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WORKING PAPER NO. 20

REGULATION OF TOXIC CHEMICALS IN THE ENVIRONMENT

by

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FOREWORD

This study is one of a series commissioned by the Economic Council's Regulation Reference which deals with various aspects of environmental regulation. These studies do not profess to cover the whole field of environmental regulation but they do focus on several important areas of concern.

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* Already published.

** Published separately by the Canadian Institute of Resources Law, The University of Calgary.

*** Published separately by Westwater Research Centre, University of British Columbia.

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Résumé

Une des principales questions sur laquelle doivent se pencher les systèmes économiques et politiques consiste à décider quel degré d'exposition aux produits chimiques dans l'environnement est socialement acceptable. L'établissement de ce niveau optimal n'est pas chose simple, puisqu'il constitue une prise de décision sociale et, comme tel, s'expose à certains des plus importants problèmes associés à ce processus. Parmi ces problèmes, mentionnons les difficultés suscitées par l'information et l'incertitude, et la nécessité de prendre des décisions rationnelles sur des questions présupposant des jugements de valeur.

L'information relative aux effets des produits chimiques sur la santé et l'environnement biologique et physique en général est à la fois difficile et coûteuse à colliger. Les longues périodes de latence, les effets difficilement décelables, les répercussions sélectives et l'irréversibilité sont tous des problèmes qui ajoutent à la difficulté d'identifier et de réparer la détérioration biologique occasionnée par les produits chimiques.

L'utilisation de produits chimiques s'accompagne d'un autre important problème, soit la répartition inégale des coûts et des bénéfices sociaux. Il nous est impossible de compter exclusivement sur le système du marché libre, comme régulateur des produits chimiques dans notre société, en raison de certaines externalités négatives.

Les effets complexes et incertains des contaminants chimiques et l'inaptitude du marché à évaluer les coûts et les bénéfices sociaux militent fortement en faveur de l'intervention du gouvernement. Le défi auquel doivent faire face les analystes des politiques et les décisionnaires publics concernant le contrôle des produits chimiques consiste à déterminer la structure et l'étendue appropriées de la réglementation publique nécessaire.

Nos recherches révèlent que le fardeau de la réglementation de l'environnement sur l'industrie des produits chimiques n'est ni excessve, ni trop onéreuse. Cette conclusion appelle cependant au moins deux réserves. Premièrement, l'industrie canadienne des produits chimiques est largement diversifiée et comprend des entreprises qui se distinguent par leur taille, leurs technologies et l'éventail de leurs produits. Les répercussions de la réglementation se répartissent donc inégalement. Il semble que les producteurs moins importants soient davantage touchés par les exigences de la réglementation, qui réduisent les marges bénéficiaires et leur imposent des coûts proportionnellement plus élevés. Les différences dans les technologies et l'éventail des produits signifient que les compagnies sont plus ou moins vulnérables à certains règlements, selon le mélange des composés chimiques utilisés et la facilité avec laquelle ils peuvent être substitués.

Deuxièmement, les mesures de protection de l'environnement ne sont qu'un des nombreux ensembles de règlements publics dont doivent s'accommoder les producteurs de produits chimiques. Toute estimation du fardeau de la réglementation doit donc tenir compte des coûts globaux imposés à l'industrie.

En nous fondant sur notre analyse des coûts tels que décrits par les compagnies de produits chimiques, nous estimons que les coûts d'exploitation moyens engendrés par le contrôle de la pollution dans l'industrie chimique sont de l'ordre de 5 à 10 % (en pourcentage du revenu net). Le pourcentage moyen de l'investissement en capitaux qui peut être attribué aux exigences en matière de protection de l'environnement est évalué aux environs de 6 à 9 %. Toutefois, il se peut qu'en rétrospective, cet investissement se révèle un avantage économique direct pour l'industrie, tout en étant bénéfique pour la société. Dans l'ensemble, le coût de la réglementation relative à la protection de l'environnement représente environ 0,25 à 1,0 % du revenu réalisé par le produit.

Un problème important dont ne tiennent pas pleinement compte les états passés des dépenses affectées à la protection de l'environnement a trait à l'élimination et au recyclage des déchets. Dans les quelques années à venir, nous prévoyons que l'industrie aura à investir considérablement dans les installations et la nouvelle technologie nécessaires pour disposer des déchets chimiques toxiques. Il faut s'attendre aussi à ce que les coûts augmentent par suite de la réglementation fédérale et provinciale prévue pour le transport des produits dangereux.

Notre étude révèle que la majeure partie des compagnies sont d'avis qu'une diminution de la réglementation concernant la protection de l'environnement aurait peu d'effet sur les sommes consacrées à la recherche et au développement dans l'industrie, sur les exportations, les prix des produits, le volume des ventes, les bénéfices et la concurrence exercée par les manufacturiers étrangers.

L'existence d'un régime fédéral au Canada ajoute une importante dimension à l'activité de réglementation; il y a toujours en effet, la possibilité de dédoublement de l'intervention gouvernementale. Il existe un chevauchement considérable dans plusieurs domaines de réglementation fédérale et provinciale de l'industrie chimique, qui engendre à la fois des coûts et des bénéfices. Certaines compagnies membres de l'industrie ont accusé les deux paliers de gouvernement de jouer à saute-mouton, multipliant les règlements dans le but de prendre la haute main dans le domaine de la protection de l'environnement. Bien que la situation actuelle ait pour effet d'introduire un certain degré d'incertitude dans le processus de prise de décisions et d'augmenter le niveau des coûts des transactions, il y a de fortes raisons qui justifient la présence des deux paliers de gouvernement dans ce domaine.

Les gouvernements provinciaux, lorsqu'ils établissent des règlements, sont mieux en mesure de tenir compte, jusqu'à un certain point, des conditions locales particulières. Les efforts du gouvernement fédéral devraient viser à compléter le rôle des provinces en assurant la conformité à certaines normes minimales à l'échelle nationale et en prévenant la balkanisation et les initiatives concurrentielles de l'industrie au détriment de l'intégrité de l'environnement.

De façon générale, si nous appliquons l'expérience américaine au Canada, nous pouvons conclure qu'à l'heure actuelle, l'ensemble des avantages sociaux de la réglementation dépasse les coûts qu'elle engendre. Néanmoins, il y a lieu de reconnaître en même temps un besoin de rationnaliser le système de réglementation de façon à augmenter son efficacité et sa flexibilité.

Notre analyse propose des modifications marginales au système dans deux importants domaines, dans le but de minimiser les risques d'une réglementation trop poussée ou d'un manque de protection. Ces deux domaines sont : (i) la fonction relative à la production, l'évaluation et l'utilisation des données, et (ii) la structure légale et institutionnelle du processus de prise de décision, y compris la part que doivent y jouer le public, les droits et les responsabilités de l'industrie, des gouvernements et du grand public, ainsi que les mécanismes visant à faciliter et à rationnaliser le processus de prise de décisions.

Summary

One of the central questions which economic and political systems must address is what exposure to chemicals in the environment is socially acceptable. The determination of this optimal level of production is a complex issue, as it encounters some of the most important problems associated with the process of social decision making. Foremost among these problems are questions of information, uncertainty, and the need for rational decision making on issues which require value judgments.

Information on the effects of chemicals on human health and the general biological and physical environment is both difficult and expensive to gather. Long latency periods, sub-clinical effects, selective impacts and irreversibilities are all problems which compound the difficulty of identifying and rectifying chemical-induced biological damage.

Another major problem which attends the use of chemical compounds is the imbalanced distribution of social costs and benefits. The existence of negative externalities precludes sole reliance on the free market system as a regulator of chemical production in our society.

The complex and uncertain effects of chemical contaminants and the inability of the market to account for social costs and social benefits present a strong case for a government presence. The challenge facing policy analysts and government decision makers in the area of chemical control is to determine the appropriate structure and extent of governmental regulation.

Our research indicates that the total burden on the chemical industry from environmental regulation is not excessive or unduly onerous. At least two qualifications to this conclusion are required. First, the chemical industry in Canada is diverse and marked by variations in corporate size, technologies and breadth of product line. The distribution of regulatory impact is consequently unequal. It appears that smaller producers may be affected more seriously by regulatory requirements which squeeze profit margins and impose proportionately larger transaction costs on companies of limited size. Differences in technologies and product lines imply selective vulnerability to particular regulations depending on the mix of compounds used in production and the ease of substitutability. Second, environmental controls are only one of numerous government regulations faced by chemical producers. An estimate of the regulatory burden must therefore consider total costs imposed on industry.

On the basis of our analysis of costs provided by chemical companies, we estimate the average operating costs for pollution abatement in the chemical industry (as a percentage of net income) to be in the range of

5-10 percent. The average percentage of capital investment that can be attributed to demands of environmental protection is estimated to be in the range of about 6-9 percent. However, some of this investment may prove, in hindsight, to be of direct economic benefit to the industry as well as being socially beneficial. In total, the cost of environmental regulation represents approximately 0.25-1.0 percent of product revenue.

A significant problem which has not been addressed fully in past expenditures on environmental protection is waste management. In the next few years, significant investment in disposal facilities and technological redesign to deal with toxic chemical wastes is anticipated. Higher future costs are also anticipated to accrue from expected federal and provincial regulation of the transportation of hazardous materials.

Our study indicates that a majority of companies consider that a relaxation of environmental regulation would have an insignificant impact on industry R&D budgets, exports, product prices, sales volume, profits and competition from foreign manufacturers.

The existence of a federal system in Canada creates an important additional issue in the field of regulatory activity -- the potential for duplication in government intervention. There is significant overlap in several areas of federal and provincial control of the chemical industry. This overlap has both costs and benefits. Industry has complained of what it perceives as "leap-frogging" regulations by both levels of government in an attempt to gain primacy in the field of environmental control. While this situation introduces some uncertainty into the decision making process and increases the level of transaction costs, there are strong reasons for the presence of both levels of government in this area.

Provincial goverments are able to make some allowances for distinctive local conditions in the setting of regulations. The activity of the federal government should complement the provincial role by guaranteeing that certain minimum standards are achieved nation-wide and by averting a process of balkanization and competitive bidding for industry at the expense of environmental integrity.

If the U.S. experience is applied conservatively to Canada, it can be concluded that, at this time, the total social benefits from regulation exceed the costs. Nevertheless, there is a concomitant need to rationalize the system of regulatory control to increase its efficacy and flexibility.

Our analysis proposes marginal modifications to the system in two critical areas to minimize the risks of over regulation or under protection: (i) the role of information generation, evaluation and use; and (ii) the legal and institutional structure of the decision making process -- including the role of public participation, the rights and responsibilities of industry, government and the general public, and mechanisms to facilitate and rationalize the decision making process.

Introduction

This paper reports on work conducted by the Regulation of Toxic Chemicals Study Group as part of a sequence of research projects on environmental regulation in Canada. These projects were initiated and supported by the Economic Council of Canada as part of its Regulation Reference. The Reference originated at the meeting of First Ministers, February 13-15, 1980. The Communique issued at the end of the meeting said, in part:

> The burden of government regulation on the private sector should be reduced and the burden of overlapping federal and provincial jurisdictions should be eliminated. Procedures will be instituted to review the effects of regulatory action on jobs and costs.

This report consists of two parts and two appendices. Part I is a summary of the environmental regulatory system and its impact upon the chemical industry in Canada. The assessment of costs and benefits of the regulatory system, and analysis of the consequences of its structure and decision processes, lead to prescriptions for some practical changes in public policies. These are reported in the concluding sections of Part I.

Part II consists of the detailed background analysis that leads to the observations and prescriptions reported in Part I. There are three policy themes which receive special attention. A paper is devoted to each theme. The first paper considers the problems and policies of information acquisition and use for regulation of chemicals in the environment. The problems of uncertainty which face regulators of chemicals are of a magnitude several orders larger than the uncertainty facing regulators of "classical" air and water pollution. This "information poor" environment requires, on the one hand, effective utilization of existing information and efficient targeting of investments in research while, on the other hand, judgments about ranges of risks that society must take and uncertainties it should absorb. Structures and processes of decision making assume a particular importance in an "information poor" environment.

The second paper focuses upon the legal and institutional framework for regulation. This paper assesses the impact of the framework and its dynamics in terms of its tendency to produce "over" or "under" protection, and the system's vulnerability to duplication of effort and inconsistencies of action. Needs to improve the instruments of accountability of regulation-making and to strengthen the decision support system are identified.

The third paper assesses regulation-making methodologies. The paper observes the need to evaluate the costs and benefits of regulatory intervention. It explores existing data concerning costs and benefits of environmental regulation with the chemical industry as a focus. This paper utilizes available information from the United States and new information collected as part of the research project in Canada to estimate the direct costs of environmental regulation to the chemical industry and indirect costs to society (e.g. balance of payments, investment, employment, etc.)

The appendix summarizes the judgments of the chemical industry, environmental regulators and public interest groups in Canada on preferences among standard setting principles, enforcement strategies, information diffusion, confidentiality policies and decision making processes. This appendix is based upon a survey conducted as part of this study.

Part I: Report on Regulation of Toxic Chemicals in the Environment

The development of our modern, industrialized system has produced a broad range of social and economic benefits. Included among these benefits is the creation of chemical compounds that facilitate and indeed make possible many contemporary human activities.

The realization of such benefits, however, is not without cost. Many chemicals and their byproducts have a significant ecological impact. Recent research has demonstrated that the release of certain chemicals into man's environment can lead to the production of cancer, birth defects, genetic damage and a range of acute and chronic diseases.

The central question which our economic and political systems must address then, is what exposure to chemicals in the environment is socially acceptable. The determination of this optimal level of production is a complex issue, as it encounters some of the most important problems associated with the process of social decision making. Foremost among these problems are questions of information, uncertainty, and the need for rational decision making on issues which require value judgments.

Information on the effect of chemicals on human health and the general biological and physical environment is both difficult and expensive to gather. Long latency periods, sub-clinical effects, selective impacts and irreversibilities are all problems which compound the difficulty of identifying and rectifying chemical-induced biological damage. A significant proportion of the uncertainty concerning such impacts cannot be easily or inexpensively reduced by current methods of scientific research. As such, it is often necessary for society to make judgments on the basis of incomplete information.

Another major problem which attends the use of chemical compounds is the imbalanced distribution of social costs and benefits. The existence of negative externalities precludes sole reliance on the free market system as a regulator of chemical production in our society.

The complex and uncertain effects of chemical contaminants and the inability of the market to account for social costs and social benefits present a strong case for a government presence. The challenge facing policy analysts and government decision makers in the area of chemical control is to determine the appropriate structure and extent of governmental regulation. This task can be achieved only by a detailed examination of the costs and burdens that regulation impose on industry and the benefits that accrue to society from the regulatory process. As in most important social issues, the identification of regulatory costs is a far easier task than the identification of benefits. This does not preclude, however, the essential effort to delineate potential benefits as clearly as possible.

Our research indicates that the total burden on the chemical industry from environmental regulation is not excessive or unduly onerous. At least two qualifications to this conclusion are required. First, the chemical industry in Canada is diverse and marked by variations in corporate size, technologies and breadth of product line. The distribution of regulatory impact is consequently unequal. It appears that smaller producers may be affected more seriously by regulatory requirements which squeeze profit margins and impose proportionately larger transaction costs on companies of limited size. Differences in technologies and product lines imply selective vulnerability to particular regulations depending on the mix of compounds used in production and the ease of substitutability. Second, environmental controls are only one of numerous government regulations faced by chemical producers. An estimate of the regulatory burden must therefore consider total costs imposed on industry.

On the basis of our analysis of costs provided by chemical companies, we estimate the average operating costs for pollution abatement in the chemical industry (as a percentage of net income) to be in the range of 5 - 10 percent. [See Part II, Paper 3]. The average percentage of capital investment that can be attributed to demands of environmental protection is estimated to be in the range of about 6 - 9 percent. However, some of this investment may prove, in hindsight, to be of direct economic benefit to the industry as well as being socially beneficial. In total, the cost of environmental regulation represents approximately 0.25 - 1.0 percent of product revenue.

Expenditures on information acquisition concerning the toxicity of chemicals are about 4 percent of the resources available for data acquisition in the United States. Since little research and development on new chemicals is conducted in Canada, most of the costs associated with pre-market notification accrue to "foreign parent companies" which develop the chemicals.*

A significant problem which has not been addressed fully in past expenditures on environmental protection is waste management. In the next few years, significant investment in disposal facilities and technological redesign to deal with toxic chemical wastes is anticipated. The extent of the expected burden of waste disposal upon industry will depend on the approach taken by provincial governments with respect to the management of waste disposal on land. Higher future costs are also anticipated to accrue from expected federal and provincial regulation of the transportation of hazardous materials.

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* One should note, however, that many parent companies do charge their subsidiaries royalties which reflect part of these costs.

Our study indicates that a majority of companies consider that a relaxation of environmental regulation would have an insignificant impact on industry R&D budgets, exports, product prices, sales volume, profits and competition from foreign manufacturers. [For details, see Part II, Paper 3].

The existence of a federal system in Canada creates an important additional issue in the field of regulatory activity -- the potential for duplication in government intervention. There is significant overlap in several areas of federal and provincial control of the chemical industry. This overlap has both costs and benefits. Industry has complained of what it perceives as "leap-frogging" regulations by both levels of government in an attempt to gain primacy in the field of environmental control. While this situation introduces some uncertainty into the decision making process and increases the level of transaction costs, there are strong reasons for the presence of both levels of government in this area.

Provincial governments are able to make some allowances for distinctive local conditions in the setting of regulations. The activity of the federal government should complement the provincial role by guaranteeing that certain minimum standards are achieved nation-wide and by averting a process of balkanization and competitive bidding for industry at the expense of environmental integrity. It should be stated that the consultative process between industry and government in Canada for the formation of environmental regulations tends to moderate potential costs associated with multi-level government decision making.

While the benefits from chemical regulation are more difficult to quantify than the direct costs to industry, they are no less important and include improvements in human health, animal and plant productivity, material survival and aesthetic values. The value of benefits in Canada is much more uncertain than in the United States since few studies have been conducted in this country to estimate national benefits of improvements in environmental quality. Without these figures, it is necessary to rely on U.S. estimates of benefits from pollution control. There appear to be pronounced similarities in the patterns of regulatory costs and benefits between the two countries. If the U.S. experience is applied conservatively to Canada, it can be concluded that, at this time, the total social benefits from regulation exceed the costs. Nevertheless, there is a concomitant need to rationalize our system of regulatory control to increase its efficacy and flexibility. Significantly increased social benefits can be achieved by a reallocation of regulatory efforts.

While it is possible to make observations and formulate policy conclusions and recommendations concerning the current regulatory situation in Canada, it is also necessary to go beyond this type of static analysis and conduct a detailed examination of the dynamics of the structure and functioning of the regulatory process in order to anticipate the future pattern of costs and benefits.

The British North America Act of 1867 provides the demarcation of federal and provincial jurisdictions. Environment, as a general field, was not covered by the BNA Act. In many instances, environmental management problems lie within the jurisdiction of both levels of government, each of which view it from a different perspective. This difference in perspective in overlapping areas of jurisdiction may lead to inconsistencies in the law and its application. The existence of overlapping jurisdictions, therefore, necessitates effective measures of coordination to avoid conflicts, duplication and unnecessary administrative burdens upon those affected by the law.

Coordination is achieved in Canada through both formal and informal means. The formal means consist of inter-governmental accords which establish the roles of the federal and provincial governments with respect to regulation making and enforcement. The major informal mechanism is the consultative process employed by the federal government in regulation making. The process of consultation involves the establishment of task forces composed of representatives from provincial governments and federal departments. The deliberations of these task forces facilitate the flow of information between the two levels of government, reducing the likelihood of inconsistencies in regulations.

The major perceived role of the federal government in the field of environmental protection includes: (1) the development and provision of technological know-how; (2) the standardization and coordination of regulations in Canada by developing national guidelines, introducing base-line standards through regulations (to prevent pollution havens), and disseminating information; and (3) the management of problem areas involving interprovincial or international matters.

Provincial governments are oriented toward the adaptive management of the environment based upon local conditions. The provincial legislative models, therefore, favour control schemes which utilize systems of site-specific permits or approvals to regulate discharges of contaminants into air, water or land.

Legislation provides only a framework which shapes the dynamics of regulation. Much of the specific content of regulation in Canada is developed through the exercise of delegated powers by the bureaucracy in charge. The dynamics of regulation are also affected by the institutional and procedural framework which guides regulation-making in general, and by the special characteristics of the environmental political arena, i.e. the network of personal interactions and the political economy which underlie the decision processes concerning regulation.

Among the procedures which may have an important constraining effect upon the proliferation of federal regulations is the Socio-Economic Impact Analysis (SEIA). This procedure is required of those federal departments introducing "major" new regulations in the domains of Health, Safety and Fairness. The SEIA provides a model for other governments of a process which increases the accountability of regulators. The SEIA policy indicates the need to apply risk-benefit, or at least cost-benefit, analysis in the process of regulation making. However, in those instances where the policy has been implemented in the field of environmental protection, only a cost-effectiveness analysis has been employed. This was principally the result of a lack of adequate information concerning the expected benefits of proposed regulations.

The political and bureaucratic environmental arena is characterized by a struggle to control the locus of decision making. The means of this struggle may be expansion in the "productivity" of executives of different governments in terms of regulation output. The tempering forces in the political arena include defensive actions by both industry and governments to protect other (non-environmental) objectives.

The funding of regulation activities concerned with environmental protection is highly constrained and shrinking in real terms. The following attributes of the current system can be identified:

(1) generally, environmental regulation making in Canada is based

upon consensus reached through negotiation with industry. Evidence suggests that the chemical producers have effectively utilized the channels for industrial participation to modify many proposals for regulations which could have had a negative and sometimes unnecessary impact upon the industry;

(2) the regulatory process leaves great areas of discretion in the hands of government executives. Discretion, well exercised, implies flexibility. Discretion, poorly managed, however, may lead to arbitrariness. Though the system provides many channels of appeal, the openness of the system is a source of burden -- the burden of uncertainty; and

(3) there is a tendency in the system for regulatory "spill-over" and competitive acceleration in the production of regulations. The formal mechanisms and policies of some governments encourage this process.

The influence of U.S. regulation through informal contacts of executives and through joint commissions and the production of information is intense. In some cases (e.g. the regulation of beryllium), Canadian regulators resisted the introduction of U.S. regulations which did not meet our national needs. In terms of regulation priorities, however, it is clear that Canada can benefit from the influence of the United States which has massive resources available for research and development in the field of regulation.

The record of Canadian regulation making and implementation reveals that, so far, the regulatory process is perhaps less stringent than in the United States. However, in spite of flexible compliance schedules, the final environmental protection standards achieved through regulation in Canada are frequently no lower than those achieved under similar geographical and ecological conditions in the United States.

The restricted resource base for the development and implementation of environmental regulations in Canada forces the federal and provincial governments to seek industrial cooperation. This reliance on cooperation is a force which moderates regulation. Shifts in public priorities toward economic and resource goals and ideological pressures for deregulation have led to a further dampening of regulation growth in the environmental field. Much of the pressure to deregulate has resulted, however, not in relaxed standards but in the elimination of unnecessary irritants. Generally, efforts to deregulate are focused upon a reduction of red tape, integration of services (e.g. "one-stop" regulatory shopping) and the introduction of some form of impact accounting to the process of regulation making.

The efficacy of the system is measured not only by the quality of its rule making process but also by the degree to which it can achieve compliance with its rules. This compliance can be gained through persuasion and/or coercion. The Canadian system, to a great extent, promotes voluntary compliance. The major vehicle in this process is consultation between government and industry throughout the regulation-making and implementation phases. The cooperative (as opposed to adversarial) mode of interaction usually leads to mutual understanding between regulators and industrial executives. This process of co-optation through participation promotes, to a certain degree, adoption of the norms of social responsibility within the industry. Participation not only reduces resistance to regulation, but also ensures feasibility of implementation and a more accurate flow of information to expand the regulation and technological options available to industry.

The formal effort to disseminate information concerning environmental regulation is limited by the small budgets allocated for such activities. Therefore, an important "educational" role is performed by trade associations and their technical committees. Though the prime role of these associations is the advancement of industry interests, they also serve as an excellent channel of information between government and industry. Canadian unions and public interest groups, on the other hand, have played a relatively insignificant role in promoting compliance with environmental regulations. Most unions have, as their natural focus, the plant environment rather than the larger external environment. Public interest groups in Canada have tended to focus their activities on influencing the regulation making process rather than on day-to-day environmental surveillance. Without government financing, this limited role of public interest groups will prevail in the future.

The pool of resources for environmental regulation "enforcement" in Canada is shallow and is likely to remain so. General public concerns about excessive bureaucratic growth will constrain the pool of resources dedicated to enforcement of environmental regulation. This means selective enforcement efforts.

The discretion and selectivity which are exercised in the enforcement of regulation frequently create uncertainty. This uncertainty often leads to feelings of victimization on the part of industry and the perception that power is used arbitrarily. These negative perceptions and feelings are minimized when enforcement practices emphasize openness and communication with affected parties. Equity and reason are, therefore, two principles of effective enforcement policy.

To conclude, the Canadian system is in an equilibrium of checks and balances producing environmental regulation at a moderate pace. The system enjoys, however, a large degree of flexibility which will permit it to respond swiftly to new demands for regulation. This flexibility is a source of uncertainty and, in industry's view, may leave the system susceptible to "over" regulation resulting from power strategies of participating governments.

Our analysis proposes marginal modifications to the system in two critical areas to minimize the risks of over regulation or under protection: (i) the role of information generation, evaluation and use; and (ii) the legal and institutional structure of the decision making process -- including the role of public participation, the rights and responsibilities of industry, government and the general public, and mechanisms to facilitate and rationalize the decision making process.

PRESCRIPTIONS

Information, Generation, Evaluation and Use

(1) Full utilization of available information about chemicals requires the establishment of a network which interconnects the many existing information systems to permit efficient retrieval. The network must be augmented by groups of experts to facilitate processing and integration of data. These groups should be equipped with a decision support system to reduce biases in assessment. Organizational mechanisms such as science courts or mediation boards should be established to evaluate quality and validity of information inputs in order to resolve questions which are largely technical.

(2) Standardized protocols of testing and other data acquisition procedures should be developed to permit the collection of consistent and comparable information. Monitoring programs should be established as part of the network to provide early warning of potential environ-

mental threats and permit accumulation of experience through quasi-experiments. For example, a quasi-experiment could include changes in the use of compounds as experimental interventions in what have been called interrupted time-series designs.

(3) A multi-tier system of information acquisition should be implemented which is based on the criterion of maximizing the expected net value of information. Such factors as level of exposure, persistence, suspected adverse impacts, perceived benefits of a chemical, and control possibilities offered by better information would simultaneously form the basis for movement upwards in the tiers. Formal criteria should be tempered by the employment of discretion to permit recognition of individual characteristics of compounds and their patterns of use.

(4) Since many of the questions of information interpretation and acquisition are questions of values, forums for public participation should be established. A communication strategy should be implemented with the objectives of providing information, triggering value identification and opinion formation processes, and improving societal abilities to process risk information. Since so little is known about the optimal formats for information diffusion and public participation, it is necessary to experiment with a diversity of techniques in order to find those formats which lead to societal consensus without inhibiting technical progress or taking irreversible and unwarranted risks.

(5) Movement toward an informed society requires openness in information systems. To ensure the integrity of information collection and preservation of rights, the confidentiality of valuable information must be secured and compensation provided for economically valuable

information that may be released without authorization. Mechanisms for the release of confidential information in the public interest should insure that the rights of all parties involved receive adequate protection. Where risks are imposed on a population, society has the right to be informed. This right implies an obligation on those who are the sources of risks to ensure that those who are exposed, or may be exposed, to such risks are kept fully informed. Only with these safeguards will each member of society be able to make intelligent and informed decisions on matters of importance and concern to all.

(6) Recent attempts to broaden the consultative process to include representatives of public interest groups seem to arouse little antagonism on the part of industry. However, resources at the disposal of public interest groups in Canada are small and limit their effectiveness both in representing and providing information to the public. Since there is some objection to direct governmental financial support of interest groups, a first step to ensure information flow would be to establish independent chemical risk and benefit information resource centers with tripartite advisory boards representing governments, industry and public interest groups. The financing of these centers must ensure their independence from external pressures on particular issues.

(7) The Canadian information strategy must differ from a U.S. strategy not only because the political and social traditions and structures are different in Canada, but also because of smaller population size and more limited resources. Canada cannot invest the resources on the scale contemplated by the United States in order to improve the information base on chemical risks. Thus, Canada, to a certain degree,

will continue to depend on the United States for information services. In light of the differences between the two countries, however, not all the information which is relevant to decision making in the United States is relevant to Canada. There is a resulting need to filter information obtained from the United States and to adjust it to reflect Canadian conditions. This would supplement local data collection required for decision making. One must also consider the impact of unintended information spillovers which may misinform the public and some decision makers. The intense exposure to U.S. mass-media, and the misperceptions it may induce, must be corrected by appropriate counter-information which explains differences in conditions and values between the two countries (as well as pointing out similarities) and their implications for the management of chemicals in the environment. The locus of such activities should be the proposed tripartite information resource centers. In sum, Canada can profit from the information and expertise of other countries but, ultimately, the regulation of toxic chemicals in Canada must be based on Canadian problems and values.

The Legal and Institutional Structure

To reduce the costs of system flexibility and discretion, while maintaining their important benefits, the following prescriptions are proposed:

(8) the establishment of appeal boards independent of the administering agency responsible for regulation in order to review public and industry complaints with respect to regulation and enforcement. These boards should act as mediators/adjudicators to reduce transaction costs and to act as complements to judicial or quasi-judicial processes of appeal;

(9) a broadening of the consultative process to include informed

public participation. The proceedings should be opened to reduce public perceptions of arbitrariness. Lead times in the consultative process should be increased to permit better preparation of inputs from the public or industry;

(10) a strengthening of regulation review procedures. In particular, sufficient resources should be allocated to conduct proper impact analysis of regulation. Impact analysis should be used to screen both regulations and guidelines since guidelines often are internalized as regulations;

(11) an improvement in the rationality of the process by the development of better information bases for decision making as well as by development of a decision support system (e.g. risk/cost/benefit methodologies); and

(12) a broadening of the application of the Canadian consultative process model to include international commissions (e.g. the International Joint Commission).

To reduce the costs of system overlap, the following prescriptions are suggested:

(13) the development of inter-agency (provincial-federal) permanent coordination committees for regulation making. These committees should screen proposals for regulations by federal and provincial governments in their initial stages of development and coordinate information acquisition and dissemination efforts to reduce the paper burden resulting from duplication;

(14) the improvement of the division of labour between the federal government and the provinces to ensure that federal regulations are set at levels

high enough to prevent the formation of pollution havens, yet low enough to allow the provinces to adaptively manage their environments. The role of the federal government as a source of expertise and technology should be strengthened by appropriating additional resources for research and development activities in the field of environmental protection; and

(15) the development of regional "one-stop shopping centers" for environmental regulation information, permits, etc.

Issues of Costs and Benefits

(16) The system of regulation making which constrains emissions from particular sources without permitting trade-offs is inherently less efficient than a system which ensures global attainment of objectives while permitting trade-offs in means. Technology-based criteria for standard making (e.g. "best practicable technology") tend to de-emphasize the need to balance social costs and benefits; rather, they focus on what is feasible and not necessarily on what is optimal. Technology-based standards, however, can be reasonable applied when dealing with persistent chemicals which cannot be assimilated and detoxified by the environment even when concentration are low.

(17) An analysis of cost-effectiveness is a first step toward improved regulation making. This type of analysis provides a means for improving the implementation of given objectives. However, analysis of cost-effectiveness should always be accompanied by a statement which justifies the chosen targets.

(18) A cost-benefit analysis provides an examination not only of the means to attain environmental objectives but also of the objectives themselves. In spite of the inadequate state of the art of environmental

cost-benefit analysis, attempts should be made to conduct such analyses when developing regulations. The initial role of such analyses will be to ensure that adequate consideration is given to the benefits of actions in relation to their costs. It is recommended that sufficient resources be devoted to research into the benefits of improved environmental quality and the costs of environmental regulation in order to develop a suitable information base. Without adequate information, decisions concerning regulation will tend to be more a reflection of the political balance of power in Canada and of environmental regulation in the United States than of the calculus of social costs and benefits.

(19) Our analysis also indicates, with respect to pre-market screening of new chemicals, that risk-benefit analysis is potentially useful as a means of identifying reasonable limits on risks. Explicit identification of assumptions about values and consequences is necessary to ensure the integrity of the process and reduce potential occurrences of costly responses in those instances where public alarm is unwarranted. It should be noted, when dealing with uncertainty, that the realm of facts and values cannot be separated. The issue of what is information becomes a policy question, not a question of science. Research concerning values in environmental decision making is a neglected facet of environmental protection research and should be initiated.

In summary, more complete information and an improved framework for decision making can result in better regulation. Adequate methodologies and information are necessary but not sufficient conditions for optimal regulation. Like other decision aids in the political arena, these methodologies are subject to manipulation. Consequently, an informed, interested and vigilant public is an essential ingredient to assure better regulations.

Conclusion

The system of environmental regulation making in Canada is sound but can be strengthened. Certain provisions for improved coordination and checks against arbitrariness have been proposed to improve its operation and to reduce the chance of malfunctions. These changes will not necessarily reduce claims of over-regulation by those who pay and under protection by those who benefit. The Canadian system permits a process of flexible, joint decision making, but the quality of this process, as with any other, depends on the calibre of the participants and the information at their disposal. The best assurance of good decisions is having good decision makers.

PART II

PAPER 1

An Adaptive Information Policy for Management of Chemical Risks in the Environment

I. Introduction

Over four million chemical substances have been identified. Of these, more than seventy thousand substances are in common commercial use (Weinstein, 1979) and their number is growing by more than a thousand substances a year. There is little information about chemical pathways through the environment or the consequences to man of most chemicals currently in use. The process of obtaining new data is expensive and is constrained by resource availabilities. Furthermore, the process of transforming data into the kinds of information which can improve the ability of society and individuals to manage their resources is not well understood and is a source of conflicts.

The main purpose of this paper is to assess alternative processes of data acquisition and information generation as they apply to societal efforts to promote the beneficial use of chemicals while reducing the risks which accrue to man and the environment.

The analysis begins with a reference to a theoretical model of rational choice that prescribes information acquisition and processing strategies so as to maximize the net economic value of information. The model provides a useful framework for analysis and articulation of the role of human values in the determination of guidelines for an information policy. The paper then examines the ways in which the model deviates from reality. Since this paper is particularly concerned with chemicals, types of information relevant to the management of chemicals in the environment are discussed at length. Weaknesses inherent in the processes of collection and interpretation of data are identified and alternatives to rectify them are proposed. The paper next explores the linkages between the information system and policy making. The analysis focuses upon two major problem areas of information policy: (1) institutional arrangements for conflict resolution in interpreting data; and (2) the management of information diffusion in view of the reactive nature of information (i.e. the effect of information exposure patterns on values). The paper concludes with an outline of a dynamic, adaptive information strategy for managing chemicals.

II. An Information Value Maximization Model

The classic microeconomic model of rational decision making assumes that decision makers have complete knowledge of all feasible options and the consequences of each option. Furthermore, the model assumes that decision makers have unlimited ability to compare options and that this process of comparison is costless. Rational choice is value maximizing. "The rational agent selects the alternative whose consequences rank highest in terms of his goals and objectives" (Allison, 1971, p. 37). This theoretical perspective identifies classes of information required for policy formation:

(1) the feasible management options,

(2) the consequences of each option, and

(3) the statement of societal objectives and goals.

The options for managing chemicals range from probibiting the production of certain chemicals at one extreme to a laissez faire market at the other.

The environmental consequences of chemicals depend upon the management regime, life styles, natural forces and inherent chemical properties which influence the pathways through the ecosystem. To define the relevant consequences, one must examine the objectives of society. This is not an easy or necessarily fruitful path of analysis since the mere definition of objectives introduces assumptions about values. Without actually obtaining a detailed statement of objectives, however, one can still identify some basic goal dimensions which tend to be broadly recognized:

(1) human health (e.g. mortality, morbidity);

(2) quality of life (e.g. economic impact, distributive impact);

(3) resource conservation (e.g. the preservation of the natural environment, and conservation of non-renewable and renewable resources); and

(4) national security.

The number of attributes for each dimension is large and unmanageable. Thus, it is necessary to reduce the number of attributes to those most relevant for choice. How should this be done? What appears on the surface to be a technical question is, in fact, a question of value judgment. For example, Burton and Whyte (1978) list the following direct consequences of risks to human health: premature death of many individuals; premature death of a particular individual; severe, acute illness as major disability; chronic, debilitating disease; minor disability; temporary, minor illness; discomfort; behavioral changes; temporary, emotional effects and discomfort; temporary, emotional effects and minor physiological change. Consider the category of minor physiological changes. It is known, for example, that lead levels below 100 micrograms per 100 ml. of whole blood do not cause clinical anaemia, but lead affects the activity of ALA dehydrase in the hemoglobin chain (Hernberg, 1972). In at least one country, the U.S.S.R., this is considered to have significant impact upon health, while in Canada it is not (Burton and Whyte, 1978). This is a value judgment although it may superficially appear to be purely technical in nature. Even when there is agreement on the importance of a particular category, such as mortality rates, the level of spatial and temporal aggregation used in deriving the attribute indexes depends upon value judgements. Is, for example, the catastrophic and sudden loss of half the people in a small village similar qualitatively to the death of the same number of people over a longer period of time such as a year?

The problem becomes even more complex when one recognizes the interdependencies among attributes of health. A reduction in the prevalence and severity of acute diseases leads not only to longer life expectancies, but also to a higher prevalence of chronic diseases.

The rational choice model, as mentioned, assumes complete and free information about the options and consequences. In contrast, information in most spheres of policy making is neither complete nor free. The rational model can be extended to consider strategies for information acquisition when the strategies themselves are subject to constraints of feasibility and impose demands on societal resources. This involves calculating the value of additional information. The theory concerning the economic value of information (Marschak, 1971) is based upon a simple principle: one acquires information up to the point where its marginal utility equals its marginal cost. To evaluate the marginal utility of information, one must assess the additional net benefits which accrue from improved knowledge. If the decision rule is insensitive to the additional information, then this information is without value. If, for example, it is known in advance that a decision rule excludes banning peanuts, whatever the toxicological studies of Aflatoxin in peanuts may reveal, these studies impose unnecessary costs upon the system.

In order to measure the value of additional information, one should use probabilities of events to compute the difference between expected payoffs of a decision made with information and without it. By way of example, consider a chemical suspected of being toxic. Current information derived from toxicity studies of chemicals with similar structures may assign a probability of 0.2 that the chemical is toxic and will cause $200 billion damage to the environment; yet the chemical contributes $10 billion to the economy. What then is the value of research that will determine with probability of 0.9 the correct impact of the chemical? Without research, the chemical will be banned and the contribution to the economy lost. With research, however, the chemical is banned if pronounced toxic or cleared for use if it gets a clean bill of health. Since there are four possible states of the world, the expected payoff of this strategy is:

- (0.2) (0.9) $0 billion	-	(0.2) (0.1) ($200-10 billion)	+	(0.8) (0.9) ($10 billion)
The chemical is toxic and research pronounces it as toxic. (Chemical is banned)		The chemical is toxic but research gives it a clean bill of health. (Chemical is produced)		The chemical is not toxic and it gets a clean bill of health. (Chemical is produced)
- (0.8) (0.1) ($0 billion)	=	$11 billion.		
The chemical is not toxic but is pronounced toxic. (Chemical is banned).				

The value of the information of the toxicological research in our example is 11 billion dollars.

The practical problems in developing research strategies such as the one above lie in identifying the costs and benefits of different strategies of management and agreeing upon the prior probabilities of risks, as well as the appropriate revisions of probabilities which should take place when the research is completed.

We turn now to an assessment of the types of information available concerning the management of chemicals in the environment as inputs to a rational decision making model.

III. Information Needs and Availabilities: From Inherent Chemical Characteristics to Human Values

A. Chemical and Environmental Characteristics

Baseline information to assess the potential path of a chemical in the environment is provided by data about the inherent physical properties of the chemical. Under the Toxic Substances Control Act (TSCA), the United States Environmental Protection Agency chose to characterize the environmental mobility and persistence of a chemical by parameters describing: water solubility, absorption, desorption, volatility, photochemical, chemical and biological degradation, and other physical and chemical attributes including a partition coefficient. These data can be used in detailed models of the environment to determine the expected path of the chemical once it is introduced. Some of these data can be used to choose candidates for further testing. For example, those chemicals which are soluble and persistent are more likely, *ceteris paribus*, to cause damage in the long run than chemicals which are not soluble (and therefore less mobile) or chemicals which are subject to fast degradation and impose only a temporary and non-cumulative threat.

The behavior of a chemical and its concentration in any geosphere depends on its properties and the particular characteristics of the geosphere (National Academy of Science, 1975).

The three main factors affecting entry into the air and transport of chemicals through it are vapour pressure, heat of vapourization and the partition coefficient between the atmosphere and another medium, and the characteristics of air flow (National Academy of Science, 1975). In order to predict the probable path and fate of a chemical, knowledge of the rate of exchange between the atmosphere and other geospheres is essential.

An important factor influencing the rate of chemical entry into the atmosphere from the soil is the presence of moisture. For example, DDT, evaporates more quickly in damp soil (Acree et al., 1963; Freed et al., 1962). Additional factors mediating the influence of vapour pressure are temperature, humidity, pH, and other physical properties of the chemical. High molecular weight, for example, tends to limit the dispersal of molecules in the atmosphere. Other chemical properties having atmospheric implications are crystal structure, light sensitivity, ring structures and multiple bonds (National Academy of Science, 1975).

The crystal structure of chemicals can have major indirect effects on weather. Many chemicals, depending on light sensitivity and structure, are susceptible to photochemical oxidation. Those chemicals containing oxygen, hydrogen or halogens can interact with ultraviolet light to form smog. Other chemicals contributing to smog are those with double bonds, aromatic and hetrocyclic rings, or especially strained 3, 4, or 7-member rings.

Factors which affect solubility and stability are pH and temperature. For example, triazine solubility is an inverse function of pH (Ward and Weber, 1968). Temperature has the opposite effect, causing an increase in the solubility of many chemicals as it rises. Polarity, molecular weight and vapour pressure have a similar effect on the mobility of the compound in water as in air.

The major influencing factors on chemicals in the soil are absorption and leaching. Strongly ionic chemicals such as inorganic salts or organic cations tend to be absorbed onto clay soil through an exchange mechanism making them less mobile than neutral organics absorbed from an aqueous solution through a physical process. Absorption is inversely related to solubility and to leaching. As absorption increases, leaching decreases.

The path of a chemical in the environment may be affected by its interaction with the biotic system. One must consider interactions with microorganisms, particularly through processes of synthesis and degradation. Of special importance is the ability of organisms to reduce or oxidize heavy metals, since the new valence states may be more toxic.

The degree of lipid solubility of a chemical is important in the identification of the potential for bio-accumulation. High degrees of lipid solubility cause a chemical to concentrate in fat tissue, thus raising the exposure to a chemical above the environmental level.

The Report of the National Academy of Science (1975, pp. 56-57) concludes that, "on the basis of existing knowledge, it is generally possible for microbiologists, biochemists and chemists working together to determine metabolic sequences for both natural and totally synthetic compounds and to identify those that may pose environmental problems". Base line information prescribed by NAS covers: oxidation; reduction; hydrolysis;

alkylation and dealkylation; conjugation with metabolites such as amino acids, polypeptides or saccharides; and the rates and extent of reactions. Basic characteristics of a chemical must also be known, including: melting and boiling points; decomposition temperature; flash point; natural physical state; vapour pressure; and crystalline form. Finally, for the monitoring and testing of micro amounts of chemicals, absorption spectra must also be known.

These data are useful in identifying the path of chemicals after introduction to the environment. Knowledge of the interaction of chemicals with man is essential for analyzing the ways in which a chemical is introduced to the environment as well as patterns of human exposure to the chemical. Information about production and marketing processes and quantities provide another element in identifying the potential impacts of a chemical upon man and his environment. In developing a list of candidate chemicals for further information gathering, the TSCA Interagency Testing Committee considers exposure data (production volume, environmental release, occupational exposure, and non-occupational human exposure) as the criterion of highest importance.

Since commercial chemicals are rarely pure and impurities can have a significant impact on chemical and toxic behaviour, these impurities must be considered explicitly. Foreign matter introduced through handling, storage or transportation, the residues of reactants and solvents, or the products of side reactions are all probable contaminants of industrial chemicals. In fact, they may be more dangerous than the principal chemical. Tetrachloro-p-dibenzodioxin in the pesticide 2,4,5-T is, for example, far more toxic than the pesticide itself (Wilson, 1971). Information about chemical production and marketing is therefore an essential element of the rational assessment model.

There are some problems in obtaining and processing information concerning the production, marketing and end-use of chemicals. In particular, problems may result from the need to protect trade secrets and other confidential economic data. The major difficulty in assessing the interaction between man and chemicals, however, lies in the high variance of life styles, and individual differences in behavior. Furthermore, life style and behavioral changes occur continuously, introducing an element of uncertainty which is difficult to quantify.

B. Information about Health Impacts

Information on impacts of chemicals upon the biological environment and health is probably the most difficult, and therefore expensive, to obtain directly. Harmful effects may be immediate and visible or they may be latent and long term. Present methods of information collection "are generally adequate for detecting causes of acute effects that appear soon after exposure, and which are often reversible after the chemical is removed" (National Research Council (U.S.), 1979, p. 5-1). However, information is scarce about the causes of chronic and serious diseases with long latency periods such as cancer. A biological or health problem may appear or persist long after exposure to a triggering agent.

Similarly, information about the long term ecological impact of chemicals is often not available until a system dose threshold is exceeded and irreversible changes have already occurred. Another complicating factor in assessing consequences to human health and the environment is the potential for synergistic and antagonistic interactions among different chemicals. Some chemicals may initiate cancer by inducing mutation in a single cell. In certain other cases, however, for a cell to become malignant, "promotion" appears to be essential - i.e., the promoter may be another chemical agent. "The essential nature of the promotion process is not yet understood" (National Research Council (U.S.), 1979, p. 5-4). The lack of information about the mechanisms through which cancer is induced and promoted constrains the ability to derive a dose-response curve which is needed for determining the appropriate management regime for a particular chemical. The question of what happens after exposure to very low doses of carcinogens is one which leads to intense debate between those who believe carcinogens can be detoxified and those who do not. There is little scientific evidence to support either point of view (Maugh II, 1978). One compromise position suggests that initiation is irreversible, but that many of the events that occur during promotion and before the appearance of a cancer are reversible (National Research Council (U.S.), 1979).

There is evidence currently establishing 26 chemicals as causing cancer in humans. This information is derived mostly from occupational settings (Tomatis *et al.*, 1978). There is further evidence suggesting that 200 chemicals are carcinogenic in at least one animal species. Unfortunately, development of evidence is a time consuming process frequently involving 1/4 to 1/2 of the average life span of the animals. Most of the effort to develop information about the health impacts of chemicals is focused upon four major areas: cancer, birth defects, gene mutation and chronic illnesses. Cancer has received the greatest attention but, as suggested above, information is limited and often of poor quality.

There are three strategies for acquiring more information about the health consequences of exposure to chemicals:

a) epidemiological studies,

b) animal experiments, and

c) short term tests on bacteria or cultured mammalian cells.

Epidemiological studies are based upon comparisons of groups who have been exposed to a substance with control groups who have not. "Differences of interpretation arise over epidemiological studies. Because retrospective epidemiological data often lie on the borderline of statistical significance, how a scientist interprets particular findings often depends on subjective considerations. Moreover, the fact that the result of a retrospective study depends entirely on how the initial test and control cohort are selected means that this highly subjective partition is also subject to dispute among highly qualified scientists ... Indeed, epidemiologists occasionally accuse one another of result oriented research" (McGarity, 1979; pp. 740-41).

Without appropriate experimental designs, the conclusiveness of epidemiological research suffers from a variety of threats to external and internal validity. Since epidemiological studies are longitudinal, it is difficult to control for confounding impacts of irrelevant events occurring during the study. These events include subject mortality due to unrelated causes, population mobility and other time dependent processes. In addition, selection of control and experimental groups is rarely random. Hence, it is almost impossible to extrapolate results to broader populations.

Lilienfeld (1976) suggests that the following criteria can be used to evaluate the quality of information provided by epidemiological studies:

(1) Are the associations among variables strong?

(2) Did other researchers produce similar results?

(3) Are the effects in humans consistent with those discovered in laboratory experiments with animals?

(4) Is the hypothesis of causality consistent with the temporal sequence of events, i.e. did exposure in any particular epidemiological study in fact precede illness?

(5) What is the dose-response gradient? Does an increase in dose lead to an increase in illness? When the cause is removed, does illness diminish or disappear?

Despite their limitations, epidemiological studies are considered the source of best evidence to establish an association between exposure to a substance and a particular human illness. The major practical limitation in obtaining information through epidemiological study is the need for large sample sizes to obtain sufficient statistical significance. Negative results may be a function of small sample sizes rather than an indication that there are no ill effects to humans from chemical exposure. Evaluating epidemiologic studies, Weinstein (1979, p. 347) concludes that: "while these studies will continue to serve a useful, though limited, purpose, the reality is that most of the evidence on carcinogenicity must derive from other than human populations. We can expect epidemiological data to be useful for suggesting hypotheses about associations between chemicals and human concern, but we cannot in general, expect such data to be sufficient to prove the existence or strength of these effects. Furthermore, because of the long latent period of concern, epidemiologic studies are seldom helpful at revealing carcinogenic effects in time to prevent widespread exposure to carcinogens".

There are similarities in the way cells and tissues of lower animals respond to toxic chemicals and the way in which human tissues and cells respond to exposure to the same toxic chemicals. These similarities and the fact that ethical considerations prohibit experiments with human subjects lead to the use of animals in the evaluation of health impacts of chemicals upon man. The advantages of using animals are their short life spans (about two years for rats and mice, the most frequently used animals in bioassays) and the possibility of sacrificing subjects to examine organs and tissues anatomically, pathologically and biochemically. Scientists still debate, however, whether a carcinogenic response in a single rodent species without duplication in another species is a sufficient basis to infer that a chemical poses a carcinogenic risk to man (McGarity, 1979, p. 745).

A commonly accepted testing protocol in the United States is a test of two animal species using 50 animals of each sex at two dosage levels for each species, for a minimum of 300 animals per species per experiment including untreated controls (National Research Council (U.S.), 1979). Such a study would cost between $250,000 and $500,000 and would take up to three years. Several factors limit the validity of inference from animal tests to human health: (1) experiments with animals are conducted with higher doses than occur normally; (2) physiological differences between humans and animals may affect the impact of chemicals; (3) the route of exposure in the laboratory may be basically different from that experienced by man (e.g. exposure by injection in the laboratory as opposed to inhalation by humans); (4) laboratory animals are highly inbred and often are bred selectively so as to increase their response sensitivity. Human populations have a varied genetic makeup and may respond to the chemical differently; and (5) exposure to a single chemical in the laboratory does not account for synergistic effects from the many chemicals which may be encountered in the environment.

There are theoretical problems in transferring the results of dose-response relationships from animals to man. Man is larger, lives longer and has a lower metabolic rate than rodents used in the laboratory. The determination of equivalent dose in humans and animals must take into account these differences. There is no agreement upon the appropriate methodology to achieve this objective. The debate continues between those who assume proportionality of response to body-weight and those who assume proportionality of response to surface area of the species. The Environmental Studies Board of the U.S. National Research Council concluded, after comparing inferences from animal tests and epidemiological studies, "... that it seems reasonable to assume that the life time cancer incidence induced by chronic exposure in humans can be approximated by the life time incidence induced by a similar exposure in laboratory animals, if calculated at the same total dose per body weight" (1979, p. 5-24).

In vitro tests are considered part of a multi-tier information acquisition strategy. These tests investigate genetic mutation, damage and growth transformations in micro-organisms or cultured mammalian cells. They provide a rapid and inexpensive means for screening compounds. Such short term tests vary in cost from several hundred dollars to about ten thousand dollars. These tests assume that chemicals cause changes in DNA (chromosome damage, mutations, etc.) which, in turn, may be correlated with the ability to cause cancer.

Various studies (e.g., McCann *et al.*, 1975; McCann and Ames, 1976; Purchase, Longstaff, and Ashby *et al.*, 1978) have investigated this association between short term tests and inferences about carcinogenicity of compounds based on animal laboratory and epidemiological studies. The correlations found were generally high. For example, McCann et al. (1975) found that 90% of the non-carcinogens were not mutagenic.

It is important to note that there are more than eighty short term tests which are available. Many of these have specialized functions. The use of batteries of tests is therefore recommended if more sensitive screening is desired. However, there is a tradeoff between sensitivity and specificity.

C. Information about Human Behavior and Values

The complexity and uncertainty characterizing information about chemical pathways in the environment and about ecological and health impacts are increased further when one attempts to account for human behavior. Moynihan (1979, p. 17), in attempting to evaluate the quality of information about behavior, posed the following questions about the social sciences: "How good are they? How well do they predict? Have they attained any of the stability that Pound observed in the natural sciences in the early years of the century?" His answer is "that the social sciences are labile in the extreme. What is thought to be settled in one decade is as often as not unsettled in the very next; and even that 'decent interval' is not always observed ..." Even if one does not take the extreme position of Moynihan, it can be shown that the most simple descriptive data about many areas of human activity are not available. Furthermore, the impact of human values upon the development of information in the social sciences is significantly stronger than in the natural sciences.

The complete model of assessment of alternative management regimes for chemicals must recognize present and future responses of people to the introduction of new products and technologies as well as exposure to new information and experiences. Basic social value patterns define constraints in any public choice model and the tradeoffs desired between alternative attributes of the system. Descriptive information about dimensions relevant in evaluating the acceptability of various chemical risks is scarce and of poor quality. There are only a few studies, for example, which attempt to describe the way people evaluate risks to life. Several methodologies have been proposed, ranging from "revealed preferences" obtained by observing behavior (Starr, 1969; Otway and Cohen, 1975) to attitudinal measurement based on questionnaires (Fischhoff *et al.*, 1978). There is a high level of uncertainty with regard to the internal validity of these methodologies of measurement and the generalizability of the limited information now available. It is interesting to note, for example, that replication of the Starr (1969) study by Otway and Cohen (1975) failed to confirm the original study's conclusions. One general observation which is supported by all the studies concerns the reactive nature of values to management regimes. Processes of regulating risks and policies of information diffusion affect public values.

The review of information needed and available for rational decision making reveals that the static, comprehensive, rational model of choice is an unattainable ideal, at least for the foreseeable future.

IV. The Multi-tier Model: The Approximation of Rationality

Identifying the rational model of choice as a myth does not, however, mean that it may not provide a useful framework for formulating an information acquisition strategy.

The model prescribes the economic use of information. A dynamic strategy will therefore involve a multi-tier, information acquisition format. The net expected value of information is maximized at each tier. Probabilities are revised once information is obtained (using Bayes Rule) and a choice is made to acquire information at each stage which is likely to have the highest net expected value. Efforts to develop frameworks for screening tend to focus first upon information which is available; for example, chemical structure. This information is then combined with data which estimates exposure and potential economic value in order to determine the next phase of information acquisition.

By way of example, Stanford Research Institute (SRI) attempted to use structure-activity relationships to assess prior probabilities that a chemical is carcinogenic (Dehn and Helms, 1974). Structure-activity relationships are not sufficient to predict carcinogenicity since very similar chemicals often have substantially different toxicological properties. This kind of analysis, however, may significantly improve the targeting of information acquisition strategies by providing a better *a priori* probability distribution.

One conclusion that can be drawn from the rational model is that there is a loss of information associated with procedures for information processing by regulatory agencies. A typical position is to ignore uncertainty in decision making by using judgmental labels with certainty - for example, a compound is declared a carcinogen or is cleared. In fact, scientists pose issues of interest as hypotheses. Scientists, then accept or reject these hypotheses based on scientific data subject to pre-specified probabilities of error. The probability of rejecting a true hypothesis is usually set at 5%. Government agencies frequently report hypotheses as accepted or rejected without mention of these probabilities. This means loss of information. The Bayesian choice model, concerned more with making better decisions than guaranteeing conclusiveness, uses the full evidence to modify prior probabilities. Judge J. Skelly Wright in his Ethyl Corp. V. EPA opinion has pointed out this facet of scientific processing of information: "Typically, a scientist will not so certify evidence unless the probability of error, by standard statistical measurement, is less than 5%. That is, scientific fact is at least 95% certain. Such certainty has never characterized the judicial or the administrative process. It may be that the 'beyond a reasonable doubt' standard of criminal law demands 95% certainty. But the standard of ordinary civil litigation, a preponderance of the evidence, demands only

51% certainty. A jury may weigh conflicting evidence and certify as adjudicative (although not scientific) fact that which it believes is more likely than not" (Judge J. Skelly Wright quoted in McGarity, 1979, p. 748). The rational choice model prescribes retention of all possible alternatives weighted by the probability that they are correct. In contrast, in adjudication, the choice of one alternative is made at each stage, hence information is lost for subsequent steps in the decision process.

There are several tiered strategies for information collection now in use in different countries. In the prototype, multi-tier system described earlier, information is collected about exposure, production levels, control options and economic, biological and health consequences. The decision rules for transferring a chemical from one information tier to another are rarely formulated explicitly as they depend upon integration of data from diverse dimensions - an integration which requires information about social values or exercise of value judgment.

The EEC scheme is an example where movement among tiers depends to a large extent on production levels. The proposed EEC system of information acquisition suggests the following information for a new chemical before its introduction to commercial use:

(1) the name of the chemical

(2) formula

(3) purity

(4) proposed uses

(5) lists of stabilizers or inhibitors used

(6) methods of analysis

(7) quantities to be produced

(8) emergency storage and handling methods

(9) the lethal dose to half a group of animals (the LD50)

(10) a 28-day exposure study, and tests for skin and eye irritancy and skin sensitization

(11) results of two short term tests (one bacterial and one not)

(12) environmental effects of the chemical (e.g. acute toxicity to fish and Daphnia)

The above information would be required only for compounds which are produced in quantities greater than one ton a year. This threshold was suggested in order to limit the number of chemicals about which notification is required to a manageable level, e.g. 300-400 a year (McGinty, 1979). The EEC scheme of tiers allows safety authorities to demand more sophisticated, complex and expensive toxicological data. The rule for climbing through tiers depends mainly on threshold production levels (10 tonnes a year, 100 tonnes a year, and 1000 tonnes a year or 5000 tonnes cumulative production). The scheme is flexible in its implementation and depends to a large degree upon exercise of judgment by safety authorities. Clearly, positive findings about risks in a lower tier would tend to trigger movement to a higher tier of tests. The use of production alone as a sole index of exposure is subject to strong criticism since there are many cases where this index does not reflect the chemical's exposure intensity to man and the environment. Judgment, exercised properly, can substitute for this index under special circumstances. The prominence, however, of the production index will increase the probability that it will be used frequently without due consideration for its appropriateness.

Decision rules in the United States for tier determination are largely informal. The Chemical Selection Working Group of the National Cancer Institute selects chemicals to be tested under the NCI bioassay program. The committee tends to derive priorities without an explicit, formal rule. The factors which are considered include: proposed or actual production levels and use patterns, chemical structure and existing information concerning health consequences. The U.S. Interagency Testing Committee (ITC) has developed formal rules based upon numerical scales for production volume, quantity release, occupational exposure, and general exposure. These scales, derived independently, are assumed to indicate potential exposure. Chemicals which are first selected on the basis of exposure are then rated according to the likelihood that they pose a carcinogenic risk. Compounds which are identified as likely to pose a risk of cancer are then placed on a short list from which chemicals are chosen informally for further testing. Weinstein (1979, p. 371), commenting on this process of selection, notes that "at no stages in the process are the data on exposure, anticipated risk, and the sensitivity and specificity of the test protocol joined explicitly to derive an overall measure of test information value". He concludes that "while ITC has taken a giant stride toward reasoned priority setting, its procedures are still more lexicographic than balanced; it considers exposure first, likely health risk second, the value of testing third, and control cost only implicitly at the end, if at all".

Almost any current or proposed scheme of information acquisition involves judgment. The size and complexity of problems require judgment concerning selection of relevant elements and assumptions about the boundaries of the referent system for decision making. In most cases, the need to integrate and interpret data derived from different sources and through different methodologies cannot be met solely by the employment of formal information processing models (e.g. computer models). Yet, while judgment is necessary to ensure flexible and effective utilization of data, it poses some serious dangers.

V. Judgment and Informal Processing of Risk Information: Pathologies and Remedies

A. Pathologies

Slovic, Fischhoff and Lichtenstein (1979, p. 38) concluded that "Whatever role judgment plays, its products should be treated with caution. Research not only demonstrates that judgment is fallible, but it shows that the degree of fallibility is often surprisingly great and that faulty beliefs may be held with great confidence".

One can identify two major classes of biases which affect information processing by individuals: (1) those which can be attributed to the bounded rationality of the individual, and (2) those which can be attributed to organizational behavior. Simon (1957) has observed that cognitive limitations force decision makers to construct simplified models in order to cope with a complex world. To simplify mental tasks confronting them, people employ rules of judgment called heuristics. Many of the biases characterizing faulty information processing can be traced to heuristics employed that do not provide a valid approximation to rational processing. Tversky and Kahneman (1971) concluded, after studying scientific reports of psychologists interpreting experimental results, that these scientists tended to interpret results of small samples as if they were large. As a result of this bias (the "belief in the law of small numbers"), scientists ignored the impact of variability upon research results, speculating with high and unmerited confidence about the meanings and generality of the results. Using a sample of undergraduates, Kahneman and Tversky (1972) observed that many people do not understand the basic principle of sampling - decreasing variance as sample size increases. In a paper entitled "On the Psychology of Prediction" (1973), they show that people tend to ignore prior probabilities or base rate information when making predictions, while relying heavily upon descriptive information of dubious relevance to the prediction. For example, subjects were told that someone is a member of a community containing 70 lawyers and 30 engineers and were then provided with descriptive, specific information about his or her hobbies, marital status and age. They were asked to judge the probability that the person is an engineer. Change in the proportion of engineers and lawyers did not affect the subjects' estimated probabilities. The study concluded that people tend to rely on specific information and ignore prior probabilities despite the fact that the rational model implies an influence from prior probabilities even in the presence of highly relevant specific information.

The variance of one's predictions should be sensitive to the quality of information on which the prediction is based. If specific information is less valid, the prediction should be closer to the population central values. People did not follow this principle even when they judged the specific information to be of low validity. Kahneman and Tversky (1973) also found that people tend to have confidence in predictions based on redundant data despite the fact that redundancy adds no further information. Furthermore, they suggested that people do not intelligently incorporate probabilities into their decision making processes. In gambling situations, people accept the basic notion of probability but still display biases while, in non-gambling situations, they frequently do not see the relevance of probabilistic data. If people do understand the relevance of these data, they often do not know how to combine prior probabilities with new observations.

Nisbett et al. (1976, p. 128) suggest that an alternative principle may be at work. Base rate information "is remote, pallid and abstract. In contrast, specific or target case information is vivid, salient and concrete .... The logical pertinence of the base rate information notwithstanding, such information may simply lack the clout to trigger further cognitive work". The authors trace this explanation to Bertrand Russell who suggested that, "popular induction depends upon the emotional interest of the instances not upon their number" (1927, p. 269).

A related source of bias in probabilistic information processing is the bias of availability (Tversky and Kahneman, 1973). People tend to judge probabilities by the ease with which they can imagine an event or recall past instances. This heuristic provides a reasonable approximation since, the more frequently an event occurs, the easier it is to imagine its occurrence or recall its past occurrences. The biases in employing this heuristic stem from the impact of unrelated factors such as publicity, emotional arousal or the occurrence of a recent related event. For example, the death of a president from a rare heart disease will tend to increase the estimate of most people concerning the frequency of the disease for a period of time after the event. The movie The China Syndrome and the accident at Three Mile Island may combine to exaggerate the average probability that some people would now tend to assign to the occurrence of a nuclear disaster. In contrast, selective retention and attention may work to reduce probability assignment. Vertinsky (1979) has discussed several studies which show the tendency of people to forget or avoid unpleasant information.

"Anchoring adjustment" is another source of bias in processing information (Lichtenstein and Slovic, 1971; Tversky and Kahneman, 1974). A natural anchor, or starting point, is used as a first approximation. This anchor is then adjusted according to new information. Typically, the anchor receives a higher weight and additional information receives a lower weight than is merited.

Edwards (1968) pointed out other deficiencies in judgment of risky outcomes. One proposition which has been supported by substantial research is that human beings are conservative processors of information. Even when people perceive each datum accurately and are well aware of its individual diagnostic meaning, they are unable to combine it with prior information correctly and revise their opinions accordingly. Experiments have shown that opinion change is in the right direction but that the magnitude of change is insufficient (Phillips and Edwards, 1966; Peterson _et_ _al_., 1965).

Another important bias of information processing has been noted in gambling experiments. There is a tendency by subjects to consistently over-value long shots, i.e. low probabilities of high winnings (Edwards, 1961). People also tend to assign lower probabilities to events further away from the mean on the assumption that the distribution is always unimodal and symmetric (Alpert and Raiffa, 1969), or assign probabilities according to the degree to which an event is considered representative of some population from which it originated (Kahneman and Tversky, 1973).

People tend to be overconfident about judgments made by their peers. Consequently, in assessing risks, there is often a tendency to discount the probability of human error. The Rasmussen study on nuclear safety, for example, concluded that human errors were both the greatest source of danger and the most poorly understood (Fischhoff, 1977; Weatherwax, 1975).

The need to decompose problems in order to make them manageable leads to another bias - the failure to recognize interdependence. For example, in assessing the probability of system failures, there is a tendency to overlook "common mode" or "common cause" failures, i.e. events which lead to simultaneous failures in independent systems (Nuclear Regulatory Commission (U.S.), 1978).

Cognitive limitations also make judgments highly sensitive to the representation of a problem (Fischhoff, Slovic and Lichtenstein, 1978). Not surprisingly, the form in which data are presented tends to focus the attention of the human information processor upon particular consequences and not on others.

Similarly, the particular choice of indicators or measurements for a given decision attribute tends to affect judgment, often without triggering appropriate inquiry into the correct diagnostic meaning of the measure. For example, it is fashionable to present different events in terms of their riskiness to man. This exercise helps to target policy development efforts or to indicate choice among substitutes on the basis of safety. The particular choice of indicator may change the basic conclusion about the relative safety of two alternatives. If one uses number of deaths per passenger mile, air transportation seems safer. If, however, deaths per trip are considered, then land transportation appears safer. Burton and Whyte (1978, p. 65) conclude that the basis of comparison is crucial to the ranking of risks being compared, and that a little statistical manipulation can change the ranking of safety. The content and format of data presented clearly affect choice. One must attempt to reduce biases of selectivity by permitting maximum opportunities for cross verification of data and its meaning.

To this point, the focus of this discussion has been upon the bounded rationality of individuals and its impact upon judgement and information processing. One must, however, consider the fact that most relevant decisions in the public policy arena are made within organizations and frequently by groups of decision-makers rather than by individuals. Organizational behavior and structure is another source of bias in information processing, especially when there is a major crisis such as the Mississauga derailment of a train loaded with toxic gases. Smart and Vertinsky (1977) review different organizational phenomena that induce pathologies in information processing and judgment during crisis and non-crisis situations. Generally, in order to ensure coordination and economical information processing, organizations develop standard operating procedures. These procedures restrict the information transmitted and tend to interpret signals in rigid ways. Information about novel situations that do not fit into the established mode tends to be distorted and misinterpreted.

Information distortion also occurs through the process of "filtering". Information flowing up through the organizational hierarchy tends to pass through several levels. At each level, certain processes of selection and interpretation filter the information which is transmitted upward. Often, information reported to a decision unit as being highly uncertain is retransmitted, after filtering, as more certain information.

The process of filtering often acts in synergy with a psychological tendency of those who know less to be more confident about their knowledge than those who know more (Lichtenstein and Fishhoff, 1977). The combination of filtering and confidence in knowledge patterns tends to increase the weight of "confident fools" in organizational information processing.

Another factor which distorts information processing in groups is the variance in perceptions stemming from differences in specialization among individuals in different organizational levels and functions. Risk assessment which requires the participation of multi-disciplinary and inter-institutional groups is especially vulnerable to these distortions.

The special dynamics of groups can also lead, under stress, to severe distortion of judgment and information processing. Janis (1972, p. 13) identified one pathological process which he named "groupthink". He states: "The concept of groupthink pinpoints an entirely different source of trouble residing neither in the individual nor the organizational setting. Over and beyond all the familiar sources of human error is the powerful source of defective judgment that arises in cohesive groups - the concurrence-seeking tendency, which fosters over-optimism, lack of vigilance, and sloganistic thinking about the weakness and immorality of the out-group". One could identify these symptoms in many highly stressful and emotional situations which have occurred recently during confrontations between industry and public interest groups on issues of safety. In particular, these symptoms included the pervasive use of slogans instead of information in debates on the issues.

B. Remedies

There are several measures which can be taken to improve judgment and information processing. The provision of training and decision support systems can correct some of the biases reflected in the way individuals process information for decision making. Training is needed to improve the ability of the public, in general, and those involved in policy making and implementation, in particular, to estimate probabilities and use them appropriately in their diagnosis and decision making. The major decisions that this and future generations will face involve a choice among different risky alternatives. The ability to confront and digest risk information and manage risks rationally is a generally desirable attribute which research suggests is rare even among those who have received some formal training in statistics. The development of intuitive statisticians as members of a risk managing society is a prime task for educators.

To aid decision making and to correct for biases, decision aids (decision support systems) can be provided. Some of these decision aids attempt to correct for biases directly. One example is the Probability Encoding Program (PEP) which was developed by the Stanford Research Institute. This program is used to convert judgments about uncertain variables to probability distributions. PEP asks the user simple choice questions that do not directly invoke the specification of probabilities. When enough information is obtained, a probability distribution is printed and plotted (Spetzler and Stäl von Holstein, 1975). Frequently, programs make corrections for known biases, but this can result in a risk of overcorrection. Programs are available for the use of persons who have little experience with encoding probabilities and can thereby correct for conservative bias. Research indicates that this correction is especially desirable when decision makers face complex new situations.

Other decision aids include tools for the systematic enumeration of consequences. Fischhoff (1977) describes two of the principal decision aids in reliability assessment: fault-tree and event-tree analysis. The tree structure is used in each of these techniques to show the interrelationships among different elements of a system, and to help organize data about possible pathways in the system. One of the most extensive recent studies employing fault-tree analysis is the Rasmussen report (U.S. Nuclear Regulatory Commission, 1975) on the safety of nuclear reactor systems.

Decision aids permit the structuring of information and improve the attention targeting of decision makers. They do require, however, access to an information base. Economical access to information and information development requires the creation of an appropriate information system.

VI. Information Systems to Aid Decision Makers Dealing with Environmental Impacts of Chemicals

Efficient chemical data systems can offer many advantages to government and the private sector. Reduced duplication of research and data reporting saves time and money. Information which is available faster helps reduce uncertainty. Use of the computer to combine information in different ways may improve insights about the system and help generate new control options (TSSC, 1979).

Various methods of chemical data compilation, storage and retrieval have been tried. These systems, ranging from standard manual methods to sophisticated computer models (some even able to translate data from foreign languages (Dubois, 1979)), are designed to minimize specific problems or maximize desired advantages to a given user. Depending on the user's needs, parameters such as access methods, cost, speed of retrieval, type of information and system capacity can be adjusted.

Port (1978) describes three information systems: national, European and international. The national system has the acronym DESCNET which stands for the Network of Data On Environmentally Significant Chemicals. It was originally designed by the Department of the Environment of the UK to provide the government and others with information on chemicals. The structure resembles a spider's web in that it is organized as a network around a centre. The peripheral nodes store data on chemicals in a common format to facilitate information exchange with each other and with other information systems. The centre acts as a reference for sources and questions. A pilot project has been initiated to determine answers to questions of feasibility and needs of users.

The European system is being developed at the Joint Research Centre of the European Communities (Norager _et al_., 1978). Its name, ECDIN, is the acronym for European Chemicals Data and Information Network. This information system can be visualized as a spoked wheel since it stores its data in a single data bank at the hub of the wheel. Users with compatible computer terminals will have access through EURONET which links users through phone lines at post offices.

Data on approximately 30,000 chemicals will be segmented into ten categories of information on each chemical. Each category will be divided further into fields and subfields to a total of 200 properties. The categories include scientific information on structure and properties, as well as production information such as use, transportation methods, and dispersion in the environment. The design of the data base is such that a simple information category like solubility can be retrieved, or a sophisticated retrieval program called ADABAS can be used to retrieve cross-referenced information. An example of this would be a breakdown of chemicals that: (1) are pesticides; (2) are found in milk; and (3) are carcinogenic to rats (Port, 1978).

As part of the pilot project, some of the data from the Registry of Toxic Effects of Chemical Substances at NIOSH (National Institute of Occupational Safety and Health) were incorporated into the data base (Norager _et al_., 1978). The data on the approximately 5000 chemicals (Johnson, 1978) were taken at face value from the Registry — their integrity unquestioned. "Of necessity, we rely on editing provided by the scientific community before publishing " (Norager _et al_., 1978, p. 135).*

The third model, the international information system model, is under the auspices of the United Nations Environmental Program (UNEP) and is connected to the UNEP Global Monitoring System (O'Sullivan, 1976). The organizational structure of IRPTC (International Registry of Potentially Toxic Chemicals) is a network with a centre but it places greater emphasis on secondary data bases than the UK DESCNET. Although the centre at Geneva will carry out administrative duties such as referrals and answering questions, in addition to acting as a computer data storage centre, the peripheral nodes of the network named 'National Correspondents' will each be encouraged to build up a selective semi-autonomous data base. This arrangement will develop a capacity to answer questions pertinent to a particular geographic area without going through the centre at Geneva (Huismans, 1978).

IRPTC will cover a geographically larger area and have a somewhat broader mandate than most other information systems. Users will be globally distributed and will include such institutes as the World Health Organization and International Agency for Research on Cancer, as well as diverse member countries.

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* The question of validity and cross certification of data and inferences is addressed later in this paper.

As a result of this breadth and depth, IRPTC has unique goals and constraints. Husimans (1978) points out four functional objectives of IRPTC.

First, IRPTC will not attempt to centralize all data, but rather may refer requests for information to the appropriate National Correspondent. Thus, a National Correspondent may participate in two ways: the data base may be stored centrally at the Program Activity Centre as has occurred with data from NIOSH in the US; or information may be released directly from individual files on request. In any case, an additional function of each National Correspondent will be to search out required information from its specific sector and to make it available throughout the network.

A second function of IRPTC takes advantage of the extensiveness of the network in order to reveal global information deficiencies in toxic chemical data and to direct research to reduce the gaps. This will be accomplished through the cooperation and collaboration of various world wide programs.

The third function will revolve around the identification of potential chemical hazards. Here, the agencies will utilize the network to distribute data on current chemical hazards and controls of global interest. Members will be alerted to current chemical risks throughout the world and to steps taken to control such risks.

Finally, Huismans (1978) expects that IRPTC will disseminate data on regulatory approaches and policies of member countries by whatever means seem appropriate. This might range from regular bulletins for routine information to special alerts for more urgent information.

According to Port (1978), the actual chemical data base is expected to be smaller than the 30,000 chemical capacity of ECDIN. The organization of the files also will be slightly different - they will be comprised of only eight categories divided into 140 attributes. Huisman (1978) states that the information will include chemical characteristics (molecular formula, molecular weight and toxic dose) and regulatory information (reviews, standards and regulations).

Many other systems have been developed in response to the specific needs of a particular user. The U.S. Council on Environmental Quality has formed the Chemical Substances Information Network (CSIN) (TSCC, 1979). It will have a very large capacity (about 500,000 chemicals) and is expected to serve federal agencies, private groups in industry, and public interest groups. Software, management, and funding are some of the areas currently under review.

The United States has several other systems which provide specialized data bases. Merian (1978) mentions: MEDLARS, TOXLINE, CHEMLINE and TOXBANK administered by the National Library of Medicine; data banks maintained by NIOSH, CPSC (Consumer Product Safety Commission) and EMIC (Environmental Mutagens Information Centre); and also the extensive files of the EPA.

Other existing systems include the German UMPLIS (Umweltplanungsinformationssystem), DABAWAS (Dataenbank für wassergefährdende Stoffe), and DIMI-systems (Deutsches Institut für medizinische Dokumentation und Information) (Merian, 1978).

These are but a few of the many systems in the chemical information field. Most systems are incompatible with others, and so represent not only duplication of effort but also limited access to unique data. The rationalizing of such systems presents several problem areas.

Many of the advantages and disadvantages of computerized data systems are the same as those brought by a computer to any system. A computer can scan a tremendous amount of data in a short time with greater accuracy than can a manual searcher. However, the computer adage 'garbage in garbage out' still applies.

Information systems face several problems. The data itself must be of good quality. The program to handle the files must be sound and efficient. The needs of the potential users must be met in such areas as access, structure, funding and confidentiality. Finally, experts must be available to prepare data and run the system (Krentz, 1978).

Different data are important to different users (Adams, 1978). This has a profound effect on the criteria used to develop a comprehensive, current and accurate data base. For example, a user seeking information on only the physical characterization of a chemical requires stable data which is fairly easy to obtain. The accuracy of such data is simple to verify and not subject to excessive distortion as it passes through the data gathering system. These data may include molecular weight, melting point, structural formula and other 'hard' facts. Since this information is obtained through the 'physical' sciences using established procedures, there is little judgment involved. These types of data can be gathered easily on thousands of chemicals (Port, 1978). However, other users such as regulatory agencies or public interest groups are interested in the broader implications of data. Port (1978) points out that, in these cases, summaries and interpretations are needed. What are to be treated as relevant data becomes a question of policy involving value judgment.

Another problem is the difficulty of keeping information current since limited resources constrain the fields of new data that can be examined. The entry speed for new data has a large impact on the system. Even a simple bibliography data base such as TOXLINE lags months behind current journals (Port, 1978).

Some procedures have been developed to improve data quality and to reduce the impact of errors and omissions. Port (1978) advocates the establishment of data bases in conjunction with institutes doing research in the same subject area. This would increase data quality by providing expert advice on the interpretation and inclusion or exclusion of data for the bank. Adams (1978), in summarizing the results of the National Forum on Scientific and Technical Communications, stresses the need to educate those concerned with the system (from data generator through data provider to data user) about the standards of the system. Adams also points out the need for people who are entering the data to understand both the scientific area involved and the information system being used.

There are several problem areas peculiar to the design of chemical information systems which must be resolved. These include standardization of chemical references, categorization of chemical uses, and the organization of a system which is amenable to integration of information from different sources while maintaining confidentiality of some of its data.

A first step toward rational system design would be a standardized method of chemical reference and the development of standard chemical use categories. At present, a chemical may be referred to by formula, by commercial or trade name, by common name or any of several chemical names in English or a foreign language. To rationalize chemical data systems, it is important that all the information attached to various related names be retrieved when only one chemical name is given. One solution to this problem is to assign a unique number to each chemical no matter what synonym is used. The American Chemical Society has been using such a system for its Chemical Abstracts Service (CAS) and has already assigned numbers to four million chemicals. Adoption of such a plan seems feasible (TSSC, 1979).

A portion of the problem not addressed by the CAS numbering system is that raised by mixtures. TSSC (1979) points out the difficulty of identifying and categorizing mixes such as tar. Many other complex organic mixes such as flavourings may fall into this problem area (Schlegel, 1978). Another problem of retrieval concerns the standardization of chemical use data. A standard industrial classification code exists in the U.S. but fails to provide appropriate details for exposure analysis. The EPA has developed a method which classifies chemicals by function and application. This classification consists of 800 terms.

A second step in the design of rational chemical information systems will consist of a choice of organization, a data center, or a network model for the system. Each has advantages. A network allows a data base to be geographically closer to major users of data generators. Proximity to data generators may improve data quality by increasing the availability of subject expertise, while proximity to users may reduce the cost of access. A single data centre, on the other hand, allows greater utilization of the computer's capability to manipulate data for cross-referencing and linking (Port, 1978). Such a system conserves scarce expertise and provides a more stimulating and supportive environment. In addition, greater control over the data is generally possible. In most cases, the amalgamation of independent, existing data banks seems more likely than the establishment of a new, central data base.

A method is needed, however, to tie existing and future files together. By way of example, research in epidemiology requires methods to relate extensive personal files containing demographic, medical and occupational data on individuals to chemical use and exposure data. This is difficult because of personal mobility and possible name changes. An obvious answer is the use of the Social Insurance Number. Unfortunately, it is felt by many that use of the SIN number presents severe threats to personal privacy since it represents a potentially powerful tool to suppress personal freedom by both government and private parties. Possible use and potential effects are now under study by a federal commission in Canada.

Private companies have expressed concern about the confidentiality of computer data. Dueltgen (1979), speaking for a private company in the U.S., recognizes the value of computer information to the private sector, but emphasizes the cost of unauthorized disclosure of proprietary data. He points out that possession of manufacturing data on chemicals presents a significant market advantage to other companies in the industry. He questions the legal status of data in such areas as responsibility for accuracy and proper use. Dueltgen feels, at present, that the chemical industry in the U.S. is not inclined to disclose sensitive information, pending satisfactory resolution of the confidentiality question.

A similar attitude appears to exist in Canada (Neff and Mutton, 1980). The Canadian problem may be compounded by circumstances in the U.S. since Canada depends heavily on U.S. data bases and information services (Werdel and Steele, 1978). Canadian companies may not wish to risk placing their information in U.S. data banks if the American attitude to data confidentiality creates a greater risk of disclosure.

One method of handling the problem of proprietary or other restricted information is to segment a file system. Information required for chemical files established by the Toxic Substances Control Act (TOSCA) is split into public information available to all, and private information available only to the EPA (TSSC, 1979). Thus, the public and other companies are refused legal access to proprietary data through security mechanisms.

Such mechanisms restrict access to computer files through three broad methods designed to verify the identity of an authorized user (Lowe, 1976). Verification may be based on some physical possession such as a key or magnetic card, some property of the user such as a fingerprint or signature, or some knowledge of the user such as a password or answers to a series of questions. However, no security system is perfect. At best, these features, when combined with others, provide "a high degree of security" (p. 17). A trade-off between cost and difficulty of operation on one hand and the importance of data security on the other must be made, keeping in mind industry's reluctance to reveal trade secrets without adequate protection.

Information systems and decision aids may improve the rationality of policy making if their information inputs are both valid and valuable. An information system must have the means of cross verification and validation. The ability to exchange information among systems and compare information within a system for validation requires the standardization of information collection and storage. While, from a short run perspective, the Bayesian information processor can receive and integrate information from diverse sources and organize it to form a judgment of posterior probabilities, the long-run accumulation of knowledge requires some degree of uniformity in data sources. The development of standard laboratory protocols in the research of health consequences of exposure is one example. The Organization for Economic Cooperation and Development (OECD) is now engaged, through its groups of experts, in reaching an international agreement on such uniform laboratory practices. Even without uniform standards to govern information production, a system should identify information which is robust, i.e. information whose content has held constant even though its production involved different assumptions, instruments and methods.

An important problem occurs when information inputs conflict. The determination of validity and the resolution of these conflicts are important questions for an information policy to address.

VII. Conflicting Information Inputs: How to Decide and Who Should Decide on Validity Issues

The problem of validity of scientific information has two facets: (1) the internal resolution of conflicts within the scientific community as to what constitutes valid information; and (2) the perception of the public and policy makers as to the validity of scientific information.

The internal problem of science stems from the fact that the degree of conclusiveness required by the traditional scientific method cannot accommodate the demands of policy making in a complex and rapidly changing environment. Scientists are asked to provide information before it is subjected to a rigorous, time consuming system of checks (i.e. controlling for rival hypotheses). Scientists are also requested to interpret their results in policy terms. "This new social commitment of scientists has made it increasingly difficult for the scientists and the non-scientists to separate the expert's advice concerning what is from that concerned with what ought to be" (Gilpin, 1962, p. 298).

While a complete separation of facts from values is impossible, there is a need in science for a mechanism through which conflicts in scientific information can be defined as much as possible as conflicts of facts versus conflicts of values. Furthermore, the mechanism must attend to the question of the perception of information validity by the public. The mechanism shoudl minimize the chance and appearance of misuse of expertise as a means of supporting particular policies, rather than as an input into policy making. The mechanism should prevent, and should appear to prevent, the process of information collection from becoming a process of selection of data and interpretation on the basis of policy goals (Benveniste, 1972).

In the mid-sixties, Kantrowitz (1967) presented a proposal for an institution intended to resolve conflicts about facts in technical and scientific disputes - a Science Court. This idea did not receive much attention until the mid-seventies when Kantrowitz was named a chairman of the (U.S.) Task Force of the

Presidential Advisory Group on Anticipated Advances in Science and Technology. The Task Force recommended in 1976 that the idea of a Science Court should receive serious consideration.

"The assumption inherent in the Science Court concept is that factual claims can be debated and resolved apart from questions of 'social value'" (OECD 1978). The procedure proposed by the Task Force as an experiment consists of the identification of science issues about which there is conflict and the appointment of case managers for each side of an issue. It embodies both an adversary process and a mediation process. Panels of scientists would serve as judges.

Case managers would start by formulating a series of factual statements that they regarded as most important to their case. These statements would consist of results of experiments and observations. Their relevance would be ruled on by the judges before presentation. Each side would then present its statements and challenge those of the opposition. Those statements accepted by both sides would be the first information output of the science court.

A mediation procedure would then be employed to narrow the area of disagreement or to negotiate a revised statement of fact acceptable to both sides. Newly accepted statements would be added to the original list. Those statements which remain challenged would then be subjected to an adversary procedure. After presentations and cross examinations of evidence, a renewed attempt at mediation would be made. If mediation was still not successful, the judges would write their opinions on the contested statement of fact (Bulletin of the Atomic Scientists, 1977, p. 45).

The critics of the Science Court concept suggest that the use of court-like procedures does not provide guarantees of objectivity or of freedom from preconceptions. Furthermore, the formalization of the procedure may cause observers to attribute higher conclusiveness to its outputs than the contents of the proceedings merit.

Nelkin (1977, p. 27) points out that the most useful attribute of the Science Court concept is its plan to organize a forum in which opposing parties confront each other on specific issues. The objective of the adversary process should not be to reach a judgment but to "reveal the assumptions underlying different views and the multiple dimensions of policy problems that make them so difficult".

Abrams and Berry (1977, p. 52) suggest that mediation employed by itself is a better process for "bringing out the facts through better communication, whether differences remained or not". The mediation approach to resolving technical and science controversies has received increasing attention (OECD, 1978). Mediation involves voluntary meetings for discussion and negotiation among parties who promote conflicting information in the presence of a mediator and discuss disagreements about facts. The mediator's role is not to judge but to guide and facilitate the process. This process is aimed at narrowing the extent of disagreement through clarification and delimitation of the areas of disagreement. The model of mediation is closer to what Churchman (1971) describes as a Kantian information system - the emphasis is upon synthesizing alternative perspectives to obtain a valid statement of information. The mediation process requires a well-defined framework of rules for validation and comparison of different viewpoints. Conflicts which are largely technical can be better resolved by mediation.

The adversary process in the Science Court, by contrast, can be viewed as an Hegelian information system where the maximization of conflict permits the identification of implicit assumptions. Making such assumptions explicit may lead to the enlightenment of judges and perhaps participants. The drama of the conflict generated by the adversary procedures encourages qualitative changes in the opinions, emotions and values of participants and observers. Ill-structured problems and conflicts which involve a high degree of disagreement on values, not just fact, are especially amenable to Hegelian inquiry systems.

Both the mediation and adversarial processes are of value since many questions appear to be questions of science but cannot be answered by science alone. Weinberg (1972, p. 209) has defined these questions as trans-scientific in nature, although "these questions, epistemologically speaking, are questions of fact and can be stated in the language of science". For example, questions which involve estimation of very improbable events are questions of fact but, because of economic considerations, science cannot provide the answers. "To demonstrate with ninety-five percent confidence that the carcinogenic response rate is less than one in a million, an experimenter need only feed three million animals at the human exposure rate and compare the response with three million control animals that have been raised under identical conditions but with no exposure to the chemical. As a practical matter, however, scientists cannot conduct this 'mega mouse' experiment because it would require feeding and caring for six million rodents for eighteen to twenty four months. Scientists therefore test significantly fewer animals at much higher dosage rates ... The agency can never be certain whether a chemical that causes cancer at high doses will cause cancer at the lower doses to which humans are typically exposed" (McGarity 1979, pp. 733-734).

The determination of validity is therefore a policy (value) decision rather than a scientific determination. This fact and the observation that "scientists today are listened to much more and believed much less" (Brooks, 1975, p. 257) lead us to the important problem of identifying a process for obtaining better information and resolving conflicts about values.

VIII. Information About Values and Resolution of Value Conflicts

The past decade saw the development of advocacy politics promoting the following key slogans associated with communication information policies: participation, demystification and accountability (Nelkin, 1975). Several mechanisms were proposed for the improvement of inputs on values into the decision process to achieve these goals. For example, the Report of the Committee for Scientific and Technological Policy of the OECD (1978), entitled "Public Participation in Decision Making Related to Science and Technology", lists the following mechanisms:

a) Advisory boards

b) Public hearings

c) Commissions of Inquiry

d) Special Ad Hoc Mechanisms (e.g. opinion polls surveys, in-depth interviews, and literature scanning techniques such as Codinvolve)

To these mechanisms one must add hearings held by courts. The court system, especially in the U.S., has been called upon to resolve scientific questions about which there is significant dispute and uncertainty in the scientific community.

Advisory boards are used by many governments as mechanisms for consultation with diverse interest groups. These boards consist typically of members with special expertise and/or members drawn from different interest groups. Advisory boards are therefore used to elicit information about group preferences through representation, as well as to enhance the level of technical expertise for decision making.

Public hearings are one of the most frequent responses to pressures for greater public input into decision making. A system of legislative hearings is very extensive in the United States. "Congressional hearings serve as the principal mechanism by which legislators collectively assess public views and interests related to legislative proposals" (OECD 1978, p. 68). To increase the credibility of the process as well as to ensure broad participation, committee meetings have sometimes been televised. Closed circuit television systems between Washington and local communities have also been implemented to allow remote participation in public hearings. In other countries such as Denmark, France and Germany, public hearing processes are generally restricted to administrative and regulatory decision making. In Parliamentary systems such as the U.K. and Canada, legislative public hearings are held occasionally but with little impact upon the policy making process. "A more general response in these latter countries has been to rely on extra-parliamentary institutions as a primary means for informing policy makers. These include such mechanisms as Royal Commissions, major inquiry commissions, administrative tribunals and public inquiries" (OECD 1978, p. 69).

Commissions of inquiry may take a number of forms. Royal Commissions may be appointed for a fixed duration to examine and report on specific policy matters or for an indefinite duration to provide continuous advice. Other types of commissions may be concerned with information on specific projects. Commissions of inquiry are considered a means of guaranteeing that the full range of public opinion on given issues is explored. In particular, for issues which directly affect minority groups, inquiry through a commission tends to ensure an open channel for minority opinions which are often poorly represented. When the prime function of the Commission is to explore values held by the public in complex technical issues, the commission must engage in a process of public education. The inquiry becomes not only a mechanism for information collection, but also a mechanism for information diffusion. In the process of discussion and debate during the inquiry, the commission learns about community values while the community learns about the issues and reexamines its own values.

In contrast, when the prime role of the commission is to resolve conflicts or to validate information, the inquiry is used mainly as a mechanism to assemble, challenge and evaluate evidence in an effort to narrow differences, and make a final judgment with the highest feasible level of certainty.

A review of experiences in the U.K. (The Windscale Inquiry of 1977) and in Canada (The MacKenzie Valley Pipeline Inquiry of 1974-75) led to the following recommendations for the conduct of future national inquiries (OECD 1978, pp. 89-90):

"Sufficient time for the critical preparatory phases must be allowed for, and reliable preliminary information is essential if all participants in such inquiries are to have an equal opportunity of putting forward their particular arguments. Financial assistance to certain groups appears to be especially warranted to ensure a more democratic representation of views and interests before an Inquiry.

"Inquiries that proceed by a structural discussion of each major issue, as opposed to some more arbitrary sequence of proponent and opposition intervenor groups, not only have the advantage of reducing the presentation of repetitive testimony, but, more importantly, of developing a cumulative information base from which to assess cumulative impacts. Recourse to the adversarial approach to the examination and cross-examination of witnesses and testimony can often result in more critical information becoming available, in the more thorough and penetrating examination of competing claims, and in the clearer articulation of individual and groups' interests and biases. This is all the more true when there is but one major proponent, as was the case at Windscale. It also has its disadvantages, however, especially when it results in sometimes exclusive reliance on lawyers and technical experts to the detriment of direct citizen participation. Developing a system of more flexible formal and informal public hearings, at which citizens and experts alike can participate, represents one possible approach. More carefully structuring the treatment of issues themselves in terms of their policy-related and technically-substantive components, is another".

In place of formally constituted commissions, governments may employ a variety of committees to increase channels of communication from the public to decision makers. The problems with these and other organizational methods for collecting information about values are cost and the limited capacities of information channels. These limits force selectivity in the communication of values.

In contrast to organizational methods of collecting information about values, public opinion polls, in-depth interviews, mail questionnaires and other survey techniques permit better control over sampling methods for determining value profiles, but suffer from problems of instrument validity. The lack of opportunities for two-way communication and feedback is a major threat to the validity of interpretation of their results. These indirect methods of surveying opinions should be regarded as barometers of change rather than as inputs of specific information. For example, the U.S. Forest Service developed and implemented experimentally a system to survey written public opinion from various published sources. This system, called Codinvolve, utilizes content analysis of relevant written statements (e.g. letters, reports, petitions, editorials, etc.) to produce a public opinion profile about a particular issue. The validity of the instrument as a means of identifying a profile of public preferences is doubtful. It may be useful, however, as a sensitive warning system about changing values or as a supplementary source of confirmation of other data. "The Codinvolve system is basically conceived of as an analytical tool, which permits policy-makers to evaluate a broader spectrum of attitudes than may emerge at public hearings or in response to public announcements" (OECD 1978, p. 93).

It is hard to determine the final arbiter on the validity of value inputs. In some countries, such as Canada, matters of value judgment are ultimately resolved in the Federal or provincial cabinets depending on the jurisdiction and decided by a vote of Parliament. In the United States, for example, courts have a more prominent role as arbitrators of social value information. The employment of judicial or quasi-judicial processes to resolve questions of values or information validity suffers from several shortcomings:

(1) the right to participate - i.e. legal standing - is often restricted;

(2) the processes are costly and time consuming, hence, their use may open opportunities for strategic manipulation by parties who attempt to subvert the process of conflict resolution. Furthermore, costs impose constraints upon the ability of certain groups to participate in the process; and

(3) standards of proof may not meet the criteria of the efficient utilization of information.

The advantages of judicial or quasi-judicial processes lie in the guarantees of fairness that due process offers. It should be noted that, in many instances, courts and other judicial bodies have taken a liberal position in granting standing, significantly broadening the potential for participation in the process. Costs and delays in these processes may be a major problem, but government financial support for participants (even those who advocate positions opposed to those of the government) may overcome some of these barriers. The rigidity of courts in employing the standard of proof is now reduced at least in the United States. Franson et al. (1977) observe that recent U.S. statutes and court decisions have followed a risk-benefit approach where the standard of proof has varied according to the gravity of alleged harm or benefits of the defendant's activity. There is increased flexibility in the sense that a lower standard of proof will suffice where: (1) the magnitude of the damage, should it occur, would be large; (2) the probability of occurrence is significant; and (3) viable alternatives exist. Franson et al. (1977) note that Canadian courts do essentially the same thing in determining whether preliminary injunctions should be granted under the test of balance of convenience. These flexible standards prevent the loss of information which accrues from step-wise information filtering, and uncertainty "absorption".

All the processes described above assume that participants are equipped with sufficient information and understanding to define options and express value preferences about these options.

IX. Access to Information and Rights of Confidentiality

Access to information can be defined in terms of legal authority or right to retrieve a particular data set and in terms of the cost associated with retrieving and processing the data. Most governments are endowed with extensive powers to acquire information. Therefore, the right of access to information held by the government is an important factor in decision making about scientific, safety or economic matters. The United States and Scandinavian countries have pioneered in establishing the rights of citizens to obtain government documents and other information in the possession of government. In these countries, individuals or organizations outside government can ask for information without having to show a "special interest" in acquiring this information. Clearly, these rights are restricted in certain areas where security or the rights of others are concerned. In some countries, such as Norway, information access is restricted when there may be a threat to national economic interests. Experience with the U.S. "Sunshine Act" of 1977 reveals that legislation allowing access to information increases the belief in the integrity and perceived accountability of government rather than helps to inform the public. The major seekers of information in the U.S. are industrial firms attempting to gather information about competitors, and individuals seeking access to personal records. One thriving, business-intelligence firm is now operating a processing system which permits, for a fee, access to and analysis of information in government files. "It would seem, therefore, that such mandatory information disclosure measures are ... largely passive" (OECD 1978, p. 19).

In Canada, recent attempts to introduce a freedom of information bill temporarily died with the defeat of the last government. The federal cabinet has, in the past, published guidelines on the production of documents for parliamentary purposes. These guidelines could not, however, be utilized by a citizen against the government. Franson *et al*. (1977) suggest that the combined effect of the federal Official Secrets Act and the oath of office of government employees leads to a practical presumption against disclosure. Agencies may have the discretion to release information, but there are many organizational incentives which militate against disclosure.

A policy of increasing access to government files sometimes results in a lower availability of information. Frequently, the perceived security needs of data contributors may not be satisfied by a government agency collecting the information. Under these circumstances, the contributors of information may not cooperate and may, at times, provide misinformation, particularly in matters concerning sales, production processes and product composition data.

In October 1979, The Business and Industry Advisory Committee (BIAC) of OECD published the views of its Chemicals Subgroup regarding controls affecting commerce in chemicals. They stated: "The legal requirements for reporting that Governments have recently imposed on the chemical industry include information that traditionally has been considered confidential. Furthermore, differing, mandatory public-disclosure requirements with regard to reported data have also been imposed and are under consideration by various governments ... Information such as the method of processing, the uses, the timing, or the distribution of a particular chemical, all is considered proprietary because it represents potential business or an advantage which one company may have over its competitors. A company may have spent considerable resources to obtain this advantage and it may be lost if this information is freely given to its competitors. The chemical industry is not opposed in principle to providing to Government information that is necessary to assess the potential risk of a chemical to man and his environment. It is, however, strongly opposed to the unlimited releases of any information, beyond the usual limitations which contracts, licenses, and even governmental arrangements provide for the protection of technical data, since those limitations do and would, protect commercial and innovation interests" (BIAC, 1979, pp. 5-6).

There is merit to demands for confidentiality of information when the sacrifice of vital economic interests (national or individual) occurring with the release of information cannot be balanced by benefits. The difficulties in applying this principle lie in reaching an agreement on the locus of the assessment and decision process. For instance, if industry is allowed, without checks, to determine whether particular information should be released or not, the integrity of the process will be doubted since industry clearly has interests which are dominated by a responsibility to stockholders to obtain maximal economic gains. In addition, government is often suspected of partiality to powerful, concentrated economic interests who may incur high benefits or costs from regulation in contrast to the diffused benefits and costs experienced by the population at large. Furthermore, the industrial sector itself does not have full confidence in the ability of government to defend industrial rights of confidentiality when there is a temporary surge of public sentiment favouring release of information. It seems plausible to assume that industry has the best ability to evaluate the economic value of information it has produced. Nevertheless, representatives of the public, aided by independent experts, can identify information whose release may be in the public interest, even after consideration of the costs of compensating the source of the information. A process by which industry can designate information it provides to government as confidential, with checks offered by an independent audit committee to represent public interest, may permit a more equitable balancing of rights to confidentiality and the public right to know. To ensure fairness, rights of appeal on determinations by such an audit committee should be granted to both industry and the public.

Governments must accept responsibility for securing confidential information as long as such information retains the confidential status assigned by industry. If inter-governmental exchanges of information are required, or access to confidential information is to be granted to outsiders, the security arrangements of information receivers must meet the same standards as the source. These information sources must verify that recipients of information maintain security and are legally liable for damages accruing from unauthorized release of confidential information. Industry should be pre-notified and given the chance to object to plans to grant others access to confidential information.

Some data are economically valuable, though not confidential in the traditional sense of the word. A firm may have an investment in the preparation of data for government use (e.g. notification information for new chemicals). If other firms can use these data once they are on file, without compensating the original producer of information, they obtain an unfair competitive advantage. It seems reasonable to demand that costs accruing to a firm in the preparation of information required by the government be shared by subsequent users, at least for some specified period of time.

There are areas where the right of the public to know supersedes any other considerations. When a product is introduced into regular commercial channels, it is the obligation of the producer and the marketer to inform the public about major health risks involved in its use. Employees in contact with dangerous compounds during the production process also have the right to be informed about risks. In these and similar cases, it is not simply the right of access to information which is required, but also the obligation to transmit information. This is an active rather than a passive obligation on the information source. It implies a duty to ensure that information is received and understood.

Attempts by government or industry to inform the public must be carefully designed since the forms and media of communications have a high impact upon knowledge and values.

X. The Management of Information Diffusion

There are several possible social objectives for diffusion of information concerning chemicals: (1) to increase public competency to participate in decision processes concerning regulation of chemicals; (2) to increase competency of individuals in making informed market choices; (3) to insure competent use of chemicals; and (4) to increase the abilities of individuals and organizations to cope effectively with crises if and when they occur.

Communications have the potential to affect value systems. Strategies of communication may consciously focus upon value change and behavioral manipulation rather than the mere provision of information. However, at times, value change and behavioral modification may be unanticipated by-products of an effort to inform.

The realm of science and technology has seen in recent years a variety of government efforts at information diffusion with differing impacts. Such efforts have included study circles, mass media campaigns, establishment or sponsorship of non-government information groups and the promotion of self-study systems. In spite of the above efforts, surveys consistently find that a large part of any population escapes contact with certain pieces of information which are widely reported.

Before reviewing the relative advantages and shortcomings of different diffusion strategies and relating these strategies to objectives for the diffusion of information about chemicals, it is necessary to describe some of the basic characteristics common to diffusion programs.

There are three processes of information selection: exposure, perception and retention. The physical exposure to the message is determined to a large extent by the choice of channels for communication, although accessibility to a channel may not necessarily imply exposure. Books, pamphlets, newspapers and television reach millions of people; yet they are more likely to reach those people with higher socio-economic status, education and more community involvement, often in leadership positions (Feldman, 1966). Much exposure to information will be indirect and accrue through social interaction networks (Vertinsky et al., 1972). Katz and Lazarsfeld (1955) have demonstrated, for example, the relationship between social organization and the reception of information from the mass-media.

Research suggests the existence of a multi-step flow of information in society in which one opinion leader may inform and influence other opinion leaders and they, in turn, inform and influence their followers (Defleur, 1970). Clearly, appropriate use of the existing social organizations or the promotion of specialized social organizations is an important determinant of the fate of information inputs to a social system. The filtering of information through a social information network may inappropriately magnify or discount certain dimensions of the information.

Magnification, decay or subversion of information depends upon individual processes of selective perception and retention. People tend to read, listen or watch primarily those things which fit their preconceived notions about a subject. In sorting and interpreting information, an individual tends to rely upon assumptions based on past experience which have proved to be generally reliable. What is perceived tends to be governed by personal interests,wants, concerns, fears, hopes and expectations - motivating forces that are acquired through experience (Vertinsky et al., 1972). It is not surprising that environmental groups, with lengthy experience with environmental problems, would tend to focus upon environmental cost information about a new compound; while those from the chemical industry would tend to focus on information about the benefits. Similar processes affect the retention of new information and the process by which prior information is revised.

The design of messages directly affects the process of selection. As has been indicated, the form, the intensity and the emotional associations of the message all contribute to the impact the message may have upon the knowledge and behavior of the recipient of information.

Vertinsky (1979) suggests several strategies for information dissemination. When the information content concerns the general nature of the problem and the specific goals are the focusing of attention and the triggering of social interest, then the target of diffusion should be the population in general but opinion leaders in particular. The preferred media mix is television and radio for conceptual messages and printed media for details directed at opinion leaders. Continuity in diffusion efforts should be emphasized over intensity in order to minimize information overload. Detailed information should be directed at community facilitators such as teachers and members of volunteer groups, with the population at large informed about the availability and location of sources of information. In addition to traditional mass media channels (in particular the printed media), specialized channels such as interactive computer programs are also recommended for dissemination of detailed information.

Vertinsky (1979) recommends education aimed at improving general abilities for processing information and rational decision making. The primary target populations for this long term strategy are children. Television and radio can act as primers with the printed media as follow up. As a longer term educational strategy, continuity of information dissemination at a moderate intensity is required. Clearly, such a strategy should be coordinated with appropriate school programs.

Information for marginal behavioral modification requires the employment of "push and pull" strategies directed at correcting misconceptions and undesirable behavior while providing information about alternatives. Strategies for important behavioral modification must involve integrated approaches which mobilize organizational infrastructures (agencies and institutions) essential for bringing about social change. "Timing of different messages targeted depends on specific social dynamics which evolve over time. Community organizations must become an integral part of the campaign" (Vertinsky, 1979, p. 411).

Two other task categories for information diffusion which are discussed by Vertinsky are the use of information as triggers for action (facilitators of implementation) and for crisis management. The latter task has special significance for chemical-information strategies. The major recommendation [illegible] for maximum exposure. Messages must be designed to reduce anxiety. Information must be specific, clear and simple. Continuity and availability must be high, and intensity must be controlled to avoid information overload.

Experience with information campaigns in science and technology is limited and mostly involves information concerning energy issues. For example, in 1973, the Swedish government initiated a major project of public information. The mechanism chosen was that of "study circles" (Nelkin, 1977). The Swedish version of this mechanism was comprised of small study groups run by educational committees of various organizations, such as political parties, trade unions and religious organizations. The government provided financial resources and documentation to participating organizations. The Swedish government also established a specialized communication channel in the form of an independent resource group consisting of experts in the relevant fields. The mass-media were used only as a means of focusing attention on the problems and on the opportunities to acquire information. Not surprisingly, the majority of the 80,000 "participants" came from the already well-educated, well informed, politically-active population groups, not from the groups who were, perhaps, most in the need of knowledge" (OECD, 1978, p. 26).

An alternative approach employing the printed media was attempted in Sweden in 1977 by Centrala Driftlendningen - a non-profit, quasi-governmental organization. This organization published booklets on nuclear energy for distribution to schools, study circles, trade unions, companies and other organizations. Environmental interest groups discredited these materials as "propaganda for nuclear power paid for with government funds" (OECD, 1978, p. 29).

The federal government of West Germany has also conducted an information campaign concerning nuclear energy. The goal was to disseminate information and initiate an "opinion forming process" (OECD, 1978, p. 32). Started in 1975, the campaign was an example of the utilization of mass media and initiation and mobilization of social support structures. It continued over a long period of time, starting with the priming of public interest. It provided detailed information to interest groups and individuals upon request; developed an outstanding series of handbooks and other general information materials; and utilized existing organizational infrastructures to stimulate on-going discussions. Seminars were organized for special target groups and information packages were prepared for schools and other centers of education.

The dilemma which is common to these and other information campaigns is the uncertain identification of the boundary between effective information dissemination and manipulation. What may appear to some as information made accessible, may appear to others as propaganda filled with biases or oversimplifications. In the design of information diffusion strategies, one must consider not only the integrity of the communication process, but also the appearance of integrity. Furthermore, a long term view must be adopted in contrast to the characteristic political myopia of governments which prefer short term remedies. An investment must be made to improve the abilities of the public in general to receive and process technical information concerning risk.

XI. An Adaptive Dynamic Information Strategy

The arena of decisions concerning regulation of chemicals involves potentially large benefits and risks. Because of high costs of information and constraints which severely limit the pace of information acquisition, the decision process is locked in a world of hypotheses (Holling, 1979; Hafele, 1974). As a result, it is sometimes necessary to substitute value judgments for rigorous tests of particular assumptions. In other decision situations, one must adopt a trial and error methodology to learn by doing. Segmentation and separation of dimensions of evaluation, which characterize the disjointed incremental modes of decisions in our society, may create paradoxical situations where an extremely conservative quest for safety in one dimension leads to reckless risk taking in other dimensions.

Wildavsky (1980), for example, has demonstrated that safety tends to be positively related to wealth; i.e. "richer is safer". Although a broad generalization, this statement does indicate that with greater wealth there are more opportunities to acquire information and develop technologies to improve safety. As a consequence, information policy concerning chemical risks should not prevent innovation, but direct it in a manner which maximizes net social benefits. To achieve this goal, it is imperative to obtain the maximum value from all existing information bases, to learn efficiently from new experiences, and to invest in the development of a capital stock of information so as to maximize future expected yields.

Full utilization of available information about chemicals requires the establishment of a network which interconnects the many existing information systems to permit efficient retrieval. The network must be augmented by groups of experts to facilitate integration of data and to act as human processors of information. These groups should be equipped with a decision support system to reduce biases in assessment. Organizational mechanisms such as science courts or mediation boards should be established to evaluate quality and validity of information inputs into the network and to resolve questions which are largely technical. Their function would be restricted to the correction of probability distributions associated with different hypotheses. They would not rule on the acceptance or rejection of these hypotheses. Standardized protocols of testing and other data acquisition procedures should be developed to permit the collection of consistent and comparable information. Societal monitoring programs should be established as part of the network to provide early warning and permit accumulation of experience through quasi-experiments. For example, a quasi-experiment could include the introduction of compounds or changes in their use as experimental interventions in what Campbell and Stanley (1973) have called interrupted time-series designs.

A multi-tier system of information acquisition should be implemented which is motivated by the criterion of maximizing the expected net value of information. Such factors as level of exposure, persistence, suspected adverse impacts, perceived benefits of a chemical, and control possibilities offered by better information would simultaneously form the basis for movement upwards in the tiers. Formal criteria should be tempered by the employment of discretion to permit recognition of individual characteristics of compounds and their patterns of use.

Since many of the questions of information interpretation and acquistion are questions of values, forums for public participation should be established. A communication strategy should be implemented with the objectives of providing information, triggering value identification and opinion formation processes, and improving societal abilities to process risk information. Since so little is known about the optimal formats for information diffusion and public participation, it is necessary to experiment with a diversity of techniques in order to find those formats which lead to societal consensus without inhibiting technical progress or taking irreversible and unwarranted risks.

Movement toward an informed society requires openness in information systems. This may impose significant costs upon innovation and conflict with property rights which have been considered basic to our economic system. Furthermore, openness which threatens the vital interests of organizations supplying information could lead to temptations to distort information inputs. To ensure the integrity of information collection and preservation of rights, the confidentiality of valuable information must be secured and compensation provided for economically valuable information which is released without authorization. Mechanisms for the release of confidential information in the public interest should insure that the rights of all parties involved receive adequate protection.

Where risks are imposed on a population, society has the right to be informed. This right implies an obligation on those who are the sources of risk to ensure that those who are exposed, or may be exposed, to such risks are kept fully informed. Only with these safeguards will each member of society be able to make intelligent and informed decisions on matters of importance and concern to all.

XII. The Canadian Point of View and Some Specific Guidelines for Implementation of a Chemical Information Policy in Canada

A. Questionnaire Results and Some Specific Guidelines

The likelihood of implementing a chemical information policy in Canada depends in part upon the social acceptance of its principles. A policy upon which there is a national consensus is likely to be implemented without delay if the government bureaucracy strongly supports it (Thompson and Stanbury, 1979). A policy which is likely to mobilize strong opposition from industry would tend to have a low probability of implementation.

To assess the positions of different groups in Canada concerning information policy, a questionnaire was designed and distributed to all members of the Canadian Chemical Producers Association (CCPA), a sample of members of the Canadian Manufacturers of Chemical Specialties Association (CMCSA), senior environmental regulators in the Federal Government and in two provincial governments (Ontario and British Columbia), and environmental protection groups.

Seventy chemical producers, 18 regulators and 10 interest groups responded to the questionnaire. The questions dealt with information access and exchange policies as well as treatment of confidential information. Participants in the survey were asked to indicate their agreement or disagreement with policy statements using a 7-point Likert scale. A brief summary of the results is given below.

There is a consensus that information relating to public health risks from hazardous chemicals should be generally accessible. Regulators and public interest groups tend to favor stronger involvement of public interest groups in the process of examining information as well as providing information about public preferences to the decision process. The positions of industry tend overall to mildly support public participation, but there is a high variance in attitudes within industry.

Regulators and public interest groups strongly support government funding of resource centers to help the public and interest groups to gain access to information as well as process information which is retrieved. There is only mild overall support for this position in industry with opinions largely divided between those who are indifferent to the policy and those who support it. Only interest groups strongly support direct funding of interest group information retrieval and processing activities. Regulators are sharply divided on this issue. Industry strongly objects to direct financial support of public interest groups.

There is a consensus that both government and industry have the responsibility to provide information to people who are exposed to risk. Not surprisingly, chemical producers tend to strongly support direct industry involvement in the dissemination of risk information as opposed to dissemination of information through government channels. There is a consensus that the right of provision of risk information to those exposed to the risk supersedes industry's rights for security. There is also a consensus that information about government decision making should be provided to the public. In particular, the main arguments which influenced arrival at a decision should be explained to the public.

The major area of disagreement among the different parties is the treatment of confidential information. The difference lies particularly in the area of information sharing among different organizations engaged in regulatory decision making and implementation.

While interest groups and regulators feel that confidential data provided by industry should be shared with other federal agencies, industry tends to object to such arrangements unless the provider of information has control and satisfactory guarantees that security will be maintained in the receiving agency.

The strength of positions held by industrialists depends upon the importance that innovation plays in obtaining a competitive edge in their type of business. Manufacturers of fertilizers, for example, are less concerned with information security than manufacturers of bulk chemicals. Interviews with some chemical manufacturers indicated that security of confidential and economically valuable information is their prime concern with respect to potential changes in regulation of the industry. Furthermore, interviews indicated that without adequate guarantees of security, information inputs to government would tend to be minimal. Similar attitudes exist about federal-provincial exchanges of information. Some federal and provincial regulators, however, are not inclined to be strong advocates of such exchanges, perhaps reflecting the differences among governments in security arrangements.

Sharing confidential data with outside contractors is strongly opposed by the chemical industry but is supported by public interest groups. Regulators are divided on this issue, with the majority in support of confidential data-sharing with contractors. Similar patterns of attitudes exist about sharing confidential data with those exposed to chemicals. Industry strongly objects to information sharing, regulators are divided on the issue, and public interest groups support government information sharing with those exposed.

Clearly, release of information to those exposed to a chemical will hinder the prservation of security. The position of industry in this case is based on the argument that information which does not directly bear upon health or safety should be presumed irrelevant unless shown otherwise (e.g. through a judicial process).

Industry's position can be summarized by the following policy position: "information developed and paid for by a company and designated as confidential is company property. Therefore, the company should have sole control over its distribution even after it is disclosed to a government agency". This policy position was strongly opposed by public groups and government regulators. (It is interesting to note that while this policy contradicts the existing doctrine of crown privilege, it fits well with the administrative practice of maintaining secrecy.) Interviews with industry revealed that industry is largely satisfied with current security arrangements and the maintenance of confidentiality by governments in Canada. The threat of a change in practice which is not guarded by formal guarantees is a source of concern to industry.

Traditions of informal information sharing and maintenance of secrecy by government may impede attempts in Canada to move into an era with formal integrated information networks. A move into a formal information system requires a change in the legal infrastructure to formally protect rights to confidentiality and access. These rights are presently maintained through the exercise of administrative traditions and the cooperative framework of interactions between industry and government (Doern, 1977). Formal information systems would require formal security arrangements.

Recent attempts to broaden the consultative process to include representatives of public interest groups seem to arouse little antagonism on the part of industry. However, resources at the disposal of public interest groups in Canada are small and limit their effectiveness both in representing the public on issues of values and in providing information to the public. Since there is some objection to direct governmental financial support of interest groups, a first step to ensure information flow would be to establish independent chemical risk and benefit information resource centers with tripartite advisory boards representing governments, industry and public interest groups. The method of financing these centers must ensure their independence from external pressures on particular issues.

B. The American Influence

The Canadian information strategy must differ from a U.S. strategy not only because the political and social traditions and structures are different in Canada, but also because of smaller population size and more limited resources. Canada cannot invest the resources on the scale contemplated by the United States in order to improve the information base on chemical risks. Thus, Canada, to a certain degree, will continue to depend on the United States for information services. Since the geography and the economic and social structures of Canada are different from those of the United States, not all the information which is relevant to decision making in the United States is relevant to Canada. There is resulting need to filter information obtained from the United

States and to adjust it to reflect Canadian conditions. This would supplement local data collection required for decision making.

One must also consider the impact of unintended information spillovers which may misinform the public and some decision makers. The intense exposure to U.S. mass-media and the misperceptions they may induce must be corrected by appropriate counter-information which explains differences in conditions and values between the two countries (as well as pointing out similarities) and their implications for the management of chemicals in the environment. The locus of such activities should be the proposed tripartite information resource centers.

In sum, Canada can profit from information and expertise of other countries but, ultimately, the regulation of toxic chemicals in Canada must be based on distinctly Canadian problems and values.

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Part II

Paper 2

Environmental Regulation of the Chemical Industry in Canada: Organizational and Legal Analysis

Introduction

This paper analyzes the influence of Canadian legal and institutional structures upon environmental regulation of the chemical industry. First, the paper reviews the theoretical objectives (or rationales) for the environmental regulation of industry. It then explores the opportunities and constraints which are imposed by the Canadian legal system. Starting with constitutional limitations on the powers of different governments, the paper then describes major existing environmental legislation which affects chemical producers. Most of the legislation provides only general guidelines for the exercise of delegated powers. Therefore, the actual process of developing and imposing specific restrictions upon industry determines, to a large extent, the effectiveness of regulation in attaining social objectives. The process of developing specific regulations consists of the subprocesses of evaluation and inter-institutional coordination. The actual and perceived efficacy of these subprocesses is assessed to provide a partial answer to the questions: (1) Is the system inclined to produce "over" or "under" protection of the environment? (2) Is the structure of the system a cause of burdensome jurisdictional overlaps? (3) Is the system likely to produce unnecessary restrictions on industrial behavior?

The paper then deals with the implementation of regulations. The potential effects of implementation depend upon the ability of goverments and the public to impose sanctions upon violators. The major legal issues involved in determining the availability of legal sanctions include liability, legal standing and the burden of proof. The paper concludes with prescriptions for institutional and legal modifications which may reduce the burden of overlap and ensure a socially desirable level of environmental protection.

Objectives or Rationale for Environmental Regulation

There is evidence linking health problems with chemical contamination of the environment (Higginson, 1968, Bridges, 1976). While cancer has received great public notoriety, there are other pathologies caused by chemicals in the environment such as deterioration of the nervous system, pulmonary function, cardiovascular efficiency and activities of other essential organs in the body.

The market fails to appropriately balance the social costs and benefits in determining the production and consumption patterns of dangerous chemicals. The major reason for market failure lies in the existence of negative externalities (or spillovers) which fall upon members of society not directly involved in the production or consumption of toxic chemicals. Since the market usually does not offer incentives to deter the imposition of externalities, there is a case for government intervention. Furthermore, when such externalities impose an irreversible penalty on future generations (e.g., mutagens which may change the gene pool of generations as yet unborn), it can be argued that it is the role of the government to protect the rights of future generations not presently represented in the market place.

Market failure also occurs when there is inadequate information for rational decision making by consumers. "In a world of increasing specialization and complex technologies, information for intelligent decision making about a wide variety of goods and services cannot be summed up in their observable characteristics" (ECC, 1979, p. 48). The mere provision of information by the government may not be sufficient, since the capacity of individuals to receive and process information is limited. Furthermore, the provision of information and its processing by individuals may involve high costs. In these cases there is a justification for government regulation.

While one could envisage the introduction of a market mechanism to regulate classical pollutants (e.g., by defining appropriate property rights), it would be infeasible to deal through the market with what Page (1978) has called the "new" pollutants. New pollutants are different from classical pollutants in several ways. First, they are very potent -- concentrations measured in parts per billion or less can cause harm. For example, the World Health Organization (1967) considered mercury levels of over fifty parts per billion in air and water to be unacceptable. Second, the time span between exposure to these pollutants and evidence of ill effects can be very long; skin cancer from coal tar has a latency period of ten to twenty years (Heuper, 1959). Third, the effects of new pollutants may be irreversible and difficult to detect.

These properties of the new pollutants not only ensure "market failure" but raise doubt even about the ability of government regulations to ensure socially desired levels of protection.

The Canadian Legal System

Despite the fact that "Constitutional limitations are often mentioned as a reason why governments are not able to combat environmental problems as they might wish", Franson and Lucas (1977, p. 13) conclude that this is not the case. "Even if one level of government were forced to 'go it alone', it would probably find that it has ample constitutional power at its disposal to accomplish its objectives" (p. 13).

The British North America Act of 1867 which divides legislative power between the federal Parliament and provincial legislatures is the principal document of the Canadian constitution. This Act enumerates general and specific areas of federal and provincial jurisdiction.

Environment, as a general field, is not covered by the B.N.A. Act; but the courts have developed legal doctrines to allocate legislative authority in unspecified fields. "For any particular statute to be within the power of the legislature enacting it, it must deal with a matter which falls within the subjects over which the legislature has authority. As long as the true character of legislative concern is a matter which is within the competence of the legislative body enacting it, the legislation will always be valid. There is, thus, a two-step process: (1) to determine the true character of the legislation -- its matter, and (2) to determine whether that matter falls within those subjects over which the particular legislature has control" (Ince, 1976, p. 15).

Often, a particular problem may lie within the jurisdiction of both levels of government, each of whom view it from a different perspective. For example, in a particular case of water pollution, the federal government may view regulation as a matter of protecting the fisheries while the provincial government may view it as protecting the public's health. It should be noted that municipalities are also involved in environmental control but, since they are created by provincial legislation, they act principally as delegates of provincial legislatures.

Section 91 of the B.N.A. Act, 1867 grants the federal government the constitutional authority "to make laws for the peace, order and good government of Canada". Gibson (1973) suggests that powers under this clause provide the federal government with the authority to deal with all forms of pollution which cross provincial boundaries and international borders and to handle an environmental emergency such as a large scale escape of poisonous substances to the environment.

Of the powers enumerated in Section 91 of the B.N.A. Act, Franson and Lucas (1977) find those associated with criminal law and trade and commerce the most likely to be of use in dealing with hazardous substances.

However, there are several limitations on the ability of the federal government to use the criminal law to regulate chemicals in the environment. Federal criminal law may not be used in a "colourable" attempt to encroach upon traditional areas of provincial jurisdiction which are protected by the Court. Also, the use of criminal law restricts the type of available remedies and sanctions (MacDonald, Railquip Enterprises v. Vapor Canada (1976), 7 N.R. 477; 66 D.L.R. (3d) 1.). The courts oversee the appropriateness of sanctions in new legislation to determine if it is a valid application of the criminal law power.

Three sections of the Canadian Criminal Code have relevance to environmental protection (sections 176, 174 and 175). Under section 176 the Code makes it an offence to commit a common nuisance. For someone to be convicted under that section, however, the court must be satisfied that the conduct was a violation of some additional law. This makes the application of section 176 unlikely.

Section 174 prohibits the throwing, injecting or depositing of offensive, volatile substances that are likely to alarm, inconvenience, discommode, or discomfort any person or cause damage to property. Section 175 gives a Justice of the Peace or magistrate wide powers to prevent a person from injuring others. Ince (1976, pp. 43-44) comments that "such broad discretionary powers would be invoked in only the most serious cases, and therefore, this section has limited usefulness in an environmental context, yet it may be applicable where the environmental threat poses immediate and serious danger to life and property".

The federal trade and commerce power has been recently interpreted more broadly. For example, the courts have allowed the expansion of federal regulation of interprovincial trade (Franson & Lucas, 1977, p. 16). Franson and Lucas (1977, p. 16-17) conclude that the "trade and commerce power adds another justification [to the criminal law power and general power] that might be offered. Certainly some commodity standards are motivated by economic considerations and would be beyond question. With respect to more doubtful cases, it must be borne in mind that the person challenging any legislation has the burden of showing that it is unconstitutional. It would be hard to mount such a challenge because of the difficulty of determining the real aim or objective of the legislation and because Parliamentary debates, speeches, and other extrinsic aids probably could not be resorted to before the courts".

The B.N.A. Act gives both the federal and provincial governments powers with respect to agriculture. However, the section expressly states that any provincial act concerning agriculture shall have effect only if it does not contradict any federal law (Ince, 1976). Both levels of government can use this power to authorize legislation dealing with fertilizers, feed products, and pesticides.

Section 92 of the B.N.A. Act, 1867 gives the provinces wide domains of jurisdiction. Provincial legislatures have authority within their provinces over matters of manufacturing, municipal institutions, property and civil rights, the working environment and waste disposal. Clearly, provincial authority is limited to the boundaries of the province. Ince (1976, p. 23) observes: "Because [provincial powers of legislation] are framed in such general terms, it is very difficult to limit provincial powers. Over the past century the courts have, quite understandably, interpreted these powers very broadly which has enabled the provincial legislatures to deal with a vast number of areas. On the basis of the provinces' powers to control property, civil rights and local matters, a great deal of environmental legislation is authorized. We can safely say that these powers allow the province to legislate on land, air, water and noise pollution, land use control, parks and industrial regulation". However, by the doctrine of paramountcy, provincial legislation does not take effect whenever it conflicts in an operational sense with valid federal legislation (Local Prohibition Case [1896] AC 348).

The federal Parliament also has power over the census and collection of statistics. These powers ensure the ability of the federal government to force the release of any information it needs. Provincial governments do not have similar general powers to obtain information. They must rely upon other powers within their control to indirectly obtain information they require (e.g., by making the granting of a licence dependent upon the provision of some specified information).

Federal Legislation

The major environmental acts which may affect the behavior of chemical producers are as follows:

(1) the Fisheries Act;

(2) the Canada Water Act;

(3) the Clean Air Act;

(4) the Environmental Contaminants Act;

and (5) the Pest Control Products Act.

The Fisheries Act, the Canada Water Act and the Clean Air Act are general pollution control statutes. The Fisheries Act is based upon the specifically designated federal power to deal with sea coast and inland fisheries. The act prohibits the deposit of deleterious substances of any type in water frequented by fish or in any place under any conditions where these or other substances which result may enter such water. Deleterious substances are considered to be those which, when added to water, render it "deleterious to fish or to the use by man of fish that frequent that water". Furthermore, the federal Cabinet may prescribe, by regulation, substances which are considered deleterious to fish under the Act. Cabinet may also identify conditions under which substances can be legally deposited. The provisions of this Act are very general, making almost any discharge to water frequented by fish a violation of the Act. Indeed, the Act is so wide ranging that it cannot be implemented without regulations specifying what discharges to water are permitted. In fact, the federal government has not prosecuted industries under this Act where specific regulations have not yet been developed. There is one area of the Act, however, that does not permit any exceptions: discharge to spawning grounds. The Act states that "The eggs or fry of fish on the spawning grounds shall not at any time be destroyed."

The Canada Water Act authorizes the establishment of water quality management areas by the federal government in collaboration with provincial governments. For water bodies which are under sole federal control, interjurisdictional waters, or when an urgent national need exists, the Act permits unilateral action by the federal government. The major task of agencies which manage water quality areas is to maintain waste treatment facilities and to achieve effective water quality management. Some of the steps to ensure effective management include monitoring, research, and the establishment of a water quality management plan. Such a plan would include:

(1) recommendations concerning water quality standards and a schedule of implementation;

(2) recommendations about the types of wastes and quantities (if any) that may be deposited into the water and the conditions under which the wastes can be deposited;

(3) recommendations as to the type of treatment facilities necessary to achieve the prescribed standards; and

(4) recommendations as to appropriate effluent discharge fees and appropriate waste treatment charges for government treatment facilities and waste sample analysis charges for inspection of other facilities.

These recommendations would be widely published (including in the Canada Gazette).

Where these plans are approved by the federal Cabinet for federal waters, and by the federal Cabinet and the appropriate provincial government for jointly managed waters, an agency managing a water quality area will have wide power to implement its plan. Cabinet may make regulations to prescribe substances and quantities that may be deposited in management areas and to set forth the conditions for their deposit. Cabinet may make regulations to prescribe the procedure followed by each agency in its management of the water bodies under its jurisdiction. Cabinet may then prescribe criteria for the determination of discharge fees and the manner in which such fees are to be paid. All regulations are in force if they are made on the recommendation of the agency, or on the joint recommendation of the federal and provincial cabinets where the cabinets are parties to the water management agreement.

There are still no areas designated as water management areas and therefore the general restrictions imposed by section 8 of the Act are not yet in force. The Act offers only a potential for the coordinated efforts of the federal and provincial governments. The second part of the Act dealing with nutrients especially affects the manufacture of laundry detergents and other cleaning agents with constituents which may cause eutrophication. The Act forbids the manufacture or importation of any cleaning agent or water conditioner that contains a nutrient in a concentration that is greater than the prescribed maximum. Cabinet has the power to choose the nutrients and to set maximum concentrations.

The Clean Air Act, like the Canada Water Act, is cast in general terms and its implementation depends upon further government action -- in this case, the promulgation of specific emission standards. This act gives Cabinet the power to establish maximum limits on emissions from stationary sources to the ambient air if such emissions impose risks on health or are in violation of an international agreement. The Act also permits the establishment of an air pollution monitoring system. Under the Act, the Minister responsible for its administration is authorized to formulate national ambient air quality objectives. Objectives suggest the atmospheric concentrations of specific substances which are considered desirable, acceptable or tolerable by the government. These objectives are only guidelines and are not legally enforceable. The objectives provide a signal to industry about potential federal regulation as well as notifying provinces to incorporate the objectives into their own regulations. The Act provides broad powers of inspection and information collection.

The Environmental Contaminants Act overlaps, in part, the domain of the other general pollution control acts. "Environment Canada officials maintain ... [that the act] ... is designed for a supplementary role. It is intended to cover problems that cannot be dealt with effectively under other environmental legislation" (Franson and Lucas 1977, p. 48). This act is specifically designed to deal with the "new" pollutants identified by Page (1970). It is jointly administered by the federal ministers of the Environment and National Health and Welfare. Where they have reason to believe that a substance may enter the environment in quantities or concentrations that may constitute a danger to human health or the environment, the ministers are authorized to (1) require commercial producers of that substance or class of substances to notify the government of such activities and provide information about the substances, and (2) require producers and importers of the substance, or any product containing it, to conduct any tests which the ministers may reasonably require.

Where a person manufactures or imports for the first time a chemical compound in excess of five hundred kilograms, he must, within three months, notify the government of the name of the compound, the quantity manufactured or imported during that year, and any information in his possession about any danger to human health or to the environment posed by the compound. After consultation with industry and the provinces, the federal government may prepare proposals for regulation. These proposals must be published in the Canada Gazette.

There is a period of 60 days after publication during which objections to the proposed regulation can be filed. Objections are reviewed by a special Environmental Contaminants Board of Review which is established especially for this purpose. The board makes recommendations to the Minister of the Environment who is not legally obligated to accept them. After these procedures are followed, Cabinet may make the final regulations effective. The Act provides broad powers of inspection and seizure to ensure that regulations are obeyed. In emergency cases, Cabinet may suspend this lengthy procedure and make regulations effective immediately. One should note that the right to object and involve the government in an expensive review process effectively deters government from introducing regulations without an extensive consultation process.

Like many other federal environmental control statutes, the Act is an enabling statute which becomes meaningful only when specific regulations are made under it. In a later section we therefore pay special attention to the process through which specific federal regulations are developed. The wide powers of enabling acts, however, have an important psychological value -- they create industry expectations which result, at times, in voluntary compliance without the need for formal regulation. The broad powers which are delegated by an enabling act, however, also create uncertainties which may inhibit some of their useful economic functions.

The Pest Control Products Act requires the registration of all pesticides and adherence to restrictions on storage, packaging, and labelling. The registration process is prescribed by regulations under the Act.

Other federal legislation which may be invoked to protect the environment and which directly affects the production of chemicals includes the Hazardous Products Act and various acts which affect the transportation of chemicals by land or water.

Some recent proposals for provincial and federal legislation concerning transportation of hazardous goods raise questions of principle as to the degree of industry's liability and means of compensation. These questions are dealt with separately in a later section of this paper.

Provincial Legislation

"General pollution control statutes exist in all the provinces. These establish regulatory schemes based on permits or approvals to regulate the discharge of contaminants into air, water or land" (Franson and Lucas, 1977 p. 27).

The B.C. Pollution Control Act (1967), for example, established a Pollution Control Board appointed by the provincial government to oversee the operation of the Pollution Control Branch. The Board, after public hearings, develops a set of objectives for different industries. These objectives are unenforceable guidelines.

The emissions by industry to air, land or water are controlled by a system of site-specific permits. These permits are issued by the Director of the Pollution Control Branch who enjoys considerable discretion in issuing permits. The Director may also issue an approval for a temporary discharge instead of issuing a permit, and Cabinet may exempt certain classes of polluters from the provisions of the Act. The Director also has wide powers to change and cancel permits once they are granted. Discharge without approval is an offence.

The Act provides adequate powers to investigate possible violations, but the penalties are not severe. Ince claims "it is doubtful whether such penalties are effective deterrents in all cases. It is conceivable that large corporate polluters could find it economically profitable to violate the Act and pay $500 per day fine" (1976, p. 54). Of course, the permit might be revoked if there were a continuing violation.

Objections to applications for permits can be filed by those whose interests may be directly affected. However, members of the public who are not eligible to file objections directly may file indirectly through the Pollution Control Board which then decides whether the public interest requires the Director to consider the objection. The Director has complete discretion to hold or not to hold a hearing about an objection, but the courts have ruled that in exercising his discretion the Director must act in a judicial manner (Ince, 1976).

Appeals concerning the decisions of the Director may be filed with the Board, and appeals concerning Board decisions can be filed with Cabinet or the Supreme Court of B.C., as the appellant may decide.

The Environmental Protection Act (1971, amended 1972) of Ontario is the principal instrument in that province for controlling discharges into the environment. The Act prohibits discharge into the natural environment of any contaminant in an amount or concentration in excess of that prescribed by regulations. The Ministry of the Environment may issue a stop order to those who discharge emissions which constitute an immediate danger to human life. The Act states that discharges to the natural environment are prohibited that may: (1) damage the quality of the natural environment, (2) cause damage to property, or to plant or animal life, (3) are likely to cause harm or material discomfort to any person, (4) adversely affect the health of any person or impair his safety, or (5) make any property or plant or animal unfit for use by man.

The Act requires approval by the Ministry for contaminant discharges into air. The approvals are based on ambient air quality criteria established by regulation. These ambient criteria are not linked to an offence or to compliance order provisions. Consequently, they are not legally enforceable except to the extent that they are incorporated as terms or conditions in approvals issued by the Ministry of the Environment. "Regulation under ... [the Act] ..., however, establishes point of impingement (stack) standards (as opposed to ambient criteria) which are enforceable through criminal prosecutions" (Franson and Lucas, 1977, p. 28).

The Ministry may also issue an order to limit or control the rate of emission or discharge of a contaminant to the natural environment or to specify other actions which are designed to control the emission. An appeal procedure is available when applications for certificates or approval are denied, modified, or granted conditionally. The Act also develops a system of approvals for waste management or disposal sites.

Water pollution in Ontario, however, is primarily dealt with by regulations developed under the Ontario Water Resources Act (1970, amended 1972). The Act prohibits the discharge of any substance which may impair the quality of water. This impairment is considered to have occurred if materials deposited or discharged cause or may cause injury to any person, animal, bird or other living thing as a result of the use, consumption or contact with the water. Breach of the Act is punishable on summary conviction by a fine, imprisonment or both. The Ministry of the Environment may also demand corrective action from industry (e.g., installation of pollution control equipment). The Act requires approval for the establishment of sewage works as well as notification of all accidental discharges of contaminants. Under the Act, regulations can be developed to prescribe standards of quality for sewage and industrial waste effluents, receiving streams and water courses.

Most provinces have similar pollution control statutes which cover all media of discharge (water, air and land). Alberta and Saskatchewan have separate water and air pollution control acts. The basic legislative models for provincial environmental protection typically include a system of permits and regulations or guidelines which specify different parameters of quality. In addition, provincial legislation grants powers to the appropriate agencies to issue orders to modify or stop emissions. Legislation authorizes information collection for both general research and specific monitoring purposes.

The Alberta Clean Air Act (1971, amended 1972 and 1974), for example, uses the preceding approaches. Industrial development must be approved before construction. Once a plant is constructed, it requires a licence to operate. Existing plants also require a licence to continue operations. Where it appears to the Director of Pollution Control that there exists, in any part of Alberta, an air contaminant which violates air quality regulations, or which has an unacceptable visual impact or an offensive odour, the Director may issue a control order to the person responsible for the emission. The order may instruct the polluter to limit the rate of emission, stop the emission permanently or for a specified period of time, or install pollution control equipment.

Failure to respond to a control order may trigger the issuance of a stop order. Failure to comply with a stop order within 48 hours is an offence punishable on summary conviction by fine, imprisonment or both. Each day of violation is considered a new offence. The Act authorizes regulations which prescribe for all or part of the province: (1) the permissible concentration of any air contaminant,(2) maximum ground level concentration standards for any air contaminant, (3) maximum concentration of any air contaminant emitted to the atmosphere from any plant, structure or thing, (4) maximum weight of any air contaminant emitted to the atmosphere from any plant, and (5) the method or type of method or instrument to measure the various control parameters. The Alberta Clean Water Act (1971, amended 1972 and 1974) provides a similar control scheme for discharges to water.

The Hazardous Chemicals Act (1978) of Alberta, like the federal Environmental Contaminants Act, was intended to fill remaining legislative gaps, especially with respect to management of wastes on land. To date, no regulations have been issued under this act. This state of affairs exemplifies the policy uncertainty which prevails with respect to the question of waste disposal on land. Several provinces including Alberta are in the process of examining alternative policy models of management of wastes on land and it is expected that intensive new regulatory activity will take place in this area of environmental protection.

In addition to general pollution control statutes, many provinces have public health acts which include provisions for pollution control. Furthermore, indirect control of emissions to the environment are imposed by industrial safety and occupational health statutes. Finally, the use and production of pesticides and fertilizers is controlled not only by federal acts and regulations, but also by a variety of provincial legislation and regulatory instruments.

To conclude, in the provinces where most of the production of chemicals is concentrated, namely Ontario, Quebec, Alberta and B.C., there exists a network of statutes which permit tight controls by provincial governments of discharges to the environment. The controls are subject, to a large extent, to the discretion of provincial pollution control agencies. The flexibility in exercising discretion depends upon (1) the degree to which environmental quality standards are formalized in enforceable regulations, or clarified in guidelines (objectives), (2) the ease with which appeal proceedings can be initiated against decisions of the government, (3) the availability of information outside the industry and the government, and (4) the severity of sanctions imposed upon violators.

In addition to statutory regulation, the common law still retains (at least potentially) an important role in environmental law. It would not be appropriate here to go into extensive detail on these common law causes of action, but a brief review is provided. The law of tort provides five major causes of action: (1) nuisance -- both public and private; (2) strict liability -- commonly known as the "Ryland v Fletcher doctrine"; (3) trespass; (4) negligence, and (5) riparian rights.

This particular analysis concentrates on nuisance and strict liability, as these appear to be the most commonly utilized remedies in the environmental area (see further: Katz, 1969; Fuergensmeyer, 1971; McLaren, 1972). Nuisance is the leading edge of the common law; as a leading American text puts it: "[n]uisance theory and case law is the common law backbone of modern environmental and energy law" (Rodgers, 1977).

Historically there were important differences between the doctrines of public and private nuisance. Private nuisance is the unreasonable interference with the use and enjoyment of land. A public nuisance (in common law) is the unreasonable interference with a right common to the public at large. In public nuisance cases the plaintiff had to demonstrate that the injury suffered was different in kind (or at least extensive degree) from that suffered by other persons with the same public right; however, it has been claimed that "the differences are fast disappearing" (Rodgers, 1977). The current view of the Canadian courts on difference in kind is not yet clear. In Stein v. The City of Winnipeg the Manitoba Court of Appeal held that a plaintiff did have standing even though only suffering the same damage as neighbours.

A wide variety of injuries or annoyances have been held to fall under the doctrine of private nuisance -- chemicals, fumes, particulate matter, and noise -- are a few examples. The keys to private nuisance are fourfold: (1) unreasonable interference, (2) an interest in land, (3) substantial harm, and (4) continuous damage. There is some disagreement whether the test of reasonableness is the same as for negligence. Burns and Slutsky (1973) argue it is not: "[i]n the context of nuisance, though, reasonableness means more than taking proper care. Rather it refers to what is legally right between the parties taking all factors into account. It is no defence to a nuisance action to argue that all proper care was taken" (p. 144). For example, both Canadian and American cases have established that the use of the best available technology is not an adequate defense (Appleby v. Erie Tobacco Co., (1910) 22 O.L.R. 533 (Div. Ct. Ont.); Richards v. Washington Terminal R.R. 233 U.S. 546, 34 S. Ct. 654 (1914)).

The potential impact of private nuisance -- and the political constraints historically imposed upon it -- are revealed in McKie v. The K.V.P. Co. ([1948] 3 D.L.R. 201). In this case the owners of summer cottages and tourist facilities on land bordering a river in Ontario sued the defendant company which owned and operated a Kraft paper mill thirty-five miles upstream. It was found that waste effluent discharged into the river by the company had killed the fish, created foul odours and materially altered the taste and quality of the river's water. The action in nuisance was based on the odiferous emanations from the Kraft pulp mill substantially interfering with the comfort and enjoyment of the plaintiffs' properties. The court accepted the argument that the smell rendered the resort less desirble to tourists, thus interfering with the plaintiffs' business, as well as the personal enjoyment of their properties. Both damages and an injunction were granted. However, the Ontario legislature quickly enacted legislation which dissolved the injunction (The K.V.P. Company Limited Act, S.O. 1950, c.33).

A second major cause of action is that of strict liability, or the so-called "Rylands v. Fletcher" cases ((1866) L.R. 1 Ex. 265. Aff'd 1868 L.R. 3 H.L. 330). The classic statement of Justice Blackburn bears repeating: "[a] person who for his own purposes brings onto his lands and collects and keeps there anything likely to do mischief if it escapes, must keep it in at his peril, and if he does not do so, is prima facie answerable for all the damage which is the natural consequence of its escape" ((1866) L.R. 1 Ex. 265, pp. 279-280). Subsequent case law development has been somewhat confused as to the conditions under which strict liability will be held. The central issue is the naturalness of the use. An American casebook summarizes the debate thus:

> Dean Prosser insists that the English cases affirm that strict liability is confined to things or activities that are "extraordinary", "exceptional", or "abnormal" and does not apply to the "usual and normal". But "non-natural uses", according to the cases collected in the Prosser handbook, include many common activities which are simply high in risk: water collected in large quantities in hydraulic power mains; gas stored in quantity; and high-powered electricity transmitted under the streets. Indeed, it is said that "the storage in quantity of explosives or inflammable liquids, or blasting, or the accumulation of sewage, or the emission of creosote fumes, or pile driving which sets up excessive vibration, all have the same element

of the unusual, excessive and bizarre and have been considered 'non-natural' uses, leading to strict liability when they result in harm to another" (Rodgers, 1977, p. 159).

Perhaps the most important case relating to chemicals is the American case of Fritz v. E.I DuPont (6 Terry (Del.) 427, 75 A.2d. 256 (1950)), which prompted a commentator to state that "Delaware is zoned for chemicals" (Rodgers, 1977), p. 160). In this case it was held that the possession of chlorine gas was not dangerous per se.

Alternative causes of action are to be found under negligence, trespass and riparian rights.

Several factors have mitigated the usefulness of these common law actions in the Canadian context. Historically the most important has been the bar to class actions: "the machinery of a representative suit is absolutely inapplicable" (Markt & Co. v. Knight Steamship Co. [1910] 2 K.B. 1021 at 1035 (C.A.)). This can be contrasted with the courts in the United States where the Supreme Court has ruled that individuals can proceed as a group where they are the direct beneficiaries of a resource and will be denied continued use unless they can proceed in court (Sierra Club v. Morton, 405 U.S. 727 (1972)). There may be, however, some slight weakening of this prohibition in Canada (see Thorson v. The Attorney General of Canada (1975) S.C.R. 138 and Stein supra).

Secondly, a defense of statutory authority may lie. In cases where the defendant has been authorized to do something which cannot be carried out without damage and provided that the defendant does not act negligently the defense will lie (Linden, 1966; McLaren, 1973). This defense appears to be limited to cases where the acts are required, rather than permitted.

The potential damages under common law remedies are enormous as some recent cases in the United States reveal. Allied Chemical Company has paid at least $12 million in damages and an unknown number of suits have been settled out of court (Pfennigstorf, 1979; Goldfarb, 1978). Recently in Puerto Rico v. S.S. Zoe Colocotroni (456 F.Supp. 1327 (D.P.R. 1978)) the defendants were held liable for five million dollars for the replacement of marine animals alone.

Under the civil law in Quebec, there are only limited remedies available. "Private law recognizes two types of remedy against the industry reponsible: the injunction and the action for damages ... The injunction is a drastic remedy. If granted, it will either result in the closing of the plant, or necessitate considerable expenditure in equipment and labour. The court does not concern itself with the practical difficulties that an industry might have to face in complying with the court order. Some famous decisions have thus simply ordered companies to stop polluting the atmosphere ..." (Giroux and Kenniff, 1977, p. 143). Balance of convenience must be taken into account when the injunction requested is an interlocutory injunction. When a permanent injunction is requested, the judge must limit himself to considering the merit of the claim" (Giroux and Kenniff, 1977, pp. 143-4).

The other type of remedy consists of action for damages based on Article 1053 of the Quebec Civil Code. The applicant must establish the damage, the fault committed by the respondent and a causal link between the damage and the fault. In cases concerning pollution, "the courts have added a particular gloss (sic) to the rule based on the theory of troubles de voisinage (roughly analogous to the common law of private nuisance). An enterprise (regardless of its title to the land) is considered responsible for any damage to adjacent areas caused by its activity when such loss exceeds the normal inconveniences of the area" (Giroux and Kenniff, 1977, p. 144). These remedies are problematic when applied to toxic substances with long latency, since there is a time limit on damage suits. Furthermore, the special rules applicable to situations of troubles de voisinage require geographical adjacency between the source of the nuisance and the place of damage.

Another element of the formal legal system in Canada concerns the country's international obligations. The most important of these, from the point of view of the chemical industry, is the Boundary Waters Treaty of 1909 that provided for the establishment of the International Joint Commission (I.J.C.). The I.J.C. is a permanent intergovernmental advisory body consisting of three members appointed by the Government of Canada and three members appointed by the President of the United States. The treaty stipulates that "boundary waters and waters flowing across the boundary shall not be polluted on either side to the injury of health and property on the other". The Commission is asked by both governments, from time to time, to examine and report on any questions or matters of difference concerning their obligations to each other. The I.J.C. has carried out several water pollution investigations (e.g., in the Great Lakes, the St. Croix River, the Rainy River and the Red River). Using excerpts from the Commission's report concerning the Pollution of the Rainy River (1965), Thompson (1977, pp. 126-127) summarizes its attitude toward the pollution of boundary waters:

"1. The maximum beneficial use of available water resources should be permitted and unreasonable use of water should be prevented. The disposal of wastes into the river should be controlled so as to achieve the highest quality consistent with the maximum benefit to all users.

2. Discharging suitably treated domestic and industrial wastes into the river is a reasonable use of these waters provided that such use does not create a hazard to public health or cause undue interference with the rights of others to use these waters for legitimate purposes. Wastes discharged into the river must be such as not to cause injury to health or property in the other country. Undue interference with the development of desirable types of aquatic life constitutes an injury to property even though it may be the property of the public at large.

3. Water quality requirements should not only safeguard public health and protect the beneficial uses of these waters but also permit legitimate use of these waters for the disposal of adequately prepared wastes. Water quality objectives should not exclude all impurities from the water course; nor should they tolerate the maximum quantity of domestic and industrial wastes that the stream can assimilate. Objectives designed to alleviate pollution in a specific stream or body of water are not necessarily applicable to other watercourses where the conditions may be quite different.
4. If, in the future, there should be a substantial change in the uses to be made of the waters or in the quantity and nature of the wastes discharged into the waters, the objectives should be reviewed and amended as necessary to take into account the new factors so as to ensure that there will be no injury to health or property.
5. The primary responsibility in the field of water pollution rests with the province and the state. However, each Federal Government has an obligation to the other under Article IV of the Boundary Waters Treaty of 1909. Thus the achievement of the water quality objectives recommended will require the co-operation of the two levels of government in both countries."

In 1972 the governments of Canada and the United States entered into an Agreement on Great Lakes Water Quality. More recently on

November 22, 1978 the United States and Canada signed an agreement. This agreement is based on the following conclusions: (1) "the Great Lakes Water Quality Agreement of April 15, 1972 and subsequent reports of the International Joint Commission provide a sound basis for new and more effective cooperative actions to restore and enhance water quality in the Great Lakes Basin Ecosystem ... (2) that the best means to preserve the aquatic ecosystem and achieve improved water quality throughout the Great Lakes System is by adopting common objectives, developing and implementing cooperative programs and other measures, and assigning special responsibilities and functions to the International Joint Commission".

A stated policy of the U.S. and Canada is that "the discharge of toxic substances in toxic amounts be prohibited and that the discharge of any or all persistent toxic substances be virtually eliminated" (Great Lakes Water Quality Agreement, 1978, p. 4). In addition to a general policy statement, the agreement also details some specific objectives. Those specific international objectives which are adopted will represent minimum levels of water quality desired in the boundary waters of the Great Lakes System but will not be intended to prevent the establishment of more stringent national requirements.

The I.J.C. and the parties to the agreement are charged with the task of reviewing the specific objectives and making appropriate recommendations. Canada and the United States are charged with the responsibility of developing requirements in their respective jurisdictions which shall be consistent with the achievement of both the general and the specific objectives of the agreement.

With regard to industrial pollution, the agreement specifies a program of abatement, control and prevention of pollution. This program includes two major activities which have a potential impact upon the chemical industry: (1) establishment of waste treatment or control requirements expressed as effluent limitations (concentration and/or loading limits for specific pollutants where possible) for all industrial plants; and (2) development of requirements for the substantial elimination of persistent toxic discharges into the Great Lakes System. The schedule of implementation sets December 31, 1983 as the final deadline.

The agreement also includes a call for waste-disposal control programs and tighter controls of hazardous polluting substances. Persistent toxic substances (i.e. those with a half life in water greater than eight weeks) are identified as special targets. Controls will cover production, use, distribution and disposal.

The I.J.C. is the major joint vehicle of implementation. In discharging its responsibilities, the Commission is authorized by the agreement to exercise "all of the powers conferred upon it by the Boundary Waters Treaty and by any legislation passed pursuant thereto including the power to conduct public hearings, and to compel the testimony of witnesses and the production of documents" (I.J.C., 1978,

p. 11).

The Process of Federal Regulation Making
Formal Elements Designed to Ensure Accountability

Legislation and treaties provide a framework which shapes the dynamics of regulation. Much of the specific content of regulations is developed through the exercise of delegated powers by the bureaucracy in charge. The dynamics of regulation are also affected by the institutional and procedural framework which guides regulation making in general and by the special characteristics of the environmental or political arena, i.e. the network of personal interactions and the political economy which underlie the decision processes concerning environmental regulation.

Following the third report of the House of Commons Special Committee on Statutory Instruments (1969), the Statutory Instruments Act replaced (on January 1st, 1972) the Regulation Act. The Statutory Instruments Act was the first of three elements designed to strengthen the accountability to Parliament and the public of the exercise of delegated power. The Act requires almost all new federal regulations to be examined in draft form by the Clerk of the Privy Council in consultation with the Deputy Minister of Justice, and to be published in the Canada Gazette. This examination of new draft regulations is to ensure that they are authorized by the statute under which they are enacted; that the regulations do not constitute an unusual exercise of authority; and, that they do not violate the provisions of the

Canadian Bill of Rights. The Clerk of the Privy Council must also ensure that the form of the regulation meets established standards. Approval of a draft regulation leads to the formal submission of the proposal to Cabinet. After Cabinet review and approval, the proposed regulation is sent for registration. The final step in the process is publication in the Canada Gazette. Regulations usually take effect after registration. However, with some exceptions, a person is protected from the force of a regulation that has not yet been published in the Gazette.

The Standing Joint Committee on Regulations and Other Statutory Instruments is the second element affecting the process of regulation making. Its purpose is to increase the accountability of the executive branch of government to Parliament. "The Committee performs this function by examining individual statutory instruments after they are made to ensure, for example, that they are not inconsistent with the Canadian Bill of Rights ... The fifteen criteria used by the committee in performing its ex post scrutiny of ... regulations ... go far beyond the four primary criteria used by the Department of Justice in performing its ex ante scrutiny of regulation" (Anderson, 1980, p. 167).

The third and most recent element in the process of regulation making designed to increase accountability is the Socio-Economic Impact Analysis (SEIA). This procedure is required of those federal departments introducing "major" new regulations in the domains of

Health, Safety and Fairness. Copies of the impact analysis must be available to the public for comment for at least sixty days.

The policy of requiring a SEIA has been in effect since August 1, 1978. "This policy is intended to (a) promote a more thorough and systematic analysis of the socio-economic impact of new [Health, Safety and Fairness] regulations in order to prevent misallocative effects and/or negative effects of a non-allocative nature, (b) ensure uniformity across departments and agencies currently administering statutes which confer the power to make regulations ... [as well as] in the methodologies and assumptions used to perform such analyses and (c) provide an opportunity for increased public participation in the regulations making process" (Treasury Board document, (n.d.), p.2). While the SEIA policy stresses the appropriateness of applying risk-benefit or at least cost-benefit analysis, the instances in which the policy has been implemented in the environmental protection field indicate only a cost-effectiveness orientation (Anderson, 1980, pp. 175-177). This may be partly due to lack of adequate information concerning both the costs and the benefits of proposed restrictions.

The three formal elements designed to ensure accountability of federal regulation making in the environmental field are strengthened considerably by institutional arrangements to ensure consultation at different levels of regulation development. Additionally they may overlap. Commenting on one SEIA study, Anderson concludes: "However, it would seem that this saving [in anticipated social costs] might have occurred even without the preparation of a SEIA, as a result of the consultations with industry that have long been routine within some regulatory departments and agencies. Indeed, the Director of the Planning, Policy and Analysis Branch of Environment Canada - the branch that prepared the analysis - has stated that 'the SEIA did influence the final outcome but considerable credit should be given to the Regulation Development Process which preceded it '" (1980, p.175).

Organizational Elements Designed to Ensure Coordination and Accountability: The Consultative Process

The "task force" method of consultation is the most widely used format in developing specific proposals for regulation and the development of guidelines. When a preliminary proposal for regulation is initiated within the bureaucracy, a task force is assembled consisting of representatives from other relevant federal departments, provincial governments and the industry concerned. The task force is usually assisted by several working groups that consider, in detail, various technical aspects of the proposal, including the practicability of alternative available control technologies.

On the basis of papers submitted by the different groups, recommendations are developed by the task force. The working group collects information from different sources concerning existing discharges to the environment, monitoring technologies and health and safety information. The information collection process relies heavily upon industry cooperation. Often the relevant trade association, through its representatives on the task force and the working groups, assists in the dissemination, collection and processing of detailed questionnaires which gather information from industry. Such questionnaires may include information on industrial practices, impact assessment of alternative proposed control regimes and preferences among control strategies.

Because of the technical nature of task force deliberations and the presumption that the government adequately represents the public, no representatives of public interest groups have been included in task forces assembled to develop specific environmental regulations. The recent development of a new consultative format -- the SEIA seminar -- promises greater participation by representatives of public groups.

The advantages of the informal consultative process are: (1) the expertise at the disposal of the government is increased; (2) the information base for decision making is improved; (3) uncertainty is reduced (in particular, industrial uncertainty) through participative decision making; and (4) the likelihood of compliance with regulation by both industry and provincial governments is increased.

The task forces are also an important mechanism for coordinating the actions of different federal departments and the federal and provincial governments. As informal mechanisms they significantly reduce the burdens resulting from inconsistent regulations.

Some of the problems which may arise from a consultative process are: (1) the credibility of government efforts to protect the public is threatened (e.g. the process is open to accusations that government does not treat industry at arm's length as is the case in the adversary system in the United States); (2) the process of regulation making is slowed; and (3) nongovernment representatives often have insufficient time to prepare adequately since the government controls lead-times.

Public participation may alleviate the first problem. Provision of longer lead-times, in most cases (excluding emergencies), would reduce the problem of information collection for nongovernment members of task forces. As to the claim that the process slows down regulation making -- a comparison of the Canadian and U.S. systems suggests that the consultative process quickens implementation since litigation following regulation is minimized. Furthermore, the process has proved flexible enough to accommodate emergencies as well. The time span of the consultative process was reduced in two major cases to less than nine months from an average of more than two years.

The Politics of Consultation

Before presenting findings on the operation of the consultative process, the research methodology is briefly described. The researchers conducted open-ended interviews with most of the central participants in the consultative process: industry participants (both from individual firms and trade associations), government (both federal and provincial) regulators in the various departments, government scientific experts and public interest groups interested in environmental matters. Industry interviews were conducted over a 3 week period primarily in Montreal, Toronto and Ottawa, usually at the Canadian head office of the company. In most cases, at least two of the authors were present. Participants from the individual firms included both senior management and those staff directly engaged in consultation and negotiation with the relevant ministries. Interviews often lasted an hour and a half, although in some cases they lasted much longer. The researchers took notes during the interviews and wrote up the interviews within 48 hours.

Interviews with the federal departments usually involved group discussions (on several occasions an Assistant Deputy Ministry was present) and individual interviews. All of the ministries involved in chemical regulation -- including Environment, Agriculture, Health and Welfare and Transport -- were interviewed.

At the provincial level it was not possible to conduct interviews in all provinces; interviews were conducted in Ontario, Alberta and British Columbia. The attached appendix lists all the companies and ministries interviewed. The discussion that follows does not attribute views to individual interviewees, but we believe that it reflects a synthesis of the views expressed. Additional information was solicited by letters and questionnaires sent to 125 firms and 30 environmental-related interest groups. Responses were received from 71 firms and 14 interest groups. Finally, draft reports were sent to representatives of industry, government and environmental groups for comment and changes were made in the manuscript in response to these comments.

Any informal system of consultation which is not tightly constrained by legal barriers provides the advantage of flexibility while imposing the risk that discretionary power will be exercised arbitrarily. The working of such a system depends upon the skills of the participants and their acceptance of social norms. Review of the experiences of environmental regulation making (where the major industrial participants were represented by the Chemical Producers Association) suggests that the process of consultation and negotiation led to mutual learning and adjustments. This analysis will argue that the process has produced policies acceptable to industry without unduly compromising environmental quality standards; results which are favorable when compared to those achieved in similar circumstances by the United States. One important factor which inhibits the tendency to adopt extreme positions by participants is the globally shared desire to make the consultative process work.

The chemical industry, represented by the Canadian Chemical Producers Association, is diverse. On many issues, particular segments of the industry have concerns differing from those of other segments. The association is a vehicle through which industrial consensus can be reached. Thus, the process of searching for an internal consensus tends to moderate the position of industry.

The size and scope of industrial economic interests is another moderating factor. With close to $8.5 billion dollars in assets and a labor force of more than 82,000 people, the chemical producers have incentives to pursue their profit goals in a socially responsible manner. The industry is large enough that lack of response to public demands in a particular area (e.g. environmental protection) may trigger pressures for punitive actions in a variety of economic areas, including consumer resistance.

Concomitantly, the size and scope of economic impact of the industry may temper governmental actions which affect the industry adversely. Increased unemployment, decreased production of beneficial materials, decreased exports, or substituted imports affect other government goals. These and other factors are now explicitly recognized as having impacts which must be considered during the development of regulations. Representation on the task forces of other federal departments (in particular, those with economic development objectives such as the Department of Industry, Trade and Commerce) strengthens the pressures to adopt a flexible posture toward the trading off of costs and benefits during regulation development.

Provincial governments add to the moderating pressures. They tend to support the federal government's role as a provider of expertise and know-how rather than as an environmental manager -- a task governments of most provinces prefer to claim as their own.

As we have noted, public interest groups have had little involvement in task forces. However, "[p]ublic interest groups such as the Consumer's Association of Canada, Pollution Probe, Energy Probe, ... and the Canadian Environmental Law Association have all been formed or reinvigorated in recent years.... These groups have developed a considerable expertise in their own right and have begun to establish day-to-day contact with environment and consumer departments, federally and provincially....They tend ... to have focused their attention more on the regulation-making aspects of regulation than on day-to-day compliance issues" (Doern 1977, p. 66).

In spite of the emergence of these active public groups interested in regulation making, there are several constraints mediating their national impact on the consultative process. First, participation in regulation making requires a large commitment of time and resources. Most of the public interest groups rely on volunteer work which significantly reduces the effectiveness of their participation in any time-intensive effort on a regular basis. Public interest groups also have problems in reaching an internal consensus. Often there is a struggle within these organizations between members with expertise and those who lack expertise but have a high commitment to certain organizational values or ideologies. Lack of resources and internal conflict may weaken the influence such groups can have on a decision process which also includes representatives of governments and industrial organizations.

Although the function of task forces is not likely to be affected significantly by public participation, in fact, such participation will contribute to the perceived integrity of the process -- at least in the short-run. Furthermore, it may create a channel for mutual education through which industry, the government and the public can learn more about a problem by recognizing their diverse perspectives. In the longer run, however, the public may become influenced by the American approach which is more open and demands a more visible role for public participation.

Exogenous factors which affect the dynamics of consultation include: foreign and international governmental activities in the area; new information; the mass media; and general public attitudes and crises. Many attempts to initiate regulation in Canada can be traced to similar efforts in other countries. In particular, regulation in the United States tends to have an important impact upon the Canadian regulatory agenda. Proposed standards in the United States tend to serve as "anchors" in the deliberation of Canadian task forces. This often leads to economies in deliberation efforts but, at times, it may offer a counterproductive focus when U.S. problems and technologies do not apply to Canadian circumstances. Some ways in which U.S. regulatory actions influence Canadian regulation include frequent informal meetings between bureaucrats of the two countries, meetings organized by joint commissions and international committees, and exposure to the mass media which tend to sensitize Canadians to problems important in the U.S. Since the United States leads the world in safety and health research, priorities and targets which are chosen there eventually affect the regulatory agenda of most other Western countries. E.E.C. regulatory efforts and the work of OECD and UN expert committees have more limited, but still significant impacts.

The work of task forces and their agendas is also influenced by information disseminated through the media which captures public attention. Crises, for example, with their dramatic impact (magnified by the media) upon public attitudes and perceived priorities tend to pressure government regulatory participants to push for stronger actions, while industry tends to concede more ground under public pressure than it would otherwise. The attention which the public generally pays to environmental issues (as opposed to energy or economic issues) is also reflected in the regulatory pace. Clearly, public attitudes (as perceived by government representatives in the consultative process) affect political calculations in making choices between more or less stringent requirements. The mass media, though a crude reflection (or indicator) of public priorities and attitudes, play an important role in shaping government executives' perceptions of public opinion.

Formal Coordination Arrangements: the Formal Accords between Provinces and the Federal Government

The federal government and seven of the provincial governments have entered into formal agreements which attempt to coordinate environmental protection. One province, British Columbia, is still negotiating an agreement, while Quebec had asked for a special status agreement which was refused. Newfoundland has decided to continue operating without an accord but with informal coordination ties between federal and provincial administrators.

A key problem in federal and provincial relationships is the identification of the locus of power. The provinces want Environment Canada to be source of technology, know-how and information but they simultaneously desire to retain their own decision making powers. The federal government sees its major objective in environmental protection as assuring that no "pollution havens" are created and that Canadian citizens are not provided with highly variable levels of health protection. This last objective is contentious since health matters in Canada are within the jurisdiction of the provinces.

Given these objectives and the inadequate resources of Environment Canada to implement a comprehensive system of inspection and controls, the federal government and most of the provincial governments have agreed to leave implementation in the hands of the provinces.

For example, the Canada-Ontario Accord for the Protection and Enhancement of Environmental Quality (1975) states the following responsibilities: "Canada agrees, after consultation with the Province and all other provinces, to establish broad national ambient quality objectives for air and water based upon nationally agreed scientific criteria....Canada, after consultation with the Province, agrees to develop national baseline effluent and emission requirements and guidelines for specific industrial groups and specific pollutants. Specific groups or classifications of industries will be agreed upon from time to time for the purpose of establishing priorities....Canada and the Province undertake to carry out pollution control programs for facilities under their respective control to meet agreed objectives and federal and provincial requirements....The Province agrees to establish and enforce requirements at least as stringent as the agreed national baseline requirements. Such requirements would be applied at start-up for all new installations or for installations undergoing major plant modifications. In all other cases the national baseline requirements would be applied as a minimum as rapidly as possible to meet agreed objectives and time schedules."

Canada will take enforcement actions in federal facilities at the request of the province or where the province cannot, or for some reason fails to, fulfill its obligations under the accord in matters of federal jurisdiction which are delegated for administration to the province.

The accord establishes cooperative arrangements concerning the monitoring of air and water quality in areas of joint interest. As part of this cooperative effort, an agreement on monitoring and surveillance methods and analysis must be reached to ensure comparable results. The province has the major role of surveillance of effluents and emissions and ensuring compliance with effluent and emission standards.

Canada and the province, in concert with other provinces, agree to exchange all data freely and to develop procedures relating to the publication of data having due regard for confidentiality or security as may be required. The accord emphasizes the role of the federal government as a source of information and technical know-how and training.

While a significant reduction in duplication was achieved by the accord, the present study has noted some instances where information-gathering by the federal and provincial governments has led to duplication. This can be attributed in part to the industry's insistence upon control of data as well as to the industry's opposition to unconstrained information sharing between provincial and federal governments.

Implementation of Regulation

Both provincial and federal strategies for the implementation of environmental protection programs distinguish between the treatment of existing plants and new developments. Existing plants are constrained with regard to the adoption of new pollution control technologies since modification of their operations often presents unique problems. Therefore, there is a need to accommodate their special needs into pollution compliance schedules.

Compliance schedules are typically negotiated between a specific plant and the provincial and federal pollution control administrations. In a decade of rapidly changing technologies, implementation schedules assume an important role since, at the end of the life cycle of a technology, modifications are significantly less costly. In fact, industry, in anticipation of future regulatory requirements to reduce costs of change, tends to invest in environmental protection technologies when developing new plants or modifying existing plants. To a large extent, the discretion which is exercised at this stage of the implementaion process determines the burden of regulation upon industry. Negotiated schedules of compliance "indicate specific steps that the company agrees to take, over a specified period, to bring the plant into compliance with the regulations. This is intended to allow existing plants to meet regulatory requirements without undue economic or technological hardship" (Buffa and Higgins, 1978, p. 5).

Questions of Appropriate Regulation Levels and Problems of Overlap

This analysis has identified several major attributes of the environmental regulatory system. They are:

(1) jurisdictional overlap between the federal and the provincial governments;

(2) broad domains of delegated powers to the executives of federal and provincial governments;

(3) broad discretionary powers of both provincial and federal government executives to determine compliance schedules;

(4) consultative processes to determine specific proposals for regulation, and traditions of consensus seeking;

(5) three elements, at the federal level, of formal review of regulation, including impact analysis;

(6) political and bureaucratic arenas which are characterized by a struggle to control the locus of decision-making. The means of this struggle may be expansion in the "productivity" of executives in different governments in terms of regulation making. Tempering forces in these arenas include defensive moves by industry and governments to protect other (non-environmental) objectives; and

(7) accords which coordinate provincial and federal requirements and implementation processes.

These attributes, coupled with the fact that the resource base for regulation activities concerned with environmental protection is highly constrained and shrinking in real terms, imply that:

(1) generally, environmental regulation making in Canada is based upon consensus reached through negotiation with industry. Evidence suggests that the chemical producers have effectively utilized the channels for industrial participation to modify many regulatory proposals which could have had a negative and/or an unnecessary impact upon the industry;

(2) the regulatory process leaves considerable discretion in the hands of government officials. Discretion, well exercised,

implies flexibility. Discretion, poorly managed, however, may lead to arbitrariness. Though the system provides many channels of appeal, the discretion inherent in the Canadian system is itself a source of burden - the burden of uncertainty; and

(3) there is a tendency in the system for regulatory "spill-over" and competitive acceleration in the production of regulations. The formal mechanisms and policies of some governments encourage this process. For example, the government of Ontario, in its policy statement concerning water management (1978) is proposing to adopt as regulations (i.e. legally enforceable) effluent requirements specified in federal guidelines (i.e. not legally enforceable) if these guidelines are more stringent than the effluent requirement of the province. Thus the guidelines at the federal level become regulations at the provincial level. Industry argues that this is a serious competitive acceleration or "leap frogging" of regulations; there is a very great difference between informal guidelines, which discussed and negotiated, and regulations which have the force of law. The chemical industry presented several examples where the second level of government to become so involved in regulation adopted more severe standards, perhaps in an attempt to be "holier than thou." (See further on this issue below.)

The influence of U.S. regulatory efforts on the Canadian decision making process through informal contacts between government officials, through joint commissions, and through the production of information is intense. In some cases (e.g. regulation of beryllium), Canadian regulators have resisted the introduction of U.S. regulations which did not meet Canadian needs. In terms of regulation priorities, however, it is clear that Canada cannot avoid the influence of the United States which has massive research and development resources.

The record of Canadian regulation making and implementation suggests that, so far, the formal regulatory requirements are perhaps less stringent than in the United States (e.g., the Delaney Amendment to the U.S. Food and Drug Act). However, in spite of flexible compliance schedules, the final environmental protection standards achieved through regulation in Canada may not be lower than those achieved under similar geographical and ecological conditions in the United States. The restricted resource base for environmental regulation work in Canada forces the governments of Canada and the provinces to seek industrial cooperation rather than engage in overt conflict.

This reliance on cooperation is a force which moderates formal regulation. Additionally, current shifts in public priorities toward economic and resource goals and the ideological pressures for deregulation seem to be leading to a further dampening of regulation growth in the environmental field. Much of the pressure to deregulate appears to have resulted, however, not in relaxed standards but in the elimination of unnecessary irritants. For example, the efforts of the Ontario Ministry of the Environment to deregulate (1979b, pp. 11-12) have led to the following actions:

(1) the Ministry instituted an economic assessment process for its major abatement programs and industrial clean-up efforts;

(2) two appeal boards in the ministry have been integrated into one;

(3) annual renewals of the certification of waste management sites have been eliminated;

(4) some approvals of extensions to water and sewage facilities have been delegated to regional municipalities in order to avoid duplication of effort; and

(5) the functions of land-based management and the disposal of waste have been consolidated and streamlined.

Generally, efforts to "deregulate" are focused upon a reduction of red tape, integration of services (e.g. "one-stop" regulatory shopping) and the introduction of some form of impact accounting. The system enjoys, however, a large degree of flexibility which will permit it to respond swiftly to new demands for regulation. This flexibility is a source of uncertainty and may leave the system susceptible to "over" regulation resulting from power strategies of participating governments.

To assess the perceptions of industry with regard to the burden from provincial and federal overlap in regulatory processes, a questionnaire was distributed to all member companies of CCPA and a sample of other producers of chemicals in Canada.

Duplication of federal and provincial legislation was perceived as a significant problem in setting standards but not in implementation and enforcement. Interviews with a sample of executives revealed that the major problem of duplication lies in what was described by one member of the association as a "leap frog numbers game". It was perceived that the provinces, to maintain initiative and control, often increase the stringency of their requirements. Many respondents in the chemical industry also noted that the federal Environmental Protection Service tends to set extremely stringent baseline standards for pollutants, "instead of [setting] comfortably defensible minimum performance standards which would leave provision for provinces, regions or local sites to extend their requirements to more stringent specific requirements when these are scientifically defensible on the basis of greater sensitivity of the local environment" [Shales, 1980, p. 6].

Another source of duplication identified was the reporting requirements imposed by the federal Environmental Protection Service. One company indicated that it responds to the federal regulation concerning chlor-alkali mercury in four different provinces "using four different sets of reporting routines".

Areas of duplicated efforts which were identified include:

(1) waste disposal -- several provincial and federal studies and task forces;

(2) spills of hazardous materials -- spill reporting regulation proposals under the Federal Fisheries Act and liability for clean-up stipulations under Ontario Bill 24;

(3) fertilizer manufacturing facilities -- the Alberta development of guidelines for fertilizer plant emissions takes place in parallel to those of the Federal-Industry Joint Working Group on Fertilizer Industry Environmental Concerns.

A further major concern of industry is the existence of inconsistencies in federal and provincial approaches to standard setting. For example, a brief received from C.I.L. (Shales, 1980, p. 9) states:

"In addition to duplication, there is concern about differences in basic policy toward environmental management. For example, federal regulations universally address end-of-pipe effluent emission standards. Ontario embraces a policy utilizing part of the recuperative and assimilative capacity of the natural environment. This concept is incorporated in recent developments under the Great Lakes Water Quality Agreement to coordinate...the definition of "mixing zones" downstream of discharge points. The GLWQ Agreement is a result of Canada-U.S. negotiations and is pursued under the authority of the International Joint Commission which becomes a third separate authority introducing environmental requirements in the Great Lakes Water shed."

Clearly, a federal system of government is complex. A flexible, complex system which is also affected by developments in foreign systems is a source of uncertainty. Much of this uncertainty could be reduced by introducing a more rigid system with adversary proceedings. However, all the participants in the consultative processes in Canada reject such a move and suggest that the increased transaction costs would not be beneficial. One major improvement endorsed by both public interest groups and industry was the introduction of more independent appeals into the administrative environmental management system. It was felt that appeals to bodies "within" a department are less likely to succeed since internal bodies are likely to protect their own agency.

Other improvements which were accepted by all participants amount to what Simon (1978) has referred to as "procedural rationality". For example, before the process of rigorous standard setting is begun, an attempt should be made to assess, at least descriptively, the social costs and benefits of regulating an emission.

Compliance

Compliance can be achieved through persuasion and/or through coercion. Previously, it was noted that to a great extent the Canadian system promotes voluntary compliance. The major vehicle for promoting compliance is consultation between government and industry throughout the regulation-making and implementation phases. The cooperative (as opposed to adversarial) mode of interactions leads to mutual understanding between regulators and industrial executives. This process of co-optation through participation promotes, to a certain degree, adoption of the norms of social responsibility within the industry. Participation not only reduces resistance to regulation but also ensures feasibility of implementation and a more accurate flow of information to expand the administrative and technological options available to industry.

The formal effort to disseminate information concerning environmental regulation is limited by the small budgets allocated for such activities. Therefore, an important 'educational' role is performed by trade associations and their technical committees. Though the prime role of these associations is the advancement of industry interests, they also serve as an excellent channel of information between government and industry. Canadian unions and public interest groups, on the other hand, have played a relatively insignificant role in promoting compliance with environmental regulations. Most unions have, as their natural focus, the work environment rather than the larger, external environment. Public interest groups in Canada have tended to focus their activities on influencing the regulation making process rather than on day-to-day environmental surveillance.

The pool of resources for environmental regulation 'enforcement' in Canada is shallow. "Most regulatory agencies in Canada tend to be sparsely staffed. Their compliance capability does not usually measure up to their regulatory intent. Up to some undefined point, more effective regulatory compliance does require more staff, although more staff is clearly not itself a sufficient condition for more effective compliance....Some [bureaucratic] growth is necessary, but the concern about excessive bureaucratic growth should counsel a more intelligent search for other compliance mechanisms" [Doern, 1977, p. 24].

From industry's point of view, lack of vigilant, universal enforcement results in unfair advantages for those who are less socially responsible. Interviews indicated, for example, that some larger companies suffered unfair competition from small operators in the area of waste disposal. The need to selectively employ scarce enforcement resources means that, while the larger companies are cost-effective targets, the smaller companies have high incentives to violate regulations and gain a competitive edge.

The discretion and selectivity which are exercised in the enforcement of regulation create uncertainty. This uncertainty leads to feelings of victimization and the perception that power is used arbitrarily.

These negative perceptions and feelings are minimized when enforcement practices emphasize openness and communication with affected parties. This openness occurred even when enforcement of regulation was vigorous. Equity and reason are two principles of effective enforcement policy.

Legal Issues of Enforcement

The major legal issues involved in determining the availability of legal sanctions include legal standing, liability and burden of proof.

(1) Legal standing

The use of private civil remedies is a potentially important tool for protection of the environment. However, the effectiveness of this tool depends upon the access that persons and groups have to private civil actions in the control of pollution. "To initiate an action the plaintiff must establish that he has locus standi; that is, he must show that he has suffered injury peculiar to himself and not merely inconvenience or harm common to the general public" (Franson and Lucas, 1977, p. 63). Canadian courts have taken a strict view of the requirement for evidence of "special and peculiar" damage, thus significantly restricting private legal actions as a means for citizens enforcement. Furthermore, in Canada it has been held that "a group of individuals, none of whom can show the requisite special damage, are in no better position than one of their number" (Franson and Lucas, 1977, p. 63); hence, the standing requirement is not relaxed by bringing a class action on behalf of the public affected by a pollutant.

(2) Liability for "Public Welfare" Offences

One of the most difficult, and until recently most uncertain, areas of Canadian law is the nature of an offender's liability for so-called "public welfare" offences. It is a difficulty shared by other common law jurisdictions. The advent of the industrial revolution has resulted in a large number of prohibitions relating to health, welfare and safety. For historical reasons, these offences have fallen within the preview of the criminal law, but without the usual requirement of a guilty mind (mens rea) associated with the traditional "infamous crimes of the common law" (Sayre, 1933; Weiler, 1971; Law Reform Commission of Canada, 1974; Hogan, 1975; Paulus, 1978; Hutchinson, 1979).

These "public welfare" or "regulatory" offences have presented the courts with an awkward policy problem. Courts have tended to deal exclusively with the problem of liability in terms of either mens rea (i.e. cases requiring proof of intent or "guilty mind"), or absolute liability (those cases where the only defences are denial of the violation or a denial that there was damage). "In recent years, however, the courts have taken a more responsive attitude and have been prepared to grapple with the problem. Attempts have been made to mediate the traditional polarity of approach. The result of this trend has been that the Supreme Court of Canada in R. v. City of Sault St. Marie [1978] has seen fit to introduce a third category of liability that lies between the requirements of full mens rea and the imposition of absolute liability" (Hutchinson, 1979, p.416).

"[T]he court replaced the existing dual basis of liability with a three-tiered structure of liability:

1. Offenses in which mens rea, consisting of some positive state of mind such as intent, knowledge, or recklessness, must be proved by the prosecution either as an inference from the nature of the act committed, or by additional evidence;

2. Offenses in which there is no necessity for the prosecution to prove the existence of mens rea; the doing of the prohibited act prima facie imports the offence, leaving it open to the accused to avoid liability by proving that he took all reasonable care. This involves consideration of what a reasonable man would have done in the circumstances. The defence will be available if the accused reasonably believed in a mistaken set of facts which, if true, would render the act or omission innocent, or if he took all reasonable steps to avoid the particular events. These offenses may properly be called offenses of strict liability.

3. Offenses of absolute liability where it is not open to the accused to exculpate himself by showing that he was free of fault" [Hutchinson, 1974, p. 419].

The Supreme Court ruled that a standard of absolute liability will be utilized only when the legislation clearly indicates that that was the intent of the legislature. In contrast, the current Canadian definition of strict liability requires the defendant to prove, on balance of probabilities, that he has taken due care.

This can be further contrasted with "normal" mens rea offences where the prosecution has to demonstrate beyond a reasonable doubt that the defendant had a guilty mind.

What difference will the change in law make in practice? Paulus (1978), after a review of empirical studies of the application of strict liability laws (now called absolute liability by the Canadian Supreme Court), concludes that defendants were generally not prosecuted unless there was some degree of moral blame (either intentional acts or negligence) (Smith and Pearson, 1969; Carson, 1970; Paulus, 1973; Law Reform Commission of Canada, 1974). However, Paulus still argues for the continuation of absolute liability (i.e. no defence of negligence) on the grounds that generally the laws are only enforced in cases of an intentional act or negligence of the offender (i.e. the new Canadian meaning of "strict" liability.) Arguments for absolute liability are summarized by Fletcher [(1978) quoted in Hutchinson, 1979, p. 428], who states: "In short, absolute liability, it is contended, is the most efficient and effective way of ensuring compliance with minor regulatory legislation and the social ends to be achieved are of such importance as to override the unfortunate by-product of punishing those who may be free of moral turpitude. In further justification, it is urged that slight penalties are usually imposed and that conviction for breach of a public welfare offence does not carry the stigma associated with conviction for a criminal offence."

The counterargument is that punishing without any regard to fault threatens the moral fabric of society and would reduce the incentives for executives to exercise "due diligence".

The opposition to provisions of absolute liability is widespread and recent legislative proposals which included absolute liability in environmental protection matters in Ontario were amended to remove absolute liability from the legislation.

Reducing the domain of criminal liability does not mean that incentives to protect the environment are eliminated. Private rights of action for compensation by the injured against those causing the injury may offer a sufficient incentive for compliance with environmental quality standards. Furthermore, different levels of government are considering the establishment of funds maintained by compulsory contributions levied against the industries likely to cause injury (e.g. Ontario Ministry of the Environment, 1979a). The major problem with such funds is in developing equitable schedules of contributions which provide incentives for environmental protection. Such funds, however, should be managed to provide a basis for improved environmental management and not to act as a mere tax upon the industry.

(3) <u>Proof</u>

The definition of legal proof is a critical issue in the usefulness of court action in enforcing environmental and health protection. There are two variables at work: (1) the costs and feasibility of assembling the evidence, and (2) the degree of conclusiveness required (i.e. standards of proof). The knowledge of long term (latent) consequences of many chemicals in the environment is lacking. As well, in many of these cases where evidence exists, it fails to meet the scientific requirements for conclusiveness (e.g. α error of 5%). In cases where long latency periods are involved, interpretation of evidence relies upon policy assumptions rather than on scientific inference rules. In this uncertain environment, there is a tendency for legislatures to shift the burden of proof or at least evidentiary burden (burden of adducing evidence) to manufacturers and to adopt more flexible requirements of standards of proof. The pre-manufacturing or importation notification requirements in the Environmental Contaminants Act is perhaps an example of this shift in the evidentiary burden. When danger to human health is suspected by the regulator, industry can be compelled to provide information about the substances. Under the Act, the burden of proof necessary to prohibit the manufacturing of the substance is on the federal government but, in practice, the burden can be avoided since delay actions, and escalation in information requirements by government can effectively prohibit the manufacture of a substance.

The traditional standards of proof ("balance of probabilities" in civil actions and "beyond reasonable doubt" for criminal actions) do not fit the complex information and risk environments created by the proliferation of new chemical substances. Standards of proof must be functions of the expected consequences of the alternative actions.

The risk-benefit approach would require high standards for proof of risk from substances with large benefits where substitutes were not available. Conversely, the requirements of proof needed to ban or restrict the use of a particular chemical would be low when substances have few social benefits and there are many substitutes available. Similarly, the standard of proof will vary with the seriousness of the anticipated negative impacts of a substance.

Recent U.S. court decisions and statutes have adopted such a flexible system of employing different standards of proof depending on the circumstances of the cases. "Canadian courts do essentially the same thing in determining whether preliminary injunctions should be granted under the test of 'balance of convenience'" [Franson and Lucas, 1977, p. 56].

"Apart from preliminary injunctions, serious problems of proof exist in Canada in civil legal actions and judicial review proceedings" [Franson and Lucas, 1977, pp. 56-57]. In contrast, the standard of proof which regulatory agencies must meet in environmental protection (as opposed to the standard of proof required in courts) reflects the broad areas of discretion left to administrators. This practice makes the standards or tests which regulators must meet in implementing an act a matter of internal administrative policy. The discretionary powers, however, are constrained formally by the process in place to review regulations and constrained informally by the consultative process.

Conclusions and Prescriptions

Review of the legal and administrative system of environmental regulation in Canada as it affects the chemical industry reveals that:

(1) environmental laws (as are many others) are written in broad, enabling language. Consequently, government agencies charged with enforcement have enormous discretion. The broad scope of this discretion is a source of uncertainty to industry;

(2) there is a high level of flexibility and broad areas of administrative discretion in regulation making and enforcement in Canada. This flexibility and discretionary power are both liked and feared by industry. While there were no major complaints of arbitrary use of delegated power, fears were expressed of future potential misuse because of the susceptibility of the process to dysfunctional influences;

(3) partially because of the wide, discretionary powers in the hands of government agencies, the Canadian system has superficially produced less formal stringent regulations than in the U.S. but it appears to have achieved similar levels of environmental protection through better compliance. The higher compliance is attributable to the consultative processes which characterize the Canadian regulation approach;

(4) the resource pool at the disposal of enforcement agencies is relatively shallow given the breadth of their tasks. Enforcement is necessarily selective and targeted towards the bigger

companies. Compliance, to an important extent, depends on industrial cooperation; and

(5) overlap tends to lead to acceleration in regulation making and imposes some unnecessary transaction costs (having to respond to the same regulation in a different manner in different provinces). Overlap in terms of implementation is minimized by formal and informal coordination (e.g. Accords).

To reduce the costs of flexibility and discretion, while maintaining their important benefits, the following prescriptions are proposed:

(1) establish independent (of the administrating agency responsible for regulation) quasi-judicial appeal boards to review public and industry's complaints with respect to regulation and enforcement. These boards should act as mediators/adjudicators to reduce transaction costs and to act as complements to judicial processes of appeal;

(2) broaden the consultative process to include informed public participation. Open the proceedings to reduce public perceptions of arbitrariness. Increase lead times in the consultative process to permit better preparation of inputs from the public or industry;

(3) strengthen regulation review procedures. In particular, allocate sufficient resources to conduct proper impact analysis of regulation. Use impact analysis to screen both regulations and

guidelines since guidelines often are internalized as regulations;

(4) improve the rationality of the process by the development of better information bases for decision making as well as by the development of a decision support system (e.g., risk/cost/benefit methodologies); and

(5) broaden the application of the Canadian consultative process model to include international commissions (e.g., I.J.C.).

To reduce the costs of overlap, the following prescriptions are suggested:

(1) develop inter-agency (provincial-federal) permanent coordination committees for regulation making. These committees should screen proposals for regulations by federal and provincial governments in their initial stages of development and coordinate information acquisition and dissemination efforts to reduce the paper burden resulting from duplication;

(2) improve the division of labor between the federal government and the provinces to ensure that federal regulation is set at levels high enough to prevent the formation of pollution havens, yet low enough to allow the provinces to adaptively manage their environments. The role of the federal government as a source of expertise and technology should be strengthened by appropriating additional resources for R&D activities in the field of environmental protection; and

(3) develop regional "one-stop shopping centers" for environmental regulation information, permits, etc.

To conclude, the system of environmental regulation making in Canada is sound but can be improved. Certain provisions for improved coordination and checks against arbitrariness are proposed to improve its operation and to reduce the chance of malfunctions. These changes will not reduce claims of over-regulation by those who pay and under-protection by those who benefit. The Canadian system permits a process of flexible, joint decision making, but the quality of this process, as with any other system, depends on the calibre of the participants and the information at their disposal. The best assurance of good decisions is having good decision makers.

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PART II

PAPER 3

Costs, Benefits and Risks: Methodologies of Standard Setting and Some Preliminary Estimates of Costs to the Chemical Industry in Canada

Introduction

The preceding papers which focused upon the information base and the system of decision making and enforcement for environmental protection generated the following observations:

(1) The information upon which many regulatory decisions are made is characterized by a high degree of uncertainty.

(2) Resolution of much of the uncertainty in the decision process (i.e. the actual use and interpretation of available information) relies to a large degree upon policy/value judgments and not upon scientific principles.

(3) The consultative processes which characterize decision making and enforcement practices in Canadian environmental management permit flexible accommodation of knowledge from various sources and benefit from the different value perspectives which are represented in the process.

The papers emphasized the need to improve procedural rationality by introducing into the process of regulation making decision aids which ensure the accountability of the outputs of the regulatory process. In this paper, therefore, the focus is the framework for accountability of environmental regulation. First, alternative social value assumptions are identified and their practical manifestation in regulatory decision rules (standard setting principles) are described. The analysis of decision rules for standard setting examines the state of the art in the field and assesses the future of alternative methodologies for improving accountability of environmental regulation making.

The paper identifies areas where investment in research and development of methodologies and base line information is required if an improved framework for evaluating environmental regulation is desired.

The second part of the paper employs the framework for accountability developed in the first part to examine the benefits and costs of environmental regulation with respect to the chemical industry of Canada. The paper concludes with prescriptions for improving decision making in environmental regulation.

Criteria for Setting Standards for Environmental Quality

Crandall (1979, p. 29) argues that the question of environmental regulation is similar to other questions of an economic nature. "Ultimately, everyone debating environmental issues must answer the question 'How much pollution do we really want?' This is not different from determining how much bread, how many automobiles, or how many movies we want.... Pollution control is a 'good' which no one wants in unlimited quantities unless someone else pays for it.... Unfortunately, not only is there no free lunch even for consumers of clean air and water, but there is evidence that they are paying substantially more for what they are getting than they would if we had a more rational environmental policy".

Crandall defines two basic problems to be solved in controlling environmental pollution. One concerns the determination of objectives (how much pollution do we want), and the other is the question of means (how to obtain the reduction in pollution at the lowest possible cost). "A market oriented system of control might ... minimize control costs - but it would not necessarily solve the problem of determining the desired magnitude of the clean up effort" (Crandall, 1979, p. 31). Crandall admits that access by consumers to air and water is not easily rationed by a market system.

The determination of environmental objectives, given the prevailing market ideology in western democracies, should reflect, in principle, the preferences of the public, i.e. the willingness of the public to pay for alternative control levels. The choice of alternative environmental quality standards is contrained in part by (1) intergenerational responsibilities, and (2) social-ethical constraints on the imposition of risks to life.

Governments in democracies tend to act not only on behalf of the present generation but also to preserve the rights of future generations. These responsibilities imply that where the survival of future generation is at risk from irreversible changes introduced for the benefit of the current generation, governments must try to prevent such changes. Under these circumstances, discount rates reflecting the rate of exchange of present goods for future goods by current consumers have no relevance in deciding upon certain measures to protect the environment. Similarly, the choice of pollution levels is constrained by norms which regulate the imposition of risk to life in our society.

For example, condemning (during peace time) particular segments of our population to almost certain death (i.e. naming those who are likely to die) as an explicit social trade-off is unacceptable. By contrast, adding risks to life through marginal increases in probability, if done anonymously, is permitted and, indeed, is expected almost as a daily activity. There is evidence which suggests that the social and individual definitions of acceptable risks to life depend on the particular circumstances involved and the decision process employed to determine those risks (Starr, 1969; Fischhoff et al., 1978).

It is important to note that, when the consequences of alternatives are not fully known, society may regulate the assignment of subjective probabilities (i.e. probabilities which indicate strength of beliefs rather than some objective, realized or calculated long term frequencies). For example, society may choose to label new chemicals which fail some socially determined tests as probable carcinogens, or may label all new chemicals as safe unless experience has proved their toxicity. These policy determinations depend upon value judgments. Often, the rules of probability assignment which underlie social policy reflect either assumptions concerning social benefits and costs in particular situations or social constraints imposed by individual rights in these situations. The rules for standard setting in cases of uncertainty range from a theoretical principle of "no risk" to maximization of net expected social benefits, subject to some constraints upon risks.

"No risk" and "insignificant risks"

The "no risk" principle, often called the Delaney principle, is employed in the United States to regulate food additives. The Delaney amendment stipulates that no additive shall be deemed safe if it is found after tests to induce cancer in man or animal. The justification for a "no risk" approach with regard to food additives is based on the fact that exposure is universal, involuntary and leaves many consumers without alternatives (Upton, 1979). The underlying assumption is that benefits accruing from additives are relatively low compared to the expected costs of cancer. Furthermore, prohibiting additives in food is expected to be relatively inexpensive. In contrast, water which is also used universally, involuntarily and has no alternatives does not enjoy similar protection. A major reason for this lack of protection has been the costs involved in upgrading water supplies. It is interesting to note that the use of water which is legally deemed safe for drinking may be considered legally unsafe when used in food preparation.

The "no risk" principle, in practice, is only an indication of a social ideal, not a realized guideline. Examination of its application reveals that what constitutes an appropriate test of carcinogenicity (the standard of proof) depends upon cost-benefit relationships. For example, nitrites (which are used to preserve meat) in combination with certain amines become nitrosamines which are known carcinogens (Lijinsky and Epstein, 1970). However, eliminating nitrites from preserved meats will increase the risks of botulism. The cost-benefit calculus requires the violation of the rigid stipulations of the Delaney Clause. The use of nitrites was permitted because they are not carcinogenic when initially added to food (Kessler, 1977). There are strong pressures in the U.S. to overtly relax the "no risk" position with respect to food additives. Even those who are conservative consider a "no risk" position as an ideal to motivate, rather than as a guideline to implement (Abramson, 1979).

The use of "no risk" as a guideline means a complete dependence of standards upon the technology of detection. Such automatic regulation of an important activity lacks a logical basis in an area which is marked by rapidly increasing abilities to detect minute traces of substances.

A modification of the "no risk" approach is the principle of "no detectable adverse effect". The Soviet Union, for example, uses this principle in setting their maximum permissible concentrations (MPC) for occupational exposure (Roschin and Timofeevskaya, 1975, p. 32). The standards of exposure are based on "concentrations which, with a work day of not more than 8 hours through the whole of the service record, do not cause any disease or have any other adverse effects on the health status of the workers that could be detected by the modern methods of investigation either directly in the course of work or at later dates."

The principle of no detectable adverse effect and similar principles such as the criterion of "toxicologically insignificant level" admit some exposure to risk and require some direct evidence of its realization in setting limits upon exposure. The "custom of usage" rule with respect to existing facilities and substances is a logical extension of these rules which are based on "realized" risks. Under this rule, prevailing practices which have not caused detectable damage are "generally recognized as safe". (This criterion is referred to as the GRAS criterion.) The major problems which arise when rules for standard setting are based on the evidence of impact are the long latency period and the lack of information about their long term biological impacts. In these cases, determination of safety thresholds are trans-scientific (policy based) rather than strictly scientific. The diversity of norms for the same substance in different countries illustrates this point. For example, the Soviet MPC's are generally lower than the U.S. threshold limit values (TLV) for the same chemicals, a major reason being that most TLV's are weighted mean concentrations rather than maximum single time exposures (Roschin and Timofeevskaya, 1975).

Another major consideration in the setting of standards is the sensitivity of those people tested. Naturally, if those most sensitive to the chemical are not tested, the permissible level will be higher than it would be otherwise, allowing a small percentage of workers to suffer adverse effects. When dealing with non-occupational environments, the problem becomes even more complex. Without case by case, benefit-cost calculations, only baseline standards for population averages can be determined (i.e. reflecting the implicit assumption that if the "average" person exposed to the chemical has detectable adverse symptoms, then the benefits of regulation would be high relative to the costs).

Open Ended Standards based on Control Technologies

The criteria of "best available practice", "highest practicable protection" and "lowest practicable exposure" are based partially on cost considerations and the current state of control technology. The main problem with criteria based upon technology but tempered by some cost calculations is defining the key tests of "best" and "practicable" (Lowrance, 1976). "Best" implies some consideration of benefits from the regulation, while "practicable" implies attention to economic feasibility.

Vagueness in legislation leaves much to the discretion of implementors. Burton and Whyte (1978, p. 168) list some of the problems facing the implementor of technology-based criteria:

1. What factors are to be included in the assessment?
2. From whose point of view is practicality to be defined?
3. Who defines what is practicable?
4. Does the 'best practicable means' include the extreme case of prohibition of the cause in order to reduce pollution to zero?

Often technology-based standards are used to force the adoption of specific technology (setting the standard of what is practicable at the highest level attained within the industry rather than upon specific calculations of feasibility). Without explicit cost-benefit calculations, the application of the rule may reflect short term local political considerations rather than long term needs. Technology-based rules may have little relevance to global objectives. It is possible that some plants can achieve a more cost-effective reduction of emissions than other plants. Crandall (1979), for example, notes that a technology-based approach is an inefficient means of achieving given environmental objectives. He predicts a significant improvement in efficiencies "by substituting a system of marketable rights for current technology-based standards. Polluters would be given standards that immediately become transferable rights. If a firm found that it could lower its costs by paying someone else in the same area to reduce pollution below his required standard, rather than complying with the standard itself, the firm would pay this other source for the reduction, and could exceed its own standard by a corresponding amount" (Crandall, 1979, p. 31). The use of pollution rights is an intuitively appealing method of achieving an efficient reduction in pollution levels, but there are some problems associated with the adoption of this technique (Nemetz, 1977, p. 120).

Explicit Recognition of Benefits, Costs and Risks

Explicit treatment of the costs and benefits involved in environmental protection regulations makes the decision process less susceptible to manipulation and may improve its rationality. Explicit identification of data bases used, assumptions made and calculations executed increases the accountability of the process and encourages a broader range of inputs.

The treatment of costs, benefits and risks may take a variety of forms, ranging from a simple statement of the costs, benefits and risks considered in the decision process, to a sophisticated, mathematical, risk-benefit optimization system.

It is important to note that a more sophisticated analytic framework is not necessarily better than a simpler one. In choosing an analytical framework for regulation making, one must consider: (1) the quality of data available (being precise but wrong is not better than having only an approximation of the correct solution), (2) the costs involved in analyzing information, and (3) the accessibility of the analytic framework to regulators, the public and industry. Zeckhauser (1975), for example, suggests that it is sometimes more important how you do something than what you do. Decision makers may prefer a procedure that can be justified and explained, rather than a more correct but esoteric approach with obscure methodology (Slovic *et al.*, 1975).

Statement of Benefits and Costs of Emission Controls

The first step in explicating the benefits and costs of regulation making is to describe the relevant, distinguishing attributes of alternative control options, and to quantify probable outcomes. The description of the consequences of alternative control options must specify the outcome not only in terms of the amount of different social goods (utility enhancing goods and services) and bads (those consequences that reduce social utility levels), but also in terms of the distribution of effects among the public (who receives the goods and the bads? is the distribution equitable?).

The major benefits of pollution control can be classified as health benefits, aesthetic benefits and benefits which accrue from reduced damage to vegetation, animals and materials.

Health benefits include reduction in morbidity and mortality. Here one must consider the interaction of morbidity and mortality patterns. Pollution can be regarded as a harvester of death and/or a contributor to death. As a harvester (during a high pollution episode), pollution shifts short-term patterns of death by triggering death of those who are about to die. Long term age adjusted mortality rates or life expectancies are left unchanged. Pollution may alter the immediate morbidity/mortality profile of society by affecting particular segments of the population and, in the long run, alter the genetic makeup of society. Pollution may also be a contributor to long term increases in morbidity and mortality rates.

The variable impact of pollution upon health depends on the attributes of the pollution and the affected population. The threshold for a harvesting impact may be very high, while long term, latent impacts of pollution may accrue linearly and with minute pollution levels.

Aesthetic benefits resulting from the reduction in pollution may be reflected in higher property values and changes in behavioral patterns (e.g. using leisure time in the city as opposed to escaping pollution by week-end emigration to the countryside).

Reduction in damage to vegetation, animals and materials may be reflected in lower rates of deterioration of plants, machines, and buildings, improved production rates in agriculture and fisheries and improved recreational opportunities (e.g. moving recreation from a more distant site to a closer site once pollution is reduced).

Every proposal for regulation should state explicitly the gross benefits which may accrue from the regulation. This basic requirement (when further cost-benefit analysis is not conducted) may reduce regulation which is induced solely by technological control opportunities. In many instances, the simple availability of control technology creates demands for regulation. Control of emissions is perceived as intrinsically valuable, even when no external benefits of control are expected.

Costs accruing from environmental regulation include direct impacts upon the industry such as:

a) the direct capital and operating costs of pollution control systems,

b) reduction in the international competitive position (resulting in reduced growth prospects and less employment), and

c) reduction in investment, particularly in research and development.

These direct consequences of regulation on industry may incur social costs in terms of:

a) distribution of income,

b) regional balance,

c) market structure and competition, in particular increased market concentration,

d) balance of payments,

e) consumption of scarce national resources (e.g. energy),

f) national security, and

g) inflation.

There is a need to quantify and express all costs and benefits in terms of a common unit of value (for example, dollars). If all the social costs and benefits are considered and expressed in terms of a common unit of value, the option which maximizes expected net benefits should be selected. Unfortunately, undeveloped evaluation methodologies and the restricted domain of alternative environmental protection options constrain the application of such a comprehensive cost-benefit approach.

The major theoretical obstacles lie in the areas of:

(1) uncertainty,

(2) the discount rate,

(3) distributive consequences, and

(4) the evaluation of life.

Since many of the uncertain and risky consequences of regulation can be described only by means of changes in probability distributions, one needs to compare distributions, not just particular moments of a distribution (e.g. means and variances). Without defining social utility functions for risky alternatives, risk neutrality is often assumed and decisions are made with respect to outcome expectations (perhaps constrained by permissible ranges of possible outcomes or other measures of risk).

An alternative to this approach is the use of stochastic dominance for comparing distributions of risky alternatives (Thompson et al., 1979; Huang et al., 1978; Hammond, 1974; Levhari et al., 1975; Levy and Paroush, 1974 and others). Stochastic dominance screening uses some common qualitative attributes of population preference profiles to screen alternatives with preferable probability distributions. For example, the most general assumption is that utility functions are monotonically increasing. This implies only that "more is better than less" -- an assumption that is satisfied by the most goods for the most people (or equivalently "less is better than more for 'bads'"). Higher screening powers can be achieved if less universally acceptable assumptions are made with respect to the preferences of the public (e.g. assuming that the public is risk averse). Techniques which are less comprehensive, but simpler to apply, include various portfolio evaluation techniques (e.g. mean-variance analysis).

The second problem area concerns the appropriate discount rate used to determine the present worth of future values. It has no simple solution, especially when dealing with intergenerational impacts. Zeckhauser and Shepard (1976, p. 14) have pointed out the reality of "generation selfishness". They concluded that each generation has the incentive to skimp on its bequests to future generations. This may result in a suboptimally reduced bequest stream. Freeman (1978, p. II-24) summarizes the issue of discounting in evaluating alternative options of environmental protection as follows: "The issues are more complex when we consider effects extending over very long periods of time, for example between generations. Discounting with the normal discount rate can reduce even catastrophic distant future effects to nominal present values. For example, with a relatively low discount rate of 5%, the benefit of avoiding some number of deaths 200 years in the future is reduced by a factor of 0.0006. On the basis of conventional discounting, the benefits of preventing some future catastrophe, for example, the effects of possible destruction of the ozone layer, may seem less than the present costs of preventing the effect. It appears that in cases of this sort, the major consideration is not intertemporal efficiency in resource allocation, but rather intergenerational equity in the distribution of welfare. Hence, it should not be surprising that decision rules based on the efficiency criterion should appear to give unreasonable results. This is a problem which is beginning to receive attention in the literature. But as yet, there is not generally accepted answers."

The distribution of benefits and costs is important because, often, those who bear the costs of regulation or lack of regulation are not those who benefit from them. Fischhoff (1977, p.

179) notes that "cost-benefit theory is concerned with the total costs and benefits accruing to society from a project and not with their distribution. For many projects, however, the risks accrue to different people than do the benefits.... The cost-benefit analyst typically deals with this problem by saying that if a project's benefits outweigh its costs, then in principle, the losers could be compensated by the gainers. Although attractive in theory, such compensation may be exceedingly difficult to carry out in practice. Often it is impossible even to identify the losers, for example when they are members of future generations". Even if identification is possible, transaction costs may be prohibitive (Graaf, 1975).

The most difficult problem in terms of moral and political implications is the question of the value of life. It was noted that there are strong constraints in western societies which, in non-emergency situations, forbid explicit, involuntary sacrifice of specifically named people in order to increase social benefits. However, these ethical constraints do not prohibit marginal modifications in anonymous mortality probabilities to gain social benefits. In such cases, it is necessary and permissible to use an explicit value for human life. Several methodologies have been proposed by economists to determine the value of life (Linnerooth, 1979). A widely accepted procedure for "pricing" an expected change in population mortality is to estimate the expected loss in terms of earned income; the value of a person's life is calculated as his discounted expected future earnings" (Linnerooth 1979, p. 52). This method, which is widely used, ignores the person's own desire to live and ignores the social value of a person's contribution not reflected in national income accounts.

An alternative method was advanced by Mishan (1971) who suggested that the value of life should be expressed in terms of the willingness of each person to pay for a reduction in mortality risks.

Thaler and Rosen (1975) have examined the wage differentials of those engaged in more and less risky jobs to identify their implicit willingness to assume risks for pay. Linnerooth (1979, p. 53) notes that "there are several limitations to this market approach, the most critical being the implied assumption that the workers must perceive the risks accurately and have the necessary mobility to change their occupation".

Another method for evaluating the value of life is "simply to ask people what is the worth of their increased survival chances. But such survey approaches have also been criticized on the grounds that people have difficulty in assessing probabilities and answering hypothetical questions" (Linnerooth, 1979, p. 54). There are other theoretically interesting approaches which attempt to take into account life-long utility functions, but these are of little direct empirical/policy value.

The value of life problem is complicated further when one deals in non-marginal changes in risks to life. In these circumstances, the willingness to assume risks to life is situation-specific and cannot be regarded as an homogeneous economic "bad" (i.e. one type of risk of death may be valued differently from another risk of death). The problems raised by the interdependence between the value placed upon life, the decision processes involved in risk taking, types of threats of death and expected levels of benefits are especially important when social constraints upon risk acceptability are explored.

Allocative efficiency can be improved in the absence of a complete framework of costs and benefits by the employment of cost-effectiveness. Cost-effectiveness analysis searches among alternative control options for the alternative which attains a given level of benefit with minimum costs. For example, in achieving a particular level of life savings, it is possible to search for the least costly method by directing scarce resources to areas where their contribution to life savings is maximal.

Okrent (1980) cites many studies which compare expenditures to "save a life". He notes (p. 374) that "the expenditures made by society to save a single life vary to a remarkable degree". In France, for example, it was estimated that $30,000 was being spent per life saved through road accident prevention and about $1 million per life saved in aviation accident prevention (Morlat, 1970). In Great Britain, Sinclair et al. (1972) estimated that $10,000 were spent to save the life of an agricultural worker, while $20 million were spent to save the life of one high-rise apartment dweller. These and other quoted numbers indicate that there is ample room to maneuver even in the "business" of improving life savings with a given resource bundle, without having to determine the value of life saved. Clearly, using these numbers without other information to determine regulation priorities ignores the political costs associated with the visibility and drama of a life saved because of government action or life lost because of government inaction.

The theoretical problems underlying the use of cost-effectiveness analysis are minute in comparison to problems of obtaining the information needed for cost-benefit analysis. In the first paper of this series, the focus was upon information availability and quality. It was noted that there was a lack of validated information about the functional relationship of exposure to different pollutants and the subsequent impacts upon health. Similarly, there is little information about the relationship existing between environmental quality and human behaviour (Stevens, 1978, P. IV-10). There is some local information about material and economic damage functions of pollutants in the United States but, even there, extrapolation to the whole system or to other systems has limited validity. The analyst obtains, at best, a reference system for orders of magnitude of costs and benefits of pollution control and not specific estimates of consequences.

The "State of the Art" and the "State of Information" of cost-benefit analysis of environmental protection makes such analyses of limited use for the direct determination of optimal regulation levels. However, with the introduction of sensitivity analysis into the framework, it is possible to obtain some bounds. Flexible use of the analysis to structure information and to provide bounds (using extreme assumptions) as inputs to a policy formulation process have great potential for improving environmental management decisions. Asking the right questions may lead to investment in getting the correct information. While cost-benefit analysis can establish the optimal societal level of environmental controls, it is also necessary to identify the range of solutions that society is willing to accept. Analysis of socially acceptable risks must complement the analysis of costs and benefits.

Socially Acceptable Risks

Risk-benefit analysis is the term used to describe the process which answers the question "How safe is safe enough?" (Slovic *et al.*, 1975). Starr (1969) proposed a quantitative method to answer this question on the basis of revealed societal choices. He assumed that, through trial and error, society develops norms of acceptable risks. By observing what risks people take under certain circumstances, one can identify the acceptable bounds upon risks. His study suggested that: (1) bounds on acceptable risks are proportional to the third power of perceived (or realized) benefits, (2) bounds on risks taken voluntarily are a thousand times greater than those which are acceptable in involuntary activites yielding the same levels of benefit, and (3) maximal levels of acceptable risks are inversely related to the number of people exposed to the risks. Starr also speculated that the risks of morbidity provide anchors for determining bounds on risks.

Otway and Cohen (1975) attempted to reproduce Starr's results and failed. They concluded that while the conclusions "were probably" philosophically correct, the results could not be justified on the basis of his analysis. It was further concluded that the mathematical relationship indicating the relative importance of the determinants must be regarded as unlikely (Otway and Pahner, 1976, p. 132). Otway and Pahner (1976) pointed out that the manner in which information is transmitted to the public and the resultant dynamics of group interaction play an important role in shaping the social norms which regulate risk taking.

Rowe (1977, p. 119) proposes several factors which could affect the social acceptability of risks. They are: (a) equity of risk and benefit distribution, (b) the avoidability of risk and availability of alternatives, and (c) the manner in which risk is imposed on the risk taker. Fischhoff et al. (1978) found that people tended to place tighter bounds on acceptable risks if consquences were immediate; risks realized in the distant future seemed more acceptable. In contrast, others (e.g. Zeckhauser, 1975) have pointed out that the time between exposure to risk and realization of consequences may create an anxiety which may lead to tighter bounds on acceptable risks if consequences are deferred and uncertain.

Other factors which influence the social acceptability of a risk include (Fischhoff *et al*., 1978):

(1) the familiarity with the risk,

(2) the perceived controllability of a risk,

(3) the potential for catastrophic (multiple-fatality) consequences, and

(4) the extent of scientific and public knowledge about the consequences.

Fischhoff *et al*. (1978, p. 143) conclude on the basis of a survey of attitudes that "for any given level of benefit, greater risk was tolerated if that risk was voluntary, immediate, known precisely, controllable and familiar".

Knowledge of the behavioral and moral constraints upon risk-benefit choices is inconclusive. It is clear, however, that these constraints are not rigid and can be relaxed if the public is convinced of the integrity of the decision procedure which demands taking more risks. In contrast, lack of trust in government and business, lack of information, a coercive environment and perceived social inequities in the distribution of benefits could lead to public pressures to tighten constraints on risk and make them rigid.

Employing Cost-Benefit Analysis in Environmental Protection Regulation Making.

There is almost universal agreement with the *principle* of cost-benefit optimization within the domains of socially acceptable risks. The major arguments against the application of this methodology revolve around determining the constraints upon socially acceptable trade-offs and the means for comparing values underlying the estimation of costs and benefits in terms of a single metric. There is agreement that the methodologies necessary for resolving the arguments have not yet attained maturity. Lave and Seskin (1979, p. 30), for example, view cost-benefit analysis as extremely helpful in evaluating environmental issues. They do not regard it as a panacea, however. "A good cost-benefit analysis is not easy to do, and the potential difficulties ensure that one cannot be completely confident about the outcome." In spite of this, they regard cost-benefit analysis as a valuable framework and tool that can aid the decision maker in identifying the range of outcomes and the economic impact of a proposed action.

With this objective in mind (i.e. to identify ranges of economic impacts), the following sections of this paper attempt to explore the costs and benefits of environmental regulation in general, and the impact of environmental regulation on the Canadian chemical industry in particular. We start with a review of the basic data available about costs and benefits of environmental regulation in the United States. These data are used as a reference in estimating benefits and costs of environmental regulation in Canada and in interpreting data collected in Canada through a survey of the chemical industry.

General Information about Benefits and Costs of Environmental Protection.

Air Pollution: Benefits and Costs in the United States.

Lave and Seskin (1977 and 1979) identify the following classes of economic and intangible benefits of improving air quality: (1) improvements in human health, (2) increased productivity of ecological systems, (3) enhancement of recreational opportunities, (4) reduction of adverse impacts on household and industrial production (e.g. lower cleaning costs), and (5) improved quality of life (e.g. reduction of noxious odors, improved visibility). The costs associated with improving air quality include: (1) new abatement equipment, (2) modification of existing technology, (3) increased operating and maintenance costs, (4) process and design changes, (4) plant shutdowns causing temporary or permanent unemployment, and (5) the administration, implementation and enforcement costs of a control program.

In evaluating the benefits and costs of air pollution, Lave and Seskin (1979, p. 41) conclude that "defensible figures do not currently exist for most of the benefit categories cited above, although they recognize that they could total many billions of dollars a year".

As a lower bound on the benefits of air pollution control, they use the benefits of improved human health. Their basic findings concerning consequences to health of improved air quality are summarized in table 1 below:

Table 1

50% Reduction in Air Pollutants
Linked to Lower Mortalilty Rates

Date base	Air pollutants	Total mortality rate[a] (% decrease)	
		Unadjusted	Age-sex-race-adjusted
1960 annual cross section (117 SMSA's)[b]	Sulfates and particulates	4.7%	4.8%
1969 annual cross section (112 SMSA's)	Sulfates and particulates	5.8	5.0
1969 annual cross section (69 SMSA's)	Sulfates and particulates	5.3	4.8
	Sulfur dioxide and particulates	6.3	5.5
1960-69 annual cross-sectional time-series (26 SMSA's)	Sulfates and particulates	4.7	5.1
1962-68 annual cross-sectional time-series (15 SMSA's)	Sulfates and particulates	5.9	6.3
	Sulfur dioxide and particulates	5.3	5.7
1963-64 daily time-series (Chicago)	Sulfur dioxide	5.4	

a For 50% reduction in indicated air pollutant

b SMSA's are U.S. Standard Metropolitan Statistical Areas

Source: Lave, L. B., E. P. Seskin, "Air Pollution and Human Health", p. 218, Johns Hopkins University Press, Baltimore, 1977.

They combined their results with the U.S. Environmental Protection Agency's (EPA) estimates of the decrease by 1979 of sulfur oxide emmissions (88%) and particulate emissions (58%) that would result from the implementation of authorized controls upon stationary sources. The result is a 7.0% decrease in total mortality. The minimum economic value of this reduction in mortality (and an assumed similar reduction in morbidity) is the sum of direct medical care expenses and losses of earnings due to sickness and death which are avoided. They arrived at benefits of $16.1 billion (1973 dollars) compared to the estimates of $9.5 billion in control costs provided by the EPA.

Heintz et al. (1976) provided national estimates of air pollution damage. These are the benefits that would accrue annually from the reduction of air pollution to threshold levels. Health damage is estimated at $5.7 billion (1973 dollars) with a range of $2.0-$9.4 billion. Aesthetic damage is estimated at $9.7 billion with a range of $5.7-$13.7 billion. Damage to vegetation was estimated at $2.9 billion with a range of $1.0-$9.6 billion. Damage to materials was estimated at $1.9 billion with a range of $0.8-$2.7 billion. The total damage estimate was $20.2 billion with a range of $9.5-$35.4 billion.

Some information exists about the direct industrial costs of environmental regulation. For control of air pollution in the United States, Haveman and Smith (1978) quote the following numbers based upon modelling work of the Chase Econometric Associates and the analysis of the Council on Environmental Quality

(CEO). Investment in abatement of air pollution from fixed sources for 1970-75 in the United States was $13.53 billion (1974 dollars), and annual operating and maintenance costs were $10.79 billion. For the period 1976-83, the estimates are $21.56 billion for investment and $66.63 billion for operating costs.

The comparable chemical industry figures for the period 1970-75 are $0.84 and $0.79 billion for investment and annual operating costs respectively. For the period 1976-83, the estimates are $1.27 and $3.54 in investment and operating costs respectively. The chemical industry experienced a higher rate of growth in environmental investment and annual operating costs than other industrial sectors, but growth was below the industrial average for total fixed sources (where utilities experienced the highest burden of costs).

During 1974-75, the U.S. chemical industry devoted between 1.03% and 2.19% of its total new investment to air pollution abatement as compared to a general manufacturing industry average of between 0.74% and 0.81%.

Water Pollution Control

Heintz *et al*. 1976 provide estimates of national U.S. water-pollution damages. These are the annual benefits from reduction of water pollution to "threshold" levels. The estimates in 1973 dollars are:

a) for outdoor recreation -- $6.3 billion, with a range of $2.5- $12.6 billion,

b) aesthetic and ecological damage -- \$1.5 billion, with a range of \$0.6- \$2.8 billion,

c) for health -- \$0.6 billion, with a range of \$0.3-\$1.0, and

d) for production -- \$1.7 billion, with a range of \$1.1-\$2.3.

The estimated range of the total is between \$4.5 and \$18.7 billion (1973) dollars. Heintz et al. consider the underlying quality of the data base for these estimates as of mainly poor to fair reliability.

Haveman and Smith (1978) provide actual and estimated direct industry costs of water pollution control. Using the Chase Econometric model and CEQ analysis, they conclude that general investment in water pollution abatement in the United States during the period 1970-75 was \$7.91 billion, with annual operating costs of \$6.35 billion (in 1974 dollars). During 1976-83 the costs for all sources of emission are estimated to be \$30.69 billion for investment and \$41.58 billion for annual operating and maintenance costs.

The U.S. chemical industry has spent \$0.84 billion in investment and \$0.85 billion in annual operating and maintenance costs during the period 1970-75. Investment in water pollution abatement in the chemical industry during the period 1976-83 is expected to rise to \$7.61 billion while annual operating and maintenance costs will reach \$10.74 billion. The rate of growth in investment and operating costs between the two periods for the U.S. chemical industry is about double that of the industrial sector as a whole.

Global Costs of Pollution Abatement Policies in the United States

Using the Chase Macroeconomic model, the performance of the economy was tested with and without abatement policies. For each variable considered, Haveman and Smith report the percentage difference between the baseline economy without regulations and the economy as it would appear with the impact of regulation (Table 2). Three scenarios are displayed. The first, referred to by Haveman and Smith as BASE-CEQ, compares the economy with regulations in effect with a long term forecast that assumes low unemployment rates until mid-1977, followed by a recession and recovery. Unemployment remains in the 6 percent range in both recovery periods. The second scenario, designated BASE-HC, uses estimates of incremental pollution abatement investment and costs that are arbitrarily increased by 25 percent, and the same base-line economic forecast is used as in the BASE-CEQ scenario. The final scenario, FULL-CEQ, uses the Congressional Budget Office five year projections as a baseline. These projections presume the economy will experience close to full employment conditions. The same incremental investment and cost estimates used in BASE-CEQ are employed in FULL-CEQ (Haveman and Smith, 1970, p. 181-182).

Control of Toxic Chemicals

The benefits of controlling toxic chemicals are not sufficiently documented. The major preoccupation of regulators is with

Table 2

Impact of a Pollution Control Policy on Macroeconomic Variables, Expressed as the Percentage Difference Between the Economy Without the Policy (BASE or FULL) and with the Policy (CEQ or HC), 1976-1983

(percentage)

Macroeconomic variables	Years							
	1976	1977	1978	1979	1980	1981	1982	1983
Real GNP								
BASE-CEQ	0.09	-0.48	-1.03	-1.16	-1.42	-1.70	-1.97	-2.17
BASE-HC	0.14	-0.59	-1.28	-1.40	-1.73	-2.09	-2.44	-2.68
FULL-CEQ	0.11	-0.53	-0.93	-1.16	-1.41	-1.74	-1.95	-2.27
Consumer price index								
BASE-CEQ	1.56	2.26	2.72	3.17	3.64	4.05	4.47	4.71
BASE-HC	1.82	2.74	3.40	3.90	4.53	5.03	5.59	5.94
FULL-CEQ	1.54	2.32	2.78	3.39	3.84	4.41	4.77	5.34
Growth rate of consumer price index								
BASE-CEQ	0.7	1.1	1.0	0.8	0.8	0.8	0.7	0.7
BASE-HC	0.9	1.4	1.2	1.0	1.1	1.1	0.9	0.9
FULL-CEQ	0.8	1.2	0.9	0.9	0.9	0.8	0.8	0.8
Unemployment rate								
BASE-CEQ	-5.56	-7.35	-2.41	-2.02	-1.15	0.00	1.64	3.64
BASE-HC	-8.33	-10.29	-3.61	-3.03	-2.30	-1.43	0.00	1.82
FULL-CEQ	-5.48	-7.94	-3.64	-2.13	-2.27	0.00		4.55
Real fixed investment (Producers' durables)								
BASE-CEQ	6.04	4.96	3.62	4.05	3.19	1.87	0.84	0.35
BASE-HC	7.46	6.01	4.50	4.98	4.07	2.39	0.92	0.49
FULL-CEQ	5.70	5.01	2.76	2.56	2.07	1.35	0.52	0.22
Housing starts								
BASE-CEQ	-6.62	-19.15	-21.15	-13.29	-10.05	-12.57	-13.14	-13.48
BASE-HC	-7.95	-23.40	-25.00	-15.38	-12.44	-14.66	-16.00	-16.85
FULL-CEQ	-6.33	-13.59	-11.79	-9.59	-10.67	-12.38	-14.74	-16.65
Aa corporate bond rate for new issues								
BASE-CEQ	8.43	10.84	11.71	13.90	15.05	13.88	12.82	12.01
BASE-HC	10.51	13.50	14.56	17.62	18.91	17.48	16.03	15.01
FULL-CEQ	8.48	11.56	12.42	12.65	12.90	12.90	12.54	13.40

Source: Haveman and Smith 1978, p. 181 quoting Chase Econometric Associates, Macroeconomic Impacts, pp. 12-14, 19-20, 21-22.

potential carcinogenicity and mutagenicity of existing and new chemicals.

Conclusive evidence of carcinogenicity exists for less than 30 chemicals (Maugh II, 1978), but the U.S. National Institute of Environmental Health Sciences (NIEHS) has produced a list of 56 other chemicals which it suspects of carcinogenicity. The International Agency for Research on Cancer has determined, on the basis of animal tests, that there are 212 chemicals which may be suspected carcinogens (Knelman, 1979).

Thus, the arena for toxic chemical regulation is wide open; its benefits are highly uncertain since they depend on the as yet unknown state of toxicity of chemicals, many of which have not yet been discovered. However, it is known that the costs of regulating toxic chemicals in the United States are high and expected to rise significantly. Seventy-five percent of all chemicals produced in the United States have an annual production volume of 100,000 pounds or less. The high expenses involved in testing chemicals for TSCA may be prohibitive and lead to the elimination of many chemicals currently produced in low volumes.

In 1975, three estimates of the costs of TSCA to industry were given by EPA, the Chemical Manufacturers Association (CMA) and Dow Chemicals. EPA estimated the costs of TSCA to range between $80 and $140 million; CMA estimated the costs to be between $360 million and $1.3 billion; and Dow Chemicals estimated the costs at the $2 billion level. The U.S. General Accounting Office, after reviewing the studies, concluded that the total costs of TSCA would range between $100 and $200 million a year. (The breakdown, details of computations and their evaluation are provided in Rohlich, Toxic Chemicals Regulation: The Toxic Substances Control Act, p. 115-152.) The indirect social costs of TSCA are not known. Industry claims that the expectation of reduced profit margins and the uncertainty generated by TSCA will reduce R&D investments and threaten the competitive position of the United States in the international markets for chemicals.

Costs of Environmental Regulation to the Chemical Industry in Canada.

The Canadian chemical industry,in 1978, had gross assets of $8.3 billion. In that year, the estimated value of shipments of chemicals and chemical products reached $7.9 billion (up 21.7% from a year earlier). This total represented more than 6% of the output of all manufactured goods in Canada. In 1978, imports of chemicals reached $2.7 billion while exports totalled about $1.9 billion,creating a sectoral balance of trade deficit of $877 million.

The industry is very diversified in terms of product markets and technologies. The market diversity and the differences in technological sophistication and capital intensity lead to important differences in the impact and administration of environmental regulations. The fertilizer industry, for example, is a net exporter and employs relatively unsophisticated technologies. Its competitive position depends upon the costs of production and marketing. As a result, product development and differentiation and technological advances have a relatively minor role in the economic fate of the industry.

Environmental regulation of fertilizer production processes has had little impact upon the costs of production. On the other hand, government policies which affect domestic demand (e.g. agricultural income policies), international trade or the cost of raw materials or transportation have a significant economic impact. Demands for fertilizers (in particular, the demand mix) are affected by provincial and federal regulations aimed at reducing the risks of eutrophication. The impact of these regulations on the sector as a whole have not been significant. Information collection by the government for the purposes of regulation is considered an irritant by the industry, but fears of a breach of data confidentiality do not play an important role in shaping investment decisions in this sector.

In contrast, the petrochemical industry, with a research and development expenditure pattern which is historically the highest of all manufacturing sectors in Canada, considers protection of data confidentiality a major factor in maintaining a climate conducive to investment. This industry has been affected by the rapid growth of environmental and occupational safety regulations. As in the case of the fertilizer industry, environmental regulation by itself is not a major determinant of the economic state of the industry. However, in contrast to the fertilizer industry, environmental regulation of the chemical industry is a small but significant factor which may reduce profit margins and the attraction of further investment to the sector. An examination of the differences between these two sectors of the chemical industry demonstrates the problem facing any universal assessment of the costs of environmental regulation to the total industry. The average does not reflect the burdens upon those sectors that are the most volunerable to environmental regulation.

To assess the impact of environmental regulation upon the chemical producers, three complementary methods were used:

(1) case studies of direct investments and operating costs of pollution abatement;

(2) an industry-wide mail survey to measure the marginal impact of a reduction in the stringency of regulation from present standards; and

(3) interviews with a sample of companies to identify qualitative impacts of environmental regulation upon the industry.

Two companies volunteered cost data concerning pollution abatement efforts. The numbers are compared to environmentally related cost figures from the United States, which were provided in the preceding section, in order to obtain interval estimates of direct average costs of environmental regulation on the chemical industry in Canada.

The industry-wide survey consisted of a mail questionnaire attempting to estimate the order of magnitude of remedial impacts which may result from removing the constraints imposed by particular environmental regulations. The impact dimensions examined included stimulation of R&D investments, increases in exports, reduction of product prices, increases in production, increases in profits and impacts upon domestic competitive features of the responding firm. Sixty-nine producers of chemicals have responded to the survey.

To estimate long term impacts which cannot be presented simply in terms of dollar costs, interviews were conducted with 10 companies. These interviews focused upon the impact of the environmental regulatory system as a whole (as opposed to specific regulations) on the industry (e.g. impacts upon the business climate). The interviews also provided an insight into the role that expectations about regulation play in changing the dynamics of the industry (e.g. triggering responses in anticipation of regulation).

Industry costs of compliance with environmental regulation were provided by two companies: C.I.L. Inc. and Polysar Ltd.

C.I.L. Inc. has a highly diversified product line and plants in all ten provinces of Canada. It employed more than 8000 employees at the end of 1978. The products which contribute most to C.I.L. revenues are large-volume heavy, chemicals. Net income margins for sales reflect this orientation, ranging from 3.5% to 7.2%.

Table 3 provides C.I.L. environmental regulation costs (not improvements introduced in anticipation of regulation). The table also provides other performance data concerning the opera-

Table 3

C.I.L. Environmental Regulation Costs

($ millions)

Year	Sales	Total New Capital	Net Income Before Extra-Ordinary Items	Direct Investment in Environmental Controls (Existing Plants Only)	Environ-mental Operating Costs
1973	383	21.5	15.9	0.87	0.96
1974	518	48.6	34.8	1.28	1.13
1975	595	55.4	42.6	2.50	1.22
1976	614	62.9	24.4	2.89	1.43
1977	668	59.3	24.9	2.48	1.66
1978	747	102.5	26.4	3.89	1.87

tions of the company. Studies by C.I.L. and its parent company in the U.K. (I.C.I.) suggest that about 5%-15% of all new capital outlays in the industry can be attributed to process redesigns which are integrated into new production processes with the major objective of eliminating wastes and reducing emissions. This indirect investment is not included in the table (and should be added to derive a total investment figure in environmental protection).

Operating costs of pollution controls, as a percentage of net operating income, have increased to more than 7% in 1978. As a percentage of sales, the number is small (0.25%) but, since profit margins are small, it has an important impact upon net income. During the period 1976-1978, investment in pollution abatement equipment in existing plants amounted to 4% of total new capital. This number falls in the range of 3.65-4.65 % (annual pollution abatement investment increments as a percentage of total new investment) given by Haveman and Smith (1978) for the United States in the period 1974-75.

The second company, Polysar Ltd., is less typical as it represents a particular segment of the industry (rather than a cross section). Polysar primarily produces and sells synthetic rubber, various kinds of latex, thermoplastic resins and basic materials for the chemical industry. Table 4 provides general information about the operations of the company and environmentally related expenditures.

Table 4

Polysar Inc., Environmental Regulation Costs

(millions of dollars)

Year	Sales	Total new capital (excluding Petrosar)	Net income	Direct investment in environmental control, including new plants	Environmental operating costs
1973	261	61.0	12.6	0.4	1.26
1974	392	20.4	22.8	0.4	1.46
1975	392	42.6	1.6	0.6	1.45
1976	458	76.0	7.5	7.0	1.53
1977	577	43	14.4	7.5	1.70
1978	747	-	18.5	3.1	1.65

It is important to note that the direct computation of regulatory cost ratios in this case is not meaningful since the Canadian market area represents only 22% of this multi-national business. During the period 1973-75, investment in environmental controls amounted to about 7% of all capital investments (excluding investments in Petrosar). As a percentage of total sales during 1976-78, environmentally related operating costs amounted to 0.27%. If a correction is made for Canadian related revenues, operating costs of pollution abatement activities amount to more than 1%. If one considers the fragile state of profit margins between 1975-1978, the adverse impact of environmental regulation on Polysar's Canadian operations is significant. One should note that the environmentally related investment figures given by Polysar include investment in new plants and modifications to existing plants.

Interviews we have conducted suggest that the Polysar experience is typical of the most vulnerable sections of the chemical industry (e.g. the petrochemical sector) where environmental demands accelerated during a period of poor industry performance. During this time, high expansion was followed by soft markets and generally increasing costs of production. This yielded a poor overall economic performance, thus sharpening the adverse impact of environmental regulation.

On the basis of our analysis of costs provided by the two companies as well as information provided by other companies during our interviews, we estimate the average operating costs for pollution abatement in the chemical industry (as a percentage of net income) to be in the range of 5-10%. As a percentage of sales, we estimate these expenditures to be between 0.25 - 1%. The average percentage of total capital investment that can be attributed to demands of environmental protection is estimated to be in the range of about 6%-9%. However, some of this investment may prove, in hindsight, to be economically beneficial. (Unexpected future price increases of raw materials may justify secondary recovery which at present is uneconomical and undertaken solely for environmental protection.)

A significant issue which has not been fully addressed in past expenditures on environmental protection is the problem of waste management. Many of the expenditures associated with this problem have been deferred by keeping wastes on company premises until appropriate sites are opened or regulations concerning disposal are developed. In the next five years, we forecast significant investment in disposal facilities and technological redesign to deal with toxic chemical wastes. These expenditures will compensate for a decline in the need for investments in air and water pollution facilities, and will lead to a net increase (in real terms) in demands for environmentally related investments.

Other expenditures by chemical producers may be necessary if "funds" raised by levies upon industry are established for waste management (see for example, Ontario Ministry of the Environment, 1979a).

To assess the extent to which marginal reforms in existing regulations may generate benefits for industry and society, a questionnaire was designed and sent to all member companies of the Canadian Chemical Producers Association (CCPA) and a sample of Canadian Manufacturers of Chemical Specialties (CMCS).

The questionnaire asked a company to identify the particular federal or provincial act which has the highest adverse economic impact on it. It then requested a response to the following questions:

- If the constraints that this Act imposes on our activites were removed, we would increase/decrease (circle one) our R&D budget by ( ) percent.
- If the constraints of this Act were removed, our exports would increase in the next decade by ( ) percent.
- If the constraints imposed by this Act were removed, competition from foreign manufacturers would increase/decrease (circle one) and prices for affected ranges of products would tend to increase/decrease by ( ) percent.
- If the constraints of this Act were removed now, our volume of sales would increase by ( ) percent.

- If enforcement procedures of the Act were simplified (e.g. reduced red tape), the profit of our firm would be increased by ( ) percent.
- If all federal and provincial legislation concerning the manufacturing of chemicals was rationalized (made consistent), the adverse effects of the Act would be reduced by ( ) percent.

The survey must be interpreted as providing only qualitative estimates, since many of the numbers requested are based on the judgments of corporate executives who do not have access to detailed, internal studies of impacts.

Members of CMCS participating in the survey (N=24) have identified non-environmental, safety related regulations as the major source of economic burden. Only twenty-five percent of the respondents identified environmental regulation as a major source of economic burden. We therefore focus in our analysis only on the responses of the Chemical Producers.

The acts which were identified by the 47 CCPA members as sources of regulation with the highest adverse economic impact were: The Fisheries Act (23%), The Clean Air Act (17%) and the Environmental Contaminants Act (17%).

The Environmental Contaminants Act (34%) followed by the Clean Air Act (17%) and Fisheries (10%) were identified as the major sources of uncertainty with respect to future economic burdens upon industry.

The impacts of regulation constraints on R&D efforts of chemical producers were generally insignificant for 66% of those responding. About 16% of the respondents expected a reduction in R&D budgets, reflecting diminishing needs for process improvements associated with pollution abatement. Nineteen percent expected an increase in R&D budgets, with about 9% of the companies considering 30-50% increases. It should be noted that the decrease in R&D was expected by large companies, while the increase in R&D budgets was expected by small companies (with annual sales of less than $50 million).

In conclusion, environmental regulation seem to be a stimulant to R&D associated with production-process redesigns. Gains in R&D from removal of regulatory constraints are expected in small companies. For the majority of the companies, R&D budgets seem to be a fixed proportion of total operating costs and are not expected to vary significantly if environmental regulations are relaxed.

The impact of environmental regulation upon exports was judged as insignificant by 89% of those responding. One large company indicated a very small change, while a very small producer (sales of less than $10 million) indicated a significant increase in exports. Most respondents did not attribute any significant impact upon their competitive edge to a relaxation in environmental regulation. Only 17 percent of the companies expected improvement in their competitive position relative to foreign suppliers in the domestic market.

About 40% of the companies responding expected a reduction in product prices with removal of regulations. Most of the companies indicating an expected price reduction as a result of deregulation were small. Twenty-nine percent of the sample expected increases in their sales volume as a result of a relaxation in environmental regulation.

The simplification (e.g. reduction of red tape) of the environmental regulation enforcement process was expected to improve profits in about 36% of the companies answering the question; but again this impact was not significant for large producers.

Forty-four percent of the responding companies indicated some reduction in adverse affects of environmental regulation if duplication and conflict were eliminated. These anticipated effects were generally significant for small producers only (with the exception of one large producer).

The survey indicates that small producers may be affected significantly by changes in the stringency of standards and the enforcement procedures of environmental regulation. Large producers, in anticipation of regulation and public demands, often invest in environmental protection before it is required, achieving higher standards than those currently demanded. Relaxation of particular standards or rationalization of the enforcement system therefore may have a small impact upon operations. However, one must consider environmental regulation as a constituent of a larger package of regulations. Although individual regulations may have an insignificant impact upon business, in total they have a major impact.

Interviews with executives in a sample of large firms confirmed the observation that environmental regulations, though costly, have only a limited direct adverse affect upon the chemical producing sector. The major concern expressed by these companies was the contribution of the environmental regulatory system to uncertainty. This uncertainty was identified as a factor which inhibits industrial growth. Interviews with some of the companies indicated that fears of government release of confidential information submitted in conformance with regulations is another important source of uncertainty. Generally, executives who were interviewed judged the performance of the consultative regulation system as superior to the U.S. adversary system. The Canadian system, it was stated, produced regulations which resulted in a minimum of unnecessary burden. Reached through a process of negotiation, many of these regulations appear to achieve an approximate balance between social costs and benefits. However, it was noted that there are pressures for the adoption of regulations similar to those in the United States which may not reflect Canadian conditions.

The direct costs of the environmental regulation of the chemical industry are impossible to assess since, if the industry was de-regulated, it is doubtful that the resources would be freed for other non-regulatory tasks. Expenditures on information acquisition concerning the toxicity of chemicals are about

4% of the resources available for data acquisition in the United States. Since little R&D on new chemicals is conducted in Canada, most of the costs associated with pre-market notification accrue to "foreign parent companies" who develop the chemicals.

The overall pattern in Canada of regulation costs of the chemical industry seem to be similar to those in the United States. The value of benefits is much more uncertain since almost no studies have been conducted in Canada to estimate national benefits of improvements in environmental quality. Without these figures, it is possible to use only U.S. estimates of benefits of pollution control. These indicate that while costs of control are significant, expected social benefits may be even larger. To utilize a rational method of balancing costs and benefits, it is necessary to dedicate sufficient resources for research to ascertain for Canada, the national and regional incremental benefits arising from a cleaner environment.

Prescriptions

Environmental regulations are costly. In our judgement, however, the social benefits of pollution abatement efforts have exceeded the social costs. But this does not imply that society has incurred only the minimal, necessary costs to achieve environmental objectives.

The system of regulation making which constrains emissions from particular sources without permitting trade-offs is inherently less efficient than a system which assures global attainment of objectives while permitting trade-offs in means. Furthermore, technology-based criteria for standard making (e.g. "best practicable technology") tend to de-emphasize the need to balance social costs and benefits; rather, they focus on what is feasible and not necessarily on what is optimal. Technology-based standards, however, can be reasonably applied when dealing with persistent chemicals which cannot be assimilated and detoxified by the environment even when concentrations are low.

An analysis of cost-effectiveness is a first step toward improved regulation making. This type of analysis provides a means for improving the implementation of given objectives. However, analysis of cost-effectiveness should always be accompanied by a statement which justifies the chosen targets.

A cost-benefit analysis provides an examination not only of means to attain environmental objectives, but also of the objectives themselves. In spite of the inadequate state of the art of environmental cost-benefit analysis, attempts should be made to conduct such analyses when developing regulations. The initial role of such analyses will be to ensure that adequate consideration is given to the benefits of actions in relation to their costs.

It is recommended that sufficient resources be devoted to research into the benefits of improved environmental quality and the costs of environmental regulation in order to develop a suitable information base. Without adequate information, decisions concerning regulation will tend to be more a reflection of the political balance of power in Canada and of environmental regulation in the United States than of the calculus of social costs and benefits.

Our analysis also indicates, with respect to pre-market screening of new chemicals, that risk-benefit analysis is potentially useful as a means of identifying reasonable limits upon risks. Explicit identification of assumptions about values and consequences is necessary to ensure the integrity of the process and reduce potential occurrences of costly responses in instances where public alarm is unwarranted. It should be noted, when dealing with uncertainty, that the realm of facts and values cannot be separated. The issue of what is information becomes a policy question, not a question of science. Research concerning values in environmental decision making is a neglected facet of environmental protection research and should be initiated.

To conclude, more complete information and an improved framework for decision making can result in better regulation. Nevertheless, adequate methodologies and information are necessary but not sufficient conditions for optimal regulation. Like other decision aids in the political arena, these methodologies are subject to manipulation. Majone (1978, p. 502) has observed: "many analysts have lambasted the administrative approach (prohibitions, standards, incentives, and so on) for its lack of effectiveness and for its tendency to become a political process entailing bargaining between parties of unequal power.

They have proposed effluent charges and related market-oriented techniques as alternatives that by their automatism ... would reduce the scope for administrative discretion and bargaining.

But these normative conclusions overlook one important point: the same forces that influence and distort the regulatory framework will also affect other approaches, by the same or by different methods. The comparison between, say, an uncorrupted system of effluent charges and a regulatory machinery captured by special interests is a specious one. Where effluent charges have been used -- for instance, in France -- they have proved to be as subject to bargaining and as conditioned by considerations of political and administrative expediency as have standards, licenses, and other regulatory measures. Thus, the search for a system that would resolve most of the political conflict over the environment in a highly visible way, in the same sense in which planning-programming-budgeting was supposed to lift the budgetary process out of the morass of political compromise, is bound to lead to disappointment." Consequently, an informed, interested and vigilant public is essential to assure better regulations.

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APPENDIX

SUMMARY STATISTICS FOR QUESTIONNAIRE RESULTS

STANDARD SETTING PROCEDURES

Answers are selected from a scale of 1=strongly disagree to 7=strongly agree. The number of repondents is: 18 regulators, 4 scientists, 47 CCPA (Canadian Chemical Producers Association) members, 24 CMCS (Canadian Manufactures of Chemical Specialties) members and 9 public interest groups.

STATEMENT:
Standards for allowable levels of emissions should be negotiable between the appropriate governmental agency and industry.

Group	Mean	Standard Deviation
Regulators	2.9	2.0
Scientists	5.3	2.2
CCPA	6.0	1.6
CMCS	5.8	1.6
Public Interest Groups	2.8	2.5

STATEMENT:
Standards should be set which exceed current technology.

Group	Mean	Standard Deviation
Regulators	3.6	2.0
Scientists	3.0	1.8
CCPA	1.7	1.3
CMCS	2.7	1.7
Public Interest Groups	4.9	1.6

STATEMENT:
Standards should be set by Parliament or provincial legislatures, not decided by the administrators of the enabling legislation.

Group	Mean	Standard Deviation
Regulators	5.2	2.3
Scientists	2.8	2.9
CCPA	2.8	2.0
CMCS	3.3	2.6
Public Interest Groups	4.4	2.0

STATEMENT:
Minimum emissions standards should be set by the federal government to prevent pollution havens.

Group	Mean	Standard Deviation
Regulators	---	---
Scientists	---	---
CCPA	4.6	2.3
CMCS	5.5	2.0
Public Interest Groups	6.7	0.7

STATEMENT:
Provincial and regional governments rather than the federal government should develop more stringent standards to reflect local and regional needs.

Group	Mean	Standard Deviation
Regulators	---	---
Scientists	---	---
CCPA	4.9	2.2
CMCS	4.6	2.0
Public Interest Groups	5.1	2.3

STATEMENT:
Toxicity standards should be allowed to reflect varying local and regional conditions.

Group	Mean	Standard Deviation
Regulators	4.3	3.1
Scientists	---	---
CCPA	---	---
CMCS	---	---
Public Interest Groups	---	---

STATEMENT:
Toxicity standards should be set by local jurisdictions as opposed to a central agency.

Group	Mean	Standard Deviation
Regulators	2.3	1.5
Scientists	---	---
CCPA	---	---
CMCS	---	---
Public Interest Groups	---	---

STATEMENT:

Toxicity standards should be set by local jurisdictions (as opposed to a central agency) and should be allowed to reflect varying local and regional conditions.

Group	Mean	Standard Deviation
Regulators	1.9	1.2
Scientists	4.8	1.0
CCPA	---	---
CMCS	---	---
Public Interest Groups	---	---

STATEMENT:

Standards should be set to protect the most sensitive individual likely to be exposed in the environment.

Group	Mean	Standard Deviation
Regulators	4.2	1.9
Scientists	2.3	1.0
CCPA	2.6	1.7
CMCS	3.4	2.0
Public Interest Groups	5.6	2.0

STATEMENT:

Standards should be based on the concept that there is a threshold below which no deleterious effects occur.

Group	Mean	Standard Deviation
Regulators	4.2	2.1
Scientists	4.5	1.9
CCPA	5.4	1.9
CMCS	5.6	1.3
Public Interest Groups	2.2	1.4

STATEMENT:

Standards should be set so that some total exposure to a particular chemical from <u>all</u> sources is not exceeded, no matter which medium conveys the chemical (eg. air, water, physical contact).

Group	Mean	Standard Deviation
Regulators	5.2	1.7
Scientists	4.8	1.9
CCPA	4.8	1.7
CMCS	4.9	1.9
Public Interest Groups	6.6	0.5

STATEMENT:

External environmental standards should be set so that some total exposure to a particular chemical from all sources is not exceeded no matter which medium conveys the chemical.

Group	Mean	Standard Deviation
Regulators	---	---
Scientists	---	---
CCPA	4.7	1.6
CMCS	5.0	1.7
Public Interest Groups	6.1	0.7

STATEMENT:

Standards should be set so that occupational exposure levels are not higher than those faced by the public.

Group	Mean	Standard Deviation
Regulators	2.7	1.5
Scientists	4.3	1.7
CCPA	2.9	2.2
CMCS	3.4	2.0
Public Interest Groups	6.8	0.4

STATEMENT:

Industry should be allowed to exceed environmental standards in a local jurisdiction provided it can ensure adequate compensation.

Group	Mean	Standard Deviation
Regulators	1.8	1.5
Scientists	2.0	1.2
CCPA	1.9	1.5
CMCS	2.8	1.8
Public Interest Groups	1.2	1.4

STATEMENT:

Any amount of pollutant should be dischargeable into the environment provided the polluter pays a certain fee per unit.

Group	Mean	Standard Deviation
Regulators	1.1	0.3
Scientists	1.5	1.0
CCPA	1.9	1.6
CMCS	1.5	1.1
Public Interest Groups	1.7	2.0

STATEMENT:

A fee per unit system for pollutants is preferable to a fixed standard system.

Group	Mean	Standard Deviation
Regulators	2.7	2.3
Scientists	2.8	1.3
CCPA	3.2	2.4
CMCS	2.8	2.0
Public Interest Groups	1.3	0.5

STATEMENT:

An individual should be allowed to increase his personal exposure in an occupational setting on a voluntary basis (e.g. for extra wages).

Group	Mean	Standard Deviation
Regulators	3.1	2.1
Scientists	3.8	2.2
CCPA	2.4	2.0
CMCS	2.6	2.0
Public Interest Groups	1.8	1.1

STATEMENT:

Because of similarities between the U.S. and Canada and because of more extensive research facilities in the U.S., Canada should adopt most U.S. standards.

Group	Mean	Standard Deviation
Regulators	4.6	1.7
Scientists	4.5	1.7
CCPA	3.0	1.9
CMCS	3.3	1.8
Public Interest Groups	2.9	1.5

STATEMENT:

Standards adopted internationally should be adopted automatically by Canada (e.g. OECD standards).

Group	Mean	Standard Deviation
Regulators	3.5	1.9
Scientists	3.3	2.6
CCPA	2.7	1.8
CMCS	3.0	1.9
Public Interest Groups	3.3	2.0

STATEMENT:
Only standards enforced internationally should be adopted automatically by Canada.

Group	Mean	Standard Deviation
Regulators	---	---
Scientists	---	---
CCPA	3.4	2.2
CMCS	3.4	1.7
Public Interest Groups	2.4	1.4

STATEMENT:
Standards should be developed through a decision process that includes broad public participation (e.g. open hearings).

Group	Mean	Standard Deviation
Regulators	5.1	1.6
Scientists	3.0	1.2
CCPA	3.7	1.9
CMCS	3.3	2.2
Public Interest Groups	6.7	1.0

STATEMENT:
As much as possible, standards should be set in consultation with elected public representatives (e.g. representation on decision making committees).

Group	Mean	Standard Deviation
Regulators	4.9	1.9
Scientists	4.0	2.4
CCPA	4.3	1.9
CMCS	4.0	2.0
Public Interest Groups	5.9	1.7

STATEMENT:
As much as possible, standards should be set in consultation with public interest groups (e.g. representation on decision making committees).

Group	Mean	Standard Deviation
Regulators	4.9	1.5
Scientists	4.0	1.2
CCPA	3.7	2.0
CMCS	3.6	1.9
Public Interest Groups	6.8	0.7

STATEMENT:

Where current technology is demonstrated as inadequate, the source of contamination should be eliminated (e.g. plant shut down).

Group	Mean	Standard Deviation
Regulators	---	---
Scientists	---	---
CCPA	2.6	1.7
CMCS	3.3	1.9
Public Interest Groups	5.8	1.9

STATEMENT:

Ambient environmental standards should be related to occupational health standards.

Group	Mean	Standard Deviation
Regulators	---	---
Scientists	---	---
CCPA	4.1	2.1
CMCS	4.7	1.5
Public Interest Groups	6.1	0.6

STATEMENT:

The selection of individuals for a consultative, standard setting body should be based on their expertise. (Laymen without technical knowledge should be excluded.)

Group	Mean	Standard Deviation
Regulators	---	---
Scientists	---	---
CCPA	5.5	1.8
CMCS	6.0	1.6
Public Interest Groups	1.2	0.4

STATEMENT:

Parties affected by a regulation (public or industry) should have the right of appeal to an independent third party.

Group	Mean	Standard Deviation
Regulators	---	---
Scientists	---	---
CCPA	6.2	1.3
CMCS	6.0	1.1
Public Interest Groups	5.4	1.5

STATEMENT:

Before the process of rigorous standard setting is begun, an attempt should be made to assess, at least qualitatively, the social cost and benefit of regulating an emission.

Group	Mean	Standard Deviation
Regulators	---	---
Scientists	---	---
CCPA	6.6	1.0
CMCS	6.4	1.3
Public Interest Groups	5.2	1.8

STATEMENT:

Duplication of federal and provincial legislation is currently a significant problem in setting standards.

Group	Mean	Standard Deviation
Regulators	---	---
Scientists	---	---
CCPA	5.4	1.4
CMCS	4.9	1.8
Public Interest Groups	4.2	1.5

STATEMENT:

Duplication of federal and provincial legislation is currently a significant problem in implementing standards.

Group	Mean	Standard Deviation
Regulators	---	---
Scientists	---	---
CCPA	4.9	1.7
CMCS	4.9	1.8
Public Interest Groups	4.6	1.8

COMPLIANCE STRATEGIES

STATEMENT:

Direct economic incentives and penalties are sufficient to ensure attainment of regulation objectives.

Group	Mean	Standard Deviation
Regulators	2.7	1.6
Scientists	4.0	1.8
CCPA	3.9	1.8
CMCS	3.4	2.3
Public Interest Groups	3.3	2.2

STATEMENT:

Self-regulation by industry is an important element in protecting society from toxic chemicals.

Group	Mean	Standard Deviation
Regulators	4.3	2.2
Scientists	6.0	0.8
CCPA	6.1	1.3
CMCS	5.1	1.9
Public Interest Groups	3.3	2.4

STATEMENT:

The provision of adequate information on toxicity in occupation settings to relevant unions will improve industry compliance with existing regulatory standards.

Group	Mean	Standard Deviation
Regulators	4.9	1.6
Scientists	5.3	1.5
CCPA	4.5	1.5
CMCS	4.5	1.7
Public Interest Groups	5.8	1.0

STATEMENT:

The provision of adequate information on toxicity in occupational settings to relevant unions will result in toxic levels in occupational settings reduced beyond existing guidelines.

Group	Mean	Standard Deviation
Regulators	3.5	1.9
Scientists	4.0	1.8
CCPA	3.7	1.5
CMCS	3.9	1.9
Public Interest Groups	4.9	2.2

STATEMENT:

The provision of adequate information on toxicity and exposure in non-occupational settings is a necessary element in a successful compliance strategy.

Group	Mean	Standard Deviation
Regulators	5.8	0.9
Scientists	5.3	1.7
CCPA	4.6	1.9
CMCS	5.0	1.4
Public Interest Groups	6.4	1.0

RISK EVALUATION

STATEMENT:

The benefits of a chemical should be compared to its risk to society before any decision is made to ban the chemical.

A. In cases of voluntary exposure.

Group	Mean	Standard Deviation
Regulators	5.2	1.8
Scientists	5.8	2.5
CCPA	6.2	1.3
CMCS	6.4	0.7
Public Interest Groups	4.9	2.1

B. In cases of involuntary exposure.

Group	Mean	Standard Deviation
Regulators	4.5	2.4
Scientists	5.5	2.4
CCPA	6.1	1.4
CMCS	5.5	1.6
Public Interest Groups	4.4	2.5

STATEMENT:

No chemical with a direct risk to life should be marketed when <u>some</u> involuntary exposure is involved (e.g. transportation of explosives on a public highway).

Group	Mean	Standard Deviation
Regulators	4.6	2.0
Scientists	2.3	0.5
CCPA	2.0	1.7
CMCS	2.8	1.9
Public Interest Groups	5.3	1.8

STATEMENT:

No chemical with a direct risk to life should be marketed when <u>significant</u> involuntary exposure is involved (e.g. transportation of explosives through a densely populated area).

Group	Mean	Standard Deviation
Regulators	---	---
Scientists	---	---
CCPA	3.0	2.3
CMCS	4.3	2.2
Public Interest Groups	6.6	0.7

STATEMENT:

Individuals should be allowed personal access to any chemical when they have been provided with complete information on the risks and when there is no danger to others.

Group	Mean	Standard Deviation
Regulators	3.9	2.3
Scientists	4.0	2.2
CCPA	3.1	1.9
CMCS	4.4	2.1
Public Interest Groups	3.6	1.8

STATEMENT:

Individuals should be allowed personal access to any chemical when the risk is completely understood by them and there is no danger to others.

Group	Mean	Standard Deviation
Regulators	---	---
Scientists	---	---
CCPA	4.9	1.7
CMCS	5.1	2.2
Public Interest Groups	5.0	1.3

STATEMENT:

If a certain involuntary risk is acceptable from one source, it should be equally acceptable from another source.

Group	Mean	Standard Deviation
Regulators	2.8	1.6
Scientists	4.3	1.9
CCPA	4.5	2.1
CMCS	2.7	1.9
Public Interest Groups	2.0	1.0

STATEMENT:
A socially acceptable level of risk to be used in decision making should be determined through a general public survey.

Group	Mean	Standard Deviation
Regulators	3.2	1.7
Scientists	2.5	1.9
CCPA	2.1	1.5
CMCS	2.5	1.9
Public Interest Groups	4.4	1.6

STATEMENT:
A socially acceptable level of risk to be used in decision making should be determined largely from the amount of risk acceptable in the past.

Group	Mean	Standard Deviation
Regulators	2.7	1.8
Scientists	3.8	1.0
CCPA	2.1	1.4
CMCS	2.8	1.8
Public Interest Groups	1.9	1.1

STATEMENT:
Individuals subject to exposure to toxic chemicals should have the right to information concerning their level of risk and the possible consequences.

Group	Mean	Standard Deviation
Regulators	6.8	0.5
Scientists	6.5	0.6
CCPA	6.6	1.1
CMCS	6.5	0.7
Public Interest Groups	7.0	0.0

INFORMATION ACCESS AND EXCHANGE

STATEMENT:
Information relating to public health risks from hazardous chemicals should be generally accessible (information not including trade-secrets).

Group	Mean	Standard Deviation
Regulators	7.0	0.0
Scientists	---	---
CCPA	6.4	0.7
CMCS	5.8	1.7
Public Interest Groups	6.9	0.3

STATEMENT:
Information relating to potential risks from toxic chemicals should be accessible only to affected parties; i.e. those with demonstrated cause for concern. (information not including trade-secrets).

Group	Mean	Standard Deviation
Regulators	1.7	0.6
Scientists	---	---
CCPA	2.9	1.9
CMCS	3.7	1.9
Public Interest Groups	1.2	0.4

STATEMENT:
Information from an industry about risks from toxic chemicals should be generally accessible only to government agencies directly involved in regulating such matters.

Group	Mean	Standard Deviation
Regulators	1.3	0.6
Scientists	---	---
CCPA	2.0	1.4
CMCS	2.9	1.9
Public Interest Groups	1.1	0.3

STATEMENT:

Interest groups should be encouraged to examine and criticize information concerning the incidence and level of risk.

Group	Mean	Standard Deviation
Regulators	5.7	1.2
Scientists	---	---
CCPA	4.7	1.5
CMCS	4.4	1.8
Public Interest Groups	6.6	1.3

STATEMENT:

Interest groups should be encouraged to contribute information on the incidence and socially acceptable level of risk.

Group	Mean	Standard Deviation
Regulators	6.3	1.2
Scientists	---	---
CCPA	5.0	1.3
CMCS	4.8	1.9
Public Interest Groups	6.6	1.3

STATEMENT:

Agencies regulating toxic chemicals should produce reports explaining the main factors considered in their decisions and make them available to the public.

Group	Mean	Standard Deviation
Regulators	6.7	0.6
Scientists	---	---
CCPA	6.1	1.2
CMCS	6.0	1.3
Public Interest Groups	6.7	1.0

STATEMENT:

Unions should have access to information relating to risk from hazardous chemicals irrespective of industry's need to protect trade-secrets.

Group	Mean	Standard Deviation
Regulators	4.7	0.6
Scientists	---	---
CCPA	3.1	2.1
CMCS	3.3	2.0
Public Interest Groups	6.9	0.3

STATEMENT:
The government should fund centers and institutions which will help the public and interest groups to access and process information.

Group	Mean	Standard Deviation
Regulators	6.0	1.0
Scientists	---	---
CCPA	3.4	1.8
CMCS	3.3	2.0
Public Interest Groups	6.2	1.4

STATEMENT:
The government should fund interest groups to allow them tO access and process information.

Group	Mean	Standard Deviation
Regulators	4.0	2.6
Scientists	---	---
CCPA	1.9	0.9
CMCS	2.5	1.8
Public Interest Groups	6.6	0.7

STATEMENT:
It is the responsibility of industry to provide information on the amount of risk and the possible consequences to people exposed to risk irrespective of industry's needs to protect trade-secrets.

Group	Mean	Standard Deviation
Regulators	6.3	0.6
Scientists	---	---
CCPA	5.2	1.8
CMCS	5.4	1.9
Public Interest Groups	6.8	0.7

STATEMENT:
It is the responsibility of government to ensure the provision of information to people at risk.

Group	Mean	Standard Deviation
Regulators	6.0	1.0
Scientists	---	---
CCPA	4.7	2.1
CMCS	5.8	1.5
Public Interest Groups	6.9	0.3

TRADE-SECRET AND CONFIDENTIAL ECONOMIC INFORMATION

STATEMENT:
Confidential data collected by one federal agency should be shared with other federal government agencies.

Group	Mean	Standard Deviation
Regulators	5.9	1.0
Scientists	---	---
CCPA	2.0	1.8
CMCS	3.9	2.3
Public Interest Groups	6.4	0.9

STATEMENT:
Confidential data collected by a federal agency should be shared with provincial agencies.

Group	Mean	Standard Deviation
Regulators	5.5	1.0
Scientists	---	---
CCPA	2.0	1.8
CMCS	3.8	2.3
Public Interest Groups	6.4	0.9

STATEMENT:
Confidential data collected by a federal agency should be shared with nongovernment contractors helping an agency assess a toxic substance problem.

Group	Mean	Standard Deviation
Regulators	4.6	2.1
Scientists	---	---
CCPA	2.1	1.8
CMCS	3.1	2.1
Public Interest Groups	6.4	0.9

STATEMENT:
Confidential data collected by a federal agency should be shared with those exposed to the chemicals.

Group	Mean	Standard Deviation
Regulators	4.1	1.8
Scientists	---	---
CCPA	2.3	2.0
CMCS	3.8	2.3
Public Interest Groups	6.8	0.4

STATEMENT:

Information developed and paid for by a company and designated as confidential is company property. Therefore, the company should have sole control over its distribution even after it is disclosd to a government agency.

Group	Mean	Standard Deviation
Regulators	---	---
Scientists	---	---
CCPA	6.2	1.5
CMCS	5.8	1.6
Public Interest Groups	1.7	1.0