

RISK ANALYSIS AND THE REGULATION OF SAFETY BY ADMINISTRATIVE TRIBUNALS: A CASE STUDY

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This paper describes how a risk analysis study was used in argument at the Canadian Transportation Commission's 1981 Show Cause hearing into the transportation of dangerous commodities by rail. The hearing was called to consider the principal recommendations of Grange J., arising out of his inquiry into the well-known Mississauga train derailment. During the course of the hearings, other proposals were advanced, including one advocated by CP Rail, which received support from industry groups. The risk analysis showed that the principal recommendations of Grange J., when limited in application to the most dangerous commodities, would have resulted in an almost imperceptible improvement in safety, at enormous cost; and that the operating procedures proposed by CP Rail, while superficially attractive, were in fact less safe than the existing procedures for transporting dangerous commodities by rail. The Tribunal rejected both the Grange and CP proposals, in part because of the findings of the risk analysis. The paper also discusses the use of similar studies before administrative tribunals and possible applications in other contexts.

Cet article traite de l'utilisation qu'on a faite d'une étude sur l'analyse des risques au cours de l'exposé des faits de la Commission canadienne des transports de 1981 sur le transport par chemin de fer des produits dangereux. La séance avait pour but d'examiner les recommandations majeures qu'avait faites le juge Grange après avoir enquêté sur le fameux déraillement de Mississauga. Au cours des débats il y eut d'autres propositions, dont l'une, préconisée par CP Rail, reçut l'appui de groupes représentant l'industrie. L'analyse des risques démontra que, si on en limitait l'application aux produits les plus dangereux, les recommandations majeures du juge Grange auraient eu pour résultat une amélioration presque négligeable de la sécurité à un coût extrêmement élevé. Elle démontra aussi que les règles que CP Rail proposait d'observer, quoiqu'intéressantes à première vue, s'avèreraient en fait plus dangereuses que les règles alors en vigueur pour le transport par chemin de fer des produits dangereux. Le tribunal rejeta les recommandations du juge Grange comme celles de CP Rail à cause, en partie, des conclusions de l'étude sur l'analyse des risques. L'article examine aussi le recours à des études de ce genre devant les tribunaux administratifs et l'application qu'on peut en faire dans d'autres contextes.

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Introduction

The recent and growing role of administrative tribunals in regulatory decision-making poses a number of interesting advocacy problems for applicants and intervenors appearing before such tribunals. Increasingly, the tribunals become embroiled in lengthy and complex public hearings in an attempt to adjudicate on a particular regulatory issue. The tribunal is often faced with the conflict of demands for regulatory action by citizens' groups and other public interest organizations on the one hand and the equally adamant position of industry, which is concerned about the potentially burdensome costs of regulation, to maintain the status quo.

Unfortunately, strongly held views, loudly expressed, and many traditional forms of argument often do not greatly assist the tribunal in reaching a decision which is truly in the public interest. Sometimes new and creative approaches must be sought by applicants and intervenors. This article describes one such effort in the context of recent hearings on railway safety by the Railway Transport Committee (RTC) of the Canadian Transport Commission (CTC).

On Saturday, November 10, 1979, shortly before midnight, a Canadian Pacific Railway ("CP") freight train derailed in the City of Mississauga, Ontario. In the days that followed, the accident received world-wide publicity, due to the decision by civil authorities to evacuate almost a quarter of a million people in the Mississauga area because of the perceived danger posed by a ruptured tank car containing ninety tons of liquid chlorine.

Despite the fact that no one was seriously hurt, the general public, the press and politicians all called for immediate action by regulatory authorities to prevent the recurrence of a similar incident. This resulted in two of the more lengthy public hearings in Canadian regulatory history. These were the inquiry and report¹ of the Honourable Mr. Justice Samuel G.M. Grange of the Supreme Court of Ontario and the subsequent "Show Cause" hearing of the CTC on the principal recommendations of the Grange report.

The inquiry and report of Grange J. generated a number of specific safety improvement recommendations; however, Grange J. did not view it as within his mandate to investigate the costs of implementing these recommendations. This he left to the Railway Transport Committee of the CTC.

In April, 1981, the RTC convened a show cause hearing to consider certain of the Grange report's recommendations. In general terms, the municipalities and citizens groups supported the recommendations of Grange J., while the railways and other affected industrial groups opposed

¹ The Honourable Mr. Justice S.G.M. Grange, Report of the Mississauga Railway Accident Inquiry, 1981.

them as being too expensive to implement. The authors of this paper were associated with the representations made on behalf of the Canadian tank car leasing industry. As the lessors of a high percentage of the tank cars used to transport dangerous commodities by rail in Canada and, in particular, the cars involved in the Mississauga fire and explosion, the tank car companies were obviously a focus of particular attention at the hearing.

In its written submission to the show cause hearing, CP advanced a proposal involving the "marshalling" of tank cars in a particular order for transport which quickly gained the support of a number of industry groups. This proposal was seen as a compromise to the Grange recommendations. It appeared to offer nearly as much in terms of improved safety, and could be implemented at much less cost. The costs would have still been substantial, however, and, unlike those associated with the Grange recommendations, would have fallen almost entirely on the tank car lessors and chemical shippers.

It was in this context that the tank car leasing companies decided to commission a risk analysis of the Grange recommendations and the CP proposals. This analysis attempted to measure the reduction in risk which would be achieved by each of these proposals relative to the risk associated with continued operations under existing regulations; and then compare these improvements in safety with the increased costs that would be incurred in implementing the recommendations. It was anticipated that the study would show that, for both the Grange and CP proposals, the risk reduction would be relatively small in comparison to the increase in cost.

This article describes the particular problem which the tank car companies faced at this hearing and how the risk analysis study was used to evaluate the proposals that had been placed before the Committee. Because of the complexity of the risk analysis model and the statistical estimation problems, it was extremely important that both the written and oral presentations of the results of the analysis be understood and accepted. A discussion of the problems of presentation is included. Finally, the paper evaluates the use of the study in the context of the Tribunal's decision, which was released on September 30, 1981.

I. Background

A. The Mississauga Derailment

The Mississauga train wreck resulted in the derailment of 24 cars, of which 19 carried dangerous regulated commodities (chlorine, propane, toluene and caustic soda). Fire broke out almost immediately, and within an hour three of the derailed tank cars carrying propane exploded.

However spectacular and potentially dangerous the fire and explosions were, attention quickly focused on a tank car containing pressurized liquid chlorine—a deadly gas when released at atmospheric pressure. By early Sunday morning, as the fire died down, it became apparent that there

was a hole in the chlorine car of some two feet in diameter. No one on the scene knew how much of the gas still remained in the car, and how much had already escaped into the atmosphere.

Because of the potential danger posed by the chlorine gas, a large part of Mississauga and parts of two neighbouring communities were evacuated. Of the estimated 250,000 individuals who were removed from the area, some 75,000 remained evacuated until the following Friday, November 16, 1979.

Shortly after the accident, the cause of the derailment was apparent. A bearing on one of the axles of the toluene tank car had overheated. The considerable friction within the axle component caused the "journal" part of the axle to overheat and eventually separate, resulting in the toluene car leaving the tracks and taking the next 23 cars with it. In railway terminology, the derailment was caused by an undetected "hot box" which resulted in a "burnt-off journal".

Two types of axle bearings are used on rail cars. The more recent type is the sealed roller bearing, which has been installed on all new rail cars produced since the late 1960's. The older type, the "plain" or "friction" bearing, depends upon a reservoir of oil for reducing friction and must be maintained regularly. At the time of the hearing, about 40 percent of the rail cars in Canada consisted of plain bearing equipped cars. The car which suffered the burnt-off journal in the Mississauga derailment had plain bearings.

B. The Grange Inquiry

The public outcry resulting from the Mississauga derailment was enormous. On December 4, 1979, the then Minister of Transport, the Honourable Don Mazankowski, announced the appointment of Grange J. to conduct an independent inquiry. His terms of reference were to report on the contributing factors and causes of the derailment and to recommend any steps which should be taken to reduce the risk of a recurrence of a similar accident involving dangerous commodities.

Grange J. commenced his hearing in Mississauga on February 4, 1980 and concluded it eight months later, after receiving some 687 exhibits and compiling nearly 24,000 pages of testimony. On January 19, 1981 he submitted the "Report of the Mississauga Railway Accident Inquiry" to the Minister of Transport. The report made sweeping recommendations concerning various aspects of railway safety, and in particular made recommendations concerning the safe transport of dangerous commodities by rail. It suggested that three of its major recommendations be immediately implemented. These called for:

- (1) mandatory conversion from plain to roller bearings for all cars in trains carrying dangerous commodities;

- (2) the increased use of track-side electronic monitoring equipment (hot box detectors) to spot overheated bearings before derailments resulted; and
- (3) an order which would limit the speed and length of trains carrying dangerous commodities until such time as the first two recommendations had been implemented.

C. The Railway Transport Committee "Show Cause" Hearing

Most of the recommendations made in the Grange report fell within the regulatory jurisdiction of the CTC and its Railway Transport Committee. Accordingly, one week after the release of the Grange report, the RTC issued an order to all railways subject to its jurisdiction to "show cause" why the CTC should not implement the above three Grange recommendations. The show cause order was met with vigorous opposition from the affected railways and various other intervenors. As a result, the CTC decided to hold a full-scale public hearing on the show cause order. The hearing commenced April 21, 1981 and, after hearing some 5,063 pages of oral testimony and receiving numerous written reports and exhibits, was concluded on July 1, 1981. The CTC hearing aroused considerable public interest because of the spectacular nature of the Mississauga derailment and the understandable desire to avoid a recurrence. CN and CP, the major Canadian railways, together with the tank car leasing companies and various public interest groups, were represented throughout.

In essence, the Grange recommendations considered at the CTC hearing would have required certain modifications to the rolling stock of the railways, failing which a train transporting dangerous commodities would have been restricted to 4,000 feet in length and to a speed of 25 miles per hour when passing through any centre of population containing 500 or more people in proximity to the track. The primary rolling stock modification called for all cars in a dangerous commodity train presently equipped with plain bearings to be "retrofitted" with roller bearings (or scrapped and replaced with a new roller bearing equipped car).

Before the hearings commenced two matters were generally acknowledged. First, the implementation of the Grange recommendations would be extremely expensive, some estimates putting the total cost at more than a billion dollars. Second, there was a general public demand for the CTC to take strong action, the CTC having been extensively criticized in Grange J.'s report for previous inactivity in regulating railway safety.

D. The CP Rail Marshalling Proposal

With the public outcry for increased safety set against industry reluctance to spend hundreds of millions of dollars on safety proposals which it viewed as having only marginal safety benefit, there was obviously scope

for alternative proposals. CP mooted such an alternative at the Grange inquiry hearings and returned with it before the CTC.

The CP proposal would have required that all tank cars containing "special dangerous commodities" be bunched together near the front of the train, separated from the lead locomotive by a buffer of five cars carrying inert substances. Both the tank cars containing the special dangerous commodities and the five buffer cars would be equipped with roller bearings. In addition, certain other safety improvements would be made to the tank cars, as had been recommended by Grange J. The suggested list of 34 special dangerous commodities consisted primarily of poisonous substances (principally chlorine, anhydrous ammonia and sulfur dioxide), whose accidental release was judged to pose the greatest potential hazard. (By comparison, several thousand products are classified as dangerous commodities.)

At the outset of the CTC hearing the CP proposal was seen as attractive by many observers and one which was likely to receive favourable consideration by the Tribunal. A major concern of Grange J. was that a plain bearing car was statistically more likely to derail than a roller bearing equipped car. He therefore recommended that all cars on trains carrying dangerous commodities be equipped with roller bearings. The attractiveness of the CP proposal was that only the dangerous commodity cars and those cars in front of the dangerous commodity cars would have to be so equipped, on the theory that a car which derailed would derail only cars behind it. In addition, it was argued that marshalling the dangerous commodity cars near the front of the train would increase the chances of visual detection by the cab crew of any hot box which threatened the derailment of a dangerous commodity car.

The CP proposal had an obvious attraction for the railways: it would satisfy the considerable public pressure for improvements in railway safety at very little cost to them. However, both the Grange recommendations and the CP proposal were seen as being prohibitively expensive by the tank car leasing companies and their lessors. Clearly, a method had to be developed to effectively test the validity of both proposals.

The tank car companies provided an obvious focus for both the railways and the public interest groups at the hearing. Virtually all of the dangerous commodities transported by rail in Canada are carried in tank cars. Indeed, regulations prohibit many of the most dangerous materials from being transported by road, thus requiring that they be carried by rail. For largely historical reasons, tank cars are not owned by the railways, but rather are either owned by shippers or, as is most often the case, leased to the shippers by tank car leasing companies. Consequently, any modifications ordered for the tank cars would involve costs which would be borne by the tank car companies and shippers, rather than the railways.

II. *The Risk Analysis*

A. *The Need for Analysis*

The central dilemma facing the Tribunal was balancing the public perception of the need for improved railway safety with the high cost to industry of implementing the Grange recommendations. The Grange report intentionally did not focus on the cost of implementing its recommendations as Grange J. did not perceive this as being within his mandate. At the show cause hearing, the railway transportation industry was able to amass impressive evidence as to the magnitude of the costs that would be involved. The cost for the roller bearing retrofit program was particularly astronomical. Based on certain assumptions, CN and CP estimated the cost of the refit at more than one billion dollars. What was striking by its omission, however, was any attempt, by the Grange report, the railways or the CTC, to quantify the relative risk reduction which might be achieved if any of the safety proposals were mandated.

Because any of the alternatives being considered would have had a profound effect on the tank car leasing companies, these companies decided to investigate the possibility of preparing some type of quantitative analysis of the various proposals. Two types of analyses were initially examined. The better known is benefit-cost analysis, which attempts to assist a decision-maker by quantifying in dollar terms, to the extent practicable, all of the benefits and costs associated with a particular proposal. In the railway safety context, this would have involved quantifying the safety benefits to be derived from a proposed set of regulations, and comparing this with the increased cost of operating in conformity with the regulations. The benefits would include expected savings in property and human life as a result of the safety improvement; the economic costs were primarily the costs of retrofitting the new plain-bearing tank cars with roller bearings plus the value of productive capacity which would be lost due to the scrapping of the older plain-bearing tank cars (i.e., those cars for which retrofitting with roller bearings would have been uneconomic). This type of analysis would conclude that the proposal being considered should be adopted only if total benefits were found to exceed total costs.

There were two main difficulties in using benefit-cost analysis in this situation. First, rail spills of dangerous commodities are sufficiently rare in occurrence and so diverse in outcome that there is no satisfactory way of estimating the consequences of a future dangerous commodity spill in Canada, in terms of lives lost, numbers and severity of injuries and property damage. Second, even if the consequences of spills could be estimated, there would remain the difficult and contentious problem of placing dollar figures on reductions in loss of life and avoidance of injuries.

Because of these difficulties, another approach was considered and eventually adopted. It was thought that it would greatly assist the Tribunal in putting matters into perspective if estimates could be made of the risks of

dangerous commodity spills in the future, for each of the proposals being put forward before the hearing. This was developed, not as a substitute for decision-making on the part of the Tribunal, but rather as a tool to assist it in reaching a decision. This analytical process is known as risk analysis.

B. The Risk Analysis Model

The risk analysis study was intended to provide quantitative measures of the safety implications of certain specific changes in rail equipment and operating procedures that had been proposed. Both major railways, in written submissions filed shortly before the hearing began, had identified certain measures that they were planning to take over the next few years to improve safety on their lines. The study assumed that these measures would in fact be taken over the periods indicated and used this as a "base case" option against which the Grange and CP proposals were compared. Thus, the base case effectively represented a continuation of the present practice of transporting dangerous commodities by rail. For each of the three options — the base case, the Grange recommendations and the CP proposal—the study estimated the "expected number" of spills of special dangerous commodities in "built-up" areas of Canada, between 1982 and the year 2000.

The central problem faced in preparing the analysis was to accurately determine the various factors which influence whether a derailment and subsequent dangerous commodity spill will occur and, if so, where the spill might occur. In the course of the preliminary data collection it became obvious that some of the interactions between the rail safety factors were quite complex. The likelihood of a journal burning off on a particular car and resulting in a derailment, for example, depends on a series of considerations, including the number of miles travelled by the car each year in built-up areas; the type of journal bearings fitted (roller or plain); the position of the car in the train; and the extent to which hot box detection equipment is in place on the route being travelled by the train. Consequently, the safety implications of implementing each of the three options considered could only be quantified within an analytic framework that was able to take account of these complex interactions. The principal factors which had to be considered in the analysis, for each of the options considered, were as follows:

- (1) the number of miles which cars carrying special dangerous commodities would be expected to travel, in built-up areas and outside built-up areas, each year during the period 1982-2000;
- (2) the projected numbers of plain and roller bearing equipped special dangerous commodity tank cars in the Canadian rail fleet during each year of the period 1982-2000;
- (3) the projected numbers of plain and roller bearing equipped general freight cars in the Canadian rail fleet during each year of the period 1982-2000;

- (4) measures of the average reliability of both plain and roller bearings, expressed in terms of million journal-miles per burnt-off journal;
- (5) the projected amount and location of track which will be protected by hot box detectors, in each year of the period 1982-2000;
- (6) the patterns of derailed cars in train derailments, for derailments caused by burnt-off journals and derailments caused by other reasons;
- (7) derailment rates for derailments occurring for reasons other than burnt-off journals (i.e., other rolling stock failures, track-related problems, collisions and level crossing accidents); and
- (8) the proportion of derailed cars carrying special dangerous commodities which would spill part or all of their contents.

The size and complexity of the risk analysis model made it necessary to construct a computer model to perform the required calculations. By changing the variables to describe each of the three options considered, it was then possible to estimate the risk reduction which would result from the Grange and the CP proposals.

The analysis itself was done under extreme time constraints, most of it as the hearing was actually being conducted. In addition to the task of constructing a model which accounted for all of the major factors which influence the likelihood of a rail spill of a special dangerous commodity, the consultants were also faced with the difficulty of obtaining sufficient data to accurately calibrate the model. Good statistical analysis is based on having access to a sufficient pool of reliable data to make accurate analysis possible. A great deal of data was presented by both CN and CP in their written submissions to the hearing. The railways were also asked outside the hearing to make additional information available for study and they cooperated fully in this regard. Of particular value were detailed records of train operations provided by CN. The data used for estimating accident rates and the patterns of derailed cars in train derailments were taken from CTC accident files. Due to rarity of train derailments in Canada which result in spills of special dangerous commodities (other than Mississauga, there has only been one since 1970) it was necessary to augment the Canadian data with various rail operating and accident statistics that were drawn from sources in the United States.

The risk analysis model was then used to compare the two proposals for improved rail safety against the "base case" option. These two proposals were, it will be recalled, (1) the retrofitting of all cars on special dangerous commodity trains with roller bearings (as Grange J. had recommended, in respect of the transport of all dangerous commodities), and (2) the CP proposal to equip special dangerous commodity cars with roller bearings and marshall them near the front of the train, separated from the

lead locomotive by a buffer of five roller-bearing-equipped cars carrying inert substances. It was assumed that the other tank car improvements recommended by Grange J. would be made under all options, including the base case option.

C. Results of the Analysis

The statistical analysis produced two significant results, one of which could perhaps have been expected and one which was quite startling. The predictable finding concerned the degree to which safety would be improved by the implementation of the Grange recommendations. Before the analysis had begun, it was known that most of the Grange recommendations, concerned with derailments resulting from burnt-off journals, would affect only a small percentage of potential derailments; approximately 90 percent of all derailments are caused by factors unrelated to bearing failure. The analysis showed that, while the Grange proposal (as restricted to special dangerous commodities) resulted in the largest reduction in risk of the options considered, the expected statistical reduction was only .007 spills (i.e., seven one-thousandths of one spill) of special dangerous commodities in built-up areas over the 19 year study period 1982-2000. While some small safety improvement was apparent, the results indicated that a more cost-effective solution to the safety problem of derailments should be sought.

The unexpected conclusion related to the CP marshalling proposal. This proposal apparently had been formulated without reference to, or analysis of, any CTC or CP accident data. Rather, it was an intellectual response based on the proposition that the likelihood of a derailment would be reduced if all cars carrying special dangerous commodities and all cars in front of the dangerous commodity cars were equipped with roller bearings. CP argued that the risk reduction offered by its proposal would be equal to that offered by the Grange recommendations. The CP proposal also implicitly assumed, however, that, other things being equal, the likelihood of a spill was no greater when the special dangerous commodity cars were marshalled near the front of the train than when they were more-or-less randomly distributed throughout the train, as they currently are and as they would be under the Grange proposal.

The risk analysis showed that this second assumption was not correct; the likelihood of a car derailing in a derailment accident was found to be significantly higher when the car is located near the front of the train than when it is randomly distributed throughout the train. Although the reason for this phenomenon was not clear, the statistical sample used was large enough to give strong support to this finding. The computer simulation revealed that, over the entire study period 1982-2000, the expected number of spills (i.e., in a statistical sense) of special dangerous commodities in built-up areas was approximately 50 percent higher under the CP proposal than under the base case. Although these total expected numbers of spills

were quite small in both cases (i.e., 1.0 under the base case and 1.5 under the CP proposal), the relatively large percentage difference made it clear that the CP proposal was less safe than a continuation of present practice, insofar as the transport of special dangerous commodities is concerned.

D. Sensitivity Analysis

It was recognized from the outset that the analysis was based on a number of assumptions and estimates. While the analysts involved in the proceedings were more sanguine, the lawyers, from experience, were concerned that the model not turn into the proverbial house of cards. One of the accepted methods of testing the soundness of the conclusions reached by means of such an analysis is through sensitivity analysis. Following this approach, various calculations were carried out to determine how variations in individual estimates might influence the results of the analysis.

Changes in certain estimated probabilities would affect the overall expected number of spills in roughly the same way for all of the options considered; for example, the probability that a car carrying a special dangerous commodity spills after it derails. Variations in this value would cause the expected number of spills for all options to increase or decrease by the same percentage amount. Accordingly, such variations would not affect the ordering of the options relative to each other.

For certain other factors in the model, statistical variation in estimated quantities potentially could affect the ordering of the options. In particular, changes in the patterns of cars derailing in derailment accidents could affect the relative attractiveness of the CP marshalling proposal. The sensitivity analysis concluded, however, that it was highly unlikely that statistical variations in the estimates could have been large enough to have caused the options to be ranked incorrectly.

III. Presentation of Results

The analysis was presented to the hearing in both written and oral form. The written submission outlined the background and purpose of the study and provided detailed descriptions of the risk analysis model, the estimation of the model's parameters and the results of the analysis. The main body of the submission consisted of some 38 pages and four tables. Two detailed technical appendices were also included to provide an opportunity for commission staff and interested parties to analyze both the methodology used and the statistics from which the parameters of the model were estimated. Much of this material was produced in tabular form; these appendices constituted 45 pages of supporting documentation.

While the authors of the report had substantial experience in mathematical and economic modelling, they were novices in the area of railway safety. As the analysis was being done, considerable time was spent with experts from the major railways to ensure that the evolving model accurate-

ly reflected railway operating conditions. In this regard, the railway staff involved made useful suggestions as to how the model could be improved and how certain estimates might be made.

A draft of the report was reviewed extensively with counsel for the tank car companies to ensure both its accuracy and its comprehensibility to the commissioners and other interested parties. A major difficulty was that, due to its complexity, the risk analysis model was difficult to describe in simple and succinct terms. This problem in presentation was handled in part by segregating out much of the data and mathematical material into the technical appendices. The body of the report was simplified as much as possible in its explanation of the model and associated statistical analysis. Every attempt was made to eliminate economic and other jargon.

While the technical appendices may have been impossible for the average person to understand without expert assistance, it was essential that they be included in the written filing. As with most Canadian tribunals, the written submission at the CTC hearing was pre-filed. This gave the commission's staff and any experts engaged by other parties to the hearing an opportunity to review the analysis for any flaws that it might contain. Without such a procedure there would be no basis on which such a complex, technical analysis could be either sustained or challenged. Having been submitted for critical review, however, it was recognized that if the analysis stood up to cross-examination at the hearing, the underpinnings of the model could only be strengthened in the eyes of the tribunal.

Counsel spent a great deal of time in preparing one of the authors of the report for oral testimony after the written submission had been pre-filed. Summary charts were prepared to highlight the conclusions of the evidence and to assist the author in giving his evidence-in-chief. The examination-in-chief was conducted in detail, to explain how the analysis was done, highlight the results of the study and deal with potential areas of cross-examination. The potential weaknesses were obvious. If the model did not accurately reflect the interactions among variables which influence the likelihood of special dangerous commodity spills, then it would be open to attack. Similarly, if the data used to calibrate the model was not accurate or sufficiently extensive, then the results of the simulations could be challenged. Finally, if the conclusions of the analysis were found to be particularly sensitive to certain key variables, then the estimation of these variables had to be examined with special care. Accordingly, extra time was spent in addressing questions to the witness as to the rationale for the model, the data sources that were used, the statistical analysis that was done and the sensitivity analyses that were carried out.

The study was not extensively attacked on cross-examination. It was the only evidence placed before the hearing which attempted to estimate the risk reduction which would be achieved by the various options put before the CTC for consideration.

IV. *The CTC Decision*

The decision² of the Railway Transport Committee, released on September 30, 1981, was generally greeted favourably by hearing participants and the country's editorial writers. The written decision did not follow the usual practice of the CTC of including a written summary of evidence as part of the written decision. Rather, because of perceived urgency of the situation, the summary of evidence was published separately at a later date.

The entire decision, consisting of some 60 pages, reflected an approach to the problem which the commissioners described as follows:³

The prudent course is one which balances the benefits of net safety improvement against the cost necessary to achieve the improvement, taking into account the public perception of what level of overall risk is acceptable.

The Committee noted that it was required by its statutory mandate to weigh the benefits of the recommendations made by Grange J. against the economic cost of their implementation and the possible adverse implications for other aspects of railway safety, recognizing that limited economic resources are available for rail safety improvement.

In considering the question of public safety, the panel noted:⁴

. . . to impose a tax on one sector of the economy in order to attain an anomalously low risk relative to the general risk accepted by the public in every day life does not make sense. Hence, the evaluation of the probable level of safety improvement arising from implementation of various possible actions is of utmost importance. The panel also concludes that it is in the public interest to look beyond the Grange recommendations for other options that may yield the results intended but at lower cost.

The decision went on to discuss the question of cost-benefit analysis. While recognizing that this approach required not only an heroic attempt at valuing all consequences of a proposal, it pointed out that certain intrinsically unquantifiable factors also must be considered, such as savings in human life.

The Committee rejected the CP marshalling proposal. In so doing, it noted:⁵

The risk analysis prepared by Dr. C. Swoveland for the tank car companies concluded that the head-end marshalling of dangerous commodity tank cars is less safe than random marshalling of such cars between the first five and last five cars in the train.

It went on to discuss specific types of accidents which appear to primarily affect cars located near the front of the train, and also expressed concern about the potential difficulties of dealing with derailment accidents in which two or more cars containing different dangerous commodities spill

² Show Cause Hearing Decision on Railway Safety, Canadian Transport Commission, 1981

³ *Ibid.*, p. 13.

⁴ *Ibid.*

⁵ *Ibid.*, p. 54.

their contents, and, due to their close proximity to each other, the hazardous materials are mixed together.

The Committee also rejected the wholesale roller bearing conversion program that Grange J. had recommended. It instead required the Canadian railways to have 75 percent of their owned and leased revenue car fleets roller bearing equipped by December 31, 1987. Most of the railways will be able to meet this figure simply through attrition.

In July, 1982, the CTC released a lengthy summary of the evidence heard at the hearing.⁶ The risk analysis was considered in some detail and the overall conclusion reached gave a further indication of the weight that was given to the study by the Committee.⁷

The analysis techniques required a large number of assumptions to be made and the calibrating data was derived from different sources and under different conditions, in some cases, from the conditions to which the model was applied. The results, however, would seem to be based on a logical and scientific approach to evaluating evidence. As well, even though the results by themselves are not claimed to be a valid predictor of the absolute number of accidents that will occur, they would seem to be a reasonable best guess indicator of the *relative* frequency of occurrence of one situation to another.

Conclusions

This paper described how a risk analysis study was used in argument at the Canadian Transportation Commission's Show Cause hearing into the transportation of dangerous commodities by rail. The hearing was called to consider the principal recommendations of Grange J., who had held a year-long inquiry into the Mississauga train derailment of November 10, 1979. During the course of the hearings, other proposals were advanced, including one advocated by CP Rail, which received support from industry groups. The risk analysis, which was done on behalf of a group of Canadian companies which lease rail tank cars to shippers, showed the principal recommendations of Grange J., when limited in application to the most dangerous commodities, would have resulted in an almost imperceptible improvement in safety, at enormous cost; and that the operating procedures proposed by CP Rail, while superficially attractive, were in fact less safe than the existing procedures for transporting dangerous commodities by rail. The Tribunal rejected both the Grange and CP proposals, in part because of the findings of the risk analysis study.

The risk analysis study appeared to have another intended effect, beyond its actual conclusions: its introduction into evidence, together with the accompanying oral testimony, helped to direct arguments towards the problem of balancing safety benefits and costs, and away from the proposition that the public is entitled to a certain level of safety, regardless of the

⁶ Staff Summary of Evidence—Show Cause Hearing on Railway Safety, Canadian Transport Commission, 1982.

⁷ *Ibid.*, pp. 128-29. (Emphasis in the original.)

costs involved. In its decision, the Rail Transport Committee took the position that, because the resources available for improving rail safety—and transportation safety generally—are limited, it is essential that they be used in the most efficient manner possible. This “economist’s” view of the problem of rail safety was evident throughout the decision.

There is of course no way of knowing how far, if at all, the Committee’s approach to the problem may have been influenced by the risk analysis study, but it is noteworthy that the strong economic orientation of this decision is somewhat of a departure from its previous decisions. Moreover, to the authors’ knowledge, this is the only instance where the Rail Transport Committee has considered the results of a risk analysis in the context of a rail safety issue. Having seen its value in this situation, it can be expected that the Committee may be interested in the findings of risk analysis studies in the context of other rail safety issues.

More generally, in recent years there has been a growing acceptance in Canada of the need to undertake systematic comparisons of costs and potential benefits where major changes in regulations affecting the health or safety of the population are at issue. In part, this has resulted from advances in the techniques of regulatory evaluation and the availability of more extensive data bases. Of greater importance, however, has been a concern on the part of governments and government agencies that regulatory changes should not only enhance health and safety, but that they should do so in an efficient manner that does not place an undue strain on the economic resources of the country.

To this end, the federal government has had a policy in effect since August, 1978 which requires that all major new regulations concerning health, safety and fairness be subjected to a “socio-economic impact analysis.”⁸ In the areas of health and safety, the socio-economic impact analyses have attempted to compare the risk reduction that would be achieved by the proposed regulations with the costs associated with their implementation. Such studies have been done, for example, in respect of proposed regulations concerning occupational health in uranium mines,⁹ safety glazing,¹⁰ school bus safety standards,¹¹ soft drink bottle

⁸ “Socio-Economic Impact of Health, Safety and Fairness Regulations,” Treasury Board Canada, Chapter 490, Administrative Policy Manual, November 1978. Analyses carried out to comply with the directive are summarized in Part I of the Canada Gazette.

⁹ Montador, *The Assessment of Occupational Health Regulations in the Case of radiation in Uranium Mines*, Treasury Board Secretariat, Ottawa: Minister of Supply and Services Canada, 1979.

¹⁰ McCabe, *A Case Study of Consumer Products Safety Glazing Regulations under the Hazardous Products Act*, Consumer and Corporate Affairs, Ottawa: Minister of Supply and Services Canada, 1979.

¹¹ Morin and Proulx, *A Case Study: Proposed School Bus Safety Standards under the Canadian Motor Vehicle Safety Act*, Treasury Board Secretariat, Ottawa: Minister of Supply and Services Canada, 1979.

regulations¹² and the use of chlorofluorocarbons.¹³ Some months after the show cause decision on rail safety was announced, the CTC published a socio-economic impact analysis of the new regulations.¹⁴ The study concluded that the new regulations would improve rail safety, but it did not estimate the extent to which safety would be improved.

The use of quantitative policy evaluation techniques by federal administrative tribunals has been mixed. At one extreme, the National Energy Board has, for many years, routinely required that benefit-cost studies be done for all major proposals that come before it. Since the mid-1970's, the findings of these studies have assumed increasing prominence in its decisions.¹⁵ By contrast, benefit-cost analysis, risk analysis and related techniques have had little or no application by most other federal tribunals. Certainly, the nature of the issues that a tribunal deals with has an important bearing on the potential usefulness of these kinds of studies; one would expect, for example, that they would have greater application by the National Energy Board, where the principal effects of proposals can be quantified relatively easily, than by the Canadian Radio Television and Telecommunications Commission, which must deal with issues whose complex social and cultural effects are difficult to reduce to numerical terms.

In view of the types of issues that come before it, the Canadian Transportation Commission would seem to be a candidate for increased use of these kinds of techniques. Aside from the risk analysis study described in this paper, however, the authors are aware of only one other instance where a similar type of study has been done in respect of some matter that was before the CTC. In its consideration of proposals for the licensing of one or more air carriers to provide STOL (Short Take-off and Landing) air transport services based at Toronto Island Airport, benefit-cost analyses of the proposed services were entered into evidence before the Air Transport Committee of the CTC by Transport Canada and by the City of Toronto.¹⁶

The use of these techniques by administrative tribunals is by no means a substitute for the exercise of good judgment. Moreover, the scope for the

¹² A Socio-Economic Impact Analysis of 1.5 litre Soft Drink Bottle Regulations, Canada Gazette, Part I, vol. 114, no. 31, August 2, 1980, pp. 4580-4582.

¹³ Proposed Order and Regulations Respecting Chlorofluorocarbons: Summary of Socio-Economic Analysis, Canada Gazette, Part I, vol. 113, no. 12, March 24, 1979, pp. 1804-1806.

¹⁴ Jackson, A Socio-Economic Impact Analysis of the Regulations Emanating from the R.T.C. Show Cause Hearing Decision on Railway Safety, Canadian Transport Commission, 1982.

¹⁵ See, for example, National Energy Board, Reasons for Decision—Northern Pipelines, Ottawa, Minister of Supply and Services Canada, 1977, pp. 4-259-4-300.

¹⁶ Swoveland, Benefit-Cost Analysis of a Proposed Canadian STOL Air Transport System, 1981 and Report on the Proposed Establishment of a Limited Toronto Island Based Dash-7 STOL Service.

application of these methods is in fact quite limited. In many cases, insufficient data will be available to do a proper analysis. If the analysis is based on unreasonable assumptions or questionable data, one obviously cannot expect that the results will carry much, if any, weight.

In the United States, benefit-cost analysis and related techniques have been used for the analysis of proposed regulations for many years.¹⁷ Most authors who have considered the effects of such studies on regulatory decisions have concluded that, while the studies have sometimes been poorly done or have been biased, they generally have been helpful in assessing the economic implications of proposed actions, particularly where several options were being compared.¹⁸ The studies have also aided regulators in giving more thorough explanations of the reasons for their decisions.

Critics have argued that government agencies often manipulate the results of the studies to produce conclusions which justify regulatory decisions.¹⁹ Considering the technical complexity of most of these studies, and the need for simplifying assumptions and subjective estimates, there generally is considerable opportunity for guiding the results in a particular direction. Even where the researcher attempts to be impartial in his analysis, the conclusions may be influenced by his outlook and values; a businessman and biologist, with the same training in economics, may study the same issue and come to conflicting conclusions. The most common faults of benefit-cost analyses and related techniques that have been cited in the literature are:

- (1) inadequate identification of costs and benefits;
- (2) unreasonable assumptions;
- (3) inaccurate forecasting;
- (4) incorrect valuation of intangibles; and
- (5) inappropriate choice of discount rate.²⁰

¹⁷ For an overview, see: Miller and Yandle, eds., *Benefit-Cost Analyses of Social Regulation: Case Studies from the Council on Wage and Price Stability*, Washington, D.C.: American Enterprise Institute, 1979; Williams, *Benefit-Cost Analysis in Natural Resources Decision-making: An Economic and Legal Overview* (1979), 11 Nat. Res. Lawyer 761; Kasper, *Cost Benefit Analysis in Environmental Decision-making* (1977), 45 Geo. Wash. L. Rev. 1013; Baram, *Cost-Benefit Analysis: An Inadequate Basis for Health, Safety and Environmental Regulatory Decision-making* (1980), 8 Ecology L. Q. 473; Egan, Note—*Cost-Benefit Analysis in the Courts: Judicial Review under NEPA* (1975), 9 Georgia L. Rev. 417; and, Burmeister, Note—*Cost-Benefit Analysis and the National Environmental Policy Act of 1969* (1972), 24 Stan. L. R. 1092.

¹⁸ Kasper, *op. cit.*, footnote 12, p. 1024; Green, *Cost-Risk Benefit Assessment and the Law: Introduction and Perspective* (1977), 45 Geo. Wash. L. R. 901 at p. 190.

¹⁹ Baram, *op. cit.*, footnote 17, pp. 518-523. Burmeister, *op. cit.*, footnote 17, p. 1104.

²⁰ Williams, *op. cit.*, footnote 17, pp. 768-789; Baram, *op. cit.*, footnote 17, pp. 481-492; Egan, *op. cit.*, footnote 17, pp. 426-429.

These objections, which are often quite legitimate, underscore the importance of subjecting these kinds of studies to close public scrutiny.

The lessons to be learned from the United States experience are that quantitative policy evaluation techniques can be of value in regulatory decision-making in Canada, but that this type of analysis must be fully vetted before decisions are made. For Canadian administrative tribunals conducting hearings into regulatory proposals, these kinds of studies should always be pre-filed, to allow effective cross-examination to take place. Where the tribunal's research staff conducts the analysis itself, the study report should be made available to all interested parties and the author should be called upon to testify and be cross-examined at the hearing.

The possible use of this type of analysis by applicants and intervenors at public hearings presents special problems for legal counsel. Where it is thought that the client's position might be strengthened by commissioning such a study, it is important to retain an expert at an early stage, preferably well before the hearing begins. After some preliminary research and discussions with the counsel and client, the expert should be able to determine whether a study would be feasible and, if so, the questions that it could help answer and approximately how long it would take and how much it would cost. It could well be that insufficient data is available to do a satisfactory analysis, or that the study could not be completed before the conclusion of the hearing.

If the decision is made to commission a study, legal counsel must monitor the progress of the analysis closely, with particular attention to the issues to be addressed and the formulation of the study report. If opposing parties are unwilling to provide information required for the analysis, the tribunal should be requested to direct that the information be made available. The witness must be adequately prepared for both evidence-in-chief and cross-examination, and counsel must be familiar with the evidence in detail, so that the examination-in-chief will be thorough and clear.

The expert retained must have a reputation for technical excellence and professional integrity, and must be able to convey his findings clearly and succinctly to the members of the tribunal. It is also desirable for the expert to be familiar with the subject matter of the hearing, but in the authors' experience this is a secondary consideration.

Recent trends indicate that quantitative policy evaluation tools will be used increasingly by Canadian administrative tribunals. These tools can be useful aids to regulators, by providing an indication of the relative importance of the various effects that proposed regulations would have. Sometimes, as in the situation described in this paper, these studies produce conclusions which are unexpected, but which make sense once the underlying analysis has been explained. In these situations, the findings may be particularly valuable. The techniques do not have universal application, however, and can be misused. The best way of judging the value of such studies is to subject them to thorough cross-examination at public hearings.