSURE LEVELS SPECIFICALLY IN ONTARIO FROM THE MINISTRY'S OWN MONITORING ACTIVITIES.

THE SCIENTIFIC CRITERIA DOCUMENT WILL PRESENT A RECOMMENDED AVERAGE DAILY INTAKE OF THESE SUBSTANCES, (THAT'S AVERAGED ANNUALLY), AND INFORMATION ON SOURCES AND ENVIRONMENTAL CONCENTRATIONS.

THIS WORK IS BEING DONE IN CO-OPERATION WITH SEVERAL AGENCIES WHOSE MANDATES INCLUDE THIS ISSUE. MY BRANCH CO-ORDINATES AN INTERNAL EXPERT COMMITTEE MADE UP OF

SPECIALISTS FROM THE MINISTRY'S AIR RESOURCES BRANCH, WATER RESOURCES BRANCH, POLICY AND PLANNING BRANCH, AND THE LABORATORY, WITH MEDICAL ADVICE PROVIDED BY THE MINISTRY OF LABOUR. THIS COMMITTEE, DIVIDED INTO A HUMAN EFFECTS GROUP AND AN ENVIRONMENTAL EFFECTS GROUP, IS RESPONSIBLE FOR THE PREPARATION OF THE SCIENTIFIC CRITERIA DOCUMENT.

(FIG. 12) THERE IS ALSO AN EXTERNAL EXPERT COMMITTEE TO GIVE SCIENTIFIC DIRECTION TO THE EXERCISE BY A REVIEW OF THE INTERNAL COMMITTEE'S INFORMATION, FINDINGS AND CONCLUSIONS. PEOPLE ON THIS EXTERNAL COMMITTEE, CALLED THE ONTARIO SCIENTIFIC ADVISORY COMMITTEE ON DIOXINS AND FURANS, ARE ON THE SCIENTIFIC FOREFRONT ON THE ISSUE--THEY ARE TOP CLASS IN THEIR FIELD. THEY ARE:

- DR. O. HUTZINGER, OF THE UNIVERSITY OF BAYREUTH IN GERMANY;
- DR. S. SAFE OF TEXAS A & M UNIVERSITY;
- DR. G. L. PLAA, OF THE UNIVERSITY OF MONTREAL;
- DR. E. SPENCER OF THE UNIVERSITY OF WESTERN ONTARIO.

WE ARE PREPARING ANOTHER SCIENTIFIC REPORT WHICH LOOKS AT A NEW WAY OF CALCULATING RISKS TO HUMANS FROM MICROORGANISMS IN WATERS USED FOR PUBLIC SWIMMING. RECENT STUDIES IN THE FIELD OF EPIDEMIOLOGY HAVE PROVEN CORRELATIONS BETWEEN CERTAIN MICROORGANISMS AND BATHER-RELATED ILLNESSES, SUCH AS GASTROINTESTINAL ILLNESS AND EARACHE. THE CORRELATIONS ALLOW RISKS TO BE CALCULATED MORE ACCURATELY. THE CORRELATIONS MADE

IN THE EPIDEMIOLOGICAL STUDIES WILL BE REFINED INTO A SCIENTIFIC DOCUMENT. WE BELIEVE THE INFORMATION IN THE DOCUMENT CAN BE USED AS A FIRST STEP IN SETTING MICROBIOLOGICAL STANDARDS FOR RECREATIONALLY-USED WATERS.

LIKE THE DIOXIN STUDY, THIS WORK IS BEING DONE UNDER THE TECHNICAL DIRECTION OF TWO EXPERT COMMITTEES. THE INTERNAL COMMITTEE INCLUDES SPECIALISTS FROM THE MINISTRY OF HEALTH AND MINISTRY OF THE ENVIRONMENT. THE EXTERNAL COMMITTEE INCLUDES SCIENTISTS FROM THE MINISTRY OF HEALTH, SOCIETY OF MEDICAL OFFICERS OF HEALTH OF ONTARIO, THE US ENVIRONMENTAL PROTECTION AGENCY, UNIVERSITY OF TORONTO, UNIVERSITY OF BRITISH COLUMBIA, AND HEALTH AND WELFARE CANADA.

THIS WORK, AGAIN, IS NOT NEW RESEARCH, BUT IT REPRESENTS REAL PROGRESS IN OUR ATTEMPTS TO RELIABLY MEASURE RISK LEVELS.

THIS BRINGS ME TO THE NEXT STEP IN THE OVERALL PROCESS OF MANAGING TOXIC SUBSTANCES IN THE ENVIRONMENT-- THE STEP WE HAVE CALLED "RISK ASSESSMENT". THIS IS THE SYNTHESIS STEP, WHERE FACTORS IN ADDITION TO THE SCIENTIFIC INFORMATION ARE CONSIDERED AND WEIGHED TO EVOLVE A LEVEL OF RISK WE THINK WE CAN LIVE WITH. IN A NUTSHELL, THIS IS THE BIG STEP, THE HARD PART. THAT'S BECAUSE IT IS A HARD DECISION THAT HAS TO BE MADE, AND SO MANY DIVERSE INTERESTS AND DISCIPLINES HAVE TO BE INCLUDED.

HERE IS A SIMPLIFIED ILLUSTRATION OF WHAT IS REALLY A VERY COMPLEX SITUATION. (FIG. 13) AS YOU SEE, IT INVOLVES A VARIETY OF IMPORTANT CONSIDERATIONS--LEGAL, POLITICAL, PUBLIC, SOCIAL AND ECONOMIC. THESE ARE IN ADDITION TO THE SCIENTIFIC INFORMATION WHICH FORMS THE BASIS OF THE SUBSEQUENT VALUE JUDGMENTS AT THIS STAGE. THIS IS THE STEP WHERE WE DETERMINE THE SIGNIFICANCE OR THE VALUE OF IDENTIFIED HAZARDS AND ESTIMATED RISKS TO THOSE PEOPLE CONCERNED WITH OR AFFECTED BY THE DECISION ON THIS MATTER.

OF COURSE, WE KNOW THAT THE PROCESS OF SETTING REASONABLE STANDARDS THAT GIVE DUE AND ADEQUATE WEIGHT TO THE RISKS, COSTS AND BENEFITS OF THE STANDARDS ADOPTED IS ALMOST CERTAIN TO BE CONTROVERSIAL. IN THIS GAME, THE STAKES ARE HIGH AND THERE ARE NO DEFINITIVE ANSWERS. THE SCIENCE IS UNCERTAIN, AND THE ISSUE IS VOLATILE, SO WE NEED TO LOOK AT ALL SIDES OF THE MATTER CAREFULLY. (FIG. 14)

IT MUST ACCOMMODATE THE CONFLICTING AND LEGITIMATE INTERESTS OF VARIOUS "PUBLICS". THESE INCLUDE INDUSTRY, BUSINESS, ENVIRONMENTALISTS, MUNICIPAL REPRESENTATIVES, MEDIA PERSONNEL, PUBLIC INTEREST GROUPS, AND PROBABLY A HOST OF OTHERS.

AT A MORE SPECIALIZED LEVEL, THE SITUATION IS JUST AS COMPLEX. MANY DISCIPLINES AND PROFESSIONS SHOULD LEGITIMATELY PLAY A PART IN THE RISK ASSESSMENT PROCESS: THE EPIDEMIOLOGIST, PHYSICIAN, TOXICOLOGIST, BIOLOGIST, INDUSTRIAL HYGIENIST, ECONOMIST, ENGINEER, STATISTICIAN, AND LAWYER, JUST TO NAME SOME.

BECAUSE OF THE RANGE OF STAKEHOLDERS AND RELEVANT PROFESSIONALS, IT'S IMPORTANT TO HAVE A FAIR AND OBJECTIVE WAY OF HANDLING ALL THIS INFORMATION AND ALL THESE INTERESTS.

IT HAS TO PROVIDE THE OPPORTUNITY FOR VARIOUS PUBLICS TO BE HEARD. PEOPLE DON'T LIKE DECISIONS BEING MADE FOR THEM WITHOUT THEIR KNOWLEDGE AND INPUT, ESPECIALLY IF IT IS A DECISION ON SOMETHING LIKE EXPOSING THEM TO A RISK OF 10 TO THE MINUS 3 (ONE IN 1,000) OF BECOMING ILL FROM SOMETHING THAT FRIGHTENS THEM IN THE FIRST PLACE. THEY WANT TO KNOW THEY HAVE ACCESS TO THE PROCESS.

AND, ONCE THE PROCESS IS IN PLACE, IT HAS TO WORK IN SUCH A WAY THAT PEOPLE SEE THEIR PARTICIPATION AS BEING EFFECTIVE AND MEANINGFUL. IF STAKEHOLDERS FIND THAT THEIR INTERESTS ARE NOT GENUINELY OR MEANINGFULLY CONSIDERED, OR IF ANY BIAS OR "LIP SERVICE" IS APPARENT, THEN THE PROCESS WON'T BE SANCTIONED AND SUPPORTED BY THE VERY PEOPLE IT IS MEANT TO SERVE. AND ULTIMATELY, THE "STANDARDS" THAT EVOLVE FROM THE PROCESS WILL BE HARD TO DEFEND.

FINALLY, ALL THIS MUST BE DONE IN A WAY THAT CAN STABILIZE THE PROCESS AND KEEP IT ON COURSE. THE STANDARD-SETTING EXERCISE CANNOT AFFORD TO BE HELD TO RANSOM BY ONE GROUP OR ANOTHER IF IT IS TO EMERGE AS A CREDIBLE PROCEDURE.

BECAUSE ULTIMATELY, THE RISK ASSESSMENT PROCESS HAS TO DEAL WITH ISSUES IN A TIMELY WAY. WRANGLING FOR YEARS

OVER WHAT STANDARD SHOULD BE CONSIDERED ACCEPTABLE DOESN'T DO MUCH FOR EITHER PROTECTING THE PUBLIC OR FULFILLING THE RESPONSIBILITIES OF INDUSTRY AND GOVERNMENT.

WE WANT TO MINIMIZE, AS MUCH AS POSSIBLE, PUBLIC EXPOSURE TO HAZARDOUS SUBSTANCES. AT THE SAME TIME, WE WANT TO ENSURE THAT CONTINUED ECONOMIC DEVELOPMENT DOES NOT STALL IN UNCERTAINTY OVER WHAT SHOULD BE DONE ABOUT UNWANTED BYPRODUCTS THAT WE DON'T KNOW HOW TO USE OTHERWISE YET. IF WE DO THIS RIGHT, WE CAN PROTECT THE PUBLIC AND ASSIST INDUSTRY. AS I MENTIONED EARLIER, ONE OF THE BENEFITS OF STANDARD-SETTING IS TO LET EVERYONE KNOW THE RULES OF THE GAME.

WHILE WE'RE ON THIS SUBJECT OF PUBLIC INVOLVEMENT IN THE RISK ASSESSMENT PROCESS, LET ME ADD THAT THERE SHOULD ALSO BE SOME CONSIDERATION GIVEN TO PUBLIC PERCEPTION OF RISK MEASUREMENTS. IT IS DIFFICULT ENOUGH TO BE PRECISE IN RISK MEASUREMENTS, AND WHEN THEY ARE CALCULATED, IT IS NATURALLY DIFFICULT FOR CERTAIN PUBLICS TO RELATE TO THEM.

THIS POINT IS TAKEN A STEP FURTHER IN A RECENT ARTICLE IN NEW SCIENTIST, WITH REFERENCE TO THE ROLE OF RISK ANALYSIS IN PERSUADING THE PUBLIC THAT NUCLEAR POWER IS SAFE. THE ARTICLE IS ENTITLED, "WHY THE PUBLIC IGNORES RISK ANALYSIS." ACCORDING TO DR. J. VAN DER PLIGT OF THE UNIVERSITY OF EXETER, "IT IS TOTALLY IRRELEVANT TO THE PUBLIC WHETHER THE ACCIDENT PROBABILITY IS ONE IN 10,000 OR ONE IN 10 MILLION."

AN ANALYSIS OF DATA FROM PUBLIC OPINION POLLS IN THE US, EUROPE AND BRITAIN REVEALED THAT

> ... "PEOPLE'S PERCEPTION OF THE RISK OF NUCLEAR ENERGY IS RELATIVELY UNAFFECTED BY THE LOW PROBABILITY OF ACCIDENTS AND MAINLY DETERMINED BY THE CHARACTERISTICS OF THE HAZARD, MOST PROMINENT AMONG THESE ARE ITS CATASTROPHIC AND INVOLUNTARY NATURE AND THE FACT THAT IT IS AN UNKNOWN HAZARD."

THIS IS AN ADDITIONAL COMPLICATION TO A PROCESS WE KNOW WILL BE DIFFICULT AND CONTROVERSIAL.

(FIG. 15) SO, THERE HAS TO BE A "PUBLIC" DECISION, MADE FOR THE "PUBLIC" GOOD, BY MEANS OF A PROCESS TO WHICH VARIOUS "PUBLICS" HAVE ACCESS. AND IT HAS TO BE DONE IN A REASONABLE TIME IF IT IS TO BE USEFUL.

WHAT WE HOPE TO GET OUT OF THIS COMPLEX PROCESS IS A WAY OF JUDGING WHAT MIGHT BE AN <u>ACCEPTABLE</u> STANDARD OF RISK. AND IT CAN ONLY BE CONSIDERED ACCEPTABLE AS A RESULT OF OUR HAVING <u>KNOWINGLY AND WILLINGLY</u> CONFRONTED THE RELATIVE "WEIGHTS" OF RISKS, BENEFITS AND COSTS, ON A BROAD SCALE.

I WANT TO TELL YOU A STORY TO ILLUSTRATE THE IMPORTANCE OF DEVELOPING A FAIR SYSTEM FOR RISK ASSESSMENT.

THERE WAS A FARMER WHO GREW A WONDERFUL CROP OF WATERMELONS IN HIS PATCH, BUT FOUND THAT PEOPLE WERE

STEALING THEM AT NIGHT. HE TRIED VARIOUS MEASURES TO CONTROL THIS "HAZARD" TO HIS CROP, BUT ALL OF THEM FAILED. FINALLY, HE PUT UP A SIGN THAT SAID, "ONE OF THESE WATERMELONS IS POISONED." THAT DID THE TRICK; FOR MONTHS AFTERWARD, THE PATCH WAS UNDISTURBED. THEN ONE MORNING THE FARMER NOTICED THAT THE SIGN HAD BEEN CHANGED. IT NOW SAID, "TWO OF THESE WATERMELONS HAVE BEEN POISONED." THE MORAL OF THIS TALE? DON'T SET STANDARDS IN ISOLATION.

WE KNOW WHAT WE SHOULD AIM FOR IN DEVELOPING A PROCESS FOR RISK ASSESSMENT. BUT HOW DO WE DO IT, ESPECIALLY SINCE WE'RE ON FAIRLY UNCHARTED GROUND HERE? WHO IS TO MAKE THE VALUE JUDGMENTS FOR SOCIETY AS A WHOLE? THERE ARE A NUMBER OF WAYS WE CAN DO THIS, AND THEY FALL UNDER THREE MAIN PROCEDURAL OPTIONS: (FIG. 16)

- THE MINISTRY OF THE ENVIRONMENT CONDUCTS THE RISK ASSESSMENT PROCESS AND MINISTER IS THE FINAL ARBITER ON THE STANDARD SELECTED.

- STANDARDS ARE JOINTLY DEVELOPED BY MOE AND:

  - FEDERAL GOVERNMENT
  - OTHER ONTARIO GOVERNMENT MINISTRIES
  - UNIVERSITIES, AND/OR OTHER PROVINCES.

- AN INDEPENDENT BODY OR ARBITER IS ESTABLISHED TO CONDUCT THE RISK ASSESSMENT PROCESS AND DECIDE ON AN ACCEPTABLE STANDARD.

ALL THESE OPTIONS HAVE A VARIETY OF IMPLICATIONS, BOTH PROS AND CONS. ALL OF THEM, I SHOULD ADD, REQUIRE THE CONCURRENCE OF CABINET.

IN THE FIRST ONE, THE MINISTER CAN GO TO VARIOUS SOURCES FOR ADVICE ON THE MATTER. THIS CAN BE DONE THROUGH A VARIETY OF ADMINISTRATIVE PROCEDURES. THIS IS AN INTERNALLY- DRIVEN PROCESS, WHICH NO MATTER HOW CAREFULLY IT IS PUT IN PLACE, CARRIES A PERCEIVED DRAWBACK; THE AGENCY WOULD BE SEEN TO BE MAKING AN ARBITRARY DECISION, OR EVEN, IN SOME CASES, RULING ON ITS OWN RECOMMENDATIONS.

THE NEXT OPTION HAS MOE DEVELOPING STANDARDS JOINTLY WITH OTHER AGENCIES, AS APPROPRIATE. THE PUBLIC INPUT COMPONENT COULD BE CONDUCTED JOINTLY OR SEPARATELY, FORMALLY OR INFORMALLY. THE STANDARD THAT EVOLVES THROUGH THIS POOLING OF RESOURCES MIGHT HAVE TO BE MODIFIED FOR ONTARIO, FOR EXAMPLE, BECAUSE OF SPECIAL INFORMATION (LIKE PUBLIC ATTITUDES) OR BECAUSE OF A HIGHER CONCENTRATION OF A SUBSTANCE BEING PRESENT IN ONTARIO THAN ELSEWHERE.

ANOTHER WAY IS TO HAVE AN INDEPENDENT BODY SET UP TO CONDUCT A REVIEW OF ALL THE FACTORS IN THE RISK ASSESSMENT PROCESS AND TO SET A STANDARD ON THIS BASIS. ITS POWERS WOULD BE SIMILAR TO THAT OF THE ENVIRONMENTAL ASSESSMENT BOARD IN ONTARIO WHICH CAN MAKE DECISIONS UNDER VARIOUS PIECES OF ENVIRONMENTAL LEGISLATION IN THE PROVINCE. THE BOARD CONDUCTS HEARINGS AND CONSIDERS EVIDENCE AND PUBLIC INPUT, AND MAKES A RULING WHICH HAS THE EFFECT OF A RECOMMENDA-

TION TO CABINET; CABINET CAN VETO IT OR CHANGE IT, BUT RARELY DOES SO.

THIS OPTION COULD BE MADE MORE FORMALIZED BY EMPOWERING A JUDGE OR OTHER ARBITER TO DO THE SAME THING, AFTER HEARING ARGUMENTS PRESENTED BY EXPERTS AND LAY PERSONS UNDER RULES OF EVIDENCE SIMILAR TO THOSE OF A CIVIL COURT. PROPONENTS OF THIS FORMALIZED APPROACH SEE ADVANTAGES TO ESTABLISHING RULES OF EVIDENCE AND CLEARLY DEFINING ADVERSARIAL ROLES OF EACH PARTY.

PERHAPS IT'S WORTH POINTING OUT HERE THAT THE LEGAL SYSTEM IS PREMISED ON THE CONTENTION THAT IF THERE IS A "SHADOW" OF DOUBT ABOUT THE MATTER IN QUESTION, THERE IS NO CASE TO BE MADE; RULES OF EVIDENCE REQUIRE THINGS TO BE IN "BLACK AND WHITE". IN SCIENCE, HOWEVER, WE OFTEN FIND THAT WE ARE WORKING WITH AN INFINITY OF "SHADES OF GREY".

THERE IS ANOTHER KIND OF HYBRID APPROACH THAT WE FAVOUR IN ONTARIO. THIS IS JUST AN IDEA, BUT THE MORE WE LOOK AT IT THE MORE WE SEE ITS ADVANTAGES FOR US. IT'S A CONCEPT THAT FEATURES AN ENVIRONMENTAL STANDARDS ADVISORY FUNCTION--WE CALL IT ESAC. ESSENTIALLY, IT'S AN EXTERNAL PUBLIC CONSULTATIVE PROCESS, BUT WE HAVEN'T WORKED OUT ALL THE DETAILS YET.

THIS MIGHT TAKE THE FORM OF A STANDING COMMITTEE, OR A GROUP OF PEOPLE (BOTH PROFESSIONAL AND LAY PERSONS) APPOINTED ON AN AD HOC BASIS FOR EACH SUBSTANCE, OR A

POOL OF PEOPLE CALLED UPON AT DIFFERENT TIMES AS REQUIRED. THIS GROUP WOULD BE RESPONSIBLE TO THE MINISTER OF THE ENVIRONMENT.

HERE IS HOW ESAC MIGHT WORK IN GENERAL. (FIG. 17) FIRST, THE SCIENTIFIC INFORMATION RELEVANT TO THE SUBSTANCE IN QUESTION IS PRESENTED TO THE MINSITER OF THE ENVIRONMENT. HE THEN PASSES IT ON TO ESAC. WITH THE SCIENTIFIC INFORMATION AS THE BASIS FOR FURTHER ASSESSMENT, ESAC CONDUCTS A PUBLIC REVIEW OF THE ISSUE.

BY "PUBLIC REVIEW" WE MEAN A REVIEW BY VARIOUS "PUBLICS" --ENVIRONMENTALISTS, INDUSTRY, PUBLIC HEALTH ORGANIZATIONS, SCIENTIFIC ORGANIZATIONS, AND OF COURSE INDIVIDUALS. THIS COULD BE DONE IN A NUMBER OF WAYS--FORMALLY, INFORMALLY, PUBLICLY OR PRIVATELY. BUT ESAC WOULD HAVE THE RESPONSIBILITY FOR ADJUDICATING ALL THE INFORMATION BEFORE IT AND THEN RECOMMENDING AN ACCEPTABLE STANDARD FOR THE SUBSTANCE IN QUESTION TO THE MINISTER OF THE ENVIRONMENT.

THIS APPROACH HAS A NUMBER OF ADVANTAGES. (FIG. 18)

- IT INTERPOSES A DISTINCT GROUP OF NON-GOVERNMENT PEOPLE BETWEEN THE MINISTER AND ALL THE INTERESTS AND INFORMATION HE HAS TO CONSIDER, INCREASING THE MINISTER'S OBJECTIVITY AND <u>CREDIBILITY</u>.

- IT GIVES ENOUGH CONTROL OVER THE PROCESS AND THE DECISION TO A SINGLE BODY, PROVIDING <u>STABILITY</u> TO THE RISK ASSESSMENT PROCESS.

- IT HAS ENOUGH FLEXIBILITY TO RESPOND TO DIFFERENT CIRCUMSTANCESS OR LEVELS OF HAZARD. IT CAN CALL UPON THE RANGE OF EXPERTISE THAT IS REQUIRED IN EACH CASE, AND IT IS ABLE TO VARY THE RANGE OR DETAIL OF ITS ATTENTION ACCORDINGLY.

WE THINK THIS OPTION PROVIDES THE GREATEST PROMISE FOR US AT OUR STAGE OF DEVELOPMENT. WE'RE STILL REVIEWING THE EXPERIENCES AND DEVELOPMENTS OF OTHER JURISDICTIONS IN THIS FIELD. WE'VE UNDERTAKEN ONLY TWO SCIENTIFIC CRITERIA DOCUMENTS SO FAR. AND IN THIS NEXT STEP--RISK ASSESSMENT--WE DON'T WANT TO TAKE ON MORE THAN WHAT WE CAN DO A GOOD JOB ON, AND LEARN FROM, AT THIS POINT.

SO, WITH THESE CONSIDERATIONS IN MIND, WE HOPE TO PUT INTO PLACE AN APPROPRIATE MECHANISM BY WHICH WE CAN EVOLVE "ACCEPTABLE" STANDARDS FOR TOXIC SUBSTANCES. WHAT NEXT? HOLDING THE LINE, THAT'S THE NEXT STEP.

RISK MANAGEMENT IS WHAT WE CALL THE RANGE OF CONTROL MECHANISMS TO ENSURE THAT THE STANDARDS WE HAVE SET ARE MET BY THE GENERATORS OF THOSE SUBSTANCES. NOW, IT MAY SEEM ODD TO TALK ABOUT REGULATING OR MANAGING SOMETHING THAT IS, AT BEST, AN APPROXIMATION (A STANDARD), WHICH IN TURN IS BASED ON A MIXTURE OF OBJECTIVE AND SUBJECTIVE VALUES(THE RISK ASSESSMENT PROCESS), WHICH VALUES THEMSELVES ARE PREDICATED ON AN UNCERTAIN SCIENCE. BUT THE STEPS I HAVE DISCUSSED UP TO THIS POINT ARE THE BEST WE HAVE TO WORK WITH, AND WE HAVE TO MAKE A START SOMEWHERE. RISK MANAGEMENT IS

THE LOGICAL CONCLUSION TO THOSE EFFORTS--AND THE ONLY RESPONSIBLE CONCLUSION TO THEM.

OPTIONS FOR MANAGING THE RISKS WE'VE DECIDED TO LIVE WITH ARE WAYS OF GIVING SOME MUSCLE TO THE DECISION ON STANDARDS. CONTROL OPTIONS VALIDATE THAT DECISION AND SPRING IT INTO ACTION.

BUT EVEN IN TAKING ACTION, WE SHOULD BE ABLE TO FIT THE NATURE OF THE CONTROL TO THE DEGREE OF HAZARD OR DEGREE OF EXCESS. THERE IS A RANGE OF OPTIONS FOR DOING SO, GOING FROM THE LEAST TO THE MOST STRINGENT, AND THEY CAN ALL SERVE OUR PURPOSE. (FIG. 19)

CO-OPERATIVE CONTROL CAN INCLUDE SUCH THINGS AS GUIDELINES OR MINISTERIAL RECOMMENDATIONS FOR INDUSTRY. IN MANY CASES, INDUSTRY HAS BEEN CO-OPERATIVE (AND IN OTHERS, OF COURSE, THEY HAVE NOT), BUT CO-OPERATION IS AN APPROACH WE WOULD LIKE TO ENCOURAGE WHERE IT CAN WORK FOR MUTUAL BENEFIT.

MOE., BY THE WAY HAS ISSUED A NUMBER OF SUCH GUIDELINES:

- WATER RESOURCES BRANCH DEVELOPED "ONTARIO DRINKING WATER OBJECTIVES" UNDER THE ONTARIO WATER RESOURCES ACT, "PROVINCIAL WATER QUALITY OBJECTIVES", AND "GUIDELINES FOR SPORT FISH CONSUMPTION".

- ° Air Resources Branch developed "Air Standards and Guidelines" under the Enviromental Protection Act.

- ° Waste Management Branch developed "Hazardous Waste Guidelines" under the Environmental Protection Act.

The next level is what we've called "restrictions", which can include abatement and modification measures, in other words, mitigation. In this regard, the Environmental Protection Amendment Act, 1983, enables orders to be issued to a person who owns or has management or control of an undertaking or property, to take precautions regarding any hazardous aspect of an undertkaing or property. This may require him to be ready with equipment, materials and personnel to rectify a dangerous situation if it should occur.

Formal enforcement actions require some statutory basis in the form of regulations or provisions of environmental legislation. These can cover such things as emission or effluent limits for certain substances, and orders, and prosections and associated fines if those limits are exceeded.

In Ontario, we have a number of control mechanisms provided in various pieces of environmental legislation, the main ones of which are:

- the Environmental Protection Act
- the Ontario Water Resources Act

- THE PESTICIDES ACT
- THE ENVIRONMENTAL ASSESSMENT ACT

ESSENTIALLY, THESE CONTROL PROVISIONS CAN BE DIVIDED INTO "BEFORE-THE-FACT" AND "AFTER-THE-FACT" ONES. CONDITIONS OF APPROVAL CAN PROVIDE FOR A VARIETY OF WAYS FOR RESTRICTIONS TO BE PLACED ON A NEW FACILITY.

IF IRREGULARITIES ARE NOTED AFTER THE FACILITY HAS BEEN APPROVED, WITH OR WITHOUT CONDITIONS, ORDERS CAN BE IMPOSED TO HALT OPERATIONS OR REQUIRE COMPLIANCE WITH THE CONDITIONS BREACHED, AND PROSECTIONS CAN TAKE PLACE.

FINALLY, A SUBSTANCE CAN BE BANNED FROM USE ALTOGETHER; IN ONTARIO, THIS CAN BE DONE ONLY UNDER THE PESTICIDES ACT. UNDER THE ENVIRONMENTAL PROTECTION ACT, THE MINISTRY OF THE ENVIRONMENT CAN PROHIBIT THE DISCHARGE OF CERTAIN SUBSTANCES DIRECTLY INTO THE ENVIRONMENT, BUT NOT THEIR USE IN CERTAIN OTHER INDIRECT APPLICATIONS.

THE PROCESS OF CHOOSING MANAGEMENT OPTIONS BEGINS AND ENDS WITH MONITORING, AS YOU SEE, FOR DETERMINING WHETHER STANDARDS ARE MET, FOR CONTINUOUSLY REVIEWING UNCERTAINTIES, AND FOR ENSURING THAT REQUIREMENTS OF MANAGEMENT MEASURES ARE MET.

NONE OF US ARE NAIVE ENOUGH TO THINK THAT DESPITE OUR EFFORTS, THERE AREN'T SERIOUS INFRINGEMENTS OF BOTH THE LAW AND GOOD ENVIRONMENTAL PRACTICES OCCURRING EVERY DAY. BUT WE SHOULD ALSO REMEMBER THAT THE MEDIA

LOVE GOOD STORIES ABOUT BAD THINGS, BECAUSE THEIR AUDIENCE DOES, TOO. HERE'S AN EXCERPT FROM LAST MONTH'S TORONTO STAR:

> "IN A PROVINCIAL CONSULTANTS' STUDY JUST RELEASED, INVESTIGATORS FOUND THAT 45 OUT OF 101 ONTARIO COMPANIES LICENSED TO POUR WASTE PRODUCTS INTO THE LAKES WERE FLOUTING PROVINCIAL AND FEDERAL LAWS, OFTEN BECAUSE IT WAS CHEAPER TO PAY FINES THAN TO COMPLY WITH REGULATIONS."

THE RATHER SENSATIONAL HEADLINE IS "LOW FINES ENCOURAGE POLLUTION OF LAKES, TWO REPORTS SAY". THE TRUTH IS PROBABLY SOMEWHERE IN THE MIDDLE.

NEWS ITEMS SUCH AS THIS CAN DO MORE THAN TELL US WHAT APPEARS TO BE HAPPENING. THEY CAN ENCOURAGE US TO EXAMINE WHERE WE'VE COME IN TERMS OF MANAGING TOXIC SUBSTANCES. THEY INVITE US TO FIND OUT THE REAL NATURE OF THE PROBLEM, HOW THE STUDY WAS DONE, WHAT MANAGEMENT PRACTICES ARE BEING USED, AND WHETHER ALL THIS IS SATISFACTORY OR NOT.

I THINK WE'RE AT A MILESTONE HERE. WE NEED TO LOOK AGAIN AT WHAT OUR REAL CHOICES ARE--AND WE'RE HELPED IN THIS BY SCIENCE-- AND AT WHERE ON THE SPECTRUM OF SOCIAL RESPONSIBILITY VARIOUS CHOICES ARE LOCATED. (FIG. 20)

MILESTONES ARE AN ESSENTIAL PART OF A SOCIETY MATURING. FOR EXAMPLE, IN THE 1960'S, WE THOUGHT THAT "THE SOLUTION TO POLLUTION IS DILUTION" SO WE SENT THE

STUFF UP INTO THE AIR AND DOWNSTREAM IN THE WATER. IN THE 1970'S WE LEARNED THAT WHAT GOES UP MUST COME DOWN, AND WHAT GOES DOWNSTREAM JUST ENDS UP FURTHER AWAY. AND WHEN THAT HAPPENS, PEOPLE DOWNWIND AND DOWNSTREAM END UP WITH A PROBLEM. NOW IN THE 1980'S WE ARE DISCOVERING THAT WHAT COMES DOWN AND GOES FURTHER AWAY HURTS--IT AFFECTS OUR HEALTH AND COSTS US MONEY.

WE CAN ENGAGE IN MASSIVE CLEAN-UP OPERATIONS, BUT THESE COST A LOT OF MONEY. INDUSTRY INSISTS THAT IT CAN'T AFFORD THE "BURDEN" OF POLLUTION CONTROL, AND PUBLICS INSIST ON PROTECTION FROM THE RISKS POSED BY TOXIC SUBSTANCES. BUT EVERYONE IS IN THE SAME BALLGAME. NO ONE IS EXEMPT FROM THE RESPONSIBILITY FOR CONTROLLING TOXIC SUBSTANCES--NOT INDUSTRY, NOT GOVERNMENT, AND NOT EVEN THE GUY WHO DOESN'T WANT TREATMENT OR CONTAINMENT FACILITIES IN HIS BACKYARD.

EVERYONE HAS A PART TO PLAY. THE SCIENTISTS WHO IDENTIFY TOXIC SUBSTANCES AND EVALUATE THE RISKS THEY POSE. PUBLICS WHO HAVE TO LIVE WITH SOME OF THAT RISK AND PUT THEIR POINT OF VIEW ACROSS IN THE PROCESS OF MAKING A DECISION ON RISK. INDUSTRY WHICH CREATES UNWANTED BYPRODUCTS IN THE PROCESS OF GIVING SOCIETY WHAT IT WANTS AND NEEDS. AND GOVERNMENTS WHICH ARE OBLIGED TO SET UP SYSTEMS TO ADDRESS RISKS-- TO MAKE DECISIONS ABOUT THEM AND TO CONTROL THEM.

LAST FALL, THE HONOURABLE ANDREW S. BRANDT, MINISTER OF THE ENVIRONMENT, SAID THIS IN THE LEGISLATURE:

"THE IDENTIFICATION OF THE HEALTH RISKS ASSOCIATED WITH EMISSIONS OF HAZARDOUS CONTAMINANTS AND THE SETTING OF APPROPRIATE STANDARDS ARE AMONG THE EMERGING CHALLENGES OF THE 1980S. I RECOGNIZE THE PUBLIC CONCERNS REGARDING HAZARDOUS CHEMICAL CONTAMINANTS, AND I INTEND TO PROVIDE WHATEVER MEASURES ARE NECESSARY FOR THE PROTECTION OF HUMAN HEALTH AND THE ENVIRONMENT. I CAN THEREFORE ASSURE YOU THAT WE HAVE ACTION PLANS TO MEET THESE CHALLENGES AND THAT EVERY EFFORT WILL BE MADE TO ALLOCATE THE RESOURCES AND THE SCIENTIFIC EXPERTISE REQUIRED TO COMPLETE THIS VERY DIFFICULT TASK."

WHAT I HAVE BEEN TALKING ABOUT TODAY BEARS OUT EACH OF THE MINISTER'S POINTS.

AND THAT'S MY FINAL POINT. WE ARE <u>DOING</u> THINGS, WE HAVE PLANS, WE ARE COLLECTING INFORMATION, WE ARE TAKING ACTION. EVEN IF WE CAN'T RUN YET, WE'RE GOING TO <u>WALK</u>, NOT STAND STILL. WHILE WE ARE CAREFULLY STUDYING AND WEIGHING THE <u>THEORETICAL</u> DIMENSIONS OF THE PROBLEM, TO GIVE OUR EFFORTS DIRECTION, WE ARE COMPLEMENTING THIS WITH DEVISING <u>PRACTICAL</u> MEASURES TO ADDRESS THE CONCERNS WE FACE.

WE KNOW IT WILL BE DIFFICULT, WE KNOW THERE WILL BE PITFALLS, BUT WE HAVE TO TRY TO GRAPPLE WITH THE SITUATION AND LEARN FROM OUR EXPERIENCES. IT'S SAID THAT THE WORLD IS DIVIDED INTO THREE KINDS OF PEOPLE: THOSE WHO <u>MAKE</u> THINGS HAPPEN; THOSE WHO <u>WATCH</u> WHAT

HAPPENS; AND THOSE WHO <u>WONDER</u> WHAT HAPPENED. WE BELIEVE WE ARE IN THE FIRST CATEGORY.

I'LL LEAVE YOU WITH A LITTLE STORY ABOUT RESPONSIBILITY. THIS IS A STORY ABOUT FOUR PEOPLE: EVERYBODY, SOMEBODY, ANYBODY AND NOBODY. THERE WAS AN IMPORTANT JOB TO BE DONE, AND EVERYBODY WAS SURE THAT SOMEBODY WOULD DO IT. ANYBODY COULD HAVE DONE IT, BUT NOBODY DID. NOW, SOMEBODY GOT ANGRY ABOUT THAT, BECAUSE IT WAS EVERYBODY'S JOB. EVERYBODY THOUGHT ANYBODY COULD DO IT, BUT NOBODY REALIZED THAT EVERYBODY WOULDN'T DO IT. IT ENDED UP THAT EVERYBODY BLAMED SOMEBODY WHEN NOBODY DID WHAT ANYBODY COULD HAVE DONE.

AS FAR AS MANAGEMENT OF TOXIC SUBSTANCES IS CONCERNED, <u>WE</u> HAVE THE RESPONSIBILITY TO ACT IN EVERYONE'S BEST INTERESTS. LET'S WORK TOGETHER TO <u>MAKE</u> THINGS HAPPEN.

FIGURE 1

RISK AND RESPONSIBILITY

MANAGING TOXIC SUBSTANCES IN THE ENVIRONMENT

FIGURE 2

"THERE ARE SO MANY DIFFERENT PRODUCTS IN THE FISH WE ANALYSE THAT YOU WONDER HOW THEY STAY AFLOAT."

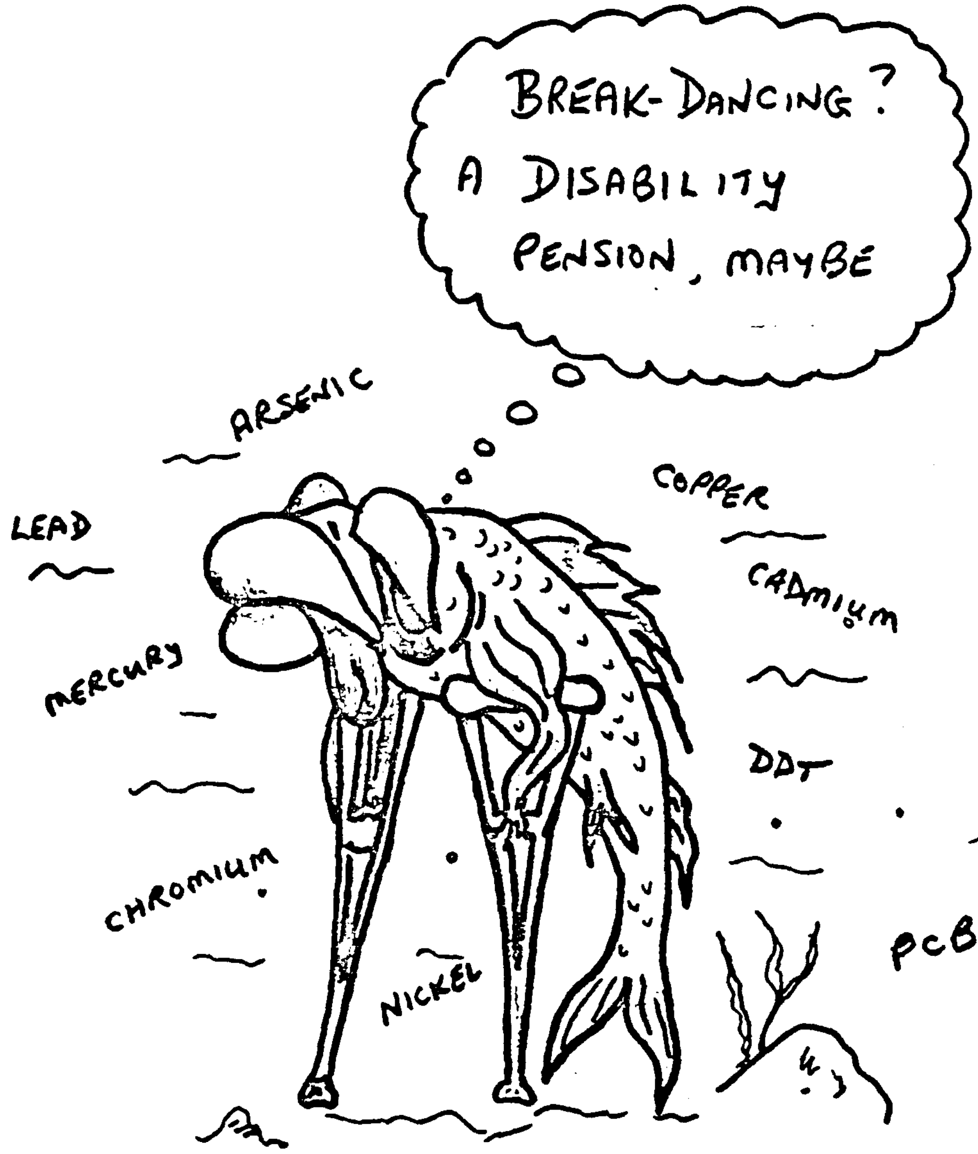


FIGURE 3

SPHERES OF ACTIVITY

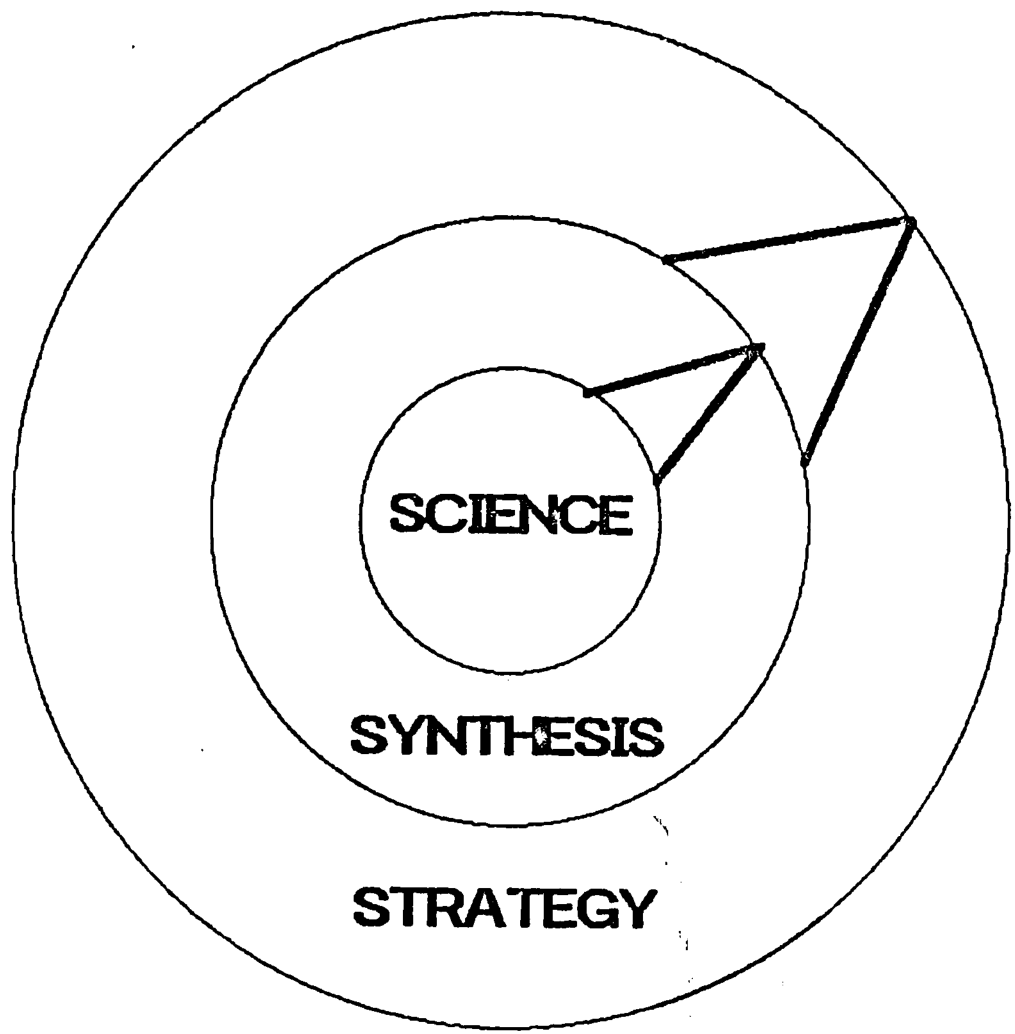


FIGURE 4

GOOD THINGS

AIR RESOURCES	- "SUPER-MODEL" - (MONITORING)
WATER RESOURCES	- DRINKING WATER - (MONITORING)
WASTE MANAGEMENT	- MOBILE PCB DESTRUCTOR - "BLUEPRINT" FOR WASTE MANAGEMENT
HAZARDOUS CONTAMINANANTS	- ENVIRONMENTAL FATE ANALYSIS - STANDARD-SETTING
LABORATORY SERVICES	- ACID RAIN RESEARCH - DIOXIN RESEARCH
REGIONS	- IMPLEMENTATION - MONITORING

FIGURE 5

HAZARDOUS CONTAMINANTS AND STANDARDS BRANCH

A) TO ASSESS THE SIGNIFICANCE OF HAZARDOUS CONTAMINANTS AND CO-ORDINATE MINISTRY ACTIVITIES FOR THEIR CONTROL

B) TO ESTABLISH STANDARDS FOR THE PROTECTION OF PUBLIC HEALTH AND THE ENVIRONMENT

FIGURE 6

BENEFITS OF STANDARDS

1. PROTECT PEOPLE AND ENVIRONMENT BY MULTI-MEDIA STUDY OF EXPOSURE TO RISK.

2. FOCUS RESEARCH AND ABATEMENT WORK.

3. PROVIDE BENCHMARKS FOR MONITORING.

4. STABILIZE INDUSTRIAL/BUSINESS DEVELOPMENT - "KNOWING THE RULES".

FIGURE 7

STANDARD-SETTING PROCESS

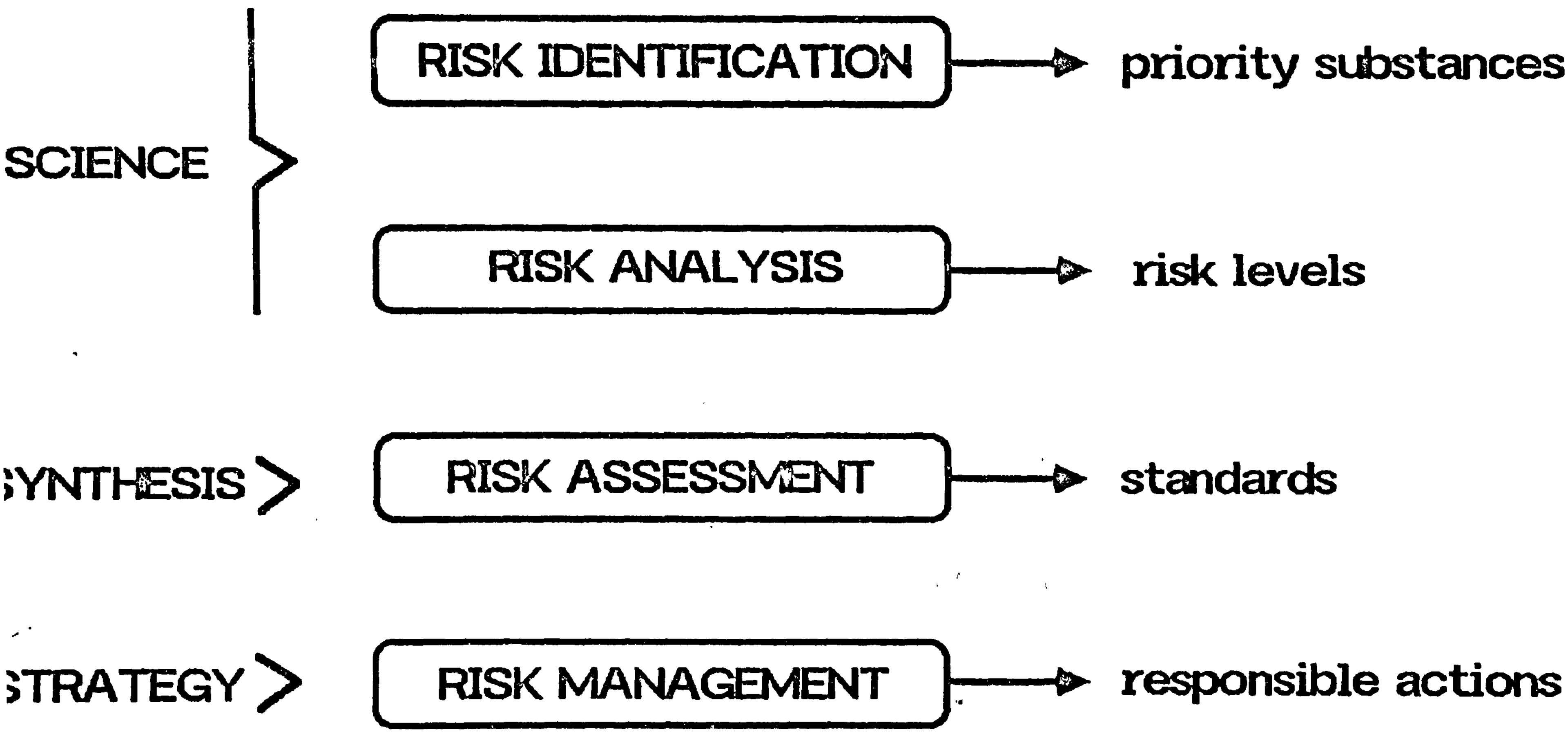


FIGURE 8

PRIORITY LIST WORKING GROUP

1. DEVELOP CRITERIA FOR SELECTING CANDIDATE SUBSTANCES.

2. DEVELOP METHOD FOR RANKING CANDIDATE SUBSTANCES.

3. EXPAND EXISTING LIST OF 209 SUBSTANCES.

"EXPOSURE ASSESSMENT"

FIGURE 9

DATA:

- FEDERAL GOVERNMENT
- PROVINCIAL AGENCIES
- MINISTRY OF ENVIRONMENT
- CONSULTANT
- CANADIAN CHEMICAL PRODUCERS ASSOCIATION

FIGURE 10

"EFFECTS ASSESSMENT"

RANKING FOR:

- ACUTE TOXICITY
- CARCINOGENICITY
- MUTAGENICITY
- TERATOGENICITY
- PERSISTENCE
- BIOACCUMULATION
- OTHER ADVERSE EFFECTS

} MICHIGAN'S HAZARD ASSESSMENT PROCESS

FIGURE 11

DIOXIN ISSUE

ONTARIO SOURCES:

- NIAGARA RIVER CONTAMINATION
- INCINERATION
- WOOD PRESERVING INDUSTRY
- ONE SITE FORMULATING HERBICIDE

FIGURE 12

ONTARIO SCIENTIFIC ADVISORY COMMITTEE ON DIOXINS AND FURANS

DR. O. HUTZINGER (BAYREUTH)

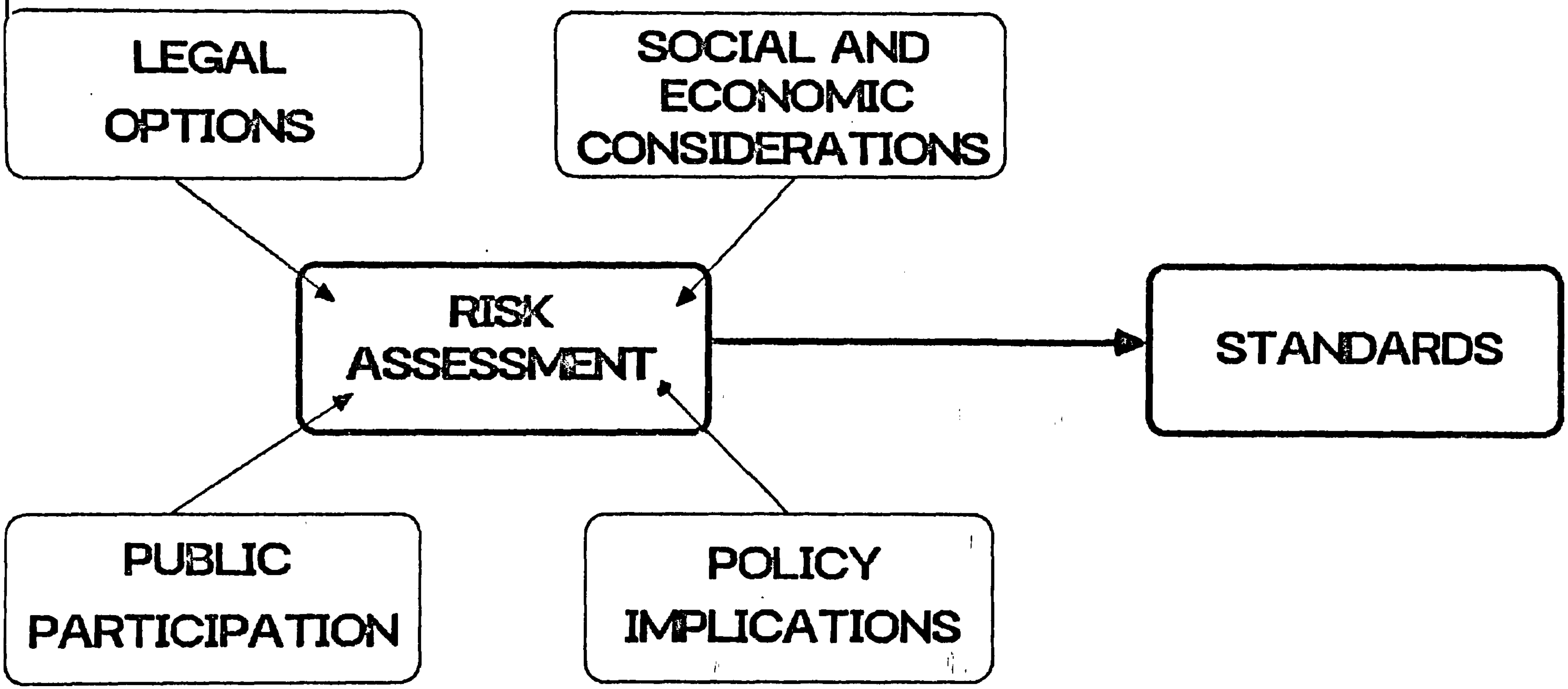
DR. S. SAFE (TEXAS A & M)

DR. G. PLAA (MONTREAL)

DR. E. SPENCER (WESTERN ONTARIO)

FIGURE 13

RISK ASSESSMENT



RISK ASSESSMENT PROCESS

FIGURE 14

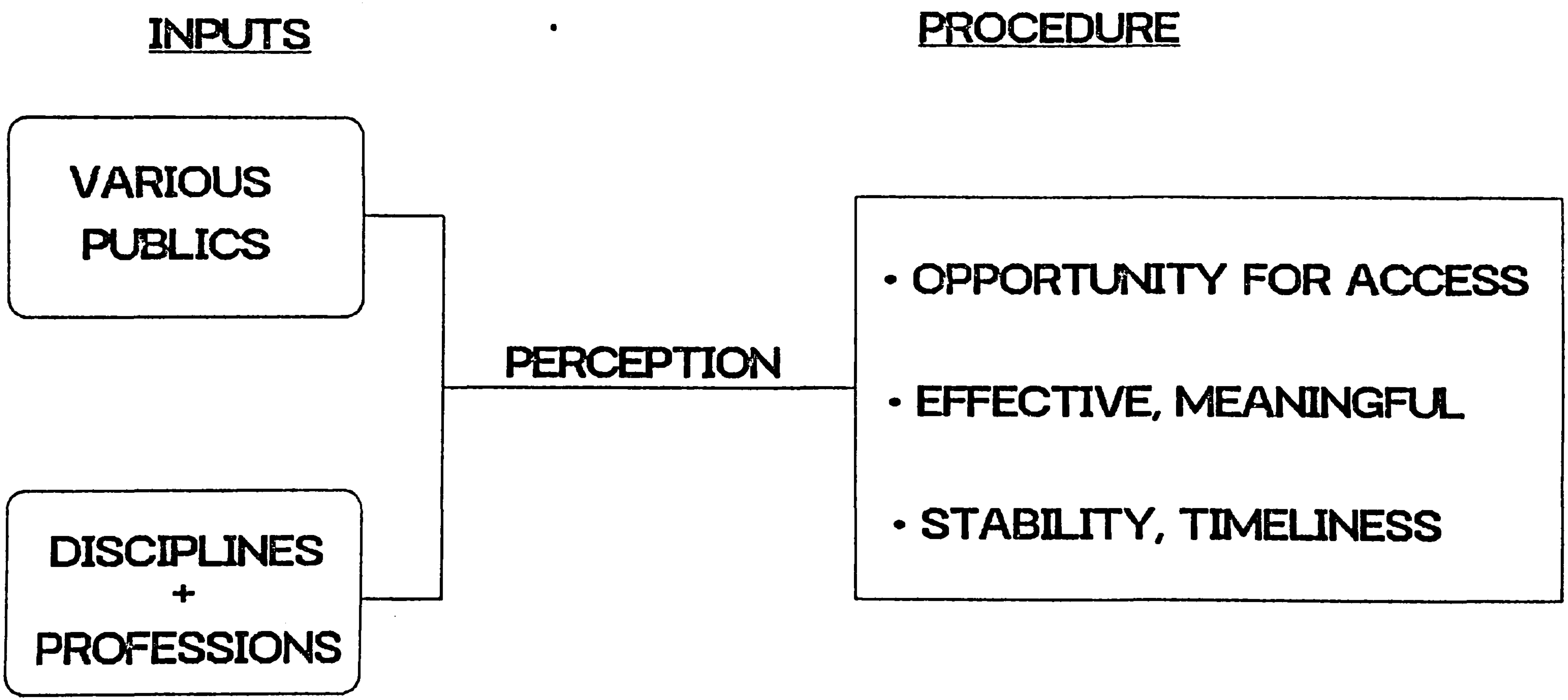


FIGURE 15

RISK ASSESSMENT PROCESS

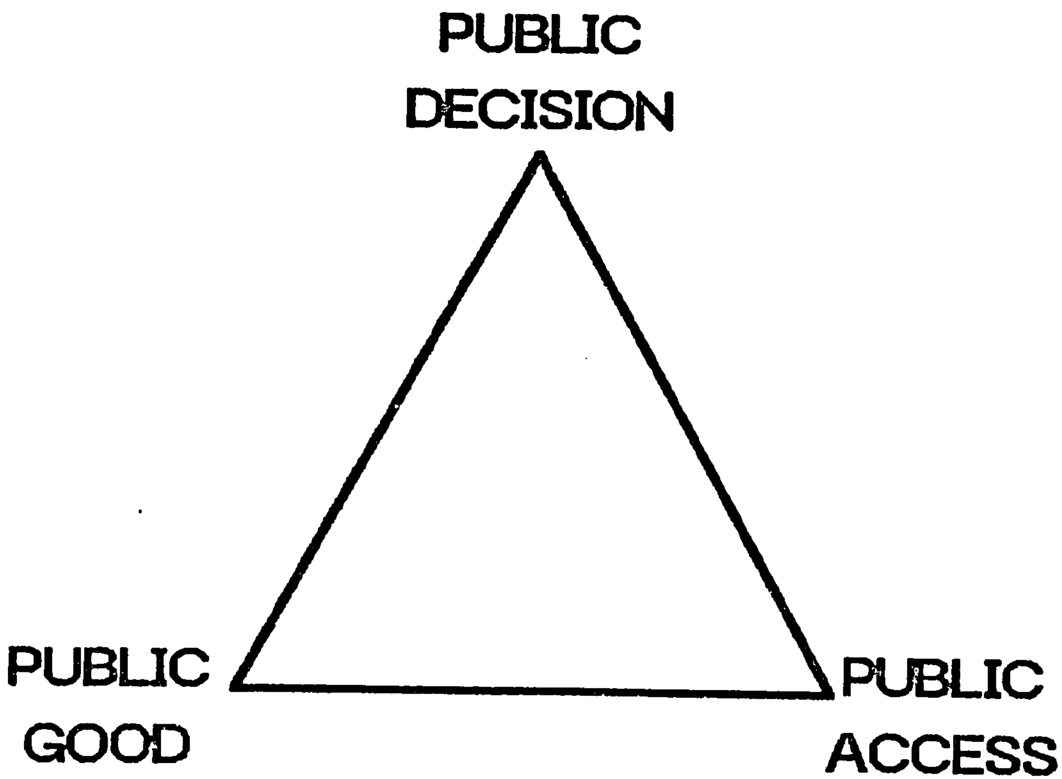


FIGURE 16

PROCEDURAL OPTIONS

1. MINISTRY OF THE ENVIRONMENT CONDUCTS RISK ASSESSMENT PROCESS - MINISTER DECIDES ON STANDARD

2. JOINT DEVELOPMENT OF STANDARD - MOE AND:

   - FEDERAL GOVERNMENT
   - OTHER ONTARIO GOVT. MINISTRIES
   - UNIVERSITIES, OTHER PROVINCES

3. INDEPENDENT BODY OR ARBITER

FIGURE 17

ESAC OPTION

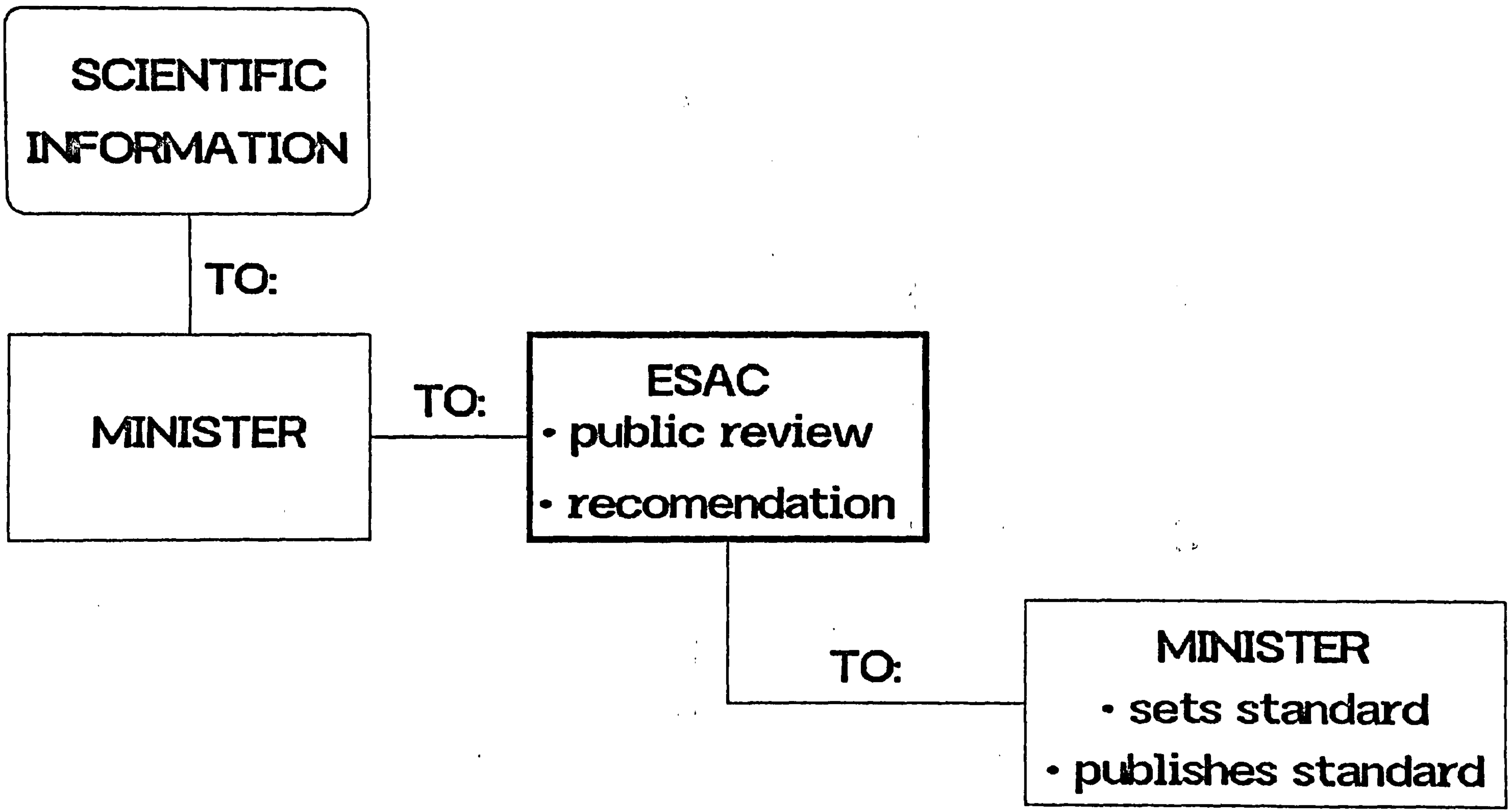


FIGURE 18

ADVANTAGES OF ESAC

- CREDIBILITY

- STABILITY

- FLEXIBILITY

RISK MANAGEMENT

FIGURE 19

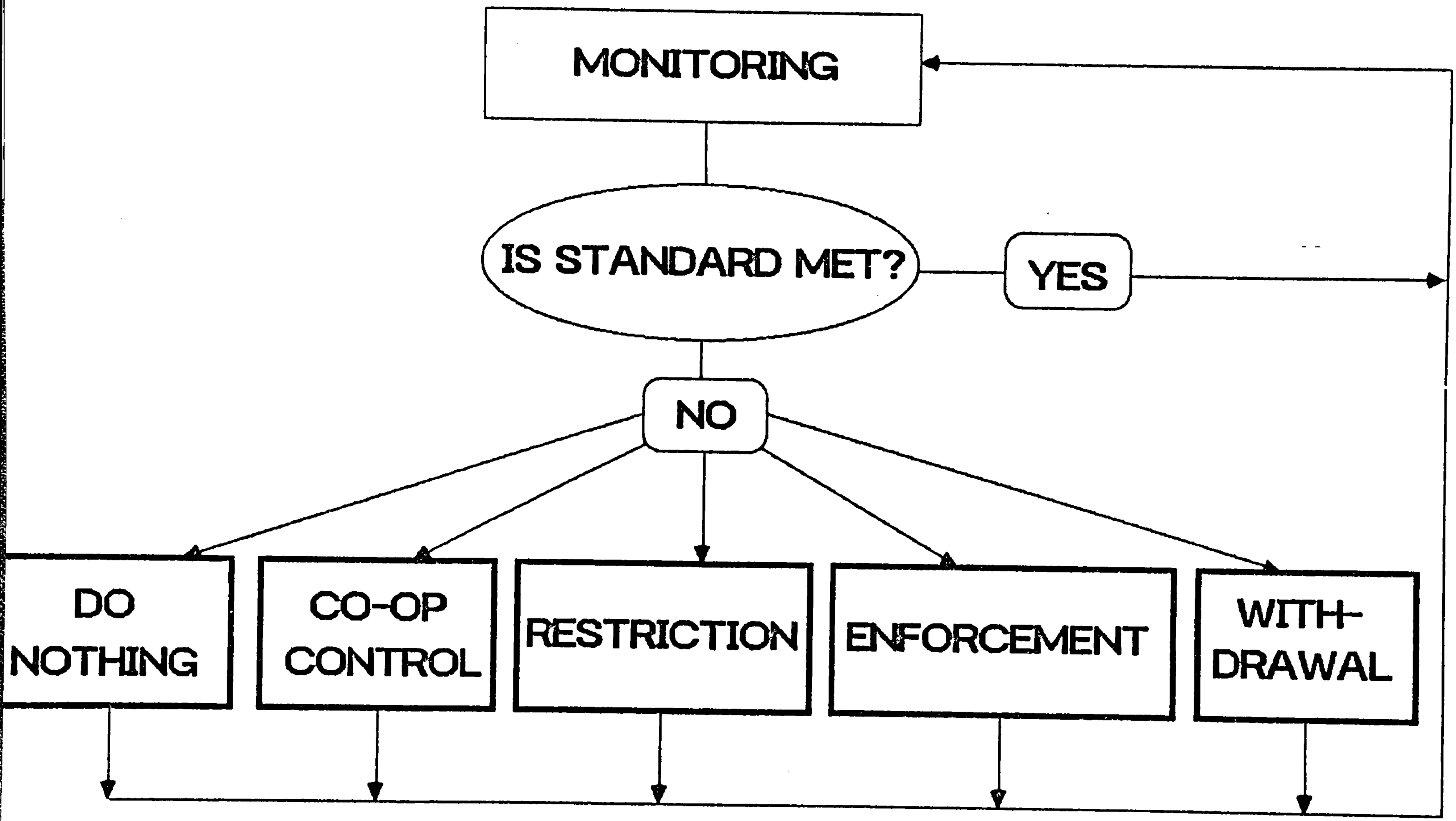


FIGURE 20

MILESTONES

1960'S SOLUTION IS DILUTION

1970'S WHAT GOES UP...

1980'S RISK AND RESPONSIBILITY

Politique québécoise de gestion des substances toxiques

Raymond Perrier

Directeur général - ARMAT

Ministère de l'Environnement du Québec

Mesdames, Messieurs les congressistes,

Je vais tenter, ce matin, de vous exposer les éléments de politique que le ministère de l'Environnement du Québec met de l'avant dans la gestion des substances toxiques.

Je préfère parler d'éléments de politique parce que le Ministère n'a jamais adopté une politique globale sur ce sujet. Il existe bien une politique de gestion des déchets industriels (1981) mais il n'y en a pas sur l'ensemble des substances toxiques. Cependant, au fur et à mesure qu'il était confronté avec de nouveaux problèmes, le Ministère a réagi de façon sectorielle et s'est doté de programmes d'action sectoriels de manière à protéger le milieu ambiant et surtout, la santé publique. C'est de ces programmes et de la ligne de pensée qui les sous-tend dont je vais vous entretenir.

L'intérêt de plus en plus manifeste de nombreux intervenants vis-à-vis les substances toxiques dans l'environnement est une suite logique aux préoccupations qui ont confronté le Québec au milieu des années '70. A cette époque, après la publication d'un rapport intitulé "Le mercure au Nord-Ouest québécois - Aspects environnementaux" les Services de protection de l'environnement du Québec mettaient sur pied le Bureau d'étude sur les substances toxiques plus connu sous le nom de B.E.S.T.

Dès sa formation, le B.E.S.T. chercha à déterminer quelles étaient, parmi la grande variété des substances toxiques, celles qui méritaient une attention plus immédiate. Une consultation tenue auprès de plusieurs organismes scientifiques permit de dégager un groupe de 14 substances pour lesquelles une problématique spécifique fut définie.

Il s'agit des acides forts, de l'amiante, l'arsenic, le benzène, les biphényles polychlorés, le chlore, le chlorure de vinyle, les composés phénoliques, les polluants atmosphériques, les cyanures, les fluorures, les huiles et graisses, les métaux lourds et le plomb.

Chacune de ces substances fut l'objet d'un rapport spécifique (dont vous trouvez une illustration sur l'écran) qui, en plus de la problématique, dégageait des hypothèses de solution et faisait état des moyens d'action appropriés.

Les préoccupations qui prévalaient à ce moment situaient d'abord le problème au niveau de l'eau. Au cours de son mandat qui a duré près de trois ans, le B.E.S.T. s'est donc attaqué de façon particulière au milieu aquatique en mettant sur pied "Le réseau de surveillance des substances toxiques dans le milieu aquatique". Des campagnes d'échantillonnage sont menées annuellement et quatre rapports sont déjà publiés. On les retrouve à l'écran, ils sont intitulés:

1- Métaux: contamination du milieu aquatique au Québec méridional
2- Toxiques inorganiques dans l'eau des rivières et des lacs du Québec méridional
3- BPC: contamination du milieu aquatique au Québec méridional
4- Pesticides organochlorés: contamination du milieu aquatique au Québec méridional.

Cette amorce de l'action du ministère de l'Environnement du Québec dans le domaine des contaminants toxiques fut suivie d'une action plus globale incluant l'air et le sol. Si un décalage a pu se produire dans la mise en oeuvre des actions spécifiques à ces deux secteurs en comparaison avec l'eau compte tenu des connaissances de l'époque, il est certain que les préoccupations actuelles du Ministère vis-à-vis la présence des contaminants dans l'air et dans le sol nous achemine rapidement vers les solutions appropriées.

La réglementation touchant la qualité de l'atmosphère, celle touchant les déchets liquides et la démarche gouvernementale concernant l'élimination des déchets inorganiques et l'incinération des déchets organiques dangereux sont les bases d'une action de plus en plus ferme pour garantir aux citoyens d'aujourd'hui et de demain un environnement meilleur.

Sans minimiser l'importance des secteurs eau et sol, il m'apparait opportun dans le contexte de ce colloque de mettre l'accent sur les contaminants toxiques dans l'atmosphère. Les toxiques sont peut-être moins perceptibles dans l'air que ceux qui contaminent l'eau et le sol. Mais les problèmes potentiels découlant d'un air contaminé sont très préoccupants parce que l'homme doit forcément respirer l'air qui l'entoure quelle que soit sa qualité.

A) SUBSTANCES DÉJA DÉFINIES EN 1978

Certaines des substances énumérées précédemment ont fait l'objet d'études plus particulières et de prises de position de la part de notre Ministère. Ce sont: l'amiante, les pesticides, l'arsenic et les BPC.

L'amiante

Le Québec est responsable de 25% de la production mondiale d'amiante. Conscients des conséquences potentielles de la manipulation des fibres d'amiante sur la santé des travailleurs, les Services de la protection de l'environnement du Québec se sont occupés très sérieusement de ce problème dès les années 1974-75.

Un groupe de travail fut constitué pour réviser les règles de l'art du dépoussiérage dans l'industrie minière de l'amiante et pour déterminer l'efficacité de la technologie disponible. C'est ainsi qu'on a pu fixer à deux fibres par centimètre cube la quantité d'amiante permissible dans les émissions provenant de ce secteur d'activités. Cette norme fut publiée en 1979 dans le règlement cadre relatif à la qualité de l'atmosphère.

Par la suite, un programme de mise en application de ce règlement fut développé en collaboration avec le Gouvernement fédéral. Plus de 200 sources ponctuelles de rejet à l'atmosphère furent inventoriées et contrôlées. Un programme d'échantillonnage et de surveillance de toutes les sources fut amorcé en 1979 et se poursuit toujours. Les résultats obtenus sont satisfaisants et Environnement Québec continue d'exercer un contrôle serré dans ce secteur. On a constaté qu'avec un entretien approprié et une surveillance continue des systèmes de dépoussiérage la norme prescrite pouvait être rencontrée.

Les pesticides

Les pesticides, en raison de leur nature toxique et de l'utilisation intensive qui en est faite, constituent une grande préoccupation au Québec. Ils ont fait l'objet d'une attention particulière du Ministère au niveau de la prévention. La politique adoptée vise à s'assurer que les pratiques de lutte et de protection contre les ennemis des récoltes et des biens utiles à l'homme présentent un risque minimum pour ce dernier et pour son environnement.

Quatre principes dirigent l'action du Ministère, ce sont: la responsabilisation, les moyens naturels, les règles d'utilisation des pesticides et la recherche.

1. les utilisateurs de pesticides doivent être responsabilisés quant aux incidences environnementales de l'usage des pesticides et on doit les amener à prendre conscience des dangers inhérents à l'utilisation de ces produits;
2. les méthodes préventives de lutte de même que les moyens physiques, naturels et biologiques de répression doivent être privilégiés;
3. les méthodes de lutte peuvent inclure l'utilisation de pesticides; toutefois des règles d'utilisation et de mesures de protection doivent être suivies;
4. le Ministère doit réaliser, développer et encourager les recherches qui permettent le développement de méthodes, systèmes ou stratégies de lutte intégrée.

Pour assurer la protection de l'environnement dans le contexte de l'usage des pesticides, le Ministère a établi un plan d'action en cinq points:

1. Certains projets d'utilisation tels la pulvérisation dans les corridors de transport ou d'énergie, l'utilisation de produits non enregistrés en vertu de la Loi sur les produits antiparasitaires, la pulvérisation aérienne à des fins non agricoles et l'utilisation dans un milieu aquatique doivent faire l'objet d'une autorisation spécifique et ponctuelle de la part du ministère de l'Environnement en vertu de l'article 22 de la Loi sur la qualité de l'environnement. Pour ces

projets, le Ministère fournit aux utilisateurs des guides adéquats indiquant les dangers des produits et les autres moyens de lutte; de même il indique comment obtenir les autorisations nécessaires;

2. établir la compétence des utilisateurs de pesticides en collaborant à la préparation de cours de formation;
3. signer des protocoles d'ententes avec les principaux intervenants comme les vendeurs et distributeurs, les exterminateurs, les applicateurs à forfait et possiblement l'UPA. A titre d'exemple, le 28 octobre dernier, M. Adrien Ouellette, ministre de l'Environnement, signait le premier protocole avec l'Association des spécialistes en extermination. Ces initiatives ont pour effet de rendre les utilisateurs responsables de leurs actes.
4. préparer une réglementation minimale pour l'usage de certains produits qui peuvent présenter un risque pour l'homme ou l'environnement en raison de leurs propriétés, telles la toxicité et la persistance, ou à cause de la fragilité des milieux d'utilisation.

A cet effet, le ministère de l'Environnement du Québec entreprendra sous peu la mise en place d'un cadre réglementaire additionnel qui s'effectuera en deux phases, soit:

I- la modification à court terme de la réglementation actuelle pour inclure une classification des pesticides, les règles de formation des utilisateurs et des conditions générales d'utilisation. Cette modification permettra d'exercer un contrôle plus serré sur l'utilisation de huit matières actives très problématiques qui sont:

- le DDT
- l'endrine
- le dieldrine
- l'amino-4 pyridène
- le chlorydrate d'azacostérol
- le senthion
- le strychnine
- l'alpha trifloro nitro-4 Crésol

II- la modification à long terme à la Loi sur la qualité de l'environnement permettant d'agir sur la vente des pesticides.

5. assujettir à la procédure d'étude d'impact et à une consultation publique certains projets de grande envergure, comme les programmes de pulvérisations aériennes de pesticides à des fins non agricoles sur une superficie de 600 hectares ou plus.

Le 30 décembre 1980 entrait en vigueur le règlement d'évaluation et d'examen des impacts sur l'environnement qui identifie les catégories de projets assujettis à cette procédure. A l'article 2q) on y indique que tout programme ou projet de pulvérisation aérienne de pesticides doit faire l'objet d'une étude d'impact.

Depuis cette date, deux projets de pulvérisation aérienne du M.E.R. (ministère Énergie et Ressources) furent soumis à des audiences publiques. L'un impliquait des insecticides chimiques (fénitrothion et aminocarbe) utilisé contre la tordeuse des bourgeons de l'épinette. Lors de cette audience, les principes d'action du Ministère furent très bien définis, et le décret émis à la suite de cette audience, en faisait état. En effet, ce décret ordonne l'utilisation de l'insecticide biologique Bacillus thuringiensis (B.T.) pour une zone dont la superficie devra aller en s'intensifiant avec les années. (60,000 hectares en 1983 et 300,000 hectares en 1984) etc.

L'autre projet impliquait l'utilisation des phytocides 2,4-D et 2,4,5-T; toutefois, vu l'impopularité de ces produits face à la population, le M.E.R. retira le projet une fois les audiences publiques terminées.

L'arsenic

L'arsenic fait aussi l'objet d'une attention particulière. Il est connu depuis fort longtemps pour ses propriétés médicinales et toxiques. L'arsenic présent comme impureté dans la plupart des minerais, l'exploitation de ceux-ci le libère dans l'atmosphère où on le retrouve sous forme de fines particules composées principalement d'oxydes d'arsenic inorganiques. Les industries minières et métallurgiques et particulièrement celles du cuivre, du plomb, du zinc et de l'or sont les principales sources émettrices de cette substance.

L'industrie du "Smeltage du cuivre" au Québec compte parmi les premiers au monde; le Ministère est donc conscient du potentiel d'émission d'arsenic que représente ce secteur d'activités. Pour cette raison, il demandait en 1983 aux deux industries du Smeltage du cuivre de lui fournir l'inventaire des émissions d'arsenic à leur usine pour les années 1980, 1981, 1982.

De plus, ces deux industries étant munies de systèmes différents d'épuration des gaz, le Ministère entreprendra au cours de 1984, un programme d'échantillonnage chez ces dernières afin de comparer l'efficacité de leur système d'épuration et de mieux définir leurs émissions à l'atmosphère. Déjà, à la lumière des résultats obtenus, le Ministère envisage de réglementer ces émissions. Incidemment, la construction d'une usine d'acide sulfurique à l'usine Horne de Rouyn-Noranda permettrait de résoudre à la fois le problème des pluies acides et celui de l'arsenic.

Les biphényles polychlorés (BPC)

Les biphényles polychlorés ou BPC sont un sujet de grande préoccupation pour le ministère de l'Environnement, que ce soit à cause de leur potentiel cancérigène ou de leurs effets sur la reproduction et sur la progéniture.

L'usage largement répandu des BPC pendant une cinquantaine d'années a quelque chose d'alarmant quand on sait l'extrême stabilité de ce produit. Répandu dans l'environnement, les BPC persisteront pendant des millénaires. Le fait qu'on n'ait pas démontré hors de tout doute que le produit est cancérigène ne change en rien le niveau d'inquiétude des environnementalistes. Il n'y a pas de risque à prendre avec la santé humaine.

C'est pourquoi le ministère de l'Environnement traite les BPC avec le plus grand "respect" pour qu'on ne les retrouve pas dans le sol, dans l'eau ou dans l'air.

Même si la commercialisation des BPC est interdite par le Gouvernement fédéral depuis le 1er juillet 1980, d'énormes quantités de BPC sont toujours utilisées dans les transformateurs et condensateurs. Sur le territoire québécois, on évalue à trois millions de litres (650,000 gallons) les BPC à forte concentration (50 à 70% Arochlor) en usage ou entreposés. De plus, on estime à une valeur équivalente les diélectriques contaminés à plus de 50 p.p.m. de BPC.

Depuis cinq ans le ministère de l'Environnement autorise l'ENTREPOSAGE des BPC selon des critères rigoureux en attendant qu'une solution adéquate d'élimination soit développée.

Jusqu'à ce jour, même si les BPC ne sont pas en grande quantité dans l'atmosphère, le risque est grand de les y retrouver comme tels ou transformés en substances encore plus dangereuses.

En effet, le moyen le plus couramment utilisé pour détruire les substances organiques dangereuses ou non est l'incinération dont les gaz émis se retrouvent à l'atmosphère. Or, on risque de retrouver des BPC par inadvertance dans n'importe quel incinérateur à déchets ménagers.

De plus, la destruction des substances organiques toxiques demande des précautions très particulières parce que lors de l'incinération, les sous-produits formés émis à l'atmosphère peuvent être plus toxiques que les produits initiaux. Dans le cas des substances halogénées, dont le BPC, les conditions de destruction doivent être encore plus sévères, compte tenu de la formation des sous-produits très toxiques, tels les dioxines et les furannes.

En 1980, le ministère de l'Environnement a voulu assurer le contrôle de l'élimination des substances dangereuses ou toxiques en assujettissant au règlement sur l'évaluation et l'examen des impacts sur l'environnement, l'implantation ou l'agrandissement d'un lieu d'élimination de déchets toxiques (que ce soit par traitement, incinération, enfouissement ou autrement), (art. 2t).

Suite à cette action, le Ministère lançait en septembre 1982 un appel à tout promoteur qualifié pour l'élimination et le recyclage des déchets organiques. La politique d'Environnement Québec est de laisser à l'industrie privée le soin de construire et d'opérer les outils d'élimination des déchets dangereux tout en lui imposant des normes sévères.

Treize (13) projets ont été soumis et celui de la Société pour l'élimination et le recyclage des déchets organiques du Québec, appelée SERDOQ a été retenu sur le principe que le promoteur offrait la meilleure technologie disponible d'élimination et de gestion des déchets organiques dangereux, y compris les BPC.

Dans le processus d'étude des projets sõumis, les responsables de notre Ministère dans ce dossier ont visité les plus grands centres d'élimination européens afin de vérifier la technologie proposée par les divers promoteurs et de la comparer avec les autres technologies utilisées.

Les exigences, quant aux critères de conception, d'opération et d'épuration, ont été dressées afin de s'assurer du maximum de protection du milieu environnant. Cette démarche gouvernementale s'inscrit dans la politique de gestion des déchets toxiques.

B) SUBSTANCES NOUVELLEMENT DÉFINIES

L'évolution des priorités gouvernementales vis-à-vis les contaminants toxiques est un corollaire de l'évolution des connaissances scientifiques qui sont liées à la recherche.

Le législateur doit, dans le domaine des contaminants toxiques, statuer sur les situations potentiellement alarmantes sans pour autant posséder tous les éléments de décision souhaitables. Il doit parfois prendre des actions drastiques envers des produits réputés potentiellement dangereux même s'il ne possède pas une connaissance exhaustive de leurs effets sur la santé des individus ou sur l'environnement en général.

L'acquisition de nouvelles connaissances a fait encore s'allonger, au cours des dernières années, la liste des substances toxiques et dans ce contexte nous n'avons d'autre choix que de les intégrer à nos politiques d'action voire même en certains cas en faire nos nouvelles priorités. C'est dans ce contexte que je voudrais aborder les substances "nouvellement" définies comme toxiques.

Les hydrocarbures aromatiques polycycliques

Mentionnons premièrement les hydrocarbures aromatiques polycycliques ou HAP qui constituent un des neuf groupes de composés chimiques nommés "les matières organiques polycycliques".

Le Ministère s'intéresse particulièrement à ceux-ci parce qu'ils sont formés en quantité très importante lors de la combustion incomplète de matières organiques. Ils sont donc susceptibles de se retrouver en plus grande quantité dans l'air ambiant.

Le benzo(a)pyrène est, parmi les HAP, celui qui à ce jour a été le plus étudié étant donné que son activité cancérigène est reconnue depuis longtemps; il représente de 1 à 20% de tous les HAP émis à l'atmosphère.

Les sources fixes d'émission de HAP sont généralement considérées en trois catégories distinctes, ce sont:

a) les procédés industriels
b) les installations de production d'énergie
c) l'incinération des déchets et les feux à ciel ouvert.

Au chapitre des activités industrielles, la production de l'aluminium de première fusion représente très probablement au Québec l'activité responsable de la plus grande quantité de HAP émis à l'atmosphère. Une étude menée à Arvida a mis en évidence des émissions aussi élevées que 5 kilogrammes de HAP par tonne d'aluminium, produite dans les cellules d'électrolyse du type pâte anodique Soderberg. Uniquement pour le BaP, le facteur d'émission a été calculé à 200g/tonne Al produit. Au Québec, il existe cinq alumineries qui opèrent ce type de cellules, elles sont situées à Arvida, Baie-Comeau, Shawinigan, Alma et Beauharnois. La production totale d'aluminium pour ces dernières se chiffre à 665,000 t/an, ce qui nous permet d'estimer à 3,325 t/an les émissions de HAP à l'atmosphère dues à cette activité. Une campagne d'échantillonnage de ces sources d'émission sera entreprise dans les mois à venir afin d'évaluer, de façon précise, l'importance des émissions de HAP que l'on peut attribuer à ce secteur d'activités.

La fabrication de carbure de silicium, un abrasif est une activité industrielle susceptible de libérer des HAP dans l'air. Ce composé est fabriqué par chauffage d'un mélange de silice et de coke de pétrole dans un four à résistance électrique et c'est à cette étape que la formation de HAP peut se produire; nous comptons deux usines de ce genre au Québec, elles sont situées à Cap-de-la-Madeleine et à Shawinigan. Au cours de l'hiver dernier, notre Ministère a procédé à l'échantillonnage des gaz de cheminée d'un four expérimental installé chez une de ces industries. Les résultats seront bientôt disponibles.

D'autres sources constituent aussi un potentiel pour ces émissions. Mentionnons la fabrication des électrodes de carbone de même que la regénération du catalyseur utilisé dans les unités de craquage catalytique des raffineries de pétrole.

Quant aux installations de production d'énergie la source principale au Québec serait les usines de fabrication de pâtes et papiers dont la majorité opère des chaudières à écorces pour la production de la vapeur nécessaire au procédé; les scieries en possèdent également. Les températures de combustion retrouvées (800-900 °C) favorisent la formation d'hydrocarbures à caractère aromatique. On dénombre pour ces deux types d'industries plus d'une trentaine de ces appareils de combustion au Québec. La combustion du bois dans les foyers domestiques constitue aussi une source d'émission de HAP. Ceci s'explique du fait que c'est habituellement dans ces petites unités que l'efficacité de combustion est la moindre dû principalement aux basses températures rencontrées combinées au mauvais entretien de l'équipement et de la désuétude des appareils.

•Au chapitre de l'incinération, mentionnons que l'utilisation d'incinérateurs aux fins d'élimination de déchets ménagers est répandue au Québec. C'est ainsi que l'on retrouve trois (3) incinérateurs municipaux, un incinérateur de déchets toxiques, des incinérateurs de déchets pathologiques et de déchets domestiques. Ces deux derniers types sont difficilement dénombrables mais couramment rencontrés dans les hôpitaux et les grosses conciergeries. La réglementation au Québec interdit l'usage d'incinérateurs à chambre unique pour les déchets solides, cependant il est probable que les HAP puissent se former étant donné la grande variété de déchets brûlés même dans incinérateurs avec post-combustion.

Le Ministère est très concerné par les émissions de HAP à l'atmosphère et c'est pourquoi une campagne d'échantillonnage est déjà amorcée au niveau des principales sources identifiées et s'étendra éventuellement aux autres sources.

De plus, afin de pouvoir caractériser ces substances et de définir les risques sur la santé chez les humains dûs à leur présence dans l'atmosphère, le focus sera mis sur l'échantillonnage de l'air ambiant dans le cas des agglomérations où les résultats d'échantillonnage des sources fixes montreraient des émissions significatives d'HAP.

Ces mesures permettront au Ministère de pouvoir mettre sur pied une politique de contrôle adéquate auprès des responsables de l'émission de ces substances qui débouchera sur une directive et éventuellement une réglementation.

<u>Les dioxines et les furannes</u>

On ne pourrait terminer sans parler des dioxines et des furannes qui sont peut-être les substances reconnues comme les plus toxiques à ce jour.

Tout comme les HAP, ils sont formés lors de la combustion incomplète de composés organiques. Nous ne possédons pas d'étude nous permettant d'identifier clairement toutes les sources d'émissions de ces produits. Toutefois, comme le procédé d'incinération municipale et industrielle est reconnu comme la principale source d'émission de ces substances, une attention particulière sera donnée à ce secteur afin de les identifier quantitativement dans les émissions à l'atmosphère. L'échantillonnage des autres sources sera conditionnel aux données obtenues dans cette première approche.

Encore une fois, l'échantillonnage de l'air ambiant sera utilisé pour évaluer l'incidence des émissions sur le milieu et guider l'élaboration d'une politique de contrôle.

CONCLUSION

Le MENVIQ est un petit ministère dont les ressources financières et humaines sont limitées. Il ne peut, par conséquent, être aussi présent dans tous les volets de la gestion des substances toxiques. C'est ainsi que l'aspect "recherche" est modeste et confiné à des sujets pratico-pratiques. Il veut, cependant, compenser son absence sur le plan recherche en se tenant à l'affût des derniers développements et en passant rapidement à l'action, en mettant sur pied des outils de gestion des substances reconnues toxiques par les chercheurs, en préparant des politiques, des directives, de la réglementation, voire de la législation et en mettant l'accent sur la mise en place de moyens propres à assurer le respect de l'environnement.

Il ne sert à rien en effet d'interdire par lois et règlements, l'usage, le transport et l'émission de substances toxiques si on n'a pas en même temps, par exemple, pris les moyens pour assurer la mise en place d'outils sécuritaires de gestion de ces substances.

Il ne sert à rien de dire aux gens, aux industries: "Vous ne pouvez pas jeter tels produits dans l'environnement", si on ne fait pas en même temps l'effort de développer, de concert avec les gens et les industries, des moyens sécuritaires d'élimination de ces produits.

C'est dans cet esprit qu'Environnement Québec a traité la gestion des déchets organiques et inorganiques dangereux, en favorisant l'implantation de STABLEX, en privilégiant un Centre d'éliminatin des D.O.D. comme SERDOQ. C'est aussi en intervenant au niveau des procédés industriels qu'on obtiendra les plus importants résultats:

- en favorisant des procédés de fabrication utilisant des substances moins toxiques;
- en favorisant la consommation de produits générant moins de déchets;
- en encourageant la récupération et le recyclage.

Ce sont là aussi des éléments de la politique préventive du Ministère en matière de gestion des toxiques.

Le travail accompli et les actions entreprises par le ministère de l'Environnement et par d'autres intervenants du domaine des substances toxiques ont, certes, amélioré la situation passée; on peut, à titre d'exemple, évoquer la réglementation visant les chlorures de vinyle et de polyvinyle et celle touchant les fluorures. Toutefois, à mesure que le brouillard se lève, au rythme de l'acquisition de nouvelles connaissances, on s'aperçoit que le rivage est devant nous mais que l'atteinte de la terre ferme nécessitera de nouveaux efforts.

Le présent colloque est donc une initiative heureuse et nécessaire, puisqu'il permet la mise en commun de connaissances diverses ainsi que des échanges de point de vue qui ne peuvent qu'accélérer une meilleure définition des problèmes, et de là, la mise en oeuvre de politiques adéquates qui assureront une gérance efficace de ces substances et une qualité de l'air et du milieu en général compatible avec le bien-être des individus.

Agro-Chemical Substances as protecting Agents: Policy and Regulation

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Agriculture currently in Canada's number one industry. The value of production at the farm gate is about $18 billion annually and one job in four in this country has direct relationship to and dependence on food production.

Nowadays there is, in some segments of the urban population that formerly was largely indifferent about agriculture, a new awareness of the sizable stake everyone in Canada has in our basic agriculture and food industry.

This is not just recognition of the reality of the importance of adequate food supplies; it is also recognition of the profound and constructive impact agriculture has on the national economy - on incomes and employment - through its 1:5 multiplier effect on the economy generally.

Unfortunately, many people still do not understand that modern agriculture is a high technology industry, quite unlike the image of it cherished by those who have had little, if any, contact with a real farming operation. They do not realize the importance of technology to the handful of farmers who have the responsibility of feeding us, generating a substantial portion of our exports and supporting employment in a variety of industries downstream from the farm gate.

Because of this, they demand a regulatory system dedicated to zero risk - a condition that doesn't exist in any area of human activity, be et work or play.

The potential of Canadian agriculture has been compromised by the widespread anxiety about the use of chemical and, indeed, other technology in food production. This is manifest in many ways; but for today's discussion I want to relate it to the regulatory process in Canada.

Regulatory agencies have been under pressure from individuals and organizations that vocalize the "chemophobia" of a large proportion of the Canadian population. They are part of the political process and as such are obliged to respond to political pressures.

Canadian requirements for the regulation of crop protection chemicals are the most stringent in the developed world. As a result our registration process is the slowest in the world.

Today Canadian farmers are being denied the use of important new crop protection compounds, they proceed slowly through the registration process, while their opposite numbers in the U.S. and elsewhere are using them and have been using them for as long as four years.

This is a regulatory environment that puts Canada at a competitive disadvantage in the export food markets of the world. Also, it is a regulatory environment that discourages international investment in Canada's agricultural chemicals industry.

This is a serious matter. Agriculture is one of the relatively few industries in which Canadians have the ability to produce and sell sucessfully on a world scale. In this situation, it is tragically short sighted to make no effort to build, in this country, the industries that are necessary for the support of a high technology agriculture.

These industries include such knowledge intensive fields as genetic engineering and other branches of the new biotechnological sciences.

One of the keys to attracting them is an efficient and balanced regulatory system that does not impede the transfer of technology.

The base legislation for the regulation of agrochemicals is comprised of four acts which I will outline in some detail.

The Pest Control Products Act

This is the principal statute controlling pesticides in Canada and it is administered by Agriculture Canada with the advice of three other federal departments. The act prohibits any person from manufacturing, storing, displaying, distributing or using a control product "Under unsafe conditions". The prohibitions extend to importing or selling such products in Canada unless they have been registered, packaged and labelled according to prescribed conditions.

The Minister of Agriculture has broad authority to require registration of all control products imported or sold in Canada and can specify the scientific information to be submitted in support of a registration application. In conjunction with labelling requirements, the Minister can prohibit the use of pesticides in a manner inconsistent with such labelling. Also, the Minister can authorize record-keeping, inspections, and can undertake a variety of enforcement actions, under the Act.

Pesticides must be registered <u>before</u> being sold in Canada. Pesticides may only be registered if the Agriculture Minister is of the opinion that the control product has merit or value for the purposes claimed when used in accordance with label directions. The perticide's use must not lead to an "unacceptable risk of harm" to (1) things on or in relation to which the control product is intended to be used, or (2) public health, plants, animals or the environment. A registration application must provide sufficient information to allow the Minister to determine "the sagery, merit and value of the control product". The applicant for a control product registration must provide the Minister with the results of scientific studies demonstrating the control product's efficacy; occupational safety and exposure; effects on host plant, animal, article or non-target organisms; residue persistence, retention and movement; analytical methods for detecting the control product and its residues in food, deed and the environment; detoxification or neutralization methods with respect to the control product in soil, water, air or articles; disposal methods for the control product and its empty containers; and information respecting the storage, display, stability and compatibility of the control product with other products. Where the control product is intended for human consumption the applicant must also provide test results respecting the effects of the control product or its residues on test animals in order to assess human or animal risks associated with the product and related concerns.

Under the Act, the efficacy of new pest control products in the responsibility of Agriculture Canada. This is determined from data submitted to the Department by the company seeding the registration. To help applicants meet the requirements of the Act and regulations, Department guidelines and trade memoranda provide guidance for organizing the technical data to be submitted in support of registration applications under the Act. For the registration of a new active ingredient the data the Department requires include draft label, product chemistry, toxicology, metabolism studies, food, feed and tobacco residue studies, and information on environmental chemistry, environmental toxicology and efficacy.

In 1980, Agriculture Canada implemented registration procedures that are product specific, rather than generic in nature. This policy of Product Specific Registration (PSR), focuses more directly on the specific source of an active ingredient or formulated agrochemical product. Agriculture Canada has stated:

> "PRS ties each individual registered product to a specific basic producer of the active ingredient and to a data package that relates specifically to the pesticide to be registered...PSR allow (Agriculture Canada) to "track" individual products back to a basic supplier's technical or active ingregient and manufacturing process and to the ...data package that related directly to it"

Agriculture Canada's concern in developing PSR, in part, is that different manufacturing processes can result in variations in product quality, including the levels of microcontaminants, such as nitrosamines. Agriculture Canada has acted in certain instances to register individual active ingredients as produced by a manufacturer using a specific process at a designated plant.

The food and Drugs Act

A general prohibition of the sale of adulterated food is found in section 4 of the Food and Drugs Act (FDA), administered by the Department of Natinal Health and Welfare. Section 4 prohibits the sale of any article of food that has in or upon it any poisonous or harmful substance; is unfit for human consumption; or is adulterated. Division 15 of the FDA regulations establish maximum residue limits for agricultural chemicals. Agricultural chemicals are defined in the regulations and include both substances that have been registered under the Pest Control Porducts Act as well as other pesticides, not registered in Canada which may result in residues on imported food.

Maximum residue limits (expressed in parts per million) have been established for approximately 90 agricultural chemicals. Any chemical found exceeding the limit set out in Division 15, Table 4, will be deemed an adulterant and in breach of section 4(d) of the Act. Pesticide residue limits are set at levels which will cover residues likely to remain in food at point of wholesale marketing; that is, at harvest of a crop, slaughter of an animal, removal from a warehouse in the case of treatment of stored foods, or point of entry into the country in the case of imported foods. The regulations were amended in 1978 to provide that a food is adulterated if it contains more than 0,1 ppm of any agricultural chemical not specifically listed in Division 15. The Department of National Health and Welfare has outlined the rationale for this as follows:

A) relatively simple legal action can be taken against pesticide residues exceeding 0,1 ppm, without the need to prove hazard or to take action under section 4 of the Act;

B) many pesticides originally thought to leave no residues on foods (i.e. below the sensitivity of the analytical method) have been subsequently found to leave very low residues which may be toxicologically negrigible; and

C) residue levels below 0,1 ppm which are considered to be toxicologically significant may still be listed in Table II, Division 15.

Detailed information is required by Health and Welfare Canada from the registrant on: the amount to be applied; frequency and times of application; satisfactory methods of analysis for determining residues in food; plant and animal matabolism studies; data on the quantity and chemical nature of residues remaining on fools at harvest, slaughter or point of sale; toxicity studies designed to evaluate the hazards of residues to experimental animals; and proposed residue limits in food.

A determination of the Acceptable Daily Intake (ADI) of the particular pesticide is made by Health and Welfare. The ADI is the amount of chemical which toxicologists consider to be safe for humans to injest each day for an entire lifetime. Calculations are made of the lowest no effect dose from toxicity studies of the pesticide on each animal species tested. The lowest no effect level is then divided by a safety factor such as 100 to establish the ADI.

A separate assessment is made to determine the allowable maximum residue level (MRL). The residue studies submitted are examined, but MRL's are only accepted providing that the total consumption of residues from all food uses will not exceed the ADI estimated for the particular pesticide from the toxicity studies.

The environmental Contaminants Act

As you know, the purpose of the Environmental Contaminants Act is "to protect human health and the environment from substances that contaminate the environment". The Ministers of Environment and National Health and Welfare are given the authority to ban or restrict the Import, manufacture, processing, sale, commercial use or release of a substance, or class of substances, that the ministers are satisfied does or will constitute "a significant danger... to human health or the environment". Before acting, the Ministers must be satisfied that the problem will not be eliminated by the use of other federal or provincial laws after consulting, or offering to consult, with the provinces and other federal departments. Accordigly, it has had only a marginal impact on pesticide problems. Environment Canada officials noted as early as 1975 that:

"The Environmental Contaminants Act will not be concerned with pesticides. However, it will be concerned with those chemical substances which are used as pesticides as well as for other industrial or commercial purposes"

Fisheries Act

Under the Fisheries Act, no person may deposit deleterious substances into waters frequented by Fish. Thus, the improper application or disposal of pesticides into fish frequented waters could be the subject of a Fisheries Act prosecution. While the Fisheries Act has general regulation-making authority, no regulations for pesticide discharges from manufacturing or formulating plants have been promulgated to date. However both Environment Canada and Fisheries and Oceans Canada routinely participate in the pre-registration review of the supporting data for pesticides which include tests to measure a condidate compound's toxicity to fish and potential impact on the aquatic environment.

In addition to the four federal statutes I have mentioned, theClean Air Act, the Migratory Birds Conservation Act, the Transportation and Dangerous Goods Act and the Criminal Code also have potential applicability to agrochemicals

In its administration of the Pest Control Products Act, Agriculture Canada frequently seeks advice beyond the other three federal departments whose roles have been outlined thus far. For example, if the proposed new registration requires a new maximum residue limit for a grain crop, the Canadian Grain Commission will be asked for comment. If the new product, though made for agriculture, has possible use in forestry, the Forest Pest Management Institute, Canadian Forestry Service of Environment Canada will be asked for advice.

All compounds developed for use on tabacco are referred to the Delhi (Ontario) research station of Agriculture Canada; and insecticides for use on livestock are reviewed by two additional consultants: Agriculture Canada's Lethbridge Research Station and the Animal Disease Research Institute. Provincial ministries also are consulted from time to time as part of the pre-registration review process.

In summary existing policies and laws are fully adequate. While pesticides are a special concern because they infused into the environment, we know infinitely more about them, the way they work, the way they biodegrade and the potential hazard that may be associated with them than is known about anything else that man lets loose into his surroundings, including automobile exhaust and municipal garbage. This is so because of the very thorough, comprehensive and painstaking review of masses of supporting data <u>berore</u> a pesticide is introduced.

There is an urgent need for additional hightly trained scientists to be allocated to this review process by the four federal departments involved to deal with the burgeoning flow of new technology for agriculture.

Gestion des déchets toxiques et action populaire

Lynnae Dudley
S.T.O.P. Inc.

Le problème de la gestion des déchets toxiques et l'utilisation des produits toxiques dans la société, sont des problèmes qui préoccupent les groupes environnementaux depuis très longtemps. Nous somme d'avis, en général, que les procédés qui produisent des produits toxiques, produisent en même temps des déchets et des rejets toxiques. Si le procédé est muni d'un système anti-pollution, il en résulte une décharge concentrée de matière toxique qui est difficile à entreposer, à éliminer ou à traiter.

Une approche préventive a donc été élaborée. De façon général, le mouvement écologiste promet une classification des produits qui tient compte de leur utilité sociale et de leur toxicité:

TOXIXITÉ			
	Haute	non-utile et dangeureux	utile et dangeureux
	Basse	non-utile et sécuritaire	utile et sécuritaire
		basse	haute

UTILITÉ SOCIALE

Les produits qui ne sont que très peu utiles pour la société ne devraient pas être produits, et, si en plus, ils sont toxiques, l'argument devient encore plus fort. De l'autre côté, si le produit toxique montre un vrai avantage social, sa production, de façon bien contrôlée, doit être considéré. Si des alternatives moins dangereuses existent elles devraient être avantagées. De toute façon, les nouveaux produits doivent être condidérés dangereux jusqu'au moment où le contraire est prouvé; ceci servira à éviter des catastrophes comme l'affaire de la mousse isolante à l'urée formaldéhyde.

Nous croyons aussi que la population doit être incluse dans le processus décisionel concernant la gestion des déchets dangereux. Quand le Bureau des audiences publiques sur l'environnement a été inauguré en 1978, la participation du public a été favorisée d'une sorte, mais comme le BAPE n'a pas de poids décisionel, l'opinion du public ne serva qu'à titre informatique. L'intérêt de la population est, par contre, très évident; il ne faut que regarder la forte participation des groupes de citoyens aux audiences publiques sur le projet STABLEX, le projet d'arrosage de la tordeuse des bourgeons et le projet d'arrosage des herbicides.

Il existe toujours certains préjugés de la part des gouvernements et de l'industrie au sujet de la réaction du public aux questions des déchets toxiques. J'ai l'impression qu'ils n'attendent que deux réactions possibles de la population.

La première peut être illustrée par l'exemple suivant; depuis fort longtemps, les groupes intéressés au problème des déversements de déchets toxiques dans des vieux dépotoires et d'autre lieux non-autorisés, savaient que le ministère de l'environnement préparait une liste de sites potentiellement dangereux au Québec. Le désastre des lagunes à Ville Mercier, ainsi que les dépotoires à Boucherville, LaSalle Coke, Ste-Julie et autres, étaient bien publicisés dans les médias, et le gouvernement fédéral venait de rendre public son rapport sur les sites de déchets toxiques sur les terres fédérales; mais la liste québécoise était toujours bien cachée dans la bureaucratie du gouvernement. Une raison pour laquelle le Ministère ne voulait pas rendre public les résultats de son étude était pour éviter la panique qui aurait pu être engendrée dans les régions affectées, due à une population réactionnaire et mal renseignée. Finalement, suite surtout aux pressions de la Société pour Vaincre la Pollution, qui a publié sa propre liste de 90 sites contaminés et potentiellement contaminés, le Ministère renda public la liste de sites prioritaires, l'an dernier. De mes conaissances, aucune crise de panique n'a été observée et maintenent, la population est mieux renseignée et est en mesure de réagir de façon respondable.

La deuxième réaction, surnommée le syndrôme "NIMBY", de l'américain "Not In My Back Yard", ou bien "pas dans ma cour", est dite à chaque fois qu'un promotteur tente d'installer une usine de traitement ou un lieu d'élimination de déchets dangereux dans une minicipalité. Pendant la période où STABLEX cherchait un site pour implanter son usine de solidification des déchets inorganiques, la compagnie a rencontré à plusieurs reprises, de l'opposition de la part des populations locales et des représentants municipaux. La première fois était à Laval-des-Rapides, puis à Mascouche. Finalement elle à été accueillie à Blainville, où encore là, la population n'a jamais prononcé son consentement.

Ce phénomène souligne l'importance qui doit être accordée à la qualité du site associé aux projets de ce type. Non seulement tous les paramètres physiques et chimiques doivent être convenables mais, la vocation du territoire, agricole, industriel, urbain..., doit aussi entrer en jeu.

Justement, dans la région de Mercier, 40 km au sud de Montréal, un groupe de citoyens s'est formé suite à une mauvaise gestion de déchets toxiques. Depuis 1969, une vieille sablière reçoit des déchets industriels; la perméabilité du sous-sol a permis la contamination d'une des plus importantes nappes d'eau sousterraine du Québec, de telle sorte que le gouvernement à été obligé d'interdire l'utilisation de cette eau sur un territoire qui touche à une minicipalité, trois paroises et deux villes. De plus, le gouvernement procède actuellement au pompage et au traitement des eaux. Pour régler le problème des déchets entreposés dans les lagunes, un incinérateur a été battie sur le site. Depuis cette date, 1972, la compagnie gérante n'a pas arrêté de polluer la région, mais cette fois par la voie aérienne. En 1982, les émissions de l'incinérateur de TRICIL, excédaient les normes provinciales de treize fois.

D'après les calculs du regroupement "Protégeons notre santé et notre environnement" environs 1 400 tonnes de chlore, 55 tonnes de chrome, 90 tonnes de plomb, 120 tonnes d'aluminiun, 2 tonnes d'arsenic et un total de 6 800 tonnes de matière particulaire sont sortis de cette cheminée dans les dix dernières années, pour être déposées sur le territoire essentiellement à vocation agricole.

Il me semble tout à fait normal que dans des cas aussi flagrants que ceux-ci, la population se regroupe pour s'assurer que sa voix soit entendue et pour forcer les personnes dans les positions décisionelles de prendre position.

Ce regroupement compte 1 200 membres et, donc, n'est pas formé juste de marginaux, de freaks et de trippeux; le problème d'eau potable et de rejets atmosphériques a réussi à regrouper une population de personnes comme vous et moi, dans un but précis, soit de régler le problème actuel, d'éduquer le reste de la population et d'assurer que de tels désastres ne se reproduisent plus.

Le regroupement a choisi d'utiliser un moyen de pression qui pour l'instant est très peu exploité par les groupes environnementaux, soit; par voie légale. Mais au fur et à mesure que le potentiel de la Loi sur la qualité de l'environnement soit compris et assimilé, ce genre d'action deviendra plus courrant.

À S.T.O.P., notre première intervention publique dans le domaine des toxiques fut une présentation devant le Bureau des audiences publiques sur l'environnement, sur la question de l'implantation de l'usine de STABLEX à Blainville. Notre position lors des audiences publiques n'a pas changé. Nous avons demandé:

- que le gouvernement du Québec énonce sa politique de gestion de déchets toxiques, ce qui a été fait en décembre 1980;
- qu'un débat public soit organisé sur cette politique, ce qui n'a jamais été fait;
- qu'une politique définitive soit formulée;
- qu'elle soit présentée sous forme de projet de règlement;
- que 60 jours soient accordés pour recevoir les commentaires du public, sur le projet de règlement;
- que le règlement définitif soit publié;
- que la technologie appropriée soit proposée,et
- que des audiences publiques sur le choix du site soient organisées.

Le but est d'avoir une politique de gestion qui convient aux besoins et aux aspirations des québécois, d'assurer que les informations nécessaires soient mises à la disposition des population susceptibles de recevoir un lieu de traitement de déchets dangereux et d'assurer que le site soit le plus approprié possible.

Au mois de mai 1982, S.T.O.P. a été au coeur de l'organisation d'un atelier de deux jours entre les groupes environnementaux et Environnement Canada, sur le sujet des produits toxiques dans la société. Douze groupes non-gouvernementaux, représentant presque la totalité des provinces canadiennes, se sont réunis avec des représentants d'Environnement Canada, d'Agriculture Canada et du ministère de la Santé et du Bien-Être du Canada. Les sujets abordés incluaient la prévention de la contamination du milieu, la sécurité dans le milieu du travail, la réduction et le recyclage de produits toxiques, l'épandage des pesticides, la gestion des déchets et la classification des substances toxiques. Le but primaire de cette rencontre était d'ouvrir les portes pour permettre des échanges entre les différents ministères et les groupes environnementaux, et le résultat final était la publication d'un document, produit par les groupes et disponible au bureau de S.T.O.P.

Sans tarder, S.T.O.P. a rendu public à l'automne de 1982, sa prise de position sur la gestion des déchets toxiques au Québec. Dégouté par le nombre croissant de découvertes de sites contaminés par des déchets industriels toxiques, S.T.O.P. proposa certaines avenues d'action, telles le contrôle à la source, le contrôle des déchets importés, le contrôle du transport des déchets, et la promotion de la recherche en réduction et recyclage, que pouvait prendre le ministère.

C'est grâce à cette intervention que S.T.O.P. a pu commencer une étude sur le potentiel de recyclage et de réutilisation de certains produits chimiques toxiques dans la province. Six secteurs industriels ont été choisis selon les deux paramètres suivants; la qualité du déchet toxique produit, et l'importance de l'industrie dans l'économie québécoise. Les buts de l'étude sont, dans un premier temps, d'évaluer les technologies existantes qui pourraient servir ou qui servent déjà à l'industrie québécoise, et, dans un deuxième temps, de monter un répertoire de compagnies québécoises oeuvrant dans le domaine de recyclage de ces déchets.

Déjà nous nous appercevons que l'information disponible sur la quantité et les types de déchets industriels produits au Québec est manquante, ce qui renforce l'argument pour l'avancement de ce dossier. L'information acquise lors de cette étude servira non seulement pour établir des politiques de gestion, mais sera très pertinente pour les petites industries québécoises qui cherchent actuellement des alternatives aux déversements clandestins et au coût élevé de l'élimination sécuritaire de leurs déchets.

Pour conclure, je veux revenir à mon point de départ, et dire que la société doit reconcidérer ses actions actuelles et réduire sa dépendance sur les produits toxiques. Il faut que l'industrie se penche sur l'élaboration de procédés moins nocifs pour l'environnement et pour la santé humaine et que les gouvernements trouvent les moyens de promouvoir ce "virage" et en même temps le contrôler. Pour sa part, la population doit s'informer, ce qui sera plus facile si l'information était plus accessible, et s'intéroger sur les choix qui sont faits. Et peut-être un jour, ces trois parties distinctes de la société, se sentiront toutes responsables de l'avenir et de la sauvegarde de notre environnement, et agiront comme une seule entité, sans les frictions et les préjugés qu'on y rencontre aujourd'hui.

MERCI

Managing Chemicals Better

R.W. Slater

Assistant Deputy Minister

Environment Canada

MESDAMES ET MESSIEURS, IL ME FAIT UN GRAND PLAISIR D'AVOIR L'OCCASION D'AJOUTER UN DERNIER MOT A CETTE SESSION SUR LA GESTION DES SUBSTANCES TOXIQUES.

I WOULD LIKE TO OUTLINE FOR YOU THE FEDERAL GOVERNMENT'S VIEW OF THE TOXIC CHEMICALS ISSUE AND THE CHANGES THAT ARE OCCURRING IN OUR APPROACH TO RESOLVING IT. I'D LIKE TO LEAVE YOU WITH A SENSE OF WHAT WE ARE TRYING TO ACHIEVE AND THE ROLE YOU MAY SEE FOR YOURSELVES IN THIS ISSUE.

WE ARE ALL AWARE OF THE TREMENDOUS MEDIA INTEREST IN TOXIC CHEMICALS. DAILY, WE READ ABOUT DIOXINS, PCB'S, PESTICIDES AND THE 800 CHEMICALS IN THE BIOTA OF THE GREAT LAKES. THERE ARE A GREAT NUMBER AND VARIETY OF CHEMICALS IN USE TODAY AND OUR TECHNOLOGICAL ABILITY TO DETECT CHEMICALS IS INCREASING SO QUICKLY THAT WE ARE USUALLY AT A LOSS TO KNOW WHAT SIGNIFICANCE THE WIDESPREAD DISPERSAL OF CHEMICALS HAVE ON THE ECOSYSTEM OR OURSELVES. INFORMATION INCREASES - OUR WISDOM DECREASES.

EVEN IN INSTANCES WHEN WE HAVE SOME SCIENTIFIC EVIDENCE ABOUT A CHEMICAL'S EFFECT, THE SCIENTIFIC OPINION IS NOT USUALLY UNANIMOUS. WHAT IS TAKEN AS A FACT TODAY, MAY BECOME TOMORROW'S ARTIFACT. WE HAVE FOUND OURSELVES DEALING WITH CHEMICALS AFTER THE DAMAGE OCCURS, AND THE APPROACH BECOMES SO FRAGMENTED THAT THE PUBLIC PERCEPTION IS THAT GOVERNMENTS AND INDUSTRY ARE UNABLE TO HANDLE THE PROBLEM.

L'INDUSTRIE PRÉTEND SAVOIR CE QU'ELLE FAIT ET DE RÉPONDRE AUX BESOINS DU PUBLIC. LE GOUVERNMENT AUSSI PRÉTEND SAVOIR CE QU'IL FAIT ET DE RÉPONDRE AUX BESOINS DU PUBLIC. CEPENDANT, LE PUBLIC S'INTERROGE SUR LA FACON DONT NOUS RENCONTRONS CES BESOINS. BASÉ SUR NOS ACCOMPLISSEMENTS DU PASSÉ, CECI NE M'ÉTONNE PAS. MALHEUREUSEMENT, NOS ERREURS SONT TROP NOMBREUSES POUR S'ATTENDRE A CE QUE LE PUBLIC CROIT AUTOMATIQUEMENT A NOS ASSURANCES DE COMPÉTENCE ET D'INTÉRET

THE PUBLIC HAS LOST CONFIDENCE IN US, IT PERCEIVES THAT GOVERNMENTS HAVE MADE DECISIONS, HAVE REGULATED WITHOUT TAKING ACCOUNT OF THE PUBLIC'S VIEW. IT QUESTIONS THE LEGITIMACY OF THOSE DECISIONS.

WE HAVE A PROBLEM - A CREDIBILITY PROBLEM. IT IS IN OUR COMMON INTEREST TO BEGIN RESOLVING IT. EACH GROUP AT A MEETING SUCH AS THIS HAS ITS OWN PERSPECTIVE AND IMPERATIVES, ITS OWN SET OF PROBLEMS, CONSTRAINTS AND RESPONSIBILITIES - AND ITS OWN VIEWS AND REACTIONS TO THE INTERESTS AND ACTIONS OF THE OTHERS. EACH OF US IN THE LEGITIMATE PURSUIT OF OUR PARTICULAR INTEREST RUNS THE RISK OF IGNORING OR LOSING SIGHT OF THE GENERAL INTEREST OF OUR SOCIETY AS A WHOLE. EACH OF US, ONE SUSPECTS, IS BETTER ABLE TO DETECT THE MOTE IN THE OTHER PERSON'S EYE THAN THE BEAM IN OUR OWN. BUT THE BEAM IS THERE - AND IT CAN IMPAIR OUR VISION, CAN LIMIT OUR PERSPECTIVE AND PUT AT RISK THE LIKELIHOOD OF ACHIEVING ANY BALANCED, RATIONAL AND

RESPONSIBLE INTEGRATION OF SOCIAL, ECONOMIC AND ENVIRONMENTAL OBJECTIVES AND ACTIONS.

THE RESPONSIBILITY FOR PROPER MANAGEMENT OF CHEMICALS DOES NOT REST WITH GOVERNMENT ALONE, NOR INDUSTRY ALONE NOR IS THERE UNLIMITED VIRTUE IN THE VIEWS EXPRESSED BY THE PUBLIC. WE ARE NOT LOOKING FOR MAGICAL SOLUTIONS - TOGETHER, WE ARE LOOKING TO EXPLORE THE POSSIBILITIES OF FINDING A BALANCE OF INTERESTS AND RESPONSIBILITIES WHICH WILL SERVE US ALL WELL.

NOUS VIVONS ACTUELLEMENT DANS UNE SOCIÉTÉ CHIMIQUE - NOTRE QUALITÉ DE VIE NE DÉPEND SUR LES PRODUITS CHIMIQUES ET IL FAUT FAIRE FACE A L'ENVERGURE DU PROBLEME AU LIEU DE LE RÉSOUDRE ÉTAPE PAR ÉTAPE, - OU CE QUI SEMBLE ETRE SOUVENT LE CAS, PAR CRISE OU PAR DÉSASTRE.

I THINK OF CHEMICAL CONTAMINATION OF THE ENVIRONMENT AS ONLY A SYMPTOM OF THE PROBLEM; THE REAL PROBLEM IS THE PAST, CURRENT AND FUTURE POTENTIAL MISMANAGEMENT OF THE HUMAN ACTIVITIES THAT RESULT IN THE RELEASE OF CHEMICALS INTO THE ENVIRONMENT. THE "TOXIC CHEMICALS ISSUE" CAN BE VIEWED MORE CONSTRUCTIVELY IN TERMS OF THE "BETTER MANAGEMENT OF CHEMICALS" - THAT IS, WE REMEDY OUR PAST AND PRESENT MISTAKES BUT AT THE SAME TIME, IMPROVE OUR MANAGEMENT OF CHEMICALS TO PREVENT THE FUTURE REPETITION OF THESE MISTAKES.

OUR REMEDIAL FUNCTION DRAWS DIRECTLY ON OUR LARGE BODY OF SCIENTIFIC EXPERTISE AND IS, PERHAPS, MOST CLOSELY ALLIED TO WHAT MOST

OF US THINK OF AS A TRADITIONAL REGULATORY ROLE. ON BALANCE, I THINK WE DO THIS REASONABLY WELL - BUT NOT AS WELL AS WE SHOULD LIKE. THERE IS NO DOUBT AT ALL IN MY MIND THAT REGULATORY ACTIVITY WILL CONTINUE TO BE A CRITICALLY IMPORTANT FUNCTION IN COPING WITH TOXIC CHEMICALS. EQUALLY, THAT IT IS NOT ENOUGH. REGULATORY ACTION, TO BORROW AN ANALOGY FROM SPORTS, IS ESSENTIALLY "CATCH-UP BALL": IT OFFERS NO SATISFACTORY LONGTERM PROSPECT OF WINNING, OF PREVENTING ENVIRONMENTAL DAMAGE FROM OCCURRING IN THE FIRST PLACE. MORE SERIOUS STILL, PERHAPS, IS THAT, IN THE PUBLIC PERCEPTION, IT LEAVES THE INITIATIVE WITH THOSE SOCIAL AND ECONOMIC FORCES WHICH GENERATE THE ENVIRONMENTAL THREAT RATHER THAN WITH THOSE IN WHOSE INTEREST IT IS TO CONSERVE AND PROTECT OUR ENVIRONMENT. IN THAT SENSE, THE REGULATORY APPROACH ATTACKS BUT HALF THE PROBLEM.

OUR OTHER RESPONSIBILITY - MORE NEGLECTED AND LESS FAMILIAR IS DIRECTED AT COUNTERING THE INFLUENCE OF THE TECHNICAL, SOCIAL, AND ECONOMIC CONDITIONS WHICH NOT ONLY GIVE RISE TO, BUT OCCASSIONALY ENCOURAGE, ENVIRONMENTAL DAMAGE. THAT IS THE PARTICULAR FOCUS OF OUR PREVENTIVE FUNCTION - AND IT REQUIRES A DIFFERENT APPROACH, ONE THAT IS COMPLEMENTARY TO OUR MORE FAMILIAR AND TRADITIONAL REGULATORY ROLE, WHICH WILL RE-INFORCE IT RATHER THAN REPLACE IT. IT REQUIRES OUR TAKING ON AN ADVOCACY ROLE - AN APPROACH WHICH ATTEMPTS TO INFLUENCE AND CHANNEL SOCIAL AND ECONOMIC FORCES TOWARDS ENVIRONMENTALLY PRUDENT COURSES OF ACTION.

THERE IS NOTHING PARTICULARLY NEW ABOUT ADVOCACY, WE HAVE ALWAYS DONE A CERTAIN AMOUNT OF IT. BUT IN THE PAST, WE HAVE NOT, SPOKEN AND ACTED AS THOUGH IT WAS JUST AS IMPORTANT AS OUR REMEDIAL AND REGULATORY ACTIVITIES. THE POINT HAS NOW BEEN REACHED WHERE WE MUST DO MORE. THE RANGE, VARIETY, AND COMPLEXITY OF THE THREATS TO THE ENVIRONMENT CONTINUE TO GROW. INEVITABLY, THE RESULT MUST BE THAT THE LEVEL OF RISK TO THE ENVIRONMENT WILL BECOME SIGNIFICANTLY GREATER AND CONTINUE OVER INCREASINGLY LONG PERIODS OF TIME. THAT IS NOT SOMETHING WE CAN IGNORE.

IT IS THAT CONCERN WHICH IS AT THE ROOT OF OUR INCREASING RECOGNITION, OF THE NEED TO DEAL NOT ONLY WITH SPECIFIC CHEMICALS OR CLASSES OF CHEMICALS BUT, SOMEHOW, TO GET AHEAD OF THE PROBLEM-TO "MANAGE CHEMICALS BETTER". THIS IS THE PATH WE MUST FOLLOW, AND A SHIFT IN EMPHASIS TOWARDS AN ADVOCACY APPROACH IS AN ESSENTIAL STEP ALONG THE WAY. IT WILL ONLY BE EFFECTIVE IF WE WORK CO-OPERATIVELY WITH INDUSTRY AND WITH OTHER PARTICIPANTS TO RESOLVE THE COMMON PROBLEMS WE SHARE.

OUR EMERGING PRIORITY IN THE TOXIC CHEMICALS FIELD IS TO INSTITUTE AN APPROACH TO CHEMICALS BASED ON MANAGING THE STAGES OF THE CHEMICAL LIFE CYCLE IN SUCH A WAY AS TO PREVENT ENVIRONMENTAL DAMAGE. IT DEMONSTRATES GOOD ENVIRONMENTAL DETECTIVE WORK - TO EXAMINE THE LIFE CYCLE OF CHEMICALS FROM DEVELOPMENT, TO MANUFACTURE, TO TRANSPORTATION, TO ULTIMATE USE AND DISPOSAL; TO IDENTIFY THE POTENTIAL

ENTRY POINTS OF CHEMICALS INTO THE ENVIRONMENT DURING THEIR LIFE CYCLE AND TO ACT TO STOP OR AT LEAST MINIMIZE THAT ENTRY. NOT A SMALL JOB BUT ONE WHICH I AND MY FEDERAL COLLEAGUES AGREE OFFERS THE LONG TERM SOLUTION TO THE PROBLEM.

LET ME BRIEFLY DEMONSTRATE THIS WITH THE MERCURY PROBLEM OF SOME YEARS AGO. WE WERE ABLE TO MOVE FAIRLY QUICKLY TO ENACT REGULATIONS LIMITING THE DISCHARGE OF MERCURY FROM CHLORALKALI PLANTS AND YET THE PROBLEM OF MERCURY DID NOT DISAPPEAR BECAUSE WE ONLY ADDRESSED THE OBVIOUS EXISTING SOURCES. IF WE HAD APPLIED THE CONCEPT OF MANAGING CHEMICALS BETTER AND THE LIFE CYCLE APPROACH TO OUR EXAMINATION OF THE PROBLEM' WE WOULD HAVE IDENTIFIED OTHER INDUSTRIAL SOURCES AND TAKEN ACTION TO PREVENT THE CONTINUED DISCHARGE OF MERCURY TO THE ENVIRONMENT. WE ARE TAKING THIS APPROACH NOW WITH LEAD IN THE ENVIRONMENT.

THE CONCEPT OF MANAGING CHEMICALS BETTER AND ITS PRINCIPLES AND APPROACHES ARE A NEW WAY OF THINKING FOR THE FEDERAL GOVERNMENT AND WE ARE ONLY NOW BEGINNING TO BRING OTHER PARTIES ONSIDE WITH US. THERE WILL BE A LONG PERIOD THROUGH WHICH OUR ACTIONS MUST GAIN THE PUBLIC'S SUPPORT AND THE WAY WE DO BUSINESS MUST DEMONSTRATE THAT THE PUBLIC CONCERN IS ADDRESSED BY OUR ACTIONS, AND AVENUES FOR PUBLIC INVOLVEMENT ARE PROVIDED IN OUR PROCESSES.

AND THIS IS AN AREA WHERE WE ARE SEEKING YOUR SUPPORT. GOVERNMENTS CANNOT DO THE JOB QUICKLY, OR WELL, WITHOUT THE ACTIVE SUPPORT AND PARTICIPATION OF THE CHEMICAL INDUSTRY, AS WELL AS ALL THE PUBLICS WHO HAVE AN INTEREST IN THE AREA. OVER THE NEXT YEARS, WE WILL CONTINUE TO IMPROVE OUR CONSULTATIONS WITH YOU SO THAT TOGETHER WE CAN MANAGE OUR CHEMICAL ACTIVITIES BETTER.

LA FORMATION DU COMITÉ CONSULTATIF SUR LES PRODUITS CHIMIQUES DU SERVICE DE LA PROTECTION DE L'ENVIRONNEMENT EST UNE INITIATIVE RÉCENTE QUI M'A VRAIMENT FAIT PLAISIR. CE COMITÉ, JE L'ESPERE, SERA LE FORUM POUR LES DISCUSSIONS SUR LA PRÉVENTION DES PROBLÊMES DE PRODUITS CHIMIQUES TOXIQUES.

A SIMILAR FORUM IS BEING ESTABLISHED ON THE ISSUE OF LEAD IN THE ENVIRONMENT. AND ALSO WITHIN ENVIRONMENT CANADA WAS THE ESTABLISHMENT OF THE FEDERAL WATER INQUIRY TO ENSURE OUR WATER POLICIES RESPOND TO THE SOCIAL AND ECONOMIC NEEDS OF THE COUNTRY. RECENTLY, AGRICULTURE CANADA ANNOUNCED ITS INTENTION TO SEEK PUBLIC INPUT INTO THE REGISTRATION AND USE OF PESTICIDES - AN INITIATIVE WE ALL LOOK FORWARD TO.

THESE ALL DEMONSTRATE THE GROWING RECOGNITION ON THE PART OF GOVERNMENT FOR INFORMED PUBLIC INPUT INTO OUR DECISION-MAKING PROCESSES - THE DECISIONS THAT WE MAKE ARE FAR REACHING, HAVE ECONOMIC VALUES ATTACHED TO THEM AND HAVE THAT LONG-TERM EFFECTS THEY MUST REFLECT THE SOCIAL VALUES OF THIS COUNTRY.

THESE ARE JUST SOME OF THE WAYS WE ARE MOVING TO GET AHEAD IN THIS ISSUE. LET ME STRESS THAT MY DOOR IS OPEN TO YOU - INDEED THE DOOR TO EPS IS OPEN - TO DISCUSS YOUR ENVIRONMENTAL PROBLEMS AND THEIR SOLUTIONS AND THE WAYS IN WHICH WE CAN SUPPORT EACH OTHERS INITIATIVES. I WOULD LIKE TO SEE US BUILD ON OUR SUCCESSES OF THE PAST FOR THE HERITAGE OF THE FUTURE.

SESSION IV

Les solutions techniques

Control Solutions

European Hazardous Waste Disposal Facilities

(abstract)

Peter Lovgren

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Abstract: Denmark is one of the countries which has come closest to solving the problems of hazardous waste. Legislation was passed by the Danish Parliament in 1971 and 21 central transfer stations and more than 275 small collection points for chemical waste originating from households were established. In 1974, KOMMUNEKEMI, the central treatment plant, started operating its incinerators, oil and physical treatment facilities and controlled landfill.

The Central Hazardous Waste Treatment Facility in Nyborg has a total treatment capacity of 130,000 metric tons/year, including two large Rotary Kiln Incinerators for Organic Waste, Physical/Chemical Treatment Plant for Inorganic Waste, Treatment Plant for Oil and a controlled landfill.

In West Germany, a number of regional hazardous waste treatment facilities are now in operation. GSB at Ebenhausen in Bavaria started operation in 1976. The plant includes inorganic treatment plant and two rotary kiln incinerators. The total capacity if 160,000 metric tons/year.

The government in Hessen issued in 1976 a plan for "Special Wastes" and HIM was established with an incinerator plant at Biebesheim, a landfill at Mainflingen, physical/chemical treatment plants at Frankfurt and at Kassel and underground storage in an abandoned salt mine at Herfa-Neurode. The capacity of the incinerators + inorganic plants is 150,000 metric tons/year.

Sweden carried out research for many years before adopting a system similar to the Danish model including transfer stations and central treatment and disposal facility, SAKAB, at Norrtorp. The plant with a total capacity of 60,000 metric tons/year, including pretreatment of waste oil, evaporation of solvents and long term storage, started up in 1983.

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Finland decided in 1980 to set up a central system for collection, transportation, treatment and disposal of chemical waste based upon the Danish Experience modified to Finnish conditions. OY SUOMEN ONGELMAJATE (Finlands Problemavfall ab) at Riihimaki will, in 1984, have a capacity of 70,000 metric tons/year including a rotary kiln incinerator, an inorganic treatment plant and a long term storage.

Developing Design Criteria for Liquid Industrial Waste Incineration Systems

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INTRODUCTION

The design of a hazardous waste incineration system must provide flexibility in terms of the wastes to be processed and must, as well, ensure process stability in terms of performance parameters and emissions. Liquid industrial waste is a highly variable feedstock and the waste coding procedure and waste reception, pretreatment and storage facilities must be designed to minimize these variations and, as a result, to complement the design of the incineration system. To accomplish this requires accurate data on the composition and characteristics of the wastes to be treated. Without this kind of information the design parameters cannot be adequately defined and the assumptions that would be required could very easily result in a plant which is either very significantly overdesigned, entailing unnecessary additional capital expense, or one which cannot achieve the performance or capacity for which it was intended. The present paper provides an illustration of the impact of detailed waste composition information on incineration design criteria.

DESIGN APPROACH

Solid market information on the wastes to be treated provides the foundation for the plant design. In addition to the average waste characteristics and annual volumes, the following must be defined:

- the variability in the chemical composition
- the variability in the physical characteristics
- the type and size of transportation required
- the schedule of waste generation

Although analytical data developed from samples of each load of waste received at an operating plant provides the backbone for this assessment, an understanding of the customer's waste generating process is necessary to fully develop the information. In the final analysis, the confidence in the data developed will, to a large extent, be dependent on the waste control procedure to be used; it must be proven practical and effective to ensure that the wastes which enter the plant will be within the defined specifications.

Operating analytical and process information for an existing incineration system can be used to confirm the market information in terms of the waste composition and volume variations, to provide more detailed information on the waste composition, including the presence of minor constituents, and, more importantly, to quantify the effectiveness of pretreatment and storage facilities in reducing the waste variability.

The ability of the waste control procedure and the waste receiving, pretreatment and storage facilities to provide a consistant feedstock will determine the ultimate stability of the incineration process.

The state-of-the-art of hazardous waste incineration technology is being advanced throughout the world to maximize the cost-effectiveness and to minimize the environmental impact of these facilities. In concert with these developments, enviromental regulations are revised to ensure the implementation of the best practical technology. To select the most appropriate technology requires an evaluation of the latest information on equipment, processes and full-scale testing from around the world with reference to the particular waste market to be served by the design.

The processes which generate the waste, as well as transportation methods, vary from country to country and, as a result, the assessment of any new technology must be tempered with the reality of the local situation.

Based on all of the preceding, the wastes to be treated and the processes to be used can be defined and the preliminary system design can be developed. A Hazard and Operability study to evaluate potential hazards to the equipment, people and the environment provides a means of further improving the design. An overall risk assessment is also a useful procedure to define the relative potential environmental impact of the integrated facility; including the waste control procedure, waste receiving, pretreatment and storage, incineration and air pollution control, emergency procedures, etc. For example, two different installations may, based on a strict definition, incinerate as part of the waste a specific chemical compound. In one plant it may be a minor contaminant and the concentration can be controlled to, for example, less than 100 ppm, whereas the second plant will store and incinerate concentrated wastes containing 100,000 ppm. Clearly the potential environmental impacts from these two facilities are quite different and, as a result, their designs need to be different. A risk assessment can be a useful means of comparing these factors and as a result, assessing the adequacy of the design.

It is important to realize the interactive relationship of the waste treatment facility and the waste generators. The facility must be able to serve the needs of its customers and yet it can also influence the volumes and characteristics of the wastes that it receives. To optimize the design requires knowledge of what is practically achievable by the customer so that the design can provide the most cost-effective approach overall. In so doing, the facility will be better able to meet the customer's needs by providing environmentally sound management of his waste at the lowest total cost.

TRICIL SARNIA PROCESS OVERVIEW

Alkaline By-Product System

The alkaline by-product material is transferred from the receiving tank into one of two large agitated storage tanks; each provides about 7 days of operating capacity. The alkaline by-product material is transferred from the storage tanks to the Day/Mix tank where water can be added simultaneously to obtain the correct alkalinity in the feed to the spray dryer.

Organic Waste System

Mixed organic wastes are transferred from the receiving tank into one of two large separation tanks. The contents of these tanks are recirculated and screened and a quiescent period is provided for phase separation. After the quiescent period the high energy material, or rich waste, is transferred to a separate storage tank and the aqueous phase, or lean waste, is also transferred to a separate storage tank. Rich waste material received at the plant can be transferred directly into one of four segregated storage tanks. This system provides a storage capacity of approximately 10 days of operation.

Combustion System

The rich waste is burned in a vortometric burner which is equipped to simultaneously burn natural gas. The lean waste is injected into the incinerator at about the mid-point in its length via a number of two-fluid nozzles spaced radially around the incinerator. The raw incinerator exhaust is cooled by water sprays to 700°C before entering a heat exchanger in which the exhaust is further cooled to 450°C.

Air Pollution Control System

The heat exchanger exhaust gas is cooled to 200°C in the spray dryer by the addition of the alkaline material from the Day/Mix tank. The alkalinity in the material simultaneously removes a portion of the HCl and SO_2 content from the raw incinerator exhaust gas.

The spray dryer exhaust is treated in a pulse-jet baghouse for particulate removal before discharge to the atmosphere.

Ash Treatment

The particulate from the incinerator, spray dryer and baghouse is transferred via a series of enclosed conveyors to a storage bin. The particulate is subsequently treated in a pelletizer to provide a dust-free material for secure chemical landfill.

SARNIA OPERATING AND PILOT-PLANT DATA

A comprehensive waste coding system was implemented at the Tricil Sarnia plant more than 8 years ago to improve the control of the wastes entering the plant. This involves:

- o Preparation of a code sheet by Tricil before acceptance of the waste for treatment. This includes information on the generator, the waste generating process, analytical data on the waste, processing requirements, special handling procedures, etc.

- o Sampling and analysis of all wastes upon arrival at the plant to ensure compliance with the code sheets.

Six years ago, automatic composite samplers were installed on the waste feeds to the incinerator. These 24 hour composite samples were subsequently analyzed for heating value, specific gravity, pH, organic chloride, organic sulphur, etc. Detailed incinerator operating records were also maintained.

The new spray dryer/fabric filter air pollution control system, was tested at the pilot-scale with alkaline by-product material. The pilot unit was installed on the existing incinerator and operated over a period of approximately 6 months to evaluate the effects of process variables and to define the design parameters for the full scale system.

DESIGN DEVELOPMENT

Reception, Pretreatment and Storage

The market and historical data provided accurate information on the ranges of the physical characteristics as well as chemical compositions for the wastes to be received at the plant. It was possible, therefore, to define design limits on, for example, waste viscosities, waste variability, erosion and corrosion potential, etc.

All of the waste streams received at the plant are screened to remove course suspended solids to minimize erosion and plugging of the injection nozzles in the incineration system. To define the screening designs, for example, required information on not only the range of the total suspended solid concentrations but also on the variation in concentration for a number of particle size ranges for each waste stream.

The variability in the product from the pretreatment and storage facility defines the limits for the incinerator feeds. A summary of the general limits for selected parameters is provided in Table 1 for the rich waste and Table 2 for the lean waste and Table 3 for the alkaline by-product material. The actual design considered many more parameters, including the organic chlorine and sulphur concentration, but the few presented provide an indication of the degree of variation and the complexities involved in the design.

Incineration

The incinerator design constraints were as follows:

- The primary combustion zone exhaust gas temperature is maintained at from 1300°C to 1400°C and typically at 1335°C.

- The secondary combustion zone exhaust gas temperature is maintained at from 750°C to 825°C and typically at 815°C.

- The maximum heat release for the main burner is 125,000 MJ/hour.

- The total excess air from the incinerator is maintained at from 40% to 65% and typically at 55%.

Based on the above prescribed limits and the established variation in compositions of the two waste streams, an evaluation of the incineration system performance requirements was undertaken.

A computer program was developed to perform the complex energy and material balances for the incineration system so that the impact of independent variations in the composition of the feed streams could be thoroughly evaluated.
On the basis of the waste design parameters and the design constraints, the process design envelope for the system was defined. Completion of this analysis provided operating limits as well as design limits for the incineration system, including:

- Variations in gas composition, including HCl and SO_2 concentrations as well as moisture contents and particulate loadings.

- Variations in the specific heat of the incineration exhaust gas.

- Variations in the temperature, flow-rate and total energy content of the exhaust gas.

The operating and design limits of the water quench and heat exchanger were readily defined on the basis of the above information.

Air Pollution Control System

The spray dryer was designed to achieve a minimum removal in HCl of 75% and SO_2 of 50% which, based on the pilot-scale trials, would require a stoichiometric ratio of $CaCO_3$ equivalent to HCl and SO_2 of in the order of 1.5 to 2.0. A relatively large excess of alkaline by-product material was anticipated which would provide an average stoichiometric ratio of 6.5. Sophisticated controls to minimize alkali consumption were not, therefore, required and the design, while based on an excess alkalinity, ensures adequate alkalinity to meet the demands and facilitates inventory control.

The operating and design limits for the incineration exhaust gas provided the limits for determining the process requirements of the spray dryer given the maximum and minimum outlet temperature limits of 225°C and 175°C, respectively. An additional series of criteria were used to determine the design limits for the spray dryer to include, for example, operation with the spray dryer feed at the maximum raw material composition (i.e. at reception) which may be required for inventory control purposes.

The resultant energy and material balance evaluations for the spray dryer provided the design criteria for the fabric filter in terms of gas temperature, flow-rate, particulate loading, etc.

Summary

The process design analysis, as outlined in the preceding, generated design and operating limits for the entire system. These limits were subsequently used to define the requirements of the auxiliary equipment, including the ash handling, equipment, compressed air system, steam boiler system, water supply system, etc.

Selected process design parameters are presented in Table 4. Even with stringent control of waste inventories, there is a relatively large variation in some of the process parameters resulting from the cumulative effect of the process variables. The relatively large design ranges shown emphasize the importance of defining the waste variability so that the equipment specifications can be optimized.

CONCLUSIONS

To design any kind of process system requires a thorough knowledge of the characteristics of the feedstock which will be used and a liquid industrial waste incineration system is no different. To optimize the design requires not only a knowledge of the wastes but also an understanding of the processes which generate the waste. An effective waste control procedure is also imperative. Without this type of information, the assumptions made could result in a system which is very significantly overdesigned, resulting in unnecessary capital costs as well as operational problems, or one which would be unable to achieve the waste throughput and overall performance for which it was intended. A design which is based on accurate market and operational data can provide sufficient process flexibility to accomodate the waste variabilities encountered in practice and, in addition, the process performance stability which is essential for these facilities can be demonstrated.

TABLE 1

RICH WASTE - COMPOSITION VARIATION

	Mean Operating Condition	Minimum Operating Limit	Maximum Operating Limit
Flow Rate (liters/minute)	54.0	40.0	70.0
Ash (% wt/wt)	5.0	1.0	10.0
Heating Value (MJ/kg)	29.0	20.0	40.8

TABLE 2

LEAN WASTE - COMPOSITION VARIATION

	Mean Operating Condition	Minimum Operating Limit	Maximum Operating Limit
Flow Rate (liters/minute)	196.0	150.0	250.0
Ash (% wt/wt)	2.0	0.5	4.0
Heating Value (MJ/kg)	1.0	0.4	2.0

TABLE 3

ALKALINE BY-PRODUCTS - COMPOSITION VARIATION

	Mean Operating Condition	Minimum Operating Limit	Maximum Operating Limit
Total Solids (% wt/wt)	21.0	10.0	35.0
Suspended Solids (% wt/wt)	10.0	5.0	25.0
Dissolved Solids (% wt/wt)	11.0	15.0	10.0
Total Alkalinity (% $CaCO_3$ wt/wt)	11.5	6.0	20.0

TABLE 4

SELECTED PROCESS DESIGN LIMITS

Parameter	Design Limit Minimum	Operating Limit Minimum	Mean Operating Condition	Operating Limit Maximum	Design Limit Maximum
Combustion Air Flow Rate (Nm^3/m)	310	480	600	680	790
Raw Incinerator Exhaust Gas Flow Rate (Nm^3/m)	565	695	875	1,175	1,275
Total Heat Exchanger Heat Transfer (10^3 MJ/hr)	11.5	15.0	20.5	27.5	29.0
Spray Dryer Exhaust Gas Flow Rate (Am^3/m)	1,130	1,415	1,840	2,260	3,100
Spray Dryer Exhaust Particulate Flow Rate (Kg/min)	1.2	1.5	12.1	30.0	45.0
Stack Exhaust Gas Flow Rate (Am^3/m)	1,035	1,260	1,868	2,700	3,350
Flow Rate of Captured Solids To Collection Bin (Kg/min)	2.3	2.6	16.0	40.0	6[illegible]

Incinération des déchets industriels dangereux chez SERDOQ

Incineration of Dangerous Industrial Waste at SERDOQ

John Barter, ing. (Eng.)
Directeur de projet (Project Manager)

1.0 INTRODUCTION

I would like to present to you this afternoon the solution that the Quebec Ministry of Environment endorses and that SERDOQ plans to implement for the handling of Quebec's dangerous industrial organic wastes. I will briefly describe who SERDOQ is and then elaborate on our plans for the project's implementation.

SERDOQ is owned by several Quebec investors including Monenco and Société d'Ingénierie Cartier Limitée. SERDOQ (Société d'Élimination et de Recyclage des Déchets Organiques du Québec) was formed in 1982 to respond to a public call for proposals by the Quebec Ministry of Environment to finance, design, build and operate a central industrial waste incinerator. SERDOQ was nominated in August 1983 by the Honorable Minister of Environment, Mr. Adrien Ouellette, as the organisation best suited to respond to Quebec's needs for a privately operated industrial organic waste centre.

Since August 1983, we have been doing various market, engineering, environmental, economic and financial studies to assure ourselves that first of all there is indeed a market that is willing to pay the high cost associated with such a facility. Today, I would like to share with you some of the results of these studies and invite you at the time of the panel discussion to question our hypotheses.

1.0 INTRODUCTION

J'aimerais vous présenter cet après-midi, la solution privilégiée par le Ministère de l'Environnement du Québec et que SERDOQ envisage mettre en oeuvre pour le traitement des déchets organiques industriels et dangereux du Québec. Je décrirai brièvement en quoi consiste SERDOQ, puis je présenterai plus en détail les perspectives d'implantation du projet.

SERDOQ appartient à plusieurs investisseurs du Québec dont Monenco et la Société d'Ingénierie Cartier Limitée. SERDOQ (Société d'Élimination et de Recyclage des Déchets Organiques du Québec) a été formée en 1982 à la suite d'un appel d'offres public lancé par le Ministère de l'Environnement du Québec afin de financer, concevoir, construire et exploiter un incinérateur central pour les déchets industriels. En août 1983, SERDOQ était nommée par l'Honorable Adrien Ouellette, Ministre de l'Environnement, comme étant la société la plus apte à répondre aux besoins du Québec pour l'opération privée d'un centre de gestion des déchets organiques industriels et dangereux.

Depuis août 1983, nous avons effectué diverses études de préfaisabilité, dont une étude de marché, une étude d'ingénierie préliminaire, une étude économique et financière et une pré-sélection de sites, afin de nous assurer qu'il existe un marché potentiel apte à assumer les frais élevés associés à une telle installation. Aujourd'hui, je tiens à partager avec vous certains des résultats de ces études et je vous invite au moment des discussions en table ronde à nous questionner sur nos hypothèses.

2.0 MARKET

The size of the market for our proposed incinerator depends to a very large degree on the price of service. In addition, there is presently a need in Quebec for the establishment of hazardous industrial waste regulations. Such regulations and their application are pre-requisites for the success of a privately owned and operated industrial waste incinerator.

Assuming that such regulations will be gazetted in the next few months and certainly before the public hearing for our project, and that SERDOQ's charges will be competitive with the other alternatives available to industry, then it is expected that there is sufficient waste generated on a yearly basis to warrant the construction of an incinerator having a capacity of approximately 60,000 metric tonnes per year at an average high heating value of 8,100 kJ/kg (3,500 Btu/lb). These wastes can be divided into various categories as shown in the following Table:

TABLE 1

WASTE DISTRIBUTION

Category of Waste	Distribution %
Mixed liquids	50-60
Sludges	20-30
Solids	5-15
Special liquids	5-10
Containers	3-6
Special sludges	1-4

2.0 MARCHÉ

L'ampleur du marché pour l'incinérateur que nous proposons dépend principalement du prix imposé à l'industrie. De plus, il existe au Québec un besoin d'établir des règlements concernant les déchets industriels toxiques. De tels règlements et leur application sont nécessaires au succès d'un incinérateur de déchets industriels détenu et exploité par le secteur privé.

En supposant que de tels règlements entrent en vigueur au cours des prochains mois et nécessairement avant les audiences publiques qui se tiendront dans le cadre de notre projet, et en supposant également que les prix de SERDOQ soient concurrentiels à ceux des autres solutions offertes par l'industrie, on peut alors s'attendre à ce que la quantité de déchets générés annuellement soit suffisante pour justifier la construction d'un incinérateur d'une capacité d'environ 60,000 tonnes métriques par année pour des déchets d'une valeur calorifique moyenne brute de 8,100 kJ/kg (3,500 Btu/lb). Ces déchets peuvent être classés en diverses catégories, tel qu'indiqué au Tableau suivant:

TABLEAU 1

DISTRIBUTION DES DÉCHETS

Catégories de déchets	Distribution %
Liquides mixtes	50-60
Boues	20-30
Solides	5-15
Liquides spéciaux	5-10
Contenants	3-6
Boues spéciales	1-4

We have visited the majority of hazardous organic waste generators in Quebec and all of those interviewed indicated the need to have such a facility available to industry at a reasonable price.

Nous avons visité la majorité des producteurs de déchets organiques dangereux au Québec, et le résultat des rencontres confirme le besoin d'une telle installation, si toutefois les prix sont raisonnables.

3.0 WASTE RECYCLING

In addition to the above, we estimate that there are between approximately 3,000-5,000 metric tonnes per year of waste solvents. These are presently difficult to recycle because of three main reasons: a lack of recycling capability in the Province; in most recycling processes there is a sludge that has to be incinerated; and also there is a high energy demand that would not warrant the recycling of certain solvents. At SERDOQ we plan to recycle these solvents because we will have a certain amount of waste heat from the incinerator that can be used in the distillation process and also the incinerator will be able to handle the sludges from the recycling process.

In addition to the recycling of waste solvents, we believe that, if the use of waste oils from both industry and local garages was banned for use in road oiling and as a replacement for bunker "C" in boilers (greenhouses, commercial buildings, etc.), then an oil recycling plant could also be integrated into the facility.

3.0 RECYCLAGE DES DÉCHETS

En plus des quantités de déchets destinés à l'incinération, nous estimons qu'il y aura entre 3,000 et 5,000 tonnes métriques par an de solvants usés. Ces produits sont, pour le moment, difficiles à recycler pour trois raisons principales: il y a présentement un manque d'installations de recyclage au Québec; la plupart des procédés de recyclage génèrent une boue qui doit être incinérée; et il y a aussi une forte demande en énergie qui ne pourrait justifier le recyclage de certains solvants. SERDOQ propose de recycler ces solvants puisque une certaine quantité de la chaleur provenant de l'incinérateur pourrait être utilisée comme source principale d'énergie pour un procédé de distillation; de plus, l'incinérateur sera capable de traiter les boues résiduelles générées lors du recyclage.

En plus du recyclage des solvants usés, nous croyons que si l'utilisation des huiles usées provenant à la fois de l'industrie et des garages locaux, n'était plus permise pour l'épandage d'huiles abat-poussière sur les routes et comme substitut au mazout "C" dans les chaudières (serres, bâtiments commerciaux, etc.), une unité de recyclage des huiles usées pourrait aussi être intégrée à l'installation principale.

It is understood, on reviewing the proposed management of dangerous wastes regulations, that such a ban will be implemented and we are confident that a waste oil recycling plant will be incorporated into our facility. The same advantages would hold for the waste oil recycling plant as for the waste solvent recycling facility i.e. waste heat and sludge disposal capability.

Nous croyons comprendre, après avoir passé en revue la réglementation sur la gestion des déchets dangereux, qu'une telle interdiction sera mise en application et qu'il serait possible qu'une usine de recyclage des huiles usées puisse être incorporée à notre installation. Les avantages pertinents à l'unité de recyclage des solvants usés seraient également valables pour l'unité de recyclage des huiles usées, c'est-à-dire les possibilités d'utilisation de l'énergie disponible et d'élimination des boues produites.

4.0 FACILITY DESIGN

In addition to the recycling facility, the SERDOQ project will have the following major components:

- waste reception, storage and handling including way scales and laboratory;
- rotary kiln incinerator including gas treatment system and stack;
- waste water treatment system for any contaminated natural site run-off; and
- administration building.

4.0 CONCEPTION DE L'INSTALLATION

En plus des unités de recyclage, le projet SERDOQ comportera les principaux éléments suivants:

- réception, stockage et manutention des déchets, incluant les équipements de contrôle de la quantité (balance) et de la qualité (laboratoire) des déchets;
- l'incinérateur à four rotatif incluant le système de traitement des gaz de combustion et la cheminée;
- le système de traitement des eaux usées pour toutes les eaux contaminées sur le site; et
- un bâtiment d'administration.

I will describe in the next few minutes the system as we have studied it, giving also some ideas of the alternatives that we are presently considering. In general terms, wastes in either liquid, semi-solid or solid form will be received at the plant, weighed, categorised, stored in the appropriate place and then fed into the incinerator or recycled. The off-gases from the incinerator or recycling distillation process will be treated before being discharged to the atmosphere via the plant's stack. The ashes from the incinerator and gas treatment system will be fixed, solidified and landfilled off-site.

Je vais maintenant vous décrire brièvement le système tel que nous l'avons étudié, présentant aussi quelques idées sur les variantes que nous envisageons actuellement. Règle générale, les déchets sous forme liquide, semi-solide ou solide, reçus à l'usine, seront pesés, classés, stockés dans un endroit approprié, puis alimentés à l'incinérateur ou recyclés. Les gaz dégagés par l'incinérateur ou par les procédés de recyclage seront traités avant d'être libérés à l'atmosphère par la cheminée de l'usine. Les cendres provenant de l'incinérateur et du système de traitement des gaz seront fixées, solidifiées et enfouies à l'extérieur du site.

401 WASTE RECEPTION AND HANDLING

Quebec is in the process of establishing a waste manifest system. This system would also be used by SERDOQ and in addition, once the waste arrives at the site, a sample will be taken for a rapid analysis, to verify that the waste received is the same as the waste previously agreed to between the generator and SERDOQ.

Once this has been done, the waste will either be pumped to a storage reservoir, stored in barrels, or if it's dry solids then it will initially be discharged to pits.

401 RECEPTION DES DECHETS ET MANUTENTION

La province de Québec est actuellement en voie de mettre en place un système de manifeste pour la gestion des déchets industriels. Ce système sera également utilisé par SERDOQ et de plus, une fois les déchets arrivés au site, un échantillon sera prélevé pour une analyse rapide afin de vérifier que les déchets reçus sont identiques à ceux ayant fait l'objet de l'entente entre le producteur de déchets et SERDOQ.

Une fois ceci effectué, les déchets seront soit pompés à un réservoir de stockage, entreposés dans des barils, ou, s'il s'agit de solides secs, déchargés dans des fosses dès leur arrivée au centre.

The whole question of how dangerous wastes should be handled is the subject of many seminars, and regulators and industry representatives alike have not totally agreed to how it should be done. It is our belief that, if the waste is very toxic such as PCB contaminated solids, then it should be handled in barrels. If the waste is classified as dangerous under the regulations but not handled in barrels in the generating industry, then we believe that, as a minimum, the same safety and odour control precautions should be applied to us. There are presently certain waste solids and sludges that are handled in bulk in large open lagoons or storage tanks in industry and thus our storage facilities should be compatible.

L'ensemble de la question portant sur la manutention des déchets dangereux a fait l'objet de plusieurs séminaires, et les autorités, tout comme les représentants de l'industrie, ne sont pas entièrement d'accord sur la façon de procéder. Nous croyons que si le déchet est très dangereux, comme c'est le cas de solides contaminés par les BPC, il devrait être manutentionné dans des barils. Si le déchet est classifié comme dangereux en vertu des règlements mais n'est pas manutentionné dans des barils par l'industrie qui le génère, nous croyons alors qu'au minimum les mêmes précautions de contrôle des odeurs et de sécurité devraient être applicables à notre endroit. Il y a actuellement dans l'industrie certains déchets solides et certaines boues qui sont stockés en vrac dans de grands bassins ouverts ou réservoirs de stockage, et à cet égard notre installation de stockage devrait être compatible.

As time goes on, we believe that industry will be substantially reducing its liquid hazardous wastes and producing more sludges that will be much more toxic in their concentrations and more difficult to handle. Thus we believe that the trend will be towards containerised shipment and storage and away from the bulk handling. However, our facility must be designed to handle the wastes presently being generated and thus initially some of the wastes will be handled in bulk and stored at the plant in pits.

Avec le temps, nous croyons que l'industrie réduira substantiellement ses déchets liquides dangereux et produira plus de boues qui seront davantage toxiques de par leur concentration et par conséquent beaucoup plus difficiles à traiter. Nous croyons donc que la tendance de l'industrie ira vers l'envoi de déchets en barils, ce qui contribuera à l'élimination progressive de la manutention et du stockage en vrac. Cependant, notre installation doit être conçue pour traiter les déchets tels qu'ils sont produits actuellement, d'où la nécessité de prévoir des fosses sur le site de l'usine pour la manutention et le stockage des déchets.

402 INCINERATOR SYSTEM

The incinerator system as shown in Figure 1 will consist of:

- a rotary kiln incinerator;
- a secondary combustory chamber;
- a waste heat recovery system;
- a gas cleaning system; and
- a stack.

The rotary kiln incinerator will be sized to handle the market which is presently estimated to be about 60,000 tonnes per year. The kiln, 5.1 m outside diameter and 13.1 m long, will be designed to rotate at less than 1 r.p.m. to allow for good mixing and thus complete combustion. Combustion efficiencies of at least 99.99% are expected, and when the temperature is raised to 1250°C and the residence time is at least 2.0 seconds in the kiln, then the destruction efficiency will be as high as 99,9999%, which would allow SERDOQ to safely eliminate PCB and other highly toxic wastes. It is expected that the kiln will be operated at about 1000°C the majority of the time and raised to 1250°C when substances that are more difficult to eliminate, such as PCB and other polychlorinated wastes, are to be incinerated. The kiln will be lined with high alumina refractory. Kiln construction will be of a heavy duty design with air cooled end seals, cast steel tyres and support rollers, and a variable speed drive unit.

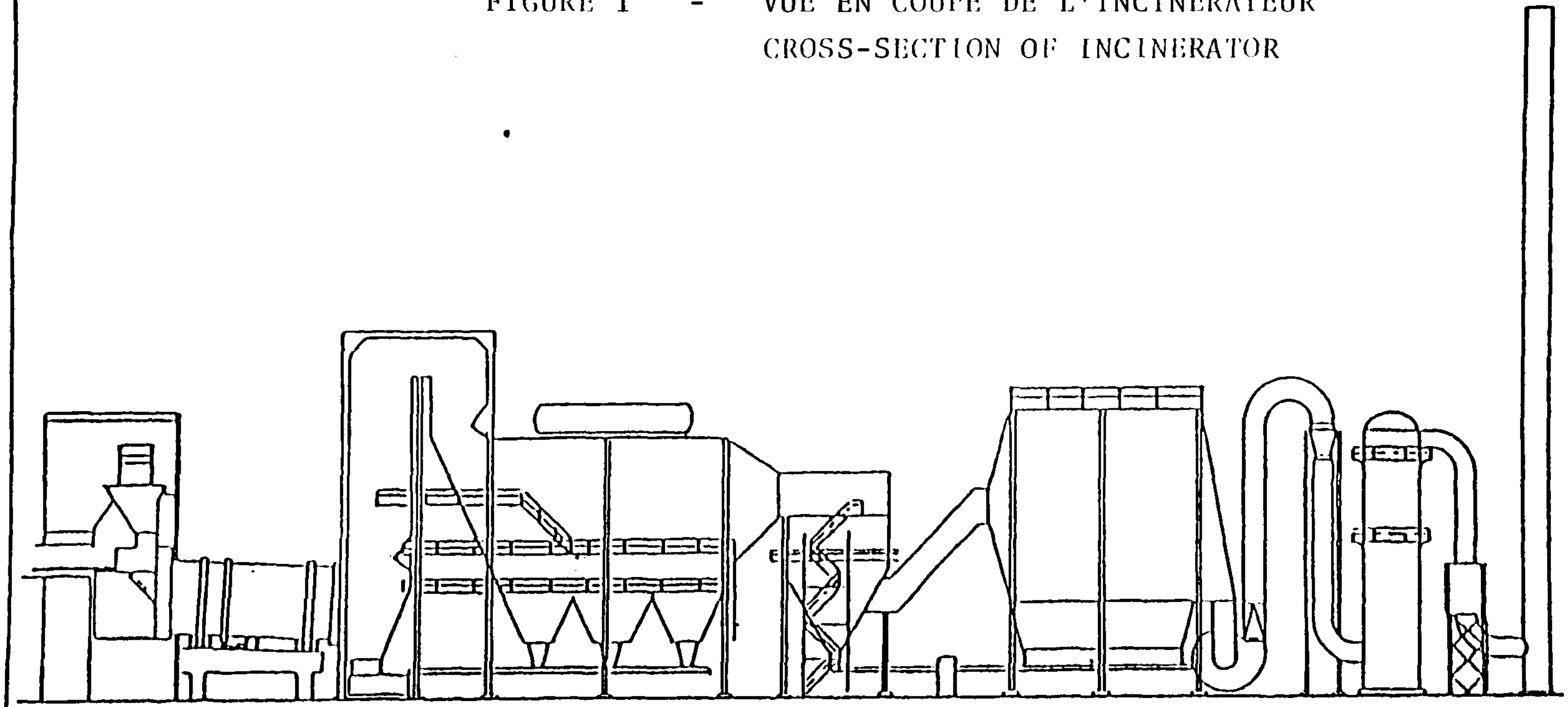
402 SYSTEME D'INCINERATION

Le système d'incinération tel qu'indiqué à la Figure 1, comprendra:

- un incinérateur à four rotatif;
- une chambre de post-combustion;
- un système de récupération de l'énergie disponible;
- un système d'épuration des gaz; et
- une cheminée.

L'incinérateur à four rotatif aura les dimensions adaptées à la demande du marché que l'on estime actuellement être d'environ 60 000 tonnes par an. Le four, d'un diamètre extérieur de 5,1 m et d'une longueur de 13,1 m, sera conçu pour tourner à moins de 1 tour par minute pour permettre de bien mélanger les déchets et ainsi d'assurer une combustion complète. L'efficacité de combustion serait d'au moins 99,99%, et lorsque la température est portée à 1250°C et que le temps de résidence est d'au moins 2,0 secondes dans le four, l'efficacité de destruction peut atteindre 99,9999%, ce qui permettra à SERDOQ d'éliminer en toute sécurité les BPC et autres déchets très toxiques. On s'attend à ce que le four fonctionne à environ 1000°C la plupart du temps et que sa température soit portée à 1250°C lorsque des substances plus difficiles à éliminer, telles que les BPC et autres déchets polychlorés, doivent être incinérés. Le four sera recouvert d'un revêtement réfractaire à haute teneur en alumine. La construction du four reposera sur une conception ultra-robuste avec des joints étanches refroidis à l'air aux extrémités, des roues et des rouleaux de support en acier coulé, et une unité d'entraînement à vitesse variable.

FIGURE 1 - VUE EN COUPE DE L'INCINÉRATEUR
CROSS-SECTION OF INCINERATOR



SYSTÈME D'ALIMENTATION DE DÉCHETS	FOUR ROTATIF	CHAMBRE DE POST-COMBUSTION	CHAUDIÈRE DE RÉCUPÉRATION DE LA CHALEUR	SÉCHOIR VAPORISANT/ ÉPURATEUR SEC	PRÉCIPITATEUR ÉLECTROSTATIQUE OU DÉPOUSSIÉREUR À SACS FILTRANTS	TOUR DE LAVAGE	CHEMINÉE
WASTE FEEDING SYSTEM	ROTARY KILN	SECONDARY COMBUSTION CHAMBER	WASTE HEAT BOILER	SPRAY DRYER/ REACTOR	ELECTROSTATIC PRECIPITATOR OR BAG HOUSE	WET GAS SCRUBBER	STACK

CENTRE D'ÉLIMINATION ET DE RECYCLAGE DES
DÉCHETS ORGANIQUES DANGEREUX DU QUÉBEC
SERDOQ

The secondary combustion chamber will be designed to meet the proposed regulations which call for a residence time of 2.5 seconds. It is expected that high moisture and non-halogenated wastes, both delivered and separated on site, will be directly injected into the secondary chamber to reduce the evaporative loading on the kiln. Refractories in the secondary chamber are of similar qualities to those in the kiln. The refractory bricks will be backed by insulating bricks and fibre insulation to minimize heat losses from the chamber.

As the hot gases leave the secondary combustion chamber, it is presently envisaged to cool them by using air. The flue gases will be cooled to 750°C prior to them entering the convective waste heat boiler. This temperature is a prerequisite for this type of boiler so that the tubes are not over-heated and that corrosion and maintenance are kept to a minimum. The need for a waste heat boiler is, however, presently under review because at the majority of sites pre-selected it would be difficult, if not impossible, to sell the generated steam. Other alternatives being considered will be the use of heat exchangers because at least half of the waste heat energy from the system will be required to heat the plant and reused for the solvent and waste oil recycling units.

La chambre de post-combustion sera conçue pour respecter les futurs règlements exigeant un temps de rétention des gaz de 2,5 secondes. On prévoit que des déchets liquides non-halogénés à faible teneur calorifique soient injectés directement dans la chambre de post-combustion afin de réduire l'évaporation dans le four. Les matériaux réfractaires de la chambre de post-combustion auront des caractéristiques semblables à celles du four. Les briques réfractaires seront apposées à des briques isolantes et à un isolant en fibre afin de réduire le plus possible les pertes de chaleur de la chambre.

Lorsque les gaz chauds quittent la chambre de post-combustion, ceux-ci sont refroidis par l'addition d'air. La température recherchée à l'entrée de la chaudière de récupération d'énergie sera de 750°C. Cette température est un prérequis essentiel afin que les tubes de la chaudière ne soient pas surchauffés et que la corrosion et l'entretien soient réduits au minimum. Cependant le besoin d'avoir une chaudière de récupération d'énergie est actuellement à l'étude puisqu'aux sites pré-sélectionnés il serait difficile, sinon impossible, de vendre la vapeur générée. Les autres solutions à l'étude comportent l'utilisation d'échangeurs de chaleur en considérant qu'au moins la moitié de l'énergie disponible serait requise pour chauffer l'usine et utilisée pour pour les unités de recyclage de solvants et des huiles usées.

From the waste heat recovery system, whichever will be finally selected, the contaminated flue gases pass to the gas cleaning system. In order to meet the very stringent emission standards which in summary are:

Particulates	< 50 mg/Nm^3
HCl	< 75 mg/Nm^3
SO_2	< 200 mg/Nm^3

(all corrected to 50% excess air (dry)), and in order to have a zero liquid effluent under normal operating conditions, the following flue gas treatment system appears to offer the response of best available technology:

- Spray dryer/reactor utilizing blow-down water from the downstream wet-scrubber, together with lime reagent for the capture of acid gases and heavy metals.

- Electrostatic precipitator or baghouse for the primary removal of particulates.

- Induced draft fan with variable speed drive, which maintains about 10 mm Hg of negative pressure in the rotary kiln.

- Wet gas scrubber including quench section, venturi-jets and fluid bed contact section followed by mist separation, for the final removal of particulates, acid gases, heavy metals and aerosols.

- 60 m high insulated steel stack.

Quel que soit le système choisi, les gaz de combustion quittant la chaudière de récupération d'énergie seront acheminés au système d'épuration des gaz. Afin de respecter les normes d'émission atmosphériques suivantes:

Particules	< 50 mg/Nm^3
HCl	< 75 mg/Nm^3
SO_2	< 200 mg/Nm^3

(tous corrigés à 50% d'excès d'air (sec)), et aussi d'assurer qu'aucun effluent liquide ne soit produit sous des conditions d'exploitation normales, le système de traitement des gaz de combustion suivant semble offrir la meilleure solution technologique possible:

- séchoir/réacteur vaporisant utilisant l'eau de purge de l'épurateur humide en aval, et contenant de la chaux pour capter les gaz acides et les métaux lourds.

- précipitateur électrostatique ou épurateur à sacs filtrants pour l'enlèvement primaire des particules.

- ventilateur d'air induit avec entraînement à vitesse variable, qui maintient une pression négative d'environ 10 mm Hg dans le four rotatif.

- épurateur des gaz humides incluant une section de refroidissement, des jets à venturi et une section de contact à lit fluidisé suivie par une séparation des vapeurs humides, pour l'enlèvement final des particules, des gaz acides, des métaux lourds et des aérosols.

- cheminée isolée en acier, d'une hauteur de 60 m.

As you can see, this system represents the major cost item for the project and thus every effort is being made to minimize any unnecessary items. SERDOQ feels, however, that the gas cleaning system of such a facility should be the centre of attention because, after the combustion capability, it is the main system of environmental control to ensure that the risk of operating such a facility is kept to an absolute minimum. One way that we are presently studying to reduce the cost of the gas cleaning system, without changing the components, is to cool the flue gases by using a wet spray. This has the effect of keeping the volume of gases to a minimum and thus reducing the size and cost of each piece of equipment.

Comme vous le voyez, ce système représente le principal élément des coûts du projet, et tous les efforts sont donc mis en oeuvre pour réduire tout équipement qui n'est pas nécessaire. Cependant, SERDOQ croit que le système d'épuration des gaz d'une telle installation doit être au coeur même des efforts prodigués, étant donné que, mis à part les critères de combustion, il s'agit là du principal système de contrôle de l'environnement assurant que le risque d'exploitation d'une telle installation est réduit à son minimum absolu. Nous envisageons actuellement la possibilité de réduire le coût du système d'épuration des gaz sans en changer les composantes, en refroidissant les gaz de combustion par l'utilisation d'un pulvérisateur humide. Ceci a pour effet de réduire au minimum le volume des gaz à traiter, donc de réduire la dimension des équipements et, par conséquent, les coûts inhérents.

403 WASTE WATER TREATMENT SYSTEM

There are basically three types of waste waters originating from the SERDOQ facility:

- Sanitary sewage will be discharged directly to the off-site sanitary sewer system;
- Vehicle/container cleaning waste water will be concentrated and either incinerated or treated in the waste water treatment plant; and
- Storm water runoff from the unpaved areas and roof drains will be directed to the off-site storm sewer, while runoff from the paved areas will be controlled and if necessary treated before discharge to the off-site sanitary sewer.

403 SYSTEME DE TRAITEMENT DES EAUX USEES

Il existe essentiellement trois types d'eaux usées qui seront générées sur le site de SERDOQ:

- les eaux usées sanitaires, qui seront déchargées directement au système d'égoût sanitaire hors-site;
- les eaux usées de nettoyage des véhicules et des contenants,qui seront concentrées puis incinérées ou traitées à l'usine de traitement des eaux usées;
- les eaux de ruissellement des eaux pluviales provenant des secteurs non pavés et des drains de toiture, qui seront acheminées à l'égout pluvial hors-site, alors que le ruissellement des aires pavées sera contrôlé et, aubesoin, traité avant d'être rejeté à l'égout sanitaire hors-site.

The waste water treatment plant that will be used to treat any contaminated runoff consists of the following unit operations: flow equalization, flocculation, clarification, oxidation, filtration and pH correction with optional passage through an activated carbon filter.

Le système de traitement des eaux usées qui sera utilisé pour traiter toute eau de ruissellement contaminée comprendra les opérations individuelles suivantes: égalisation du débit, floculation, clarification, oxydation, filtration et correction du pH avec passage optionnel à travers un filtre au charbon activé.

An option that is presently being studied is the possibility of dewatering the incoming liquid wastes by way of physical/chemical treatment in order to reduce the unnecessary water load on the incinerator and thus possibly increase the heating value of the feed to the incinerator. The water removed in this manner could then be used to cool the flue gases before the gas cleaning system in order to maintain the zero effluent design criteria.

On étudie actuellement la possi bilité d'assécher les déchets liquides arrivant au site au moyen d'un traitement physico-chimique afin de réduire la charge d'eau inutile apportée à l'incinérateur et d'augmenter la valeur calorifique des déchets alimentés à l'incinérateur. L'eau ainsi enlevée pourrait être utilisée pour refroidir les gaz de combustion en amont du système de nettoyage des gaz et ainsi maintenir le critère conceptuel suggérant qu'aucun effluent de procédé liquide ne soit produit.

We have found in our market studies that the average high calorific value of the waste in Quebec is very low, of the order of 8,100 kJ/kg (3,500 Btu/lb). A recent review of European operations, by our staff, indicates that in Europe the average is considerably higher being around 12,000 kJ/kg (5,200 Btu/lb). One of the reasons for this of course could be that European industry has been subjected to central waste incinerators for over 10 years now and has probably changed the internal processes such that the wastes are much more concentrated, lower in volume, and thereby reducing the cost of off-site disposal. We believe that the same phenomena will occur in North America in the coming years once projects like SERDOQ get off the ground. However, it may be cheaper for SERDOQ to de-water a good part of industries wastes and for that reason we are giving it further consideration.

Nos études de marché ont révélé que la valeur calorifique brute moyenne des déchets du Québec est très faible, de l'ordre de 8,100 kJ/kg (3,500 Btu/lb). Une récente étude des centres européens effectuée par notre personnel indique qu'en Europe la moyenne est considérablement plus élevée et se situe autour de 12,000 kJ/kg (5,200 Btu/lb). Une des raisons pourrait être que l'industrie européenne est contrainte de faire appel à des incinérateurs centraux de déchets depuis plus de 10 ans et qu'elle a probablement changé ses procédés internes de sorte que les déchets sont beaucoup plus concentrés, réduisant ainsi leur volume et les frais d'élimination hors-site. Nous croyons que le même phénomène se produira en Amérique du Nord au cours des prochaines années, lorsque des centres comme SERDOQ auront été mis en place. Cependant, il peut être moins coûteux pour SERDOQ d'assécher une bonne partie des déchets de l'industrie et pour cette raison nous étudions plus en détail cette possibilité.

5.0 COST TO INDUSTRY

As you all know, it is very expensive to incinerate industrial wastes because of the elaborate environmental controls necessary to show the general public and you and me that the plant is controlling pollution and not creating it. Centrally operated and controlled facilities have been shown to be the answer in Europe and we believe that very shortly, this type of facility will see the light in North America. Unlike Europe, however, where most of the central facilities are subsidised by the various levels of government, the majority of North American, including Quebec, facilities are expected to be operated on a profit basis. This has the advantage of putting the waste management industry on the same incentive basis as the industries that it serves. In order to do this, relatively high costs will have to be charged and SERDOQ has estimated that the average cost to industry will be about $250 per metric tonne delivered to the plant. Not all wastes will be charged at the same rate and if we refer to the market breakdown shown in Table 1, the average prices that are expected to be charged to industry for the safe, legal, and environmentally accepted disposal of organic waste at SERDOQ are shown in Table 2.

TABLE 2

Category of Waste	Distri-tion	Cost of Disposal
	%	$
Mixed liquids	50-60	125
Sludges	20-30	230
Solids	5-15	295
Special liquids	5-10	580
Containers	3-6	1,250 (200/barrel)
Special sludges	1-4	720

5.0 COÛT A L'INDUSTRIE

Comme vous le savez, l'incinération des déchets est un procédé d'élimination très coûteux étant donné les stricts contrôles de l'environnement qui sont nécessaires pour garantir à tous les utilisateurs et au public que l'usine contrôle la pollution et ne la crée pas. Des installations centrales approuvées se sont avérées être la réponse en Europe et nous croyons que très prochainement ce type d'installation verra le jour en Amérique du Nord. Cependant, contrairement à l'Europe où toutes les installations centrales sont subventionnées par divers niveaux de gouvernement, la majorité des installations en Amérique du Nord, y compris celles au Québec, doivent être exploitées sur une base rentable. Afin qu'il en soit ainsi, des prix élevés doivent être imposés et SERDOQ estime que le prix moyen pour l'industrie sera d'environ 250$ par tonne métrique livrée à l'usine. Tous les déchets ne seront pas facturés au même taux. Se référant à l'éventail du marché, le Tableau suivant montre les prix moyens qui seront facturés à l'industrie pour l'élimination acceptable du point de vue de l'environnement, légale et sécuritaire des déchets organiques chez SERDOQ.

TABLEAU 2

Catégorie déchets	Distri-bution	Coût de l'élimination
	%	$
Liquides mixtes	50-60	125
Boues	20-30	230
Solides	5-15	295
Liquides spéciaux	5-10	580
Contenants	3-6	1,250 (200/baril)
Boues spéciales	1-4	720

These are general categories and will be refined once a more detailed market assessment has been developed and a better knowledge obtained of the waste categorization. It is very difficult for me today to state which of the above will be charged to any specific industry but I can say that liquid wastes presently being incinerated at the Tricil Ville Mercier facility will probably be charged $125 per metric tonne or 12.5¢/L (47.5¢/U.S. gal).

Ce sont là des catégories de déchets générales qui seront mises au point une fois que l'évaluation détaillée du marché sera développée et qu'une meilleure connaissance des catégories de déchets sera obtenue. Il m'est très difficile aujourd'hui de dire lequel des items ci-dessus sera facturé à une industrie spécifique quelconque mais je peux quand même dire que les déchets liquides actuellement incinérés à l'installation de Tricil Ville Mercier seront probablement facturés à 125$ par tonne métrique soit 12,5¢ le litre ou 47,5¢ le gallon américain.

Flue Gas Cleaning by Spray Absorption after Incinerator Plants

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FLUE GAS CLEANING BY SPRAY ABSORPTION AFTER INCINERATOR PLANTS

Abstract

This paper describes the technology and capabilities of the Niro Atomizer/Joy Manufacturing dry scrubbing process for absorption of acid gases, and reduction of trace toxic elements and particulate emission.

Four (4) spray dryer absorption plants (SDA) delivered to hazardous waste incinerators are handling a total flue gas flow of more than 300,000 ACFM. Of these, installations in the U.S. and Finland are provided with baghouses, while installations in Denmark and Sweden use electrostatic precipitators for particulate collection.

The SDA process provides a number of advantages compared to traditional flue gas cleaning methods. Operational experience is presented, together with emission measurements from operating plants.

1. INTRODUCTION

When using an incineration process, hazardous waste is detoxified and the ultimate disposal product represents only a small percentage of the initial waste volume. The flue gas from such incinerators represent a severe environmental impact, and a flue gas cleaning process must be selected to prevent emission of harmful compounds.

According to various reports, primarily from Europe, flue gas cleaning through the use of wet scrubbing often causes corrosion and operational problems resulting in high operating cost; specially where reheating of the scrubber off-gases are required. The HCl emission requirements can normally be met using a wet scrubber, but a relatively large quantity of liquid effluent is created. This effluent can seldom be disposed of directly due to the high salt content and the content of heavy metals, but requires a complicated after treatment system.

Introduction of a dry absorbent into the incinerator flue gas (the so-called dry injection process) has only shown limited success. Typically, the acid gas emission regulations cannot be met. Further, operating cost are generally high due to the large consumption of reagent material, which further increases the volume of waste product that must be disposed of.

It was appropriate to combine the positive characteristics of the wet scrubbing and the dry injection process in one hybrid process. The dry scrubbing or dry flue gas cleaning process using spray drying absorption has been established as this combination.

The Niro Atomizer/Joy Manufacturing spray absorption system meets the regulatory requirements for flue gas cleaning with low operating costs. The dry waste product which is produced in small quantities can easily be disposed of. The plant operates without creation of waste water, and with no corrosion. These advantages have resulted in a number of contracts, both for incineration and boiler plants. See Figure 1.

<u>SPRAY DRYERS</u>

5000	Industrial Plants
150	Plants with more than 100,000 ACFM of drying gas
50	Plants with more than 20 TPH of product

<u>SPRAY ABSORBERS</u>

13	Utility Plants, more than 6,000 MW
10	Industrial Boilers
	A total of more than 20 million ACFM of flue gas.
4	Hazardous Waste Incinerators
3	Solid Waste Incinerators
	A total of more than 500,000 ACFM of flue gas.

<u>Figure 1 - References</u>

2. PROCESS DESCRIPTION

SPRAY DRYING - SPRAY ABSORPTION

The dry scrubbing process based on spray dryer absorption has only been applied for the last eight (8) years. The concept is, however, based on a technology - the spray drying technology - which has been known and applied commercially for half a century within a variety of industries.

In spray drying a material in the liquid state (solution, slurry, or paste) is transformed into a dry particulate product in one single operation. The process can be divided into the following stages:

1. Atomization of the liquid.

2. Mixing of the atomized droplets and the drying gas with simultaneous evaporation of the water.

3. Separation of the dry product from the drying gas partly at the base of the spray drying chamber and partly in the subsequent dust collector.

The atomization can be performed by a rotary atomizer or by different types of nozzles. A number of rotary atomizers in different sizes are available for this purpose. The advantage of rotary atomizers is the simplicity of operating one single atomizer as compared to a large number of nozzles. Nozzles are susceptible to plugging and wear, which will change the degree of atomization and thereby impair the drying process. In order to avoid this, operating personnel have to pay special attention to nozzle inspection and replacement.

The patented atomizer wheel (Figure 2) consists of a corrosion resistant wheel body provided with inserts. These inserts protrude inside the wheel body itself to maintain a stationary layer of slurry, which protects the inside of the wheel body from wear. The bottom plate and these inserts are made of an abrasion resistant material such as silicon carbide.

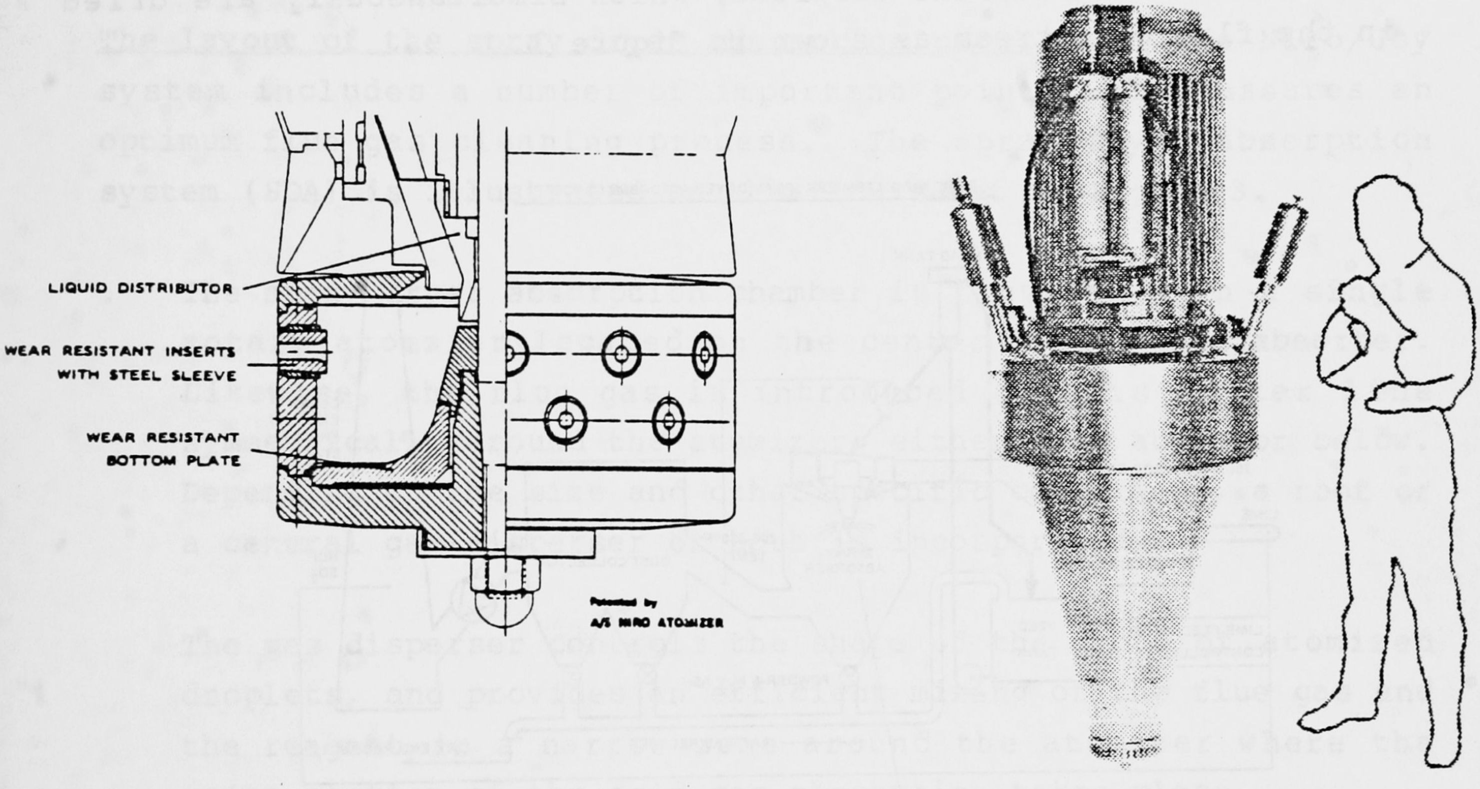

Figure 2 - Atomizer with Wear Resistant Atomizer Wheel

Optimum conditions for heat and mass transfer exist due to the enormous surface area created of the reagent material through the process of atomization, and due to the intimate contact between the hot flue gases and the reagent spray.

Spray absorption can be considered a special case of spray drying. The process is characterized through introduction of the flue gases into a spray chamber, in which an alkaline liquid solution or suspension of reagent is atomized by means of a rotary atomizer.

Acid gases such as SO_2, SO_3, HF, and HCl contained in the flue gas reacts with the alkaline droplets, which simultaneously are dried in the flue gas stream as shown in Figure 3.

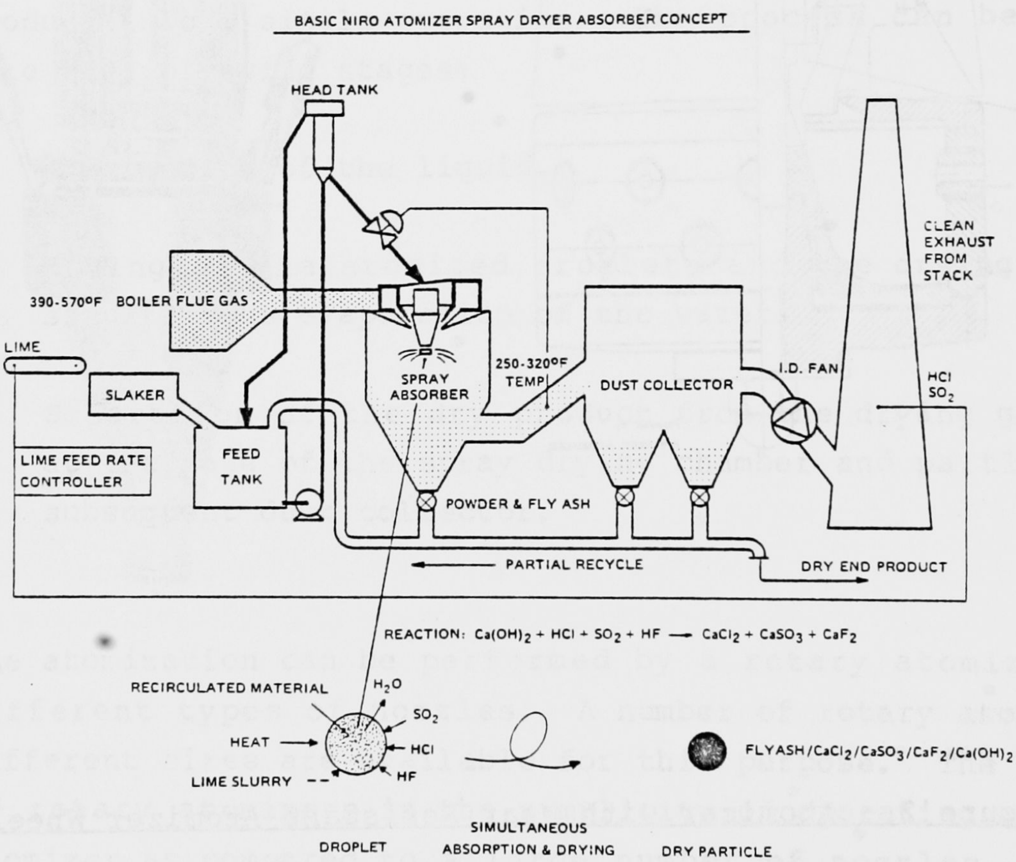

Figure 3 - Niro/Joy Dry Scrubber Flow Sheet

In the spray absorption process the corrosive gases are removed without creating any wet/dry interface, which can cause corrosion. The absorption chamber is therefore fabricated in mild steel.

The dry waste product is a fine, free-flowing powder which is easy to handle. The disposal properties are good due to the high alkalinity of the waste product, which reduces solubility and therefore leaching of heavy metals.

The layout of the spray dryer absorption process in the Niro/Joy system includes a number of important points which assures an optimum flue gas cleaning process. The spray dryer absorption system (SDA) is illustrated on the flow sheet in Figure 3.

- The spray dryer absorption chamber is provided with a single rotary atomzier located on the center line of the absorber. Likewise, the flue gas is introduced on this center line symmetrically around the atomizer, either from above or below. Depending on the size and other specific conditions, a roof or a central gas disperser or both is incorporated.

  The gas disperser controls the shape of the cloud of atomized droplets, and provides an efficient mixing of the flue gas and the reagent in a narrow zone around the atomizer where the major portion of the acid gas absorption takes place.

- Separate waste product discharge from the base of the absorption chamber and the subsequent dust collector provides assurance against obstruction to gas flow at all process conditions. Further, the spiral gas flow pattern established by the gas disperser gives a cyclonic effect in the absorption chamber. The flue gas exits through an outlet duct starting at the center line of the absorption chamber.

- The partial recirculation system patented by Niro Atomizer is the preferred process layout; it entails several advantages.

  - The recycled material contains non-reacted reagent; therefore this concept reduces the overall reagent consumption.

  - The high and constant solid content in the feed to the spray dryer absorber simplifies the process control at changing flue gas composition, temperature, or quantity.

  The recirculation concept is especially advantageous when the inlet concentrations of acid gas is high, as is the case with hazardous waste incineration, or if very large flue gas quantities are involved.

- When the spray absorption process takes place in a chamber provided with many nozzles, practical experience has shown it to be difficult to distribute the correct flue gas quantity around each nozzle; specially during changing gas flow conditions.

  This neither effective nor ideal mixing of flue gas and reagent spray results in an unnecessary high lime consumption, and it is probably impossible to achieve high removal efficiencies (>90-95%). (Ref. 4).

- Conventional dust collectors, such as electrostatic precipitators or baghouses as currently used for incineration facilities, can be used without increase in size in spite of the higher particulate loading in the gas stream entering the dust collector.

<u>The process control</u> for a dry scrubber system is quite simple. It basically consists of two control loops as indicated in Figure 3.

The flue gas temperature leaving the spray dryer absorber is controlled at a temperature resulting in good removal of acid gases at a low reagent consumption as well as a satisfactory drying, resulting in a free-flowing waste product. Normally a temperature of 120-160°C (250-320°F) is selected; the selected temperature is kept within a narrow range.

The other loop controls the emission of acid gases, such as HCl or SO_2, in the stack through variation of the amount of reagent introduced into the dry scrubber system.

The temperature loop is always necessary; an automatic emission control loop is optional depending on the specific condition.

3. DRY SCRUBBER SYSTEMS FOR INCINERATORS, INDUSTRIAL EXPERIENCE

The incinerators at Kommunekemi, Denmark; SAKAB, Sweden; and Ongelmajäte, Finland, treats hazardous waste consisting of waste oils, solvents, slurrys, solids, and waste water.

The installation at Kommunekemi was started-up in 1982, and the installation at SAKAB was started-up during the 2nd half of 1983. The installation in Finland will be started-up late 1984.

The incinerator facility at the City of Leverkusen, Germany, is for municipal solid waste and consists of three (3) trains; one (1) entire new incinerator, dry scrubber line, and two (2) dry scrubbers for existing incinerators. This facility will be constructed during 1985 and 1986.

The design conditions for these dry scrubber installations are shown in Figure 4.

		Kommunekemi Nyborg Denmark	SAKAB Norrtorp Sweden	Ongelmajäte Riihimäki Finland	City of Leverkusen Leverkusen Germany
Inlet Flue Gas to Dry Scrubber					
Flue Gas Flow (nominal)	Nm^3/h	56,000	62,000	68,000	3x65,000
Temperature	oC	250-280	230-300	230-280	230-280
Flyash	mg/Nm^3	5,000	3,000	4,000	6-15,000
HCl					
Average	mg/Nm^3		2,000	2,500	900
Maximum	mg/Nm^3	2,200	4,000	4,000	1,500
SO_2					
Average	mg/Nm^3		500	1,000	400
Maximum	mg/Nm^3	1,100	2,000	2,000	1,000
HF					
Maximum	mg/Nm^3	50	250	250	25
Outlet Flue Gas from Dry Scrubber:					
Reference Conditions		7% CO_2 dry	10% CO_2 dry	10% CO_2 dry	11% CO_2 dry
Temperature	oC	140 (min)	130 (min)	140	140
HCl	mg/Nm^3	300	35	35	50
SO_2	mg/Nm^3	500	-	200	200
HF	mg/Nm^3	5	5	5	5
Particulate	mg/Nm^3	100	35	35	50
Heavy Metals Removal		-	-	+	+
Dust Collector		Electrostatic Precipitator	Electrostatic Precipitator	Baghouse, Pulse Type	Electrostati Precipitator

Figure 4 - Reference List - Incinerators
Niro/Joy Dry Scrubber Plants

Operating Experience

The dry scrubber systems can be supervised by one person, who at the same time can perform other duties. The handling of the waste product is as expected easier than handling of the pure fly ash, and has also facilitated the operation of the electrostatic precipitators.

The adjustment of the lime addition as reagent is simple and is normally corrected on the basis of waste analysis, evaluation of the operation, as well as the acid gas emissions from the stack.

Kommunekemi: The availability of the dry scrubber system has since early 1983 increased from 80-85% to the present 90-95%. The realibility of the dry scrubber system is therefore on a fully acceptable level, equal to that of the remaining equipment in the incinerator line.

Emission measurements made over a 3-month period showed HCl emissions of 20-200 mg/Nm^3 (15-160 ppm), well below the 300 mg/Nm^3 required by Danish regulations. Based on a mass balance over the plant, this corresponds to 85-90% HCl removal, which was obtained with a lime consumption in good agreement with the stoichiometric ratio established during the performance testing.

The energy consumption of the dry scrubber system, exclusive of ID fan and electrostatic precipitators, is some 10 kWh/ton waste during representative operation.

SAKAB: The start-up of this unit commenced in August, 1983. Only minor technical problems have caused shut-down of the installation, and altogether this amount to only a few days. The operation and the emissions were supervised by the Swedish authorities during the start-up phase, and on this basis the dry scrubber system was taken over by the customer late 1983. The HCl emission was measured as less than 30 mg/Nm^3 (25 ppm) corrected to 10% CO_2, dry. (Ref. 3).

The operational experience from the first two dry scrubber installations on hazardous waste incinerators is thereby very satisfactory; especially in view of the fact that the start-up took place simultaneously with start-up of new incinerators, where upset conditions are likely to occur.

Emissions and Removal Efficiencies

Several measuring programs have been carried out in order to confirm the capability of the dry scrubbing systems in industrial scale. After the start-up of the system at Kommunekemi, "Dansk Kedelforening" (the Danish Boiler Association) took measurements (in June 1982), these results were the basis for the customer accepting the plant (Ref. 1).

Niro Atomizer has also taken measurements, which confirmed the results from previous pilot plant testing.

In order to establish an extensive data base, Niro Atomizer, in cooperation with Kommunekemi, contracted for a detailed measuring program, carried out the the German Environmental Service Company, TÜV, Rheinland (Ref. 2).

The Swedish government-owned company, "Studsvik, Energiteknik", has both carried out a measuring program on Kommunekemi as well as supervised the operation at SAKAB during the start-up phase. (Ref. 3).

A summary of the removal efficiencies for HCl, SO_2, and HF at Kommunekemi is shown in Figure 5 (Ref. 2).

	Flue Gas to Dry Scrubber	Stack Gas after Electrostatic Precipitator	Stack Gas after Pulse Type Baghouse 1)	Lime Consumption (as stoichiometric ratio)
HCl, mg/Nm^3 2)	1,000-3,000	< 100	< 20	1.-1.5 based on
HF, mg/Nm^3 2)	25-75	< 0.3	< 0.3	acid gas concentration
SO_2, mg/Nm^3 2)	200-1,000	70-350	20-70	into dry scrubber

1) Pilot plant baghouse treating slipstream.

2) Corrected to 11% O_2, wet.

<u>Figure 5 - Industrial Results by Niro/Joy Dry Scrubber Plant</u>

The removal efficiencies obtained during performance testing was 97-99% for HCl, 98-99% for HF, and 70-90% for SO_2 in the dry scrubber system when using an electrostatic precipitator for particulate removal. These removal efficiencies can also be obtained at higher acid gas concentrations into the dry scrubber.

Higher removal efficiencies can be obtained by the use of a baghouse; the lime consumption is not increased in order to achieve this higher removal efficiencies. The reason being that some acid gases are removed in the baghouse itself, while acid gas removal in an electrostatic precipitator is more limited.

Data, both from Kommunekemi and SAKAB, have shown that HCl emission after an electrostatic precipitator can be reduced to less than 35 mg/Nm^3 (29 ppm) when using a somewhat increased lime consumption.

Consequently, the dry scrubber system can readily meet the United States regulation for HCl removal of 99%. Based on the above data, this can be obtained both by use of a baghouse and an electrostatic precipitator for particulate collection.

It has further been established that the dry scrubber system does exhibit a good buffer capacity so that low emission values can be maintained even at short two or three-fold increases in the concentration of acid gases.

<u>Particulate and Heavy Metals Emissions</u>

Measurements of the particulate emission from dry scrubber installations have shown that the efficiency of the electrostatic precipitator has been improved. The collection efficiency of the electrostatic precipitator has been increased from approximately 95% to 99% based on the particulate loading entering the dry scrubber system. The separation efficiency of the electrostatic precipitator itself was increased to approximately 99.8%, inasmuch as the particulate loading from the spray dryer absorber into the precipitator was increased due to introduction of reagent and the use of a recirculation concept.

When using a baghouse, particulate emissions were measured below 10 mg/Nm^3 (0.005 gr/scf) corresponding to a particulate removal of 99.5% compared to the particulate loading in the flue gas entering the dry scrubber system.

In conclusion, the results show that the dry scrubber system can meet all existing regulations for removal of acid gases, particulates, and heavy metals.

The dry scrubber system using rotary atomization offers the following advantages:

1. The dry free-flowing waste product - no waste water.

2. A high removal efficiency for acid gases and heavy metals.

3. High acid gas removal with low consumption of an inexpensive reagent material (lime).

4. Operational flexibility during changing acid gas concentrations and emission requirements.

5. Good turndown capability allowing the dry scrubber system to follow changes in incinerator or waste heat boiler operation.

6. No problems with wet/dry interfaces.

7. No corrosion-carbon steel is used as material of construction.

8. No re-heating of the clean flue gas.

9. Low pressure drop and power consumption.

10. Simple operation and high availability.

11. Low maintenance requirement.

12. Competitive.

13. Improved performance of an electrostatic precipitator for particulate removal.

14. Safer operation of a baghouse due to the temperature drop over the spray dryer absorber.

15. Easy handling of the dry free-flowing waste product which can easily be disposed of.

16. Possibility for utilization of waste water from other sources.

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The installation has a high availability (> 90-95%) as required by the major components in an incinerator line; the installation can be supervised by one person.

The operational experience and measurements have shown good removal efficiencies as well as a high degree of stability - buffer capacity - even when significant changes in acid gas concentrations are experienced.

The economical advantages of the dry scrubber system are as follows:

- A low consumption of an inexpensive reagent material (lime) at high acid gas removal rates.
- A low power consumption due to an efficient atomization and a low pressure drop.
- No requirement for re-heating of the flue gas prior to the stack.
- Low maintenance cost due to minimum use of exotic construction materials.

The total power consumption is 20-25 kWh/Ton of waste when using a recirculation concept; without recirculation, this power consumption is even lower, approximately 15 kWh/Ton of waste.

The cost of disposing of the waste product is primarily a function of the waste product quantity. The low lime consumption of a Niro/Joy dry scrubber system assures this cost is kept as low as possible.

During measurements on emission of heavy metals (lead, cadmium, arsenic, mercury), separate measurements were made for emissions in solid phase and in vapor phase. These measurements show that when using a dry scrubber system not only heavy metals in the particulate phase, but also heavy metals in the vapor phase, are removed to a significant extent.

In order to achieve a high removal efficiency of harmful trace elements, which after the incinerator process entirely or partly exists in the vapor phase; for instance, heavy metals or organic compounds such as polyaromatic hydrocarbons and chlorinated compounds; it is important that the flue gas is cooled to an appropriate temperature prior to particulate collection. The presence of large amounts of particulate gives enough surface area for condensation and/or absorption of vapor phase trace elements, and thereby prevents the formation of ultra fine aerosols. Further, both theoretical data and practical measurements have shown that $Ca(OH)_2$ and $CaCl_2$ present in the atomized particles in the spray dryer absorber, together with the fly ash, improves removal of such trace elements.

The small particles have the biggest surface area, and data shows these particles to contain the largest amount of volatile heavy metals, so it is very important that the smallest particles (less than 2 microns) be removed from the flue gas stream prior to exhaust to atmosphere.

4. SUMMARY

The operation of a dry scrubber system shows a good flexibility in connection with changes in the composition and quantity of the flue gas. The maintenance requirement is low, and no corrosion problems have been experienced.

Application of Plasma to Toxic Substance Destruction

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ABSTRACT

APPLICATION OF PLASMA TO TOXIC SUBSTANCE DESTRUCTION

A thermal plasma, properly applied to toxic waste destruction, provides a pyrolytic environment with distinct advantages over other competing technologies. Complete atomization of organic fluids have been demonstrated to occur in less than one third of a millisecond. Kinetic recombinations of atomic entities are predictable. Chlorinated wastes produce a hydrogen chloride byproduct which is completely converted to salt in a caustic scrubber. Destruction efficiencies in excess of 99.9999999 percent have been corroborated by external monitoring agencies for the destruction of askarel fluids with chlorine contents up to 58 percent.

Since this process is pyrolytic, the scale of the equipment is small for high throughput rates. Energy requirements for the destruction of askarels are typically less than one kilowatt-hour per kilogram of waste. A mobile prototype unit is being constructed for the Department of Environmental Conservation of the State of New York for a throughput rate of four kilograms per minute of liquid waste. The mobility and efficiency of such systems limit the controversy associated with siting fixed facilities.

APPLICATION OF PLASMA TO TOXIC SUBSTANCE DESTRUCTION

Introduction

Plasma pyrolysis shows strong promise of providing a safe and efficient method for destroying toxic chemicals. The US Environmental Protection Agency considers this process as one of the top five emerging technologies for combatting this major environmental threat.

Research has been conducted at the Royal Military College of Canada since 1979 to investigate the use of plasma pyrolysis to dispose of toxic chemicals, specifically chlorinated hydrocarbons. RMC completed, in 1982 for the Ontario Ministry of Environment, a research project to determine the ability of a plasma pyrolysis system to destroy polychlorinated biphenyls (PCB's). The process achieved destruction efficiencies in excess of 99.9999 percent.

Later in 1982, the plasma system was modified by the adoption of a collinear• electrode configuration in an attempt to obtain even higher destruction efficiencies. Tests to verify the efficiency improvement were conducted with Askarel, a commercial PCB mixture, and tetrachloromethane.

Process Description

The plasma pyrolysis process involves the following steps as illustrated in Figure 1. First, a 250 to 500 kW plasma is created by an electric arc. Second, the toxic material is injected into the arc space at a rate between 1 and 2 litres per minute. Third, thermochemical and photochemical dissociation of the toxic materials occurs in the presence of the plasma to produce atoms and ions which are then free to recombine according to kinetic equilibrium theory. Fourth, the recombination products, primarily H_2, CO, CO_2, CH_4, HCl, H_2O and particulate carbon, leave the reactor at about 900°C and pass through a spray mist scrubber. Water and NaOH are injected into the scrubber to quench the gas products, remove the soot and neutralize the HCl. Sixth, the quenched gas passes to a flare where the gas is burned. Samples of the fluid from the scrubber are taken for analysis for residual toxic constituents.

Experimental

Materials Used

Askarel provided by Ontario Hydro was used in the experiments designed to demonstrate the efficacy of plasma pyrolysis in destroying PCB's. The askarel consisted of 20 percent by mass Arochlor 1254 and 20 percent Arochlor 1260 dissolved in trichlorobenzene.

The tetrachloromethane feed consisted of a 50:50 CCl_4/ethanol solution. The addition of ethanol to the feed stream increased the hydrogen concentration in the product gas, thereby suppressing the formation of $COCl_2$.

Pyrolysis Procedure

A 250 kW electric arc was first established between the collinear electrodes to create the air plasma. Paraffin oil was then injected into the plasma to stabilize it and to transfer some of the energy to other parts of the reactor to prevent cold spots.

When the temperature of the product gas leaving the reactor had exceeded 850°C, injection of the chlorinated material began. Askarel feed rates between 1.0 and 1.2 litres per minute were maintained by a servo-controlled Masterflex peristaltic pump. The average CCl_4 solution feed rate was 0.55 litres per minute. The hot product gas passed through the venturi scrubber where the HCl was neutralized by NaOH, the particulate carbon removed and the gas temperature reduced to less than 80°C. The cooled, cleaned product gas was then flared. The spent scrubbing water was sent to the sewer.

Sampling

The spent scrubbing water has been determined to be the preferable point for sampling for traces of the chlorinated feed. The extraction efficiency of the product gas scrubbing system was determined for various materials differing in solubility and vapour pressure. Extraction efficiencies ranged from 37 percent for volatile, non-soluble toluene to 96 percent for paraffin oil and ethanol. The sampling of both product gas and scrubbing water in previous askarel experiments indicated that the scrubbing system had removed the majority of the trace organic material from the product gas and thus supported this modified sampling procedure.

Four types of 300 mL water samples were collected. Pre-run background samples consisted of samples obtained before the plasma had been created and then while the paraffin oil was being fed into the system. Samples were collected once a minute while the chlorinated material was being pyrolyzed. Finally, 15 minutes after the plasma had been turned off, a post-run water sample was collected.

Analysis

As the prime objective of these experiments was to determine the efficiency with which the chlorinated hydrocarbons were destroyed, analysis focused upon the measurement of feed residual. Procedures employing GC-ECD and GC-MS techniques were employed. Analyses were performed by the Department of Pharmacology and Toxicology, Queen's University and by the New York State Department of Health.

Results

The GC-ECD analysis of the scrubbing water did not detect the presence of any askarel feed residual. Analysis by Queen's University of samples from 3 tests indicated that the residual concentration would be less than 30 ng/g, representing a PCB destruction efficiency greater than 99.9999 percent. These results were corroborated by analyses of water from the third test by the New York State Department of Health. This analysis could not detect the presence of Arochlors 1016, 1221, 1242, 1254 or 1260 at the analytical limit of 0.17 ng/g. Thus, a PCB destruction efficiency exceeding 99.9999999 percent was indicated.

The possibility that the PCB's in the feed material could have been only slightly altered in structure rather than having been totally pyrolyzed to carbon, hydrogen and chlorine was considered. As a preliminary investigation, mass spectrographic analysis of the scrubbing water did not reveal the presence of chlorinated hydrocarbons at an analytical limit of 200 ng/g.

The preliminary testing of the pyrolysis of CCl_4 was promising. A residual concentration of 4 μg/g in the scrubbing water indicated a destruction efficiency greater than 99.99 percent.

Discussion

The plasma pyrolysis system at RMC has demonstrated the ability to destroy chlorinated hydrocarbons, specifically a variety of PCB's, at extremely high levels of efficiency. The adoption of a collinear electrode configuration improved the destruction efficiency previously obtained for askarel by a factor of 1000 to 99.9999999 percent. Initial testing with CCl_4 indicated that the pyrolysis system could handle a chemical that proves to be very difficult to destroy by incineration.

The US EPA has ranked several hundred hazardous organic chemicals in increasing degree of incinerability[1]. Tetrachloromethane is the fourth

[1] 40 CFR Part 261 Appendix VIII, US Code of Federal Regulations

most difficult chemical to incinerate (after the bromo- and fluoromethanes). Hexachlorobiphenyl is ranked at 69, trichlorobenzene at 74, TCDD at 75 and DDT at 118. Therefore, successful destruction of CCl_4 would suggest an ability to destroy a wide variety of hazardous organic compounds.

Preliminary analysis did not indicate the formation of hazardous byproducts by the plasma pyrolysis process. These findings corroborate results from previous experiments using a less efficient reactor design. In this latter case, polychlorinated dibenzofurans were detected in the scrubbing water at concentrations of approximately 0.05 ng/g and chlorinated dibenzo-p-dioxins were not detected. Current research is attempting to more accurately quantify the presence of chlorinated hydrocarbons in the effluent streams. However, the evidence to date strongly suggests that plasma pyrolysis does not convert chlorinated hydrocarbons, particularly PCB's, into dioxins or furans.

Prognosis

The success of the numerous demonstrations conducted at RMC during the past four years has attracted the attention of many regulatory agencies and the industrial community. In a recent evaluation of emerging technologies conducted by the US EPA, plasma pyrolysis was selected as one of the five emerging technologies to be evaluated. The EPA and the New York State Department of Environmental Conservation are jointly funding a Canadian company, Pyrolysis Systems Inc., to fabricate and demonstrate a commercial prototype of a mobile plasma pyrolysis system.

Fitting within a forty-five foot moving van trailer, the mobile plasma system will pyrolyze wastes at rates up to 4 kilograms per minute. Operating and monitoring equipment, including a GC-MSD system, will be controlled by a computer. Failsafe considerations preclude the release of any measurable amounts of toxic material to the environment. Computer simulations based on kinetic equilibria and verified by laboratory tests showed that over one thousand tonnes of waste would have to be fed through the system before one gram of residual undestroyed waste would be detected in the stack gas. The stack gas is flared as a safeguard against the release of this gram of material. Following successful shakedown testing in Canada, the unit may be moved to Love Canal in New York State. There, the system's ability to safely and effectively pyrolyze the oily sludge which is leaching from the Love Canal disposal site would be evaluated.

Success of the first unit at such a challenging location should spur the development of additional units which could visit toxic waste producing industries and eliminate that waste on-site. This approach to toxic waste disposal should obviate the need for the continued use of controversial landfill techniques.

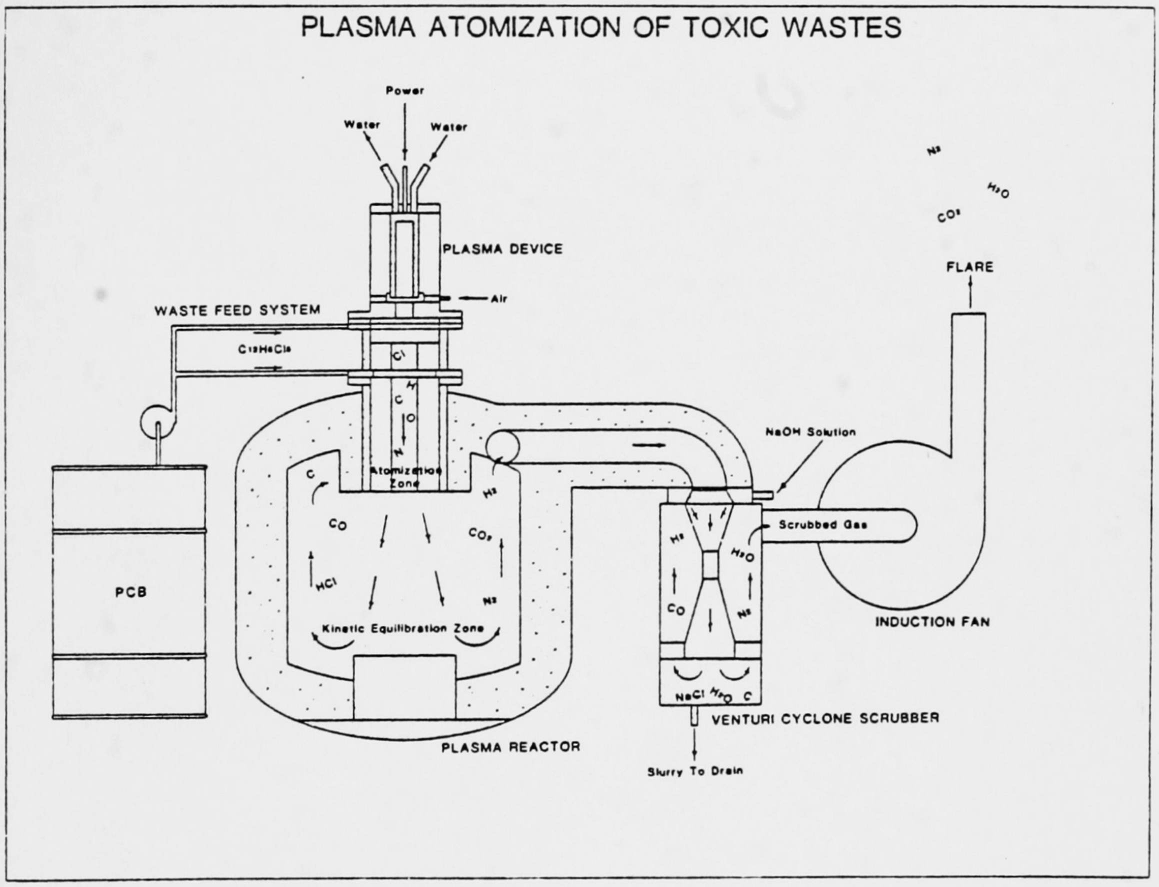

FIGURE 1 SCHEMATIC OF THE PLASMA PYROLYSIS OF PCB'S