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A Case Study: Petroleum Refinery Effluent Regulations and Guidelines under the Fisheries Act

Sixth in a Series of Studies on Government Regulatory Activity

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FOREWORD

In recent years, increasing concern has been expressed both inside and outside government about the social and economic impact of government regulatory activity. On the one hand, the regulatory process itself has been faulted for being insensitive to public needs and opinions while, on the other hand, doubts have been expressed concerning the efficiency and effectiveness of particular regulations, standards or guidelines. More specifically, with the onslaught of serious inflationary problems, it has been argued that regulations may be unnecessarily adding to costs and prices. In fact, it was in the context of the establishment of the Anti-Inflation Board and the resulting debate on controls and post-controls policies that the Cabinet directed the Department of Consumer and Corporate Affairs and the Treasury Board Secretariat to assess the feasibility of applying cost-benefit and related methods of analysis to government social regulations, and to suggest modifications to the regulatory process which might encourage greater public participation.

In response to this mandate, a Working Group on Social Regulations, chaired by François Lacasse of the Treasury Board Secretariat, was established. In the Department of Consumer and Corporate Affairs, the project was originally directed by Lawson Hunter and subsequently by Dale Orr. Other members of the Working Group included Harry Baumann (Project Manager), Bruce Montador, Michel Proulx, André Morin and Joan Huntley (Treasury Board Secretariat) and Lee McCabe and Ron Hirshhorn (Consumer and Corporate Affairs). As well, the Working Group received advice on legal matters from Allan Rosenzveig (seconded to CCA from the Department of Justice). The Federal-Provincial Relations Office made available the services of Richard Schultz as a consultant on jurisdictional problems between levels of government in the regulatory area. In addition, the Working Group received considerable help on technical matters from the Departments of Transport, Environment, Health and

Welfare, Energy Mines & Resources as well as the National Research Council and the Atomic Energy Control Board.

Because of the nature of the mandate and the limited resources, the Working Group pursued the following operational strategy. First, it concentrated on health, safety and fairness regulations leaving aside economic or rate-setting regulations. This decision proved to be fortuitous since little research on social regulations has been carried out in Canada, and more extensive provisions exist for public participation in the rate-setting process. Second, the Working Group decided to study both the allocative and non-allocative effects of regulations. In other words, the Working Group was concerned not only with the impact of regulations on economic (market) efficiency, but also their impact on (a) the distribution of income - who pays, who benefits (b) technical progress (c) international competitiveness (d) regional balance (e) market structure (f) inflation. Third, the Working Group decided to prepare two types of background papers. The first type were general studies on the reasons for social regulation, the US experience with regulatory reform, the regulatory process in Canada and techniques for the evaluation of regulations. The second group of papers consisted of case studies of representative regulations of recent vintage in the health, safety and fairness area.

Since a major purpose of this project was the examination of various mechanisms for encouraging greater public input into the regulation-making process, we have decided that selected background papers and case studies prepared by the Working Group should be published in order to increase public awareness of this very important aspect of government activity.

Sylvia Ostry
Deputy Minister-CCA

Maurice LeClair
Secretary-TBS

SUMMARY

This study examines the feasibility of using available methodologies to analyse the allocative (or efficiency) effects as well as the potential non-allocative effects of regulations pertaining to the protection of the environment. The Petroleum Refinery Effluent Regulations and Guidelines, issued under the Fisheries Act in November 1973, were selected as a case study for this purpose. The study was conducted in 1977.

If criteria to identify proposals that might have a major socio-economic impact had been used at the time these regulations and guidelines were being developed, they would, in all probability, have been subjected to a systematic evaluation. That they would have been subjected to analysis to determine the degree of their socio-economic impact is indicated by their total cost, estimated (in 1972 dollars, using a real social rate of discount of 10 per cent) as varying from $7 million to $23 million in any given year ($11 million to $58 million in current dollars) during the period 1973 to 1980.

The Petroleum Refinery Effluent Regulations and Guidelines set limits on the amount of oil and grease, phenols, sulfide, ammonia nitrogen, and total suspended matter that can be contained in a refinery effluent, along with pH limits. The limits are expressed in pounds per 1,000 barrels of crude oil. They are therefore related solely to plant capacity and are independent of effluent volume.

The major costs of these regulations and guidelines are the capital expenditures required for compliance and the costs of operating and maintaining the necessary effluent-treatment facilities. Ideally, the potential benefits could be described in terms of the protection of fish and other marine organisms, increased recreational opportunities (e.g. swimming, fishing), and improved aesthetic qualities. However, no information is available on the relationship between the reduction in

the pollutant discharges and the satisfaction of water-quality criteria for specific activities in the bodies of water affected by the policy. For this reason, the benefits had to be considered strictly in terms of the reduction in the discharge of the controlled pollutants.

The discounted cost per pound of pollutants not discharged because of these regulations and guidelines would be between 39 and 60 cents, depending on the assumption made concerning the annual growth rate in crude throughput. It was impossible, however, to determine whether the Petroleum Refinery Effluent Regulations and Guidelines are cost-effective, either from the point of view of containing pollution at source or from the broader perspective of a water-quality management approach (i.e. defining the desired uses of the affected bodies of water and the corresponding water-quality criteria, and establishing requirements that firms would have to meet in order to satisfy these criteria). The legal authority to control water pollution, which is conferred by the Fisheries Act, allows for consideration of the containment-at-source, or technology-based, approach. In this approach, which is used by Environment Canada, thorough analysis of the allocative effects of the regulations and guidelines proved to be almost impossible. The unfeasibility of such analysis is related not to limitations of the cost-effectiveness methodology but to the fact that in order to establish priorities, it is necessary to rank the various industries discharging pollutants in the bodies of water affected by the requirements, particularly on the basis of the toxicity of their effluents, but also with respect to the total volume of their discharge, and other relevant factors. Indeed, without a means for ranking these industrial sectors (some of which are not subject to effluent regulations), it is impossible to determine whether the Petroleum Refinery Effluent Regulations and Guidelines are the most cost-effective in terms of containment-at-source. In other words, while the discounted cost per pound of pollutants not discharged by the petroleum refining industry as a result of these regulations and guidelines would be between 39 and 60 cents, it could be lower for another industry discharging equally harmful substances into the same water.

However, a cost-effectiveness comparison of the various types of effluent treatment (e.g. intermediate treatment, secondary treatment) would show that the percentage increase in the water pollution abatement costs that would result from the imposition of more stringent requirements than those currently prevailing for the petroleum refining industry would be much greater than the corresponding percentage increase in the benefits. Given the general approach used, the current requirements for the petroleum refining industry thus appear to represent a situation in which the minimum-cost point has been attained, if not surpassed.

In addition, effluent charges as a policy-instrument alternative were considered, but they were not practicable. In this particular case, the absence of sufficient knowledge about the damage functions (upon which the implementation and effectiveness of effluent-charge mechanisms depend) would have been a deterrent to the use of this approach.

The regulations and guidelines are not expected to have a major impact on the price of refined petroleum products, distribution of income, technological progress, international trade, or employment. The additional expenditures necessary to comply with the requirements would increase only slightly the already very high barriers to entry into this industry.

The study also considers the relationship between the federal government and provincial governments in the formulation and enforcement of these regulations. No duplication of effort in the formulation of petroleum refinery effluent regulations took place. There was a potential for conflict between the federal and provincial governments with respect to policies and objectives, but such conflict did not emerge, because of the process used in developing the regulations (i.e. consultations between the federal and provincial governments) and because federal regulations did not impose requirements more stringent than those which provincial governments had already imposed or were preparing to impose.

In addition, since compliance with the regulations is ensured by either federal or provincial officials, there is no duplication of enforcement expenditures.

Finally, it should be noted that the analysis of the allocative and non-allocative effects of the Petroleum Refinery Effluent Regulations and Guidelines presented here was performed at a specific point in time, using information and methodologies then available to address the problem at hand, and that developments in the areas of information, analytical techniques, etc. may allow for the use of a different methodology in the future. For this reason, this experimental study should not necessarily be considered a model for future analyses of the socio-economic impact of regulations dealing with protection of the environment.

INTRODUCTION

In 1972, there were forty petroleum refineries operating in Canada, with a total crude-oil capacity of about 1.7 million barrels per day.[1] During that year, 18,300 pounds of oil and grease, 3,900 pounds of phenols, 10,200 pounds of sulfide, 23,900 pounds of ammonia nitrogen, and 46,000 pounds of suspended solids were discharged per day by these refineries.[2]

Under the Fisheries Act as amended in June 1970, the federal government has the authority to regulate the emission of contaminants into all watercourses populated by marine life. After the development of regulations for the pulp and paper and the chlor-alkali industries,[3] Environment Canada formed a joint industry-government task force early in 1972 to develop uniform water-effluent regulations for the petroleum refining industry.

The federal Petroleum Refinery Effluent Regulations and Guidelines promulgated in November 1973 set limits on the amount of oil and grease, phenols, sulfide, ammonia nitrogen, and total suspended matters that can be contained in a refinery effluent, along with pH limits. In addition to these parameters, an acute fish-toxicity limit has been set.

If criteria to identify proposals that might have a major socio-economic impact had been used at the time these regulations and guidelines were being developed, they would, in all probability, have been subjected to a systematic evaluation. That they would have been subjected to analysis to determine the degree of their socio-economic impact is indicated by their total cost, estimated (in 1972 dollars and using a real social rate of discount of 10 per cent) as varying from $7 million to $23 million in any given year (from $11 million to $58 million in current dollars) during the period 1973-80. Although the nature of this study is retrospective,[4] an analysis of the socio-economic impact of the above controls was performed in order to examine the feasibility of using available methodologies to analyse the allocative (or efficiency) effects as well as the potential non-allocative effects of proposed regulations pertaining to protection of the environment.

Part 1 of this paper provides a general description of the nature of the controls. In Part 2, the social costs and benefits of the requirements are examined, cost-effectiveness ratios are presented, and alternatives for achieving the same objective are discussed. Part 3 presents an analysis of the possible non-allocative effects of these regulations and guidelines (i.e. on the price of refined petroleum products, distribution of income, market structure, technological progress, international trade, and employment). Some conclusions are offered in the last part.

1. THE PETROLEUM REFINERY EFFLUENT REGULATIONS AND GUIDELINES UNDER THE FISHERIES ACT

The federal Petroleum Refinery Effluent Regulations and Guidelines, which have their statutory basis in the Fisheries Act, were promulgated in November 1973. This section provides a general description of the content of the control documents. The regulations and guidelines cited in the sections below are taken verbatim from the Explanatory Notes in Environment Canada, Petroleum Refinery Effluent Regulations and Guidelines, Regulations, Codes and Protocols Report EPS 1-WP-74-1, Ottawa: Information Canada, 1974. Further details can be found in that document.[5] Comments are also made on provincial regulations and guidelines pertaining to petroleum refinery effluents.

Intent and Purpose

The intent of the controls embodied in the federal Petroleum Refinery Effluent Regulations and Guidelines is to protect the fish and marine organisms across Canada from the discharge of harmful substances.

The controls apply uniformly across Canada as national baseline standards. However, a refinery[6] located in an environmentally sensitive area may be subject to stricter controls. Provincial or local governments may thus impose even more stringent standards than the federal requirements, depending on local circumstances. Of course, the more stringent requirements prevail.

The aim of the federal regulations and guidelines is to ensure that all refineries operating in Canada apply best practicable treatment technology to their liquid effluents.[7]

Control Documents

Restrictions on contaminants contained in petroleum refinery effluents have been specified in three documents:[8]

(1) Petroleum Refinery Liquid Effluent Regulations, which specify the allowable limits for deleterious substances contained in effluents from new refineries, defined as any refinery that commences the processing of crude oil after October 31, 1973.

(2) Petroleum Refinery Liquid Effluent Guidelines, which describe two fish-toxicity tests, a 96-hour flow-through test and a 24-hour static test, to be applied to the effluents from new refineries.

(3) Existing Petroleum Refinery Liquid Effluent Guidelines, which specify the allowable limits for deleterious substances contained in effluents from existing refineries,[9] defined as all refineries not covered under the Regulations. Also included are two fish-toxicity tests, a 96-hour flow-through test and a 24-hour static test, to be applied to existing refinery effluents.

Controlled Parameters

Limits are set on the amount of oil and grease, phenols, sulfide, ammonia nitrogen, and total suspended matters that can be contained in a refinery effluent, along with pH limits.[10] In addition to these parameters, an acute fish toxicity limit has also been set.[11]

The limits on the specific substances mentioned above are expressed in pounds per 1,000 barrels of crude oil.[12] They are therefore related solely to plant capacity and are independent of effluent volume.

Reflecting the containment-at-source approach[13] and the fact that the controls are applied as national baseline standards, the limits were not necessarily designed to meet water-quality criteria that would permit the desired uses of the various bodies of water affected by the policy. The Petroleum Association for Conservation of the Canadian Environment[14] believes that although federal legislation may serve a useful short-term purpose, it cannot be relied upon to meet the needs of society in the long run. For long-term purposes, a water-quality management approach (i.e. defining the desired uses of the affected bodies of water and the corresponding water-quality criteria, and establishing requirements that firms would have to meet in order to satisfy these criteria) would appear more appropriate. This belief is not necessarily shared by all parties concerned. The legal authority to control water pollution, which is conferred by the Fisheries Act, allows for consideration of the containment-at-source or technology-based approach. The Environmental Protection Service contends that the development of "best practicable treatment" standards under the Fisheries Act leads to a set of requirements which are practicable for industry to meet while providing a reasonable degree of environmental protection. One argument is that the main problem with the water-quality management approach is a lack of adequate data on water-quality standards on which to base a pollution abatement program; another, that in the long run a hybrid of the technology-based and water-quality management approaches will probably prevail.

In any case, issues related to the stock of pollutants contained in the affected bodies of water should be examined from a broader perspective than the containment-at-source approach. Another issue that arises in the context of the general approach used is that firms (other than petroleum refineries) that are not currently subject to effluent regulations are discharging pollutants in the watercourses affected by the policy considered here.[15] There is a move within Environment Canada to standardize test procedures so that the various industries can eventually be ranked on the basis of the toxicity of their effluents.[16]

Until such standardization has been introduced, however, it is impossible to establish priorities (or a ranking of the various industries discharging pollutants into the bodies of water affected by the requirements, particularly on the basis of the toxicity of their effluents but also with respect to the total volume of their discharges and other relevant factors).

Acute Fish-Toxicity Limit

In view of the intent of these regulations and guidelines under the Fisheries Act, the significant control factor for assessing effluent water-quality is a measure of its toxicity to fish.

The acute fish-toxicity limit is based on the premise that if an effluent prior to discharge can support at least a 50-per-cent fish survival rate, then there should exist a certain margin of safety from the point of view of acute toxicity for fish or other aquatic organisms in the receiving water. The acute fish-toxicity limit is believed to be compatible with the application of best practicable treatment.

By subjecting an effluent to the fish-toxicity test, the need for monitoring a whole group of other chemical parameters, such as BOD_5, COD, TOC and heavy metals, is eliminated.[17]

It is recognized that the current best practicable treatment technology may not ensure that an effluent will continually meet the toxicity limit, since other factors that may affect toxicity, such as the nature of the crude oil being processed, seasonal variations, etc. have not been completely researched. Engineering practices could not allow the design of a treatment plant that would meet the given acute fish-toxicity requirement 100 per cent of the time. For this reason, the toxicity limit was formulated as a guideline rather than a regulation.

Provincial Controls of Petroleum Refinery Effluents

By reason of their jurisdiction over recreational, aesthetic, and other aspects of watercourses, provincial governments may impose standards with respect to petroleum refinery effluents. At the present time, three provinces have their own regulations: Quebec, Alberta, and British Columbia.[18] Although the petroleum refinery effluent regulations in Quebec and Alberta are quite similar to the federal ones, those of British Columbia are somewhat more stringent.[19] Ontario does not have specific regulations pertaining to petroleum refinery effluents, but given the water-quality management approach used in that province, there could be regulation on a firm-by-firm basis.[20]

Even though the controls in British Columbia are somewhat more stringent than the federal requirements, only the federal Petroleum Refinery Effluent Regulations and Guidelines were subjected to the socio-economic impact analysis presented in the next sections.[21]

2. AN ANALYSIS OF THE ALLOCATIVE EFFECTS OF THE REGULATIONS AND GUIDELINES

This section examines the social costs and benefits of the Petroleum Refinery Effluent Regulations and Guidelines. Cost-effectiveness ratios are presented, and technological and policy-instrument alternatives for achieving the same objective as the regulations and guidelines are considered. It was not possible to use the benefit-cost methodology to analyse the allocative effects of these controls because the benefits considered can only be expressed in physical terms.

Costs

The major costs of the regulations and guidelines are the capital expenditures required for compliance and the costs of operating and maintaining the necessary effluent treatment facilities.

An estimate of these costs for all refineries covering the period 1973-80 was provided by the Petroleum Association for Conservation of the Canadian Environment.[22] All existing and known new[23] refineries are expected to be in compliance with the regulations and guidelines by the year 1980. Consequently, it is expected that these refineries will not be subject to additional capital expenditures in connection with these requirements after that date.

An accounting analysis would probably assume a 10-year write-off period for the capital investment. For cost-effectiveness analyses, however, the expected useful life of the capital equipment is a more appropriate framework for a consideration of the social costs (and benefits). For the capital equipment under consideration, the life-expectancy is assumed to be about 20 years, on average. The social costs are calculated over the period 1973-95 and, as can be seen in Table 1, operating and maintenance costs identical in real terms to their 1980 level were assumed for each year of the period 1981-95. (The year 1995 would also correspond approximately to the time at which a review of the regulations and guidelines would be possible in view of prospective technologies for substantially reducing the discharge of pollutants of all refineries.)

Table 1

Capital Expenditures Required for Compliance and the Operating and Maintenance Costs for the Years 1973 to 1995

(in 1972 dollars)

Year	Capital Expenditures ($000s)	Operating and Maintenance Costs ($000s)	Total ($000s)
1973	9,213	1,034	10,247
1974	8,030	1,830	9,860
1975	17,569	3,204	20,773
1976	28,938	4,819	33,757
1977	27,626	6,612	34,238
1978	15,237	7,011	22,248
1979	12,165	7,158	19,323
1980	7,251	6,990	14,241
for each year from 1981 to 1995	-	6,990	6,990

The above cost estimates for the period 1973-95 should be viewed as underestimates, since they do not take into account the costs that refineries which come into operation after 1977 but before 1995 would have to incur in order to comply with the regulations and guidelines.[24]

Using a real social rate of discount of 10 per cent (the usual norm for government investment projects), the present (1972) value of the capital, operating, and maintenance costs is approximately $131 million.[25]

Benefits

Ideally, the potential benefits of the Petroleum Refinery Effluent Regulations and Guidelines could be described in terms of the protection of fish and other marine organisms, increased recreational opportunities (e.g. swimming, fishing), and improved aesthetic qualities.[26]

However, given the lack of information on the relationship between the reduction in the pollutant discharge and the satisfaction of water-quality criteria for specific activities in the bodies of water affected by the policy, the benefits had to be considered strictly in terms of the reduction in the discharge of the controlled pollutants. The benefits are thus expressed in physical terms (i.e. pounds of pollutants not discharged because of the regulations and guidelines) but, like the monetary costs, will be discounted.[27]

Table 2 shows the number of pounds of each controlled pollutant discharged (per barrel of crude throughput) prior to the promulgation of the regulations and guidelines and the number that would be discharged under the assumption of full compliance with the requirements.[28]

Table 2

Number of Pounds of each Controlled Pollutant per Barrel of Crude Throughput prior to and under a 100-per-cent Compliance Rate with the Regulations and Guidelines

(1) Substance	(2) Before	(3) Full Compliance
oil and grease	0.0106	0.0034
phenols	0.0023	0.0003
sulphide	0.0059	0.0001
ammonia nitrogen	0.0139	0.0029
suspended solids	0.0267	0.0086
Total	0.0594	0.0153

As can be seen in Table 2, the estimated difference between the total number of pounds of pollutants discharged (per barrel of crude throughput) prior to the coming into force of the regulations and guidelines and that discharged under full compliance is 0.0441.[29]

The present value of the number of pounds of pollutants not discharged as a result of the regulations and guidelines over the period 1973-95 (PND) can be calculated with the aid of the following formula, which also allows for the consideration of various assumptions concerning the annual rate of growth in crude throughput:

$$PND = \sum_{i=1}^{23} \frac{[CT\ (1 + g)^{i}]\ x\ PD}{(1 + r)^{i}}$$

where

CT = the 1972 level of crude throughput (1.7 million barrels per day x 328.5 days; thus, a 90-per-cent effective utilization of calendar-day capacity is assumed (see United States Environmental Protection Agency, Economic Impact of E.P.A.'s Regulations on the Petroleum Refining Industry, Washington, D.C.: NITS, April 1976, Part 3, p. 31).

PD = the estimated difference between the total number of pounds of pollutants discharged (per barrel of crude throughput) prior to the promulgation of the regulations and guidelines and that discharged assuming full compliance.

g = the annual rate of growth in crude throughput.

r = real social rate of discount.

Using a 10-per-cent real social rate of discount and various assumptions concerning "g" (0 per cent, three per cent, five per cent),[30] one obtains estimates of the discounted number of pounds of pollutants, varying from 219 million to 340 million, not discharged as a result of the requirements over the period 1973-95.[31]

Cost-Effectiveness Ratios

The limits of the range within which the cost-effectiveness ratio of the regulations and guidelines would fall can easily be calculated from the information on social costs and benefits.

Under the assumption of a 0-per-cent annual rate of growth in crude throughput, the discounted cost per pound of pollutants not discharged as a result of the regulations and guidelines is 60 cents ($131 million/219 million pounds of pollutants not discharged) for the period 1973-95. This figure represents an upper-limit estimate. Using a five-per-cent annual rate of growth in crude throughput, the discounted cost per pound of pollutants not discharged is 39 cents ($131 million/ 340 million pounds of pollutants not discharged). This is a lower-limit estimate, in that it does not take into account the additional capital, operating, and maintenance expenditures for compliance that would be implied by the assumed rate of growth. Under the assumption of a three-per-cent annual rate of growth (which appears to be more realistic), the discounted cost per pound of pollutants not discharged is 46 cents ($131 million/283 million pounds of pollutants not discharged).

Thus, the discounted cost per pound of pollutants not discharged as a result of the regulations and guidelines would fall between 39 and 60 cents.

The "Status Quo" Alternative

In addition to contravening the legal requirement (under the Fisheries Act as amended in June 1970) that the emission of contaminants into all watercourses populated by fish life be controlled, the status quo alternative is undesirable because a lack of intervention at present would make more difficult any future attempt to deal with the stock of contaminants contained in the watercourses affected by the policy.

As previously mentioned, industrial sectors (other than the petroleum industry) that are not currently subject to effluent regulations are discharging pollutants into the bodies of water affected by the requirements under consideration. One could ask whether it might have been more beneficial to control the quality of the effluents of some of these other non-regulated industrial sectors prior to controlling petroleum refinery effluents. This question is discussed below.

Alternatives for Achieving the Same Objective as the Regulations and Guidelines

In the section on cost-effectiveness ratios, the discounted cost per pound of pollutants not discharged resulting from the regulations and guidelines was estimated to be between 39 and 60 cents, depending on the assumed annual rate of growth in crude throughput. These figures represent cost-effectiveness ratios averaged over refineries, contaminants, etc.[32] It is impossible, however, to determine whether the Petroleum Refinery Effluent Regulations and Guidelines are cost-effective in containing pollution at source. The unfeasibility of such analysis is related not to limitations of the cost-effectiveness methodology, but rather to the fact that in order to establish priorities, it is necessary to rank the various industrial sectors discharging pollutants into the affected bodies of water on the basis of the toxicity of their effluents, the total volume of their discharge, and other relevant factors. Indeed, without a means for ranking these industrial sectors (some of which are not subject to effluent regulations), it is impossible to determine whether the Petroleum Refinery Effluent Regulations and Guidelines are the most cost-effective in terms of containment at source.

Moreover, the lack of information on the relationship between the reduction in the discharge of the controlled pollutants and the satisfaction of water-quality criteria for specific activities in the bodies of water affected by the policy made it impossible to determine whether the regulations and guidelines considered are cost-effective from the broader perspective of a water-quality management approach.

For the petroleum refining industry, and given the general approach used, the current requirements appear to represent a situation in which the point of minimum cost has been attained, if not surpassed. Indeed, although it was not possible to calculate cost-effectiveness ratios for the various types of effluent treatment used,[33] a cost-effectiveness comparison of the various types of effluent treatment would show that the percentage increase in the water pollution abatement costs that would result from the imposition of more stringent requirements than those currently prevailing, would be much greater than the corresponding percentage increase in the benefits. Although the percentage increase in the benefits could be substantial for some of the controlled pollutants,[34] the associated percentage increase in the abatement costs would be much greater,[35] given currently practicable technologies.

Effluent charges as a policy-instrument alternative were considered but they were not practicable. The advantages and problems associated with the application of the effluent-charge approach are discussed by several authors.[36] In this particular case, the absence of sufficient knowledge about the damage functions[37] (upon which the implementation and effectiveness of effluent charge mechanisms depend) would have been a deterrent to the use of this approach.

3. NON-ALLOCATIVE EFFECTS OF THE REGULATIONS AND GUIDELINES

In Part 2, the social costs and benefits of the Petroleum Refinery Effluent Regulations and Guidelines were examined. The analysis did not take into account the possible impact of these regulations and guidelines on the price of refined petroleum products, distribution of income, market structure and competition, technological progress, international trade, and employment. The purpose of this part is to examine the potential impact of the regulations and guidelines on these variables. The relationship between the federal and provincial governments in the formulation and enforcement of the petroleum refinery effluent regulations was also considered, and an analysis is presented in the Appendix.

In some cases, it may be useful to use a model of the industry to simulate the effects of a social regulation on some of the variables mentioned above. In the particular case being considered, the recent drastic change in the cost of crude oil would make any attempt to isolate the effects of relatively small changes very difficult. For this reason, the following analysis relies on less sophisticated and less costly techniques.

Impact on Prices

The capital, operating, and maintenance costs required to comply with the regulations and guidelines can be considered as additional fixed costs of petroleum refining. This section estimates the impact of these additional fixed costs on prices of refined petroleum products, assuming that all the costs will be passed on to consumers of petroleum products.[38] Since control of waterborne emission affects the basic refining process,[39] the costs of this process should be allocated to all finished products (e.g. motor gasoline, diesel fuel) equally.

The additional fixed costs required for compliance can be translated into dollars or cents per barrel of crude oil. The calculations below are made under the assumptions that there will be no change in crude-oil capacity from 1975 to 1995 and that the effective utilization of calendar-day capacity will be 90 per cent.[40] The first assumption may be sound for some years of the period considered but not for others.[41] If, on average, there was a positive annual rate of growth in crude oil capacity (and use), the cost per barrel of crude oil that would be incurred to comply with the regulations and guidelines would consequently be smaller. The estimates presented below should thus be considered as upper-limit estimates.

As indicated in Part 2, in the section on costs, the present value (in 1972) of the capital, operating, and maintenance costs for compliance over the period 1973-95 is approximately $131 million. When this figure is divided by the estimated 15.6 billion barrels of crude oil that will be processed over the same period,[42] one obtains a discounted amount of 0.8 cents per barrel of crude oil. This would represent, for example, an increase of about 0.023 cent per gallon of motor gasoline or, in other words, an increase of about 0.1 per cent in the price of a gallon of motor gasoline (using the 1972 distribution price).[43]

Such an estimate of the impact of the Petroleum Refinery Effluent Regulations and Guidelines on the prices of refined petroleum products may have been appropriate in 1972. However, *ex post*, it is not possible to determine the impact on prices before the controls on wages and prices expire, since until that time the prices of petroleum products will be controlled. One can only guess as to whether control regulations will permit the costs of conforming to the Petroleum Refinery Effluent Regulations and Guidelines to be passed on as product price-increases.[44] If the costs are passed on in the long-run, and assuming downward price rigidity,[45] the price increase corresponding to the highest present value of the costs for compliance in any given year (approximately $23 million in 1976) could provide an estimate of the maximum price impact for the remainder of the period considered after the controls have expired. In 1976, compliance with the regulations and guidelines would have cost 3.4 cents per barrel of crude oil.[46] This would represent, for example, an increase of 0.1 cent (or 0.4 per cent) per gallon of motor gasoline.[47] Such a price impact might be felt over the remainder of the period considered here (1973-95) after the controls have expired, even if it were higher than that which would have corresponded to the discounted costs of each of these years. This might be the case given the relatively small size of the increase, the oligopolistic nature of the industry, and the need for recovering the costs not passed on during the period of controls.

Impact on Distribution of Income

The distributive incidence of the benefits of the Petroleum Refinery Effluent Regulations and Guidelines is extremely difficult to measure.[48] Beneficiaries of these regulations and guidelines are those water users whose well-being is enhanced by the reduction in pollutant discharges (e.g. commercial and sport fishermen, water-sport enthusiasts). However, the lack of information on the relationship between the reduction in the discharge of the pollutants considered and the satisfaction of water-quality criteria for specific activities in the bodies of water affected by the policy, prevents a delineation of the distributive incidence of the benefits.

Some information on the distributive impact of the costs of these regulations and guidelines can be obtained. Although the impact is relatively small,[49] the increased price of refined petroleum products has implications for Canadian consumers, particularly those with low incomes. The impact on different income groups can be measured in terms of the reduction in real income attendant upon the estimated price increases. Studies indicate that the demand for some refined petroleum products by Canadian consumers is income inelastic and that the income effect among different income groups is therefore regressive.[50] Consequently, the lower income groups would pay a disproportionate share of their income for the improvements resulting from the regulations and guidelines.

Market Structure and Competition

No effect of the regulations and guidelines on the creation of new refineries or the survival of existing plants is anticipated. Indeed, the consultations that took place between industry representatives and representatives of the federal and provincial governments during the development of the regulations and guidelines were a means of ensuring the absence of any such effects.[51]

It is well known that the petroleum refining industry is highly concentrated. In 1968, the four largest firms in this oligopolistic industry accounted for 78 per cent of the value of shipments, 80 per cent of the value added, and 82 per cent of production and related workers at the manufacturing level.[52] In 1972, the four largest firms (i.e. Imperial Oil, Gulf Oil, Shell Canada, and Texaco) owned two-thirds (27/41) of the plants and accounted for 70 per cent (1,164,900/1,666,550 bbl./day) of the crude-oil capacity.[53]

Table 3

Number of Plants and Capacity by Firm

Firm	Number of Plants	Capacity (bbl.day)
Imperial Oil	9	447,000
Gulf Oil	8	327,900
Shell Canada	6	248,000
Texaco	4	142,000
Golden Eagle	2	115,500
BP Oil	2	107,000
Petrofina Canada	1	65,000
Irving Refining	1	108,000
Others	8	106,150
Total	41	1,666,550

Source: V. Humphreys, "Modest Expansion is Predicted in Refining Capacity during 1972", Oilweek, June 5, 1972, p. 23.

No major effect on the market structure in this highly concentrated Canadian industry is expected, although some producers have a slight advantage in complying with the regulations and guidelines.[54] The additional expenditures required to comply with the regulations do not significantly affect the already very high barriers to entry into the industry.[55] The new barrier created by the petroleum refining effluent regulations thus is not expected to constitute, by itself, a deterrent to entry into this industry.

Technological Progress

No major effect of the regulations and guidelines on technological progress is expected. Each existing or new refinery has the freedom to comply with the requirements in the manner most advantageous to it, technically and economically. Indeed, although a technology to meet the requirements was proposed by the federal government, the refineries can use an "equivalent" technology. This feature may even lead to the development of new technical processes.[56]

International Trade

From an ex post point of view, the potential increase (after the controls on wages and prices have expired) in Canadian prices of refined petroleum products is not likely to have a major effect on Canadian exports of these products. The absence of such an effect is suggested by current Canadian policies. Indeed, some recent government actions (e.g. export tax increases on petroleum products shipped to the United States[57]) were taken to discourage the shipment of products refined from domestic crude oil. In that sense, the need to be competitive on the foreign markets for these products is lessened.[58]

Employment Effects

Since no plants are expected to close because of the impact of the Petroleum Refinery Effluent Regulations and Guidelines, the effect of these water-effluent controls would be a slight increase in employment in the petroleum refining industry over the level that would have occurred in their absence. Indeed, operators and maintenance personnel would be required for effluent treatment facilities.

An approximation of the employment increase could be derived from the assumption that employment is proportional to capital investment (in constant dollars).[59] However, the forecast would be highly uncertain since it ignores the fact that, in the past, technological improvement has maintained a virtually constant level of employment despite rising output.[60]

For this reason, only a rough approximation of the employment increase was derived from information provided by individuals responsible for the elaboration of the regulations and guidelines. The requirements were generally expected to necessitate four additional workers per plant (except for very large plants,[61] where eight additional workers would be needed). Under the assumption that all refineries would be required to install effluent treatment facilities,[62] the additional employment generated by the regulations and guidelines over and above the employment level that would have occurred in their absence can be estimated in any given year at about 190 jobs.[63]

This estimate does not, however, take into account the potential impact of the price increase of refined petroleum products on output and sales and, consequently, on employment. Under the assumption of a constant output/labour ratio, and even if one assumes a price elasticity equal to unity, the gross reduction in employment (even using the highest estimate of the price increase at the wholesale rather than at the retail level: 0.4 per cent) would be approximately 25 jobs. The net effect on employment would thus be an increase of about 165 jobs. This last figure represents 2.8 per cent of the total number (5,870) of production and related workers in the petroleum refining industry in 1972.[64]

CONCLUSIONS

Although the nature of this study is retrospective, its purpose was to determine the feasibility of using available methodologies to analyse the allocative (or efficiency) effects as well as the non-allocative effects of proposed regulations pertaining to the protection of the environment.

The major costs of the Petroleum Refinery Effluent Regulations and Guidelines are the capital expenditures required for compliance and the costs of operating and maintaining the necessary effluent-treatment facilities. Estimates of these costs were obtained from the Petroleum Association for Conservation of the Canadian Environment. The major benefits can potentially be described in terms of the protection of fish and marine organisms, increased recreational opportunities, and improved aesthetic qualities. However, because there is no information available on the relationship between the reduction in the pollutant discharge and the satisfaction of water-quality criteria for specific activities in the bodies of water affected by the policy, the benefit considered was the reduction in the discharge of the controlled pollutants. The information required to estimate this benefit was made available by individuals responsible for the elaboration of the regulations and guidelines.

The cost-effectiveness rather than the benefit-cost methodology was used to analyse the allocative effects of the requirements, because the benefits (i.e. pounds of pollutants not discharged because of the regulations and guidelines) can only be expressed in physical terms. The discounted cost per pound of pollutants not discharged because of the regulations and guidelines would fall between 39 and 60 cents, depending on the assumption made concerning the annual rate of growth in crude throughput. It was impossible, however, to determine whether the Petroleum Refinery Effluent Regulations and Guidelines are cost-effective, either from the point of view of containing pollution at source or from the broader perspective of a water-quality management approach (i.e. defining the desired uses of the affected bodies of water and the corresponding water-quality criteria, and establishing requirements that firms would have to meet to satisfy these criteria). The legal authority to control water pollution that is conferred by the Fisheries Act allows for a consideration of the containment-at-source or technology-based approach. Under this approach, which is that used by Environment Canada, thorough analysis of the allocative effects of the regulations and guidelines under consideration proved to be almost impossible. The unfeasibility of such analysis is related not to limitations of the cost-effectiveness methodology, but rather to the fact that in order to establish priorities, it is necessary to rank the various industrial sectors discharging pollutants in the bodies of water affected by the requirements, particularly on the basis of the toxicity of their effluents but also with respect to the total volume of their discharge, and other relevant factors. Indeed, without a means for ranking these industrial sectors (some of which are not subject to effluent regulations), it is impossible to determine whether the Petroleum Refinery Effluent Regulations and Guidelines are the most cost-effective in terms of containment at source.

However, a cost-effectiveness comparison of the various types of effluent treatment would show that the percentage increase in the water pollution abatement costs that would result from the imposition of more stringent requirements than those currently prevailing for the petroleum refining industry would be much greater than the corresponding percentage increase in the benefits. For the petroleum refining industry, given the general approach used, the current requirements thus appear to represent a situation where the minimum-cost point has been attained, if not surpassed.

In addition, effluent charges as a policy-instrument alternative were considered but they were not practical. In this particular case, the absence of sufficient knowledge about the damage functions (upon which the implementation and effectiveness of effluent charge mechanisms depend) would have been a deterrent to the use of this approach.

The potential non-allocative effects of the Petroleum Refinery Effluent Regulations and Guidelines were also considered. However, no major impact on the price of refined petroleum products, distribution of income, technological progress, international trade, and employment is expected. The additional expenditures required to comply with the requirements increase only slightly the already very high barriers to entry into this industry. The relationship between the federal and provincial governments in the formulation and enforcement of the controls was also considered; no duplication of effort has taken place. The information used to examine such potential effects was either available from published documents or made available by federal and provincial officials as well as by the Petroleum Association for Conservation of the Canadian Environment.

NOTES

1. Energy, Mines and Resources Canada , Petroleum Refineries in Canada (Ottawa: Supply and Services Canada, January 1976), p. 27.

2. Environment Canada, Status Report on Abatement of Water Pollution from the Canadian Petroleum Refining Industry for 1975 (mimeo, 1976), p. 1.

3. See Environment Canada, Pulp and Paper Effluent Regulations, Regulations, Codes and Protocols, Water Pollution Control Directorate (November 1971); and Environment Canada, Chlor-Alkali Mercury Regulations, Regulations, Codes and Protocols, Report EPS 1-WP-72-3 (April 1972).

4. Because of the retrospective nature of this study, estimates of the costs and benefits in a disaggregated manner (by new and existing refineries, by contaminants, etc.) were not available. For this reason, an analysis of the potential socio-economic impact was not performed separately for the regulations and guidelines.

5. Given the complexity of the subject, it was impossible to present the regulations in detail here.

6. Refinery is defined as "facilities intended primarily for the separation and conversion of crude oil into products, including liquified petroleum gas, gasolines, naphthas, heating oils, fuel oils, asphalts, lubricating oils and greases, benzene, toluene, xylene, hydrogen, sulphur and coke, and includes blending, shipping and packaging facilities located on the refinery property and all properties developed for the operation of those facilities, but does not include facilities associated with the processing of natural gas or the production of synthetic petroleum originating from coal or bituminous sands." Environment Canada, Petroleum Refinery Effluent Regulations and Guidelines, Regulations, Codes and Protocols, Report EPS 1-WP-74-1 (Ottawa: Information Canada, January 1974), p. 2.

7. "Best practicable treatment technology" means a system equivalent to the following: a) primary separation (such as an API separator) followed by b) intermediate treatment (such as air flotation) followed by c) secondary treatment (such as biological treatment); d) sour-water stripping for ammonia and sulfide removal; e) good housekeeping; f) good maintenance; g) safe disposal of spent chemicals; h) segregation and treatment of storm water, if required; i) adequate facilities to ensure smooth, continuous operation of treatment system; j) final effluent clarification if necessary. See Environment Canada, op. cit., Explanatory Notes, pp. 1-2.

8. The pollutors who do not meet effluent regulations or standards may face prosecution in the courts. The term guidelines indicates that the allowable effluent levels are set by the regulatory agency and can be enforced at its discretion.

9. The limits set for existing refineries are less stringent than those for new refineries. However, because of the "altered refinery" and "expanded refinery" concepts, every refinery will eventually have to meet the requirements for new refineries. See W. Neff, "The Development of Petroleum Refinery Effluent Controls" (mimeo, undated), pp. 11-14.

10. For the purpose of the regulations and guidelines, the pH of the liquid effluent or once-through cooling water should be within the limits of 6.0 and 9.5. For a description of the effects on aquatic life of various pH limits and of the listed pollutants, see J.S. Cannon, et al., Environmental Steel: Pollution in the Iron and Steel Industry (New York: Proeger Publishers, 1974), pp. 95-106. See also M. Halper, Development Document for Effluent Limitations Guidelines and New Source Performance Standards for the Petroleum Refining Point Source Category (Washington, DIT.: National Technical Information Service, April 1974), section VI.

11. The 96-hour flow-through bioassay procedure is the official test conducted on a periodic basis by the government agency responsible. The 24-hour static bioassay procedure is conducted by each individual refinery. This latter test is less sensitive than the former and is intended for use by the refinery as a routine check on effluent toxicity.

12. There are three limits for each parameter, each dependent on the frequency. In the table that follows, the lowest limit is based on the arithmetic mean of all discharge from a refinery during a month. The middle limit is the value that should not be exceeded more than one day a month. The highest set of values are those which should never be exceeded by the refinery.

Amounts for Calculating Maximum Deposits
(in pounds per 1,000 barrels of crude oil)

Substance	Monthly Amount		Daily Amount		Maximum Daily Amount	
	new refinery	existing refinery	new refinery	existing refinery	new refinery	existing refinery
oil and grease	3.0	6.0	5.5	11.0	7.5	15.0
phenols	0.3	0.6	0.55	1.1	0.75	1.5
sulphide	0.1	0.2	0.3	0.6	0.5	1.0
ammonia nitrogen	3.6	5.0	5.7	8.0	7.2	10.0
total suspended matter	7.2	14.4	12.0	24.0	15.0	30.0

Source: W. Neff, op. cit., pp. 5-6 and slide no. 4.

Also, special allowances are made when storm water is deposited by a refinery. (Storm water is defined as water run-off resulting from precipitation of any kind that falls on a refinery. It includes water run-off originating from outside the refinery that passes over or through the refinery.)

13. As opposed to the water-quality management approach discussed below.

14. Letter from Mr. P.T. Budzik, Chairman, PACE Water Quality Committee, to Michel Proulx, March 28, 1977.

15. One reason for controlling the effluents of the petroleum refining industry first, might have been the geographical concentration of the firms most affected by the policy.

16. See W. Neff, op. cit., p. 16.

17. BOD_5, COD, and TOC are three oxygen-demand parameters. For further details, see M. Halper, op. cit., pp. 71-75. The toxicity requirement is also designed to determine whether synergistic effects related to the various chemical are occurring.

18. The Quebec petroleum refinery effluent regulations were promulgated under the Environment Quality Act in April 1977.

19. Individuals responsible for the development of the federal regulations and guidelines believe that even though the controls of petroleum refinery effluents in British Columbia differ somewhat from the federal ones, they meet the federal fish-toxicity test.

20. See, for example, the Requirement and Direction to Polysar Limited, issued by the Ontario Ministry of the Environment (December 1976).

21. Although in 1975 seven of the 38 refineries were located in British Columbia, they accounted for only about seven per cent of the crude-oil capacity. As indicated in note 24, refineries in British Columbia account for a small proportion (five per cent) of the costs required for compliance with the federal requirements.

22. Letter from Mr. P.T. Budzik, Chairman, PACE Water Quality Committee, to Michel Proulx, March 28, 1977.

Capital Expenditures Required for Compliance, and the Operating and Maintenance Costs for the Years 1973 to 1980

Year	Capital Expenditures ($000s)	Operating and Maintenance Costs ($000s)	Total ($000s)
1973	9,600	1,090	10,690
1974	9,500	2,300	11,800
1975	23,700	5,120	28,820
1976	41,700	10,100	51,800
1977	42,600	15,200	57,800
1978	25,400	18,300	43,700
1979	21,800	20,900	42,700
1980	13,900	22,600	36,500

The annual operating costs exclude depreciation and return on investment. In addition, all the above figures are in current dollars. However, for the purpose of cost-effectiveness analysis, they had to be expressed in real terms (or 1972 dollars). This was done by applying a deflation factor to the capital expenditures and to the operating and maintenance costs for each year.

For capital expenditures, implicit price indexes (1972 = 100) for business machinery and equipment (gross fixed capital formation; Statistics Canada, National Income and Expenditure Accounts, Catalogue no. 13-001, Ottawa: Supply and Services Canada, 1978) were used, and the average increase between the years 1973 and 1977 was assumed in order to obtain indexes for the years 1978 to 1980.

On the other hand, a weighted average of the increases in the wage rate and in the cost of energy in the petroleum and coal products industry (Statistics Canada, Employment, Earnings and Hours, Catalogue no. 72-002, Ottawa: Supply and Services Canada, 1977-78) was used as a deflation factor for the operating and maintenance costs. (The assumed weight for labour and for energy was 15 per cent and 85 per cent, respectively; labour and energy serve as proxies for other operating and maintenance costs.) The increases in the cost of energy represent, in turn, weighted averages of the increases in the price per kilowatt-hour of electricity and in the price per cubic foot of natural gas (Statistics Canada, Petroleum Refineries, Catalogue no. 45-205, Ottawa: Supply and Services Canada, 1976-78). As for capital expenditures, the average increase between 1973 and 1977 was assumed in order to obtain a deflation factor for the years 1978 to 1980.

The capital expenditures, and operating and maintenance costs in 1972 dollars are presented in Table 1.

23. "New" as defined under the Petroleum Refinery Effluent Regulations and Guidelines.

24. Refineries that might come into operation after 1977 but before 1995 would also generate benefits as defined in the next section. The implicit assumption is that the discounted cost per pound of pollutants not discharged by these refineries, resulting from the federal requirements, would be similar to that averaged over the existing and known new refineries. It should be noted, however, that the refineries that come into operation after 1977 but before 1995 will incur smaller costs than already existing refineries in order to meet the requirements. (See the discussion in the section entitled Technological Progress.)

One may note that the costs of complying with the requirements vary from one province to another and from one refinery to another. For example, Quebec accounts for 50 per cent of the total costs, whereas British Columbia accounts for five per cent. The costs differ from one refinery to another because the difficulties of compliance depend on the site, climate, technology used, type of production activities, etc. Some refineries do not even need any treatment facilities because they do not have any direct effluent discharge (e.g. two refineries discharge effluents to seepage-evaporation ponds; see Environment Canada, op. cit., p. 9).

25. Using a real social rate of discount of 10 per cent, the present value in 1972 of each year's capital and operating and maintenance costs is:

Year	($000s)	Year	($000s)	Year	($000s)
1973	9,315	1981	2,964	1989	1,384
1974	8,144	1982	2,698	1990	1,258
1975	15,601	1983	2,447	1991	1,146
1976	23,056	1984	2,230	1992	1,042
1977	21,262	1985	2,027	1993	944
1978	12,548	1986	1,838	1994	860
1979	9,913	1987	1,671	1995	783
1980	6,651	1988	1,524	-	-

Over 23 years the total is $131,306,000.

26. For some examples, see D.N. Thompson, The Economics of Environmental Protection (Cambridge, Massachusetts: Winthrop Publishers Inc., 1973), pp. 102 and SS.

27. The implicit assumption is that the value of the expected reductions in pollutant discharges over the period considered is dependent upon the year in which the discharges would have occurred.

This would be the case, for example, in view of possible technological developments that could be aimed at reducing the stock of pollutants in the affected watercourses as well as developments that would imply reduced discharges of the pollutants under consideration.

28. These numbers were calculated from data in Environment Canada, Status Report on Abatement of Water Pollution from the Canadian Petroleum Refining Industry for 1975 (mimeo, May 1976).

29. The implicit assumption is that all the substances considered are equally harmful. While this is not necessarily true, it was not possible to calculate cost-effectiveness ratios for each contaminant, given the available information on the costs of reducing the discharges. If it had been possible to calculate cost-effectiveness ratios for each contaminant, the fact that some contaminants can be removed using the same treatment process (e.g. oil, grease, and suspended solids can be removed using the same treatment process) would, of course, have been taken into account.

30. Crude throughput increased by approximately five per cent per year over the period 1972 to 1975. While a 0-per-cent annual rate of growth might be unrealistic, a five-per-cent rate might be too high for the coming years, given the expected surplus productive capacity (see Oilweek, various issues from 1972 to 1976). For these reasons, a three-per-cent annual rate of growth may be more adequate, even if a sensitivity analysis is performed.

31. The present value of the number of pounds of pollutants not discharged as a result of the requirements over the period 1973-95 is presented below for each assumed annual rate of growth in crude throughput.

Annual Rate of Growth in Crude Throughput	Estimated Number of Pounds of Pollutants not Discharged (1973-95)
0 per cent	218,794,910
3 per cent	282,508,080
5 per cent	339,774,570

It should be noted that in some cases the refineries may benefit from the technology used to comply with the regulations and guidelines (e.g. the recovery of oil). These potential benefits were not taken into account in the analysis.

32. See note 24.

33. As previously mentioned, each plant has a specific technology and may require different effluent-treatment facilities.

34. The reduction of the discharge of each contaminant resulting from compliance with the requirements can be calculated as a percentage from the information presented in Table 2.

Contaminant	Reduction in Percentage Terms
oil and grease	68 per cent
phenols	87 per cent
sulphide	98 per cent
ammonia nitrogen	79 per cent
suspended solids	68 per cent
Total	74 per cent

Thus, if total prohibition of discharges were introduced, the percentage increase in the benefits could be almost 50 per cent for some of the contaminants, such as oil, grease, and suspended matters.

35. The costs would be almost infinite. The information on the percentage increase in the benefits and costs associated with more stringent requirements was provided by individuals responsible for the elaboration of the regulations and guidelines considered here.

36. See Harry Baumann, and Bruce Montador, Government Intervention in the Marketplace and the Case for Social Regulation, Planning Branch, Treasury Board Secretariat, (Ottawa: Supply and Services Canada, 1978); D.N. Dewees, et al., Economic Analysis of Environmental Policies (Toronto: University of Toronto Press, 1975); A.M. Freeman III, et al., "Water Pollution Control, River Basin Authorities, and Economic Incentives: Some Current Policy Issues", Public Policy (Winter 1971), pp. 53-74; A.V. Kneese, et al., Managing Water Quality: Economics, Technology, Institutions (Baltimore: Johns Hopkins Press, 1968); Ontario Ministry of the Environment, Alternative Policies for Pollution Abatement: The Ontario Pulp and Paper Industry volume I, 1974; D.N. Thompson, The Economics of Environmental Protection (Cambridge, Massachusetts: Winthrop Publishers Inc., 1973); M.I. Goldman, (ed.), Ecology and Economics (New Jersey: Prentice-Hall Inc., 1972).

37. Knowledge is incomplete regarding the relationship between the reduction in the discharge of the pollutants considered and the satisfaction of water-quality criteria for specific activities in the bodies of water affected by the policy.

38. This assumption, used to analyse similar requirements in the United States (see U.S. Environmental Protection Agency, op. cit., part three, pp. 31 and SS.), would be adequate for the Canadian context, at least in the long run, according to the beliefs of representatives of the Petroleum Association for Conservation of the Canadian Environment.

39. If the costs for compliance had been undertaken on behalf of a single product, it alone should have borne the costs. In fact, supply and demand for the various finished products may differ, so that the costs of compliance would probably be passed on via price increases in only some of the finished products.

40. See the subsection entitled Benefits.

41. See note 30.

42. This estimate (15,644,155,000) has been obtained using the actual values for 1973, 1974, and 1975 and the number of barrels of crude oil processed in 1975 for each of the remaining years of the period.

43. The increase of about 0.023 cent per gallon of motor gasoline was estimated using the following calculation:

$$CMG = \frac{c}{vr \times g} \times \frac{hvg}{hva} = \frac{0.8}{0.92 \times 35} \times \frac{5.25}{5.6} = 0.023 \text{ cent per gallon}$$

where CMG = estimated cost per gallon of motor gasoline;

c = cost (in cents) per barrel of crude oil processed in order to comply with the requirements;

vr = percentage volume recovery of all liquid products (92 per cent, see U.S. Environmental Protection Agency, *op. cit.*, part three, p. 36);

g = number of gallons per barrel of crude oil;

hvg = million BTU per barrel heating value for gasoline (5.25; see U.S. Environmental Protection Agency, *op. cit.*, part three, p. 36);

hva = million BTU per barrel weighted average heating value for all products (5.60; see U.S. Environmental Protection Agency, *op. cit.*, part three, p. 36).

44. The costs have not yet been passed on as product price increases, and the controls may be expected to expire in the near future.

45. The assumption of downward price rigidity might be appropriate given the oligopolistic nature of the industry.

46. The same assumptions apply as were previously used for the crude-oil capacity and for the effective utilization rate of calendar-day capacity.

47. See note 43. In this case, c = 3.4 so that CMG = 0.1 cent per gallon.

48. For some of the problems in delineating the distributive incidence of environmental programs in the United States, see R. Dorfman, "Incidence of the Benefits and Costs of Environmental Programs", A.E.R. (February 1977), pp. 333-40.

49. The impact is small compared to the impact of other government policies on the price of petroleum products.

50. Such results were obtained by Canadian government agencies as well as from studies conducted in the United States, such as R. Dorfman, op. cit., pp. 333-40.

51. See W.J. Grant, "The Co-operative Approach to Effective Effluent Regulations", presented before the C.I.C. conference in Toronto, May 27, 1975.

52. From Statistics Canada, Industrial Organization and the Concentration in the Manufacturing, Mining and Logging Industries (Ottawa: Information Canada, Catalogue no. 31-514, 1968).

53. The previous information on the value of shipments, etc. was not available for 1972.

54. See note 24.

55. In some cases, however, the capital expenditures required to comply with the effluent controls can represent as much as 13 per cent of the capital expenditures required for the creation of the refinery.

56. The Esso plant in Sarnia, Ontario, is one example of a refinery that has devised a process (i.e. filters for oil and grease) that is less costly than the technology proposed by the federal government.

57. Most Canadian exports of refined petroleum products are shipped to the United States (over 90 per cent; see Statistics Canada, Exports by Commodities, Ottawa: Information Canada, Catalogue no. 65-004, 1978).

58. Moreover, any growth in the consumption of petroleum products in the United States will, in keeping with their current policies, be furnished by American refineries (see U.S. Environmental Protection Agency, op. cit., part three, p. 6).

Because such information was not available during the development of these regulations and guidelines, the analysis would have drawn attention to their potential impact on international trade, more specifically, on Canadian exports of refined petroleum products. Aspects to consider would have been tariffs and quotas on petroleum products in Canada and the United States, as well as the fact that the United States, which is the biggest importer of Canadian exports, was in the process of elaborating similar regulations also likely to affect the price of American petroleum products.

59. See, for example, U.S. Environmental Protection Agency, op. cit., part three, pp. 84-85.

60. See Statistics Canada, Petroleum Refineries (Ottawa: Supply and Services Canada, Catalogue no. 45-205, 1976-78).

61. Large plants are defined here as those with a crude-oil capacity of 100,000 barrels per day or more.

62. This is not in fact the case (see note 24). In this sense, the estimate of the additional employment generated by the effluent controls is an overestimate.

63. In 1972, seven of the 40 refineries were large plants as defined above so that [(7 x 8) + (33 x 4)] = 188.

64. The 5,870 production and related workers in the petroleum refining industry (see Statistics Canada, op. cit., Catalogue no. 45-205, 1972) represented 0.5 per cent of the production and related workers in Canadian manufacturing industries (1,213,106; see Statistics Canada, Manufacturing Industries of Canada: National and Provincial Areas, Ottawa: Information Canada, Catalogue no. 31-203, 1972).

APPENDIX

FEDERAL-PROVINCIAL CONSIDERATIONS RELATED TO THE PETROLEUM REFINERY EFFLUENT REGULATIONS AND GUIDELINES
(by Richard Schultz, Federal-Provincial Relations Office)

This case study on the Petroleum Refinery Effluent Regulations was selected to permit an assessment of the intergovernmental considerations that may be involved in the determination of the costs and benefits of regulations.

Although no claim can be made that this is a "typical" case study, the Petroleum Refinery Effluent Regulations afford an excellent opportunity for examining the impact of intergovernmental variables on the costs of government regulatory activity. In addition to the federal government's regulatory activities in this area, a number of provincial governments have introduced regulations governing the effluents of petroleum refineries (e.g. British Columbia, Alberta, Quebec). The potential for diversity and, consequently, for costly duplication should be obvious. In the first place, the statutory basis and the objectives of the regulations may diverge. The federal regulations, for example, have their statutory basis in the Fisheries Act and although the general policy objective is water-pollution control, the specific objectives pertain to the impact of discharged pollutants on fish resources. Ontario, for example, does not have specific petroleum-refinery regulations but regulates on the basis of a general concern for water-quality management. In addition to the possibility of costly duplication as a result of conflicting regulations, the second potential cause of duplication is the enforcement procedure, inasmuch as each regulatory authority may choose to establish its own enforcement programs.

Notwithstanding the potential for costly duplication in the regulations and in personnel, this problem does not appear to have occurred in this instance. On the basis of information received during discussions with officials of three governments (federal, Quebec, and Ontario) and an analysis of available documentary material, including statements from the regulated parties, it would seem that intergovernmental factors have not added to the costs of regulating petroleum refinery effluents. By far the most significant reason for this is the extensive consultations that took place between Environment Canada, provincial authorities, and industry prior to promulgating federal regulations.

When Environment Canada decided to introduce petroleum-refinery effluent controls, a task force of federal, provincial, and industry representatives was established. The regulations were developed over a two-year period by this task force, and there was a genuine commitment to make every effort to arrive at a consensus. Inevitably, of course, there were some disagreements or divergences of opinion, but even though one province chose not to participate in the drafting of the regulations on the grounds that it already had an abatement policy, such disagreements were overcome.

As a result of the work of the task force, a set of national regulations acceptable to all parties concerned were developed. A significant feature of the intergovernmental (and government-industry) agreement was that provision was made for a province to impose more stringent regulations if it so desired. The Maritimes, Manitoba, and Saskatchewan rely on federal regulations, while in Alberta and Quebec the provincial governments have promulgated, or are in the process of developing, regulations that are almost identical to federal regulations. British Columbia has also established its own, but because these are more stringent than federal regulations, they take precedence. Although Ontario employs an alternative approach based on water-quality management, federal regulations have not imposed requirements that are either more stringent than, or incompatible with, the provincial system.

Finally, there does not appear to be any significant duplication with respect to enforcement. Those provinces which do not have alternative sets of regulations rely on federal officials for enforcement and those which have their own regulations also have their own officials whose functions are not duplicated federally.

In conclusion, notwithstanding the potential for conflict and for costly duplication in the area of petroleum refinery effluent regulation, such duplication did not emerge. This was the result of the process of drafting the regulations, which emphasized mutual accommodation and consensus, and the decision to develop complementary rather than competing regulations. Federal regulations, therefore, did not add to existing provincial regulations but served to establish the minimum regulatory requirements. Similarly, the willingness to rely on provincial enforcement when such machinery was available meant that there was no duplication in resources. In short, the avoidance of both competing regulations and duplication of resources suggests a highly valuable lesson that is no doubt of relevance to areas other than petroleum refinery effluent regulation.

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