TRB Special Report 197

Transportation of Hazardous Materials: Toward a National Strategy (Volume 2)

Transportation Research Board
National Academy of Sciences
National Research Council

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in cooperation with
U.S. Department of Transportation
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National Association of Governors Highway Safety Representatives

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The project that is the subject of this report was approved by the Governing Board of the National Research Council, whose members are drawn from the councils of the National Academy of Sciences, the National Academy of Engineering, and the Institute of Medicine. The members of the committee responsible for the report were chosen for their special competence and with regard for appropriate balance.

This report has been reviewed by a group other than the authors according to procedures approved by a Report Review Committee consisting of members of the National Academy of Sciences, the National Academy of Engineering, and the Institute of Medicine.

The views expressed in this report are those of the authors and do not necessarily reflect the view of the committee, the Transportation Research Board, the National Academy of Sciences, or the sponsors of the project.

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Sponsorship of the Papers in This Transportation Research Board Special Report

Steering Committee to Develop a National Strategy for the Transportation of Hazardous Materials and Hazardous Wastes in the 1980s

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Introduction

BACKGROUND

Although the report in Special Report 197, Volume 1, had an immediate germination period of approximately two-and-a-half years, in a larger sense it is among the most recent efforts in a 117-year process to ensure safety in the transportation of hazardous materials and hazardous wastes in the United States. Precedent within the Transportation Research Board (TRB) for convening and analyzing the best national thinking on this issue was set by the 1969 Conference on Hazardous Materials at Airlie House, Warrenton, Virginia. That conference, the result of a request by the U.S. Department of Transportation (DOT) to the National Research Council, assembled 90 people from government and industry to review the situation as it then stood.

The Airlie House recommendations paved the way for some of the reforms that were implemented during the 1970s. Legislatively, the most significant was the passage of the Hazardous Materials Transportation Act (HMTA) of 1975. Administratively, the Materials Transportation Bureau (MTB) in DOT's Research and Special Projects Administration (RSPA) was established. TRB's Standing Technical Committee on the Transportation of Hazardous Materials also grew out of the Airlie House deliberations.

COMMITTEE ACTIVITIES

Prompted by growing public and congressional concern over hazardous materials transportation in the late 1970s--a concern that resulted from a number of well-publicized hazardous materials incidents and spills (some involving multiple fatalities)--TRB's Committee on the Transportation of Hazardous Materials, in developing program plans, initiated a number of activities designed to further its role as noted below in the Committee's scope:

> This committee is concerned with the movement of hazardous materials including conditions and forces encountered during transportation, type and extent of hazards associated with material type of class, preservation and packaging to prevent cargos' damage or decomposition during transportation and handling, laws controlling and legal liabilities pertaining to hazardous materials movements, enforcement and administrative controls and procedures for such movements, signs and labels to indicate the hazardous nature of the cargo, and the knowledge of incidents occurring during transportation and handling movement risks.

Specifically, the Commiteee undertook, and published the results of, a survey to identify the ten most critical issues in hazardous materials transportation; initiated the 1981 Williamsburg Conference; and organized TRB Annual Meeting sessions that have covered all aspects of hazardous materials transportation and from which many of the papers have been published and distributed widely as part of TRB's information dissemination role.

IDENTIFICATION OF CRITICAL ISSUES

In 1980, TRB's Committee on the Transportation of Hazardous Materials issued a list of the ten most critical issues in the transportation of hazardous materials. The issues were derived from responses to a questionnaire that contained a list of 25 issues deemed by the Committee to be critical in nature. The responses came from federal, state, and local governments; industry; and trade and professional associations. Respondents were asked to identify the ten most critical issues and to add others to the list that they felt were important. The final listing was published under the auspices of the Committee as a basis for a reasoned approach and a common strategy to improve the nation's hazardous materials transportation system. The issues, not listed in order of importance, fall into five categories: regulations (issues 1 and 2); need for a coordinated systems approach (issues 3-6); data and data applications (issues 7 and 8); legal responsibilities (issue 9); and public awareness (issue 10). The ten most critical issues listed are as follows:

1. [Need for] Harmonious International, Federal, State, and Local Hazardous Matrerials Regulatory Controls;
2. The Complexity of DOT's Hazardous Materials Regulations and the Need to Convert Some of Them from Detailed Specifications to Performance-Based Criteria;
3. [Need for] a National Strategy for Control of Hazardous Materials Risks;
4. Training for All Persons Involved in the Transportation of Hazardous Materials, Including Shippers, Carriers, and Emergency-Response Personnel;
5. [Need for] a Single, National Response System for Incidents and Accidents Involving the Transportation of Hazardous Materials;
6. [Need for] an Integrated Hazardous Materials Transportation Administrative Communication System Among Federal and State Governments;
7. [Lack of] a Comprehensive Data System for the Flow of Hazardous Materials by Quantity, General Hazard Class, Route, and Mode;
8. [Need to Synthesize and Evaluate for Its Practicality] the State of the Art for Hazardous Materials Transportation Cost-Benefit-Risk Analysis Methodology;
9. Clarification of the Legal Responsibilities of Governmental and Private Agencies Involved in Hazardous Materials Transportation; and
10. [Need for Public Awareness] About the Relative Safety of Hazardous Materials Transportation.

These issues were subsequently telescoped into six discussion topics for the 1981 Williamsburg conference.

NATIONAL STRATEGIES CONFERENCE

A Steering Committee to Develop a National Strategy for the Transportation of Hazardous Materials and Hazardous Wastes in the 1980s was appointed, with the approval of the Chairman of the National Research Council, in October 1980. The Steering Committee was composed of selected members of TRB's Standing Technical Committee as well as members who represented government agencies, industry, and academia, and whose expertise covered some facet of the handling, shipping, regulation, enforcement, safety, or legal aspects of hazardous materials transportation. The Committee was chaired by Karsten J. Vieg, then Director of Traffic Safety, Illinois Department of Transportation.

The purpose of the conference, held under the Steering Committee's aegis, was to develop recommendations for a comprehensive national strategy to provide safe and efficient transportation of hazardous materials and hazardous wastes in the 1980s. The conference covered the following aspects of the hazardous materials transportation system: regulation, training, emergency response, legal responsibilities and implications, technological needs and limitations, and risk assessment. Consideration of the public interest was a pre-eminent theme underlying all the discussions.

The conference, held February 17-20, 1981, in Williamsburg, Virginia, was funded in part by the U.S. Department of Transportation's Research and Special Projects Administration; the Federal Emergency Management Agency; and the National Association of Governors Highway Safety Representatives. Attendance at the conference was by invitation--extended to hazardous materials transportation experts and policymakers who represented the executive and legislative branches of the federal government; state and local government agencies; and the private sector.

The report deliberately does not give lengthy treatment to marine or air transport of hazardous materials. This is because much of the marine traffic is international and is governed by international regulations that are beyond the scope of national strategies. Air traffic in hazardous materials is minimal, and the work of international and national trade and professional organizations has been effective in relieving many problems in this area.

The transportation of nuclear wastes and radioactive materials was not a focus of attention at the conference, largely because it is a relatively small part of current hazardous materials transportation. Furthermore, coupled as it is with public concerns about the disposal of radioactive wastes and disposal area sites, it is a volatile issue that could inappropriately mask many other important issues. However, the increasing number of nuclear materials and wastes being transported indicates that this issue is likely to command greater attention at future conferences.

The 150 conference participants were pre-assigned to two of the six topical discussion groups and received copies of the appropriate resource papers. Background papers for each of the six discussion topics were presented on the first day of the conference, after which participants attended two sessions of each of two workshops. Rapporteurs' reports, presented on the last day of the conference, highlighted issues/problems attendant to each of the discussion topics and made appropriate recommendations.

The six topics derived from the critical issues were the basis for 14 resource papers commissioned by the Steering Committee as a catalyst for discussion. These resource papers, together with the workshop rapporteurs' reports, provide a frame of reference for the Steering Committee's findings and recommendations, which are discussed in subsequent sections of the report.

CONFERENCE REPORT

The findings and recommendations of the Steering Committee, developed pursuant to the Williamsburg meeting, are based on the findings and recommendations of the six discussion groups; conferencewide discussions; the resource papers; and the collective judgment of the Steering Committee members and experts in the field of hazardous materials transportation. The findings and recommendations are summarized in Part 2 of Volume 1; they are then discussed within the context of the broader issues they represent in Part 4. Part 3 of the report is an overview of the background history, legislation, regulations, and current issues inherent in the field of hazardous materials transportation and identifies the government and private agencies that play major roles in the field. Part 5 of the report is composed of three Appendixes: references, a list of conference attendees, and a roster of the Steering Committee.

Volume 1 constitutes a summary of the conference proceedings and the Steering Committee's subsequent deliberations in developing its findings and recommendations regarding the development of a national strategy for the movement of hazardous materials and wastes. Volume 2 contains the conference resource papers and the rapporteurs' workshop summaries.

In addition to the Airlie House report, this is the second report to deal with hazardous materials transportation issues emanating from the National Research Council in recent years. The other report, prepared by the Asembly of Engineering's Committee on Transportation, is titled A Review of the Department of Transportation Research and Special Programs Administration's Hazardous Materials Research and Development Program and was prepared for the U.S. Department of Transportation in 1980. A report dealing with methodological approaches for risk assessment of hazardous materials transportation at state and local levels will be published in 1983 in the National Cooperative Highway Research Program (NCHRP) Synthesis of Highway Practice series. NCHRP is administered by TRB's Division D, Cooperative Research Programs.

PART 1

Resource Papers

Hazardous Materials Transportation Regulation

[Editor's Note: This is a three-part paper on the general subject of hazardous materials transportation regulation. The three parts examine the purpose and direction of regulation, the process of hazardous materials regulation, and the complexity of regulation. Although there was some coordination of subject matter among the authors, there are overlaps and, in some cases, conflicts in views expressed. The goal of the overall document is to spark discussion, and these differences should advance that goal.]

PART 1. PURPOSE AND DIRECTION OF REGULATION (C.H. Thompson)

As noted in the portion of this paper on the regulatory process, there is no clearly stated National Hazardous Materials Transportation Policy, except for the very general statement found in the enabling legislative policy, which can be used to accurately quantify the specific purpose of the regulatory program. This situation has existed for so long that a complex industry and regulatory schema has evolved that operates on a concept of federally issued "minimum standards" to assure the safety of hazardous materials under "conditions normally incident in transportation." A careful examination of this concept and of the current interests of the many federal agencies and several state and local agencies in hazardous materials suggests that a definition of purpose is not only desirable but has become mandatory. The purpose of these regulations must address at least the following issues:

1. What are the targets or receptors that require protection: the general public, the transportation worker, the public along the transport route, private property or property in general, including the broader context of the total environment?
2. What are the conditions normally incident in transportation, and how do these conditions relate to catastrophic events in transportation?
3. If shippers and carriers can choose for various reasons, including economic pressures resulting from product loss, to operate at a higher degree of safety than required by federal regulations, do the minimum safety standards satisfy even the general legislative policy?
4. What level of protection should be acceptable, and how should it be measured?
5. What limitations on regulatory scope are needed, such as "transportation in commerce" and intra- or interstate commerce, especially in light of other legislative demands and agency programs?
6. How can the regulations be prepared to be understandable, useful, and enforceable to both the regulated and the regulators, and yet not stifle technological innovation?

These issues are examined in more detail in the context of directions to be considered in hazardous material transportation.

Direction of Hazardous Materials Transportation Regulations

It is clear that when more than 1200 pages of detailed material specification regulations issued by one federal agency are added to at least that quantity issued by two or more other agencies, coupled with nonfederal requirements, a new direction in regulation is needed. Those who would disagree with this premise must then accept that the alternative left to the regulated community is the "best affordable effort" in awareness and compliance. In some cases, this may be no compliance at all. The size, complexity, and changing detail of regulations in a field as dynamic as hazardous materials transportation level a mighty challenge to the regulated community that can be fully met by few. And yet, with all the complexity and change, the regulatory base is always behind in technology applications and has to improvise relief mechanisms such as exemptions to avoid total chaos and halting of progress. The costs of the delay and the controls offered by the existing regulatory schemata are further reasons for new directions to be considered when it is recalled where the true responsibility of safety lies. This responsibility is not on the regulator, but on the shipper, carrier, and packaging manufacturer (see 49 CFR 172.2).

As previously noted, the existing regulations "evolved" over decades and, as such, a group of talented and dedicated persons grew with this evolution. Many of the reasons for regulatory modification were known (and still are known among a few) and, therefore, compliance programs could be built by using this experience to anticipate the pace and nature of pending changes. Now and in the future, however, other agencies have demands that, if not accommodated, will contribute to a continuation of regulatory proliferation. This widening effect has expanded the regulated community, and now there are many more people attempting to use these regulations who do not have the evolutionary background. These people are often at a total loss to understand why a given requirement exists. It is often difficult for the government to explain the reason because, in this evolutionary process, it often was not the government's initiative or experience that caused the regulatory posture but, rather, someone in the regulated community who is now unavailable or not responsible for providing guidance. It must be recognized that to assure regulatory understanding by this ever-increasing group of newly aware persons, the purpose of the rules must be defined and new directions explored.

Prior to assuming the omnipotent role of defining the purpose of the regulations and direction that should be explored, it would appear appropriate to expand on the issues that should be addressed. The issue pertaining to the target or receptor would be validated by those who have an awareness of other regulatory programs that are defined by effects that must be prevented. Recognizing that there are deficiencies also in these other regulatory strategies, there is an important principle to explore. An example would be the use of "receiving water quality criteria" on which to base a management program to protect the quality of the nation's waters. Receiving water quality criteria are scientifically derived numerical indicators and descrip-

tions suggested as protective of identified beneficial uses of water. Included in the beneficial uses of water is, for example, protection of fish and wildlife. Research work would be conducted to determine what level of a variety of materials in question would cause irreparable harm to species potentially threatened. These research results would be examined and interpreted in terms of scientifically valid criteria. The next step is to take these criteria and examine extenuating circumstances in a social and political context as a receiving water quality standard is derived. It is not the purpose of this discussion to defend this procedure, but rather to demonstrate how those who invest in equipment and training to achieve the water quality standard have before them an understanding of what it is that they are achieving or protecting.

The same is not specifically true in the hazardous materials transportation regulations. It cannot be, or there would not be the internal inconsistencies that so clearly exist. If the purpose of these regulations is to advise the general public of the hazards involved in the transportation of the materials, it would appear that the elaborate labeling, placarding, marking, and documentation system would fall short of the mark for a population even as well informed as that encountered in the United States. If the purpose of the regulation is to protect the transportation worker, then it is clear that materials that pose effects other than from acute exposures should have been regarded as significant years ago. If the purpose of the regulations is to protect the public in close proximity to the transportation activity, then it would appear that decisions with the railroad right-of-way would be more in keeping with distances provided by ancient concepts such as buffer cars. If the purpose of the regulation is to be the protection of property, perhaps even the environment, then materials that have only recently been listed in a rather ineffective manner should have been listed long before the needs were identified by EPA.

Regarding the question of the purpose of these regulations from the perspective of whom are they designed to protect, the answer is not clear. It is not even clear what the rationale is for selecting the hazards that have evolved into the regulatory system. It is thought by some that these hazards are primarily those resulting from acute exposure, such as flammability, explosion, and perhaps corrosion. However, that does not explain the inclusion of low-level radioactive materials, etiologic agents, and some materials that, when shipped in such small quantities, pose so little hazard that special categories must be created to exempt them from vigorous regulation.

If it were clearly understood whom or what we were trying to protect with these regulations, the next question would be, Under what conditions are we interested in providing this protection? Traditionally, we talk in terms of conditions normally incident to transportation. There has been very little work done to accurately define what these conditions represent in useful engineering terminology. Efforts have been made by the DOD to quantify conditions incident to certain types of transportation, and there have been other sporadic and limited efforts by the federal government and certain parties in the regulated community to define some of these conditions. The material specification regulations and the limited amount of testing associated with them are not clearly related to any defined conditions normally incident to transportation. It always is perplexing to an individual to understand the relationship of a limited drop test to conditions in transportation of a package moving at tens of miles per hour and experiencing a variety of pressures, humidities, vibrations, shocks, torsions, tensions, and compressions. And even if these conditions were defined in engineering parameters that could be used for design, the question that still stands is how these conditions relate to catastrophic events in transportation. Once again, if these regulations are designed to protect the general public, then the rationale that has been traditionally used, which suggests that these regulations are not intended to prevent or control the catastrophic event, does not seem consistent. It will be argued by some that the location of certain valves, safety vents, and quantity limitations are deliberately designed to minimize and control damage resulting from catastrophic events. Some may be critical of this prevailing theme, which would suggest that it should be illegal to have an accident. This is not without precedent, in that Section 311 of the Clean Water Act clearly makes it unlawful to have a spill that many people would consider an accident. Therefore, the traditional view that the catastrophic event is beyond the scope, purpose, or purview of the hazardous materials transportation regulations would appear to be unnecessarily limiting and inconsistent with the claims of who is being protected by these regulations.

Because these regulations were not designed to satisfy a specific purpose, nor was there an architect laying out all aspects of hazardous materials transportation and directing a grand strategy or research program to fill in all the missing pieces, and because the responsibility for safe transportation of these materials lies entirely with the shipper, the carrier, and the packaging manufacturers, these regulations have frequently been referred to as minimum safety specification regulations. If any of the regulated parties felt that a higher degree of safety was required, their decision traditionally has been respected and that flexibility provided. This traditional view should be reexamined. There are new concerns about the transportation of hazardous wastes and other materials that have broadened the needs for these regulatory requirements. These new programs are intended to be implemented at the state level, and all efforts are being made to make this happen expeditiously. The same regulations, which a few years ago were regarded as minimum safety standards, may now be referred to by some as adequate safety standards. The desirability of establishing this viewpoint is to convince those who might establish more stringent requirements that these requirements are not necessary, so that the nationwide regulatory program can maintain some semblance of order. Those who would find fault with this examination may be in a position to point to studies that demonstrate that additional safety precautions are not warranted or cost effective. The number and comprehensiveness of those studies, however, seem extremely limited. It would appear, therefore, that if the established minimum safety standards are to be regarded by (a) state government, (b) interested federal agencies other than DOT, and (c) other interested parties as adequate or even maximum safety standards, then some very careful study and documentation must be published to explain the context in which that evaluation may be valid.

The determination of acceptable levels of protection and how to measure levels of protection represents a pervasive challenge in the 1980s for all forms of regulation. It is inconceivable that a regulatory program, which addresses the quantities of materials and the numbers of people that the hazardous materials transportation regulations do,

would go through the 1980s without demonstrating cause and effects and an evaluation of risks involved. Several other agencies are engaged in risk assessment work that may be viewed by the transportation community as esoteric. However, it would appear that we should not hide from this issue, and if the risk of transporting some of these materials is equal to or greater than predicted risks, for example, by the National Cancer Institute from exposure in the workplace or in the environment, then the traditional view that the materials have to move anyway may be subject to examination. In other regulatory programs, the concept has been launched for the regulated community to consider alternatives and substitutes for materials that are infeasible to control at the levels needed to afford the acceptable level of risk. There is no clear reason why the transportation community cannot in the 1980s come to grips with these risk assessment considerations and provide the required leadership to these pervasive hazards as it provided to more obvious hazards years ago.

A challenge that confronts the direction of hazardous materials regulation must be related to the content and format of any words that must be published. The existing regulations represent millions of person-hours of dedicated energy and the format is familiar to those experienced in the hazardous materials transportation field. A portion of the regulated community would argue, however, that the existing regulatory format is more useful to the regulator than to the regulated. The exception to this, of course, must be the creation and maintenance of the hazardous materials table found in 49 CFR Section 172.101. As the uninitiated becomes more familiar with the existing regulations, a variety of suggestions is often discussed. One of the most common suggestions is to remove from the regulations those parts in which the reader is not interested. Those in favor of the existing format argue that the several parts and subparts were created to meet the need. The reader, regardless of need, is still confronted with more than a thousand pages of information with which he or she must have some working familiarity in order to ensure that his or her operation is in compliance.

The enforceability of the existing regulations is yet to be aggressively demonstrated. Considerable reliance is placed on manual specification type standards and yet, traditionally, the program has operated as a voluntary compliance program. If enforcement is truly needed, and inspector resources will continue to be limited, it would appear that other directions should be considered so that advance forms of technology could be used to assist in the enforcement. If it is determined that the only way to assure safe transportation of hazardous materials is through aggressive enforcement action, then these regulations, which were developed for voluntary compliance, should be reexamined in light of the changing statues and enforcement attitudes.

Related to enforcement and regulatory compliance is the relationship of technological innovation in modernizing hazardous materials transportation. Under the existing regulatory format it is often most difficult for the shipper, the carrier, or the packaging manufacturer to innovate, even though those parties are fully responsible for their actions. To encourage technological innovation and increase productivity, it follows that new directions are required in these regulations to allow those who are ultimately responsible to act responsibly without stifling control.

With the view in mind of stimulating discussion, the following purposes and directions of hazardous materials transportation regulations are offered. It is the purpose of the hazardous materials transportation regulations (a) to protect the general public from involuntary exposure to transported materials determined to pose health risks greater than those determined to be voluntary accepted risks, (b) to provide the central coordinating function for the protection of transportation workers from exposure to materials designated by the occupational health and safety agency, (c) to provide the central transportation coordinating function to minimize ecological damage resulting from releases of material as determined by the environmental agency, and (d) to provide protection to property involved in or adjacent to hazardous material transportation activity.

To accomplish this purpose, a program should be established that includes at least the following directions.

1. Materials identified as hazardous by all the interested agencies should be accepted and incorporated in the transportation regulations and appropriately categorized so that protection to the general public, the transportation worker, the environment, and property is assured. This comprehensive listing should be promoted for national adoption.

2. The conditions of transportation should be defined, representing both normal and accident conditions. The resulting information should be reported in engineering parameters suitable for evaluation and design.

3. With the conditions of transportation and the materials to be transported known, the population at risk during transportation should be assessed, thereby defining several program elements including hazard communication needs.

4. With the conditions of transportation understood and the population at risk quantified, the listed materials can be examined and situations described so that exposure levels may be defined.

5. With exposure levels defined, a careful examination of available health effect criteria as well as criteria that would protect property would be established that would define levels of protection required.

6. Knowing the exposure level potential and the protection levels required, criteria may then be used in an aggregate form to establish transportation performance standards that would operate under the conditions previously defined. It is at this key point where those who would invest to comply with these performance standards would have a rationale to understand what that investment would protect. The transportation performance standard would be prepared in such a manner that technology would be stimulated to achieve the required levels of protection.

7. To assist in the transition from material specification type standards, a significant public and private research and development program will evolve methods that are shown to meet the performance standards.

8. At this point, the existing regulations could be critically examined and the packaging material specifications phased out of existence except as useful guidelines where it can be clearly shown that the material specification does in fact meet the performance standards.

9. An aggressive random packaging and package performance testing program would be introduced to assure that those with the responsibility of ensuring the safe transportation of hazardous materials are in fact using the flexibility available and meeting the performance criteria.

10. The commodity packaging standards could then

be phased out, recognizing that the regulated community would accept its full responsiblity for meeting the performance specification and would be prepared to demonstrate equivalency to any material specification standard anyway.

11. Performance package standards and operations should be introduced and enforced so that the shipper, carrier, or container manufacturer is given the full flexibility under the regulations to meet the criteria that will afford the defined protection for the population at risk under the conditions of transportation for the identified materials.

In summary, what is being suggested is that Title 49 in its present format has served its purpose. Those portions of Title 49 that pertain exclusively to packaging design and manufacture should be supplanted by performance criteria derived from quantifying the conditions normally incident in transportation and for the accident environment. Those portions of the material in engineering specifications should not be lost, but should be retired and viewed as reference materials. The remainder of the hundreds of pages of regulations would be critically examined in a manner so that conditions not normally incident to transportation could also be accommodated by transportation, environmental design, and transportation system operation. It should be further noted that in no way can the task that has been suggested here be accomplished overnight, nor should it be done in a manner to undermine the credible efforts of existing organizations dedicated to assuring the safe transportation of hazardous materials. These purposes and directions for the hazardous materials transportation regulations should be designed as a parallel, non-Federal Register transportation control strategy. It should be developed by the near complete involvment of all levels of government and industry participation. Once completed, or perhaps with significant portions completed, it could then be phased into existing federal and state programs.

PART 2: THE PROCESS OF HAZARDOUS MATERIALS REGULATION (L.W. Bierlein)

The topic is regulation. This includes more than mere issuance of regulations in the Federal Register. It means any government-initiated, implemented, enforced, or inspired action to alter the behavior of people in the hazardous materials transportation community. The regulatory action can take any form, although to date the issuance of regulations has been the primary form used. The following discussion is applicable to all forms of regulatory action, including but not limited to issuance of regulations. It applies to judicial, legislative, educational, and other actions by the regulatory agency.

Many of the recommendations will seem obvious and some people may assume the concepts are already part of the program. They are not.

It Is Important to Define and Publish the Purpose of the Regulatory Agency

There is a strong need for an agency mission statement for the guidance of agency personnel, other regulators, and the public through which the objectives of the agency can be known and measured. No such mission statement exists today. There is no mechanism by which a petition for rulemaking or a specific regulatory project, for example, can be ranked by priority. Since there is no clear statement of the purpose and functions of the agency, there is no way for any person, including federal staff workers, to know whether actions or proposals are appropriate or important. For example, when issues arise involving preemption or the posture of the agency with regard to the growing refusal of common carriers to provide service to hazardous materials shippers, there is no existing mission statement to provide guidance on what to do. This necessarily requires each issue to be examined afresh in a policy vacuum, leading to substantial delay and potential for inconsistency from issue to issue.

Decisionmaking in the absence of an overall policy or mission statement established at higher levels of the agency becomes very subjective and is done in a closed environment without the awareness of higher policy officials. This has several effects. First, selection of goals and priorities at too low an administrative level fails to result in allocation of budgetary and personnel resources necessary to carry out the decision, giving rise to persistent complaints of not enough people to carry out the job. Second, decisionmaking on goals at too low a level perpetuates the view that higher levels are not interested, affecting the general significance of the program both within and without the agency. Third, the low-level, closed determination of goals and priorities leaves no visible record, so there is no measure of whether the decisionmakers have done their job or not, to the detriment of the public interest in the achievement of essential priorities.

The mission statement need not be lengthy to be effective. The following is recommended:

> The purpose of the regulating agency is to achieve the greatest level of public and transportation employee safety feasible in the movement of materials in a hazardous quantity and form, while assuring that the flow of regulated materials is not unnecessarily impeded by anyone. In carrying out this function, the agency shall be the lead agency among federal programs and nonfederal programs and shall exercise its authority affirmatively, consistent with that leadership role.

The key points in this recommended mission statement are the following.

1. The safety of people affected by transportation is paramount. Protection of the environment is not the primary or dominant role of the transportation safety agency. It is a subordinate function administered for the sake of convenience by the transportation agency on behalf of the environmental agency, for which it is the primary and dominant role. Any conflict between these functions at the transportation agency must be resolved in favor of the primary safety role of the transportation agency.

3. The quantity and form of materials as related to hazard require assessment of the nature of materials; they assume a greater priority in those posing a greater hazard.

3. Feasibility, i.e., functional and economic practicality, must be considered.

4. The essential flow of materials is recognized as a responsibility of the agency, and unnecessary impediments to the flow of commerce, i.e., those that are not essential to the achievement of feasible safety levels, are to be discouraged by the agency. Agency actions to enhance efficient movement of hazardous materials, through court action or direct intervention in other agency proceedings, are authorized.

5. The primary leadership role rests in the agency and it is the agency's obligation to carry out that role. It is improper for the agency to remain passive in the face of either danger or circumstances disruptive to hazardous materials commerce.

Establish an Agency Guideline on Assignment of Priorities

In creating a priority guideline, it is vital to accept the fact that there will never be adequate resources or personnel to do all things. An effective guideline is necessary by which all agency actions can be judged for priority, on a daily, annual, or multiannual basis. By priority is meant the speed with which an item is considered, the number of people assigned to the task, the quality of those people, the expenditure of contract or research resources, and the adaptation of other program elements to fit this project.

This guideline should be detailed and, to the extent possible, quantitative. It is the practical document by which the basic mission statement is implemented. It must be useful to all agency employees and outsiders, and that means it must be simple. Also, it must be used consistently and constantly. Use of a priority assignment guideline only on occasion invites discrimination, abuse, and inconsistency.

The guideline should be published so that all may know what is important to the agency. A published document serves to dispel the feeling that assignment of priorities is arbitrary. A petitioner for rulemaking will be able to estimate the rank to be assigned to the proposal being made and will understand better why some projects take years and others can be handled immediately.

The guideline can provide an effective management tool by which agency officials and the public can judge the success or failure of the program. This can do much to dispel frequent criticism that the agency is not doing its job, or perhaps it will document the validity of such criticism to facilitate corrective action.

The guideline should be used in both short- and long-term planning by the regulatory agency. It also should be used to effect coordination between projects. It should eliminate current work on projects that do not carry out the basic mission statement or that do not warrant consideration at this time.

Inherent in the assignment of a significant priority to a project is a commitment to complete projects that are begun. Thus, rulemaking actions will not take unnecessary years to complete because of an erratic approach to scheduling.

Another matter inherent in a hazardous materials priority guideline is the determination and weighing of the level of risk posed by the quantity and form of the shipment in question. Obviously, if the level of risk is low on a safety project, then the priority allocated to it should reflect that fact.

The Agency Should Take No Regulatory Action Unless There Is a Real Problem

Pet projects and whimsical thoughts must not find their way into, much less through, the regulatory process. Without an actual, documented transportation safety or efficiency problem, no agency action is warranted. Effective implementation of the mission statement and the priority guideline should serve to eliminate such projects.

There Are Several Sources of Information to Document Problems

Some of the sources of information are briefly explained here.

Applications for exemption highlight areas where beneficial general amendments, as opposed to applicant-specific changes, may be necessary. Exemptions with multiple parties should be converted quickly to rules of general applicability. In an efficient exemption-to-regulation program, renewal of initial two-year exemptions should be unnecessary.

Petitions for rulemaking, like exemption applications, highlight areas where change is necessary or desirable. Traditionally, however, only the regulated industry has been sufficiently cognizant of agency procedures to make use of this communication mechanism. Petitions that seek more restrictive rules because of perceived dangers are rarely received and must be given greater priority. Procedural rules on what must be included in a petition should be eliminated and replaced by a prominent invitation for petitions from all parties (including other government bodies), with only a suggestion of contents that may be helpful.

All petitions should be assigned a priority ranking on receipt, and the petitioner should be advised in writing of that rank. This advice should include a realistic estimate of the time that may be involved in handling the matter, with a caveat that matters of greater priority that are received later will be taken first. To the extent possible, time estimates should be met; they should not be dismissed lightly by agency personnel as an empty statement.

Applications for approvals by their nature are signals of a defect in the system. An approval is a time-consuming alternative to a well-written regulation and is a process without apparent statutory basis. If the approving authority has a standard by which approvals are granted or denied, then that standard can be reduced to writing so regulated parties may meet the standard without direct communication with the agency. Approvals by their nature tend to be inconsistent, arbitrary, and persistently troublesome; they should be eliminated from the system. To the extent anyone seeks approval of anything from the agency, it signals a problem and should be treated as such.

Incident reports and other sources of information on actual dangerous occurrences should be used, not just compiled, and should elevate matters for immediate corrective regulatory consideration. The incident reporting system, in effect for nearly 10 years without significant adjustment until moderate changes late in 1980, demands greater adjustment. There is need to examine the collection of data in light of the uses to which the data might be put in the regulatory process. The current requirement to report any spill of any quantity should be eliminated. It is likely that with more effective use of data-processing methods, the report form could be modified, and probably shortened.

As a source of information, incident reports must be more accessible to everyone than they have been in the past. This means ready availability of current reports.

Public demands in nonpetition form are problem indicators that must be evaluated as if they were requests for agency action. These include public correspondence as well as congressional expressions of opinion and concern as representatives of the public.

Also included among nonpetition descriptions of problems are independent regulatory actions by other agencies, cities, states, carriers, labor groups,

and institutions bypassing the agency that supposedly has the lead responsiblity. Many of these actions are clear efforts to enter a perceived regulatory vacuum. If the vacuum is real, it should be filled by the lead agency. If it is only perceived, then education alone may resolve the problem. The important thing is that the lead agency regard these signals as stimuli for action. Problems in the transportation of hazardous materials are agency problems.

Pleas from other safety regulators, at all levels of government, should be encouraged and should receive prompt agency consideration and reply. This should occur whether they take the form of formal petitions for action or not.

Internal investigative conclusions may serve to identify a problem, although to date there has been little such activity. Increase of agency research and data analysis may provide a technical mechanism for anticipatory regulatory action.

Problem Definition Before Action Is Vital and Often Overlooked

The agency must carefully assess indicators of a problem, segregating causes from results and endeavoring to state the problem in writing in the narrowest and most specific terms possible. Few significant problems have single causes, and every effort should be made to identify and isolate multiple causative factors.

In attempting problem definition, the agency should openly and frequently confer with all knowledgeable parties on problem definition. Regulatory problem definition is a public function that should involve everyone affected. It is unlikely that any agency has within its halls all expertise necessary to success; seeking outside advice very early in problem definition should be a required part of the process.

If there is a lack of technical data, spend the money for performance of essential research. In the absence of data, do not guess.

To obtain the broadest involvement in problem resolution, the agency should publish its statement of findings in problem definition.

Only After Satisfactory Problem Definition Should There Be Tentative Selection of Alternative Solutions

In examining and selecting solutions, the following steps should be included:

1. Separate symptoms from causes and list symptoms to be eliminated.
2. Isolate all alternative problem resolutions that would remove those symptoms.
3. Recognize that not all issues can be resolved by regulatory action. Regulation by the agency is not a panacea that necessarily will cure all ills. In addition, not all regulatory action takes the form of issuance of regulations in the Federal Register. Many actions within the lawful authority of the agency can affect the parties in interest, without a single regulation appearing in print. Examination of non-regulation altenatives is essential to a quality regulatory program.
4. Encourage legislation or action by other individuals, organizations, or agencies--particularly by the agency that has defined the problem, even if those others are not within the direct regulatory jurisdiction of the agency.
5. Evaluate the effectiveness of alternative solutions, individually and in combination. This should be done in advance of selection, not as hindsight to justify selections already made.
6. Evaluate the estimated economic and social impact of alternative solutions. Past agency attempts to skip this evaluation or postpone it until later in the process should be avoided.
7. Early in the process, directly solicit views of affected parties, including trade associations, labor groups, and city, state, and regional governments, at early stages in identification of alternative solutions to the defined problem. Solicitation should take more forms than just that of Federal Register publication.
8. Remove the present aura of secrecy surrounding regulatory actions. Secrecy is often a bureaucratic mechanism to hide incompetence from criticism, and it benefits no one.

Alternative Solutions Identified by the Agency Should Be Published

Describe more than one solution if it appears that more than one will work. Seek comment on effectiveness, impact, and timing. Another publication will not hurt, and something might be learned.

Adopt the Chosen Solution

After public discussion of the alternatives, select and propose the chosen solution(s) in the Federal Register for additional comment. Delays caused by several publications are no greater than those already experienced, and the reasons are more sound. Give great detail on why the chosen proposal has been selected over others.

Consider any new ideas and facts that may be submitted, and then adopt and implement the selected solution(s). The process of adoption should give a lengthy and detailed factual explanation of the problem, the alternatives considered, and the rationale supporting the action taken. This detail serves to facilitate interpretation and implementation of the new approach and to provide a mechanism by which to evaluate the intent and success of the measure in the future. Decisions based on claims of agency experience or general impressions are insufficient to support any regulatory action.

Careful Consideration Should Be Given to Selection of Mandatory Effective Dates

In establishing mandatory effective dates, organizational slowness should be considered. Bureaucracy is not limited to government. Time necessary for implementation must include time for thorough government and industry employee training. For example, at most two people in the agency understand the latest massive revisions to hazardous materials regulations well enough to explain them, and effective training for agency personnel is not in sight. No employee who has not been trained on a given matter should be allowed to talk about it outside the agency.

Existing agency training programs are too enforcement- and inspection-oriented; they are inbred to the point that errors and omissions are perpetuated. The agency should contract with professional educators to train its employees and limit the agency to nontraining tasks.

The effective date also must include time necessary for administrative adoption by related regulatory bodies, such as state governments. There is no point in encouraging any state or local government to adopt the federal rules if there is no consideration of that adopting agency when changes are made in the federal rules. Although simple cross-reference of the federal rules can avoid this, the administrative procedure acts of many states prohibit

such shortcuts and demand that specific rules be reprinted in state registers. This reprinting, particularly if it involves revision of existing provisions, is a time factor currently not considered in the federal regulatory scheme. It should be.

The Adopted Solution Should Be Made the Target of Publicity and Training

Although agency-operated training programs are not necessary, government encouragement of effective training or new regulations is essential. This should be done through grants to professional educators, not by federal employees. Grants may be given to universities and others professionally competent to instruct, preferably on a wide regional basis with some consistency between programs.

Enforcement of the Adopted Solution Is Essential to Assure Awareness and Compliance

Enforcement is an essential element in an effective regulatory process, and total, uncommunicating segregation of regulatory and enforcement functions is an error. Close coordination and cooperation between those who select regulatory actions and those who enforce them are vital. If the regulation is properly aimed to solve a safety problem, then enforcement of that regulation is an essential element of its implementation. There is little doubt that requirements highlighted through enforcement are stressed in company compliance efforts, and this energy must be harnessed to achieve the safety intended. Enforcement should be coordinated with regulation and, after a full period to allow for implementation and after enhancement of awareness through education, vigorous enforcement, and publication of enforcement efforts, should be undertaken.

Enforcement programs that are not given subject priorities correlating closely with actual accident experience or regulatory efforts in problem-solving are merely revenue-producing measures that make no improvement in safety. This has been true of much hazardous materials enforcement to date.

On the topic of enforcement generally, it is clear that the current transportation agency program is not working. Centralization of the function, or at least unification of procedures, appears warranted, so that the penalty suffered by a respondent does not vary due to the affiliation of the inspector who makes the charge.

In enforcement, as in other aspects of regulation, some quantitative guideline is essential to preclude arbitrariness and inconsistency. Today penalties vary by mode of transit, by modal affiliation of the inspector, by procedural avenues selected, by the personnel assigned to the case, and by their mood at the moment. The current system is purely subjective with any relation to seriousness of the offense often just coincidence. A specific weight must be assigned to statutory factors such as the nature of the offense and the culpability of the respondent, whether the offense occurs in highway, rail, or the other modes of commerce, and regardless of the attorney assigned to the case or his or her attitudes.

An enforcement program that thrives on cases that are easy to prove, regardless of their correlation with safety, is a disservice to the public. As a revenue-producing measure, it is ridiculously inefficient, and it certainly cannot be justified as a safety program. Selection of minor requirements and assessment of small dollar amounts on the hope the respondent will not undertake the expense of resistance also disserves to the public, for the same reason.

A vigorous enforcement effort that seeks significant penalties to deter future noncompliance with significant requirements by the respondent and others necessarily results in requirements that are more soundly based and more easily understood. The current program, avoiding the hard cases because the regulations are unclear, is not serving one of its vital functions--achievement of greater public safety through improvement of the regulations.

Effectiveness of the Selected Solution Must Be Periodically Assessed

Auditing of the program can be done through independent investigation, analysis of incoming incident reports, agency investigations, and other public processes. It is vital to determine whether the solution that was selected is being successful and, if so, whether some less severe mechanism might also succeed. If not, the process must begin again, with new experience blended with previous considerations to select new solutions. Periodic review of all regulatory efforts should be undertaken to minimize the economic burden on the public and to assure that the best solutions are implemented.

PART 3: COMPLEXITY OF HAZARDOUS MATERIALS TRANSPORTATION REGULATIONS (D.A. Boyd)

For a number of years, perhaps more than 10, numerous suggestions and recommendations have been made by various groups and persons that the hazardous materials transportation regulations should be simplified or made less complex. For example, the 1969 report of panel 3 at the 1969 Airlie conference recommended that "as an initial step, immediate efforts be made to simplify the existing regulations." In the same report, the following statement was made: "The secondary mission consists of simplification and condensation of present regulations to a more realistic and workable document."

In the intervening years it appears that little progress has been made toward achieving the goal of simple concise regulations for the transportation of hazardous materials. The Transportation Research Circular 219 listed the 10 most critical issues in hazardous materials transportation. The circular noted that DOT's hazardous materials regulations are "too complex."

TRB Circular 219 offers two solutions to the problem. The first solution would require publication of digests of the regulations (although it is not clear who would compile them or where they would be published), which would summarize the most pertinent parts and state them in language designed to be as readable as possible. At first blush, this solution appears quite reasonable and simple. On more complete analysis, however, it appears likely that this solution would create problems as confusing as the existing complicated regulations. Any attempt to summarize the present lengthy regulations (some 1200 pages) would require substantial manpower and a great deal of insight and effort. The end result would no doubt be a dual or parallel set of regulations that would duplicate the existing rules. Furthermore, in any controversy or question or even an interpretation it would be necessary to refer to the actual regulations; thus, it is quite possible that summarization of existing regulations would actually compound the problem.

While the initial effort would be substantially greater, it would appear that a broad program for revision and simplification of the existing regulations would be of more benefit to the many people

involved in the transportation of hazardous materials and ultimately would benefit the public in general. Simple, clearcut but no less demanding regulations would enable people to be occupied with safety performance rather than preoccupied and confused with complex and sometimes conflicting requirements. In fact, it is quite possible that easily understood regulations would result in better compliance. That was the conclusion of the National Transportation Safety Board (NTSB) Study of Noncompliance with the Hazardous Materials Safety Regulations (August 3, 1979). In fact, one of the principal recommendations of the NTSB calls for expediting an ongoing DOT program of evaluating every hazardous materials regulation with the objective of revising each regulation in such a manner that the persons who need to use them on a daily basis can readily understand them.

Specification versus Performance Standards (Exemptions)

Most of the requirements for hazardous material containers are set forth in the regulations with specific detail concerning the materials and manufacturing process. For example, the detailed specification standards for hazardous materials containers in the existing regulations (Part 178, 49 CFR 178.0-178.350) are quite voluminous, filling approximately 400 pages of the Code of Federal Regulations. The specifications cover such containers as carboys, cylinders, drums, boxes, bags, and portable tanks.

In 1968, the Hazardous Materials Regulations Board published a notice of its intent to substantially revise the regulations, and one of the major parts of the proposal was to "state the container requirements in performance standards rather than manufacturing specifications." (A performance standard prescribes what a container must be capable of doing after it is built, but not how to build it. No matter how it is built, any container that can meet the performance requirements would comply with the regulations.)

The 1969 Airlie conference concluded that "establishment of a performance standard approach is feasible." The conference proceedings also noted that "the primary mission is revision of regulations to reflect, insofar as practicable, a performance standards system orientation."

TRB Circular 219, when proposing solutions to simplify the regulations, suggested that the regulations be made less complex by converting the present hazardous materials packaging regulations from detailed specifications to performance criteria. The circular suggested that creativity is stifled by the present regulations, which dictate design and similar matters in great detail. An advantage to performance standards (as contrasted to specification standards) is that such a philosophy would in certain areas bring the U.S. Hazardous Materials Regulations closer to the United Nations packaging philosophy.

In this connection it should be noted that the U.N. Committee of Experts has recognized the probable impossibility of accomplishing harmonization (among the various nations) of design standards for hazardous materials containers and has recommended performance standards as an alternative.

Exemptions

Since the existing regulations are specification-oriented with little leeway for deviation, it is necessary to have a procedure whereby some innovation can be authorized. This is accomplished by the exemption procedures in Subpart B of Part 107 of Title 49 of the Code of Federal Regulations, which makes it possible to obtain administrative relief for departure from the regulations if the departure will provide equivalent levels of safety, or levels of safety consistent with the public interest and the policy of the Hazardous Materials Transportation Act (49 CFR 107.101). It appears reasonable to expect that if the regulations were more performance-oriented than they are, it would not be necessary for the MTB to issue as many exemptions as are currently in existence. As of October 1980, some 924 exemptions were outstanding for departure from the regulations. At the present time there are approximately 1200 exemption applications filed with MTB annually (this includes new exemptions, "party-to" exemptions, and renewals). It seems obvious that the processing of such a large number of exemptions that are made necessary under existing regulations might be substantially reduced if the present regulations were more performance-oriented.

A substantial amount of MTB professional staff time is spent processing exemptions. Even if staff time cannot be reduced substantially, a change of focus from design to performance standards should reduce the need for exemptions from the existing regulations.

Enforcement Versus Compliance

A review of the regulations indicates that some regulations are written from a legalistic point of view. It has been readily admitted that such regulations are written with the intent of making enforcement of violations of such regulations as successful as possible. Such a philosophy may stem from a view that at least some persons involved with the regulations will make little, if any, attempt to comply with the regulations, so they must be written to be "violation proof." This idea seems to prevail even if such an objective results in complex, hard-to-understand regulations.

The question that might be raised is whether it is appropriate to assume that shippers and carriers do desire to comply with the safety regulations (as contrasted with noncompliance) and, therefore, the regulations should be written in a clear, concise, and uncomplicated manner that would be beneficial to those persons to whom the regulations apply. Such a change in philosophy might be characterized as enforcement versus compliance.

If it is true that the existing regulations are so complex that many people subject to them cannot interpret or understand them--and as a result there is noncompliance with the regulations--one avenue to achieve better compliance would be to simplify the regulations. In view of allegations that there is substantial noncompliance now, it would seem to follow that simplified, more easily understood regulations would lead to substantially better compliance.

Conclusion

In conclusion, it is submitted that simplification and clarification of the existing regulations are the cornerstones to eliminating or at least moderating some of the criticism of the hazardous materials regulations. If the regulations were easier to interpret and understand, the training required for persons handling hazardous materials could also be simplified and accomplished in a shorter time. Simpler regulations should also enhance compliance, because the persons handling hazardous materials could better understand the regulations. Finally, less complex regulations coupled with more perfor-

mance-oriented specifications should lead to fewer exemption applications. Although the task is formidable and will not be easily accomplished, the goal of simplified, less complex hazardous materials regulations deserves the support of all persons involved with the transportation of hazardous materials. The time is ripe for concerted action rather than more discussion and studies.

A Question of Training

Arthur C. Bensmiller

During the National Strategies Conference Steering Committee meeting in Chicago, several questions arose concerning training. I believe it would be beneficial to state these questions, then respond to them from a trainer's point of view; they could be a valuable basis for further thought that may provide a meaningful list of issues from which a national plan for training could be developed.

How can we reach the millions of response persons and the general public who need some kind of mass education?

The term "hazardous materials training" is very broad. It is so broad that it is unintentionally misunderstood and misapplied. For example, let's look at the word training. I will discuss what it is later, but for now let's look at what it is not. Training and education are different words and have different meanings. In my opinion, DOT is not functionally responsible to educate the general public. In fact, I also maintain that it is restricted from such activity under training provisions incorporated in the Civil Service Reform Act. To illustrate, colleges and similar institutions educate, but DOT's Transportation Safety Institute gives safety training.

DOT does have functional responsibility to provide safety training in the transportation of hazardous materials. Such training must complement and improve an understanding of how to apply the provisions of the regulations. Good training should increase the students knowledge and skills enabling them to perform specific safety-related job functions more effectively and efficiently. In this case, the students are those from the private and public sector who are responsible for the safe transportation of hazardous materials. That is the real training need. Training of the general public would not be a valid option, but merely a perceived (not real) training need.

What is the training need?

This question also implies who is to be trained and from this we can determine what the need is. Perhaps one way to look at the question is to determine who has a job function that requires some knowledge and skill in the safe transportation of hazardous materials. Then we need to ask, Can they accomplish that job function without training? If they can, then a training need does not exist. If they cannot, then there is a need for training. In the complex area of hazardous materials transportation, the obvious answer is that we have a need for training, not only for entry level but for ongoing and/or specialized training. Perhaps the most critical need of all is for planners and those who have control over commitment of resources (funds and manpower) to understand job-oriented or job-related training. Training in hazardous materials transportation does not mean a thing unless it is tied to a specific job function. For example, if one of a firefighter's job functions is to respond to a transportation accident involving leaking or burning hazardous materials, then it would not be appropriate to give that firefighter training in the complex detailed accident prevention regulations aimed at inspection and enforcement. Yet, in spite of this basic training concept, many states and federal counterparts simply lump all of their various people together, i.e., public service inspectors, environmental inspectors, firefighters, federal inspectors, etc., and proclaim the need for hazardous materials training. From a training point of view, a clear distinction must be made in job-oriented training needs. What is it that we want the person to be able to do? If we know that, then we can start on what the training need is. The most basic and pressing issue for state and federal planners is to recognize at least two categories of differing job functions and consequently two training needs. This is a fundamental issue and must be understood. Two different training needs are accident prevention regulatory compliance and emergency response training for after-the-fact accidents. Accident prevention regulatory compliance training would generally be needed by those who have to understand and use the regulations for shipping and transporting hazardous materials and for those who check for accident prevention regulatory compliance, i.e., personnel from industry shippers and carriers, government agencies such as special state inspection and compliance units, and federal inspectors such as those from FHWA's Bureau of Motor Carrier Safety Investigators.

Emergency response training would generally be needed by those who are responsible for the various operations in an emergency and would include but not be limited to highway department maintenance personnel, law enforcement officials, firefighters, emergency services (Civil Defense), and emergency medical personnel. The transportation public has a real (not perceived) need for job-oriented training in the transportation of hazardous materials.

What are the different kinds of training and their effectiveness?

DOT uses several proven methods of training such as established recognized training centers, selected universities that have technical capabilities, computer-based instruction, computer-managed instruction, established learning centers in cooperation with industry associations, DOT training academies and/or institutes, talk-back television courses, and correspondence courses. These training methods are used separately or in combination, and with various established methods of presentation such as lecture, movies, television, slide/tape, programmed learning, and others. Whatever method is used, the goal to strive for must be performance-based (oriented) training. One way to approach it is to ask the question, What is the training objective or outcome? What is it that the learner (student) should be able to do after receiving the training? Training objectives (or outcomes) describe performance (or behavior) because an objective is specific and because performance (or behavior) is what we can be specific about.

The effectiveness of performance-based training can be evaluated. In other words, the increase in knowledge and skill in the learner can be measured. The $64-question for the decade is, Can training program effectiveness be measured? Another way of saying this is can we reduce death, injury, and

property damage in the transportation process by training? The answer is yes. Time and space do not permit me to elaborate on this, but suffice it to say that a recent controlled emergency response training program conducted by the Office of Civil Defense in Oklahoma reduced the yearly average of response personnel injury/death in hazardous material transportation-related accidents by 90 percent. Evaluation of the effectiveness of accident prevention training is more difficult. I am not aware of any final program evaluation in this area; however, I am familiar with one under way. My opinion is that it will be increasingly difficult to have safety programs (including regulatory requirements, training programs, etc.) approved during this decade unless we can evaluate total program effectiveness in terms of reduced death, injury, and property damage. Any safety program, including training, that cannot be evaluated in terms of reduced injury, death, and property damage should not receive any support.

Who would enforce whose regulations?

Enforcement of federal regulations is established by law. That is, an enabling congressional act or statute authorizes an administrator to regulate certain things. The regulations written under the authority of that congressional act have the weight and the power of the acts' penalty provisions behind them. Many states have adopted the federal hazardous materials regulations in whole or in part (adopted by exception). When adopted by a state, the federal regulation may be coded differently but would be enforceable by state agents. This is generally done on surface transportation by a public service commission or department of public safety personnel. When adopted by states, the regulations are enforceable on both intrastate and interstate surface carriers. The question is not one of who would enforce but rather who has the authority by law to enforce regulations.

Who designs curriculum and certifies graduates?

Curriculum is generally more successful if developed jointly by training specialists and experienced field personnel. However, it should be noted that training plans must be developed first. The training plan establishes the need for training (what is the problem). It then identifies what the attendees' job functions are. Then the training or course outcome (objectives) is very specifically listed--i.e., what is it that the student should be able to do after the instruction is given. The training plan is the contract and perhaps its most important function is that of agreement between the government agency that has the program authority and responsibility (including resource control) and those who provide the training. As for certification, I believe that inspectors at all levels of government who inspect and enforce the complex requirements of hazardous materials regulations related to accident prevention must be certified as to performance. This certification should consist of passing an approved training program and demonstrating skills on the job for a specific period of time. Again, the certification program must be administered by the government agency that has program authority and responsibility.

What are the cost considerations of training?

Poor training is no bargain at any price. As a general rule, you get what you pay for. Have your people received performance-based training in the transportation of hazardous materials? A decade plan suggests sound planning and continued areas of emphasis. A comprehensive plan with training as an area of emphasis suggests continuity. On-again off-again training programs are costly and expert hazardous material managers are impossible to recover from previously discontinued training programs. Organizations desiring to send personnel to distant training locations face constraints in the form of limited travel budgets and increasing travel costs. A need does exist to use training resources more effectively and efficiently to accommodate organizations whose personnel need training. One model to look at is the one developed by EPA. EPA uses a distributive training system under the direction of a central training facility with excellent results. DOT could conduct training under the supervision of its training arm for state and local governments and industry personnel. Certain training would be accomplished under contract with established training centers and universities to develop the capability of training at the centers and universities and at other locations as required. In cooperation with the transportation industry, this highly versatile capability associated with computer-based instruction and computer-managed instruction could be used. This would provide access to many contract learning centers throughout the United States and would adapt quickly to a fast need for teaching regulatory requirements in areas such as accident prevention and also in teaching transportation emergency response procedures. Also, terminals can be used at any location that has a telephone line to provide a wide distribution of training capability.

Segment I—Training Concepts Assessed

John Granito

Training usually is seen as planned learning activities designed to bring about changes in the behavior of the learner. In other words, we train people to do what we think they should in given situations. Typically we want personnel to perform defined tasks under specified conditions and in certain circumstances, so training directors work out carefully detailed projections of future situations and the sets of respondent behavior that experts believe is most desirable. Training programs should be based to a large extent on experts' predictions of future situations and problems so that students will be trained to bring incidents to a satisfactory resolution.

The ability of the expert to predict future problems depends on such skills as the ability to understand history, to analyze technical data, and to generate insights. An example is the well-known prediction of experts that exploding horizontal tanks usually burst at the rounded ends, and so attacking nozzle teams should approach from the direction of the sides. In that common lesson, training experts have predicted what is likely to happen--based on history and technical knowledge--and they attempt to modify the random behavior of emergency forces so that, through training, nozzle attack from the sides become habitual.

Almost all problems of training stem from that seemingly simple definition. Those who invest in training want to be sure that future situations will be met by "approved" behavior on the part of the trainees. Experience with hazardous materials

training points out the importance of the following concerns:

1. Training goals, or accurate prediction of future problems;
2. Reality-based curriculum, or sufficient attention to important details, logically presented;
3. Methods of teaching, or presentation of knowledge in interesting ways;
4. Performance-based instruction, or measurement of student progress;
5. Standardized instruction, or assurance that all students everywhere learn the same approved behavior;
6. Certified instructors, or guarantees that the teachers are competent;
7. Accredited providers, or assurance that the training school measures up to standards;
8. Certified or licensed graduates, or guarantees that students will behave as they are supposed to; and
9. In-service training, or provision for graduates to be updated.

The magnitude of these concerns implies a total system and this is what training should be. Unfortunately, the pressure for quick results often forces the operation of only a part of the training system, thus reducing the chance for long-term success. There may be conditions that call for "quick and dirty" training approaches, but the history of hazardous materials difficulties points toward a more thorough and comprehensive approach. Before more history passes, should we not envision a more integrated, comprehensive, and carefully planned approach to training? Many appear to agree that the time is ripe to improve training, but often the debate finds fingers pointing in other directions. Since many of the concepts important to a total training system are controversial and debatable, listing them, instead, as questions may help to stimulate thoughtful discussion:

1. Which personnel involved in hazardous materials, if any, should be subject to required training?
2. Which organizations should be recognized as the technical experts and arbiters for purposes of curriculum design?
3. What tie-ins and feedback loops should exist between field experiences and training designs, and how should they be maintained?
4. Which methods of instruction and technological aids should provide the teaching base, and in where and what kinds of facilities?
5. Which organizations, if any, should have the responsibility to accredit and standardize training curricula?
6. Should hazardous materials training instructors be certified and, if so, how and by whom?
7. Should students who complete training programs be certified and, if so, how and by whom?
8. Which organizations should offer hazardous materials training, should they be accredited, and, if so, by whom and under what conditions?
9. What should be the priority for personnel training, and what time line should be established?
10. Should a broad program of public education be mounted and, if so, how and by whom?

The results of good training are rather self-evident in terms of life and property safety, reduced costs, and improved public relations. However, the problems of designing and carrying out high-quality programs may be complex, involving not only the above concerns but also considerations of learning theory.

Oftentimes "education" is seen as learning that enables new situations to be handled, while "training" provides what is needed to carry out standard procedures. Therefore, different levels of training must rest on different kinds of education. Workers may be trained to perform the sequence of functions for operating a loading dock, but if something goes wrong, more and more understanding of principles (education) is needed as the problem escalates. Personnel are customarily trained to carry out standardized sequences, and this is effective to the degree that emergency scenarios have been anticipated by the experts and built into the training program. Difficulties arise, however, when scenarios in the real-life situation have not been anticipated.

Since a person's ability to deal with new, unanticipated change heavily depends on the ability to reason and draw valid conclusions, blocks of education, if not already present in the individual, need to be factored into the training design for persons such as supervisors of loading facilities and officers of emergency response teams, who might be expected to face the unexpected. Education that supports technical understanding and skill and that enables the individual to jump past what the instructor explained and trained for is especially important.

The challenge to training planners and managers is twofold: determine which blocks of education (in science and technology, for example) provide a first-level foundation for the piece of training in question, and decide which types of students need to master those blocks. To use fire department personnel as an example, firefighters need training to handle special foam equipment and to avoid errors in safety. Company officers need to supervise the firefighters, plus they need enough technical education to determine which type of foam is the preferred agent of choice. In addition to all of this, chief-level officers need to be able to calculate how many gallons of foam will be needed to successfully attack a particular volume of product contained in a storage tank of certain diameter.

Even those who are proponents of training sometimes neglect to consider that some training will be ineffective if students lack the education to extend thinking beyond what is presented in the course.

The second challenge, as already noted, is to modify student behavior in future situations where supervisors will not be present. If personnel would and could do all the right things, we would not need to train. When people encounter pressure to change, they typically consider their personal values, their personal gain, and the amount of inconvenience and difficulty the change will cause them. Behavior changes will become more permanent, more habitual, more repetitive, if the worker places value on the change and sees reward as a result.

Attitudinal change is probably basic to the kind of behavioral change we want in situations where safety is critical. The driver who is consistently safe, even in the absence of supervision, values the situation. Thus, training of personnel in the hazardous materials field must often aim at changing attitudes and values as well as the acquisition of knowledge and skills. Care and safety are often functions of attitude, even when excellent training is available.

TYPES OF TRAINING

There are very few jobs in the hazardous materials field that do not require both pre-service and in-service training. Pre-service training prepares people to carry out the basic tasks safely, and

in-service training aims at improved performance and updating. There are important differences between the two, not only in the level of material presented but also in the motivation of the individual student. Motivation to learn often is directly related to how much the student believes he or she already knows. The conventional wisdom that "a little learning is a dangerous thing" may have validity if a student views in-service training as unnecessary, boring, or even degrading. There even may be disagreements about what constitutes pre-service training, as with firefighters who fail to see the necessity for in-service training as hazardous materials responders, or truck drivers who are experienced, but not with placarded cargoes. If their in-service training is presented at the pre-service level, they may be antagonistic, believing that their previous experience will be sufficient.

Pre-service training may be easier to conduct because beginners are entirely new to the business and often are eager to become involved. But even here most people believe that they have some relevant experience. Thus, almost all training in hazardous materials fields is perceived by participants as some degree of in-service training, and curriculum designs and instructional styles should recognize this danger. This means that each individual student will enter the training class with a different set of attitudes, knowledge, and skills. Pretesting and individually paced instruction will get better performance results in the long run than will the easier and less expensive group instruction.

In-service instruction may deal with review of seldom used skills, such as use of emergency procedures; with the learning of brand-new knowledge and skills, such as how to contact and work with national response teams; or training on new equipment and with new procedures just incorporated into the organization. Specialized training needs to be distinct from standardized training, and carefully made decisions are needed as to which students are selected for it. Attitudes and aptitudes need to be considered. For example, there is a difference between first responders who set the mechanism in motion and the response teams who are expected to function with a mastery of the details. In-service training also must recognize the frequency with which students encounter reality. If skills are not used often in real situations, then simulations are necessary on a continuing basis. Unfortunately, the ability of individuals to remember and draw on previously learned knowledge and skills varies greatly. In high-quality, in-service training programs that variation is recognized. In quick-and-dirty programs it often is not.

To illustrate further not only the complexity of design but also the critical nature of in-service training, consider the differences often encountered by response teams accustomed to more typical incidents. The following operational areas encountered at a hazardous materials incident may well differ significantly from what public safety groups have experienced and trained for previously:

1. Incident magnitude,
2. Compounded incidents of long duration,
3. Technical assessment needs,
4. New response patterns,
5. Incident stage advancement,
6. Special skills,
7. Multiorganizational response,
8. Legal issues, and
9. Termination procedures and health concerns.

Not only must response forces learn new and appropriate behavioral response patterns, but they must unlearn behavior already assimilated through earlier training and experience. In actuality, they must keep both types of behavioral responses on ready file and be able to apply one or the other according to the dictates of the incidents. That kind of complexity is a challenge to the powers of typical training programs.

PROGRAM PLANNING

Comprehensive training begins with planning, and planning should begin with those who are in a position to see the behavior patterns of workers in field operations. Performance-based training usually is designed by first identifying the desired results and then working backward toward a design that will move the individual's starting point (which needs identifying) to the desired new behavior. The design needs to take into account three major variables: (a) the kind of knowledge, skills, and attitudes desired in the graduates; (b) the learning styles and abilities of students who will attend the course; and (c) the methods of instruction that will best match up the students with the curriculum. Also needed is a way of measuring whether each student has changed his or her behavior as desired. This last step is the core of performance-based instruction, and sometimes its application points to the need for student retraining or program redesign, which adds to the expense but will increase cost-effectiveness in the long run.

The responsibility for planning hazardous materials training programs should rest with a team comprised of field operations experts plus instructional experts. When either side plans alone, the tendency is to produce either sound behavioral objectives but without productive ways of attaining them or valid instructional approaches unfortunately aimed at inappropriate objectives. One possible way of assembling good instructional teams is to have concerned regulatory agencies bring together experienced field operators who desire improved and safer procedures with curriculum designers who have had success in working with similar kinds of students.

Comprehensive hazardous materials training implies that each group involved will be trained before work begins and periodically thereafter and that each important aspect of hazardous materials work will be analyzed to be sure an appropriate training program operates for it. The typical approach to this task is the construction of a task and worker matrix where major tasks are plotted against various worker types. Each intersection indicates a component of a comprehensive training program for a worker group. Emergency response teams serve as an example. One axis of the matrix lists types of response forces, such as police, public works, fire suppression, emergency medical, and environmental protection. The other axis lists major response tasks, such as evacuation, plugging, cooling, triage, diking, etc. The positive intersections outline which teams need which kind of training. One advantage of regional and national planning is that more cross checking occurs, and there are fewer chances of task-worker intersections being overlooked or neglected. Also, more comprehensive training is possible through a greater mix of participants and a sharing of resources. Local expertise is often lacking, and the ability to produce a valid curriculum, teaching aids, qualified instructors, etc., is limited. To conduct adequate hazardous materials training, local units must be plugged into the circuit of hazardous materials experts. This is not possible for the thousands of local units that need training, but regionalized-na-

tionalized delivery systems bring the greater strength to the smallest areas.

Key questions relate to the degree of trade-off necessary between local autonomy and larger organizational or governmental control and between broader-based resources and increased overall costs. Training costs money for both the private and public sectors. Government-mandated training for the public sector, such as police and fire, typically is paid for with tax dollars by a level of government. Mandated training for private-sector employees often is the financial burden of the private sector. At times, each side blames the other for increasingly costly incidents and insists that "the others" be trained to do the job or bear the cost of training the other team. In addition, some private industries are providing not only their own response teams but also training for public-sector personnel such as volunteer firefighters. Already designated training agencies such as the U.S. Fire Academy (FEMA) might well take on additional training responsibilities at regional levels.

It appears increasingly evident that the costs associated with incidents exceed the costs of training, but unless the training is performance-based and evaluated, costs per unit or per student trained are fairly meaningless. Three dollars per person for poorly trained students may prove to be more costly than double the price for well-trained people.

Although the possible transfer of training costs to other sectors is of short-term interest and it may be enticing to contemplate only modest training levels on a national basis, the long-term view must compare training costs for prevention and incident responses with the consequences of reduced training. The best response to a comprehensive problem would appear to be a comprehensive answer.

TRAINING PROGRAMS

Whoever manages a training program has responsibility to performance measurements. The issue of accountability is clouded, of course, by the many variables that come into play in real situations following the training. No teacher wants to take responsibility for graduates' performance in real life, although those who foot the bills do tend to hold schools responsible. Do we want a degree of accountability for those who provide hazardous materials training?

Standardized curriculums tend to help pinpoint weak spots in training because theoretically they eliminate one important variable. If experts identify sets of respondent behavior that are universally appropriate, why not standardize that content into the teaching outlines? Opponents cite local, regional, and circumstantial differences in real situations that necessitate particularized training, but the weight of the argument seems to fall on the side of standardization.

More complex are the cautions raised against the type of standardization that ignores differences in type of student groups and in individual students within the same group. There is a difference between saying we seek standardized behavioral outputs brought about by individualized training inputs and saying we seek standardized behavioral outputs brought about by standardized training inputs. Instructional methods tied more to the curriculum content than to the student's learning patterns are generally less effective. Careful definition must be given to standardization if benefits are to bless our efforts.

CERTIFICATION

The best instructors appear to be broad-based technical experts who can take each student as an individual learner and move from the known to the unknown, with appropriate attitudinal changes in students accomplished as well. When we seek these paragons we find them in short supply. Perhaps we should invest in training the trainers--i.e., in creating good hazardous materials instructors through a conscious regional or national effort. After all, the technical expertise concerning the content of hazardous materials is available, as are experts in the teaching-learning process. Good instructors, who take responsibility for student learning as well as teaching, can be produced; how to do this is scarcely a mystery. The FEMA instructor training course and other such courses could be modified to produce the specialized teachers we seek. If these train-the-trainer courses were standardized and performance-based and if graduate instructors were upgraded and refreshed through their own in-service training, we would indeed have certified instructors. The addition of a certified instructor to a standardized curriculum would appear to add strength to training programs.

A reasonable next question, then, is what should happen to a graduate who does not behave in the prescribed way after training? Performance standards can be established, of course, and sanctions imposed for those who do not meet them. Certified instructors who produce relatively large numbers of graduates who do not do well on the job could be questioned. Courses with poor records of graduate performance could be checked. The world of education is full of such examples, from trade schools to medical schools. Indeed, one mark of a profession is that the policing of standards and the exercise of sanctions is done by professional committees in addition to, or instead of, regulatory agencies. Just how professional do we care to become in the hazardous materials training business?

Many of the concepts related to performance standards, trained instructors, accredited schools and training programs, centralized control, and standardized course content relate to certification. What are some relevant forms of it?

Certification is a guarantee that the person certified either passed an approved training program or actually demonstrated the learned skills and knowledge. There are vast differences in these two basic forms of certification. The former depends on a standardized curriculum, approved instructors, and an accredited school or program. It is assumed that a student passing through that combination can do a reasonably good job on graduation, and thus a certificate or license is issued, usually by a regulatory agency, at that time. This is sometimes called approved-program certification and is based on trust plus periodic reviews of the training program by the higher or regulatory agency.

The latter form of certification applies a standardized examination at the conclusion of a training program and prior to the issuing of the certificate or license. The examination may be written only, as in the bar examination, or it may require writing and the demonstration of skills, as in a nursing or pilot's examination.

Beyond this level of certification, the regulatory agency or professional group may require in-service training and/or the maintenance of certain performance standards. Emergency medical technicians fall under this type of standard.

Certification choices range, then, from a simple certificate of attendance to judgment of performance in the field by a federal or state inspector, or a professional standards committee.

IMPROVING TRAINING AND PUBLIC EDUCATION

The typical citizen seldom sees any reference to good safety records and prompt handling of hazardous materials incidents, or even very much about good preventive measures. Therefore, both the public and private sectors should consider a coordinated program of public education to both reduce the number and severity of incidents and to highlight the steps being taken to permit the relatively safe enjoyment of countless products. Telling each other about our good work and safety record is not achieving the goal of public understanding. Perhaps all organizations and agencies involved should pull together a set of goals for public education that reflect an accurate assessment of our national state of affairs.

It may be that the natural groupings of organizations--railroad, highway transporters, manufacturing chemists, public safety agencies, regulatory agencies, etc.--could establish a national consortium dedicated to preventive training, response training, and public education, viewing the task from at least a regional but preferably a national platform. Such a consortium could consider not only public education and the several critical training issues touched on here, but also such additional issues as improved training and public education technology and reduced program costs.

Segment II—Technical Training

Fred Halvorsen

Does a problem exist in the training of personnel to ensure the safe transportation of hazardous materials, substances, and wastes? Does the transportation of these materials present an unreasonable hazard to an unsuspecting populace because of training deficiencies in response forces? Are local officials adequately informed so that they can make logical and reasonable training decisions? Is better, more advanced training of all facets of the transportation industry the answer to the problem? Is there a problem at all? Who should do the training, and who should be trained, and in what?

In my estimation, many problems do exist and especially in certain areas of training for responding to hazardous materials incidents. However, equipment, techniques, and expertise are available to solve all existing and foreseeable problems if sufficient time, effort, and monies are expended. What is needed is not new or unique solutions, but redirection and reemphasis of existing resources, better guidance from responsible federal agencies, and, if beneficial change is to occur, commitment and involvement from federal and state officials at all levels of the problems confronting us.

CATEGORIES OF HAZARDOUS MATERIALS TRAINING

Basically, all training for hazardous materials can be divided into three major categories--prevention, initial response, and reflective response. Prevention refers to those actions of the industry and the regulatory authorities that seek to ensure that the product is properly classified, packaged, labeled, documented, and handled in transportation in a safe manner. Initial response refers to the actions of industry and the various local, state, and federal response agencies taken immediately after a hazardous materials accident or incident that seek to minimize and control the effects of the accident or incident. Reflective response refers to those actions that are directed at cleaning up, neutralizing, or mopping up the spilled material after the initial controlling response actions at a hazardous materials accident or incident.

Preventive Aspects

DOT through its MTB and four modal administrations writes and enforces the regulations that govern the classification, packaging, labeling, marking, placarding, and documentation of hazardous materials in transportation. The purpose of these regulations is to place the product in a package that will safely contain the product during the expected rigors of transportation. The federal agencies are extremely active in enforcing these regulations as well as in seeking voluntary compliance from the shipping industry. Civil fines up to $10 000/day per violation are possible and fines are used effectively throughout the industry to ensure compliance. Wide dissemination of fines awarded is accomplished by a monthly newsletter. Regulatory agencies also seek voluntary compliance from industry and some use fines only as a last resort. The U.S. Coast Guard, for example, has used on-the-spot compliance while holding up a shipment as an effective tool in many port areas.

Training inspectors for the preventative role is essentially familiarization with the regulations followed by on-the-job training and experience. Inspectors can be effective immediately due to the fairly low risk involved and the fact that questions can be directed to superiors or directly to the MTB. As the inspector becomes more experienced, he or she becomes more effective and can check for more involved regulatory aspects. More importantly, industry has been extremely successful in voluntary compliance and, in many cases, industry's regulatory compliance efforts are more effective than those of the regulatory agencies. It is also important to note that besides the federal agencies, many states take an effective preventative role.

Overall, the effectiveness of the preventative aspect, which is basically compliance with the hazardous regulations in 49 CFR 170-179, is good and the training received is adequate. This evaluation is based on the number of accidents that can be attributed solely to lack of compliance with the regulations--historically, very few accidents can be so attributable.

Transportation incidents involving hazardous materials apparently occur proportionally to the number of vehicles carrying hazardous materials compared with the total number of vehicles. In other words, the presence of hazardous materials neither adds nor detracts from the possibility of a transportation incident.

Initial Response Aspects

If a transportation incident involving hazardous materials occurs, the responding personnel are most often, if not always, those response personnel who would respond to any transportation incident. Under many circumstances, it is likely that the first indication that hazardous materials are present is when the response personnel recognize through labeling, placarding, shipping papers, or from released product, or are told by the operator of the transportation vehicle that hazardous materials are involved. Their actions at that point may be supercritical. An incident improperly handled can become a serious accident or a catastrophe.

Unfortunately, the training that the first response personnel has likely received is minimal, if

at all, in the area of proper response to a hazardous materials incident. The technical qualification of response personnel in larger cities is usually better than small volunteer units but, in general, the technical competence and background of the majority of local and state police and firefighters is generally less than adequate. Few localities are aware of the type and quantity of hazardous materials moving incidently by rail or highway through their locales. For that matter, many are not aware of the type and quantities of hazardous materials even stored or used in their geographic area. Most also are not aware of the implications of the various physical, chemical, and toxicological properties of hazardous materials.

It is important to understand that this is not an indictment of this response sector, merely an observation on which action can be based. Note that the vast majority of initial response personnel will undoubtedly never be involved in an incident in which a hazardous material is released. Note also that the vast majority of initial response personnel do not have the technical background, time, or inclination to prepare for all the potential ramifications of a hazardous materials incident.

Much of the ability to respond to a hazardous materials incident is based on experience and technical competence. Basically, we must be aware that a major education and training program will be a difficult and expensive objective.

Initial emergency response training is probably the least available type of training of all hazardous materials courses now available. The training usually is not offered at the location where it will be used, nor are persons who will be involved normally those who attend.

We must also question the training in light of the ability to use, hence reinforce, the education process. It is almost a catch-22 situation. The people who must be trained rarely use the training and because they do not use the training cannot be expected to properly apply the training in a real situation. Yet we are left with the uncomfortable fact that the initial response will be made and that the initial response personnel will undoubtedly be poorly prepared and unexercised in responding to hazardous materials.

Yet, the record is not unduly frightening. Hazardous materials incidents do occur and through great effort and frantic thought are fairly well handled by those who first respond. In many cases, with great personal risk, critical emergency decisions are carried out by initial response forces and potentially serious situations are corrected. Perhaps the worst is always expected when a hazardous material is released and the worst rarely occurs. In other words, we immediately expect the most serious consequences to ensue, even though improbably, and, when these dire consequences are not manifested, believe that the action taken was the correct action.

Personal risk to the initial response forces can be extremely high. Even if the material can be readily identified, the proper type of respirators, protective clothing, and detection equipment is not always available.

Reflective Response

Reflective response is the response by knowledgeable and experienced personnel usually after the initial response forces have reported to the scene. The "reflective" part of the response is simply that the personnel have been made aware of the situation at the scene, have been given the time to consider the situation (reflect), and can respond with some degree of confidence in their actions. Personnel in this category include chemical shipping industry personnel, cleanup contractors, carrier representatives, federal on-scene coordinators (OSCs) and their forces, and trained local and state response forces. These personnel are experienced, since most are familiar with responding to hazardous materials incidents. They have proper respiratory protection, contact protection, and detection equipment. A primary part of their job is to be prepared for such incidents and they can call on already established consultative services within and without their organizations for advice and council.

Once reflective response forces have reached the scene of a hazardous materials incident, they should be expected to direct or give advice to the initial response forces.

The training of the reflective response forces is essentially through experience, involvement in past hazardous materials incidents, and technical training in scientific disciplines such as chemistry, physics, and engineering. There is also a tremendous amount of interest in providing qualified experienced reflective response personnel. The shipper gains credibility, the carrier controls his own property and equipment, and the commercial cleanup contractor makes money. The level of training of such persons is considered adequate.

WHERE TRAINING DEFICIENCIES EXIST

The one aspect of emergency response training that must be addressed is obviously the training of initial emergency response forces. Such persons consist of state and local police and local firefighters. To a lesser extent, the emergency medical teams and local disaster control and emergency preparedness personnel can be included.

These people have not received the training spotlight, so to speak, for a number of reasons. They are not employees of the federal government and able to use its large source of funds for training. They do not respond to hazardous materials incidents as a rule, and it may be difficult for them to perceive that training is needed even if they recognize the training deficiency in this area. It is difficult, if not impossible, for them to find funds or time for the training especially where travel is involved. Unlike cleanup contractors, they are not in private business and can profit from EPA, Coast Guard, or industrial contracts for cleanup or mitigation of a hazardous materials spill.

In addition, the hazardous materials training community has not specifically directed training at this group. Such training is not profitable or intellectually stimulating. The persons receiving the training may not feel comfortable in a training environment. Very simply, the initial emergency response forces have been left out of the training picture.

SPECIFIC TRAINING OBJECTIVES

In the future, perhaps exotic and sophisticated training objectives can be generated for initial response forces. In the interim, however, there are a few objectives that could be implemented to improve initial response force capabilities.

Preplanning-Contingency Plans

Some format should be generated for a local contingency plan and/or preplanning for a hazardous materials incident. An excellent example is the Manual for the Control of Hazardous Materials Spills by Gunderloy and Stone. However, this manual is quite

complicated for a small organization. It is suggested that much simpler versions be prepared and given wide dissemination.

Hazard Assessment-Sizeup of Situation

The greatest need is undoubtedly for a simplified, easily understood method of rapidly estimating the overall hazard at a hazardous materials incident. There are a number of such methods. However, one method should be universally adopted and highly publicized.

Protection Objectives

Only a certain number of tools are available to response forces who respond to a hazardous materials incident. These tools include evacuation, use of water and foam, diking with easily procured local materials, and the like. Whenever an action is taken, it should be to consciously gain an objective. The objectives should be the protection of life, property, or the environment. This concept of establishing protection objectives and taking action accordingly should be a primary training goal.

Use of Outside Expertise

When a hazardous materials incident occurs, there is a need for accurate, easily obtained, concise information for use in decisionmaking at the scene. The National Response Center (NRC) and the Chemical Manufacturers' Association's CHEMTREC are good starts on providing outside expertise or technical advice. However, there are many initial response personnel who are not familiar with CHEMTREC or the NRC. The functions and capabilities of both the NRC and CHEMTREC should be widely disseminated.

On another topic related to the use of technical experts outside the initial response organization, there have been some incidents where local forces have apparently been reluctant to use outside expertise. The philosophy should be to encourage the use of whatever expertise is available to the maximum extent possible.

BEST MEANS OF TRAINING

Over a period of years, in various training situations from the classroom to simulated exercises, many forms of training have been used. Some comments on each follow.

Classroom Lecture

This form of training is best suited as an introductory means only or to present chemical, physical, and toxicological information. The student does not participate, retention is usually poor, and the entire success of the program is placed on the instructor.

Hands-On Training

This form of training can be used effectively to teach the operation of specific items of equipment. This is best suited for equipment such as respirators, protective clothing, detection equipment, patching and plugging equipment, and decontamination procedures.

Case Studies

An effective training method in class is to pose hypothetical incidents involving hazardous materials and have the students walk through a response. All aspects of the exercise can be considered, and the other students can comment and critique the proposed response. The instructor must be quite familiar with the proper response techniques to make the exercise successful.

Mock Exercise

The most realistic, rewarding, and positive training situation is a mock exercise in which all potential players in a hazardous materials incident in a given locale are brought together. The players are then given a hazardous materials scenario, or series of scenarios, and must respond in their real-life roles. The exercise can be played with or without actually responding--for management personnel, the action can be quite effective if only described; for initial response personnel, the exercise would best be done by using equipment that the initial response personnel would normally use. After the exercise, the actions could be critiqued and evaluated, and organizational and future training decisions could then be based on the critiques. Personnel participating in the exercise should include all persons who normally would be involved at all levels of management in the local and state response organizations. Normally these people do not interact operationally until an incident occurs, and, before effective and concerted action can occur, they must sort themselves out. The mock exercise gives them the opportunity to establish command and control relationships, both formal and informal, in a simulated no-lose situation.

The Coast Guard has been conducting such exercises for Coast Guard and EPA personnel for the past two years. This exercise, the On-Scene Coordinator-Regional Response Team (OSC-RRT) Exercise, is meant to improve command and staff relationships between the federally designated OSC and the RRT, the advisory board. Thus far, the OSC-RRT Exercise has been limited to hypothetical spills of oil or hazardous substances (where a federal OSC is required), but the exercise could be extended to spills of hazardous materials as well.

Some caution must be used in training using a mock situation. Care must be used during the critique phase in order to avoid embarrassing any person or organizations. The positive aspects of the exercise must be emphasized. The group conducting the exercise should have no vested interest and be completely acceptable to the participants.

Standard Scenarios

However training is done and by whom, there is one training objective that could be easily accomplished. This objective should be to cover standard scenarios of hypothetical hazardous materials incidents. Each scenario could be used to emphasize one or more points. Wide publicity of these scenarios could help prepare all hazardous materials response forces for most potential emergencies and make them much better prepared for an unexpected emergency.

Ten hypothetical scenarios with some considerations that could be gained from the scenarios follow. These are not meant to be all-inclusive, merely representative:

1. Gasoline tank truck accident on busy city street, tank ruptures, no fire: fire and possible evacuation, water pollution-federal OSC involvment, diking and damming problem, and traffic and crowd control;
2. Liquefied flammable gas (LFG) rail tank car derailment, involving mechanical damage to car: tank

car structural integrity assessment, tank car righting and rerailing, product transfer, and evacuation;

3. Water treatment plant, chlorine gas leak from one ton cylinder: protective clothing and respirators, evacuation, handling of leaking cylinder, and chlorine gas personnel casualties;

4. Large land storage tank, uncontrollable leak of oleum: personnel protection, diking and runoff control, and neutralization and cleanup;

5. Fire in pesticide and fertilizer warehouse: toxic vapors, toxic runoff, use of water, personnel protection and decontamination, and follow-up personnel monitoring;

6. Undamaged LFG pressurized storage tank, direct fire involvement: "BLEVE" potential, evacuation, uncontrollable situation, and commitment of initial response forces;

7. Abandoned chemical waste dump site, gas venting, liquid leaching problems: population hazard evaluation, federal involvement, cleanup potential and site control, and handling of unknown chemicals;

8. Ammonia gas release, many gas inhalation injuries: handling of casualties and evacuation;

9. Freight marshalling yard, freight container leaking unknown liquid product: product identification and hazard evaluation, shipper-carrier involvement, waste generation, and liquid containment and diking; and

10. Spill of persistent pesticide onto an environmentally sensitive area: groundwater survey and hydrology, cleanup and level of cleanliness, detection equipment, and long-term effect.

WHO SHOULD BE RESPONSIBLE FOR TRAINING?

As outlined previously, the segment of the hazardous materials response forces most in need of training is the initial response force. This force will not be trained by the states in most cases because money, time, and, in many instances, interest are lacking. If initial response forces are to be trained, a federal effort is indicated. Private industry has leaped into the training arena in the prevention category, mainly to take advantage of the training aspect of the Transportation Safety Act of 1974 training requirements and, more recently, all the training and education aspects created by the 311(k) fund of the Federal Water Pollution Control Act. Most recently, the new "superfund" legislation has created a tremendous training interest in the areas of toxicology, hazardous wastes, and long-term cleanup.

The lead role in hazardous materials training should logically rest with FEMA or DOT. As stated, DOT has set up an emergency response center at the NRC manned by the U.S. Coast Guard and does have some initial response forces in the U.S. Coast Guard but their role is somewhat limited geographically. DOT also has established a new emergency response coordinator in MTB, but this is just one person and seems more politically oriented than safety oriented. DOT also has seeded private regional training centers with modest funds. FEMA seems to be the most logical training agency, and it has established courses at its National Fire Academy. The consensus is, however, that this training is management oriented and difficult to obtain. Something new is needed.

SOME SUGGESTIONS FOR THE FUTURE

As a basis for discussion, the following suggestions are proposed:

1. That a single training center for hazardous materials training be established by the federal government, preferably outside of the Washington, D.C., area; potential locations are DOT's Transportation Safety Institute or FEMA's National Fire Academy (the initial thrust of this training would be toward training of initial response forces);

2. That the training center offer both resident and road-show type training;

3. That standard texts and lesson plans be prepared at the center for use in satellite courses;

4. That funding for the program be provided through a combined federal government-industry funding program such as that in the superfund legislation for spill cleanup; and

5. That the curriculum be established by representatives of interested federal agencies, interested state agencies, representatives of chemical manufacturers, shippers, and carriers, and most importantly, representatives of fire service personnel.

Emergency Response

Jeremiah J. O'Driscoll, Bob L. Hansen, and Robert J. Mesler, Jr.

The response to an emergency incident involving hazardous materials brings together the public- and private-sector emergency response teams under stress conditions. Each emergency response team has a differing purpose and motivation for being on the scene. The public emergency response teams are there to protect the public safety, health, and property. The transportation system emergency response teams are there to clean up and restore the system back to normal as quickly and safely as possible. The hazardous material manufacturer is there to provide advice and/or assistance in his or her areas of chemical expertise, public health, environmental concerns, and safety. With such diverse purposes, the need for preplanning and operational strategies and the recognition of decisionmakers are very important. The reaction of the initial responders, the public emergency agencies, is of utmost importance; but these are the people least likely to be knowledgeable in the handling of hazardous material incidents. Training programs designed to meet the needs of the local public emergency people are necessary. There is a need for communication channels to be opened so that the barriers between the responding groups can be eliminated. Traditional methods of operations need to be reviewed because many are not appropriate in today's social or transportation environments. But, most important is the need for the change by all parties from one of mistrust to one of trust and respect.

AS VIEWED BY THE PUBLIC FIRE SERVICE

The purpose of this conference is to help develop a national strategy that will address several concerns related to hazardous materials. This paper discusses some of the issues that relate to emergency response and to a hazardous materials accident. The points raised and views expressed are ones in which I not only believe but also have heard expressed by several of my colleagues in the fire service.

Role of Public and Private Sectors

In many discussions about hazardous materials, a popular topic is the appropriate roles of the public and private sectors. There are usually several points of view put forth, depending on which sector

the speaker represents. However, there is one point on which everyone can agree: a lack of understanding of what are the appropriate roles. This provides the opportunity for errors of omission, confusion, and perhaps even confrontation.

There is a tendency on the part of many people to only consider these roles in terms of an emergency situation and then to think in terms of whose authority is final. I suggest that each group has a role to play long before the emergency occurs, and, if that role is properly played, the question of authority in an emergency will become much less important.

The preemergency role is primarily one of communication. All too often public and private officials become so involved in the day-to-day administration of their jobs that good lines of communication fail to be developed. When this occurs, it should come as no surprise that communication breaks down during an emergency incident.

How can good communications be achieved? There are many ways to improve lines of communication that will not only produce useful products but also will help to build the level of mutual trust needed to work together at an emergency.

Industry must encourage, and public safety officials must aggressively pursue, joint preemergency communications with the handlers of hazardous materials in their community. Joint planning and training sessions are probably the logical places to begin.

There is no mystery about these methods; they simply involve commitment and hard work. They include joint emergency planning for incidents, joint training exercises to assure that the plans will work, and making sure that each sector understands the problems, fears, and responsiblities of the other.

Industry must recognize its responsiblity to public safety. The fact is that many materials are hazardous, they are needed, and they are being transported through communities that are poorly trained and ill-equipped to deal with an accident. Although the local public safety official may not be well equipped, he or she is still responsible to the community. Private industry must take a strong leadership role in improving this situation. One way is to support in every way possible the education and training of public safety personnel in the communities in which they do business, or through which their products may pass.

I believe private industry has some very definite roles during a hazardous material emergency. It represents an immense resource that in the past has been underused for many reasons, not the least of which is the attitude of fire departments toward their contribution. Private industry's day-to-day involvement with hazardous materials has resulted in their becoming intimately familiar with specific hazards, precautions, procedures, equipment, and materials associated with each chemical. It also necessitates that they have an inventory of special materials and equipment that they are required to develop, process, store, or transport the chemical. They must also maintain a cadre of personnel knowledgeable of the hazards and precautions and trained in the use of special equipment and materials. This comprises a resource of tremendous knowledge, expertise, and physical materials that can be called on for assistance.

Because industry can be of vital assistance to emergency response organizations, it is important that an atmosphere be created in which industry is willing to assist. Therefore, I strongly support the passage of a good samaritan bill to protect qualified industry personnel from liability. However, I suggest that it should not be a blanket under which unqualified persons can hide. I suggest that such legislation authorize protection only for those persons who have demonstrated competence.

It must be remembered that private industry's day-to-day involvement with hazardous materials is under the ideal, controlled conditions of the normal work environment, not that of an emergency scene. While larger companies may have an emergency response team, many do not. Those who do not should not be expected to perform tasks that differ from their normal job under the pressures experienced at an emergency scene. During the emergency their role should be one of advice and support. When conditions have been stabilized and the stresses relieved, they should be expected to perform tasks similar to their normal jobs that may be associated with product control, transfer or clean up, and do so in cooperation with the public safety agency in charge at the scene.

The role of the public sector is one of providing for the public safety. That translates into intelligent regulation and response to emergencies. In the area of emergency response, some agencies play a supportive and advisory role. One public safety agency must be given the responsibility and authority to assume command of the incident. Which agency that is will vary from jurisdiction to jurisdiction. The most important thing is that one agency be clearly designated before the incident occurs and that decision be clearly communicated to all parties involved. In those states or cities that have adopted the Uniform Fire Code (unless locally amended) that agency is the fire department. Among other things, the Uniform Fire Code specifies that the fire chief is responsible for the prevention of fires, the extinguishment of dangerous or hazardous fires, and the storage, use, and handling of hazardous materials. It also states that the fire chief shall have the power and authority to direct such operations as may be necessary to extinguish or control any fire, perform any rescue operation, investigate the existence of suspected or reported fires, gas leaks, or other hazardous conditions.

Planning

Planning has but one goal: to increase effectiveness during an emergency. To increase that effectiveness, we must anticipate potential problems, their possible effect, and develop solutions prior to their occurrence. When done well, planning is hard work. It takes time. It requires commitment.

The vast majority of hazardous materials incidents is of a minor nature, perhaps even routine. They can usually be handled by the people and equipment at hand. But even minor incidents may become the major incident we all fear, and that major incident can tax resources to the limit, or beyond, especially if proper planning has not been done ahead of time. There are all too numerous examples of bad decisions based on inaccurate or inadequate information--information that planning may have provided.

In order to prepare sound emergency plans for a hazardous materials incident, public safety officials must know what materials are passing through their jurisdiction. Anyone who has made a serious attempt to find out what materials are transported through their area knows it is a very difficult task. One of the reasons it is so difficult is a frequent unwillingness on the part of industry to make such information available to public safety officials.

Several reasons are offered for this reluctance. Some consider the data confidential business infor-

mation and fear that their competitors will discover what they are transporting or with whom they are doing business. Others claim a fear that the information may fall into the hands of radicals who may commit sabotage.

The reaction on the part of some public safety officials is to become suspicious of the reasons offered. Whether that suspicion is justified is not the point. It exists. And just as importantly, the lack of such information prevents public safety officials from making good decisions about emergency planning. You just do not make good decisions without good information.

The reluctance to make this type of data available to emergency planners must be overcome, it is hoped, by building trust and confidence between industry and public safety officials. But it must be overcome.

Knowing what hazardous materials are being transported through a particular jurisdiction does not solve all problems. Another area where much effort is needed is in the development of sound risk analysis procedures that can be used at the local level. Public officials and the public in general must recognize the need for accepting a certain level of risk. I believe, for the most part, they do. The question that is the most difficult to answer is what is an acceptable level of risk, considering such things as population distribution, transportation route alternatives, public safety resources, and similar items. I believe that if risk analysis procedures are developed that public safety officials can trust, they will be used to make far more intelligent decisions on a broad range of hazardous materials issues.

An additional area in which much better information is needed to anticipate problems relates to the behavior of hazardous materials under emergency conditions. In many cases, these data are available, and the technology is available to deliver the data; what is lacking is commitment.

Recently, the Seattle Fire Department tried to find out what the result would be if a container of fireworks was exposed to a large fire. We contacted manufacturers, shippers, chemists, and others. The guesses we heard ranged from a fairly spectacular fireworks display to a major explosion. It occurred to me that it was rather curious that I could go home, turn on my television set, and see pictures of Saturn transmitted more than a billion miles through space, but I could not find out if a container of fireworks could burn or explode.

Fortunately, our question about fireworks did not result during an emergency. The emergency responder must have information immediately available that will provide guidance on how the involved materials may react--not under normal or laboratory conditions--but under emergency conditions. That emergency response data should give advice on what actions can be taken to protect large numbers of people when evacuation is not possible. I strongly believe that a major national effort should be made to develop a data base that can provide that information and that we strive for improved methods to deliver such data to emergency planners and emergency responders.

Response

In response to any hazardous materials emergency, there are a few basic principles that must be kept clearly in mind. First, the primary objective is to solve the problem with the least amount of damage and injury to anyone. While time may be an important factor, it usually should not be the paramount one. In the rush to get something done quickly, terrible mistakes can be made. A second point to remember is that a serious hazardous materials incident will probably be so complex that no single individual or organization will have all the information and answers. To resolve these incidents, it truly takes "emergency management". And that means a management-team approach has the best chance of success.

Unfortunately, there are several factors that may make such an approach at least difficult, perhaps impossible. One is a lack of trust between the various groups involved in the competence of each other. Another is fear of legal liability for what has occurred or what may occur during the emergency. Another is the "turf" problem.

That leads to a third point to keep in mind, the principle of unity of command--i.e., the idea that one person must be in charge and must accept responsibility for what occurs. There is no question in my mind that unity of command is an essential ingredient in successful emergency management. I also believe that command must be given to that person who has the legal responsibility for the public safety of the citizens in that area. In any state that has adopted the Uniform Fire Code, the person who has that responsibility is the fire chief.

Aside from any legal responsibility, there are several practical reasons that the fire chief is the logical choice. It will probably be the fire department that is the first emergency response force to arrive on the scene. The fire department will likely have to deal with the emergency for some time before any industry representatives or government agencies arrive on the scene, and there is an excellent chance that many critical decisions will be made prior to the arrival of other assistance.

A point that is often raised is that the fire chief may not be the most knowledgeable person present on the nature of the material involved or the technical procedures needed to solve the problem. That is a good point, and it is often true. But you do not solve that problem by saying that someone from another agency or industry is going to come into a jurisdiction and assume command. You solve the problem by training commanding officers to properly manage an emergency incident. Unity of command does not mean the adoption of a dictatorial position. Commanding officers must be trained to seek the advice and counsel of whatever expertise is available to them. They must be trained to establish a command post, to gather advisors about them, to weigh and consider that advice, and to act on it. At the same time, advisors must realize that the commanding officer has the responsibility for public safety and, therefore, the actions to be taken.

Communication

There are, of course, two types of communication that are important. Those lines of communication that should exist between industry and public safety officials have been addressed elsewhere in this paper.

The second type of communication I would like to comment on relates to on-scene emergency communication, both face-to-face verbal communication and the transmission of communication over distance. It is essential that a central command post be established at the emergency scene and that the commanding officer and the management team operate from that command post. Representatives of industry and other public agencies should report to the command post, identify themselves, and explain their function, responsibility, resources, and technical support capability. Whenever possible, they should remain

in and work from the command post. If they have to leave, they should remain in contact with the command post.

This brings us to an old problem. Today emergency management relies heavily on radio communication. The problem arises when all of the emergency responses transmit and receive on different frequencies. This is a problem that does not need to exist. Advances in electronic technology have resulted in synthesized transmitters and receivers capable of operating on up to 9500 frequencies, all in one radio. Less expensive synthesized radios, capable of operating on 30 or more channels, are also available. In light of these advances, command posts equipped with properly selected radios would have the capability to communicate with all the response agencies in their area. What is obviously needed are planning and money.

There is another area of communication that is more difficult to deal with--that is, communication with the public, including both releasing information to the media and public warning communication. It seems to me that press and media relations are very important parts of the emergency scene management, both from a philosophic and practical point of view. I believe that the public has a right to know what is happening in their community and that accurate and responsible reporting of an incident can meet that need. In addition, a lack of accurate information can lead to needless public distrust and perhaps even worse.

It has been my experience that, if the media are provided with accurate and up-to-date information, they will usually act in a responsible manner. If you try to avoid providing information, they will report on the incident anyway, with whatever "facts" they have or imagine to be true. So the choice is not whether the incident will be reported, but will it be reported in an accurate and responsible way.

I suggest that during the emergency, industry and public officials work together to provide accurate information to the press by means of joint statements and press releases. It is extremely important that conflicting information is not released to the media. Those people responsible for press statements should be at the scene and not try to do the job from an office telephone 50 miles away.

A major hazardous materials incident in a metropolitan area may require the warning of thousands of people. Evacuation will certainly be difficult, perhaps impractical, or even impossible. In spite of these facts, in order for a major life loss to be avoided, people must be warned to take some action to avoid injury (i.e., moving upward or downward in buildings, closing openings into buildings, securing air handling systems, etc.). At present there is no practical way of giving such public warning.

Broadcast media will reach those who happen to be listening or watching. Police may be able to warn those on the streets. But, despite our best effort, many will not hear the warning.

Perhaps the answer lies in the installation of warning devices in major occupancies that could be activated by authorities on need, either on an all-call or selective basis. Whatever the answer, the whole issue of public warning and avoidance measures is one that needs serious consideration and planning.

Training

It should be obvious that many of the problems involving hazardous materials safety are the result of poor and inadequate training. Most of the people involved with response to a hazardous materials incident will have little or no training and probably less experience. What people do not understand they will likely be afraid of, and frightened people make mistakes.

Today, there are quite a number of experts who offer training programs in managing hazardous materials emergencies. Most of them are of little value; some may be imparting useless or inaccurate information. In my view, the last thing we need is a government study of whether or not these programs are adequate.

What is needed is a carefully selected group to determine what the needs are to deal with a hazardous materials incident. Then we need to set specific objectives for that training and to get about the business of designing training courses that meet the objectives.

I suggest that we do just that, by using the fire service and the U.S. Fire Administration, with assistance from DOT and industry. Until we have clearly stated what the student needs to know, you can not expect the instructor to teach it or the student to learn it.

A major factor to consider in any emergency response training program is skills degradation (skill loss that results when specific tasks are performed infrequently) and the constant need for retraining.

Training is expensive in terms of time, money, and staff. In any given city, hazardous materials incidents do not occur every day. Therefore, it seems to me that the best choice is to train specialized units and make them available on a regional basis. It just does not make sense for emergency response forces to duplicate each other's efforts when it is not necessary. Fire chiefs must overcome their reluctance to accept assistance outside their own department and must begin to develop a regional approach to solving their problems. To do otherwise is an inexcusable waste of public funds.

Like the field of medicine, the fire service has need of the general practitioner, but we also have need of the specialist. It is hoped that the fire service is not so bound in tradition and backward thinking that it will fail to recognize the fact.

Public Involvement

There is room for improvement in a number of areas that relate to public involvement in the hazardous materials issue. They include a better understanding of the term "hazardous materials" and what role hazardous materials play in our daily lives. They need a better understanding that a certain level of risk must be accepted, and the process used to determine what that level should be must be open to public examination. However, those are topics for another paper--our concern here is the public's involvement as it relates to emergency response.

From that standpoint it seems that one of the central issues is how to educate the public to respond correctly during an emergency. Given the prevailing attitude that many people have--"It probably won't happen anyway, so why should I worry about it"--I have some doubts that a massive public education effort would be very productive. One possible effort that might produce some results would be to include some hazardous materials education as part of high school driver training programs (how to recognize a placarded vehicle, what to do in a hazardous materials accident, etc.). However, for the most part, whether or not the public responds correctly to a hazardous materials incident will depend primarily on how well public safety officials have done their planning job.

I think a good deal of work needs to be done with regard to what avoidance measures may be taken if

evacuation is not possible. If guidelines could be developed that would provide such information, they would be of great assistance to emergency response forces. This would be particularly true for metropolitan areas when vapor clouds are released in an accident. It may just not be possible to move large numbers out of the way in time.

It might also be useful to begin a public education effort to provide information on what to do if one becomes involved in a hazardous materials incident and to discourage curiosity seekers. As previously stated, such a program effort might produce few results.

AS VIEWED BY A CARRIER

The era of the 1970s introduced society to a number of new catastrophic potentials involving accidents during the transportation of hazardous materials. The public's concern and interest in such hazards were greatly accentuated by similar threats being discovered as a result of environmental pollution and dump sites for hazardous wastes that affected the health of entire communities. In response to this public concern, the actions taken by Congress in establishing new laws and the resulting actions on the part of regulatory agencies have been of questionable success in bringing about improved conditions or in removing the perceived threats involved in these situations. The preoccupation on the part of the government and regulatory agencies with laws and regulations being the solution to these problems obviously leaves much to be desired. When the lack of significant real improvements is realized, it certainly brings into question the competence of such agencies to truly improve the safety of our society. These proven threats to society will not be eliminated by legislative flurries or increased regulations, unless real problems are identified and their true causes are addressed.

These last 10 years have shown that those in a position to bring about improvements have become involved with the creation of monolithic legislation, regulations, and public relations activities that have not contributed significantly to correcting identified problems or bringing about needed improvements. During the 1980s such chaos must be eliminated and a coordinated policy and program established to ensure proper solutions and competent actions. The multitude of laws and regulations with numbers of narrow viewpoints by numerous agencies has resulted in counterproductive results, increased conflicts, jealousies, and neglect, particularly of the most critical aspect of the entire field of hazardous material emergencies--that is, proper emergency response.

Transportation incidents have posed a major publicly perceived threat to the safety and health of society. Unfortunately, such a perceived threat has been exaggerated and distorted by the media. However, real danger potentials do exist and must be addressed in a much more competent, professional manner by responsible parties if improved safety is to be achieved.

There are five major aspects of transportation emergency response activities that should be considered in greater detail.

Role of Public and Private Sectors

A review of past experiences is necessary to understand the proper role of all parties involved in transportation emergencies. These emergency situations have been occurring for many years and have been handled adequately with little real harm or injury to persons or society. Both the private and public sectors have responded in the past with remarkable competence and success. Utilities, railroads, and major industrial firms have always been organized and equipped to respond capably to restore services and their operations as promptly and safely as possible in all types of emergencies. Hazardous material incidents are unique types of incidents that occasionally occur and generally have been handled adequately by existing response actions; however, improvements are needed.

The possible unique complexities of hazardous material incidents put an unusual need on all parties involved in response actions to carefully coordinate activities to ensure that maximum use is made of all available knowledge, expertise, and experience. Proper decisionmaking in these incidents is critical. In a number of past incidents such coordination and knowledgeable decisionmaking were not accomplished and these became catastrophes with loss of life among the response personnel. "They should have known, but did not."

This lack of proper technical knowledge or control capabilities cannot be allowed to continue if society is to be protected. Such incidents present a mutual challenge to both public and private sectors to maximize the use of available expertise and to require close coordination and mutual cooperation in major emergency response actions to ensure success in limiting such complex threats to our society.

Planning Needs

Coordinated activities by various groups of individuals demand planning of some degree to permit success in achieving complex goals. Emergency responses to major hazardous material incidents during transportation and particularly railroad incidents with numbers of cars and various materials are certainly complex challenges to all response personnel.

The unique character of major hazardous material incidents during transportation presents the need for greatly improved planning by all involved parties. Planning forces parties to analyze possible situations, likely locations, potential materials, and expected complications that can be involved. This effort presents an ideal opportunity for all interested parties to get involved and learn more of the capabilities, problems, concerns, and needs of others before such incidents occur.

The existing expertise, knowledge, and experience in a community will be able to handle the vast majority of incidents likely to occur if they maximize these capabilities by good planning, involvement, and coordination. The emergency action plan is essential in these hazardous material incidents to identify limitations and needs, as well as capabilities and available expertise. Mutual aid arrangements must also be fully incorporated.

Hazardous material incidents present numerous hazard potentials not readily recognized by the majority of emergency service personnel. A good plan will maximize the use and availability of the community's personnel with the expertise and special knowledge or capabilities to the fullest.

These emergencies can involve hazards as diverse as ground-water pollution to violent rupture and rocketing of tank cars, exposure to poison or toxic gases, or injury from blasts and flying fragments. These hazards can cause injury at sizable distances from the actual site of the event and, consequently, demand a realistic decisionmaking priority system beyond usual emergency events.

Frequently, the best decision is to evacuate everyone from the immediate area and not permit response forces to fight fires or interfere with the

events. These decision criteria, policies, and guidelines are best achieved by advance planning, thorough cooperation of all involved parties, and complete analysis of possible situations and circumstances.

Response Coordinaton (Who Is in Charge?)

Coordination and cooperation in emergency response activities to these incidents are particularly critical in view of the possible far-reaching actions and threats to personnel over large areas. The issue of "who is in charge" has the potential of jeopardizing the success of any complex operation if those with certain authorities do not recognize the magnitude of the challenge to make proper decisions on the scene promptly. This decisionmaking ability does not necessarily come with the title or traditional authority for "protecting the public". Often the public is not involved, or should not be, except for prompt evacuation from a danger zone.

Incidents on public highways or streets can pose some threat to the public and, consequently, are more subject to the more traditional safety authorities. Incidents that occur in rural areas, on large industrial plant property, or on railroad rights-of-way, with little or no public exposure, emphasize the duty and rights of private parties to control response actions in a responsible manner and in cooperaton and coordination with local safety authorities.

Several recent events involving the question of authority of federal and local officials and their responsibilities in emergency response actions taken are under review in the courts in the United States and Canada. These legal conflicts will continue to occur until clear lines of authority, responsibility, and liability for actions taken are resolved in the court. In spite of the legal questions, it is obvious that the magnitude of the challenge, the complexities of the decisions, and the needed scope of knowledge demand on-scene decisionmaking by the most competent persons available. A coordinated, joint effort by all parties involved is essential. This problem poses an immediate challenge for all parties to develop a workable, mutual response and control function that will satisfy the needs of all parties and ensure proper decisionmaking on the scene.

Communication/Training Procedures

Prompt communication between local on-scene personnel and those with knowledge and expertise is essential if hazardous material response operations are to be conducted with maximum success and safety. This need for immediate communication must be addressed at the federal and state levels to provide authoritative resources and guidance with consistency. Immediate, proper on-scene decisionmaking is critical and emphasizes the serious need for better training of response personnel along with greatly improved communication abilities.

The major obstacles to improved training of response personnel have been the lack of a clear national program or clear responsibility of any agency to accomplish such goals. The frequent changes in regulations, placarding, hazard classification along with alternate versions of such understanding, or essential competence needed by the hundreds of thousands of emergency response personnel in the United States confuse field personnel and destroy existing foundations of knowledge essential in decisionmaking. Such unnecessary changes damage all past training efforts, materials, and programs that have been built on previous identification and response systems. These frequent, unnecessary changes in guidelines also frustrate those involved in training and diminish their interest or enthusiasm for doing such vital training. Such waffling must be eliminated during the 1980s if real progress is to be made in emergency response training for hazardous material incidents.

Public Involvement

Public concern in regard to the perceived threat to their safety and welfare, posed by hazardous material incidents, has been the basis and justification used repeatedly by the Congress for new transportation laws and by the MTB for increased and revised regulations. When these actions are carefully analyzed and their effects or results are studied, they do not address the real factors or valid causes of the incidents. This is a misapplication of effort, is grossly misleading, if not incompetent, and diminishes real efforts being made to correct or answer valid needs.

A review of regulatory actions taken by the MTB and its predecessors over the last 12 years is disheartening. Obviously, a lack of perception or understanding has been involved. Progress in improving experience is not evident; however, the rampant growth of regulations and the confusion of requirements are overwhelming. The public concern must be put in proper perspective and must not be used as justification for needless actions for questionable purposes or reasons.

The importance of valid public concern and involvement makes it imperative that the public be kept honestly informed and that the real hazards or exposures are explained. The misuse of their real concerns and valid interest must not continue to be used to justify needless or unnecessary regulatory actions.

The media also have a clear duty to improve the integrity of their news coverage and involved parties have an equally clear duty to ensure that the public is given maximum protection and correct information as to these events and their hazard potentials.

AS VIEWED BY A MANUFACTURER

The role of the chemical manufacturer is to provide advice and/or assistance to the public emergency forces, the carrier, and others responding to an emergency incident involving hazardous materials. This calls for a commitment by the company, the establishment of an emergency response system (ERS), and the provision of needed people and tools.

Commitment

There must be a commitment to be responsible for the products manufactured from laboratory to final disposition and to make available all the resources the company has in the event of an incident involving their products.

Emergency Response System

The purposes of an ERS are

1. To advise or assist in handling transportation emergencies so as to minimize their effects, and
2. To help prevent incidents through determining causes and initiating corrective action.

The company should appoint an ERS manager to be responsible for formulating plans to meet the needs and requirements for the materials to be shipped by

the company. For ensuring that the incidents are properly handled and that the system meets the company's expectations and fulfills the company's policy, the ERS manager should be an experienced person who is capable of managing the ERS and of making sound judgments under emergency conditions. His or her primary consideration should be to assure that each incident is handled safely so as to minimize the impact on people, environment, and property.

People

The expertise of many people is often needed to handle hazardous materials incidents. In some incidents medical personnel will need to be involved to respond to inquiries concerning exposure or injuries involving products. Where possible, contact should be made between the company's medical personnel and the on-scene medical personnel to enable rapid transmission of medical advice and to minimize the possibilities of misunderstanding. Medical personnel must be available on a 24-h basis. Chemical data files on toxicology, exposure, and inhalation studies need to be available to the doctor making the response.

Employees processing special product knowledge--for example, trained production or trained technical personnel--should be identified and trained in responding to the product-related aspects of an emergency. They should also be familiar with the transportation equipment involved and handling emergencies in public areas. These persons should have preplanned emergency response procedures for handling and safely disposing of their products. Whether to provide telephone advice only or on-scene assistance are decisions that should be made jointly by the emergency response manager and the knowledgeable contact.

If the decision is reached to dispatch assistance to the emergency scene, then the team concept should be considered. An emergency response team may consist of two or more persons. Team size and composition will depend on the types of problems likely to be encountered in each specific incident. The team's primary responsibility is to advise the emergency personnel involved in handling the incident rather than to handle the emergency operations. Various types of expertise may be required, such as product, safe product-handling methods, transportation equipment and operations, spill control, analysis, and health and environmental effects. Public relations personnel should be part of the team for all major incidents and those incidents that are likely to receive media coverage. The public relations person should be briefed on the materials involved and be kept informed of events at the scene. A coordinated public relations effort between the parties involved is the objective, so it is very important that the on-scene public relations person be kept informed in order to maintain a credible contact with the media.

Team members should be thoroughly trained in the special areas likely to be encountered at an incident. Training should include safe methods of field repair and product transfer, use of various personal protective equipment, and methods for performing emergency operations in public areas.

Technical support in other areas may be provided by a variety of other functions: analytical, distribution, environmental, industrial hygiene, legal, reactive chemicals, safety, toxicology, waste control, and others. The support of these various disciplines is a very important part of the total commitment of a company to product stewardship.

Tools

An emergency response system needs some tools to put into the hands of the emergency response coordinator, knowledgeable contact, and others involved in the response effort. Most important is the emergency response phone.

Each manufacturer-processor and/or shipping point should establish and maintain a 24-h designated emergency response telephone. The size and/or complexity of the business will play a major role in determining if the phone will be manned by full-time employees or an answering service. The emergency response phone personnel should be trained in handling emergency calls. They must remain calm and obtain as much key information on the incident as possible. They must then contact appropriate personnel quickly and relay this information to them for response. An emergency response phone has four basic responsibilities:

1. To obtain full information on each emergency during the initial call,
2. To provide immediate response information from data sheets prepared for this purpose,
3. To relay full information to the emergency response coordinator or others who may be involved, and
4. To avoid statements or discussions on liability or responsibility.

Emergency response information (ERI) sheets should be established and maintained. These ERI sheets should contain the following for each product manufactured and/or shipped: physical properties, hazardous material classification, primary and other hazards, what to do for spill or leak, fire, and contact or exposure (first aid).

Medical personnel, knowledgeable contact, and other technically trained people may understand the technical language, but the public emergency people do not. Response statements should be prepared that cover the above in language that is easily understood by those responding to an emergency.

Other data or call lists may be required and will vary depending on the size and complexity of the company's operation. Worthy of consideration are aircraft chartering services, travel agencies, legal contact, insurance contacts, travel money, and other factors.

Each person who has been designated as an emergency response team member should have a personal safety kit. In addition, repair kits of various types, patching kits, and any special kits, i.e., chlorine repair kits or analytical kits, may be required. These should be assembled and kept in a secure location for ready access by the team members. All kits, regardless of purpose, should be sized so that they can be transported aboard aircraft.

Operations

Operations of an emergency response system will vary due to the internal organization and management of the system, but, regardless, all systems are activated by an initial phone call.

The assistance needed most often can be handled by a phone call, but there are times when sending people to the incident scene will be appropriate. When the team arrives on the scene, their first act should be to locate the person in charge, and to make themselves available to advise in their areas of expertise. The manufacturer and/or shipper are present in an advisory capacity, and this advice may be accepted or rejected by the person(s) in charge of the incident.

There are some products that, due to their physical properties, i.e., chlorine, vinyl chloride

monomer (VCM), and pesticides, require some special attention on the part of the manufacturers. In the case of these, three mutual assistance programs have been established. The Chlorine Institute oversees the Chlorep program of 67 chlorine safety teams that are available to respond to any type of incident involving chlorine. The Chlorep Team closest to the incident makes the initial response. The VCM producers have a mutual assistance program whereby each producer is available to assist with the handling of a VCM transportation incident in their area.

The National Agricultural Chemicals Association (NACA) has established the Pesticide Safety Team Network (PSTN). The country is divided into 10 areas with a pesticide manufacturer representative serving as the PSTN coordinator in each area. In addition, each area has one or more safety teams. Each team has a predesignated captain. The team members are preassigned but may be different depending on the type of incident involved. The PSTN may send members to an incident scene through either of two methods: at the request of the manufacturer, or by the PSTN area coordinator if the gravity of the incident warrants and the manufacturer cannot be identified. All of these mutual assistance systems are activated through CHEMTREC.

Being prepared to provide advice or assistance is only part of an emergency response system. Each incident must be evaluated as to cause, effects, and handling procedures. These data are then used in the planning and execution of preventative programs and training programs.

Preventative activities are a major part of an emergency response system. These activities may include, but are not limited to, the following:

1. Transportation equipment specifications;
2. Transportation equipment inspections;
3. Proper filling of drums;
4. Loading patterns and techniques;
5. Blocking and bracing;
6. Appropriate placards, labels, or markings; and
7. Final gage inspections for proper shipping papers.

With any of these, there is the potential cause of an emergency incident or the ingredients for improper handling of an incident.

Preventative programs begin with the purchasing of packaging--e.g., cans, drums, or tank cars. Products must be packaged in the right container to survive the transportation environment they are likely to encounter. Loading patterns, tightness of the load, blocking, and bracing require the establishment of standards and the inspection necessary to assure compliance with the standards--assurance that all employees who need to know the various regulations receive this training and that compliance with these regulations is part of their job responsibilities.

Not all of the attention in the area of emergency response can be directed inward. There is the need to become involved with the planning and training of the public safety and emergency programs. Of the nearly 30 000 public fire-fighting forces, only a small number are full-time, professionally staffed units. The small fire companies are desperately in need of training in recognizing and identifying hazardous materials. Various association-sponsored training programs are available, but, without the involvement of the chemical manufacturer at these training sessions, the public emergency people are unaware of our concern.

The training program developed by the American Association of Railroads (AAR) and the Chemical Manufacturers Association (CMA) brings together the railroad and chemical industries in a joint effort to provide the public emergency forces with an introductory program entitled "Recognizing and Identifying Hazardous Materials". There are currently more than 200 of these programs in circulation in the continental United States. An organization that combines railroad and chemical representatives is making this program available to public emergency forces, public agencies, civic organizations, or others. A prime contact has been designated in each of the 48 states and may be reached either through AAR or CMA.

Emergency response in the chemical industry is a multifaceted program. It requires the commitment of the company's management and is an integral part of the company's safety philosophy and product stewardship programs. There must be the willingness to make available all the resources of the company to a single event that may be many miles away from these resources. And there must be the dedication of those involved every day to assure that training, inspection, and planning are the best. Finally, to work with the transportation companies and the public emergency and safety organizations and to make sure that when an incident does happen the people responding are trained to handle the incident in a manner that minimizes public and environmental exposure ensure everyone's safety and are achieved in the spirit of cooperativeness.

Civil Liability and Social Regulation

Stanley Hoffman

Both regulation and the criminal law constitute the direct exercise of governmental power to coerce conduct perceived to be socially desirable or to prohibit or restrict conduct perceived to be socially undesirable. Historically, and for constitutional reasons, the operation of the criminal law system depends on the separate exercise of legislative, judicial, and executive powers. Regulation, however, concentrates power in a single, specialized body endowed with legislative authority to define the specific content of required or restricted conduct, executive authority to investigate and enforce compliance with regulatory standards, and, usually in connection with economic regulation, jurisdiction to adjudicate disputes between private parties.

It has been asserted, therefore, that regulation is essentially a procedural mechanism which, in itself, does not establish or create substantive societal controls. Thus, in 1936 the late Justice Harlan F. Stone (1) expressed the view that regulation merely substitutes

> new methods of control...for the controls traditionally exercised by courts--a substitution made necessary, not by want of an applicable law, but because the ever expanding activities of government in dealing with the complexities of modern life had made indispensible the adoption of procedures more expeditious and better guided by specialized experience than any which the courts had provided.

Justice Stone's failure to recognize that regulation could be employed not merely to substitute for otherwise "applicable law", but also to supplement and modify such law, may reflect the limited perception of an era not yet burdened by extensive social

regulation and not yet aware that regulation itself would become one of the "complexities of modern life". Indeed, recent reforms in federal (2) and state (3) economic regulation have sought to reduce such complexities by reversion to market mechanisms designed to function with substantially less government intervention.

While the debate with regard to economic regulation has been resolved for the immediate future, it seems odd that a similar debate with respect to social regulation has hardly begun. There are, to be sure, many voices in opposition to expanded regulation and increasing government intervention in private enterprise. But such opposition has rarely attempted to articulate acceptable alternatives to the direct intervention of government in the control of socially undesirable conduct.

There has, of course, been substantial discussion in the literature (4) and even in the courts (5) regarding possible methods for better controlling the costs of social regulation (6). Such discussion, however, has simply assumed the validity of regulation as the means of control, thereby obscuring consideration of alternative means including, as in reform of economic regulation, reversion to previously applicable law accompanied by such modifications thereto as may be appropriate to the achievement of social objectives.

Social regulation and, in particular, safety regulation relate primarily to the protection of certain persons, such as employees, consumers, or motorists, against risks created by other persons, such as employers, manufacturers, or carriers. Thus, since the relation between risk makers and risk takers is noncontractual, it is improbable that alternatives to social regulation could be found in market mechanisms. If such alternatives exist, they are more likely to be found in an exploration of well-established, though continually developing, civil law pertaining to noncontractual liability. This essay seeks to probe the frontiers of such exploration.

CIVIL LIABILITY AS COMPENSATION FOR PRIVATE INJURY

Fault-Based (Tort) Liability

The law defines a tort as a civil wrong independent of contract (7). Although it is common to refer to the tort system as based on the "fault" of the responsible party, the commission of a tort may result not only from a wilful or deliberate act or a knowing failure to act, but also from an inadvertent or negligent failure to exercise reasonable care. The legal inquiry is whether or not the party charged with the commission of a tort acted or failed to act as a reasonably prudent person would or would not have acted under all of the circumstances involved in a particular situation. Unlike the consequences of criminal behavior, however, the mere commission of a tort creates no right to recover damages unless some harm or injury results, and then only when the tort is the "proximate cause" of such injury.

Because the development of regulatory mechanisms was, at least in part, a response to perceived failures of the tort system, a brief examination of the deficiencies and inequities frequently associated with that system may be profitable.

1. High Cost: The complexity of modern litigation, including pretrial discovery and other investigatory procedures, results in high cost to the litigants. As a result, injured persons are rarely "made whole" and claimants for relatively small amounts have little incentive to sue or, if they do, are easily induced to accept settlements substantially less than those that might be recoverable at trial. Over a given period of time, however, the aggregate of such uncollected amounts may represent a huge sum retained by tortfeasors (wrongdoers) or their insurers when distribution among persons who have suffered injury would appear to be more equitable.

2. Delay: The tort system is plagued by long delays, frequently extending to four or more years between injury and recovery. The results are substantially the same as those discussed above, but they are especially pernicious in the case of persons who, by virtue of injuries tortiously inflicted, are rendered incapable of earning other income.

3. Proof of Liability: The recovery of damages under the fault-based tort system requires not only proof of such damages but also proof that the person alleged to be responsible was, in fact, at fault and that such fault was the proximate cause of injury. Although modern discovery procedures tend to mitigate the difficulty of proving facts frequently more accessible to the defendent than to the claimant, such procedures are usually time-consuming and expensive.

4. Identity of Responsible Parties: Because economic relationships in a modern society are so complex, it is often difficult to identify with certainty the person or persons legally responsible for injury in a given situation. It appears that this is especially true in connection with transportation where, for example, the builder of a tank car, its owner or user, one or more railroads, or other persons might be individually or collectively responsible for its derailment and consequent damage. Thus, claimants are frequently constrained to sue all persons even remotely connected to such incidents, thereby increasing the cost and complexity of litigation. In addition, because such litigation is generally controlled by state law, it is sometimes difficult or impossible to obtain jurisdiction over all defendents in a single forum, resulting in multiple lawsuits or risking the opportunity to later recover from a responsible person due to the expiration of an applicable period of limitations.

5. Available Defenses: Many states still adhere to the doctrine that a plaintiff whose negligence contributed to the injury in any degree may not recover from a negligent defendent, however disproportionate the negligence of such respective parties may be. The availability of such defense and others of a similar nature may inhibit otherwise valid claims or induce inequitable settlements.

6. Immunity from Judgment: Even if a claimant has successfully prosecuted a claim to judgment, recovery is not always possible because the responsible party proves to be insolvent or for other reasons (such as tax or other liens) is unable to make payment.

It is generally agreed that "direct" damages recoverable under the tort system include only medical expenses and lost wages or income in the case of personal injuries and the cost of repair or replacement in the case of damage to property. Customarily, however, the fault-based liability system also allows "incidental" damages, such as pain and suffering, which may far exceed the amount of the direct damages. The availability of such incidental damages may be at least partially responsible for inducing or prolonging litigation and, unfortunately, may provide incentive for fraudulent or unjustified claims. More importantly, such damages may be so enormous that a single incident of

disastrous proportions, involving multiple claimants, may deplete the assets of a sizeable enterprise.

Alternative Systems of Liability

Strict liability, also referred to as liability without fault or absolute liability, developed from the celebrated English case of Rylands v. Fletcher (8). It permits recovery for "abnormally" dangerous or "ultrahazardous" activities even in the absence of fault or negligence. Thus, a defendent whose ultrahazardous activities have resulted in injury is held liable even though he was not at fault "merely because, as a matter of social adjustment, the conclusion is that the responsibility should be his" (9).

Although the courts have generally restrained expansive application of the doctrine, strict liability has found increasing acceptance in legislative enactments. Thus, to one degree or another, a strict liability regime has been incorporated in such diverse legislation as state child labor laws, federal and state pure food laws, and railroad safety statutes (10). The most recent federal adoption of such a regime is the so-called superfund bill, signed by President Carter on December 11, 1980, which creates strict liability for removal and response costs in connection with releases of hazardous substances (11).

Although court decisions that adhere to the strict liability rule of Rylands v. Fletcher have permitted recovery of all provable damages, statutes imposing such liability frequently limit the type of damages recoverable or the amount of such damages. Thus, the liability created under the superfund bill is limited to damages for clean-up costs and is further limited as to amount. In other cases, the amount recoverable without a showing of fault may be combined with additional damages if negligence can be demonstrated (12).

The term "limited liability" is a misnomer since the statutes that create it merely limit the amount of damages, but do not restrict the basis for liability or expand the defenses. Thus, for example, the Limitation of Liability Act (13) generally limits recoveries against shipowners to the value of the vessel and freight pending after an accident. Other examples of legislative restrictions on recoverable damages include the Price-Anderson Act of 1957 (14) and the superfund bill (15), as previously noted.

Interestingly, Canadian railroads have recently proposed legislation in Canada that, if adopted, would limit the legal liability of such carriers to $120 million for damages resulting from the release of hazardous materials in transit (16). Pointing to the potential for economic disaster and the practical limits to the insurability of such risks (because additional insurance is unavailable or would be prohibitively expensive), they suggested that the continued provision of railroad service to the public could be assured either by limiting carrier liability as requested or, alternatively, by substantially increasing freight rates on hazardous materials or refusing to carry them (17).

The so-called "compensation" system is best known in connection with employees' claims against employers for work-related injuries. Although sometimes referred to as an "insurance" system, it is a comprehensive legislative scheme characterized by (a) strict, or no-fault, liability; (b) compulsory insurance, (c) administrative, as opposed to judicial, hearings on claims; (d) limited recovery for injuries, not including incidental damages for pain and suffering or similar injuries; and (e) limited attorneys' fees.

Despite the model of the biblical Good Samaritan, physicians who happen to be present at the scene of an accident may sometimes by reluctant to volunteer expert advice or assistance. Such conduct may expose them to substantial liability if such advice or assistance is later found negligent.

In an effort to avoid such consequences and thereby encourage physicians to volunteer when needed, some states have enacted legislation immunizing the medical good-samaritan laws, while immunizing physicians against liability, do not necessarily protect them against the cost, inconvenience, and professional embarassment of litigation.

During the past two decades, a number of shippers of hazardous materials have developed emergency assistance programs whereby personnel employed by such shippers are made available as technical experts in connection with the on-scene disposition of a transportation emergency. Since a shipper is rarely liable for injuries that result from the operations of an independent carrier, it will be seen that the advice or assistance so provided exposes the good-samaritan shipper to liability it otherwise would not have. It has, therefore, been suggested that similar exculpatory protection should be provided in such cases. Apparently responsive to such suggestions, the new superfund legislation contains what appears to be the first good-samaritan provision (18) under federal law, although such exculpation is limited to liability "under this title" and to assistance rendered "in accordance with the national contingency plan or at the direction of an on-scene coordinator appointed under such plan". Thus, the scope and effect of the new provision appear to be uncertain.

Because most liability litigation is governed by state law, action by the various state legislatures would also seem to be necessary to relieve the good-samaritan shipper of potential liability. Several states, including California and Pennsylvania, have considered or are currently considering good-samaritan legislation pertaining to assistance in connection with transportation or similar emergencies. It does not appear, however, that any state has as yet adopted such legislation.

Although not a "liability system", compulsory insurance schemes and government compensation funds are briefly discussed here to demonstrate additional techniques that have been legislatively employed in an effort to assure adequate compensation to injured parties.

The idea of compulsory insurance is well known to the general public since many states now require liability insurance as a prerequisite to motor vehicle operation. Because some operators would otherwise be unable to obtain such insurance, such plans usually require insurers to issue policies to such operators, albeit at substantially higher premiums than normally applicable, under a pooling or "assigned-risk" program.

Similarly, the Motor Carrier Act of 1935 (19) requires regulated motor carriers to obtain and submit insurance or other evidence of "financial responsibility" assuring payment of damages to injured parties. The Motor Carrier Act of 1980 (20) modified such requirements by extending them to all interstate for-hire carriers, whether regulated or not, and to all carriers, including intrastate and private (proprietary) carriers, of hazardous materials. Similarly, the Resource Conservation and Recovery Act of 1976 (21), the Clean Water Act (22), and the new superfund legislation require certain persons to provide evidence of financial responsibility. Although federal legislation generally

requires evidence of certain minimum levels of insurance coverage and prohibits the conduct of specified business activities in the absence of such insurance, there appears to be no provision compelling insurers to issue such coverage. It should also be noted that the amount of required insurance does not necessarily serve as a limitation of liability to that amount, thus exposing to recovery the assets of the insured to the extent that damages exceed the insurance coverage.

An additional legislative device for assuring such recoveries (or payment for clean-up costs or environmental damage) is the establishment of a governmentally administered liability fund. Such funds have been created under a variety of statutes, including the Deepwater Port Act of 1974 (23), the Outer Continental Shelf Lands Act (24), and the superfund legislation.

Neither compulsory insurance schemes nor liability fund programs are limited to any particular systems of liability. Thus, for example, the Motor Carrier Act requires that insurance be provided by motor carriers, whose operations are normally subject to ordinary tort liability rules, which do not limit the amount of recovery. At the same time, under various environmental laws, insurance is made mandatory in conjunction with strict liability and a limited dollar amount of recovery. Similarly, insurance is an essential feature of the compensation system, which combines strict liability and recoverable damages of a limited nature.

CIVIL LIABILITY AS AN INSTRUMENT OF SOCIAL (SAFETY) POLICY

Legislative Intervention

The system of civil liability, in addition to its function of providing redress for private injury, also serves as an important instrument of social policy because likelihood of damages tends to restrain socially undesirable behavior.

Historically, the tort, or fault-based, liability system was developed by the courts and has demonstrated a remarkable ability to expand with the development of modern civilization. (Had there been no such system, the introduction of the automobile would alone demand that one be invented.) Nevertheless, we have observed that both federal and state legislatures have tended to supplement the tort system with greatly expanded regulation and, in some cases, to modify or replace it with other mechanisms. Such legislative intervention, most of which has occurred during the past four decades, has been largely piecemeal with little, if any, effort directed toward the establishment of a comprehensive and integrated liability system, logically related to a consistent set of social objectives.

Liability Resulting from Noncompliance with Regulation

Among the pervasive consequences of such legislation, though curiously disregarded by many critics of the regulatory process, has been the expansion of the well-established legal principle that violation of a criminal or other statute that requires or proscribes specified behavior constitutes negligence per se and, therefore, subjects the violator to liability for civil damages (25). Although such statutes frequently require proof of criminal or specific intent, the same principle has been extended to regulatory violations, even though similar proof is rarely necessary.

Manifestly, the huge body of highly detailed regulations affords ample opportunity for assertions of violation in private litigation. In some cases, such assertions result in the trial by jury of complicated technical issues more suitable to consideration by qualified experts. On the other hand, the involved regulation may be so obscurely drafted as to be incomprehensible even by experts and will permit a finding of violation in almost any behavior. Thus, for example, certain performance standards (as opposed to more detailed, or design, specifications) may be so broadly stated that the mere occurrence of an incident may be sufficient evidence of violation, resulting, however unintentionally, in the indirect imposition of liability without fault!

It appears that one of the factors restraining indiscriminate application of the noncompliance principle has been the sensible insistence of the courts on evidence that the violation was the proximate or probable cause of injury. Even so, in a society that heavily regulates a multiplicity of activities, it seems odd that the principle is less frequently invoked by complainants than one might expect. If indeed that observation is valid, the phenomenon may be worthy of more thorough study that might reveal either (a) that sound social regulation, coupled with a high level of compliance, may have contributed substantially to the eradication of injury-causing behavior, or (b) that such regulation has only limited relevance to such behavior.

Compliance as a Defense to Liability

If noncompliance with regulation constitutes negligence, it would seem to follow that regulatory compliance should afford adequate defense in liability litigation. Nevertheless, the courts have generally concluded, with rare exceptions (26), that mere compliance is not an absolute defense because the regulatory requirement may constitute only a minimum standard of safety or may be outdated and not reflective of the state of the art at the time. The validity of such reasons, however, may be questionable when, as in the case of many DOT packaging specifications, deviation from the required standard would be illegal even if such deviation proved to be safer than the standard itself.

It is sometimes argued that adherence to regulation should be deemed an absolute defense to liability in order to provide incentive to compliance. Such a thesis, however, is not persuasive in view of the sufficient incentive furnished by the corollary rule attaching liability to noncompliance. Also, to permit the assertion of compliance as an absolute defense might ultimately prove even more distasteful than the denial of such assertion, since a likely result would be the generation of excessive pressures on regulatory bodies for further proliferation of increasingly detailed and stringent requirements. Finally, even if such an absolute defense rule might serve the interests of the public generally, there would be a substantial question of equity as to why any person who has suffered serious injury should be precluded from damages merely because those whose actions contributed to such injury complied with an outdated or otherwise insufficient regulation as a result of government neglect or misapprehension.

The problem of such government error, of course, might be resolved by the assumption of liability in such cases by that responsible government. Although the Federal Tort Claims Act (27) waives federal (28) immunity from liability in tort, it simultaneously prohibits government liability for an exercise or failure to exercise a "discretionary function or duty" (29). Thus, since the promulgation of regulations clearly requires the exercise of discretion,

it appears that no liability would attach thereto absent an amendment of the Tort Claims Act, an unlikely prospect.

OBSERVATIONS AND CONCLUSIONS

It must be kept in mind that, unlike economic regulation, which largely replaced the previously existing market system, social regulation supplemented, but did not replace, the civil liability system by attempting to prevent or control conduct of a tortious nature or by creating new types of tort and additional remedies for recovery of damages. Thus, from the perspective of persons protected by regulation as well as by the tort system, there would appear to be little incentive to disassemble the former unless modification of the latter could produce corresponding or increased benefits as a trade-off.

As previously noted, regulation and other legislative modifications of the tort system were prompted in significant measure by the inherent deficiencies of the latter, some of which have been reviewed above. It has also been asserted that the tort system facilitates calculation of the alternative costs of avoidance or infliction of injury and permits a deliberate selection of the latter course when it is more advantageous to the prospective tortfeasor. It is, therefore, argued with considerable force that a moral society should not permit such selection and that any system of civil liability must be supplemented by other constraints that prohibit unacceptable conduct under threat of criminal and other sanctions.

Such additional constraints, however, sometimes present difficulties of considerable magnitude. The problems of proliferating regulations and burgeoning bureaucracy are legion, but beyond the scope of this essay. Similarly, the concept of compulsory insurance or mandatory contribution to liability funds, while obviously meritorious in many respects, generates difficult questions of insurability and serious problems of equity and social policy. The increased level of insurance required under the Motor Carrier Act of 1980, for example, may impede entry into the trucking business by small or minority operators, thereby conflicting with the open-entry policy simultaneously embraced under that Act in an effort to accommodate social and economic objectives unrelated to safety. So, too, there may be advantage in the idea of insurers as "private policemen" for the enforcement of socially desirable behavior, but there is also awesome potential for abuse in the capacity to withhold insurance required as a prerequisite to economic activity.

Other legislative efforts to mitigate the harsh results of the tort system may introduce problems of a similar nature. To justify statutory limitations of recoverable damages, it is often asserted that such limitations permit the insurability of otherwise prohibitive risks (30), thereby assuring the viability of enterprises whose continued existence is considered essential to society. Indeed, it may also be observed that the notion of corporate existence is itself a legal fiction designed to limit the personal liability of those participating in the venture in order to encourage investment and economic activity. Nonetheless, it may be difficult to comprehend why particular individuals should be left to suffer the burden of uncompensated loss resulting from legislative limitations of liability, while the benefits thereof accrue to others, along with society as a whole. Should not such losses more properly be borne in equal proportions by all who directly or indirectly enjoy such benefits? The same question, of course, may be raised in connection with exculpatory legislation, including good samaritan laws, which are in effect the ultimate extension of the limited-liability concept.

The compensation system, while mitigating or eliminating many of the defects in the tort system, is simultaneously afflicted with the problems inherent in strict liability, limited recovery, and compulsory insurance systems, all of which are integral parts of the compensation scheme. Nevertheless, the compensation system seems to have enjoyed substantial approbation by a variety of interests and appears to reflect a series of practical and reasonably equitable trade-offs among the interests of all concerned. An additional attraction of that system is the incentive it provides to channel productive energies into the avoidance of injury instead of the tactics and strategy for winning lawsuits.

Notwithstanding the varied activities of legislative bodies, the courts have likewise searched for new ways to allocate the burden of damages. It is apparent that the direction of that search in recent years has leaned toward imposing a larger share of the burden on those with the greatest ability to pay. Accordingly, the interest of industry in its own survival compels serious consideration of alternatives to the tort system as U.S. society grows ever more litigious and the judicial system finds novel ways to compensate the injured, such as class actions and "enterprise liability" (31). One such alternative, conceivably, may lie in more extensive reliance on the compensation systems to afford deserving claimants an expeditious method of fair recovery without the Monte Carlo aspects of tort litigation.

It also seems entirely possible that further exploration would reveal opportunities where a modified and, perhaps, more constructive liability system could be fairly and effectively substituted for a portion of government regulation including, in particular, some of the minutely detailed hazardous materials regulations of DOT (32).

It is not here suggested, however, that any liability system could adequately replace regulation where the transportation of hazardous products involves serious potential for catastrophe. It is also possible that no existing or revised system of liability will prove fully satisfactory in sorting out the multiple possibilities of individual or joint liability associated with railroad accidents. In such complex situations, however, some reasonable combination of strict and tort liability [see note 12] could conceivably provide a creative matrix for limiting the extent of regulation or the necessity of protracted litigation.

At the opposite end of the spectrum, experience has demonstrated that the transportation of many products, when shipped in less than bulk quantities, creates little likelihood of serious harm. Although the transportation of paints and related materials, for example, has produced thousands of reported "incidents" in recent years, such incidents have resulted in no fatalities and relatively few injuries. To maintain intensive regulation of such transportation, when a modified liability system might serve as an equal or more effective deterrent to unsafe behavior, tends to waste the resources of both government and industry, probably inhibits the development of improved safety methods, and detracts form the achievement of more important objectives of transport safety regulation.

It is submitted, therefore, that regulation is not necessarily the exclusive mechanism for the achievement of reasonable social objectives. Just as alternatives were identified in the effort to reform a century of economic regulation, alterna-

tives to social regulation must be actively and vigorously pursued. The proliferation of regulation during the past two decades suggests that another century should not pass before such pursuit is begun.

ACKNOWLEDGMENT

Express notice is hereby given that this document has neither been submitted to nor approved by the Union Carbide Corporation, and that all statements made and all views expressed in this paper are mine and do not necessarily reflect any position or views of Union Carbide Corporation or any other person, firm, or corporation.

NOTES AND REFERENCES

1. The Common Law in the United States, 50 Harv. L. Rev. 4, 16 (1936).

2. See inter alia, the Airline Deregulation Act of 1978, P.L. 95-504; the Motor Carrier Act of 1980, P.L. 96-296; and the Staggers Rail Act of 1980, P.L. 96-448.

3. See, e.g., Arizona Ch. 240 (S.B. 1173), Laws 1980, effective July 1, 1982.

4. For a sampling of such literature, see Crandall, "Curbing the Costs of Social Regulation", The Brookings Bulletin, Vol. 15, No. 3 (Winter 1979); "New Light on Regulatory Costs", The Morgan Guaranty Survey (April 1979); Reilly, "Caught Between Conflicting Regulations", Dun's Review (April 1979); Jellinek, "Chemical Regulation and Regulatory Reform", Chemical Engineering Progress (March 1979); Kirschten, "Can Government Place a Value on Saving a Human Life", National Journal (February 17, 1979). See also, U.S. Senate Report 96-1018 (Part I), Reform of Federal Regulation, accompanying S. 262 (96th Cong., 2d Sess.), and the literature therein cited.

5. See Industrial Union Dept. v. API, 8 OSHC 1586 (U.S. Sup. Ct., 1980), pertaining to the regulation of benzene by OSHA.

6. Almost exclusively, such discussions pertain to efforts to apply cost/benefit theory to the regulatory process under a given statute or with respect to a given set of regulations. In my opinion, however, such efforts constitute an exercise in futility since they attempt to ascertain costs that are at best elusive, and to quantify values--such as the value of human life--that a society perceived as moral and will not permit itself to quantify, except in the context of private litigation.

Cost/benefit applications also require a variety of essentially subjective determinations, such as the likelihood of hazard, the number of persons affected, and others of a similar nature. Nor does cost/benefit theory deal with the difficult problem of equity as between the segment of society that bears the risk and the segment to whom the benefits accrue. Especially in connection with transportation safety, such segments are frequently separate and distinct as opposed, for example, to workplace safety where the workers at risk are also beneficiaries of the risk-taking venture.

Moreover, even if costs and benefits could be precisely established and equitable considerations resolved, the cost/benefit approach fails to offer any rational guidance on the appropriate ratio between costs and benefits. See, for example, "OSHA, E.P.A.: The Heyday is Over", New York Times, Section 3, January 4, 1981, quoting Douglas M. Costle, E.P.A. Administrator, as follows (p. 15):

> Even if your accept the worst-case argument that regulation costs the economy $100 billion dollars a year ... that's only 3 percent [of gross national product]. Who's to say that's too much or too little for protecting our air and water?

I, therefore, am of the view that cost/benefit theory cannot be treated in isolation from a broader perspective. It makes little sense, for example, to deal with risks and benefits in connection with any one agency or any single body of regulations. Given the reality of limited national resources, can we justify the expenditure of millions of dollars to prevent a relative handful of injuries or fatalities in transportation accidents when those same dollars might be used to purchase ambulances adequately equipped to prevent thousands of premature deaths from coronary causes every year? If we cannot have both, the choice is obvious.

It would indeed be difficult to create the political machinery to rationalize the risk and synthesize the benefit to society as a whole. Such machinery would be necessary, first, to determine the limits of available national resources and, second, to allocate such resources so as to produce maximum national benefit. Considering the magnitude of the stakes involved ($100 billion per year?), such a challenge seems worthy of the best talents available in government, industry, academia, and other professional communities.

7. See 74 Am Jur 2d, Torts, & 1.

8. L.R.3, H.L. 330 (1868).

9. Prosser, Law of Torts, 4th Ed. (West Pub. Co., St. Paul, MN, 1971), & 75, p. 495. For a more complete discussion of strict liability, see Chapter 13 of this work. See also, 61 Yale L.J. 1172 (1952).

10. See, for example, the Federal Safety Appliance Act, 45 USC & 1, et.seq.

11. The Comprehensive Environmental Response, Compensation, and Liability Act of 1980, P.L. 96-510, & 107(a) and (b). Subsection (b) permits certain limited defenses to the liability created under subsection (a).

12. An example of such "combined" recovery appears in the Trans-Alaska Pipeline Authorization Act, 43 USC 1651, et. seq., which limits damages under strict liability to $50 million, but permits recoveries in excess thereof for ordinary negligence.

13. 46 USC 183, et. seq. (1851).

14. 42 USC 2210. The limitation imposed by this statute was judicially sustained in Duke Power v. Carolina, etc., 438 U.S. 59 (1978).

15. Op. cit., & 107(c).

16. It does not appear that U.S. railroads have made a similar appeal, but it is interesting to note that there is currently pending a proposed tariff rule that would impose on tank-car shippers liability for all damages, including government penalties, resulting from failure to comply with certain specified safety requirements. The propriety and enforceability of such a provision may be questionable.

Historically, however, the duty to serve has rarely been enforced except in a few instances, the most important of which were probably those involving pipelines controlled by large petroleum producers and allegedly operated in such a way as to maintain a monopoly in the distribution of oil. More recently, both the U.S. Interstate Commerce Commission (ICC) and the courts have affirmed the duty of railroads to transport radioactive materials in common carriage. See Energy R&D Administration v. A.C. & Y.R., 359 ICC 639 (1978), aff'd., 611 F. 2d 1162 (CA 6th, 1978), and similar cases cited in the decision of the court. In unusual circumstances, the ICC recently reopened a proceeding to determine if a motor common carrier had failed to comply with a 1976 order requiring it to furnish

service. No. MC-C-887, Consolidated Freightways--Investig. and Revoc. of Certificate, decision served August 25, 1980.

Interestingly, in a recent informal memorandum, the ICC staff acknowledged that "broader grants" of operating authority to be issued under the revised Motor Carrier Act "may require a redefinition of how we prescribe the common carrier obligation". To similar effect is the decision of the U.S. Court of Appeals (D.C. Circuit) in no. 78-2163, National Small Shipments Conference, et.al. v. C.A.B. (1980), upholding the CABs decision to exempt air carriers from the statutory duty to serve as consistent with the Airline Deregulation Act of 1978. See also, 45 F.R. 86800 (December 31, 1980), indicating that the ICC will initiate a separate proceeding to "more fully" set forth its views on this issue.

In my opinion, it is of little consequence whether or not the duty to serve has survived regulatory reform or, in fact, has ever existed in more than a theoretical sense. As a practical matter, such a duty is unenforceable except in unusual circumstances, and the incentive to enforce it is absent where reasonable alternative transportation is available. With the recent relaxation of entry and rate controls, it seems more likely than in the past that the operation of free market and competitive forces will produce a proper balance of service and cost, given sufficient time.

Accordingly, it would appear unnecessary to retain any statutory obligation to serve except, of course, in those cases where effective competition does not exist and cannot be made available. Conceivably, the imposition of excessive regulatory burdens, including unreasonable safety or insurance requirements, may tend to discourage competition to such an extent as to compel reexamination of common carrier obligations.

18. P.L. 96-510, & 107(d).

19. Previously Part II of the Interstate Commerce Act, 49 USC & 301, et. seq.; currently codified as 49 USC & 10101, et. seq.

20. P.L. 96-296; the financial responsibility provisions are a5 & 30.

21. 42 USC & 6901, et. seq.

22. See 33 USC & 1321.

23. 33 USC 1517.

24. Amendments of 1978, 43 USC 1811, et. seq.

25. For a more thorough discussion of the subject, see Prosser, op. cit., & 36, citing Osborne v. McMasters, 41 N.W. 543 (1889) and other cases. See also, Thayer, Public Wrong and Private Action, 27 Harv. L. Rev. 317 (1914); and Morris, Criminal Statutes and Tort Liability, 46 Harv. L.R. 453 (1933). For a discussion of the subject in relation to product liability litigation, see & 108(B) of the Model Uniform Liability Act proposed by the U.S. Department of Commerce, 44 F.R. 62731 (1979).

26. For a case holding compliance to be a defense, see Bruce v. Martin Marietta Corp., CCH Prod. Liab. Rep. #7770 (U.S. Ct. App., 10th Cir., 1976). Several states, including North Dakota, Utah, and Colorado, have enacted legislation to like effect.

27. 28 USC & 1346, 1402, et. al.

28. Many states have adopted similar waivers. See Davis, Administrative Law of the Seventies (Lawyers Cooperative Pub. Co., Rochester, NY, 1976), Ch. 25.

29. 28 USC & 2680(a).

30. A similar, though unrelated, problem resulting from the mobile nature of transportation is the unpredictable character of liability or the amount of recoverable damages since, under our federal system, such matters may vary with the territorial jurisdiction in which a particular incident happens to occur.

31. See Sindell v. Abott Labs., 163 Cal. Rptr. 132 (1980), where recovery was permitted from a group of drug manufacturers in the absence of proof as to the fault of any.

32. 49 CFR, Parts 171-199.

ADDENDUM

Section 301(e) of the superfund legislation requires the submission to Congress, by December 1981, of a study "to determine the adequacy of existing common law and statutory remedies in providing legal redress for harm to man and the environment caused by the release of hazardous substances".

The study is to be conducted with the assistance of the American Bar Association and other law organizations. It is required to evaluate, among other things, the evidentiary burdens placed on a plaintiff in proving harm, particularly in light of the scientific "uncertainty" over causation with respect to carcinogens and similar materials and the health effects of exposure over long periods of time. It is possible, perhaps, to interpret that requirement as a suggestion to the study group that the law be revised to create at least a rebuttable presumption of causation notwithstanding such uncertainty with respect thereto.

The report must be submitted to Congress along with recommendations that must address (a) the need for revisions in existing statutory and common law and (b) the form of such revisions as either federal statute or recommendations to the states for adoption.

It is interesting to note that there is no suggestion that any existing regulatory requirements be displaced by revision of the law pertaining to liability.

Criminal Sanctions and Regulating Corporate Behavior in Transportation of Hazardous Materials

H. Arvid Johnson

The purpose of this paper is to explore the issues of regulation of corporate behavior through the imposition of criminal sanctions for enforcing compliance with laws and regulations that affect the transportation of hazardous materials, substances, and waste. The paper will present (a) a brief historical perspective and review of current trends in the application and use of criminal sanctions; (b) the overall issues involved; (c) the basic rationale of regulatory crime, including the various theories of liability for corporations and individuals, particularly as to prosecuting senior executives; (d) the current statutory approach; and (e) in light of the issues presented, questions for consideration and resolution.

HISTORICAL PERSPECTIVE AND CURRENT TRENDS

Little use has been made of criminal sanctions in the enforcement of the laws affecting the transportation of hazardous materials, much less the broader areas of health, safety, and environmental laws. To this day, there have been no reported criminal convictions of corporate officers under the Hazardous Materials Transportation Act (hereafter referred to as the Act), the Consumer Product Safety Act, the

Occupational Safety and Health Act, the Toxic Substances Control Act, and the Solid Waste Disposal Act. Until 1979, there were no reported criminal convictions under the Water Pollution Control Act.

The only significant criminal proceedings in the transportation of hazardous materials that I am aware of are the indictments returned against Pan American, four other companies, and one individual in connection with November 1973 crash of a Pan American Boeing 707 at Logan Airport in Boston, which killed the three-man crew and which was caused by improper packaging and shipment of nitric acid. Criminal convictions were entered for violation of the old federal law governing hazardous materials transportation against Pan American and three of the companies after no-contest pleas. In a related incident, indictments were also returned against four other companies arising out of a shipment of sulfuric acid aboard a Trans World Airlines flight from Los Angeles to New York, which acid was subsequently shipped on the Pam American flight, but which was not a causal factor in the crash. Based on pleas of the three companies, convictions were also entered and fines levied under the old law.

While, undoubtedly, the lack of use of criminal sanctions against corporations and corporate executives in the hazardous materials area and the broader areas of safety, health, and environmental laws has many explanations, one very real problem is related to pinpointing the blame for serious violations. Giant corporations with multiple layers of management responsibility have significantly complicated the critical process of fairly pinpointing such blame.

Yet, notwithstanding the difficulty of penetrating corporate management structures, there is clear evidence that the legal and academic communities are seriously focusing on corporate and white-collar crime. Congress, which in the past has been concerned with "crime in the streets" is now giving increased attention to "crime in the suites". Even the busines press has directed its attention to the new trends and concern about corporate crime.

The application of criminal sanctions has begun in the broad areas of safety, health, and environmental laws. Twenty cases have been referred to the U.S. Department of Justice for possible criminal prosecution under S17(e) of OSHA, 16 of them in fiscal 1979. The EPA expects as many as 50 prosecutions per year, beginning in fiscal 1980, as the result of accelerated investigations by the EPA and the Justice Department into hazardous waste dumps.

The Justice Department recently unveiled new priorities for investigating and processing white-collar crime. In releasing a 50-page report that identifies targeted crime, the U.S. Attorney General stated: "We intend to zero in on the kinds of white-collar crime that most affect the people of this country." Of the seven major categories of white-collar offenses listed in the report, two directly affect safety, health, and environmental concerns. They are (a) crimes against employees, including life-endangering health and safety violations and corruption by union officials and (b) crimes affecting the health and safety of the general public, including the illegal discharge of toxic, hazardous, or carcinogenic waste and life-endangering violations of health and safety regulations.

The proposed new Federal Criminal Code would add the business crimes of consumer fraud and a new felony called endangerment. Endangerment is considered a form of assault and would be present according to the proposed law "...where an individual's conduct manifests an extreme indifference or an unjustified disregard for human life". Endangerment would be associated with federal environmental, OSHA, and similar safety laws. Quite apart from this general approach, Congress has already adopted a crime of "knowing endangerment" as part of its reauthorization of the Federal Solid Waste Disposal Act.

Why the sudden but determined aim at corporations, and particularly at business executives? The answer is obviously complicated, but one simple fact emerges. Government agency personnel and prosecutors believe that business people pay more attention to laws, rules, and regulations when there is a known risk of indictments, personal fines, and jail sentences than when a simple fine is meted out to their corporations.

ISSUES

While the frustration in enforcing current laws and regulations against business increases, the support for accelerated use of criminal sanctions will grow. Before a discussion of the basic rationale for regulatory crimes and the current law, it is helpful to keep in mind the fundamental issue and related options on the subject of regulating corporate behavior in the transportation of hazardous materials through criminal sanctions.

In this area, the fundamental issue is simply whether the area is appropriate for the imposition of criminal sanctions. This issue can be broken down into several options:

1. Should criminal sanctions be imposed at all, or should civil remedies of fines and injunctions be relied on as the sole remedies available;
2. Should criminal sanctions be generally employed, but only as a supplement to the general pattern of civil regulations--that is, used only as a last resort to punish particularly recalcitrant or egregious corporate behavior; or
3. Should the deterrent effect of criminal sanctions be aggressively employed to shape corporate action and enforce compliance?

RATIONALE OF REGULATORY CRIME

The traditional rationale for imposition of criminal sanctions in U.S. jurisprudence has normally considered four factors: (a) deterrence, (b) retribution, (c) incapacitation, and (d) rehabilitation. In punishing illicit corporate purpose, the primary rationale appears to be deterrence. However, elements of retribution are also present because of the introduction of the elements of moral culpability in satutory and regulatory models. Such words as "willful", "knowingly", "with knowledge", and "intent to injure" reflect elements of moral culpability in that they require a criminal state of mind and a culpable mental state or mens rea.

In this regard, judicial interpretation continues to support a moral culpability standard, and the courts have tended to read some form of intent into the law if the legislative purpose if vague or uncertain [see U.S. v. United States Gypsum, 438 U.S. 422, (1978)]. Generally, the remaining two elements of incapacitation and rehabilitation have played no part in the thinking behind statutory and regulatory regulation of corporate behavior.

STANDARDS OF LIABILITY--CORPORATE LIABILITY

In looking at the corporation, as opposed to individuals within the corporation, the question of liability must be evaluated in light of the dual rational for regulation of corporate conduct, e.g., deterrence and retribution. While commentators are

divided, most contend that there is little support for the proposition that criminal fines deter corporate crime. Moreover, such fines are even less likely to satisfy the call for retribution and the two rationales often conflict. For example, fining a corporation in a criminal proceeding may or may not deter the type of conduct prohibited, but the fine may be passed on as a cost of doing business and indirectly, therefore, retribution is visited on innocent stockholders and customers instead of on the individuals within the corporation who are responsible.

It has long been held that corporations may be subject to criminal sanctions. The theory of criminal liability for a corporation is known as the doctrine of respondent superior. Under this doctrine, a corporation is liable in a criminal sense for the acts of its agents or employees, if the agent or employee (a) commits a crime, (b) within the scope of his or her employment, (c) with the intent to benefit the corporation. While sometimes there may be questions as to whether the employee was acting within the scope of his or her employment, generally the doctrine is easy to meet, subject to burden-of-proof requirements. It is no defense for the corporation to argue that the employee violated company policies or directives in committing the criminal act.

STANDARDS OF LIABILITY--INDIVIDUAL EMPLOYEES

In the imposition of criminal sanctions, real difficulties occur within giant corporations with multiple layers of management responsibility. It is often difficult to focus on the primary employee responsible, much less determine who "caused" the commission of the crime. In this context, it is essential to look at two types of individuals. These break down into (a) direct actors, those lower-level corporate employees charged with carrying out the day-to-day activities of the corporation; and (b) indirect actors, those supervising, management, or executive employees charged with supervision and policymaking responsibilities.

Direct Actors--The Corporate Employee

There is no particular difficulty in establishing criminal liability of a direct actor--that is, the truck driver, shipping dock foreman, or other such individual who physically performs a criminal act, such as leaving a truck of explosives unattended or packing a shipment in the wrong container. Since normally this is a lower-level employee, prosecution of such an employee usually achieves much less deterrence than prosecution of a more senior officer of the company who has management responsibility and can affect the policy and procedures of the corporation.

Typically, in pursuing a direct actor, the prosecution must meet the applicable intent standard of the statute or regulation that is violated. The direct actor must be shown to have acted with a "willful" or "knowing" state of mind. In other words, the direct actor must have had a state of mind or an intent to commit the violation and the act complained of and not just be guilty of ordinary negligence. As a practical matter, proving a state of mind is difficult, and many times circumstantial evidence must be reduced to show reckless disregard, willful conduct, or similar states of mind to satisfy the statutory requirement.

It is no defense to individual prosecution for an employee to claim that he or she acted in the name of or for the benefit of the corporation. Also, an employee does not have a defense from prosecution if he or she claims a superior ordered or authorized the employee to commit the crime. While a prosecutor may seek to prosecute the superior who authorized the crime, he or she is not obligated to do so and still may proceed only against the direct actor or lower-level employee.

Indirect Actors--The Corporate Executive

The difficult area in imposing criminal sanctions arises in the area of liability for indirect actors--i.e., those employees who command, authorize, fail to prevent, acquiesce in, or recklessly supervise the activities of others. Indirect actors are themselves liable for crimes as principals. Although sometimes standards of liability have been spelled out for indirect actors in statutory or regulatory models [see the Clean Air Act, Section III(d)(3)], most statutes are silent on indirect-actor liability.

Generally, the standards for conviction of indirect actors are the same as direct actors. The main difference is that the activity, i.e., management supervision, is different, thereby creating problems in terms of proof and intent or state of mind. In coping with these problems, several standards of liability have been created, including strict liability, specific intent, and, as recently proposed, negligent supervision or reckless supervision.

Strict Liability

Under the theory of strict liability, there is no requirement of intent. A mere violation of the law is enough to convict. This shortcuts the burden-of-proof requirements in that the prosecutor does not have to prove a state of mind for the indirect actor. No federal statute explicitly adopts a strict liability standard, but by court interpretation, the Food, Drug, and Cosmetic Act and the Refuse Act of 1899, which do not set forth a requirement of culpable mental state or mens rea, i.e., that the violations be "willful" or "knowing", have been interpreted to impose a strict liability standard [see U.S. v. Dotterweich, 320 U.S. 277 (1943); U.S. v. Park, 421 U.S. 658 (1975); U.S. v. U.S. Steel Corp., 328 F. Supp. 354 (N.D. Indiana 1970), aff'd., 482 F. 2d 439 (7th Cir.), cert. denied, 414 U.S. 909 (1973)].

In the Park case, the president of a food company was convicted of allowing food to be stored in rat-infested company-owned warehouses. While the president was technically in charge of all his employees, the warehouses were assigned to different individuals with staffs and departments under their supervision, and he had been informed by the responsible persons reporting to him that corrective action had been taken in cleaning up the warehouses. In upholding the president's conviction, the U.S. Supreme Court stated that for an indirect actor or supervisor to be found liable under the theory of strict liability, he must (a) occupy a position of responsibility and authority with regard to the act that constitutes the crime and (b) must have had the power to prevent it through the highest standards of foresight and vigilance.

In essence, for indirect actors, the standard of behavior becomes one of extraordinary care. In Park, this was justified by the Supreme Court because of the serious health aspects of the FDA regulations. In this light, Congress has considered and rejected a bill to relax the duty of care imposed by the Supreme Court under the Federal Food, Drug, and Cosmetic Act.

While strict liability may achieve maximum deterrence, it can overdeter socially beneficial conduct,

inhibit technological and management innovation, and conflict with the basic principles of moral blameworthiness that underlies our entire system of criminal law. It is fair to state that the Park case represents the outer limits of ascribing blame on indirect actors.

Specific Intent

Under both statutory and common law principles, an executive, as an indirect actor, can be found guilty of a specific intent crime. An overt command or a specific authorization by an executive to violate a law is enough to satisfy a specific intent requirement, even though the executive, as an indirect actor, was not directly involved in the actual criminal act.

The requirement of specific intent may also be satisfied when an indirect actor (a) implicitly authorizes a violation of the law or (b) knows of a crime to be committed in his or her specific area of responsibility, but fails to act or acquiesces in the performance of the crime. Thus, an executive who orders hazardous materials to be shipped immediately, even though aware that it will take two days to obtain proper containers, may be argued to have implicitly authorized a violation of the law if, in fact, the chemicals are shipped without complying with the regulations. Similarly, an executive may know that employees are planning on shipping chemicals without using the appropriate containers and not do anything about it. Even though he or she has not directly violated the law, knowledge that a violation of the law will occur, coupled with no action on his or her part, would satisfy the specific intent requirement. The lower-level employees, who actually made the decision to violate the law, can also be prosecuted, but the prosecutor may elect to seek to prosecute the more senior official in order to achieve maximum deterrence.

It should be noted that a corporate official or executive can be liable for acquiescing in crimes of subordinates only when he or she has the power and the obligation to control their behavior. Thus, the head of the research and development department of a corporation, if he or she suspects a violation in the shipping department, cannot be held liable for a failure to act, because the department head had no power or control over these lower-level employees.

Contrasted with the strict liability doctrine, specific intent statutes reflect traditional notions of moral blameworthiness and do not overdeter legitimate entrepreneurial behavior. However, the difficulty of proving that an executive or supervisor possessed actual knowledge of a crime substantially weakens the ability to convict and the deterrent effect of the statutes.

Other Standards

In light of difficulties with both specific intent and strict liability theories, certain commentators have recognized the need for new legislative standards for executives, which are more firmly rooted in moral culpability than the strict liability doctrine but are also capable of providing greater incentives for effective supervision than specific intent statutes, os as to complement existing criminal statutes. In this regard, two intermediate standards have been proposed: negligent supervision and reckless supervision.

The negligent supervision standard would hold a superior criminally liable whenever he or she knew or should have known that there was a substantial risk that an illegal act was occurring or would occur within his or her realm of authority and failed to take reasonable steps to prevent the offense. The difficulty with this standard is the reduction of actual culpable mental state to a lesser negligent standard of "should have known".

Recently, a proposed revision of the Federal Criminal Code incorporated the standard of reckless supervision. This standard makes it a misdemeanor for a "person responsible for supervising particular activities on behalf of an organization" to permit or contribute to the commission of an offense "by his reckless failure to supervise adequately those activities".

Reckless supervision differs from negligent supervision in that it requires actual knowledge (instead of the negligent standard of "should have known") of a substantial risk of illegal activity within his or her realm of authority. Reckless supervision, which is a more severe test than negligent supervision, does reflect a degree of moral blameworthiness to which the criminal law has traditionally attached liability, while still meeting some of the difficulties with specific intent statutes and the weakness of proving specific intent.

PROCEDURAL DIFFICULTIES--CRIMINAL SANCTIONS

In the application of criminal sanctions to any type of behavior, but particularly that of corporate violations of regulatory and statutory models, there are many procedural difficulties that must be overcome in order to secure a conviction. While some procedural safeguards are present in both civil and criminal investigations, e.g., the attorney-client privilege, some procedural aspects are unique to criminal cases. These procedural safeguards, which are the foundation of our criminal system, have grown in complexity and scope in the past years. It is not the purpose of this paper to discuss whether the procedural safeguards have gone too far, but they are available to an individual who is prosecuted for a criminal violation of regulatory or statutory corporate crimes just as they are available to hardened criminals.

Burden of Proof

One distinct procedural difficulty in prosecuting for a criminal violation of a regulation is that the government is required to prove its case "beyond a reasonable doubt". This is a much higher standard of proof than required in a civil case.

Fourth and Fifth Amendment Rights

An individual, but not a corporation, has the right to the constitutional prohibition against self-incrimination, as embodied in the Fifth Amendment. While OSHA has taken the position that in a criminal investigation of an OSHA violation it does not have to issue a Fifth Amendment (Miranda) warning, it would appear that OSHA's position is not well-founded and that Miranda-type warnings must be given by their investigators. Another constitutional protection for both corporations and individuals is the Fourth Amendment prohibition against unreasonable searches and seizures. This requires that a regulatory authority secure subpoenas for documents and physical access to the premise in the course of a criminal investigation.

Right to Trial by Jury

With a criminal prosecution of regulatory crime, there is a right to a trial by jury. A jury trial often favors a defendant in a regulatory crime because of the complexity of the case, the abstract-

ness of the "crime", and the general reluctance of a jury to equate the prohibitions encompassed by regulatory, public welfare, or strict liability offenses, with the more traditional common law or statutory crimes, such as murder, assault, rape, etc.

Constitutionally Vague Resolutions

Vague, ambiguous, or complex regulations may not be enforceable by criminal sanctions. As previously noted, some specific intent to violate a statute or regulation must be shown to secure a criminal conviction. If the regulation by its own construction is vague, ambiguous, or subject to more than one interpretation, prosecutors may elect not to prosecute or the case may not be subject to constitutional attack on grounds of vagueness. Simply stated, it would be difficult or impossible to prove the requisite culpable mental state. If criminal sanctions are to have a deterrent effect, the regulations must be clear and subject to understanding by those who are regulated, otherwise prosecutors, juries, and judges will have very little sympathy with the regulatory agency. Accordingly, prosecution will be most difficult and cases will be dismissed and/or will never be brought, therefore, limiting the deterrent value of the criminal sanctions.

Concurrent Civil and Criminal Proceedings

Proceeding with both civil and criminal investigations at the same time or beginning with a civil investigation (where Fifth and Fourth Amendment prohibitions may not apply) and then commencing a criminal investigation can present problems. Misrepresentations by investigators and the scope of their investigations and their failure to warn of the possibility of criminal investigations can be raised as defenses. Defendents may be able to argue that they have been prejudiced by the civil investigation and have the criminal indictments or case dismissed. Whether defendents can gain access to grand jury information and the area of grants of immunity and promises not to prosecute are related problems.

Double Jeopardy

Bringing a criminal action may also raise constitutional questions or double jeopardy. For example, can the same defendent be criminally prosecuted in the same jurisdiction or in different jurisdictions for several accidents involving different containers of the same type manufactured in the same production batch?

The scope of this paper does not permit a detailed discussion of all the problems associated with proceeding in criminal cases and cases against a corporation and its employees, particularly where civil actions are also brought. Many of these questions have been raised in recent antitrust cases. It is enough to say that the area presents many complex problems for both defendents and prosecutors.

EXISTING STATUTORY LAW

Current federal criminal law pertaining to culpability is hopelessly confused; there are more than 75 different terms used to describe the mental elements of the criminal statutes. The courts have been left to construe the many terms used to describe mens rea, and more inconsistency and conflicting meanings have been generated.

The Hazardous Materials Transportation Act provides that a person is guilty of an offense under the Act if he or she "willfully violates the Act or a regulation issued under the Act". There is a fine of $25 000 or imprisonment for a term not to exceed 5 years, or both. Examples of other statutory terms used in the related safety, health, and environmental areas are "willfully" or "negligently" (Federal Water Pollution Control Act), "knowingly" (Clean Air Act), "knowingly" or "willful" (Toxic Substances Control Act), and "willfully and the violation caused death" (OSHA).

It has been suggested that, notwithstanding the specific requirements of statutes in the health, safety, and environmental areas, imaginative prosecutors could use several other federal criminal statutes as a method to get around certain difficult questions of proof of intent. The use of the federal statute on aiding and abetting would be one way. The purpose of this statute is to permit prosecution of those who aid or assist others in the commission of an offense and also those who cause others to perform direct illegal acts, but refrain from doing so themselves. The federal crime of conspiracy, meaning a combination of persons to accomplish an unlawful purpose, may also be useful to prosecutors. There is a broad federal statute governing the filing of false reports. After an investigation of an incident has begun, prosecutors have the criminal charges of obstruction of justice, concealment, and making false statements to fall back on. For example, the FMC Corporation recently pleaded guilty to criminal charges of filing false information, concealing information, and obstructing the EPA. As part of the plea bargaining, two FMC employees, who were charged with conspiracy, fraudulent concealment, and obstruction, had charges against them dropped.

ISSUES AND QUESTIONS

In the area of hazardous materials transportation, as previously stated, the three options to be considered are

1. Should criminal sanctions be imposed at all, or should civil remedies of fines and injunctions be relied on as the sole remedies available;
2. Should criminal sanctions be generally employed, but only as a supplement to the general pattern of civil regulations, that is, as a last resort to punish particularly recalcitrant or egregious corporate behavior; or
3. Should the full effect of criminal sanctions be aggressively employed to shape corporate action and enforce compliance?

In consideration of the use of criminal sanctions under the Act, the following highlights some of the fundamental policy questions that must be addressed in order to formulate an intelligent and meaningful policy concerning the intelligent use of such sanctions as an aid for enforcement.

1. Are the regulations clear and capable of being understood? Vague, ambiguous, and meaningless standards can and will be constitutionally attacked as being void and unenforceable, particularly in a criminal proceeding.
2. In pressing criminal sanctions, should they be imposed only against corporations, given the debatable position that criminal sanctions deter corporate behavior, or should they also be employed against individuals?
3. If criminal sanctions are brought against individuals, should they be employed only as a means of catching the direct actor, that is, the mental or

lower-level employee, or should the aim be at the "executive" level in order to achieve maximum deterrent effect?

4. If criminal sanctions are brought against direct actors, is it desirable to stigmatize all the officers, directors, and employees of a large corporation for the conduct of, for example, one truck driver or one engineer, who--in contravention of clear corporate policy--ignored a hazardous materials safety problem?

5. Should the Act be amended to delete the requirement of a culpable mental state or mens rea? That is, delete the word "willfully" in order to bring the Act in line with the strict liability of the Federal Food, Drug, and Cosmetic Act. This law, as previously indicated, permits the imposition of strict criminal liability on corporations and individuals who violate the law or FDA regulations. In this regard, it must be questioned whether the transportation of hazardous materials rises to the same degree of concern for the public health and welfare as does the Federal Food, Drug, and Cosmetic Act.

6. Is the word "willfully" appropriate, or should some other standard be incorporated to better get at indirect actors, such as supervisors and executives? For example, should standards such as reckless supervision or negligent supervision be added?

7. Is it desirable to employ criminal sanctions to deter when it may be difficult to assure any semblance of proportionality between the crime and the punishment? For example, not complying with container test requirements could be a criminal offense, even though the product may be adequate in every way.

8. If individual employees are to be prosecuted, particularly in an aggressive fashion, will the threat of such prosecutions invoke a response of self-serving, self-protective internal memoranda by fearful employees?

9. Will intra-company communications offering creative but unproven ideas, cease being written for fear such communications will be subpoenaed to show criminal intent?

10. Will an inordinate amount of employee effort be diverted to miniscule risk reductions and away from other areas of concern, such as solving quality control and product liability problems, enhancing the durability of products and efficiency of transportation, and maximizing the efficient use of scarce resources and increased means of productivity?

11. Will engineers and managers become unwilling to pioneer or approve new design concepts?

12. In light of the ability to second-guess cost/benefit analyses in the safety area, should managers seek all available data and make the most accurate analyses possible or should they make only intuitive gut judgments not reduced in writing? The former makes rational sense, but because it is easily subpoenable in a criminal prosecution, there are obvious risks.

13. Since the mere transportation, shipping, and manufacturing of containers to contain hazardous materials and the marketing of such containers inevitably create some safety risks, what risk level should a corporation determine not to exceed and at what cost? Must a standard of "zero risk" be met in order to be "safe" from criminal prosecution?

14. Is it really fair to prosecute a corporation in a situation where no single corporate representative possessed all of the knowledge necessary to render the corporation's conduct culpable? For example, an engineer may conceive a design improvement for a tank car, but reject it because it might create a minor safety problem. Another engineer working on a different aspect of the tank car--if informed of the first engineer's idea--would have seen that it would greatly reduce different safety risks involved in the tank car's use. Can the company be prosecuted for having marketed products that it knew, in a collective sense, could have been made safer on a net basis?

15. What rationale should be used and what criteria adopted so as to achieve an element of fairness in prosecution, assuming both civil and criminal sanctions will be used? Should the agency adopt a memorandum, to be made public, explaining its rationale for seeking criminal sanctions--for example, a document explaining the type of case and violation in which corporations, or corporations and individuals, would be subject to criminal prosecution?

CONCLUSION

In light of the substantive and procedural difficulties in the use of criminal sanctions and in consideration of a uniform, effective, and fair enforcement policy, it would appear that the preferred use of criminal sanctions in the enforcement of hazardous materials transportation regulations would be reserved for exception cases and not for day-to-day policing of the regulations. The latter can much more readily be left to aggressive inspection, monitoring, and enforcement with civil actions, fines, injunctions, and, possibly, private treble damage actions of a nature now found under the antitrust laws.

In using criminal sanctions in exceptional cases, concentration should be aimed to deterrence and punishment of particularly recalcitrant or egregious corporate behavior. Primary targets of enforcement should be willful, intentional, or repeat offenders, who violate important and substantive regulations. Prosecution of individual corporate officers should be attempted only where the evidence demonstrates that an intentional corporate noncompliance with the law is a direct result of an informed policy decision made by such corporate officials. Further, criminal sanctions should be employed only when knowing or willful violations can readily be proven. To bring a marginal criminal case in which the proof is weak, particularly against individual officers or employees of a corporation, will have little deterrent value if the agency is unsuccessful. On the other hand, it can have a devastating effect on careers and the general reputation of the individuals involved.

Finally, it is submitted that a comprehensive enforcement policy statement should be adopted and made public. The publishing of such an enforcement policy would ensure that organizations and individuals subject to the provisions of the Act are aware of the types of violations under which the agency will seek criminal sanctions. Once such a rationale is made public, it has an essential element of fairness that will go far in blunting any criticism of the agency's approach of preferring criminal instead of civil charges. It will eliminate the element of surprise, which should not be present in the choice of remedies by the agency, and further the preferred approach of a uniform, effective, and fair enforcement policy.

REFERENCES

[Editor's Note: The materials cited here represent a selected bibliography that may be helpful to those interested in the legal areas of study regarding aspects of transportation of hazardous materials.]

Periodicals

Ad Hoc Committee of the Section of Corporation, Banking and Business Law, American Bar Association, Report on Proposed Federal Criminal Code, 34 Bus. Law, 725 (1979).

Altman, Labeling and Advertising Trends, 34 Food Drug Cosm. L.J. 569 (1979).

Baker and Reeves, The Paper Label Sentences: Critiques, 86 Yale L.J. 619 (1977).

Breyer, Analyzing Regulatory Failure: Mismatches, Less Restrictive Alternatives and Reform, 92 Harv. L. Rev. 549 (1979).

Committee on Corporate Law Dept. Forums, Recent Developments in EEO, EPA and OSHA, 35 Bus. Law. 573 (1980).

Conyers, Corporate and White-Collar Crime: A View by the Chairman of the House Subcommittee on Crime, 17 Am. Crim. L. Rev. 287 (1979-80).

Dershowitz, The Paper Label Sentences: Critique, 86 Yale L.J. 626 (1977).

Feinberg, Toward a New Approach to Proving Culpability: Mens Rea and the Proposed Federal Criminal Code, 18 Am. Crim. L. Rev. 123 (1980).

Hutt, Food and Drug Regulation in Transition, 35 Food Drug Cosm. L.J. 283 (1980).

Levin, Crimes Against Employees: Substantive Criminal Sanctions Under the Occupational Safety and Health Act, 14 Am. Crim. L. Rev. 717 (1977).

Liman, The Paper Label Sentence: Critique, 86 Yale L.J. 630 (1977).

Manning, Hyperlexis: Our National Disease, 71 N.W. U.L. Rev. 767 (1977).

McAdams and Tower, Personal Accountability in the Corporate Sector, 16 Am. Bus. L.J. 67 (1978).

Merrill, FDA and the Effects of Substantive Rules, 35 Food Drug Cosm. L. J. 270 (1980).

O'Keefe, Criminal Liability: Park Update, 32 Food Drug Cosm. L.J. 392 (1977).

Olds, Unkovic, and Lewin, Thoughts on the Role of Penalties in the Enforcement of the Clean Air and Clean Water Acts, 17 Duq. L. Rev. 1 (1977-78).

Renfrew, The Paper Label Sentences: An Evaluation, 86 Yale L.J. 590 (1977).

Sethi and Katz, The Expanding Scope of Personal Criminal Liability of Corporate Executives--Some Implications of United States v. Park, 32 Food Drug Cosm. L.J. 544 (1977).

Wheeler, The Paper Label Sentences: Critique, 86 Yale L.J. 636 (1977).

Whiting, OSHA's Enforcement Policy, 31 Lab. L.J. 259 (1980).

Developments in the Law, Corporate Crime: Regulating Corporate Behavior Through Criminal Sanctions, 92 Harv. L. Rev. 1227 (1979).

Note, Toward a Rational Theory of Criminal Liability for the Corporate Executive, 69 J. Crim. L. and Criminology 75 (1978).

Note, Individual Liability of Agents for Corporate Crimes Under the Proposed Federal Criminal Code, 31 Vand. L. Rev. 965 (1978).

Note, Putting Bite in NEPA's Bark: New Council on Environmental Quality Regulations for the Preparation of Environmental Impact Statements, 13 U. Mich. J.L. Ref. 367 (1980).

Comment, Court-Ordered Indemnification of Corporate Officers and Directors, 1979 Ariz. St. L.J. 639.

Comment, Is Corporate Criminal Liability Really Necessary? 29 Sw. L.J. 908 (1975).

Comment, Increasing Community Control Over Corporate Crime--A Problem in the Law of Sanctions, 71 Yale L.J. 280 (1961).

Case Note, Prosecution of Corporate Officials Under the Federal Food, Drug and Cosmetic Act--United States v. Park, 37 Ohio St. L.J. 431 (1976).

Case Comment, Criminal Law: Public Welfare Violations--Imposing Criminal Sanctions With a Strick Liability Standard?--United States v. Park, 28 U. Fla. L. Rev. 596 (1976).

Books and Reports

Marshall B. Clinard and Peter C. Yeager, Corporate Crime (1980).

G. Naftalis, White-Collar Crimes (1980).

Benjamin Civiletti, National Priorities for the Investigation and Prosecution of White Collar Crime (1980). Available from U.S. Government Printing Office.

Marshall Clinard, Illegal Corporate Behavior (1979) (Law Enforcement Assistance Administration--funded study). Available from U.S. Government Printing Office.

The Conference Board, Regulatory Problems and Regulatory Reform: The Perceptions of Busines, Rep. No. 769 (1980).

The Conference Board, Regulatory Problems and Regulatory Opinions and Characteristics, Rep. No. 786 (1980).

Council on Environmental Quality, Eighth Annual Report (Dec. 1977).

Freeman, The Proposed Federal Criminal Code, Outline of Talk to Northwestern's Annual Institute for Corporate Counsel, October 9, 1980.

Management/Employee Relations Counsel and Ronald N. Green, Occupational Safety and Health: An Executive's Guide (1976).

Transportation Research Board, The Ten Most Critical Issues in Hazardous Materials Transportation, Circular No. 219, July 1980.

Congressional Hearings and Reports

Sunset, Sunrise and Related Measures: Hearings on H.R. 2 and H.R. 65 Before the Subcomm. on the Legis-

lative Process of the House Comm. on Rules, 96th Cong., 1st Sess. (1979).

Regulatory Reform: Hearings Before the Senate Comm. on the Judiciary, 96th Cong., 1st Sess. (1979).

Regulatory Reform Legislation: Hearings on S.262, S.755, S.455, and S.93 Before the Senate Comm. on Gov't Affairs, 96th Cong., 1st Sess. (1979).

Senate Comm. on the Judiciary, S. 1722 Criminal Code Reform Act of 1979, S. Rep. No. 553, 96th Cong., 2d Sess. (1980).

Congressional Quarterly

Congress Clears Legislation Increasing EPA's Authority Over Illegal Waste Dumpers, 38 Cong. Q. 3112 (weekly rept., Oct. 11, 1980).

House Passes Most of Carter's Superfund Plan, 38 Cong. Q. 2819 (weekly rept., Sept. 27, 1980).

Regulatory Reform, 38 Cong. Q. 2752 (weekly rept., Sept. 20, 1980).

Prospects Dim for 'Sunset' Legislation as Senate Panel Waters Down Original Bill, 38 Cong. Q. 2645 (weekly rept., Sept. 6, 1980).

Congress Nears Action on Superfund Bills, 38 Cong. Q. 2601 (weekly rept., August 30, 1980).

Senate Committee Approves 'Sunset' Legislation Aimed at Regulatory Agencies, 38 Cong. Q. 1891 (weekly rept., July 5, 1980).

Senate Judiciary Approves Its Own Bill to Revamp Federal Agency Rulemaking, 38 Cong. Q. 1293 (weekly rept., May 10, 1980).

House Judiciary Panel OK's Regulatory Reform Bill, Rejecting a Legislative Veto, 38 Cong. Q. 934 (weekly rept., April 5, 1980).

Bill to Overhaul Federal Regulatory Procedures Approved by Senate Unit, 38 Cong. Q. 128 (weekly rept., Jan. 19, 1980).

No Floor Action Seen on Regulatory Reform Bills Until Next Year, 37 Cong. Q. 2543 (weekly rept., Nov. 10, 1979).

House Panel Reports a Bill Designed to Reduce Federal Controls on Small Businesses, Id., at 2545.

Magazines

The Candidates on Business: Carter and Reagan Face Off On the Vital Question of Regulatory Reform, United Mainliner, Oct. 1980, at 82.

The Poisoning of America, Time, Sept. 22, 1980, at 58.

The Executive Threat to a 'Legislative Veto', Business Week, Aug. 11, 1980, at 31.

Business' Big Morality Play, Dun's Review, August 1980 at 56.

Easing Regulatory Burdens on Small Business, Business Week, June 16, 1980, at 156.

Trouble for Regulators Has Only Begun, U.S. News and World Report, June 2, 1980, at 59.

The Real Victims of Government Regulation, U.S. News and World Report, April 28, 1980, at 87.

Zero Risk, Science, Vol. 208, April 4, 1980, at 7.

Kanuck, The Role of Regulatory Agencies in the Eighties, Vital Speeches of the Day, March 1, 1980, Vol. 46, at 315.

What Price Safety? The "Zero-Risk" Debate, Dun's Review, Sept., 1979, at 49.

The Boss in the Slammer, Forbes, Feb. 5, 1979, at 61.

Is a Regulatory Revolt Next?, Nation's Business, Oct. 1978, at 28.

Government Regulators: A Shadow Industry in Need of Control, Mobil Overview, Vol. 2, No. 3, Fall 1978, inside cover.

Newspapers

Pinto Lawyer Sees More Criminal Suits Against Firms, Chicago Tribune, Dec. 15, 1980, S5 at 9.

Wishingrad and Abrams, Intent in Criminal Prosecutions: 'Per Se' Exception Unsupported, The National Law Journal, Dec. 15, 1980, at 24.

Outline Emerges in Reagan Attack on Regulations, Chicago Tribune, Nov. 16, 1980, S5, at 1.

Toxic Waste: A Legal Mess, The National Law Journal, Nov. 10, 1980, at 1.

Wheeler, The Public's Costly Mistrust of Cost-Benefit Safety Analysis, The National Law Journal, Oct. 13, 1980, at 26.

Wheeler, In Pinto's Wake, Criminal Trials Loom for More Manufacturers, The National Law Journal, Oct. 6, 1980, at 27.

White-Collar Enforcement Priorities Set, Legal Times of Washington, Sept. 15, 1980, at 2.

Life in America: Dangerous, But We Must Risk It, Chicago Tribune, Sept. 14, 1980, S1, at 5.

Is America the Next Sick Man of the West?, Chicago Tribune, Sept. 5, 1980, S3, at 3.

Asbestos Suits Catching Fire, The National Law Journal, Aug. 18, 1980, at 1.

Prosecutions of Dumpers of Toxic Waste Underscore the Shortage of Suitable Sites, Wall Street Journal, Sept. 2, 1980, at 42.

Navigating Corporate Crime Probes, The National Law Journal, July 21, 1980, at 18.

Corporate Violence Goes Unpunished, The National Law Journal, May 26, 1980, at 1.

U.S. Bares Teeth, Snaps at Environment Law Violators, Legal Times of Washington, April 21, 1980, at 47.

Friendly, 'Should We Be Turning Back the Law Flood?', Legal Times of Washington, Oct. 8, 1979, at 7.

Fatalities Prompt OSHA Criminal Review, Legal Times of Washington, May 28, 1979, at 12.

OSHA Acts to Press Criminal Charges in On-Job Fatalities, Wall Street Journal, April 16, 1979.

Lawyers Study Defense of Business Crime, New York Times, July 24, 1978.

Regulations and Fees Boost Legal Expenses; Firms Try to Cut Them, Wall Street Journal, April 13, 1978, at 1.

Services and Miscellaneous

EPA Defines, Lists Hazardous Wastes, Sets Standards for Waste Facilities, 11 Envir. Rep (BNA) 35 (Current Developments, May 9, 1980).

Toxic Substances Suits Usher in New Era in Tort Litigation, BNA Washington Memorandum, No. 71, Feb. 26, 1980, at 1.

EPA, Justice Give 'Highest Priority' to Investigating Hazardous Waste Sites, 11 Envir. Rep. (BNA) 3 (Current Developments, May 4, 1979).

Moorman Seeks More Citizen Suits, Predicts Step-Up in Criminal Probes, 8 Envir. Rep. (BNA) 1649 (Current Developments, Feb. 24, 1978).

EPA Outlines Enforcement Strategy for Municipal, Industrial 'Recalcitrants', 8 Envir. Rep. (BNA) 308 (Current Developments, June 24, 1977).

Executive Criminal Liability--United States v. Park, 3 Feb. Bus. Laws, Ch. 540 (FBL, Sept. 1975).

Selected Leading Cases

United States v. U.S. Gypsum Co., 438 U.S. 422 (1977).

United States v. Park, 421 U.S. 1903 (1975).

United States v. Frezzo Bros., Inc., 602 F. 2d 1123 (3d Cir. 1979).

Hercules, Inc. v. Environmental Protection Agency, 598 F. 2d 91 (D.C. Cir. 1978).

United States v. Winston, 558 F. 2d 105 (2d Cir. 1977).

United States v. Y. Hata and Co., 535 F. 2d 508 (9th Cir. 1976).

United States v. Sexton Cove Estates, Inc., 526 F. 2d 1293 (5th Cir. 1976).

United States v. U.S. Steel Corp., 482 F. 2d 439 (7th Cir.), cert. denied, 94 S. Ct. 229 (1973).

United States v. New England Grocers Supply Co., 488 F. Supp. 230 (D. Mass. 1980).

United States v. Acri Wholesale Grocery Co., 409 F. Supp. 529 (S.D. Iowa 1976).

United States v. U.S. Steel Corp., 328 F. Supp. 354 (N.D. Ind. 1970).

In re Winship, 397 U.S. 358 (1970).

Mullaney v. Wilbur, 421 U.S. 648 (1975).

Preemption: How Do We Deal with Interjurisdictional Conflicts with Law?

J. Kevin Healy

DEFINING THE PROBLEM

Incidents that have occurred over the course of the last decade have increasingly made known to the general public the dangers presented by the motor vehicles, trains, and vessels that carry hazardous materials through our nation's communities. In light of these incidents and of the increased public concern they have generated, officials on the federal, state, and local levels have for the past few years been actively seeking to expand and strengthen their regulatory control over such activities.

As DOT is improving its regulations under the mandates of the Hazardous Materials Transportation Act (HMTA) (1), an ever-increasing number of state and local jurisdictions are imposing more or less restrictive operating controls, routing requirements, and equipment standards on carriers transporting hazardous materials through their areas.

DOT and the transportation industry view this proliferation of differing state and local requirements with concern, fearing that the regulatory pattern in the hazardous materials field is in danger of falling into chaos. Because state and local officials, on the other hand, believe that the specific concerns of their communities are not being adequately addressed by the federal authorities, they feel that they have an obligation to act themselves.

Thus, the stage is set for a classic interjurisdictional conflict, with the state and local authorities on one side, exercising their police power to protect their constituent public from what they perceive to be an imminent danger, and with the federal authority on the other, feeling an obligation to bring consistency to the field.

Clearly, a prime objective of Congress in passing the HMTA was to avoid a multiplicity of differing and conflicting regulations (2). It, therefore, consolidated federal authority over hazardous materials transport into DOT (3), and set some very specific criteria for permissible state and local action (4).

Congress did not, however, absolutely preempt non-federal activity in the HMTA (5), apparently recognizing that state and local authorities must continue to play some role in the effort to "protect the nation adequately against the risks to life and property which are inherent in the transportation of hazardous materials in commerce" (6).

JUDICIAL DECISIONS HAVE ESTABLISHED GENERAL RULES ON PREEMPTION

As in all cases that present issues of interjurisdictional conflict involving state and local regulation of interstate commerce, the courts will measure the validity of a non-federal action to regulate hazardous materials transport against the Commerce Clause (7) and the Supremacy Clause (8) of the U.S. Constitution.

A host of decisions dealing with similar issues have led to the development of some relatively clear principles that are considered in the application of the doctrine of federal preemption. The courts begin with an assumption that a requirement promulgated by a state and local jurisdiction in the proper exercise of its police power is valid, and this is especially true when the regulation involved relates to highway safety (9).

If Congress has not passed any legislation, so that federal supremacy is not at issue, the courts will uphold state or local requirements relating to public safety or welfare so long as the statute regulates evenhandedly to effectuate a legitimate local public interest, and so long as the burden imposed on interstate commerce is not excessive in relation to the local benefits accruing from it (10). Thus, the question addressed by the courts under the Commerce Clause is one of degree, with the interest to be protected by the local measure balanced against the extent of the burden on interstate commerce (11).

Where, however, Congress has acted, the courts undertake an additional analysis to test the state action against the Supremacy Clause. Again, however, they start with an assumption that the state or local law is valid (12). They then proceed to determine whether Congress demonstrated an intent to foreclose non-federal action, either explicitly or implicitly (13).

In the event the courts conclude that Congress did not intend a total preemption, they go on to inquire into whether there is an actual conflict or inconsistency between the state or local regulation and the federal statute. Where they find such inconsistency, either because (a) compliance with the federal requirement on the one hand and the state or local requirement on the other is impossible, so that adherence to one set of requirements could lead to enforcement of the other (14); or (b) the state or local law stands as an obstacle to accomplishment and execution of the full purpose of the act of Congress (15), they will declare the state or local requirement to be preempted.

Congress has made clear by the terms of the HMTA that it did not intend to totally preempt state or local activity in the field of hazardous materials transport regulation (16). Section 112 of the Act declares an inconsistent state or local provision to be preempted, unless, on the application of an appropriate state agency, DOT determines that such inconsistent requirement affords an equal or greater protection to the public and does not unreasonably burden commerce.

Thus, Congress imposed on the Secretary of Transportation the burden of determining, by means of some sort of administrative proceeding, whether an inconsistent provision of state or local law, which would otherwise be preempted, should be given effect. In the course of making this determination, Congress directed DOT to measure the state or local requirement against the restrictions of the Commerce Clause.

It should be noted, however, that Congress did not, by the language of S.112 give DOT the duty to make the threshold determination as to whether a non-federal provision is "inconsistent" within the meaning of the act. Nevertheless, DOT has assumed this responsibility by its regulations.

DOT, IN THE COURSE OF ITS ADMINISTRATIVE PROCEEDINGS, HAS APPLIED JUDICIAL RULES OF PREEMPTION TO ISSUES ARISING UNDER THE HMTA

Inconsistency

On September 9, 1976, DOT promulgated regulations establishing procedures and standards for rendering "inconsistency rulings" and "non-preemption determinations" pursuant to S.112 of the HMTA (17).

In the prologue to these regulations, DOT--apparently in response to comments objecting to its assumption of the task of dealing with the question of inconsistency--acknowledged that this question is one that has been traditionally judicial in nature, but declared that it did not view the courts as the "exclusive arbitrators" of the issue (18). It therefore established procedures allowing it to apply to two general tests developed by the courts to resolve conflicts under the Supremacy Clause--i.e., to questions of what is inconsistency within the meaning of S.112 of the HMTA.

Under DOT's regulatory procedure, the associate director of the Office of Enforcement issues inconsistency rulings, on the application of "any affected party", and after appropriate notice to other interested persons. These rulings, which can be appealed to the director, are based on two considerations: (a) whether compliance with both the state and the local requirement and the Act or the regulations issued under the Act is possible ("the dual compliance test"); and (b) the extent to which the state or local requirement and execution of the Act and the regulations issued under the Act meet "the obstacle test".

Several applications for inconsistency rulings are now pending before DOT. Two significant decisions have been published.

The first ruling, IR-1 (19), concerned regulations promulgated by the New York City Health Department, which imposed restrictions amounting to a ban on the transportation of certain radioactive materials through the city. DOT, interpreting the restrictions as severe routing requirements for such materials, set out to apply its two tests. Since DOT had not promulgated any of its own rules in regard to routing, it found that the New York City regulation neither made it impossible to comply with any federal requirement nor stood as an obstacle to achievement of any federal regulatory objective. It therefore found the New York requirement to be consistent.

The next inconsistency ruling, IR-2, illustrates more clearly the analysis DOT will undertake to decide the issue of inconsistency. This proceeding dealt with several operating restrictions and equipment requirements imposed by the State of Rhode Island on carriers transporting hazardous materials across its borders.

DOT applied the two tests to each of the substantive Rhode Island requirements at issue and thereby determined some to be consistent, but most to be inconsistent, with the federal requirements. It found, for example, that compliance with certain Rhode Island requirements, such as those requiring the illumination of a rear bumper warning sign, would lead to violation of a federal requirement regulating the types of lights allowable in the rear of such a vehicle. It found others, such as those requiring placarding, to cause confusion with the federal Hazard Identification System and to thereby stand as an obstacle to accomplishment of a federal regulatory objective. Still others, like those imposing curfews or requiring the filing of reports, are found to stand as obstacles to the federal objective of promoting safety, since they generated unnecessary delay, and delay is incongruous to safe transport.

However, DOT made clear in this ruling that there are areas within the field of regulations in which a state or local jurisdiction might act consistently with federal authority. It stated, for example, that a non-federal authority might regulate to eliminate or reduce a peculiarly local safety hazard not adequately addressed by federal regulations.

While DOT rejected Rhode Island's argument that it was acting to protect against such local safety hazards, it found several of the state regulations, such as requiring the operating vehicles carrying hazardous materials with headlights on, or the

equipment of such vehicles with two-way radios, to be consistent. It also indicated that some types of permitting activities may not be inconsistent, but found the particular ones at issue to be so in that they required the applicant to submit redundant information.

Thus, in the Rhode Island ruling DOT has demonstrated its intent to allow some fairly extensive non-federal activity to continue.

However, a provision appearing in HM-164 (20), the regulations proposed for the routing of radioactive materials, indicates a contrary purpose. This provision simply declares several types of state or local controls on radioactive materials transport, such as curfews, pre-notification, and escorting, to be "inconsistent" with the federal requirements. Curiously, no substantial attempt was made by DOT to set forth the legal basis for this declaration and no indication appears that DOT applied its two tests for inconsistency prior to formulating this conclusion.

No judicial challenge has been filed to test any of these DOT actions. Thus, neither the procedures established by DOT to decide inconsistency nor the standards it applies have been subject to the scrutiny of a court.

Non-Preemption Determinations

DOT regulations for issuing non-preemption determinations are virtually identical to those established for inconsistency rulings. The standards applied, which relate to the considerations mandated by S.112(b), are (a) whether the state requirement affords at least an equal level of safety to the public; and (b) whether the state requirement does not unreasonably burden interstate commerce.

DOT considers several factors in making this determination (such as the impairment of efficiency resulting from the regulation)--all of which were developed by the courts in testing a state or local requirement against the Commerce Clause.

While at least one application has been submitted for a non-preemption determination, no substantive decisions have yet been issued.

SEVERAL OUTSTANDING LEGAL ISSUES HAVE YET TO BE SETTLED BY THE COURTS

Although the courts have long established many of the general principles to be used in resolution of preemption issues, they have as yet been given little opportunity to apply such principles to conflicts arising under the HMTA. Therefore, there are several outstanding issues to be judicially resolved. The most significant of these are described briefly here.

What Is the Legal Effect of an Inconsistency Ruling?

There is some question as to DOT's authority to entertain the issues of inconsistency, since the HMTA does not explicitly provide DOT with any such authority, and since this issue is one that has traditionally been determined by the courts. Presuming, as DOT has, that this authority has been granted implicitly by the language of S.112, it seems at the very least that a court is not bound by a DOT decision, and that a district court can consider the issue de novo (21).

What Standards Should Be Applied by DOT to Determine Inconsistency?

It is not clear whether DOT should properly apply both the "dual compliance" test and the obstacle test" in performing its analysis in the course of an inconsistency proceeding. An argument can be made that Congress might not have intended S.112(b), which authorizes a waiver of preemption for inconsistent provisions of state or local law, to apply to provisions that are inconsistent by reason of their standing as obstacles to the federal purpose. Congress may, in fact, have intended only to allow this waiver to apply to measures that are inconsistent in the dual-compliance sense, since it might otherwise have authorized the survival of measures obstructing its own purpose--a scheme that is somewhat improbable.

Thus, Congress may have intended to leave the obstacle test to the courts, indicating in S.112(b) that a state or local provision that is consistent (under the dual-compliance test), but that provides adequate protection and does not unreasonably burden commerce, does not indeed stand as an obstacle to the objectives of the congressional act.

An argument can, of course, be made on the other side that the waiver of preemption provision contained in S.112(b) was intended to be applied only in emergency situations to protect against particularly imminent local dangers (22), and that Congress had, only under such compelling circumstances, intended to allow inconsistent provisions under either test to stand.

What "Local Safety Hazards" Justify State or Local Action?

In the Rhode Island inconsistency ruling, DOT indicated that state or local authorities might act to protect against local safety hazards not addressed by federal regulations (23). Since this concept, if interpreted broadly by either DOT or the courts, might authorize extensive non-federal action, its clear definition is critical to the issue of preemption under the HMTA.

While no judicial decisions have as yet applied this concept under the HMTA, similar issues have been addressed in cases arising under 434 of the Federal Railroad Safety Act (24), which indicate that the local safety hazard presented must be unique. Thus, the courts have required a demonstration that the hazard being regulated is not statewide in character and is not a subject capable of being regulated through national standards (25).

DOT CAN DEVELOP ITS SUBSTANTIVE RULES SO AS TO MINIMIZE LITIGATION ARISING FROM INTERJURISDICTIONAL CONFLICT

DOT can deal with the problem of interjurisdictional conflict of regulations in any of several ways. It can (a) leave regulation to the states and localities; (b) adopt uniform national federal regulations as it sees fit, without regard for the specific concerns of states or localities; (c) enact federal regulations that impose different requirements on different areas; or (d) establish federal criteria for acceptable state or local regulations.

DOT Can Leave Regulation to the States and Localities

Although S.105 of the HMTA gives the Secretary of DOT very broad authority to develop regulations regarding hazardous materials transport, it does not mandate the Secretary to do so. Therefore, all regulatory activity, or a major part of it, can be left to the state or localities.

In fact, DOT has to some extent, either by inaction or by conscious decision, followed this course since the HMTA was enacted. It has exercised its authority over certain categories of regulatory

authority but left broad areas of the field to state and local action.

Thus, DOT has not yet promulgated routing requirements for hazardous materials transport and has, as was noted in the New York City inconsistency ruling, consequently left the states and localities with the uncontested ability to impose their own routes on carriers.

Indeed, in some areas of regulation DOT has affirmatively endorsed local requirements and directed carriers to comply with them. 49 CFR 397.2 provides that "every motor vehicle containing hazardous materials must be driven and parked in compliance with the laws, ordinances and regulations of the jurisdiction in which it is being operated, unless they are at variance with specific regulations of the Department of Transportation which are applicable to the operation of that vehicle and which impose a more stringent obligation or restraint". Hence, at least in the fields of routing, traffic, and parking regulations, DOT has allowed local regulation to remain dominant.

Perhaps DOT should continue this arrangement, since state and local officials are most informed as to the detailed social, economic, political, and topographical characteristics of their areas. They are, in addition, more reactive to the concerns of their constituent public, and, therefore, more reflective of public sentiment at the grass roots level.

However, Congress did not have this in mind when it enacted the HMTA. Recognizing that state and local officials simply did not have the sophisticated expertise on which decisions in this area must be based and recognizing also that uniformity and consistency of regulation are essential factors in bringing the transportation of hazardous materials under rational control, Congress made very clear that the primary role in these matters was to be played by the federal authority.

DOT Can Preempt the Entire Field of Regulation

DOT might promulgate federal regulations across the board, without giving specific regard to the differing concerns of the various states and localities. In effect, it can carry on its business under the HMTA as it has thus far.

There is no doubt that this is an attractive path to follow. By utilizing its vast expertise and data base and drawing on the expertise of the transportation and chemical industry, DOT can develop regulations that are uniformly applicable across the nation. It can impose a comprehensive federal routing scheme and uniform requirements for the construction, equipment, and operation of all vehicles carrying hazardous materials without regard to where such vehicles travel.

It might promulgate such regulations under its present rulemaking procedures, giving the Federal Register notice required by 49 CFR 106.15 and convening hearings and conferences as it sees fit. While this option might eventually provide great benefits in terms of consistency and uniformity, it might also generate enough opposition to mire the regulation of hazardous materials in the courts for years and might produce more litigation-induced confusion than now exists.

State and local officials, environmental organizations, and local citizen groups are deeply and personally concerned with the dangers posed by the movement of hazardous materials through their communities. As a result, they are disinclined to leave the regulation of such activities to the federal authorities. In fact, if they are not convinced that their concerns are being specifically addressed and that their interests are being protected by the federal government, they will vigorously oppose the federal action and will continue to act to protect themselves.

Thus, any rulemaking activity that does not take region-specific concerns into careful account and any regulations that do not provide a significant role to non-federal authorities will be hotly contested in court. Moreover, even if DOT succeeds in the promulgation and defense of such regulations, litigation would continue.

The simple existence of federal regulations does not, by itself, automatically invalidate state or local regulations on the same subject. DOT must first find such regulations to be inconsistent with the federal requirements pursuant to S.112 of the HMTA, must deny any petition for non-preemption submitted pursuant to S.112(b), and must then defend any consequent litigation.

Presumably, non-federal authorities would continue to enforce their requirements until finally mandated by the courts to cease. Even then, they could make legislative adjustments that could revive the entire administrative and judicial preemption process. Taking into account that there are 50 states and countless local jurisdictions, all of which view the transportation of hazardous materials with profound concern, the potential is great for litigation to bring chaos to any attempt by DOT to follow this option.

Moreover, the concerns that would engender such opposition may be quite legitimate. State and local authorities who identify an extraordinary danger within their jurisdictions have the responsibility to exercise their authority to protect their constituents, unless the federal government has, itself, adequately done so. While there is undoubtedly a need for consistency in the area of hazardous materials transport regulation, there is not necessarily a need for absolute uniformity. In fact, local conditions may exist that should be reflected in the regulatory scheme and should be considered in the rulemaking process. It would, therefore, be appropriate for DOT to develop a mechanism for the federal regulatory scheme to take local considerations into account.

DOT Might Promulgate Regulations That Vary As a Result of Local Conditions

DOT might promulgate regulations that establish a regulatory norm--imposing basic equipment requirements, operating procedures, and general routing constraints on hazardous materials transporters operating anywhere in the nation. It might then establish certain "zones" in which more restrictive requirements would be imposed.

It could attempt to do so broadly by establishing wide geographic regions with varying requirements imposed within their boundaries. Thus, it could apply more restrictive controls on the movement of hazardous materials in congested urban regions, while allowing freer movement in sparsely populated rural areas.

It might also, however, develop a more complex regulatory structure, with zones developed on a state or local level. More than one category of zone might be developed, of course, with more or less restrictive requirements applicable to each category. However, DOT could develop the requirements applicable within such zones so as to make them uniform within the category of zone to which they relate.

The particular restrictive zones could be established either on the initiative of DOT, by DOT on the petition of a state or local jurisdiction, or by

the state or local authorities subject to the approval of DOT. In any event, DOT should develop the criteria (relating to population density, industrial characteristics, road conditions, or the like) on which the restrictive zones would be designated. Under this scheme, a carrier planning a route could determine the most restrictive zone through which the carrier would travel, and thereby learn precisely what level of restriction would be imposed on that carrier's activities.

DOT Might Establish Criteria for Non-Federal Jurisdictions Seeking to Impose Specific Requirements

DOT might allow non-federal jurisdictions to impose requirements that are different from those promulgated by DOT if they fall within certain specific, federally developed guidelines. Under this scheme DOT would first initiate rulemaking proceedings to establish the criteria against which non-federal requirements would be measured and to develop a process whereby such requirements would be submitted to DOT for its approval. The criteria might allow for the establishment of region-specific hazardous materials routing plans by non-federal authorities, developed according to guidelines that would require consideration of the concerns of neighboring jurisdictions and of the affected industry. DOT, in fact, might require such plans to be developed by the state and localities on a regional, rather than on a purely local, basis.

DOT could also develop criteria allowing state and local jurisdictions to impose more or less restrictive controls along the course of such regional routes. However, such controls would have to be developed in coordination with the other jurisdictions in the region and could not unreasonably interfere with interstate commerce. In this manner, controls that might otherwise interfere with the smooth flow of commerce (such as absolute bans in limited areas, time restrictions, permit requirements, and operating controls) by subjecting a carrier to a multiplicity of conflicting regulations could be developed and imposed without confusion.

DOT CAN ENACT GUIDELINES TO MINIMIZE CONFUSION IN THE FIELD OF PREEMPTION

Regardless of how DOT goes forth to promulgate its substantive regulations, it can act to minimize administrative and judicial litigation by providing some clear guidance to state and local authorities as to what types of activities it views as permissible under the HMTA. DOT might undertake a detailed analysis of its regulations and decide for itself what sort of state or local activities are circumscribed. It might then publish informational guidance documents, or might even commence formal rulemaking proceedings to establish criteria against which non-federal activities would be measured.

Interested parties may, of course, now be guided by the views expressed in DOT's inconsistency rulings. Yet this piecemeal approach to the problem is not very efficient, and since we can expect non-federal actions to multiply in this climate of public concern, DOT may soon find itself flooded with inconsistency petitions.

DOT would therefore be well advised to face the difficult questions in a general, threshold proceeding, and thereby clear the air at the outset.

CONCLUSION

DOT is faced with the very delicate task of balancing the need for uniformity in the area of hazardous materials regulation against the need to address local safety concerns adequately. If it succeeds in striking the correct balance and in establishing a viable mechanism for including local considerations in its federal regulations, the issues surrounding preemption will be of little importance to the field. However, if DOT fails to meet its challenge, interjurisdictional conflict will proliferate, and the legal issues involved with preemption will be considered by the courts for years.

REFERENCES

1. 49 U.S.C. 1801 et seq., P.L. 93-633.
2. Senate Report 93-1192, p. 37.
3. H.R. No. 93-1083; U.S. Code Cong. and Admin. News, 93rd Cong., P. 7680.
4. HMTA, §112(b).
5. Rhode Island Inconsistency Ruling, IR-2; 44FR75565, but see Consolidated Rail Corp. v. Hancock, C.A. No. 79-0983; Dist. Ct., Mass., May 24, 1979.
6. HMTA, §102.
7. U.S. Const. Art. 1§8.
8. U.S. Const. Art. 6§2.
9. Bibb v. Navajo Freight Lines, 359 U.S. 520.
10. A&P Tea Co. v. Cottrell, 424 US366; Huron Cement Co. v. Detroit, 362 US440.
11. S. Carolina State Highway v. Barnwell, 303 US 177; Bibb v. Navajo Freight, 359 US520.
12. Rice v. Sante Fe Elevator, 331 U.S. 218; Schwartz v. Texas, 344 US 218; NYS v. Dublino, 413 US413.
13. Ray v. Atlantic Richfield, 98 S CT 988.
14. Jones v. Rath Packing Co., 430 US 537.
15. Hines v. Davinowitz, 312 US 52.
16. Rhode Island Inconsistency Ruling, IR-2.
17. 41 FR 38167; 49 CFR 107.
18. Ibid.
19. New York City Inconsistency Ruling, IR-1 43 FR. 16954 (April 20, 1978).
20. HM-164.
21. National Truck Carriers, Inc. v. Burke, 608 F2d 819.
22. 5 U.S.C. 703; 28 U.S.C.A. 1331.
23. S.R. 93-1192, P. 37, Rhode Island Inconsistency Ruling, IR-2.
24. 45 USC 434.
25. National Association of Regulatory Commissioners v. Coleman, 542 F2d 11; Donelon v. New Orleans Terminal Company, 474 F2d 1108.

Hazardous Materials Transportation Risk Assessment

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A glossary of terms useful to the reader precedes part 1 of this paper, which describes various risk estimation methodologies along with their strengths and weaknesses. Approaches to risk evaluation and acceptance are also discussed. Part 2 considers some of the ethical and philosophical aspects of risk assessment. The meaning of "safety" and the concept of the justifiability of harm are tested. A plea is made for the use of systemic risk analysis in contrast to the current piecemeal application of risk analysis. Part 3 raises questions for consideration by conference participants. It is intended that recommendations for improvements in methodologies and implementation approaches will result.

GLOSSARY OF SOME RISK ASSESSMENT TERMINOLOGY

Acceptable Risk--A level of risk from a hazardous activity deemed by some particular element of society to be sufficiently low to enable the activity to be instituted or continued. The judgment involved may or may not be similarly made by other elements of society. The process of development of the judgment is that of risk evaluation.

Accident--A failure of a system due to which damage results.

Basic Event--The occurrence of a fault of failure in a system component or of an external event that can initiate or participate in an accident sequence (i.e., a sequence of events leading to a system accident).

Consequence--A result of an accident such as the release and dispersion of a given quantity of a hazardous material, a given level of damage to a rail car, or a given number of people injured.

Fault of Failure--An undesired action, or lack of desired action, by a system or component, equipment, or human.

Harm--The likelihood of a reduction in life expectance (longevity) or likelihood of damage to the environment or property.

Hazard--A set of internal and/or external conditions in a system's operation with the potential for initiating or exacerbating an accident. Hazards include dangerous energy sources, possible conditions that could lead to an undesired energy release, or possible conditions that could inhibit or prevent a desired energy release (such as power for safety equipment or a control signal).

Incident--An inadvertent release of a hazardous material with some potential for harm. It may occur due to an accident, mishandling of the material or its container, or to unusual stresses on a container during normal transportation operations.

Loss--An outcome of an accident, expressed in terms such as the number of people killed, suffering a given severity of injury, a given loss of life expectancy, etc., or property damage.

Risk--The probability of occurrence, due to a fault of failure, or an external event, of a specific consequence or loss; e.g., the number of fatalities deriving from a given activity, such as the operation of a specified facility under specified conditions. Risk is often also used to mean the product of the probability and magnitude of a given deleterious consequence or loss, or the sum of such products over all possible consequences or loss, or the sum of such products over all possible consequences or losses, i.e., the expected consequence or loss. Individual risk is the probability of a given consequence (e.g., fatality) occurring to any member of the exposed population. Group or societal risk is the probability that a given number of individuals will suffer a given consequence.

Risk Assessment--The integrated analysis of the risks of a system or facility and their significance in an appropriate context. It incorporates risk estimation and risk evaluation.

Risk Estimation--The statistical and/or analytical modeling process leading to a quantitative estimate of a given risk.

Risk Evaluation--The appraisal of the significance of a given quantitative (or, when adequate, qualitative) measure of risk, as, for example, the comparison of the expected number of fatalities per year from a specified facility's operation, with that from a number of other, generally "accepted," causes; or appraisal of the risk of such fatalities in relation to the socioeconomic benefits of its acceptance.

Risk Management--The process whereby decisions are made to accept a known risk or hazard or to eliminate or mitigate it. Trade-offs are made among increased cost, schedule requirements, effectiveness of redesign or retraining, installation of warning and safety devices, procedural changes, and contingency plans for emergency actions.

Safety--The condition of freedom from unacceptable risk (as evaluated by a responsible consensus of society).

Terminal Event--The event to which an accident sequence leads, whose occurrence produces a particular consequence of concern. A terminal event could be a hazardous material tank rupture, a train collision given a relative speed.

PART 1: METHODOLOGY OF RISK ASSESSMENT

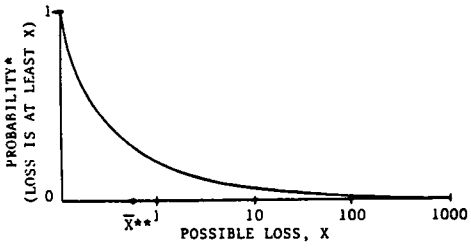
INTRODUCTORY CONCEPTS

The basis for discussion of the important aspects of risk assessment for hazardous material transportation is established in part 1. It considers the needs for risk assessment in its present and potential applications. It outlines the general character of the risk assessment methodology and the several approaches to particular areas of its application. It emphasizes the strengths and weaknesses of these approaches and motivates considerations of means for their improvement for various classes of users. It is intended that the outcome of these considerations at the National Strategies Conference, in particular, will be (a) specific research and development recommendations for establishing these improvements through enhanced data development procedures and risk modeling techniques and (b) increased facility in the application of risk assessment at all levels of its use.

Concept and Goals

It has become generally accepted that risk assessment is usefully considered to consist of two separate and, in important ways, largely independent activities: risk estimation and risk evaluation (1). Risk estimation entails (a) the acquisition and application of appropriate data to the estimation of the probabilities of occurrence of the possible deleterious consequences or losses that may result from a subject hazardous activity and (b) the combination of these probabilities and consequences or losses into an appropriate measure of the risk deriving from this activity. This measure may be a single number, e.g., the expected number of fatalities per year or per shipment and the expected number of fatalities per exposed person (equivalent to the probability of death per person) per year. To avoid the loss in perspective of low probability/high consequence events that the simple expected value measure entails, however, a complete "risk profile" may be developed (see Figure 1). [An expected value results from the combination of the losses of all possible events weighted by their probabilities of occurrence. Thus, a low probability/high consequence event, which may be of the

Figure 1. Illustrative risk profile.



*e.g., per year, per shipment, etc., for given hazardous materials transportation activity

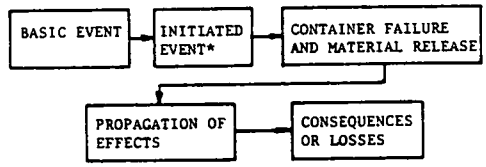
**$\bar{X}$ is the expected loss (per year, etc.), the mean of the distribution from which the risk profile derives

greatest importance to decisionmakers, may contribute only relatively little to the expected loss. A hazardous activity could then appear to be less risky than another because its expected loss is lower but could nevertheless entail a small chance of larger accidents and so, in fact, be of greater concern. Thus, for example, a nuclear power plant is of greater concern than a coal-fired plant of the same capacity even though the latter's expected loss is larger. This consideration gives rise to the need to consider "the tail of the probability curve" as well as its expected value, or mean, in assessing risks, and so motivates the development of the risk profile.] It is defined by the (complementary) cumulative probability distribution function describing the probability that a loss of at least x will occur--e.g., the probability per year or per shipment of x or more fatalities where x ranges from 0 to its maximum possible value. More generally, it may be a "vector" of risk numbers or of risk profiles whose components relate to the specific kinds of consequences or loss that are possible, such as fatalities, injuries of different severities, and property damage in dollars. Each of these consequences must be broken down for each exposed group, such as the public, transportation system workers, system owners, shippers, and insurers. If a risk vector is developed, however, means are usually required to reduce it to a scalar, single-number measure by summing its components appropriately weighted, e.g., in terms of dollar equivalents, or utility values, as will be noted later in this paper.

The risk evaluation activity consists of assessing the significance of the estimate risk with respect to its acceptability, as feasible; the risks of alternatives to the subject hazardous activity; or the worth and cost of means for mitigating it to a lower level. The problem of defining criteria for acceptable levels of risk for given hazardous activities in our contentious society has so far been unsolvable, although investigations and proposals for the development of such criteria abound.

The second and third kinds of risk evaluation noted above are somewhat less subject to controversy. They can be used on comparatively more objective considerations; first, of the relative risks of hazardous activities providing the same benefit, and, second, of the balancing of the cost of a risk mitigation with the value of the risk reduction. (This latter process may still get into trouble as arguments arise about such things as the "value of a life", or about what characteristics should be included as benefits.)

Figure 2. General risk estimation model.



*or Accident Occurrence

Just as this paper describes various applicable risk estimation techniques, so it will also attempt to outline the general kinds of approaches to risk evaluation.

General Risk Estimation Model

The risk estimation concepts introduced in the previous paragraphs can be applied to hazardous materials transportation in the following way. Possible losses accrue from a hazardous materials transportation activity as the result of a sequence of events. As illustrated in Figure 2, for the case of a transportation accident, they may generally be considered to be the occurrence of a basic event such as equipment failure that leads to an initiated event (the occurrence of a particular accident) such as a derailment. A container such as a tank car then fails and releases its contents all or in part, and thereby generates one or more possible effects (e.g., a fire, explosion, BLEVE, toxic cloud, and flammable cloud). When they impinge on some target structure (adjacent people and buildings, etc.), these effects induce certain consequences or losses (number of injuries, etc.). The effects and consequence or loss events may occur with a range of possible magnitudes. A distinction between consequences or loss is not usually required. It may be helpful, however, when consequences take several forms, but a single loss measure (e.g., equivalent dollars) is desired.

The probability of each event is then estimated, or, for effects and consequences, perhaps only an average magnitude or a "credible worst-case magnitude" may be estimated. The results are then combined into a risk profile, such as is represented typically by Equation 1 (assuming only one kind of loss, say public fatalities, is of interest). As has been noted, the result is often compressed into a single expected loss measure, which is merely the mean of the probability distribution equivalent to the risk profile:

$$\text{Prob}^{\circledast}(\text{Loss at least } x) = \sum_i \sum_j \sum_k [\text{Prob}(\text{Loss exceeds } x \mid \text{Effect } k \text{ occurs}) \cdot \text{Prob}(\text{Effect } k \mid \text{Release of material}) \cdot \text{Prob}(\text{Release} \mid \text{Accident type } j \text{ occurs}) \cdot \text{Prob}(\text{Accident type } j \mid \text{Basic event } i \text{ occurs}) \cdot \text{Prob}^{\circledast}(\text{Basic event } i)] \quad (1)$$

The circled asterisk signifies a given unit of exposure from the probability, as per year, per shipment, etc. A vertical bar indicates that the probability involved is conditional on the occurrence of the event following the bar (and is read "given that"). As x is allowed to range over its possible values, the risk profile is built up, as shown in Figure 1.

The profile expression (Equation 1) will change somewhat for different kinds of applications. A risk analysis might begin with statistics on the initiated event (accident occurrence) and basic

events would then not need to be considered. A chronic exposure risk analysis might begin with a given effect (as a chronically present concentration of a carcinogenic material) and might also incorporate a term for the probability that some number of individuals will be exposed to it. A sabotage risk analysis would assume a given sabotage attempt occurs and derive a risk profile conditional on this, and so on.

Risk Evaluation and Character of Risk Assessment Applications

The role of risk evaluation has been noted. It is concerned with considerations of the significance of an estimated risk with respect to acceptability and, perhaps, of ways to mitigate the risk where this is deemed desirable. These considerations relate to a set of possible kinds of applications of risk assessment, which may perhaps be usefully defined in terms of the questions below:

1. How safe is a particular hazardous activity?
2. How does this safety compare with the safety of other activities?
3. How much additional safety could be attained for a given cost, through some set of alternative modifications?
4. How much would it cost to attain some required level of safety, through some set of alternative modifications?
5. Which would be the safest means of accomplishing a given objective (e.g., transport of a given amount of a given material in a year over alternative routes or by alternative modes or by alternative shipment sizes)?
6. How much added risk would be imposed on some other activity due to a modification or alternative that decreases the risk in a given activity (e.g., energy from coal instead of nuclear will cause more rail-crossing accidents, more coal miner deaths and illnesses, etc.)?
7. Is the estimated (perceived?) risk "acceptable"? What are ways of appraising this central sociopolitical issue?

It will become increasingly evident that these questions underlie the philosophical issues in the use of risk assessment and the objectives of the applicable risk assessment methodologies that will be discussed in the remainder of this paper.

Techniques Applicable to Several Phases of Risk Estimation

Four general types of risk estimation methodologies have so far evolved and been applied to hazardous materials transportation risk analysis. The four methodologies are statistical inference, fault-tree modeling, analytical-simulation modeling, and subjective estimation of risk parameters. (Subjective estimation is also potentially useful in the development of inputs for the first three methodologies.)

The discussion of the four methodologies is oriented around their utility in the several phases of a transportation risk analysis: (a) estimation of the probability of occurrence of an accident and/or incident, (b) determination of the nature and probabilities of occurrence of possible effects (hazardous material tank rupture, spill and fire, explosion, etc.), (c) determination of the possible consequences, and (d) determination of the possible losses that derive from these effects (e.g., number of public fatalities, injuries, property damage, worker injuries, etc.).

Procedures related, but not necessarily identical, to the basic risk estimation procedure are also needed to identify and analyze (or predict) the effectiveness of possible risk mitigation measures.

Finally, it is to be noted that sabotage risks are not amenable to complete risk analyses due to the fundamental inability to predict occurrence probabilities. However, system vulnerability and consequence assessments can be made.

Accident-Incident Occurrence Probability Estimation

The applicability of the four methodologies to this initial phase or risk estimation is discussed in this section. Data and methodological problems, their implications to uncertainties of concern to the user, and possible approaches to improvements are noted in particular.

Statistical Inference

The most regularly employed procedure for estimating accident of incident occurrence probabilities is that of statistical inference. However, it is directly usable only if an adequate accident-incident data base exists, with significant sample sizes at the various levels of the specific hazardous conditions of concern. Also, it has to be able to be assumed that the past record satisfactorily represents (or can be modified so as to represent) what the future will hold.

In its basic form, the methodology of statistical inference assumes that a system's accidents or incidents occur independently and with constant probabilities and develops estimates of these probabilities. The past record of such accidents and incidents then provides the frequency of their occurrences over the record period and, for instance, the frequency per year that is then extrapolated to future years. For example, if the frequency per shipment, per mile, or per ton mile is desired, the "exposure" in terms of the number of shipments, miles, or ton miles that were accumulated during the record period must also be known or estimated. The result is then an inference of the future probability of occurrence of an accident or incident per shipment, for instance, given as the ratio of the frequency of accidents or incidents to the frequency of shipments. A confidence interval for the inferred probability can also be established.

A number of important problems arise in this superficially simple process, however. First, the estimation of the exposure requires that records are kept and accessible on shipments of the hazardous material. Such records are not generally available. Thus, estimates must usually be made by employing samples of shipment data, often of uncertain accuracy or even validity, with liberal judgmental interpretation.

Second, adequate data for a meaningful statistical inference may also not exist on the accident-incident occurrences. This is always the case for the rare, catastrophic events that are usually of greatest interest. If the record of exposure (e.g., number of shipments) is great enough, it may be possible to nevertheless estimate credible upper bounds on the probabilities of such events, but these are often too conservative (that is, too large) to support practical decisionmaking on the control of future shipments with just as large or larger rates of exposure.

Instead of generating such upper bounds on the probabilities of accident-incident occurrence, it is sometimes attempted to establish a "surrogate" sample of recorded data larger than the real one of interest and sufficiently large to permit direct

inferences to be made. Thus, the record of accidents with liquid natural gas (LNG) tankers, with no significant entries and a relatively limited exposure, is expanded by use of the record for oil tankers modified subjectively in various ways to reflect the differences between oil tanker and LNG tanker operations. With somewhat greater refinement, a record for a given hazardous material transported in a particular container in a particular mode is extended by incorporating all accidents-incidents for other materials that employ the same container and mode--it being agreed that as far as the occurrence (per shipment, mile, etc.) of an accident or incident is concerned, the material makes no difference. Lastly, a most common use of the "surrogate" approach is the application of the nationwide modal accident statistics, on a per mile basis, to inferences of the probabilities of accident occurrences on particular routes for which adequate route specific accident records do not exist. Clearly, this neglects the potentially significant differences in the physical and environmental characteristics of specific routes from nationwide averages of these conditions.

Another problem area in statistical inference is the even more fundamental one of the "stationarity" of the process giving rise to the accidents or incidents. That is, it must be assumed that the past record also represents the future (or it is understood how to modify it so that it will). There are many reasons why this may not be the case, e.g., if a major accident occurs once, significant actions may be taken to decrease the chance of occurrence of such an accident in the future. Or, "familiarity breeds contempt", or at least lack of concentration, among human operators so that the chance of a major accident where humans are involved may gradually increase over time. Increase in accident frequency may also be due to wear of equipment under inadequate maintenance. The validity of statistical inferences that do not, or cannot, reflect such considerations is clearly questionable.

Finally, while not an explicit element of a risk analysis, multivariate statistical analyses of a file of coded accident reports has the potential to be an important means for identifying those hazards, or "causes", whose associated risks may be significant and worthy of analysis. Univariate trend analyses are already carried out by all modal agencies in DOT. These identify apparently important single-factor accident causes. Adequate data samples are needed so that multivariate analyses of the interactions of several factors recorded in accident reports could also be conducted by using regression analysis, analysis of variance, or contingency table analysis methods.

Overcoming fully the problems that have been noted and others that could also be brought forward (2) is not possible. But the situation for the user could be improved by, first, making the uncertainties that the inference procedure gives rise to as explicit as possible so that the user can incorporate them in his or her decision process. Second, steps for improving the accident-incident and exposure recordkeeping procedures should be defined comprehensively, and carried out. This may require regulatory as well as data acquisition and management system design changes. Finally, methodological enhancements are needed that respond to the weaknesses in the various assumptions made in the quantitative developments of the inferences, including the assumptions of stationarity and independence.

Fault-Tree Modeling

This approach synthesizes the possible sequences of events initiated by the activation of some hazard and culminating in particular deleterious consequences to people (operating personnel, neighboring public, etc.), property, or the environment. Its application requires that all significant consequences will have been tracked back through all possible event sequences to their initiating basic events. To realize the full power of fault-tree modeling, the probabilities of occurrence of the initiating events and all related action initiations (e.g., a successful or unsuccessful activation of a corrective action) need to be estimated with adequate precision, and the magnitude of the consequences accurately predicted. If these requirements are met, a series of combinatorial probability calculations results in assessments of the probabilities of occurrence of specified consequences with given magnitudes, i.e., the risks deriving from the hazards under analysis.

The principal difficulties with the fault-tree procedures are the uncertainty that all significant event sequences have been considered and the acquisition of sufficiently precise data necessary for predicting, with reasonable accuracy, the initiating and related action event probabilities. These difficulties are central to the controversies on the application of logic tree methods in nuclear power plants and other fixed-facility risk assessments and their generally complete failure in transportation accident probability determinations. Because there are so many possible kinds of accidents and because interactions of possible accident causal factors exist in the dynamic operations environment of transportation systems, descriptions in terms suitable for probability analysis of all important sequences of events culminating in transportation accidents are not able to be meaningfully accomplished. However, fault trees, in particular, have been effectively applied to post-accident events analysis--most notably in analyses of nuclear material container failure under accident stresses--and to mishandling and normal operations incidents.

Despite these severe difficulties, some potential has lately appeared for the application to transportation problems of computer-based fault-tree synthesis and analysis methods (based on "digraphs") that have very recently been developed for nuclear and chemical processing plants.

Certainly, if fault-tree methods can be applied to transportation accident occurrence modeling, at least three important advantages not provided by statistical inference methods would accrue. First, the input data-acquisition problem would be changed from that of obtaining meaningful samples of accidents for all sets of conditions of interest at the system level to that of obtaining only basic-event data, such as on the failure of specific equipments or procedures. It is, of course, recognized that basic event probability data generally still require statistical methods (and perhaps some subjectivity) to develop properly. What is emphasized here is that large enough sample sizes, even for different sets of conditions, are clearly much more easily and correctly developed for basic events than for actual accident occurrences. While certainly not trivial, this problem is at least possible to be solved with appropriate recordkeeping systems, experimentation, simulation, and testing.

Second, fault trees conveniently lend themselves to the evaluation of the effectiveness of given mitigating measures. Any such measures should be able to be assessed through the changes that they would induce in the original fault tree describing the accident occurrence that it is intended to prevent or decrease its probability. The evaluation of the effectiveness of mitigating measures by using

statistical models currently requires highly, if not entirely, subjective postulations of what the changes in the given accident data would have been (and, it is presumed, would be in the inference for the future), if the mitigation had been in place during the period in which the data were acquired.

Third, even when basic-event data are not available, qualitative analyses of fault trees (employing, if desired, existing computer programs) can provide significant insights on accident-initiating event sequences (or "accident modes") that are potentially most important to system safety. This kind of analysis can proceed one step further with quantitative rankings of the relative importance of such modes if at least relative basic-event data can be provided, such as the relative likelihood of occurrence of one equipment's failure compared with that of another.

To gain these advantages, fault-tree modeling techniques need to be deepened (as with the digraph procedures) to better reflect accident dynamics, including human operator actions. Improved means are required for acquiring data on the probabilities of initiating events, equipment and human faults or failures, and control action time delays. Comprehensive testing, experimentation, and simulation programs will be needed for this.

Analytical and Simulation Modeling

Analytical and simulation modeling approaches to risk analysis begin with functional descriptions of the system under study. The operations of the system are then expressed in terms of appropriate performance parameters that express the functions and the interaction of the functions, systems components (human and equipment), and interfacing external factors. The conditions under which accidents and incidents occur, or when particular consequences arise, are associated with specific combinations of the values of these parameters. Their probabilities of occurrence and/or the effects of their occurrence are then assessed by means of probability or effects formulas (if analytical models) through numerical accumulations from repeated runs of system operation "scenarios" (in simulation models), or by combinations of both procedures.

The main problems with analytical models are the need for acceptable simplifying assumptions that the derivation of their formulations usually require and of the related departure of their modeled factors from direct physical significance. Simulations are better in these regards in that they usually tend to replicate real-world factors in a fairly recognizable way. However, to the extent that they avoid arbitrariness of their simplifications, their complexity and computational requirements increase. The need to repeat many runs of simulated operations in order to derive usable accident statistics (as in Monte Carlo simulations) exacerbates the computational requirements. Simulations are, therefore, expensive means for risk analysis (other than in specific and limited data development support roles).

Analytical models have been applied primarily in assessments of normal operations, incident occurrences, and post-accident effects and consequences, especially in the marine mode. Simulations have been used, but without great success, for estimating marine-mode accident probabilities. It is not believed that analytical-simulation modeling of accident occurrences is worth further consideration.

Subjective Estimation

When all else fails, an approach to augmenting sparse data in developing statistical inference and estimates of other forms of model parameters is that of subjective estimation by panels of experts. These experts are assumed to be sufficiently familiar with the detailed circumstances of operations similar to those of interest that they can meaningfully extrapolate their experience to new conditions, employing only their individual judgments in combination with those of the other experts (3).

Two approaches can be considered in applying this process in hazardous materials transportation risk analysis. The first is exemplified by a "Delphi" procedure that was carried out in developing risk parameter estimates for hydrogen sulfide transport as extrapolations from general experience with the material and from a "baseline" set of specific experience data for a more common hazardous material, propane.

The second is typified by an attempt that was made to estimate oil tanker spill risks. It developed numerical estimates from rankings of the likelihoods of possible causative events as these rankings derived from the experience of a team of experts on oil spills (since oil spills and their circumstances were not so rare as to require some basis for comparison with experience with another material).

Subjective estimation is perceived as inherently a relatively low confidence risk analysis methodology. However, this perception may be at least in part a result of the general lack of appreciation of the perhaps more subtle but sometimes just as significant subjective elements of the other possible methodologies. This has been evidenced to some extent in the preceding discussions of these methodologies. To improve the subjective estimation process may therefore be a worthwhile endeavor, even if less formal procedures than Delphi are considered. The objective of this improvement effort would be to enhance the selection, control, and input information development of expert panels.

Estimation Considerations of Consequences and Losses

In risk evaluation one generally is concerned with determining both the probability of an event occurring and the consequences of that event. However, there are situations when determining only one of these factors is necessary. Determining the most probable cause of an undesired event and its associated probability of occurrence in some cases is more important than understanding in detail the consequences if the event occurred. An example of this is the evaluation of an innovative method of transportation such as a "ground-effects" machine or a new concept for a rail-train system. There are other circumstances when understanding the details of the consequences of an undesired event is of prime importance. This is often the case when there is a potential for severe impact on the public in terms of majority property damage and injuries.

The determination of the losses resulting from an accident consists of several steps: (1) Generally, the material leaves the container; (2) the material disperses into the environment (if flammable, it may be ignited immediately on emerging from its container or it might find an ignition source at some time and distance from its origin); (3) exceptions to steps 1 and 2 are the small class of materials where ignition can occur spontaneously within the container and the case where external events such as fires from hot boxes can cause a reaction in the commodity in the car; and (4) depending on the characteristics of the material being released, there may be damaging effects, or the potential for losses, due to fires, explosions, toxic effects on people and vegetation, contamination of ground water, etc.

Container Failure and Release

Container failure and the subsequent release of the hazardous material to the environment are common results of an accident sequence, especially for the case of liquified gases or liquid commodities. Containers can fail from a large number of "external" causes, such as the result of an accident (e.g., a train derailment), or "internal" causes, such as an undetected structural defect (e.g., crack) in the container or the vehicle. Containers of hazardous materials can also be adversely affected by events such as fires occuring in adjacent non-hazardous material containers. (Containers, as used here, can range from relatively small packages of materials as may be found in some air shipments to rail tank cars or barges.)

Analyses to understand the response of a container and its contents to an accident situation are usually performed by structural engineers assisted by someone skilled in heat transfer and thermodynamics. The reason for the requirement for the latter skills is that the material may be cryogenic and/or pressurized, or the container may be subjected to an external fire.

The possible scenarios for analysis are limited by the ingenuity and experience of the analyst. The selections of situations to be analyzed can often be guided by a fault-tree analysis. Even when quantitative data are not available for the fault tree, qualitative estimations are of value in selecting problems for consequence analysis.

In practice, we either focus our analyses on a specific situation or else on a small number of credible situations, including worst-case scenarios. The level of detail of the analysis is guided, for the most part, by the "level of effort" that is decided on before the analysis is begun. There are seldom technological constraints to carrying out the analysis on the response of a container and its contents to a postulated accident of incident.

The analysis frequently involves comparing the loads and forces of the postulated accident situation with the strength of the container. For external causes of accidents, we are normally dealing with a dynamic situation and the loads tend to be impact induced. Some examples are the impact of one vehicle into another, leading to rupture of the container due to direct impact or overturning; or a coupler impacting and penetrating the head shield of a tank car. These and other accident scenarios are readily treated by analysis. Estimates can also be made of the size of the opening in the breached container as a result of the impact, and then of the resulting rate and quantity of material released.

"Internal" causes of releases of the commodity may be due to failures of pressure relief valves or valves that connect to a product transfer line. One can also postulate structural defects such as cracks in the undercarriage of the vehicle and/or cracks in the container, which can lead to structural failure and the subsequent release of the commodity being shipped.

These defects can be due to design defects, manufacturing defects such as inadequate welds coupled with poor inspection, or defects that arise with age and are not observed by inspection or not corrected.

Although the science and engineering methods are mature for quantifying (a) the conditions under which a container will be breached, (b) the size of the opening, and (c) the rates and quantities of materials released, it is nevertheless desirable to verify analytical predictions by tests. Testing is desirable because often it is not cost-effective to construct the most sophisticated analytical model possible, other times we do not have the material properties data required for analysis. Even when there are no constraints on the analysis, testing serves to validate the analysis. Testing can range from small-scale laboratory experiments, to full-size testing of a component in the laboratory (e.g., head-shield/coupler interaction or brake-system behavior under load), all the way to full-scale testing of the actual vehicle with a simulated commodity on a test track. One must be carefull in designing laboratory tests because often parameters of interest in understanding the response of containers to certain types of accidents do not scale.

Testing can take the form of nondestructive, instrumented tests for the purpose of measuring physical parameters such as stress, and temperature in the container or its supporting structure, for various input parameters related to normal and abnormal operating conditions. Other testing methods are destructive tests that simulate an accident situation or an "internal" failure. These tests are also instrumented so that one knows the actual test parameters (the input loads), such as speed, angle of impact, force-time relationships at various locations, etc. It is important to instrument these tests, so that comparisons can be made with the analysis of the same situation, or predictions made for situations not analyzed. Further, if there is disagreement between analysis and test results one can ascertain the source of those differences from the test data.

There are some situations where testing (without associated analysis) is the only feasible approach. These instances are generally related to effects of wear (i.e., service life coupled with environmental stress) on safety-related components.

Material Dispersion

In the event of a release of a liquefied gas or a volatile liquid, the escaping material will spread, evaporate, mix, and move downward, with the air surrounding the spill forming a cloud. (If flammable, the air-fuel mixture will burn if a suitable ignition source is present.)

The details of the spreading and cloud formation, among other things, depend on the rate of release of the material, its density, vaporization rate and buoyancy, meteorological conditions, and terrain. The cloud that is formed is characterized by its size and concentration at any location relative to the release point and at any time after release.

A number of mathematical models have been developed that attempt to describe these complex events. The models differ significantly from one another in sophistication, because of their approximations and assumptions, in characterization of the source (point or area source, instantaneous or continuous release), or in the manner of spreading and air entrainment. For the majority of materials, input data on material properties are lacking and data for similar materials are used, which give rise to errors of uncertain magnitude.

For liquefied natural gas (LNG), these models generally agree for small spills, but not for large spills. This is due to the fact that the models were calibrated for the only data available, which were those of small spills. For the case of large LNG spills on water (a much studied problem), there are more than order of magnitude differences in the different models' predictions for such parameters as downwind distance. The differences depend on the simplifying assumptions used by the analyst.

Adequately instrumented tests involving large spills are needed to verify the mathematical models, since reliable observations are lacking from the few

accidents where large quantities were spilled. Relatively small spill tests of LNG, liquid ammonia, and several light hydrocarbons on land and water have been conducted by using limited instrumentation. Larger tests are planned, but they will still be small compared with potential accident spill sizes.

The problem of modeling spreading and dissipation of soluble and insoluble liquids in water is in some ways as complex as spills on land since both physical and chemical effects must be accounted for.

Wind-tunnel simulations of LNG spills have been carried out by Meroney (4) of Colorado State University to better understand the effects of terrain features and obstructions on the dispersion and concentration of vapors in air.

Concentration measurements of materials dispersed in water are simpler to make than measurements in air. Still there is a paucity of data. Such measurements can be made in large laboratory tanks and there are several facilities that have the capability of making meaningful measurements. Currently studies of dispersion and mixing of a variety of soluble and insoluble liquids in water, to simulating flowing streams, is in progress. Much more experimental work is required to understand the behavior of the broad spectrum of materials being transported.

Characterizing Effects of Released Material

The dispersed material can lead to a number of undesired effects. Volatile liquids and liquefied gases when dispersed in air can cover an area several orders of magnitude larger than they were contained. A material in this state may be flammable, explosive, or toxic (to people, vegetation, fish, etc.).

In order for a material in its vapor phase to burn or explode, it needs to be at the proper concentration (i.e., within its flammable limits), and it needs an ignition source. A fire and/or explosion gives rise to thermal radiation, and/or overpressure and impulsive forces, which can have adverse effects on people and property. The flammable limits of many commonly shipped materials are known. The explosion effects in terms of energy release, i.e., its TNT equivalency, can be estimated from the heat of combustion of the material, if this property is known. The maximum possible energy release is never realized in accident situations because optimum conditions are never met. For maximum energy to be released in an explosion, one needs to have all the material within the explosion limits when it encounters an ignition source. Accidents tend to yield about 10 percent or less of the maximum energy possible. Meteorological conditions, structures, terrain features, etc., can give rise to areas where there is focusing or blast enhancement and also to areas where little damage occurs. Asymmetric initiation of a cloud can give rise to enchanced blast in one direction. Predictions of fire and explosion effects tend to be conservative since calculations generally consider the worst case. Any other approach cannot be readily supported, except to draw on past accident experience to "establish" a credible energy release.

For the case of toxic materials, the effect of various concentrations, on people, vegetation, etc., is known for a fraction of the materials being shipped. Moreover, much of this information was developed for occupational exposures, i.e., for people exposed on an 8-h/day basis. Except for very few materials, we do not know how large a concentration is acceptable for a single exposure resulting from an accident.

To better understand how toxic and flammable materials behave in actual incidents, the National Transportation Safety Board has recently developed an investigation and reporting format that utilizes maps of the accident area. A series of maps may be used for each accident, with each map indicating the elapsed time after the accident. The maps can thus show events that are time dependent, such as the growth of the dispersion pattern. In this way the sequence of events and the effects are readily visualized. The following information is to be displayed on the maps (5):

(1) The relationship between the dispersion pattern(s) formed by materials releases, and the size and nature of the hazardous material container.
(2) The relationship between the environmental conditions and the hazardous materials dispersion patterns.
(3) The relationship between the dispersion pattern, the location of casualties, and the degree of injury or harm.
(4) The relationship between the times associated with the dispersion patterns and injuries.

This approach has promise of aiding in understanding exceedingly complex phenomena. It will also help support and validate aspects of risk analysis consequnce estimates.

Accidents When the Container Is Not Breached

Fires, explosions, and releases of toxic materials can occur due to external causes. In the case of trains, for example, box car fires caused by hot boxes or overheated brake shoes can lead to major fires or explosions. In some cases an external fire can cause the degradation of strength properties of the container and the subsequent release of the hazardous material, be it flammable or toxic. Similarly, a fire in a box car adjacent to a car carrying hazardous materials is a credible major incident cause.

A more "exotic" cause of serious fires and explosions is that arising in materials not believed to be explosive or flammable or materials not known to be sensitized by a small amount of contaminants. An example of the former is scrap metal turnings, where a serious problem has been identified in the marine mode of transportation. The material can spontaneously ignite, and temperatures of the order of 260°C (500°F) have been measured within a pile. We do not know if the hazard is size dependent and if it occurs only in large bulk cargo ships. This problem is currently being studied.

We expect that in the future more of these exotic materials will be transported as nonhazardous wastes. We must develop a protocol for evaluating the hazards of these materials.

Chronic Exposure Risks

Chronic exposures could occur from the following kinds of accident scenarios:

1. A spill of toxic liquid that migrates through the soil and contaminates the ground water;
2. A spill of a material into a body of water that cannot assimilate the material (the contamination that persists may have adverse effects on the ecosystem and/or the recreational use of the water); and
3. Extremely toxic materials can contaminate the soil, buildings, roads, etc., which may be impossible to fully decontaminate (an example of this

type of contamination is the release of a dioxin from a chemical plant explosion in Seveso, Italy, in 1976); there has never been a comparable transportation accident; however, the continuous low-level exposure of transportation workers to toxic materials may also become a matter of growing concern.

Such chronic risks will need to be considered in future risk assessment studies.

Sabotage Risks

The probability of occurrence of a particular sabotage attempt cannot meaningfully be estimated, although some effort has been applied to correlate the likelihoods of such attempts with such large-scale societal factors as the general crime rate. Thus, sabotage risk analyses have generally been conditioned on the occurrence of a specific attempt and the effectiveness of the attempt, the system's vulnerability along with the performance of its security capabilities, if any, and then assessed quantitatively in relation to this attempt.

Fault-tree methods, for instance, can be applied to develop the conditional probability (given the attempt) of any particular outcome. The methodological and initiating and associated event data needs for a sabotage risk analysis for a transportation system give rise to the same kinds of development requirements as for transportation accident risks. Experiments and simulations are possible basic approaches to meeting these requirements.

Risk Acceptability Evaluation

While no single approach has yet been established that enables a universally appreciated evaluation of the acceptability of the risk of a hazardous activity, a number of attempts have been made to develop such an approach. These are discussed here in three categories: comparision with "ambient"/historical risks, comparisons with risks of equibenefit alternatives, and balancing of risks and benefits.

Comparisons with Ambient/Historical Risks

In 1969, Chauncey Starr (6) published the first of many articles on public risk acceptance in relation to benefits as revealed by historical data. Expected fatalities per year per individual in various groups exposed to accidents and other deleterious factors due to voluntary or involuntary hazardous activities were estimated from past data and compared with assessments of the benefits accruing from these activities. Starr found that historical levels of risk acceptance increased proportionate to the cube root of the increase in benefits and that voluntary acceptance levels were about three orders of magnitude greater than involuntary acceptance levels.

Starr's concepts have been extended by many others in attempts to establish numerical acceptable risk levels for hazardous activities that provide specific benefits or meet specified societal needs, such as potrochemical and energy facilities. These numerical levels may also reflect the confidence in the risk estimates that are evaluated.

Three major philosophical problems exist with the approach to risk acceptability evaluation based on Starr's concepts. First, for involuntary risks, the groups accepting the risks often differ from the groups receiving the benefits (or at least do not share the benefits in a manner reflecting their exposure to the added risks). Second, a risk measure based on expected, average, or mean losses, while convenient, obviates the ability to distinguish low probability/high consequence from higher probability/lower consequence risks. The former are often of more critical concern to the public and other decisionmakers. The "disutility" of accidents appears clearly to be nonlinear as accident magnitude increases. The utility functions to express this have been discussed, but they have not yet been meaningfully developed. Finally, the groups evaluating the risks of a hazardous activity may differ greatly in their perceptions of its benefits as well as risks, and thus differ on the acceptability of the activity.

Several psychometric experiments have been reported that attempt to assess how individuals balance their perceptions of the risks and benefits of hazardous activities. While consistent with Starr's generic results in some aspects, great differences were also exhibited, depending on the availability to individuals of information on the activities, their familiarity (or their beliefs that they were familiar) with these activities, and so on. The problem of obtaining a consensus on the acceptance of risks to provide specified benefits is evidently very difficult to resolve.

The second of these philosophical problems noted above is the only one that has been so far meaningfully attacked. This was in the well-known attempt at risk acceptability evaluation (albeit not presented in those terms explicitly) in the Nuclear Regulatory Commission's Reactor Safety Study. Complete risk "profiles" reflecting the probability distributions of all possible losses, rather than only their means, are generated for nuclear power plants and compared with the profiles for various ambient and historical hazards, natural and man-made. This approach has also been employed in many LNG and other hazardous materials transportation risk analyses.

The principal weakness of the ambient/historical risks comparison method (over and above arguments on the validity of the distribution functions developed) is its neglect of the fact that, even if the incremental risk of the hazardous activity is small compared with the total ambient risk, the proposed involuntary risk takers do not often happily accede to even a small addition. The overcoming of this attitude, when it is justified to do so, is a major problem of society at present. All risk evaluation procedures imply that this can best be done by increasing the risk-takers' benefits (real or perceived). Any means for enhancing the credibility to them of risk estimates would be helpful, but probably not decisive.

Risk Comparisons of Equibenefit Alternatives

A second risk acceptability evaluation approach is the standard operations research technique of assuming some activity must be put in place to satisfy a specific need, and then establishing which alternative means of implementing it would give rise to the least risk. On this basis nuclear power has been argued to be safer overall than coal for generating electricity, for example (taking into account only the mean values of the risk profile and employing, to some extent, controversial "accounting" of total system risks).

On the surface, the procedure should be a strong one for not merely evaluating but also encouraging risk acceptance. However, increasingly often, no practical alternative is deemed acceptable to the public or their spokespersons. They may demand some approach based on unproven or uneconomic technology, or the avoidance of the needed activity entirely (even at some unconsidered other risks). Nevertheless, this method, perhaps combined with procedures

for determining the incremental benefits necessary to induce rational risk acceptance, may be the most suitable for hazardous materials transportation activities.

Balancing of Risks and Benefits

Quantitative procedures exist for expressing the risks of a hazardous activity, as well as its benefits, in common economic terms, e.g., present value dollars. However, these procedures generally entail assuming some "value of a life", and this has been a difficult feature of the analysis to agree on. If it could be agreed to, it could then be argued that a hazardous activity was acceptable if its potential loss (mean, or full risk profile) induced by its risks were less than the dollar value (or a given fraction of this value) of its benefits.

A similar argument has been employed in cost-benefit analyses of the value of safety programs. (The potential saving of n lives per year was worth at least nv dollars, where v was the value of a life in dollars, and so a safety program cost per year of less than nv dollars was justified.) The direct argument has also been put forward in the United Kingdom. Its use in the United States remains questionable, nevertheless. An extension to the use of merely the value of an incremental risk avoided or accepted appears to be more practicable.

Evaluation of Possible Mitigation Measures

Mitigation measures may reduce the risk by reducing the probability of occurrence of an incident or accident and/or reduce its consequences if it should occur. Mitigation measures may be procedural or technological. Procedural approaches can range from routing decisions based on some predetermined criteria; loading and unloading procedures; maintenance and inspection frequency, quality, and comprehensiveness; compatibility of materials guidelines that could specify the "forbidden" mix of commodities in a vehicle or the arrangement of box cars in a train according to the hazard of the commodity; etc. Examples of technological approaches are flame arresters in transfer lines, thermal protection for tank cars, improved hot box detectors, better containment of commodities for all transport modes, etc.

For each mitigation measure considered, one must be very careful to assure that the risk reduced by the new approach or alternative does not result in an increase in risks somewhere else. One simple example is the consideration of having empty box cars separating hazardous material cars on a train. Although the spacing can serve to reduce the probability of the propagation of a fire or explosion to other cars carrying hazardous materials, spacer cars can, in some situations, have deleterious effects on the ability to properly "handle" the train, which in turn could increase the probability of an accident. Detailed analyses of alternatives and their "true" risk reduction potential must be carried out with extreme sensitivity to the possible opportunity to increase risks elsewhere.

If fault trees in sufficient detail could be successfully applied to transportation accident analysis, a straightforward procedure would be available for predicting the decrease in a risk resulting from a mitigating measure. It would only be necessary to recalculate the reduced probability of a particular kind of accident given that a mitigating measure has been applied to the elements of some of the "cutsets" describing the possible accident occurrence modes, thereby eliminating or decreasing the probabilities of such modes. However, as has been noted, this is not yet feasible, although new fault-tree methods may make it possible to some extent in the future.

Cost-Effectiveness of Alternatives

When evaluating alternatives for risk mitigation one first compares their effectiveness in terms of the the reduction in estimated risk. Effectiveness can be measured in a variety of ways, such as the expected number of lives saved, reduction in expected property damage, or other measures that may be selected. However, in order to make a reasonable decision as to whether one should implement an alternative strategy that has shown to be effective (i.e., the risk was reduced), the cost of the alternative should be determined. Although these costs cannot usually be estimated with the degree of precision desired, nonetheless their estimation is necessary for an orderly decisionmaking process. In view of uncertainties, the rank ordering of the cost of alternatives for a "unit" reduction in risk is a possible approach for making decisions.

An interesting rank ordering approach is to compare the cost of the risk reduction measure with the increase in longevity that would ensue. To make this comparison one must first determine the relationship between the crude mortality rate (deaths/100 000 population) and increased longevity. Schwing (7) has shown that the relationship is approximately as follows: increased longevity (Δ years) = 0.02 x crude rate. Next he constructed an index, which was the cost of a particular life extending program divided by the longevity increase it provided. The index (called an efficiency index) is expressed as the cost in dollars to gain a year of longevity for the population affected. His rank ordering of 60 life-extending programs showed the efficiency index differed by more than five orders of magnitude, from $192 to $27.5 million per person year of longevity extension. A scheme such as this for evaluation of cost-effectiveness of alternatives has the advantages that it would not only place the costs of various mitigation measures in relationship to one another, but would enable one to put these costs in perspective when compared to the safety expenditures in other sectors of society.

The implementation of any cost-effective approach requires a realistic counting of all costs. In practice this is not readily achievable. One needs to include the direct costs of an alternative that includes capital, operation, and maintenance costs. The costs of time delays and other indirect costs also need to be included. On a broader perspective are considerations of the loss of business of the carrier, to another transport mode due to the increased costs and/or loss of business of the shipper because of a reduced competitive position of goods relative to imports, etc.

If after all these factors are considered the cost of a mitigation measure to reduce risks is shown to be less than the cost of the existing method of operation, then the decision in favor of implementation is clear. However, as is usually the case, if the cost of an effective mitigation measure is higher, by any amount, than the cost of the existing method of operation, then the decision for implementation of a mitigation is not so obvious.

Evaluation of Cost-Benefit of Alternatives

For meaningful decisions to be made as to where to allocate resources, to decide where the greatest gains can and should be made, one should go a step beyond cost-effectiveness determinations and attempt to also characterize the cost and benefits (in

monetary terms) of a given mitigation measure. Although estimations of cost-effectiveness contain uncertainties due to our inability to ascertain some of the desired costs and effectiveness information, evaluating the cost and derived benefits of a given mitigation measure is even more difficult, being fraught with uncertainties, unknowns, and the likelihood of omissions and controversies.

From the simplest viewpoint, if the cost of the mitigation measure is less than the benefits derived (measured in dollars), then the mitigation measure should be implemented. In practice, this is not so simple or straightforward a decision to make. The reasons are numerous. The data, to support the magnitude of the risk reduction estimates and the cost of implementation of a mitigation measure, often contain large uncertainties.

Extreme caution must be exercised when considering whether to make a decision based on data with a high degree of uncertainty. This is especially true when the decision to implement a risk reduction measure may affect the competitive position of the carrier and/or the shipper and/or the availability of the commodity in a timely manner. Even if there were no uncertainties, can business risks be accounted for and somehow be balanced against the risk reduction of the hazard? It is not always clear that society as a whole benefits by implementing a risk reduction measure. One can create an extreme scenario where the cost of reducing the hazard risk results in a cost that makes a given mode of transportation uneconomic and another mode is used. Those people put out of work temporarily, or permanently, will suffer psychological pain and anguish that can be compared with the suffering of victims of an evacuation when a toxic material is released in a transportation accident. The cost to the economy of the unemployed transportation employee needs to be compared with the cost of such things as the evacuation just cited, and so on. The "simple" case just envisioned is not simple at all; all the benefits and all the harms are not always feasible to account for or to estimate their impacts. The effects of risk reduction measures whose economic impacts are even more subtle are subject to even greater difficulty in their proper assessment.

The approaches described are not sharply discontinuous, there are similarities and overlaps between them. They all face the same question, how are decisions to be made so that the greatest benefits can be achieved per dollar expended? Spending money on suboptimum activities results in lives sacrificed because of lack of funding of more efficient endeavors. One of our problems in reaching equitable decisions include deciding what attributes both direct and indirect benefits should have, such as longevity, lack of psychological suffering and anguish, availability of goods at a competitive price, a viable transportation network encompassing all modes (a national security benefit), etc. Even if we did agree to the attributes to be considered, we are faced with the formidable problem of placing a dollar value, or some other index, on each type of benefit. The same concerns apply to identifying and quantifying the direct and indirect costs of mitigation measures.

Approaches to Facilitating the Use of Risk Assessment

Validation Techniques for Risk Analyses

The controversies and lack of acceptance of risk analysis primarily involve its quantification. The consequences part of the risk equation is subject to direct validation by full-scale or small-scale field tests. Validation is possible because we are concerned with deterministic physical phenomena. However, estimates of the probability of undesired events or an accident stemming from various failure modes or basic events are not as readily validated. There are a number of reasons for this. The accuracy and completeness of the logic trees or other approaches directly affect the validity of the results. Incompleteness may be due to not fully understanding how the system works, either by oversight or by a simple lack of thoroughness by the analyst. An analogy is a computer program that can be incorrect due to errors, omissions, or poor logic in programming. In programming, however, these errors, etc., are almost always eventually discovered by the failure of the program to run to completion or by nonsense results. The corresponding problems with respect to risk analysis are not so readily detected and may only be overcome by a validation procedure that requires an independent analysis. There is a regulatory precedent for third-party verification in the design of off-shore oil and gas platforms.

If one tries to compare a predicted value from a fault tree, for example, with an historical value for the same top undesired event, one can encounter a number of problems. Most events are of low probability, so there is not enough experience for the existence of a statistically valid set of data. Sometimes there is enough experience but the data have simply not been collected. To overcome the data availability and adequacy problem, it is sometimes possible to obtain data from a wide range of sources and to compare results as a function of the data base used. Some examples are data acquired by U.S. government agencies, industry data either acquired by an individual company or by a trade association, insurance company data on claims (U.S. and worldwide), and data collected in foreign countries. Some of the data may be for situations or environments that are of a different severity than the problem being analyzed--but this can be accounted for in a qualitative way.

Some approaches to validation for a given problem are to (a) use more than one method; (b) have the analysis done by two people, independently of one another; and (c) use as many data bases as it is feasible to acquire. If consistent results are obtained, one can gain confidence in the validity of the methodology and the quantitative results. The above approach has been used by one of the authors for a risk analysis that was subject to public scrutiny at a nuclear power plant licensing proceeding.

A "true" validation of the currently used methods of risk estimation would be to (a) identify an activity for which there is a statistically valid data base, (b) exercise risk analysis methods that are intended to predict causes and probabilities of accidents, and (c) compare the predictions in (b) with accident experience of (a). It is also possible to consider special experiments and tests that could produce data that could be used to validate at least the lower elements of a risk model (e.g., at an intermediate level of a fault tree).

Applications for Potential Users

The requirements for risk assessment vary widely among different kinds of present and potential users. One federal regulatory office may need a methodology for assessing the risks of a given hazardous material transport operation under generic conditions that express representative nationwide factors. Another may need a detailed capability for modeling the risks of specific alternative shipment

routes, modes, or containers for a given material. A third may need to be able to assess in detail the effectiveness of some possible risk mitigating measures. State and local government agencies may need to assess the risks of shipments of one or all hazardous materials into or through their areas, as specifically as possible to the conditions on their present routes and possible alternatives to them. Shippers and carriers may require similar assessment capabilities to support their cost-safety optimization decisionmaking, which may in the future become increasingly explicit.

While the basic concepts and general techniques must be common to all such applications, it is evident that considerable variability is possible in the particular form and specific details of risk analyses appropriate to different users' needs. The main trade-off is between risk modeling precision and simplicity in applications. Of course, as has been discussed in this paper, precision is always inherently limited by the quality of available data and modeling assumptions that are made in major part because of data shortcomings. To enable simplified uses of risk assessment incorporating still more generic data and broader assumptions, a yet greater sacrifice of precision will generally be required, but if the effects of this sacrifice on the decision process using the risk assessment are understood and accounted for, the less precise but simpler-to-apply methodology will nevertheless be worthwhile.

A study therefore appears to be warranted that would define the several kinds of users of hazardous materials transportation risk assessment, the circumstances in which they could or should use it, the data available and their costs, and, finally, the specific characteristics of the methodologies that best fit the different users' needs and resources. It can be envisioned that these latter characteristics will range from full-scope modeling and data acquisition and analysis approaches to, say, simple cumulations of some scores that for given circumstances are associated with a set of risk factors provided in a predefined list and employing, to the extent feasible, a common data base. The role of the federal government, most especially, in the development and standardization of such simplified approaches and common data bases should also be defined in the suggested study. It is also suggested that an important function of the national strategies conference is the initial definition of such a study, a fuller delineation of its utility, and a determination of its potential sponsors.

PART 2: ETHICAL AND PHILOSOPHICAL ASPECTS OF RISK ASSESSMENT

The parameters of the risk assessment problem have been succinctly stated in a report of the Transportation Task Force of the Urban Consortium for Technology Initiatives (8):

> The transportation of hazardous materials is an essential activity in the twentieth century, one upon which all sectors of the economy are highly dependent. The transportation of these materials cannot be discontinued, or their flow impeded to to the extent that their use becomes prohibitive, without a return to a primitive civilization in which the hazards of life and health would far exceed the dangers inherent in their transportation.

The needs and issues being raised by hazardous material transport could not be summarized more clearly.

As this citation suggests, mounting public awareness and attention to the transport of hazardous materials will be seriously counterproductive if it results in a general failure to develop and apply a method of managing not only the materials in question, but also public perceptions of their threat to public safety. Risk assessment methodologies have been developed as tools for this managerial task. However, their adequacy and application in our current institutional framework have been questioned from a moral and ethical perspective. At least three reasons may account for the fact that the evaluation aspect of risk assessment methods is being challenged.

In the first place, as a concept as well as a goal of social policy and standard-setting, the quest for "safety"--interpreted as "absence of risk"--has grown increasingly problematic. Access to a higher standard of living enjoyed by increasing numbers of citizens is accompanied by rising expectations for acquiring those goods and services that promote a sense of "security and safety". With the attainment of first-order, basic goods essential for survival, individual pursuit of safety becomes expressed as a vital need to protect and preserve nonsubtractive, second-order or "buffer" goods. These take virtually limitless form to the extent that moral responsibility for providing such good shifts from the individual citizen to social institutions. Institutions are then expected to monitor and deliver "safety"--perceived and conceptualized as an identifiable commodity or intrinsic property possessed by a given product or process. An unrealistic expectation derives from public misconceptions of what can and cannot be delivered by social institutions. "Safety expectations" are at the root of objections to the judgment and decisions derived from risk assessment methodologies. As Max Singer (9) observes:

> Safety is one of the reasons it is better to be wealthy than poor. But as we get wealthier and safer, we become more concerned about safety.... Like most social problems, the death toll from hazards requires a complex, balanced and limited response. We cannot give ourselves up to eliminating or even reducing hazards. As individuals and a society we must not become cowardly, fearful or hypochondriacal. The weakening of our character can do us more harm than all the auto accidents and all the fires.

In the second place, there is general failure to recognize and accept what Lapham terms, "the Law of Conservation of Risk" (10). He states that, like energy, risk can neither be created nor destroyed. Unless we are careful, all we may do is cause its displacement either in time from one generation to another, or in space from one location to another. A spatial displacement of risk is exhibited by those who refuse to allow repositories for municipal, commercial or industrial waste, or transport of hazardous materials in their vicinity. We hear citizens today join in with the general clamor and exclaim "not in my backyard." We must be wary of the potential for displacement, least risks to our health and safety do not disappear but reappear in another guise. Consequently, it is sophistry to form public policy or set safety standards on the basis of considering only incremental risks and incremental benefits of one or another technological activity, as if these were simple additions to a current risk background. To the contrary, bioethics requires consideration of systemic risks--that is, risk and venefit accounting for an entire social system--as a consequence of hazardous material

transportation methods. The failure to conduct systemic risk assessment induces the possibility of a risk of far greater magnitude.

In the third place, despite their good intentions, purposes, and promises, risk assessment studies for the purpose of increasing safety have been applied within traditional institutional frameworks in ways that force them to be piecemeal, ad hoc, haphazard, isolated for one-at-a-time consideration. In the public domain, one hazard is spotlighted for a time, giving way to another in unending succession.

Moreover, each regulatory agency or branch within agencies has its own mandate to control one category of hazards. For this category it conducts ongoing research, thereby making a case for more federal funds to do more research and impose more regulatory requirements in the name of further risk reduction. Not only does piecemeal, selective concentration increase the visibility of certain hazards, but the public is often led to believe that the more studied risks are, by that fact, the more dangerous to public health and safety. But this is clearly not the case.

Philosophical Framework for Risk Evaluation

Contrary to a popular misconception, "hazards" have neither a bare factuality nor an intrinsic morality predetermining how human beings should behave in relation to them. Hazards are not baldly "there" in nature or in human transactions with it. What people regard as hazardous in any given era reflects what they have come to know about their environment, and what they value as essential or desirable on a scale of real possibilities. In short, human beings structure hazards; they are, in that sense, human artifacts. A hazard is not by definition "toxicity of substance" or "violence of event" or "magnitude of consequences" that can be known, classified, and predicted. A hazard exists only when, and to the degree that, harmful exposure of and assimilation by the human body or other valued living systems becomes a genuine and not merely an imaginable possibility. That possibility exists only when there is an inability or failure to devise and maintain controlling actions or safeguards.

Because there are vast uncertainties about "how the world works," it serves no human purpose to bewail our "legacy of risks to future generations," and then make the fraudulent claim that the goal of hazard management should be to assure centuries of control over toxic elements or to make predictions about future adverse events. Clark states that the primary goal of hazard management is "to increase our ability to tolerate error and to take productive risks" (11). His statement stands in contrast to a popular yet unexamined notion, observed by Häfele, that "we are locked in a world of untested hypotheses (of unimplemented trials) because we dare not let experience prove us wrong. The costs of failure have grown too great" (12). Not only does this notion reflect the New Pessimism, spawning defeatism and pseudoscientific dire predictions that now pervade our cultural climate, but it also constitutes in itself the ultimate hazard--the failure to design and maintain structures of social resiliency. It is the social ideal of resiliency that has been a major driving force behind the emergence of highly complex and technologically advanced societies. The social ideal of resiliency accounts for the development of the burgeoning art of risk analysis.

Because of the identification of risks with hazards by a small but vocal group of people, they have perceived a false antithesis between risks and benefits--as if there were a way to have one without the other. The trouble with the phrase, "risk-benefit analysis" is twofold: It fails to express a proper symmetry and it tends to obscure the primary motivating force of human activity, i.e., the foreseen and intended benefit that can be gained or lost. In concrete decisions, what is often "at risk" is the possibility that the intended benefit may not materialize and, instead, harm may occur. On the other hand, both benefit and harm may result, but to different groups. When harm results, it is clearly unwanted and unintended. Risks and benefits are inseparable, not antithetical.

A major problem about the growing dispute over hazardous materials transportation is the inadequacy, not of risk analysis, but of harm-benefit analysis. Some refinement in the notion of benefit is essential. Okrent and Whipple suggest three qualitative distinctions in benefits, namely those goods essential to society (e.g., food, water, energy) or basic goods; advantageous to society (e.g., most manufacturing); and of peripheral, if any, value to society (e.g., aerosol deodorants having substitutes at lower cost and likelihood of harm) (12). Each qualitative benefit has corresponding levels of harm. Basic harms may result from being deprived of goods essential to subsistence and material well-being. Justice and equity require a society to provide access to basic goods and avoid basic harms. As for second-level benefits, the total outcomes any social policy toward these improvements will have an unclear mix of benefits and harms. Automobile and airplane manufacture afford major economic benefits to employees, capital investors, travelers, and the general health of international economies. Yet, each time someone drives or enables an airplane to take off, the benefits pursued may entail the possibility of unintentionally causing the death or serious impairment of a fellow human being. Any society must, at some point, deliberately decide how we ought to balance economic benefits and costs against possible harm or loss of life.

According to critics of such balancing, a human life is of infinite value, and its loss or impairment cannot be put in a class with other "negative consequences," much less be given a finite monetary value. To do so indicates the moral bankruptcy of our materialistic, consumerized, decadent society. Cost-risk-benefit quantifications, say its critics, manifest a loss of respect for the sacredness of human life. Those who defend this conceptual tool have often used simple observations, such as "there are necessary trade-offs in any public policy decision" or "everyone puts a finite, monetary value on one's life when buying life insurance, installing safety mechanisms in a home or automobile, taking hazardous jobs because they pay higher wages". Although true, such analogies are not sufficient. The public must be confronted with the fact that any society has but a finite amount of resources to spend on health protection and safety, and that the ethical problem is to get the most protection for the most people from this finite amount.

As a conceptual tool that attempts to enhance informed consent, cost-risk-benefit quantifications are simply one tool among many others whereby policymakers endeavor to allocate finite amounts of money in a just and equitable manner. They are not tools for putting some callous dollar value on human life or injury as a moral judgment or individual worth, much less of using economic losses to society as a measure of personal expendability. We are in fact maximizing the value we place on human life when we endeavor to allocate limited amounts of money in such a way as to reduce widespread hazards,

thereby preventing as much loss of life and providing as much protection from injury as possible.

The fact that our tools for balancing economic costs against risk to human life are not morally or ethically objectionable does not amount to saying that they are easy and acceptable to the public. Far from it. The task of public education in this matter is monumental. Moreover, as Pickering observes: "We are going to have to do more than find some level of acceptable risk; we are going to have to come to terms with the question of justifiable harm. There are, after all, some kinds of harm which cannot be avoided; but there are other kinds of harm which any society should not allow and against which it should adopt protective or remedial measures to the best of its ability" (13). Which is which becomes the policy question.

Means for Enhancing Credibility of Diverse Stakeholds

If policymakers, regulators, and managers of risks from hazardous materials transport are to merit public credibility, some method should be found to demonstrate that decisions about policy and standards have been made in the context of an adequate ethical framework--one structured primarily around a fundamental bioethical principle. This formulation is suggested:

> Social justice and equity require an equitable management of sources of basic harms, that is, potential hazards that might have adverse health effects and unjustifiable social consequences.

By "equitable management" is meant that policymakers should first be comprehensively informed about the broad spectrum of both natural and ordinary manmade hazards that may have health effects for large segments of the population; then make comparisons of the actual risks as well as costs per capita (or per person affected) to reduce these effects; and only then make policies and set safety standards that will get the most public health protection for the many out of a finite amount of money. Potential hazard management is ethically equitable only if it is proportional in relation to actual basic harm that can be identified and reduced by expenditures of human effort, time, and money.

In view of this principle, one approach is to determine what society has already decided it is willing to pay to avoid the statistical occurrence of a death, an injury, or an undesirable environmental impact. Protection of society from risks due to hazardous material transport should not require greater expenditure of resources than a society has generally shown willingness to pay for equivalent protection from risks due to other potential biohazards. The inconsistency that exists in social decisions does not invalidate the approach but rather calls attention to the need for its more rigorous application.

PART 3: CONCLUSIONS AND QUESTIONS FOR DISCUSSION

Assessing the risk of hazardous materials transportation involves (a) the selection of the most appropriate method for the problem at hand and the acquisition of the data required for that method; (b) the application and implementation of risk assessment results; and (c) consideration of the ethical issues governing risk acceptability, the meaning of "safety", and the use of systemic risk analysis versus piecemeal application of risk analysis.

In order to stimulate discussion and assist in the formulation of recommendations for specific research and development programs, a series of questions are posed for consideration by workshop participants. These questions are to serve as the starting points for discussion. It is expected that a consensus will be arrived at concerning approaches and recommended programs to enhance the usefulness of risk analysis.

Methodological and Data Needs and Issues

Risk assessment involves a number of tasks. They are

1. The structuring of the problem that includes selecting the method of analysis that is consistent with answering specific questions and providing output of a specific predetermined nature; the techniques employed are suggested by the magnitude and complexity of the system being investigated, and availability of data, and the needs and resources of the sponsor/user of the analysis;
2. The determination, or estimation, of risk (i.e., probabilities and consequences of undesired events with and without mitigation measures); and
3. Evaluation and interpretation of the predicted outcomes that may result in the introduction of risk reduction measures or the acceptance of the risk.

It is clear that one of the impediments to the successful implementation of risk assessment (items 1 and 2 above) for the problems of transporting hazardous materials is the inadequacy of the data base--in both scope and detail. Data on numbers of accidents, their causes, their location, etc., are incomplete or spotty in scope. Also lacking are population data, e.g., quantities of materials shipped according to mode of shipment, box car miles, truck miles, ton miles, etc., for hazardous materials and all commodities.

Failure rate data on safety-related hardware are generally not available. Although not specifically discussed in this paper there also is the need for properly trained, experienced, and motivated personnel. We currently cannot quantify the extent to which inadequate training or lack of experience affects the accident rate or how inattention due to lack of motivation increases the consequence of an accident. The performance of people must be accounted for in risk estimations and a quantitative estimate of the failure rates is necessary input to several of the risk analysis methods.

Although extensive accident data are currently collected, their limitations are numerous. The data-collection system should be strengthened so that the data that are reported are of the type that can be used to support the various risk assessment methods.

The most controversial aspect of the implementation of risk assessment is the evaluation and interpretation of the predicted risks (item 3 above). This aspect of the problem involves judgments based on factors that are difficult to quantify. They include the hazard's risks, costs, and benefits; business and political risks; and ethical considerations and issues. There is the lack of concurrence as to what attributes should be included in these factors. Even if all the attributes could be defined and agreed to, their quantification is not readily achieved. Much research and education of the public are needed in this area.

The following questions for discussion may be helpful:

1. What approaches should be taken to improving

exposure (shipment) data bases and their reporting systems?

2. What approaches should be taken to improving accident/incident occurrence data bases and their reporting systems? Are data bases capable of supporting multivariate statistical analyses (to delineate causative factors and their associations) practicable?

3. What improvements in statistical inference, fault-tree, analytical, and subjective estimation-simulating modeling procedures would be desirable, and what approaches should be followed to investigate their feasibility and to implement them if they are feasible?

4. What are the main problems in modeling the probabilities of accident/incident occurrence, container failure and release probabilities, effects and their propagation, and consequences and losses? What are approaches to overcoming these problems? What about sabotage and chronic risk modeling? How do these approaches relate to those in items 1-3, above?

5. How might numerical risk acceptability criteria be best established? Consider both analytical and sociopolitical issues.

6. Can economics-based risk-cost-benefit calculations be used in hazardous materials transportation risk analysis? What are approaches to its best development?

7. How can the effectiveness, in the future, of risk mitigation measures best be predicted? What testing and experimentation would be practical to provide data in support of such predictions?

Application Needs and Issues

To enhance the application of risk analysis one must be convinced of its validity, understand how a specific risk compares with other societal risks or a predetermined safety goal, and effectively balance the role that risk analysis should play along with other tools and approaches available to the decisionmaker.

The following questions for discussion may be helpful:

1. What approaches should be investigated for the development of effective means for validating risk assessments? Consider, for example, internal procedures for estimating and/or overcoming uncertainties, and external procedures such as replicated analyses and special experimentation/test data (at the system level if feasible or, perhaps, at intermediate risk modeling levels).

2. How can existing risk assessment methodologies, if diligently applied, lead to improved safety?

3. How can risk/hazards assessment be made a simple, inexpensive, and practical tool for the regulator and others for everyday operational use? Is it every going to be possible?

4. Are current methods and approaches useful for comparing risks? Can and should comparative risk assessment be used separately by the regulator of each transportation mode? Should there be a DOT systemic approach or only a comprehensive comparative assessment for all hazardous activities throughout our society? Should risk analysis be required of shippers and/or carriers by regulation?

5. Can and should risk assessments be used as a guide for setting priorities and for implementation of safety measures, within a given mode and between modes?

6. Should a safety goal be set and should risk assessment methods be used to see if the goal is met?

7. Instead of a safety goal, should best available and safest technology (BAST) criteria be used or should as low as reasonable achievable (ALARA) criteria be used? Can risk assessments tell you whether BAST has been achieved?

8. Should there be standardization of risk assessment methods?

Ethical Issues

A profound misconception of "safety" dominates the controversy over hazardous materials. The working assumption has been that safety is an intrinsic, measurable, absolute property that a given system or product or activity can and should possess. Our society has institutionalized and appointed the regulators to measure approximations to that elusive property. The mandate of the regulator is to make ever more stringent regulations, presumably to come ever closer to that property by reducing risks. But the only risks the regulator is expected to monitor and minimize are a small percentage of the total spectrum of risks tolerated by members of society as a whole. Intent on making a set of risks publicly "acceptable" as an index of "safety", the professional regulator must continue to propose risk-reduction with inadequate knowledge of costs or social impacts of ever-changing regulations. Presumably he or she is "only giving the public what it wants", namely safety. This spiral is likely to continue unless or until the public comprehends the fact that safety is not an intrinsic property measured by approaching zero-risk. Safety is an evolving, relational value judgment derived from current personal or social priorities. Whereas risks can be measured, quantified, and predicted, safety cannot be measured, much less predetermined by the presence or absence of risks.

Judgments of safety are judgments about the justifiability or unjustifiability of harm. The process of reasoning for ethical safety-policy decisions should be dictated--not by risk avoidance, an impossible ideal--but by comprehensive risk estimations and cost-risk-benefit evaluations. When these comparisons make it clear that a point of diminishing returns on allocations of money, time, and effort has been reached by comparison with other potential hazards in a society, then the product or process under scrutiny is "safe enough". If indeed unintended and unwanted harm should occur, then such harm can be judged justifiable because it is unavoidable or negligible by comparison with other harms and essential benefits.

What is needed is a whole new field of numbers. We need to know, with the most comprehensive overview, how much public money is spent to reduce ordinary diseases and accidents and hazards that afflict major segments of the population, the cost per capita to reduce them, and precisely at what point vast amounts of money may be pouring into budgets that can assure only minor gains in the status of public health. We have a surfeit of statistics on public health, but those data are not arranged by any responsible public institution so as to look at risks to the entire population relatively, to make comparisons, to maximize cost-effectiveness so as to get the most public health for the many out of the expenditure of public money. Comparable risk analysis is talked about, but it is not acted on or used responsibly at a comprehensive level by those state and federal agencies empowered to do it.

The following questions for discussion may be helpful:

1. What are the paramount ethical issues in the use of risk-cost-benefit analysis and how can they

be best responded to at different government and industry levels?

2. Is the concept of "justifiability of harm" likely to enhance the utility of risk assessment?

REFERENCES

1. W.W. Lowrance. Of Acceptable Risk: Science and Determination of Safety. William Kaufman, 1976.
2. W.B. Fairley. Criteria for Evaluating the "Small" Probability of a Catastrophic Accident from the Marine Transportation of Liquefied Natural Gas. Proc., Engineering Foundation Conference on Risk-Benefit Methodology and Application, Asilomar, CA, Sept. 1975.
3. H.A. Linstone and M. Turoff, eds. The Delphi Method. Addison-Wesley, 1975.
4. R.N. Meroney et al. Wind Tunnel Modeling of LNG Spills. Presented at The American Gas Association Transmission Conference, Montreal, Canada, May 1978.
5. Standardized Maps for Hazardous Material Accidents. National Transportation Safety Board, Rept. NTSB-HZM-79-1, 1979.
6. C. Starr. Social Benefit Versus Technological Risk. Science, Vol. 165, Sept. 1969.
7. R.C. Schwing. Longevity Benefits and Costs of Reducing Various Risks. Technological Forecasting and Social Change, Vol. 13, 1979, pp. 333-345.
8. Public Technology, Inc. Transportation of Hazardous Materials. A Report of the Transportation Task Force of the Urban Consortium for Technology Initiatives. U.S. Department of Transportation, Sept. 1980.
9. M. Singer. How to Reduce Risks Rationally. Public Interest, No. 51, Spring 1978, pp. 93-112.
10. L. Lapham. On Risk, Ignorance, and Oil.
11. W.C. Clark. Managing Technological Hazard: Needs and Opportunities. Institute of Behavioral Science, Univ. of Colorado, 1977, pp. 111-142.
12. D. Okrent and C. Whipple. Approach to Societal Risk Acceptance Criteria and Risk Management. Univ. of California, Los Angeles, Rept. UCLA-ENG-7746, 1977.
13. G. Pickering. Energy and Well-Being: Whose? Electric Perspectives. Edison Electric Institute, New York, 1979, pp. 1-7.

How-to-Do-It Regulations Inhibit Research

William C. Jennings

DOT's Materials Transportation Bureau issues safety regulations for the transportation of hazardous materials in interstate commerce by all modes of transportation. These regulations are published in 49 CFR Parts 100-199.

Most of MTB's regulations relating to hardware are specific how-to-do-it requirements. This is particularly true of the requirements for designing, making, and testing containers such as drums, tank cars, tank trucks, and pipelines. These how-to-do-it requirements inhibit the development and use of new products and procedures.

The how-to-do-it language in the regulations is usually the result of MTB's adapting or adopting consensus standards as regulatory requirements. While our concern is with the whole range of specifically stated requirements, this paper will focus on the practice of adopting consensus standards as regulatory requirements.

DESCRIPTION OF CONSENSUS STANDARDS

Consensus standards are written by committees composed of representatives from (a) industry sources such as operators of facilities, manufacturers of products, and contractors who build facilities, and (b) non-industry sources such as college faculties, research institutions, and government agencies. The committee members bring to committee deliberations a wealth of technical knowledge and operational experience. They develop standards to advise the various segments of industry as to the products and procedures that experience has shown to be acceptable for general use.

Consensus standards are advisory, not mandatory. Most companies follow the recommendations because they are good. However, any company is free to experiment with new products and procedures. As a result of this experimentation, the industry is able to accumulate operating experience with new products and procedures. When there is enough operating experience with something new to show that it is acceptable for industrywide use, the committee incorporates it into the standard. Thus the consensus standard process recognizes and recommends what experience has shown to be good, while permitting experimentation and innovation.

The merit of the continuing consensus standard process is that it is self-renewing. The committee continually reviews operating experience and gives its approval to new products and procedures when industry's cumulative operating experience has shown their worth. The committee bases its recommendation on experience with yesterday's technology, but it does not foreclose use of tomorrow's technological developments. As each consensus standard is periodically updated, the new version marks another milestone in the continuing development of industrial products and procedures.

DESCRIPTION OF REGULATIONS

Regulations differ markedly from consensus standards. Regulations are mandatory, not advisory. Industry is required to use the products and follow the procedures prescribed in the regulations. Companies are not free to experiment with new products and procedures, except through the cumbersome process of getting a waiver of compliance from MTB.

When MTB adopts a consensus standard as a regulation, it decrees that industry must operate in the future on products and procedures that were already in use at the time the standard was published. The regulation does not accommodate the use of new products and procedures, except by waiver. There is little opportunity to gain operational experience with new products and procedures. As a result, the consensus committee does not get the kind of information on which it relies to update the standard. The consensus standard milestone, a mark of progress, thus becomes a regulatory milestone, inhibiting progress. By this process, industry's products and procedures are slowly fossilized by fiat.

The federal safety standards for the transportation of natural gas by pipeline are in Part 192. The requirements for pipeline materials are in Subpart B--Materials, which consists of Sections 192.51-192.65. The following provisions of Subpart B are pertinent to this discussion:

1. S.192.51 states the scope, "This subpart prescribes requirements for the selection and quali-

fication of pipe and components for use in pipelines."

2. S.192.52 states general requirements, including "materials must be...qualified in accordance with the applicable requirements of this subpart."

3. S.192.55 states specific requirements for steel pipe, including "new steel pipe is qualified for use under this part if...it is manufactured in accordance with a listed specification...."

4. Appendix B lists the specifications for pipe. In these specifications, the numbers in parentheses show the applicable editions, identified by the year the edition was published. For the type of steel pipe with which this discussion is concerned, Appendix B lists two specifications: API 5LS, steel pipe (1967, 1970, 1971 plus Supp. 1, 1973 plus Supp. 1, 1975 plus Supp. 1, and 1977); and API 5LX, steel pipe (1967, 1970, 1971 plus Supp. 1, 1973 plus Supp. 1, 1975 plus Supp. 1, and 1977).

The net effect of these provisions is to preclude use of any pipe that is not listed in API 5LS or 5LX.

When API 5LS and 5LX were first incorporated into Appendix B in August 1970, they included the then-current editions of the specifications. Appendix B has been amended from time to time to include later editions. The latest amendment in April 1978 marked the end of an interesting story. Two paragraphs from the preamble to the amendment follow:

> This amendment makes Parts 192 and 195 conform with recent developments in the manufacture and design of steel pipe. These subjects are now regulated, in part, through an incorporation by reference of API Standard 5LS and API Standard 5LX listed in Parts 192 and 195. This amendment updates the lists to include the 1977 editions of both parts and the March 1976 Supplements in Part 192.
>
> Of particular importance is that, by referencing the March 1976 Supplements and the 1977 editions of API 5LS and API 5LX, pipeline operators will be permitted to use Grade X-70 pipe in the transportation of gas. Grade X-70 is more economical for certain uses than other available grades of steel pipe because of its high strength, which permits the use of thinner walled pipe. It is projected for use in the pipeline approved under the Alaska Natural Gas Transportation Act of 1976 (15 U.S.C. 719) to transport gas from the North Slope to the lower 48 states.

THE STORY OF GRADE X-70 PIPE

The story of Grade X-70 pipe epitomizes the stultifying effect of how-to-do-it regulations on industrial innovation. Grade X-70 pipe was developed by American and Canadian industry, primarily for use in high-pressure gas pipeline service in cold climates.

By 1970, Grade X-70 pipe had been tested to the point where it was ready for operational use. But it could not be used in gas pipelines in the United States because it was not in a listed specification. And it could not be included in a listed specification because there was no operational experience to justify inclusion. By adopting a consensus standard as a regulation, converting an advisory document into a regulatory requirement, MTB prevented the gas pipeline industry from using a better product.

Fortunately, Canadian law did not prohibit it, so a Canadian operator put Grade X-70 pipe into gas pipeline service in 1971. The pipe was made in Italy, Germany, and Japan. In 1974, three years after it was put in service in Canada, the Columbia Gas Transmission Corporation, in a joint project with Bethlehem Steel Corporation, installed less than a mile of 36-in Grade X-70 pipe in the United States. The report on the project, prepared by Columbia engineers, began with this introductory paragraph:

> The primary reason for undertaking this project was to gain some experience with advancing pipe technology. Hopefully the experience would eventually lead to the approval and use of higher-strength steels having fracture toughness properties necessary to prevent long propagating shear fractures. This effect was intended to give the manufacturer, Bethlehem Steel Corporation, an opportunity to produce a sufficient quantity of this material to verify that their new and different mill practices would achieve both the higher-strength and improved fracture toughness properties in line pipe steels. It waw also intended to give Columbia experience in the girth welding of the pipes and the bending of the pipe under field construction conditions.

Based primarily on Canadian operating experience, the consensus standards committee in March 1976 included a specification for Grade X-70 pipe in Supp. 1 to the 1975 editions of API 5LS and 5LX. It is ironic that, because of MTB's how-to-do-it regulatory requirements, the American gas pipeline industry had to look abroad for technological leadership.

The story does not end with the March 1976 publication of a specification for Grade X-70 pipe. Irony compounded, the regulations still prohibited American gas pipeline operators from using Grade X-70 pipe because the specification was not included in Appendix B. As we have seen, MTB did not amend Appendix B to include a specification for Grade X-70 pipe until April 1978--two years after the consensus standards committee recommended its use and eight years after it went into service in Canada. For these years, MTB's how-to-do-it way of writing regulations prevented American gas pipeline operators from using Grade X-70 pipe.

Although MTB's regulations prohibited the use of Grade X-70 pipe in gas pipelines, MTB's regulations never did prohibit its use in liquid pipelines. (Parts 192 and 195 are constructed differently.) All the time that use of Grade X-70 was denied to gas pipeline operators, the operators of the Alaska oil pipeline were designing it to be built with Grade X-70 pipe. Keep in mind that Grade X-70 pipe was developed primarily for use in gas pipeline service.

SPECIFIC REGULATIONS INHIBIT TECHNOLOGICAL INNOVATION

As we have seen, how-to-do-it regulations clearly inhibit the use of new products and procedures. Do they also inhibit research? There is nothing in the regulations to prohibit industry from doing any kind of research for any purpose. Then how do the regulations affect research? Research in the industrial environment is not an end in itself. The purpose of industrial research is to develop new, better, more economical ways of performing industrial functions, including the transportation of hazardous materials. The prospect of using the product of research provides the incentive to do the research. Anything that limits the use of the end product lessens the incentive to do research to develop the product.

REWRITE REGULATIONS IN PERFORMANCE LANGUAGE

The vice of how-to-do-it regulations is that they prohibit the use of current technological develop-

ments. Performance standards do not limit technological innovation. S.193.2007 on definitions of the recently published liquefied natural gas regulations tells industry what the safety requirements are, but not how to meet them.

Under a performance standard, the operator analyzes the individual operation and devises appropriate means of meeting the regulatory requirements. Although now required to do so, the operator will be inclined to follow the practices recommended in consensus standards. But--and this is critical to the future health of regulated industries--the operator is not prohibited from incorporating current technological developments into the operation.

MTB has the ability to state its requirements in performance language as we have seen in much of the recently issued regulations for liquefied natural gas. MTB has stated its intention to rewrite all its regulations in performance language, insofar as it is feasible to do so. All that remains is for MTB to get on with the project on a high-priority basis.

REGULATIONS/CONSENSUS STANDARDS RELATIONSHIP

When safety regulations are properly written, regulations and consensus standards serve different purposes. The regulations tell industry the safety standards that it must meet, but not how to perform the function. In fact, since safety is but one facet of the overall function, safety cannot properly be addressed except in the context of the overall function. The consensus standard advises industry on a wide range of operational matters relating to the overall function, including means of complying with the safety requirements. In short, they serve these complementary purposes: The regulations prescribe what and the consensus standards describe how.

Historically, standards writing committees were the prime means through which industry accumulated and evaluated operating experience and exchanged information as to good operating practices. In recent years, regulatory agencies have compromised this function. When a regulatory agency makes a practice of incorporating consensus standards into the regulations, the standards become embryonic regulations. As standards committees come to understand this new role, they will eliminate operational advice and include in the standards only those things that they are willing to have in the regulations. Except as a means of manipulating the regulatory process, the committees will then lose their value to industry.

Industry began using consensus standards because there was a need to exchange operational information. Government agencies should let these standards return to their historic role, before their usefulness is destroyed. MTB should rewrite its regulations in performance language leaving the how-to-do-it details to the consensus standards committees.

Government Role in Fostering Innovation

Simon Prensky

The U.S. government has had a substantial influence on technical research and development activity since World War II, supporting more than 50 percent of the nation's R&D investment for most of that period (1). Although its direct involvement has been concentrated in the defense and health sectors, the government has impacted research in all segments of the economy including hazardous material and waste transportation. Public research and development programs, while numerous and diverse, have generally served the purposes of either developing new technology for public sector needs or advancing basic knowledge or understanding. For the most part the federal government has avoided the support or conduct of research to develop new private-market products or services (2). Even so, the overall role of the federal government in supporting public technological R&D has been questioned in light of allegations of waste and mismanagement of some research programs.

The argument for reduced government involvement in R&D is based on the premise that government, in general, will be less efficient than private industry in directing research and development activities. This position is commonly supported on grounds that bureaucratic systems lack effective mechanisms for resource allocation, government programs are more susceptible to the distortions of political influence, and government personnel lack appropriate real-world and technical expertise. These arguments, though overstated in their most extreme form, are persuasive in leading to the conclusion that the public interest is not best served when government preempts or supplants private research efforts.

On the other hand, there appears to be a near consensus among economic and business analysts that the national investment in R&D needs to be increased from current levels if future gains in productivity and the standard of living are to be ensured. Given some uncertainty over the private market's willingness to significantly increase R&D investment, especially in areas such as hazardous material safety, the federal government may be the only significant source for much of the needed additional research funds.

Although the U.S. private economy has had spectacular success in developing and bringing to the market a wide variety of commercial products, there are strong theoretical economic arguments that the private market has and will continue to fund R&D at below socially desirable levels. The most prominent reasons advanced to explain why the private market systematically underfunds R&D include the following:

1. Lack of private-market economic incentive,
2. Uncertainty of payoff from R&D investments, and
3. Restrictive regulation.

The private economy has a natural incentive to invest in the generation of goods that produce business profit. However, goods such as safety and environmental protection, while valued highly by the public, cannot be owned and sold by firms that contribute to their production. Accordingly, private investment in these areas will generally be less then the socially desirable amount. In particular, private investments in the production of new technology or other means of reducing the consequences of hazardous material spills will be made only to the extent that they are cost-effective in reducing liability and other private costs of accident. Government has the justification and responsibility for intervening in the private market to influence the production of these public goods in adequate quantities. (Safety and environmental protection are public goods in the sense that no one can be effectively excluded from obtaining their benefits and, therefore, they cannot be owned by individuals or firms.)

Economists ascribe the qualities of a public good to all research and development activities and thus often conclude that there is a general shortage of private-market funding for R&D. The argument can be summarized as follows: The most important product of research is the information generated simultaneously with the new product or process. Once generated, dissemination and use of this information throughout the economy cannot be effectively prevented. (The patent system is only partially effective at restricting the use of technical information.) In this way information is like a public good. Since private firms cannot fully own or profit by the technological information generated by research activities, they will invest less in its production than the socially optimal amount.

The uncertainty of future costs and benefits of technological research is another reason cited for the private-market failure to provide an optimal allocation of resource to R&D. "The outcome of any research project is necessarily uncertain and the most important results are likely to come from projects whose degree of uncertainty to begin with was the greatest" (3). Since private firms have been found to be generally adverse to risk with respect to investments in R&D, they will tend to underinvest in technological rsearch and skew their R&D investments away from basic or long-term research and toward applied, short-term endeavors. Because R&D expenditures in risky research are very likely to produce the most important benefits from society's point of view, an argument can be made for government intervention in the private R&D market, particularly in support of basic research.

Certain private technological investments will be underfunded, not because there is a lack of economic incentive or because there is excessive risk but because past government action has tended to inhibit innovation. Since regulation of private activity is accomplished by specifying a limited number of conforming designs or processes, there is considerable economic pressure to continue use of the technology embedded in those designs or processes. It is the nature of government regulation that acceptable designs will not generally include the latest and most efficient technologies. To the extent that extra costs and/or delays are incurred in obtaining government approval of new designs, regulated firms will tend to underinvest in new technology. In addition, the ultimate risk of new product prohibition increases the uncertainty of R&D activity and therefore also discourages technological innovation. A well-noted example of this type of restrictive regulation in hazardous material transportation is the use of design sepcifications for packaging. A thorough discussion of the benefits and problems associated with conversion to performance standards is presented elsewhere in this paper.

Such arguments indicate that the specific areas in which the government could intervene in R&D to increase the general public welfare are difficult to define. Classical welfare economic theory gives little assistance. Its prescription, i.e., invest until the marginal social benefit just equals the marginal social cost, cannot be employed in practice because of the uncertainty of estimates of social costs and benefits. Government intervention in the R&D process generally results in increased administrative costs and can lead to misdirection of private as well as public resources. Before specific public intervention can be justified, it is necessary to compare each option's prospects for remedying the market defects with the mischief that these options may themselves generate (4). The government, therefore, should be very careful in devising strategic and tactical plans for intervention in the technological R&D process. As a general rule, it should only intervene in areas where there is a clear societal benefit (measured by employing marginal cost/benefit analysis in a qualitative manner, if necessary) and favor methods of intervention that cause the least disruption to the economic process.

In addition, it is clearly desirable for the government to improve methods to evaluate the merits of technical R&D investments to narrow the uncertainty of estimates of public benefits and costs. As a consequence of extending and refining data and basic understanding (including the improvement of technology forecasting and risk analysis techniques), a greater percentage of potentially worthwhile projects will be supported while projects of questionable value will likely be dismissed.

The federal government can intervene in the technological R&D process in the following major ways: (a) tax policy, (b) regulation, and (c) direct funding.

Tax policies that may be effective in increasing the overall amount of private R&D investment include general tax cuts, investment tax credits, exemption from taxes for new ventures, accelerated depreciation of research plant and equipment, etc. These mechanisms have the advantage of leaving the greatest amount of management prerogative for direction of R&D projects in the hands of the private sector. Given the belief in the private market's relative advantage in efficiency, these techniques should lead to production of the greatest value of useful products per government dollar invested. However, the incentives tend to induce more of the same kind of R&D currently being done, whereas R&D in areas of the greatest public need may continue to be underfunded. In addition, use of tax policy in R&D runs the risk that federal funds will largely substitute for private funds, not augment them (5).

Regulation indirectly influences R&D spending by prohibiting certain activities and modifying others into prescribed patterns. Properly formulated regulations can be used to promote R&D activity, as effectively as some regulations inhibit it. One way in which regulations can induce increases in private R&D activity is by establishing standards of performance that are at levels not attainable by technology currently employed in the regulated industry. An example of using regulation in this manner is the Average Fleet Fuel Economy Standards for the U.S. automobile industry. By setting yearly miles per gallon goals (and penalties for missing them), the government forced domestic automobile makers to more rapidly change their fleet to advanced fuel-efficient designs. This approach requires that prior to promulgation, the government establishes that (a) the proposed standards are both technically and economically feasible and (b) the time frame suggested for their implementation does not cause undue financial harm to the regulated industry. Regulated performance standards have the advantage of leaving a great deal of the management control for R&D in the private market, and they can be more selectively employed than tax incentives.

Another regulatory approach to induce greater private R&D investment is to develop mechanisms that make private firms more fully responsible for the societal costs of their operations. For example, the purpose of the recently enacted hazardous waste superfund legislation is to assign the costs of cleaning up waste sites to chemical companies who share responsibilities for the problem. Chemical companies who produce hazardous chemical wastes may respond by increasing R&D investment in areas that lead to reductions in chemical pollution, thus reducing their liability under the Act. Liability

mechanisms of this type could potentially be extended to cover the consequences of hazardous materials spill. However, complicated questions of evaluation of long-term social costs and design of efficient administrative mechanisms may limit the applicability of this approach.

Direct government funding of technological R&D is accomplished through grants and contracts to universities and private industry and in government operated research laboratories.

Direct funding of research places the greatest responsibility on government agencies to efficiently (a) define specific research project requirements and approaches, (b) allocate resources for undertaking or monitoring projects, (c) evaluate results, and (d) transfer technical information to implementing organizations. Direct government technological research is required in areas of primary government responsibilities, i.e., support of regulatory activity and policy analysis. As alluded to earlier, this research is needed to accomplish such activities as (a) evaluation of the feasibility, costs, and benefits of technological alternatives; (b) development of standards for performance and condition; and (c) development of methods to test and/or evaluate adherence to standards. Direct government funding of basic research is also required because reliance on tax policy and regulatory mechanisms is not likely to induce private industry to fund basic research at the socially desirable level.

NEEDS AND OPPORTUNITIES FOR TECHNOLOGICAL INNOVATION

A critical need for technological innovation arises from a pressing need for solution to important problems. The simultaneous build-up of technical knowledge increases the likelihood that new technology can be developed or applied. In hazardous material and waste transportation safety, several factors combine to lessen the critical nature of needs for technological innovation. First, the hazardous material transportation safety record, despite the current public perception, does not clearly indicate areas where technical research would be of obvious public benefit. The problems in this areas are diverse and of limited impact, i.e., there are no specific technical bottlenecks that are holding up a wide range of safety improvements. In addition, many of the most important problems in this area seem to be most amenable to solution by non-technological means. Finally, in many areas where technology is thought likely to be profitably applied, existing techniques will suffice; the development of entirely new methods and equipment is not warranted.

The implication is not that there will be insignificant payoff from application of technology in hazardous material transportation, but that the areas where technological R&D investments should be made may be difficult to identify.

As indicated above, specific R&D projects should not be initiated without in-depth (cost/benefit) analysis. However, it is useful to identify areas of potential technological contribution that would then serve as a basis for further investigation by both industry and government. In order to foster discussion on this topic by conference participants, a list of potential technological R&D areas is presented as follows:

1. Emergency Response Communications--CB/telephone/satellite systems for improving communications at the accident site and with carriers, shippers, the National Emergency Response Center and CHEMTREC; and remote-site accident detection and warning systems.

2. Hazardous Material Neutralization and Disposal Methods--Long-term environmental and health impacts from single exposures to hazardous material spills; air and water contamination from chemical spills and on-site disposal; and use of neutralizing chemicals to lessen immediate impacts of spills or to aid in clean-up activities.

3. Training Techniques and Equipment--Computer-based emergency response simulations and hazard/materials handling information dissemination via audiovisual cassettes.

4. Estimation of Hazardous Materials/Waste Movement--Computer-based manifest/consist tracking systems and use of high-resolution airborne photography to locate vehicles containing hazardous materials/wastes.

5. Methods to Render Materials Less Hazardous During Transport--Combustion retardant packaging and additives, gelation and leak plugging materials, and shipment of less hazardous compounds and/or components.

6. Advanced Test Equipment and Methods--Automatic cargo condition sensing devices, wide spectrum analyzers for identification of chemicals at the accident site, in-ground pipeline condition test equipment, and non-destructive tests for hazardous material tank and hose condition.

REFERENCES

1. National Patterns of R&D Resources Funds and Manpower in the United States, 1953-1974. National Science Foundation, NSF 74-304, Washington, DC, 1974.
2. R Nelson. World Leadership, The Technological Gap and National Science Policy. Minerva, Vol. 9, July 1971.
3. K. Arrow. Essays in the Theory of Risk-Bearing. Markham Publishing Co., Chicago, 1971.
4. E. Wolf. Public Policy Toward Commercial By-Products from Government R&D. Forty-Ninth Annual Conference of the Western Economic Assoc., Las Vegas, June 1974.
5. H. Brumm and J. Hemphill. Role of Government in the Allocation of Resources to Technological Innovation. National Science Foundation, NSF/RDA-75/1/2, Feb. 1976.

Application of Automated Data Base Technology to an Intense Regulatory Climate

Donald M. Shilesky

Comprehensive hazardous waste management regulations were recently promulgated by EPA. At the center of the regulations lies the requirement that a written manifest accompany each shipment of hazardous waste from "cradle to grave."

The application of existing automated data management technology to the problems of hazardous waste and its transportation is promising. However, considerable obstacles remain before the full potential can be realized. One such obstacle is the myraid of inconsistent state regulations with respect to hazardous waste manifests. The effect of this collection of differing state requirements is to minimize the application of automated data base technology to the problems of hazardous waste management. This paper presents background information for manifest requirements, then discusses two pri-

mary issues facing the application of data base management techniques:

1. Should the federal government mandate a single uniform hazardous waste manifest format to be used throughout the United States?
2. Should the federal government itself develop an automated data base management system to replace the requirement for a written manifest?

As of November 19, 1980, each load of hazardous waste leaving a generator's plant site must be accompanied by a manifest. The manifest is a part of EPA's Resource Conservation and Recovery Act (RCRA) regulations that require a cradle-to-grave accounting for the transportation of hazardous wastes. This regulatory program has and will continue to cause an extensive upheaval in the transportation industry. Consideration of hazardous waste as a commodity in transit is a relatively new phenomenon. While hazardous materials in transit have traditionally been accompanied by shipping papers, waste materials have not. Written hazardous waste manifests required by EPA and DOT must now accompany waste shipments from the generator of the wastes to transporters to treatment/storage/disposal facilities (T/S/DF) and back to the generator. Each manifest must contain, as a minimum, the following data:

1. A document number;
2. Waste generator's name, address, telephone number, and EPA identification numbers;
3. Initial and subsequent transporter's names and their EPA identification numbers;
4. A designated T/S/DF and up to one alternate site by name, address, and EPA identification number;
5. A description of the waste in accordance with DOT regulations;
6. The total quantity of each hazardous waste; and
7. A certification containing specific language.

There is, however, no specific manifest format required by the federal regulations. The seven requirements listed above can be supplemented by state requirements. Several states have adopted mandatory manifest formats that require more specific waste description information. A few state regulations do not permit the use of T/S/DFs of manifests prepared by out-of-state generators unless the state format of the generator is identical to the T/S/DF state format.

The paradox is made complete when the generator and T/S/DF are separated by, let us say, six states, each with a different manifest format requirement. Each hazardous waste shipment would then conceivably require eight separate manifests, one each for the generator, disposer, and intermediate transit states. Any one of the manifests, taken alone, probably would have protected the public interest by assuring an auditable trail in the event of a mishap or intentional mismanagement.

There are important procedureal differences in addition to the substantive manifest requirements between states. Manifest document numbers and generator, transporter, and T/S/DF site codes may vary from state to state. In addition, some states require that copies of the manifest be mailed to a state agency for tracking by that agency.

In response to federal and state hazardous waste manifest requirements, several vendors are now offering an automated data base management system designed to assist hazardous waste generators in complying with manifest requirements. Such automated data base management systems serve a relatively straightforward data editing and manifest tracking function. Although specific applications differ somewhat, the following scenario is intended to illustrate the capabilities of such a system.

A generator, seeking to ship a hazardous waste from state A to state C journeying through state B, accesses a computer via a remote data entry terminal. The manifest form required by state A is displayed on the terminal screen for completion. As the data entry clerk enters the data to the form, the computer automatically checks and verifies each data entry. EPA identification codes, waste categories, waste descriptions, and other manifest requirements are all checked against a master file containing such information. Should the clerk indicate, as in this case, that disposal of the waste shipment is intended in another state (here, state C), the terminal will then display a different manifest (should one be required) for T/S/DFs operating in state C. Should the intermediate state (state B) require a different manifest format, that format will be automatically displayed by the computer terminal for completion.

A properly constructed data base can be instrumental in preventing inadvertent violations of differing state manifest requirements. However, such systems are not currently available for use in more than a handful of states. Reasons cited by vendors offering such services include the uncertainty of new state regulatory requirements and the anticipation of new federal requirements with respect to manifest.

THE ISSUES

The issue is thus squarely presented: Should the federal government mandate a uniform format for hazardous waste manifests and thereby promote the use of existing computer-based automated data management systems to solve the problems of hazardous waste transportation? A corollary to the question raised is whether the federal government should itself develop an automated data base management system for use by hazardous waste managers.

It would be unfair to accuse EPA of failing to consider the use of automated data base management techniques in promulgating its hazardous waste manifest requirements. Indeed, throughout its preamble to those regulations, EPA made reference to the fact that many hazardous waste managers would choose automated record management as a means of complying with the regulations.

The problem that EPA faced in selecting a hazardous waste manifest format (or in failing to do so) was in gaining a consensus among the various states as to the required contents for the hazardous waste manifest. What is needed is direction from a federal agency as to what pertinent information needs to be on a manifest. EPA attempted to give this direction in its regulations, but did not mandate that a common manifest be used by all states. Consequently, the states, naturally, took EPA's direction to mean they could add other pertinent information which they deemed essential to the manifest.

If a common manifest were used by all states, the use of a computer for data storage, reporting, and tracking of manifests would be enhanced. Such a uniform manifest format need not necessarily limit the additional information available to the states. A uniform format could be adopted that would permit some record fields to remain optional, depending on state regulations. These fields would not be completed in all states by all generators. However, the format would remain the same, thus simplifying a centralized approach to automating the hazardous waste data base. This is not to say that some

effort should not be made to limit the number of data fields contained in the uniform hazardous waste manifest format. Obviously, the more data fields stored in a computerized system, the more complicated (expensive) the system itself, and the more sophisticated (expensive) the equipment required.

The preceding paragraphs have discussed the opportunity for the federal hazardous waste manifest requirements to be modified to enhance the application of existing computer-based technology in hazardous waste management. The more fundamental question remains, however: Should the regulations themselves be changed to embrace the use of automation as a substitute for the written hazardous waste manifest?

The trend in our economy is toward a paperless commercial system. Commercial "paper" is transferred electronically without the benefit of paper, or with paper as a confirming back-up system. If a federal agency such as DOT or EPA were to adopt a centralized automated data base for tracking and reporting hazardous wastes, would not the result be better protection for the environment and the public health and safety with a lessened economic burden on industry? Under such a system, a generator wishing to transport a hazardous waste shipment would contact a trained data entry clerk, using an interactive computer terminal, could instantly verify permit status, waste acceptability, and the variety of EPA and other identification codes associated with wastes, generators, transporters, and disposers. At the other end of the shipment, when the disposer receives a shipment of hazardous wastes, it too will contact the central data base to remove that manifest from the active portion of the file and put the manifest information in a summary file for use by interested parties.

Telephone contact is not an essential part of such a system. Large-volume users could be equipped with their own remote data entry stations. Creation of such a centralized computer data base would, of course, raise other questions:

1. Should the system be maintained by a federal, state, or regional agency or by a private corporation or by a combination of private and government entities?
2. Could such a system be developed in which a common manifest is supplemented by other legitimate state information requirements?
3. Are we prepared, as a society, to dedicate the resources necessary to enforce regulations as quickly as violations are detected by the automated data base management system?
4. Can appropriate security measures be incorporated into the system to assure that proprietary business information is not inadvertently disclosed?

SUMMARY

The principal issue addressed by this paper is the problem created by the proliferation of inconsistent hazardous waste manifest requirements by the several states. While differences in state approaches to hazardous waste management are recognized in the statutes supporting EPA regulations, differences between the states in hazardous waste manifest requirements as such threaten to wreak havoc in interstate commerce and frustrate the ongoing efforts to apply existing computer data base management technology to the problems of hazardous waste management. Finally, the issue of federal assumption of data management responsibilities with respect to hazardous waste manifests is presented to initiate and stimulate discussion on this important question.

PART 2
Reports of Rapporteurs

Workshop on Regulation

Deborah Rudolph

I. ISSUE/PROBLEM: THE PURPOSE OF HAZARDOUS MATERIALS REGULATIONS

Due in part to the legislative history involving hazardous materials and wastes, many statutes exist that deal with differing needs and purposes for regulation in this area. In some cases, there appear to be contradictions between them.

In addition, a piecemeal regulatory system exists that covers the whole field and is managed by several federal agencies. A rational approach is needed that will minimize the inconsistencies and provide a clear purpose for regulation of hazardous materials and wastes.

In some cases, although there appears to be disagreement in interpreting these statutes, it is the belief of many that the statutes are broad enough to allow development of the needed rational approach to regulation without additional legislation.

Also lacking is a clear policy statement relating to an acceptable level of risk. There is no absolute way to avoid all risk or prevent all accidents. However, stating an acceptable risk level is not politically acceptable. While a strict policy statement, such as "thou shall not pollute" or "thou shall not spill", is unrealistic, protection is needed from an unreasonable risk. But what is a reasonable risk?

A policy statement that deals with risk and protection levels is clearly necessary.

The following statements were offered as options for a recommended policy statement on the purpose of hazardous materials regulation.

Recommended Options for a Policy Statement on the Purpose of Regulation

Statement 1. It is the responsibility of the U.S. Secretary of Transportation to assure the safe and effective transportation of hazardous materials. The Secretary shall develop feasible requirements and compliance incentives to enhance national and international harmony in minimizing risk to life, health, property, and the environment from such transportation. As the lead national official charged with this reponsibility, the Secretary shall give full consideration to the views of the affected state and local governments and shall provide technical guidance to such governments in the implementation and enforcement of national hazardous materials transportation standards.

Statement 2. The purpose of regulation is to prevent death and injury to persons, property, or the environment that result from the transportation of hazardous materials and to reduce the serious consequences of accidents that arise from such transportation. However, since the resources of society are limited, regulation must likewise be limited to reducing significant potential for simultaneous harm to many persons or to highly valuable property or natural resources.

Statement 3. Recognizing the need to serve public safety while maintaining the nation's economic system within the context of the risk brought about by the transportation of hazardous material or waste, the purpose of regulation is to reduce or minimize significant injury and death through the efficient use of technology and economic resources.

Statement 4. The safe and effective transportation of hazardous materials should be promoted.

Statement 5. To promote the safe, efficient, and economic intrastate and interstate, as well as the international, transportation of hazardous materials and wastes by devising various incentives, including, but not limited to, tax incentives, regulation, legal liability mechanisms, etc., and by taking into account the need to minimize impediments, inconsistencies between laws, etc. The national regulatory program should assure the efficient transportation of hazardous substances on the nation's streets, highways, pipelines, waterways, and airways at minimal risk to persons, property, and the environment, through controls used by private and public organizations, from point of origin to destination.

Statement 6. Human life and health, property, and the environment should be protected with due regard to the needs of commerce and defense, within a national framework that covers the special conditions accompanied by a national commitment of will and resources to implement national, state, and local objectives.

Considerations for the Purpose of Hazardous Materials Regulation

The following were offered by the workshop participants as important considerations for exacting a purpose for the regulation of hazardous materials.

1. To achieve safety for the general public through national controls that are defensible;
2. Safe, standard, effective, and flexible;
3. How best to motivate or police for safety;
4. Not based on the marginal operator but toward the ease of effectiveness and enforcement;
5. Safe and economic transportation by devising incentives--e.g., taxes, liability, etc.;
6. To protect by nature of the risk;
7. Guidelines to states (giving the states the advantage of the expertise that now exists);
8. Federal guidelines for the states for safety and efficiency;
9. Provide a uniform framework to facilitate trade given intergovernmental impediments;
10. Guidelines for safe, standard, and effective transportation other than federal preemption;
11. A deregulation of transportation to protect health, property, the environment (state and local participation must be sought);
12. Federal government should provide leadership to state and local governments with the involvement of the states;
13. Federal guidance for the safe and efficient movement of transportation and minimization of impediments to transportation;
14. A legislative initiative added to the Hazardous Materials Transportation Act should be taken into account in the mandated program, enforcement inconsistencies, and other features of the Act (the purpose is in the mandated statute);
15. National standards that would be uniform and enforced; and

16. Assure efficient transportation through controls by public and private organizations.

Recommendations

1. A select commmittee, which represents shippers, receivers, carriers, public interest groups, regulators, and all levels of government, should be formed to draft a revised policy statement that considers the concerns expressed and is augmented to include recognition of the duty of shippers, carriers, and receivers to protect the public. This statement should also include the specific authority of the U.S. Secretary of Transportation expressed in terms of criteria and prohibitions. The committee's report should be issued for comment, followed by submittal to Congress for action. The Transportation Research Board may be useful in facilitating this work.

2. This conference should recommend that a change of law, or a constitutional amendment, require that regulations have clearly stated objectives, performance measures, and time frames. Regulations not meeting the desired performance levels should be repealed.

3. Regulators should be given better guidance by the Congress and other legislators. Within these parameters, regulators should be forced to develop regulations with wide input from interested parties.

4. A Presidential Study Commission should be established to discourse on and set recommended guidance and policy for regulatory agencies and legislators to use in applying levels of risk to safety and aimed at achieving a balance in risk acceptability.

II. ISSUE/PROBLEM: THE PROCESS OF HAZARDOUS MATERIALS REGULATIONS

The process of rulemaking and the process of making changes and amendments contribute to the lack of understanding of the hazardous materials regulations. The multiplicity of the regulations--international, domestic, various modes, various government agencies at all levels--also inhibits their understanding and usage, which, in turn, compromises the goal of safety.

The multiplicity of the dockets was also mentioned as compounding the problem. The 30-day period to petition for reconsideration, for example, is not long enough to review the Federal Register, or to study, develop, petition, and submit responses. The various federal agencies have differing comment periods throughout the year that are a burden on those that are regulated.

The effective dates for implementation of the regulations also vary throughout the year and to the user's confusion and lack of understanding. There are too many dates and timetables for implementations. This also inhibits training schedules.

It was recommended that the regulators should solicit comments from the affected parties and the other levels of government early in the rulemaking process.

The format of the regulations is thought to be of more use to the regulator than the regulated. Generally, the hazardous materials regulations are geared more to the attornies and regulators rather than to the affected parties. This inhibits safety efforts.

There is also great confusion about priority setting in the rulemaking process. The schedule for the review of the regulations should be set and available to the general public--especially the regulated parties and other levels of government. This schedule should also be based on the levels of risk of a material and on its quantity and form. Agencies should take no regulatory action if there is not a real problem.

The current high levels of applications for exemptions were cited as indications of the need for general amendment that could alleviate this burden. The issuance of regulations is but one means to cure an ill; it is not the only method. The U.S. Department of Transportation (DOT) should approach hazardous material regulation with that in mind.

Petitions for rulemaking should also highlight for DOT the areas that require changes. These petitions should be assigned a priority rating and a timetable. This information should be communicated to the regulated parties.

The regulations should also be based on a real hazard with the goal of increased safety. Enforcement and penalties should be coordinated to reflect these levels of risk. Current incident-reporting data could be used for setting such risk levels--these data should be used, not just collected.

The process should also include evaluation. If a regulation or solution does not solve problems, it should be reviewed and reworked, not just kept on the books indefinitely.

As pointed out in other sections of this report, the need to petition MTB for an exemption to the current design standards could be eliminated through use of performance specifications.

Recommendations

1. One annual effective date should be set for final rulemakings by modes or even by various agencies. For example, all MTB regulations finalized in the previous 12 months would become effective for compliance on July 1 of every year.

2. Effective dates of regulations should be reviewed for DOT and other agencies and how best to coordinate them.

III. ISSUE/PROBLEM: ENFORCEMENT AND COMPLIANCE WITH THE HAZARDOUS MATERIALS REGULATIONS

The elements of the purpose statement for the national hazardous materials regulatory program should be reflected in the enforcement and compliance system. As a regulatory technique, the issuance of detailed regulation implies the necessity of an enforcement program. Without such a program, a system of voluntary compliance exists. It was pointed out that, since the resources available for enforcement have been limited, the enforcement program now depends a great deal on the voluntary efforts of the regulated community. There was a strong sense that the enforcement program should move toward a policy of voluntary compliance, rather than employ sufficient numbers of inspectors to totally police the industry.

Although it was agreed that there should be enforcement of the hazardous materials regulations, the enforcement program should be based on the need for enforcement. Penalties and fines should be based on levels of noncompliance. Penalties should fall heaviest on those who have the most severe and frequent violations. This also assumes that the enforcement program and the penalties would relate to the levels of hazard of the material and of the risk--i.e., for high levels of risk there would be high levels of enforcement and fines, and vice versa.

The regulations are currently written with the idea of making them "violation proof" for enforcement purposes. Instead, the regulation should be written more simply with the idea of encouraging voluntary compliance by the user. This would increase safety.

The enforcement program would also benefit from the simplification of the regulations. They should be made more understandable to the user community. An effective enforcement program implies that legislators and regulators sufficiently fund enforcement activities; violations be prioritized by levels of severity based on experience, and sanctions applied accordingly; and uniformity of enforcement be enhanced, i.e., state versus federal, mode versus mode.

Recommendations

1. Existing hazardous materials incident data should be analyzed to assess the levels of risk according to the volume of shipment.
2. A clear statement of enforcement policy by the regulatory authorities is needed.
3. Based on incident data, levels of enforcement based on severity should be determined and prioritized.
4. Uniformity in enforcement should be established.
5. If there are regulations, there needs to be enforcement, but enforcement should be based on the need for enforcement.
6. Fines should be based on the different levels of noncompliance.
7. The problem of enforcement would be substantially reduced if insignificant regulation would also be reduced. The reduction of regulation does not mean reverting to the law of the jungle. It would simply compel greater reliance over other inducements to socially desirable behavior, e.g., the civil liability system.
8. Elements of regulatory purpose, objectives, and compliance evidence must be incorporated into each regulation.
9. A penalty policy based on disincentives for noncompliance should be developed.
10. An enforcement management system should be developed that provides feedback to the regulated community as well as inspectors concerning enforcement, and includes comprehensive compliance history and decisions on the local regional level.
11. The levels of compliance severity should be related to the sanctions.

IV. ISSUE/PROBLEM: GOVERNMENTAL, PRIVATE SECTOR, AND INTERNATIONAL RELATIONSHIPS

The primary role in the field of hazardous materials transportation must and should be played by the federal government. However, state and local issues should and must be addressed by the federal government. Regulation cannot occur on a state-by-state basis.

The federal government should give priority consideration to issues and complaints, such as those about routing, from the other levels of government.

There must be a mechanism to give speedy attention to problems as they arise. If a problem comes up that requires regulatory attention by a non-federal authority, there should be a mechanism that allows a deviation from federal regulations to deal with such a problem.

Coordinated involvement of state and local issues could be accomplished by establishing an advisory council that would include federal, state, and local government representatives, as well as those of the private sector and public-interest groups. Such an advisory council would

1. Determine what categories and activities should be absolutely preempted (where there is a need for absolute uniformity);
2. Establish guidelines for acceptable state and local activities in other areas, which are not preempted; and
3. Coordinate enforcement activities.

There should also be a process for assessing the validity of state and local regulations and to resolve intergovernmental conflicts as they arise. Groups could also be established on a regional basis, similar to the Puget Sound Advisory Council, to assist in these functions.

Recommendations

1. Federal preemption should be established with some exceptions for specific problems associated with unique geographic areas.
2. The state and local roles should be limited to enforcement.
3. There should be a mechanism for state and local input to the strong central federal role.
4. DOT should strive to incorporate international standards and procedures wherever applicable.

V. ISSUE/PROBLEM: REGULATORY SIMPLIFICATION AND CLASSIFICATION

As Don Boyd related in his resource paper on The Complexity of Hazardous Materials Transportation Regulation (see Appendix 2), one of the recommendations of the Airlie House Conference on Hazardous Materials held in 1969 was that "immediate efforts be made to simplify the existing regulations. The secondary mission consists of simplification and condensation of present regulations to a more realistic and workable document."

In 1979 the National Transportation Safety Board recommended that DOT evaluate every hazardous materials regulation so that the regulations could be understood by those who need to use them.

The participants of this workshop echoed these same findings and stressed the need for regulations that can be understood and used by those in the field who need to use them--truck drivers, shipping clerks, etc.

The format and arrangement of 49 CFR contribute to the problem as much as the language, which appears to be written more for lawyers and regulators than operational personnel. This situation requires "translation" of regulations that result in an increased need for training courses and the possibility that safety is compromised (through lack of understanding or by the translation process).

Boyd also pointed out that, "simple, clearcut, but no less demanding regulations would enable people to be occupied with safety performance rather than preoccupied and confused with complex and sometimes conflicting regulations. It is quite possible that easily understood regulations would result in better compliance."

It was also suggested that the various shippers, carriers, and manufacturers develop guidebooks and handbooks for their employees to inform them of the specific regulations necessary for performance of their job functions. This could result, however, in the need for many such guidebooks with considerable cost for development and training employers.

The Code is too large a document to be used in its current form as a guidebook, or to be understood or applied by both shippers and manufacturers for all modes. The use of guidebooks would relieve this problem as well. It was the general thinking of the group that, although 49 CFR would never be a household document for all regulated parties, it could be simplified to some degree to the benefit of all.

The increased use of performance specifications

in the regulations, rather than detailed design standards, could simplify and reduce the 400 pages in the Code that cover container requirements. Performance standards prescribe what a container must be capable of doing after it is built. Design standards specify how a container must be built. The 1969 Airlie House Conference also stated that a performance standard approach to hazardous materials regulation should be used, where practical, in the regulations. The United Nations Committee has also recommended the use of performance standards over design standards. Another significant benefit of performance standards would be to encourage technological innovation and increased productivity. In the long run, this would mean increased cost-effectiveness.

The current need for a procedure to acquire an exemption to the design standards, requiring a substantial amount of MTB staff time, would be considerably reduced if performance specifications were used. It is estimated that 1200 exemption applications are filed annually with MTB. The existing design standards should not be thrown out, but should be kept as references in 49 CFR.

It was also pointed out that information is duplicated in 49 CFR and could be eliminated.

Recommendations

1. MTB should develop an "acceptable practices guide" for use by both regulatory inspectors and enforcement agencies that will also permit industry to comply with the regulations from a common set of lay terminology and understanding.
2. The use of jargon and "legalese" should be eliminated in favor of more common words with understood meanings.
3. Conversion to performance standards, where possible, should occur to allow for more innovation and to reduce the quantity of the text of 49 CFR.
4. The index to the Code should be improved to allow for quick reference to specific requirements.
5. The regulations should be rewritten for users and not lawyers. 49 CFR can and should be simplified. Credit language has been simplified in many states as a result of local laws. The life insurance industry is making an effort to simplify the language in insurance policies, and DOT must do the same for these regulations.

Workshop on Training

G.R. Choppin

In Transportation Research Circular 219 (July 1980), the 10 most critical issues in hazardous materials transportation were tabulated. Issue 4 was defined as the "training for all persons involved in the transportation of hazardous materials, including shippers, carriers, and emergency response personnel". It was noted that more than 2 million people require training in hazardous materials transportation and that the existing training opportunities were quite inadequate to meet this demand. It was within the context of these concerns that the panel discussions on training were held at the 1981 strategies conference.

In the position papers on training by Arthur Bensmiller, F.H. Halvorsen, and John Granito (see Appendix 2) the principal issues in training were defined. In brief, these involved questions of who should be trained, the goals and objectives for training of the various groups, and evaluations of the training programs and of the personnel who participate in the training.

Different groups constituted the panels on each day. The meeting of the first panel group was opened by Bensmiller with a statement of purpose for the panel discussion. This was defined as the development of recommendations on training for a comprehensive national strategy to provide safe and efficient transportation of hazardous materials and waste in the 1980s. Bensmiller proposed that the panel develop a factual statement of the problem to be addressed, followed by discussion of the factors bearing on this problem and possible solutions to the problem. After a discussion of each solution the panel would be asked to recommend the best possible solution. The strategies that might be useful for implementing such a "best possible solution" would be evolved and form part of the solution statement.

The panel members reviewed the issues defined in the position papers and proposed a number of statements of the most serious training problems regarding time and priority. There was strong consensus on this and several problem statements evolved. These are discussed briefly below.

PROBLEM STATEMENT I

Not all persons involved in overall transportation and incidence (e.g., packaging, labeling, shipping, receiving, incident response, etc.) of hazardous materials receive proper training to fulfill their legal and moral obligations.

The panel unanimously endorsed this statement of the major concern in training. The factors indentified as having significant bearing on this problem were as follows:

1. The number and types of people to be trained,
2. The technical background of the people who must understand and apply regulations,
3. The complexity of the regulations,
4. The fragmentation of responsibility and of training direction among different federal and state agencies,
5. The lack of defined objectives and standards in training programs,
6. The lack of a means of measuring the effectiveness of the training programs, and
7. Funding for the training programs.

Among the various groups that require training of various extent and type, the following were identified by the panel:

1. Personnel involved in establishing regulations and enforcing them;
2. Shippers whose responsibility involved the classification, packaging, marking, labeling, and certification of the hazardous material to be transported, as well as compliance with applicable rules and regulations for preparation of the hazardous material for shipment;
3. Carrier personnel who have the responsibility for accepting, handling, or transporting hazardous materials in commerce;
4. Personnel who receive the materials from the carriers and must handle them in their dissemination to users; and
5. Emergency-response personnel whose responsibility is to respond to an incident involving hazardous materials.

All of these must be trained in the proper function-

ing of their jobs and in the regulations insofar as they affect these jobs.

There are statements in Transportation Research Circular 219 from several agencies in which noncompliance is cited as due, primarily, to ignorance of regulations. The MTB, the U.S. Coast Guard, the Federal Highway Administration, and the Federal Aviation Administration are all quoted as stating that the primary reason for noncompliance is a lack of knowledge and training of carriers and shippers involved in the transportation of hazardous waste materials (1). Similarly, the training of response personnel has been judged to be inadequate (2). Particularly in the case of emergency-response personnel, the training should provide repeated exposure of each person to "war-game" type maneuvers. These simulated exercises or drills should be performed on the basis of local knowledge of where incidents are likely to occur. They should include training in the equipment and in the resources for the most likely types of incidents and the most likely hazardous materials that might be released in such incidents in a particular locale.

Solution to Problem I

The complex set of problems related to the training of persons involved in the various aspects of transporting hazardous materials and the critical importance of such training is recognized. A systems solution is recommended that would involve the identification of a single agency or coordinating office to work with various other appropriate agencies or organizations. This coordinating office would be invested with the authority to develop standardized curricula for training programs. Instructor training and certification would be a major priority for this office. It is important that industry, emergency groups, etc., be involved in the formulation of these training standards and requirements. Selection and certification standards and procedures should be developed for the various groups to be trained. The training and certification program must be funded to an extent adequate to achieve its goals.

The panel agreed that the most important element in implementing this solution is the control of the training programs under a single coordinating office. Further strategy items agreed on by the panel were as follows:

1. The distribution of training funds should be the responsibility of the coordinating agency or office.
2. In the establishment of these training objectives, current federal, state, and industrial programs should be identified and evaluated.
3. The specific groups to be trained should be identified and realistic goals and objectives for their training developed. Recognizing the large number of personnel to be trained, the coordinating agency should develop a priority ranking for the groups to be trained within the limitations of the funding and the number of training instructors available.
4. An "out-reach" system should be developed to disseminate the training programs at the state and local levels.
5. An advisory committee to the coordinating office drawn from other federal and state agencies, industry, professional organizations, etc., should be established to aid in the development of the training objectives and the implementation of the strategy for training.

Problem Statement II

There is a lack of nationwide minimum training criteria.

On the second day of the conference, a new group was convened to which no summary was given of the panel discussions and decisions from the preceding day. The new panel group defined the major problem in training in terms of a lack of training criteria. The factors that the second panel agreed were relevant to the stated problem included the following.

1. A variety of responses to training are required but no common base exists. The result is a number of diverse programs at present that are of uneven quality.
2. The magnitude of the training required in terms of personnel, funding, etc., is formidable.
3. The diversity of the groups requiring training is great.
4. No single agency is responsible to set standards and to approve different training programs.
5. The complexity and rapidly changing nature of the regulations create additional difficulties in training personnel to be knowledgeable of those regulations.
6. Training programs need to be oriented to the specific needs of each group.
7. There is at present no systematic definition of the training objectives for the various groups requiring training.
8. Training programs must be cost effective. It is not feasible to consider training the large number of people necessary at a single or even at several national centers. Problems of time, expense, etc., prohibit this. A more reasonable program would seem to be one in which a national center concentrates on teaching instructors who would then be available to provide training at state and local sites. This has been recognized and strongly recommended by a rather thorough study of the problems involved in hazardous substance accident control (2).
9. The time available for employees to spend in a training program is often rather limited.
10. An adequate number of well-trained instructor personnel are needed for training programs for the many varied groups requiring training.
11. Management must be convinced of the need for proper training of the personnel under their supervision.
12. There is no listing of the jobs related to the transportation of hazardous materials that may provide a basis for ascertaining the various groups requiring different types of training.
13. There often is a lack of proper knowledge and understanding of the many complex regulations and their implications by agency personnel, regulators, enforcers, etc.

Many of these factors are duplications of those defined by the first panel group. This only serves to reinforce the priority of these factors in the major issue, which is inadequate training for all personnel involved in the transportation of hazardous materials and in the response to incidents involving such materials.

Solution to Problem II

The panel recommends the designation of DOT as the lead agency to develop a nationwide master program for training associated with transportation of hazardous materials for all personnel involved in pub-

lic and private organizations and for all phases of transportation of hazardous materials.

Of the various agencies that might be designated as the coordinating office or lead agency, DOT was chosen since it was designated in the Hazardous Materials Transportation Act as the agency to establish and maintain a central reporting system and data center capable of furnishing technical advice to law enforcement and fire-fighting personnel to aid them in responding to emergencies that arise from transporting hazardous materials. That Act further specifies that advanced training of emergency response personnel should be considered an integral part of an adequate response system (3). Moreover, in the Hazardous Transportation Act, which was approved January 3, 1975, the DOT Secretary is authorized to establish criteria for handling hazardous materials. Among such criteria cited in the Act are a "minimum level of training and qualification for such personnel (see 49 U.S.C. 1801 et scc., P.L. 93-633, Jan. 3, 1975).

In the strategy discussion by the panel, there was strong agreement that successful implementation of this solution depends on the following:

1. Congressional designation of DOT as the lead agency that shall coordinate as appropriate with other involved federal agencies;
2. The establishment of a task force to include representatives from involved government, emergency services, and industries concerned with transportation of hazardous materials; and
3. Authorization of this task force to (a) be responsible for development of policy regarding training, (b) define the groups requiring training and the skills needed by each group, (c) promote recognition of the need for proper training of all groups, (d) establish criteria for training curricula, (e) examine the need for regional training networks, and (f) establish a priority scheme for training that considers the urgency of the problem in the various areas of the transportation systems.

The strong coincidence between the definition of the most urgent problem and the best solution by both panel groups emphasized that the highest priority should be given to the establishment of a lead agency to work with a coordinated advisory group in order to establish proper training criteria whereby training programs can be formulated and certified.

In the discussion and formulation of the next problem, the panel followed the definitions established in Halvorsen's position paper. Three classifications of training are specified: (a) preventive, which would emphasize training shippers, carriers, etc., in proper handling, labeling, packaging, etc., in order to minimize the possibility of an incident; (b) initial response in which personnel would be trained to respond immediately to an accident in order to minimize the problems created by the release of hazardous materials; and (c) reflective response in which personnel would be trained to remove the hazardous materials from the area of the accident and to restore that area to its previous condition with a minimum of continuing trauma. The panel felt that a top priority of the coordinating officer recommended in the previous problem solutions should be to give prompt attention to the initial response training program.

PROBLEM STATEMENT III

There is currently a critical need for training in initial response recognizing that training in prevention and in reflective response is more common and more effective at this time. Initial response groups include fire services, law enforcement personnel, and emergency medical services.

The factors related to this problem were identified by the panel as follows.

1. There is no direct coordination for initial response forces at the local level.
2. There is a reluctance of the initial response forces to accept coordination.
3. The technical ability, education, experience, supervision, equipment, training abilities, etc., of local forces vary widely.
4. There are difficulties in offering training to initial response forces who may have a lack of aptitude or may not be available for training at the time it is offered. These problems can be particularly severe for volunteer groups.
5. There is no mandated training requirement for initial response forces.
6. There often are difficulties at the scene of an accident with the jurisdictional scope and priority of various groups.
7. The vehicle operators should be better prepared to meet their obligations under the law in an accident.
8. Standardization of contingency planning is required.
9. There is a lack of qualified instructors, funds, etc., for training emergency-response forces.
10. There is a lack of knowledge about the availability of such courses at the state and local level.

Solution to Problem III

This panel recommends that the coordinating national agency provide the states with a model program in initial response training through the national contingency plan. It was agreed that the formulation of a central coordinating office in DOT would provide the best strategy for the implementation of the solution of response forces. To further enhance the effort of improving the training and capability of the response forces, the panel recommended that the coordinating office in DOT should give priority to the following:

1. Identify and evaluate the present training courses in emergency response and publish lists of these;
2. Promote the development in each state of an agency to direct and to assess the initial response force capability and its performance and to keep records on the personnel trained for initial response;
3. Work with state, police, and fire service organizations to serve as a training delivery system for courses in emergency response;
4. Provide courses at the federal level to train and certify instructors of initial response courses at the state and local level; and
5. Assist the states in developing a regional inventory of equipment that might be shared in an incident and a mechanism for interfacing with and resolving jurisdictional difficulties in an accident.

REFERENCES

1. Noncompliance with Hazardous Materials Regulations. National Transportation Safety Board, NTSP-HZM-79-2, Aug. 3, 1979.
2. Hazardous Substance Highway Spill Study. California Highway Patrol, Sacramento.
3. Report by the Comptroller General: Programs for Insuring the Safe Transportation of Hazardous

Materials Need Improvement. U.S. General Accounting Office, Rept. CED81-5, Nov. 4, 1980.

Workshop on Emergency Response

R. Graziano

The Steering Committee for the National Strategies Conference identified emergency response as a critical issue facing the transportation industry and the public. The workshop on emergency response based its deliberations on the resource papers provided by three authors chosen for their expertise on the subject. The authors were Robert L. Hansen, Robert Mesler, and J.J. Driscoll--all of whom were present during the sessions (see Appendix 2).

The workshop participants represented government at the federal, state, and local levels; chemical and manufacturing industries; rail, highway, pipeline, and water transportation industries; and consultants. Two groups, meeting in separate all-day work sessions, developed their own agenda with respect to the discussion and identification of issues, solutions to problems, and strategy for implementation.

Each group concluded that planning, training, who is in charge, and funding were first-line problems that should be dealt with. The priorities given these items were similar between the two groups [see the table below (not all columns add to exact numbers due to participants not voting for all issues)]:

	Priority Ranking							
Issue	1	2	3	4	5	6	7	8
Planning	13	4	1	1	0	0	0	0
Training	1	7	8	2	1	2	0	0
Who's in charge	5	3	2	3	2	2	1	3
On-scene information	1	2	3	5	8	2	0	0
Funding	1	6	6	2	1	0	5	2
Evacuation	0	0	0	3	5	7	5	0
Liability	0	0	0	3	2	4	4	6
Emergency medical services	0	1	1	1	1	4	6	7

A general viewpoint expressed was that there are too many federal agencies involved in emergency-response activities and, therefore, no one has effective responsibility for this area. This issue received the most overriding attention. A recommendation was made by both groups that a single federal lead agency be appointed to coordinate emergency response activities.

Both groups reached consensus that planning was the number-one priority. The planning function must be coordinated by a single agency at the local, state, and federal levels of government. Producers, transporters, and responders should be an integral part of this planning effort.

Preparedness planning is essential if hazardous materials incidents in transportation are to be handled effectively.

Both groups believed that training was the second-highest priority. Hazardous materials incident response training needs to be conducted by using a program aimed at the various levels of responders' needs. (Since training was more fully covered in another workshop session, our discussion is limited on the subject.)

Who's in charge and who's the coordinator were also priority items for both groups and generated the most discussion. It appeared to be an individual agenda item revolving around liability, as well as effective and legal responsibility. The consensus was that every jurisdiction shall designate an official who will be responsible for incident management.

Although other problem items were listed, they were not discussed in great enough detail to allow the group to reach consensus. They are identified in the group report attached.

REPORT OF WORKSHOP GROUP 1

Group 1 developed a list of items that it considered to be important problems in emergency response. Those problems were subdivided into preaccident, immediate (during), and secondary (post). Major subject areas were identified from this list of items (see Table 1). These major subject areas are planning, training, who's in charge, on-scene information, funding, evacuation, liability, and emergency medical services. A poll of the group resulted in setting priorities for the major subject areas. The group agreed to deal with the items in order of priority. The group did not reach a consensus on all items.

Planning

The following solutions were reviewed, discussed at length, and adopted by consensus.

1. There shall be a single focus at the federal level to plan for hazardous materials incidents.
2. There shall be at the state and local level a single focus for hazardous material incident planning.
3. Planning shall include private industry as an active participant.
4. A study of existing legislation needs to be undertaken to identify the overlapping of jurisdictions among the federal, state, and local agencies (referred to legal committee).
5. There needs to be a review of existing study data and recommendations for possible directions.
6. There is a need to publish and promote existing guidance materials for hazardous material incident planning such as the Rockwell Study, Fire Scope, Multnamah County Contingency Plan for Hazardous Materials, Puget Sound COG study, the National Contingency Plan, study by Kansas State University, and STL Post-Accident Procedures Study.
7. The administration should establish a single federal lead agency for hazardous materials emergency-response planning. The federal lead agency should establish an interagency committee on hazardous materials involving (a) state and local agencies and (b) private industries to review existing study data and recommend possible directions, publish and promote existing guidance materials, and motivate locals to action.

Training

There needs to be established a government-industry group to develop recommended criteria for hazardous materials incident training at various levels. Significant questions that need to be answered by this group include the following:

1. What is currently available?
2. What do emergency-response people at different levels need to know?
3. What people need to be trained?
4. Who will conduct the training?
5. Who will pay for the training?
6. Who is responsible to get the job done?

Table 1. Problem categories.

Preaccident	Immediate (During)	Secondary (Post)
Planning	On-scene information	Funding
Funding	Emergency medical services	Who's in charge
Training	Evacuation	Cooperation
Evacuation	Who's in charge	Media
Who's in charge on scene	Hazardous materials identification	
Emergency medical services	Communication	
Identification	Funding	
Communications	Credibility	
Risk analysis	Damage potential	
Credibility	Source of technical information	
Ability	Cooperation	
Equipment	Media	
Mission	Chemical behavior	
Damage potential	Container integrity	
Source of technical information	Environmental exposure	
Good samaritan		
Risk analysis		
Cooperation		
Media		
Perception-public		
Chemical behavior		
Response procedures		
Container integrity		

While the group identified these as significant issues, they were not able to arrive at solutions. Solutions to training problems should be considered by the training committee.

Who's in Charge?

The question, Who's in charge?, generated the most discussion. It is a question that has many answers. In the case of fire departments, they asserted that they have legal responsibility in those counties that identify the fire chiefs as having responsibility for control of hazardous materials incidents. The railroad industry viewpoint was that there is a multilevel designation of who's in charge. If the scene of the incident is on railroad property, the railroad has responsibility to initiate measures to mitigate the safety hazard and to effect clean-up. In other cases, it was asserted that the state police have responsibility for the incident. The group decided that the who's-in-charge terminology was too strong and believed that the proper terminology should be, Who's the coordinator? In further discussion, it became evident that the identification of that person is dependent on time, location, event, and political and legal determinations.

The group eventually reached a consensus: Every jurisdiction shall designate an official who will be responsible for incident management.

Dissenting Viewpoint

A dissenting viewpoint was submitted by workshop 1 participant Al Grella, U.S. Nuclear Regulatory Commission. That statement is as follows:

> I strongly dissent from the apparent consensus of the work group that the way to solve emergency-response problems is to form an interagency committee. Interagency committees seldom are effective in carrying out solutions to problems. A much better and more logical route would be to continue the lead-agency route, and FEMA was assigned as the lead agency a few years ago. If FEMA is not able to carry out its mandates as lead agency, then Congress should be asked to promulgate the necessary legislation to enable FEMA to act effectively as the lead agency, including proper funding.

REPORT OF WORKSHOP GROUP 2

The process of deliberations evolved differently in Group 2. Group 2 began its discussion and deliberations to identify the problem in handling emergency-response incidents by setting priorities and categorizing the issues. This discussion of what constitutes an emergency reflects the need to identify immediate and first-responder responsibilities and control of long-term clean-up that will be required. This group stated that consideration of the environment is receiving new attention that must be considered beyond the traditional emergency-response activities.

Likewise, it was asserted that the capability for response is not widespread among government and industry. Some question the need for having a widespread response in view of the limited emergency-response incidents that occur during any one year. Discussion was centered around a need to place in perspective the training and equipping of personnel capable of carrying out emergency response. The group was divided along government and industry lines in terms of their planning and implementation activities. Government people at the federal, state, and local levels felt that more contingency planning must be done if they are to successfully handle incidents that may occur. They agree that they cannot identify when they will occur or even if they will occur, but they did agree that they must be prepared to meet the need when it arises. It was asserted that the "public" expects local people to respond when a problem occurs.

Determining the scope of what is meant by an emergency response did not meet with any universal agreement. Personnel of the U.S. Environmental Protection Agency believe that the emergency is not over until the material is cleaned up and removed. This view was not shared by transportation interests, who view the emergency-response problem as one of immediate mitigation of hazards.

In this session, the who's-in-charge (who's-the-coordinator) question was discussed at length. It

was asserted by the fire department representatives that they have the authority and responsibility at the scene of an incident and are looked to by the local government and public to provide a response and see that the situation is brought under control. There was a need expressed to clarify the role of federal, state, local, and private groups.

A single strategy statement was adopted. The group concluded that there should be a lead federal agency to be responsible for coordinating current emergency response efforts in the areas of planning, training, role clarification, liability, research, funding, and resources at federal, state, and local levels (private and public).

The group did not feel that the lead-agency concept has been implemented at the federal level. However, this is a priority item if the emergency response problems are to be solved.

This group also adopted a second general issue statement:

> A sunset commission should be appointed to examine the transportation of hazardous materials and waste to determine the nature and extent of the problems of emergency response. This examination should be conducted in a coordinated effort of federal, state, and local government; producers; transportation; responders; and others.

This statement indicates their concern that a definition of the problem is required. This definition is needed in addition to the priority program outlined above.

Workshop on Legal Responsibilities and Implications

Stanley N. Wasser

This workshop addressed the subject of Legal Responsibilities and Implications as they pertain to the transportation of hazardous materials and hazardous wastes. The workshop sessions were led by H. Arvid Johnson. The discussions revolved around and evolved from the issues presented in three issue papers by J. Kevin Healy, H. Arvid Johnson, and Stanley Hoffman (see Appendix 2). Workshop participants included representatives of federal, state, and local governments; regional governmental associations; shippers; manufacturers; carriers; emergency responders; consultants; lawyers; and the press.

The topic of the workshop is indeed broad. No attempt was made in the sessions to clearly define what exactly was being addressed therein relative to the subject of the workshop, other than the issues presented in the three resource papers. Consequently, the workshop examined legal responsibilities and implications in the transportation of hazardous materials and hazardous wastes in a different context than it was treated in Transportation Research Board Circular 219.

Unlike some of the other workshop topics (e.g., training, emergency response, risk assessment, and technical innovation needs and limits), the nature of the issues discussed in this workshop does not and did not lend itself to the concreteness of definition and discussion as may have been the case with the other workshops. The issues are more philosophical; and their problems, strategies, and goals do not lend themselves to "laundry listing".

INTERJURISDICTIONAL CONFLICTS AND INCONSISTENT REGULATIONS

The workshop began by discussing the issue of interjurisdictional conflict, the topic of Healy's paper. It was generally agreed that of the three issues presented in the papers, this one was of the greatest immediate importance. The discussion of this issue was itself indicative of the uncertainty and chaos that will continue if the issue of interjurisdictional conflicts is not resolved. The problem is undoubtedly important and was described as "growing" and "festering" and one for which there is an "urgency" for a solution to prevent a proliferation of inconsistent regulations as well as duplicative programs. The objective, one participant stated, is to "stem the tide of conflict".

The problem of interjurisdictional conflicts was viewed both as a conflict between federal and nonfederal (state and local) laws and regulations, and also as one of "lateral" conflict between states, between local jurisdictions within a state, and perhaps even between the different regions of the country. Most of the discussion related, however, to the "vertical" conflict between federal and nonfederal (state and local) laws and regulations. The issue of international versus national conflict was not addressed.

It was generally agreed that the problem of interjurisdictional conflicts was really a problem that was prevalent in the safety regulation of the transportation of hazardous materials. The interjurisdictional conflicts did not seem to be as much of an issue in the environmental regulation of waste disposal or even in the pipeline area by reason of the site-specific nature of the regulations, the various roles that the different levels of government have played, and the mechanisms employed to establish the regulations (e.g., federally approved state program of substantial equivalency to the federal regulations).

The discussion of the problem of interjurisdictional conflicts made clear that its genesis or cause could be traced to various problems, real or perceived, depending on the various points of view of the different actors. The cause of interjurisdictional conflicts was seen to be political, and in part stimulated or generated by the media coverage. It was seen also to be the result of the perceived vacuum resulting from the lack of a strong leadership role at the federal level and the lack of a strong federal response to the problems presented by the transportation of hazardous materials. It was viewed at the local level, in particular, as a response to the fact that the actors at the local level--whether it be the local mayor, fire chief, or city counsel--are "on the firing line". They are the first to respond to incidents and the persons most directly accountable for enforcement. Since they find themselves lacking the necessary tools or money to adequately or satisfactorily respond or enforce, it is perceived as easier to pass a law that bans or prohibits even though enforcement may be left for another day. Finally, the genesis of interjurisdictional conflicts was viewed as traceable to frustration; a perceived lack of input into and feedback from the regulatory process (the Federal Register process is not sufficient); a lack of trust and confidence in those who are regulating; and a perceived lack of leadership.

The issue of interjurisdictional conflicts may have been best defined as a "conflict of concerns" with the underlying problem being the need to identify a mechanism to channel and address concerns.

With such a mechanism in place, it was felt that federal regulations would better reflect those concerns.

The apparent workshop consensus was that the problem of interjurisdictional conflicts would be characterized by four terms: (a) partnership--a partnership between the federal and non-federal actors qualified by a strong leadership role or primary role or key role by the federal government in that partnership; (b) partnership--the Federal Register process for various reasons is not sufficient, and state and local actors desire what they perceive as more participation in the regulatory process, although this lack of participation may be the result of a lack of time, resources, and expertise by the local actors; (c) coordination--the various roles of the federal and non-federal actors need to be better coordinated and defined; and (d) communication--not really defined by the discussions but reflecting a need to permit the exchange and consideration of each of the other points of view. These terms or concepts characterize the basis for the process of regulation and of how the actors can interact. It was suggested that once the process is developed, enforcement and training would fall into place.

The matter of uniqueness at the state, or more particularly the local, level was discussed as being a primary issue in the shaping of the regulatory relationships between the federal and non-federal actors. Although it was discussed whether the local uniqueness is merely a perceived rather than a real problem, there was more feeling that perhaps federally issued guidelines to assist state and local actors in addressing their particular problems would reduce some of the interjurisdictional conflicts.

One participant, following up on the issue of participation, characterized the matter as follows: If the problem is that the federal regulations are seen as inadequate to protect a given community and its perceived "local uniqueness", then the real issue is how to have better participation of the localities to produce an acceptable level of risk within their present resources. However, if no regulations could protect a given locality, the problem is not the regulations but how to best protect the people of the locality at any level of risk. The participant noted that localities are not necessarily proposing to "regulate" but to "prohibit". If this is so, the participant concluded that the solution is not regulatory but hardware--i.e., the people and money to meet the level of risk inherent in the regulations. The key question, suggested the participant, is what the partnership is going to do once it is formed.

Several examples of the partnership exist. EPA works closely with states and existing national organizations of local governments to work on national problems such as the manifest system. FEMA works with states on emergency-response matters. BCMS and DOT have cooperative enforcement agreements with states involving information exchanges, joint investigations, and cooperation in reporting and training.

The HM-164 rulemaking on routing of radioactive materials was a reference point for discussion of the various facets of the interjurisdictional conflict problem. Some participants seemed to view the process of that rulemaking as permitting extensive input and therefore reflecting local uniqueness, and as a "significant step" and a "useful pattern" for future regulations. Others viewed the process skeptically and as not one that truly reflected local or even national concerns. One participant viewed HM 164 as addressing the problem of special interests.

As the discussion evolved further, certain perceived needs or concerns of state and local actors became identifiable. It was generally agreed that if the federal government is to have the dominant or primary role in regulation--a proposition that received no real dissent--then the federal government would have to respond to state and local concerns with technical assistance and funding in the areas of knowledge, education, training, and enforcement. The unstated proposition, except by one participant, was that, if preemptive federal regulation, tempered by a responsiveness to state and local problems, is to be accepted, then the federal government must, as a sort of quid pro quo, assist the state and local actors who are, for all intents and purposes, left with the responsibility for enforcement and emergency response. This reality is, as the discussions indicated, an increasing one as the federal government returns more responsibility to the states and local governments and, as is now being done, urging states, even by legislation, to adopt and then enforce the federal regulatory schemes.

Certain goals were identified as necessary to any mechanism, strategy or solution that would be implemented to address the issue of interjurisdictional conflict. It was the consensus that there is a need to strive for uniform and consistent standards modified only when necessary by local concerns of true uniqueness. It was the consensus that an effective mechanism(s) is needed for state and local input, but that after this input is received there must be certainty of decision in the regulatory standard or policy or requirement to be imposed. It was the consensus that the solution or strategy to resolve the interjurisdictional conflict issue must provide a means to "take the presure off" the local government actors, such as a mechanism that permits the local government actor to deal with other local governments rather than the federal government. Finally, it was the consensus that the solution or strategy must resolve, or at least address, the issue on a partnership basis with shared participation, coordination, and communication.

Three recommended strategies or mechanisms evolved from the discussions. The first strategy is a "voluntary" one. It contemplates that a meeting would immediately be called, perhaps sponsored by DOT, of the interested state and local actors and by using existing state and local associational organizations to work out, or to establish a mechanism to work out, the interjurisdictional conflicts. The second strategy or mechanism calls for DOT to voluntarily set up an advisory council, perhaps through the Federal Advisory Committee Act, to assist DOT in establishing its regulatory guidelines and perhaps even adjudicating or assisting in adjudicating interjurisdictional disputes. The third strategy or mechanism contemplates a legislatively mandated advisory council, such as with the Federal Pipeline Safety Act, with a fixed charter and with the authority to issue binding rulings in case of proposed regulations on the federal, state, and local actors and the authority to use some form of an adjudicatory process to resolve conflicts. This mandatory council was viewed as a possible mechanism to take the heat off both the local as well as the federal actors.

Whatever the strategy or mechanism, the consensus appeared to be that the mechanism must address a long-term solution as well as a solution for the interim, present period. It was also considered that, even if the advisory council should maintain its high profile only on issues of national scope, it should not be a substitute for individual filings on each issue. Also, it was agreed that any advisory group that may be employed must be perceived from below as an effective forum of and for communication.

REGULATORY ENFORCEMENT AND PENALTIES TO SECURE COMPLIANCE

The resource papers on criminal liability and the regulation of corporate behavior by Johnson and on civil liability and social regulations by Hoffman were generally discussed by the workshop participants in the context of (a) the need for criminal and civil liability as enforcement tools and (b) the effectiveness of the various enforcement tools.

The consensus of the workshop appeared to be that existing enforcement mechanisms, both civil and criminal, are generally acceptable as means for securing compliance. However, it was agreed that the enforcement mechanisms need to be selectively, consistently, fairly, visibly, and aggressively used. Complaints were voiced, however, as to "nit-picking", the "time" burden of the process, and "disparities in penalties".

It was the apparent majority opinion that, although there are enough existing regulations, there is not enough enforcement.

It was generally agreed that visibility of enforcement, whether it be through more inspections, more inspectors, more fines, or more publicity, would greatly aid in compliance. It was perceived that the enforcement actions now being taken may not be as known as they should or might be. One industry participant noted that he observed an increasing sensitivity to criminal liability by business people as they observed their peers being subjected to such liability.

Regarding the existing structure for civil enforcement, it was generally agreed that on balance the existing structure was "okay". The existing civil enforcement tools generally include administratively imposed civil fines, administrative compliance orders, court injunctions, and on-scene out-of-service orders. Although discussed, there was no indication of a sense of need to have private parties help in enforcing the act through third-party or product-liability type actions.

Although civil liability and social regulation were discussed, no consensus or position evolved (other than individual viewpoints) as to whether alternative civil liability systems could or should replace government regulations as a means of controlling conduct pertaining to the transportation of hazardous materials and hazardous wastes. Possibly this is attributable to the fact, as posited by Johnson, that civil liability questions will not be resolved in the near future because industry and others have not yet adequately focused on the issues and their stake in them, and there is little consensus now among any of the involved groups. The alternative liability systems touched on in the discussions are set forth in the Johnson paper and will not be repeated here.

Two facets of the issue that were discussed related to (a) the use of cost/benefit analysis as a desirable tool for determining what, and therefore how, to regulate and (b) whether, if regulations are not going to be enforced, they should be on the books at all.

There was a difference of opinion as to the usefulness of cost/benefit analysis in discussing issues of safety of human lives. It was noted that the societal cost of regulating hazardous materials transportation may be better spent elsewhere in public health and safety. Whether regulation of hazardous materials transportation even achieves a "societal good" was discussed, and, if there is no need to regulate, changes in conduct should be left perhaps to civil tort or other forms of civil liability. Whether the problem is really the fact that there is overregulation and that the existing regulations should be pared down to those that truly meet societal needs was also examined.

This discussion led into a discussion on the validity of regulations that are not enforced. On the one hand, it was noted that, although it may be harmless to have the regulation that is not administratively enforced, civil tort liability arises from noncompliance. On the other hand, without the regulation on the books, industry would not change its conduct and the very existence of the regulation may in fact be changing behavior. In this regard, it was also noted that reliance on the civil tort system requires an injury to enforce against, while a body of civil regulations can be enforced before an injury occurs. It was also suggested that perhaps government guidelines could be used to substitute for detailed regulations that are not enforced.

Regarding the use of criminal sanctions, it was generally agreed that criminal fines and jail sentences should be reserved for the "exceptional cases" of wilful or intentional or repeat offenders who violate important substantive regulations. An example cited was the "midnight waste dumper". Criminal sanctions should not be used for the day-to-day policing of the regulations. The federal regulators pointed out that the prosecutor's caseload acted as a de facto screen such that only the worst cases did in fact get prosecuted. Also discussed and generally favored as a possible assistance to enforcement was a need to prioritize the classes of crimes perhaps into two classes of misdemeanors and two classes of felonies to reflect the various degrees of hazard that result from noncompliance. It was also generally agreed that criminal prosecutions should be directed to corporate executives and officers only where the evidence demonstrates intentional corporate noncompliance that is the direct result of an informed policy decision made by corporate officials. A requirement of intent should remain since the multitude of regulations provides for unavoidable violations by low-level corporate employees that would continually subject the corporation to liability. But it was generally agreed that criminal penalties are necessary since compliance must come from the top down. Without criminal liability, business judgments will continue to be exercised and take into account the risk of civil liability or civil forfeiture. Business judgment will not be an excuse for criminal liability since there is no room for judgment if an act is a crime.

It was considered, however, that criminal responsibility may not be a major issue at least in hazardous materials transportation because there has been little use of criminal sanctions in the past and no real efforts to reach high-level corporate officials. The 1980s may see greater use of criminal liability such as with hazardous waste disposal but not in the area of transportation.

Finally, it was discussed and recommended, albeit with qualifications and some dissent from the federal actors, that the federal government--particularly DOT--should consider adopting and publishing a policy statement on their enforcement philosophy both for criminal and civil liability. It was noted that such policy statements are or have been issued by other agencies such as EPA and OSHA. The federal regulators responded that establishing guidelines is difficult and inhibiting to the regulator. Discussion took place about whether the perceived difficulties depend on the degree of detail of the guidelines. It was pointed out that information is available as to the program emphasis of the federal regulators. It was also noted that the public might not need to know the guidelines but that the regulating agency should establish them to curb the arbitrariness of its internal decisionmaking.

Workshop on Risk Assessment

Theodore S. Glickman

ISSUE 1: THE MEANING OF RISK ASSESSMENT REQUIRES CLARIFICATION

Recommendation

It is recommended that risk assessment, when applied to materials transportation problems, be regarded as the quantitative analysis of the safety performance of the system in question under the conditions of interest. Due consideration has to be given to non-statistical approaches and to accounting for non-quantifiable factors. The objective of risk assessment is to provide better information to the responsible decisionmakers, and this purpose is best served when a systems approach is taken. A professional society concerned with risk assessment should pursue the clarification issue.

Discussion

The discussion of the need for clarification of the meaning of risk assessment began with the question of whether risk assessment was indeed worthwhile, given its shortcomings and past failures in studies about hazardous materials transportation. This proposed indictment interpreted risk assessment strictly as the application of statistical estimation techniques to safety problems in which mathematical models are used to estimate the probabilities of undesired events, i.e., accidents. Doubt was expressed about the value of spending considerable resources on the computation of probability levels that are often questionable in their accuracy and difficult to interpret, especially when they are on the order of one in a million or less. The implication was raised that such figures are not useful because they rarely, if ever, influence the judgment of the parties responsible for making decisions about actions to mitigate risk. The futility of such "overqualification" in place of sound, subjective judgment becomes even more apparent, it was argued, when the typical deficiencies of the data used are taken into account. In summary, there was vocal support given to the proposition that the power of risk assessment has been vastly overstated.

In response to this position, it was stated first of all that risk assessment ought to be construed more broadly, as the application of any systematic method to the analysis of alternatives within a decisionmaking framework in which the concern is to identify the best alternative for mitigating risks. That is, risk assessment is by nature concerned with the objective evaluation of safety problems, and in common with other scientific approaches to problem-solving uses numerical data and forms of expression. However, it is not limited to statistical methods and does not deny the value of subjective inputs. Risk assessment is but one of the tools available to decisionmakers for obtaining information. It is important that the party using the results of a risk assessment--whether obtained statistically or otherwise--be instructed about the limitations of the inputs, methodology, and outputs.

A case in point was described that concerned recent experience with railroad tank car protection, in which the narrower interpretation of risk assessment proved inadequate. Experiments were performed to analyze the sequence of events leading to violent ruptures of tank cars, and accident frequencies were computed and compared to see which vehicles would benefit most from head shields and shelf couplers. An attempt to use fault-tree analysis was thwarted by data limitations in this particular application.

Further discussion led to the consensus that risk assessment proves to be most beneficial when the objectives and the audience have been clearly targeted at the onset. The approach must then be defined to match these targets and consideration given to (a) identification of the hazards of interest, (b) estimation of the associated risks, (c) evaluation of the situations where the hazards appear, and (d) comparison of alternatives for risk mitigation. Field investigation, full-scale testing, engineering analyses, and tracking of pilot programs were all suggested as different possible aspects of the approach, to be used in addition to, or perhaps instead of, data base analysis and statistical modeling.

The observation was made that risk assessment in hazardous materials transportation has not always lived up to its expectations in the sense of producing answers. One discussant suggested that such failures are cause for pessimism; another claimed that such failures are typical of many research efforts and that a good deal of understanding is gained just by the rigorous structuring of complex hazardous materials transportation safety problems by using risk assessment.

ISSUE 2: THE FEDERAL GOVERNMENT NEEDS TO FOCUS ITS RISK ASSESSMENT ACTIVITIES

Recommendation

It is recommended that an investigation be conducted into current and potential problems in the regulation of hazardous materials transportation, that requirements for risk assessment be addressed, and that priorities be established for specific applications of risk assessment where the need is critical and the expected payoff is high. This investigation should be undertaken by an autonomous committee representing all concerned parties.

Discussion

The discussion of the need to focus federal risk assessment activities began with the observation that the current field of concern is too large; it simultaneously covers all modes of transportation and all types of hazardous materials. In addition, there is no expressed intent of concentrating on the mitigation of risk via reducing the frequency of accident occurrences, on the one hand, versus reducing the severity of accidents that do occur, on the other.

One constructive suggestion to focus efforts was that more thought be given to the motivations for performing the risk assessment in the first place. This entails cognizance of whom the study is for, why the study is being performed, which activities ought to be considered for study, and to what degree the study can be expected to be successful in view of probable limitations of data, time, budget, and methods.

The recommendation was then made that an attempt be made to identify the present and potential users of risk assessment, their applications of interest, the record of risk assessment in such situations, and the directions that could be taken to improve the record. A structure offered in response to this was to classify users as belonging basically to four groups: (a) "initiators" of hazardous material transportation activity (shippers, carriers, receivers, and their insurers and associations); (b) "responders" to hazardous material transportation accidents (fire and police departments, on-scene ex-

perts, medical and other emergency personnel); (c) "protectors" of the public interest in safety (legislators, regulators, citizen groups); and (d) "reviewers" of activities and accidents (the courts, the press). A number of general needs among these users were mentioned, including the evaluation of exemptions to federal regulations, the identification of high-risk situations, the allocation of limited resources for enforcement and emergency response, the evaluation of proposed rules, the provision of objective and informative data to the public, the development of improved industry standards, and a variety of planning information regarding research and training programs.

Some specific instances of focused non-federal risk assessment activities are the following. It was related that several large chemical manufacturers are undertaking evaluations of the historical safety records of railroads, with the intent of demanding better performance. Where the opportunity exists, other manufacturers who at one plant produce hazardous commodities that are inputs to processes at another plant are giving consideration to relocating the production of the inputs to avoid shipping risks altogether. A recent action in Canada that will require specific risk assessments to be performed and that would have repercussions on U.S. companies doing business there is a judge's recommendation that every hazardous materials shipper have an adequate plan for controlling the escape of product in accidental releases.

The remaining discussion dealt more specifically with the issue of focusing the considerable resources available for risk assessment at the federal level, where most public safety policies are established and implemented. There was general agreement that risk assessment has a contribution to make to the process of regulating hazardous materials transportation (including operations at the points of origin and destination such as loading, unloading, and temporary storage). However, it was stressed that risk assessment be used with discretion, given that (a) results need to be reported with sufficient caveats and advice as to their applicability and (b) risk assessment is simply one aspect of decisionmaking in the regulatory process. The principal advantage of risk assessment, broadly speaking, was felt to be the support of prioritization and resource allocation decisions within regulatory programs, especially the evaluation of proposed federal actions.

Some skepticism was then expressed about the realism of this position, given that experience has shown that such decisions in the past have been based almost exclusively on expert intuition and political influences alone. In response, it was stated that risk assessment has had a demonstrated and significant role in the regulatory process in England (as evidenced by the Canvey Island investigation) and the Netherlands. Furthermore, the MTB has made a commitment to employing risk assessment in regulatory planning, and it is currently developing a more structured framework for decision analysis.

The discussion then led to the subject of conditions that would be conducive to the focusing of federal risk assessment activities. It was observed that there is currently no specific legal mandate for risk assessment in the regulatory process and that, naturally, the occasion of such a mandate in the future would force the issue. In any case, the successful employment of risk assessment depends on a genuine commitment by the responsible program manager, accompanied by an ability and willingess to act on the results. Availability and quality of data (discussed elsewhere as a separate issue) were viewed somewhat as a two-way street: Improvements in the data situation would improve risk assessment and, in turn, a better resolution of the specific problems to be addressed would motivate data improvements. Another related suggestion was that if risk assessment were reoriented to be more concerned with the downstream effects of critical accident conditions or events over time, then more effective treatment of specific problems would be possible.

There was a lack of agreement on whether risk assessment should be required in the permit and exemption process. One side argued that risk assessment would enhance efficiency and consistency in the evaluation process and that standardized guidelines should be followed for the approach used and/or the supporting data. The other side argued that the current mode of evaluation is functioning successfully, that the door is open for risk assessment to be used if desired, and that most often the case for a permit or exemption can be made more simply and clearly without the benefit of a risk assessment.

ISSUE 3: RISK ASSESSMENT METHODS AND/OR RESULTS NEED TO BE MADE MORE ACCESSIBLE TO INDUSTRY AND LOCAL AGENCIES

Recommendation

It is recommended that an appropriate forum be arranged among interested representatives of different levels of government, shippers, carriers, and the research community to identify areas of mutual and individual concern about risk assessment. As a result, a mechanism would be established, with federal funding if necessary, to develop and disseminate useful risk assessment methods and/or results.

Discussion

Many of the concerns expressed in the course of the discussion about the users of risk assessment and their needs were related more to industry and local agencies than to the federal government. The observation was made that coordination among industry and local governments is necessary and that there is a federal responsibility to coordinate these concerns and to ensure that important public needs are met. A systems safety approach needs to be taken in the resolution of complex risk mitigation problems within companies and local agencies involved with hazardous materials transportation, and their diverse requirements need to be recognized, rationalized, and satisfied.

One case in point was offered by a trucking firm official, who stated that training policies for his vehicle operators could be improved if the operating aspects of their trips were better understood from an accident factor point of view. He felt that identification of the relative risks of these different aspects would help to determine the firm's overall training budget and priorities within the budget. Another case was related by a local fire official concerned with response planning and the execution of such plans, who felt that too often decisions had to be made on the basis of limited information and limited experience. He advocated the development of simplified risk assessment methods that could be applied by locals having only minimal sophistication with the use of such tools. Other participants cited public relations and the settling of legal claims as areas of high potential benefit for the application of risk assessment to issues of industrial or local concern.

The fear was expressed that an increasing number of important decisions are being made at the local government level based almost exclusively on polit-

ical grounds without the benefit of the objectivity imposed by the use of risk assessment. Those prohibitions or restrictions that have already been promulgated locally appear to be subjectively based, most likely because most local staffs do not have the technical sophistication required for risk assessment. The problem is of continuing concern, since increased public awareness and pressure for protection from risk suggest that more such actions to limit the activities of hazardous materials shippers and carriers are likely. There are, however, some positive signs of more informed approaches to local issues, such as in Pennsylvania, where a board has been established to assist in local hazardous materials shipment routing decisions using as inputs data about accident statistics, emergency response capabilities, and traffic characteristics on primary and alternate routes along with diverse expert judgments. The Central Puget Sound Regional Study, sponsored by MTB, is another encouraging effort, where a comprehensive risk assessment is under way.

The decentralized and diverse nature of hazardous materials transportation was discussed as an impediment to progress in the widespread application of risk assessment. This poses a host of challenges, ranging from the development of feasible general methodologies, the means for disseminating findings effectively, and the setting of priorities as to which specific or generic situations should be considered most important. Accessibility of risk assessment techniques and/or established findings to those companies and communities who are not in a position to develop their own was viewed as being an important federal responsibility. Perspective needs to be maintained, however, on exactly what factors are to be accounted for in the analysis, whether adequate information exists or can be generated, and how such information would be employed. References were made to a number of relevant efforts that have already been undertaken for local planning use, including a DOT University Research Contract on small community preparedness (Kansas State University), an FHWA study on the designation of routes for hazardous materials truck shipments (Peat, Marwick, and Mitchell), and a recent Canadian book on dangerous goods transportation (Zujic and Zimmerman).

Some specific recommendations for risk assessment priorities were offered. One was that since so many of the casualties due to hazardous materials transportation accidents involve response personnel, special attention should be paid to detecting the sources of risk to such parties and to developing means for risk avoidance. Another recommendation concerned ranking the hazards of shipping the various commodities by the various modes, under the various conditions which exist, and planning risk assessment needs accordingly.

ISSUE 4: IMPROVEMENTS IN RISK ASSESSMENT METHODS ARE NEEDED TO BETTER IDENTIFY AND EVALUATE CRITICAL SITUATIONS

Recommendation

It is recommended that methodologies be directed more toward the goal of detecting the causes of hazardous materials transportation accidents and the factors that contribute to them. An improved understanding of the dynamics of accident processes (especially in the case of catastrophic accidents) will require interdisciplinary approaches, with consideration given to experimentation, statistical analysis, and subjective expert judgment. Directors of ongoing and planned research programs should carry out this recommendation.

Discussion

This discussion commenced with a review of the methods that are usually used under the aegis of risk assessment and the principal phases of the risk assessment process. Typically, one or more of the following techniques are used: (a) statistical inference of accident rates and event probabilities, based on historical data; (b) fault trees that decompose an accident process and the influences on that process into more elementary, interrelated events; (c) analytical and simulation models, expressing mathematically the relationships between significant controllable and exogenous variables in the system under study, in order to gain insight into reducing risk by influencing the system's performance; and (d) more subjective yet systematic approaches for taking advantage of experience and insights that may not be readily quantifiable.

The phases of risk assessment ordinarily include estimation of (a) initiating event probabilities, (b) container failure probabilities, (c) accident consequences, and (d) costs and benefits associated with variations in operating policy and practices that are intended to mitigate risk. The decisionmaker then has to balance the results with judgments as to the realism of the analysis once institutional factors are taken into account, and with consideration to the acceptability of risk (and the difficult trade-offs and ethical aspects of such considerations).

Among the difficulties that were pointed out about generalizing on risk assessment in this manner are the differences in terminology used in this field and the degree of diversity in the applications and in the users of risk assessment. There appears to be no universally accepted body of safety analysis technology. A variety of approaches from other fields has been adapted as necessary in an ad hoc fashion with varying degrees of success, it was claimed, and there has been no purposeful weeding-out of cohesive development of unified or original methodologies. Inconsistencies in the availability of data have contributed to this problem.

One discussant observed that regardless of whether safety is being sought through government regulations, industry standards and procedures, or some other means, the fundamental goal is process control. The best way to accomplish that, it was argued, is to relate estimates of probabilities and consequences to the specific events that can be influenced within the process of interest and to the dynamics of the relationships between those events as they occur over time. Furthermore, any predictive risk estimates obtained should be shown to be consistent with experience and to be commensurate with observations that are made in accident reports and investigations. The National Transportation Safety Board is reportedly concentrating its risk assessment efforts more and more on the identification of critical events and their evolution over time during an accident.

A related point of discussion dealt with catastrophic events. The issue raised was the need to better understand the factors that contribute to these relatively rare but severe types of accidents, while recognizing that our perception of risks is not distorted by generalizing from occasional, unusual happenings. One of the most significant basic research needs in risk assessment, it was observed, is for advances in explaining and evaluating the events that occur in the "tail of the distribution". This is where the public concern really lies, given that hazardous materials transportation accidents are usually not severe, but that the potential certainly exists--and has been demon-

strated--for many lives to be taken in a single occurrence. Assessing the risks of serious accidents is difficult, however, because of the relative rarity of such accidents. Problems of sparse data and limited experience also make it difficult to differentiate between situations that may and may not occur frequently in the future.

One suggestion for overcoming the dilemma of catastrophic assessment was to approach such problems by experimentation and field testing, perhaps with voluntary industry cooperation under a nationally coordinated plan. Another contribution would come from improved accident reporting systems, which would record information specifically intended to enhance our understanding of what did or did not happen to keep an accident from assuming extreme proportions in its impacts. Consideration of "near misses" would enrich such data bases, as would attention to surrogate data about relatively common events that could be used to make inferences about similar, uncommon use.

ISSUE 5: IMPROVEMENTS IN THE REPORTING OF RISK ASSESSMENT RESULTS ARE NEEDED TO PROVIDE BETTER INFORMATION TO DECISIONMAKERS AND TO THE PARTIES AFFECTED BY THEIR DECISIONS

Recommendation

It is recommended that a survey be made to determine the range of requirements and preferences concerning hazardous materials transportation risk information. Survey results would be used to influence practical developments with regard to such concepts as societal costs, risk acceptability, and public perceptions. The validation of results is a related issue requiring resolution by the academic and professional research community.

Discussion

The discussion of the need for better reporting of risk assessment results was stimulated by a number of comments regarding the desire of various concerned parties that have more and better specific information about the potential hazards they face, the corresponding likelihoods, and some objective evaluations of the cost-effectiveness of alternatives for risk mitigation. The consensus was developed that there may be results either already available or readily attainable from risk assessment that would be beneficial if they were generated in a form that could be easily interpreted and applied by the different users. Significant inroads could be made by proper presentation and by attention to individual differences in requirements for risk assessment results.

Some time was devoted to the discussion of employing risk assessment results in a decisionmaking framework, where ultimate responsibility for selecting trade-offs must be assumed by the individual formulating the policy for allocation of resources to achieve risk mitigation. A number of different issues were raised, one of which was the choice of an acceptable level of risk. That is, on what basis and to what degree is the company or community in question, as represented by this decisionmaker, willing to provide protection against the undesirable effects (life, health, damage, etc.) of hazardous materials transportation accidents, given that it may not be possible or in any sense practical to totally eliminate risks? This was acknowledged to be an important question, fraught with ethical and technical difficulties that have already been the subject of much unresolved debate in the literature. One participant expressed doubt as to whether a single, simplistic solution would ever be possible. As a practical matter, it was observed that in many situations, the available set of resources (in terms of budget, staff, and time) has already been determined by a higher authority on grounds that may or may not have explicitly considered the question of risk acceptability. In these cases, the risk acceptability problem is thus settled conceptually by minimizing the risk within the resource constraints that have already been established; whatever level of risk then results has to be acceptable unless the resources are expanded.

In accordance with the discussion group's previous consensus that a proper risk assessment and a system safety study are essentially synonomous, attention then turned to the problems of evaluating benefits and costs. Benefits are measured by reduction in risks of various kinds. The corresponding costs are measured by the dislocations--monetary or otherwise--required to achieve those benefits. One immediate difficulty mentioned was the existence of multiple and even conflicting objectives on both the benefit and cost sides; for example, the shipping of heavy metals is a significant environmental problem, but it does not pose a threat to personal safety from the possibility of a violent release. Other examples abound with regard to which aspects of safety should be improved and who should bear the burden of providing the desired changes. The means for measuring improvements and their costs is in itself a sticky problem, as exemplified by the procedural and philosophical difficulties of calculating the value of human life.

Other aspects of the definition and quantification of measures of effectiveness in risk assessment were raised as areas where technical progress is needed. One of these is the necessary distinction between perceived and actual risks, and the lack of agreement about which is the real concern when deciding questions of public interest, especially when society may choose to emphasize certain risks to a greater extent than the weight shown by a detached mathematical analysis. Another area is the definitive characterization of release behavior and consequences, which depend on the material, the circumstances under which it was released, and the surrounding conditions. It was intended that this work should not be started anew but should take advantage of the multitude of preceding developments performed by the U.S. Coast Guard and others.

Accounting for societal costs was another measurement issue discussed at great length. The difficulties inherent in this area were agreed to be formidable but conceptually manageable and definitely in need of resolution. It was stated that experience has shown that depending on the range of societal costs included, the results of a given cost-benefit analysis of a risk mitigation strategy may lead to diametrically opposite conclusions. This is inevitable, it was said, when opposing sides such as government and industry have the opportunity to influence their research conclusions by designing the scope of their studies as they wish. Obviously, more consistency is necessary, and it was recommended that guidelines be established by an appropriate and universally agreeable means to determine which societal costs can and should be accounted for in any risk assessment intended for use by either side in deliberations about rules, regulations, or standards for safe hazardous materials transportation. A candidate for an important societal cost, which to date has reportedly been largely disregarded, was suggested by one of the federal participants: the displacement of members of the general public by hazardous materials transportation accidents, including but not limited to parties who are

evacuated. It was agreed that every risk assessment should acknowledge all potentially relevant societal costs and, at least, should discuss the impacts of those that may be significant but not measurable.

Some of the pitfalls experienced in the reporting of risk assessment results were then related, along with suggestions for avoiding them in the future. This discussion centered on improving the reliability of, and the confidence in, the numbers produced in the course of such a study. The validation of statistical estimates, especially those that could lead to costly changes in business operations based on alleged improvements in accident rates and impacts, is obviously a desirable goal. However, validation may be difficult, if not impossible, when dealing with events where there is little or no actual experience. Partial validation of those aspects of the process under assessment where there has been experience would help. The performance of several independent risk assessments either by different researchers or by different approaches would lend credence to results that are found to agree.

It was suggested that true resolution of the validation issue may be beyond the limits of knowledge; at the very worst it brings into question whether anything that cannot be validated is worth doing. On the other hand, the opportunity for validation depends on the approach taken and basic research in this spirit should be performed to identify such approaches. Moreover, it was observed that risk assessment is worthwhile even when complete validation is impossible because the study process itself is worthwhile and provides insight into final answers. The postimplementation tracking or risk assessment findings are another viable alternative to validation; this has been done in the case of the performance of tank cars that have been retrofitted with head shields and shelf couplers.

ISSUE 6: ACCIDENT REPORTING AND OTHER DATA COLLECTION FOR RISK ASSESSMENT NEED TO BE DESIGNED AND CONDUCTED MORE EFFECTIVELY

Recommendation

It is recommended that a thorough characterization be made of the types of data immediately or imminently required for risk assessment of hazardous materials transportation. Where public data are available, due attention should be paid to reliability and accessibility. Otherwise, the cooperation of industry and local agencies should be solicited to provide access to existing data or to cooperate in gathering new data.

Discussion

The availability and quality of the data used in risk assessment were recognized as being fundamental elements of the successful analysis of hazardous materials transportation safety problems. Throughout this discussion concern was expressed about (a) properly specifying data requirements, (b) making the best use of available data, (c) improving procedures in data collection, and (d) dealing with data deficiencies.

Although there was agreement that those who conduct risk assessments need to better articulate what kind of data is required and how much detail is adequate, opinions differed as to the best way to achieve this goal. One side argued that information should be obtained and organized in a piecemeal, problem-oriented fashion, thereby reducing the possibility that more effort will be expended than is required for the immediate application. The other side argued that a more global approach, in which information needs are anticipated by developing well-planned, large data bases, would be more efficient in terms of avoiding duplication of effort and having data ready and waiting for application.

It was agreed that, in either approach, attention has to be given to gathering only as much information as is needed. Sensitivity analyses can be used to help determine when refinements in the precision of inputs of a risk assessment will not pay off in terms of significantly better risk estimates. When data are employed that are known to be less than totally reliable, the onus is on the risk assessment analyst to acknowledge--and measure to the degree possible--the biases and their effects on the outputs.

Data requirements follow directly from conclusions about risk assessment priorities. Hence the strategy recommendations made in the discussion of other issues about setting priorities in risk assessment studies based on hazard rankings, on industrial concerns for accident avoidance, and on local concerns for emergency preparedness, all bear directly on the questions of which data are needed most and how much are needed. This relationship between decisionmaking objectives and the pursuit of supporting data was reiterated in the discussion of the present issue--with emphasis on economy in data collection--in terms of such questions as, Have all sources of existing data been tapped? How can existing data similar to what is needed be creatively adapted? Where are new data needed most? and How can the collection be performed most effectively?

In the case of information pertaining to accident occurrences, a number of concrete, constructive recommendations were made for improving both the nature of the data collected and the collection procedures. An expert consensus needs to be solicited on the focusing of federal accident reports to require facts on only the essential aspects of the most critical types of occurrences in terms of the conditions in which the accident happened, the events that transpired, and the impacts that resulted. The level of detail reported would depend on predetermined criteria about the significance of the accident. A suggestion was also made that consideration be given to nonpunitive reporting, as is being done in Canada, in an attempt to encourage full and factual disclosure about accidents where significant risk information might not otherwise be forthcoming because of the fear of legal action. Another suggestion was made that more attention be paid to the reporting of trucking accidents involving rollover, which is recognized as a problem requiring fuller risk assessment. This points out the desirability of more flexible reporting systems, where more details would be required on specific situations as they are deemed critical. The need to have current reports focus more on large bulk shipments of particular dangerous materials, to record the evolution of events over time during the course of an accident, and to track the performance of newly institutional mitigation procedures, were all reemphasized. A federal representative stated that the Hazardous Materials Information Reporting System is currently undergoing review and will be revised. One final observation was made that avenues should be explored to determine whether industrial records are available that would help to evaluate accident likelihoods, e.g., carrier repair records that reflect the frequency of failures of equipment employed in hazardous materials transportation.

The remainder of the discussion addressed problems and proposed improvements in the collection of data about exposure to risk stemming from the movements of various hazardous materials by the various

modes. The consensus eventually reached was that such data are best obtained at the local level, where access is likely to be best, but that precautions are needed to assure that complete and consistent measurements are taken. Specific reference was made to rail transportation, regarding the possibility that a full record of hazardous materials waybills will replace the current 1-percent sample. A reference to truck transportation was also made, indicating that there are extensive records of hazardous materials volumes (but not necessarily routings) kept by truck companies, which could be made accessible for risk assessment under an appropriate arrangement. The degree to which rail, truck, and other carriers will all be willing to share information remains to be determined. It was stated that there needs to be more mutual thought and understanding about exposure data needed, how much effort is required to operate them, and how they will be used. The State of Virginia and the Puget Sound Region have had relevant experience in flow estimation. It was suggested that federal guidelines for regional mapping of hazardous material flows be established and a university consortium be organized to carry out this process.

Workshop on Technology Development and Innovation

William A. Brobst

The federal government has had a substantial influence on technical research and development (R&D) activity since World War II. Although its direct involvement has been concentrated in the defense and health sectors, the government has impacted research in all segments of industry and society, including hazardous materials transportation. For the most part, the federal R&D programs have avoided the support or conduct of R&D to develop new private-market products or services. Even so, the overall role of the government has been questioned in light of allegations of waste and mismanagement of some research programs. One argument for reduced government involvement in R&D is based on the premise that government, in general, will be less efficient than private industry in directing R&D activities.

On the other hand, there appears to be a near consensus among economic and business analysts that the national investment in R&D needs to be increased from current levels if future gains in productivity and the standard of living are to be ensured. Given some uncertainty over the private market's willingness to significantly increase R&D investment, especially in areas such as hazardous materials transportation safety, the government may be the only meaningful source of much of the needed additional funds. These funds could be either diverted from existing programs or provided from new funding. Government funding of R&D is justified in order to correct for private-market underfunding of R&D caused by lack of private economic incentive and uncertainty of payoff in R&D and nonoptional regulation. The private economy has a natural incentive to invest in the generation of goods that produce business profit. However, safety and environmental protection cannot be owned and sold by firms that contribute to their production. Accordingly, private investment in those areas will generally be less than socially desirable.

Certain private technological investments will be underfunded, not because there is a lack of economic incentive or an excessive economic risk, but because government actions have tended to inhibit innovation. Since regulation of private activity is accomplished by specifying a limited number of conforming designs or processes, there is considerable economic pressure to continue use of the technology embedded in those designs or processes.

The government must be very careful in devising strategies and plans for intervention in the technological R&D process. As a general rule, it should only intervene in areas where there is a clear societal benefit (using the cost-risk-benefit approach) and should favor methods of intervention that cause the least disruption of the economic process.

A critical need for technological innovation arises from a pressing need for solution to important problems. In the safe transportation of hazardous materials and wastes, several factors combine to lessen the critical nature of needs for technological innovation. First, the past safety record in hazardous materials transportation has been excellent, despite the media emphasis on accidents and the public perception of problems. Because of this, the benefit of R&D often becomes clouded; handy and popular solutions often go looking for problems to solve. A wide range of safety improvements could be implemented that require only political decisions, not technological developments. The implication is not that there will be insignificant payoff from application of technological developments in hazardous materials transportation, but that the areas where technological R&D investments should be made may be difficult to identify.

GENERAL SCOPE

The Workshop on Technological Development and Innovation concentrated first on identifying and discussing those problems and issues relating to transportation of hazardous materials and wastes that require, or closely interface with, the development of new technology or innovations in order to bring about a solution. Conversely, many interesting issues were identified that did not involve technological development or innovation and were discussed only to the extent that the workshop members could determine that nothing new was needed. The mere need for application of existing technology to the solution of an issue was not enough to keep the issue on the workshop agenda.

Sixteen issues were discussed at some length, nine of which were considered relevant to technology development and innovation and within the scope of the workshop. Th group defined those nine problems, discussed the options for problem solution, made specific recommendations, and identified the responsible agencies or industry that should be responsible for the implementation of the recommendation. This last step represents the strategy of problem solution.

The group prioritized the nine recommendations, and also selected those that were of the very highest priority (the first four). These recommendations, listed in order, are noted below.

The group also discussed (briefly) the role of the government versus that of industry in technology development and innovation, particularly with respect to hardware design and competition with private industry. The conclusions of that discussion are presented prior to the discussion of the issues and recommendations.

GOVERNMENT ROLE IN TECHNOLOGY DEVELOPMENT AND INNOVATION

The resource papers presented to the conference by Jennings and Prensky (see Appendix 2) discussed at some length the government role in developing technology and innovative techniques and hardware. The workshop participants reached the following conclusions on this issue.

1. Government should not do anything to inhibit R&D by private industry. Specifically, government should not be competing with private industry in those areas where private industry is willing and able to do its own R&D. Government regulatory schemes should not be written in such a manner as to inhibit the development of new and better ways to meet government performance standards. Where industry should and can do R&D for itself in a competitive market, the government should not step in and do the work for industry.
2. Government laboratories are not necessarily a cost-beneficial place to do R&D since they too often have little incentive to keep hardware costs down. Government invents costly hardware and then requires industry to buy it.
3. The beneficial aspects of serendipity were recognized, such as the spinoffs from NASA and DOD technology development in the electronics areas. Serendipity can be used as a justification of government R&D only in retrospect; government R&D programs cannot be justified on the basis that there will be enough serendipity to pay for the program.
4. Industry consensus standards groups should find ways to meet the regulatory performance standards and publish those standards themselves. Government regulations can reference those standards as appropriate.

PRIORITIZED LIST OF ISSUES

I. Subject/Issue: Performance standards versus engineered design specifications/Do government regulations that are cast in terms of engineered design specifications inhibit innovative hardware design and development of new technology? If so, is it to the extent that such regulations should be recast in terms of performance standards?

Major Discussion Conclusions

1. Design specifications are a memorial to what has already been invented; they are unproductive to new technology and hardware.
2. The government should set the level of performance and the compliance measurement criteria--i.e., what to accomplish. The industry should devise the best ways to meet those standards--i.e., how to do it--preferably through industrial consensus standards organizations.
3. Design specifications are quickly outmoded.
4. Design specifications encourage entry of foreign business into U.S. markets; they are allowed to build better mousetraps.
5. The need for enforcement must be considered in setting performance standards, but should not be the controlling factor.
6. Design specifications inhibit our ability to produce new and better products.

Recommendations

1. Federal regulatory agencies should take action, and Congress should encourage them to write new regulations and rewrite existing regulations, to the extent practicable, in terms of performance standards in order to remove inhibitions on technology development and innovative hardware. (Note: Executive Order 12044 already requires agencies to write performance standards.)

2. Congress should require federal regulatory agencies to write standards that are practically designed to meet the need for safe transport of hazardous materials and wastes.
3. Federal regulatory agencies should use cost-risk-benefit technology to determine where levels of safety performance should be changed (up or down) in such a way as to stimulate innovation in areas where industry is capable of innovation but is not now doing it.

II. Subject/Issue: Technical bases for safety standards/Does a solid technological base exist for the development of safety standards, and does it apply or can it be applied to that effort?

Major Discussion Conclusions

1. There is a need to pull together the technical data now existing to see what other data need to be developed.
2. There is much reinventing of the wheel going on and much duplicative R&D, especially on the part of government laboratories and contractors.
3. There are much data available through the United Nations, but not much evidence that federal regulatory agencies are using them.
4. There is a need to evaluate how well performance standards really work.

Recommendation

The Research and Special Programs Administration of DOT should take the lead to review the technological data base required for establishment of performance standards, to identify gaps and needs, and to expand the data base as necessary. Where data are inadequate, performance standard development should start immediately.

III. Subject/Issue: Lowering the hazards of materials/Are there sufficient technological development and investigation into methods of modifying the physical and chemical forms of materials and packaging to improve safety in transport?

Major Discussion Conclusions

1. There is some new and developing technology being generated in this matter, but not enough of it is being applied to the transportation of hazardous materials and wastes.
2. Some possibilities are inhibitors, suppressants, neutralization, gelation, expanded metal mesh containment, and improved package design.
3. The scope of this work should include preparation of materials for transport, actions during transport, and actions after release in an accident.

Recommendation

Federal agencies (both regulatory and non-regulatory) and industry should support the development of techniques and methodologies for rendering hazardous materials less hazardous in transport, in accidents, and at the accident scene during recovery and clean-up.

IV. Subject/Issue: Evaluation of on-scene hazards/Is there enough information immediately available at the scene of an accident to allow reasonable judgment of the extent and nature of the hazard? Information needed includes the state of integrity of the containment and a clear and rapid identification of the materials involved.

Major Discussion Conclusions

1. There is a need for more and faster information.
2. It is difficult now, in many cases, to make necessary and good decisions and judgments.
3. The necessary information may not have been developed in some cases.

Recommendations

1. Federal regulatory agencies with emergency response responsibilities (FEMA, DOT, DOE, EPA, NRC, DOD) should take necessary actions to develop the required information and technology to provide for accurate and fast identification and estimation (both remote and on-scene) of the nature and degree of hazards that result from accidents and spills.
2. Congress and the Office of Management and Budget should support R&D in this area.

V. Subject/Issue: Cargo tank safety devices/Are the regulations and technology for safety devices on cargo tanks adequate?

Major Discussion Conclusions

1. Safety devices are sometimes found to be inoperative or inadequate. Special problems are remote valves, fusable links, and gaskets.
2. There is a critical need for higher reliability and for new and better devices.
3. There is a need to determine the size and extent of the problem.
4. There are several causes of the problem: (a) Federal regulations, now in the form of enginered design specification, rather than performance standards, inhibit the development of new and better designs; and (b) safety devices are poorly maintained and inspected; this is a compliance problem as well; enforcement needs to be more consistent and thorough.

Recommendations

1. Government (both federal and state) regulatory agencies should determine the size and extent of the problem.
2. Federal regulatory agencies should prescribe performance standards that encourage development of new safety device designs and should remove present regulatory inhibitions against technology development and innovative safety device design.

VI. Subject/Issue: Criteria for classification of hazards/Are present transportation safety regulatory criteria and schemes for classifying hazardous materials and wastes adequately related to the transport environment?

Major Discussion Conclusions

1. Examples of present problems include the definition and classification of flammable liquids and solids, corrosive solids, and hazardous wastes.
2. Definitions and tests are usually related to in-plant use of the materials.
3. There has been some work now and in the past, but progress has been unacceptably slow. This was an item identified at the 1969 hazardous materials conference at Airlie House, and DOT progress in this area has been lacking.
4. There is a need for strong industry input.

Recommendations

1. DOT's MTB should reexamine the present DOT-EPA definitions and classification protocols for clarity, applicability, currency, relevance to transport (normal and accident conditions), and interagency consistency.
2. DOT's Research and Special Programs Administration should, with industry input, develop whatever new technology is necessary to improve the transport hazard classification schemes.
3. The Office of Management and Budget should require the federal regulatory agencies to be consistent in their definitions and classification protocols.

VII. Subject/Issue: Protective clothing and personal equipment/Are there critical inadequacies in the design of personal protective clothing and equipment to protect emergency response and clean-up personnel at the accident scene?

Major Discussion Conclusions

1. There are lots of poor designs and only a few good ones.
2. There is a special need for chemical protection and freedom of movement.
3. There is a need for customized designs for hazardous materials accidents; these designs need to be more effective and cheaper. This requires new technology.

Recommendation

DOT, EPA, and the industry should work closely together to bring about better and more effective designs for improved personal protective clothing and equipment. The expertise and experience of the National Aeronautics and Space Administration and DOD should be used

VIII. Subject/Issue: Vehicle stability/Do the regulations adequately provide for on-road stability of cargo tank trucks?

Major Discussion Conclusions

1. Vehicle rollover is a major source of leakage.
2. The present regulations address only the tank design, not the total vehicle design.
3. There is a need for regulatory vehicle stability performance standards (e.g., rollover and jackknife).
4. New designs and technology are needed. There is also a need to better apply existing technology to innovative designs.
5. There is a need to examine the cost-risk-benefit of design changes.
6. There is a need to examine impacts on highway design and regulations.

Recommendation

FHWA should prescribe regulatory performance standards for tank vehicle stability (especially for rollover and jackknife protection). It should remove any present regulatory inhibitions against technology development and innovative vehicle designs.

IX. Subject/Issue: Increased use of pipelines/Should the use of pipelines be encouraged for transport of hazardous materials and wastes in addition to petroleum products?

Major Discussion Conclusions

1. Some anhydrous ammonia is being transported by pipeline now.
2. A high volume is needed to justify the economics of pipeline transport.
3. There are some increased safety benefits, but also some increased risk in accidents, related to pipeline transport.
4. Transport of packages by pipeline is not economically feasible now, and no present incentive exists to develop the technology.
5. A switch from surface mode transport (rail, highway, water) to pipeline could be considered.
6. Right-of-way problems, especially with the railroads, exist.
7. Existing oil and gas pipelines are probably not practical to convert for other hazardous materials and wastes.

Recommendations

1. Industry (e.g., Chemical Manufacturers Association and American Petroleum Institute) should examine the need for this type of transport and should determine what technological development and innovations might be necessary to meet any identified needs.
2. If the system proves feasible, Congress should act to facilitate the implementation of the technology, especially in the area of eminent-domain legislation.

PART 3
Appendixes

APPENDIX I: Conference Attendees

William Andrews, PNL

Edward O. Baicy, Fragmentation Branch/BRL
Darrel J. Behrendsen, Colorado Training Institute
Tom Bell, Sajen Air, Inc.
Ludwig Benner, National Transportation Safety Board
Arthur Bensmiller, Transportation Safety Institute, Oklahoma City
Lawrence Bierlein, Attorney at Law
Mike T. Bohlman, Sea-Land Service, Inc.
Jerome Bone, New York State Department of Transportation
Don A. Boyd, DuPont deNemours and Company
William A. Brobst, The Transport Environment
Thomas W. Browne, UPS
Benjamin Buchbinder, Materials Transportation Bureau, U.S. Department of Transportation
Laura Buchbinder, FEMA, U.S. Fire Administration
Ronald Buckingham, Suffolk County, New York Department of Fire Safety
Noel C. Bufe, Northwestern University
William Buglass, Wisconsin Department of Transportation
William J. Burns, OST, U.S. Department of Transportation

Edmund J. Cantilli, Polytechnic Institute of New York
R.M. Cardillo, Exxon Chemical (Americas)
Lorenzo Casanova, Federal Highway Administration, U.S. Department of Transportation
Paul R. Chagnon, Military Traffic Management Command
Gregory Choppin, Florida State University
Joseph M. Clapp, Roadway Express
Albert C. Clark, Chemical Manufacturers Association
Adrian G. Clary, Transportation Research Board
Robert D. Coffee, Eastman Kodak Company
Charles R. Corbett, U.S. Coast Guard
George H. Cramer, Los Angeles Department of Transportation and Development

Russell Dawson, Business Publishers, Inc.
Ermes E. DeMaria, New England Nuclear Corporation
George B. Donaldson, Wilbur Ellis Company
Richard M. Doyle, American Trucking Associations, Inc.
John F. Funn, Illinois House of Representatives

James A. Echols, Sajen Air, Inc.
Robert D. Ervin, University of Michigan

Frank Farenchak, Pennsylvania Emergency Management Agency
G.G. Fleming, Chessie System
Conan P. Furber, Division of Environmental Studies, Association of American Railroads

John S. Gardinier, U.S. Coast Guard
Roy F. Garrison, U.S. Department of Energy
Dennis R. Garwood, Ohio Department of Highway Safety
Peter A. Gill, Family Lines Rail System
Theodore S. Glickman, Transportation Systems Center, U.S. Department of Transportation
Richard S. Golob, Hazardous Materials Intelligence Report
John Granito, State University of New York
Robert M. Graziano, OH Materials Company
Alfred W. Grella, Office of Inspection and Enforcement, U.S. Nuclear Regulatory Commission
Alexander J. Gretes, Maryland Institute for Emergency Medicine
M.B. Grove, Exxon Pipeline
Frank C. Gunderloy, Jr., Rockwell International
William H. Gushard, Greif Brothers, Springfield, New Jersey

Fred Halvorsen, U.S. Coast Guard
Bruce H. Hamill, National Paint and Coatings Association
Bob L. Hansen, Seattle Fire Department
J.Z.B. Harding, Consolidated Rail Corporation
Diane Harmon, Edlow International
William J. Harris, Jr., Association of American Railroads
Erskine E. Harton, Jr., Consultant
Edwin W. Hauser, Institute for Transportation Research and Education
Jerry A. Havens, University of Arkansas
Kevin Healy, New York City Department of Transportation
Mark F. Hengel, Missouri Pacific Railroad
David J. Hensing, American Association of State Highway and Transportation Officials
Morris Hershson, National Barrel and Drum Association
Arland V. Hicks, Kansas Department of Energy
Paul Hinchcliffe, Transportation Systems Center, U.S. Department of Transportation
Stanley Hoffman, Union Carbide

Jack Jacobsen, Profit by Air, Inc.
Robert M. Jefferson, Sandia National Laboratories
Will Jennings, Franklin, Tennessee
William E. Johns, American Trucking Associations, Inc.
H. Arvid Johnson, Container Corporation of America

William G. Kahler, Union Carbide Corporation
William Keffer, Emergency Planning Response, U.S. Environmental Protection Agency
James W. Kerr, Technological Hazards Research, FEMA
John Killilee, Consolidated Freightways
C. Charles Kimm, Battelle Columbus Laboratories
Paul V. King, Computer Sciences Corporation
Wendell M. Knight, Environmental and Safety Designs
Rolland G. Kuhlman, Burlington Northern Railroad

Myra Lee, Multnomah County, Oregon, Emergency Management
Donald Levine, Rail Vehicle Safety Research Division, Federal Railroad Administration, U.S. Department of Transportation
J.R. Ligon, Consultant

Philip P. Madonia, Illinois Department of Transportation

John W. Marshall, Edwards Air Force Base (Rocket Propulsion Laboratory)
Steven McDougall, Industrial Hygienist, Teamsters Union
Paula H. McGrew, Price, Williams and Association
Rosemary Menard, Seattle City Council
Robert J. Mesler, Jr., Dow Chemicals (U.S.A.)
Stephan Michelson, Econometric Research, Inc.
Arnold Moodie, Fluor Engineers and Contractors

Hyla Napadensky, IIT Research Institute
John C. Nordin, Illinois State Police
Donald Nussbaumer, U.S. Nuclear Regulatory Commission

J.J. O'Driscoll, Southern Railway System
Emmett O'Hare, Consultant
Floyd E. Ouellette, Dow Chemicals (U.S.A.)

John A. Pachuta, Pennsylvania Department of Transportation
Mike Parnarouskis, U.S. Coast Guard
Robert L. Paullin, Materials Transportation Bureau, U.S. Department of Transportation
Thomas A. Phemister, Association of American Railroads
Lloyd L. Philipson, J.H. Wiggins Company
Kenneth L. Pierson, BMCS, Federal Highway Administration, U.S. Department of Transportation
Suellen Pirages, OTA, U.S. Congress
Thomas W. Powers, Maryland Department of Transportation
Simon Prensky, Transportation Systems Center, U.S. Department of Transportation
Dennis L. Price, Virginia Polytechnic Institute and State University

Elaine Randolph, Los Angeles Times
Robert G. Rhodes, A.T. Kearney, Inc.
Robert W. Riedl, Milwaukee, St. Paul and Pacific Railroad Company
Alan I. Roberts, Materials Transportation Bureau, U.S. Department of Transportation
Frank Roberts, Cedar Falls Corporation
Robert Robison, Portland Office of Emergency Services
William D. Rowe, American University
Deborah Rudolph, Office of the Secretary, U.S. Department of Transportation
Eugene R. Russell, Kansas State University
Harvey Ryland, ISE TAP/OSTP

Lee D. Santman, Materials Transportation Bureau, U.S. Department of Transportation

Raymond D. Scanlon, Port Authority of New York and New Jersey

Amy Schaeffer, Office of Enforcement, U.S. Environmental Protection Agency
William R. Schaeffer, Monsanto Chemicals
Lawrence Scheufele, Illinois State Police
J.W. Schmidt, Virginia Polytechnic Institute and State University
W.R. Seebaugh, Fried, Frank Harris, Shriver and Kampleman, Attorneys
Dick Sexton, Hazardous Materials Transportation Newsletter
H.M. Shappell, Shipping Container Institute
Ronald M. Sharp, Norfolk and Western Railway Company
Donald Shilesky, SCS Engineers
Pete Sill, RSPA, U.S. Department of Transportation
Ben Sosewitz, Envirodyne Engineers
Bonnie E. Southwick, Tri-State Motor Transit Company
Marjorie Stailkovich, Transport Canada, Ottawa
Gustav H. Strobel, Travelers Insurance Company
Anne Stubbs, Council of State Governments

David Teeter, Puget Sound Council of Governments
C.H. Thompson, Aerojet General Corporation
David Thompson, Thompson Tank and Manufacturing, Inc.
Kenneth A. Thompson, Yellow Freight System, Inc.
Edgar L. Tidd, Virginia Department of Highways and Transportation
Leonard M. Trosten, LeBoeuf, Lamb, Leiby and MacRae
Paul R. Tutt, University of Tennessee

Gary L. Urbanek, Allard, Inc.

Jack Vallas, California Highway Patrol
Karsten J. Vieg, Illinois Department of Transportation
Gordon O. Voss, Minnesota House of Representatives
Stanley N. Wasser, Illinois Department of Transportation
Marge Weissman, U.S. Department of Transportation, Seattle
L.R. Welch, Texas Eastern Transmission Products Pipeline
Hillary Whitaker, National Governors Associations
A.D. Williams, Union Pacific Company
Mary M. Williams, U.S. Coast Guard
Robert C. Williams, National Highway Traffic Safety Administration
Donna Wise, National Conference of State Legislators
David Woodbury, Wisconsin Emergency Government
Jane Woodward, Performance Development Institute
C.L. Wright, Jr., Pennsylvania Turnpike Commission
Charlie J. Wright, Union Pacific Railroad

James V. Zaccor, Scientific Services, Inc.
John C. Zercher, Chemical Manufacturers Association
Robert C. Ziegler, Chemical Lehman Tank Lines
John Zogby, Pennsylvania Department of Transportation

APPENDIX 2: Biographical Data on Steering Committee to Develop a National Strategy for the Transportation of Hazardous Wastes in the 1980s

SCANLON, RAYMOND D., (Chairman, Steering Committee, October 1982-) Administrator of safety program, hazardous materials specialist, Port Authority of New York and New Jersey; born U.S.A., March 1937. B.A. Economics, Fordham University; Master of Public Administration, Fairleigh Dickinson University; responsible for safety standards for Port Authority Facilities, conferring with patrons, government officials, shippers, manufacturers, etc., to explain and assure compliance with federal, state, and local regulations pertaining to hazardous materials, hazardous wastes, and toxic substances; training policy and civilian personnel within the Port Authority, consulting for Port Authority Aviation and Port Departments, and assisting the Authority's Law Department and Police Division on litigation proceedings. Chairman of U.S. DOT Hazardous Materials Transportation Committee, Region II; Consultant to National Fire Protection Association; Advisory Board Member, Puget Sound Council of Governments; Member, Mayor's Task Force (NYC) on Hazardous Materials Transportation.

VIEG, KARSTEN J., (Chairman, Steering Committee, 1980-1982) Traffic Safety Administrator, state highway transportation official; born U.S.A., December 12, 1934; Antioch College, B.A.; University of California, J.D.; Illinois Governor's Representative for Highway Safety and Director, Division of Traffic Safety, Illinois Department of Transportation, since 1974; Staff member, State of California and Midwest Research Institute prior to 1974. Currently heads a staff of 260 with an annual budget of approximately $20 million. The Division of Traffic Safety has jurisdiction over administration of Section 402 highway safety funds and the regulation of the Illinois Hazardous Materials Transportation Regulations over highways. In addition, the Division is responsible for Illinois' vehicle inspection programs and is the office of record for all highway accident data.

BIERLEIN, LAWRENCE W., Lawyer, hazardous materials specialist; born Cleveland, Ohio, May 4, 1942; B.A. Johns Hopkins 1964, J.D. University of Pennsylvania 1967. Private practice since 1972. Prior to that time served in Office of the General Counsel of U.S. DOT. Author of the Red Book on Transportation of Hazardous Materials, 1977. Currently Editorial Director of a monthly newsletter, "Hazardous Materials Transportation."

BROBST, WILLIAM A., Consultant, chemist; U.S. citizen born in 1930. B.S. in Chemistry from Northwestern University 1951; President, The Transport Environment, consultant in hazardous materials transportation since 1979; Chief, transportation safety programs for DOE (and its predecessors ERDA and AEC), manager of DOE's transportation systems research, development, and testing programs for a variety of fuels and wastes 1970-1979; Deputy Director, DOT's Office of Hazardous Materials 1966-1970; previously served in a similar position with the ICC; head of the radiological physics program in AEC's Chicago office; naval officer with extensive nuclear weapons storage and testing experience. Chairman, Transport Advisory Group, International Atomic Energy Agency.

CHOPPIN, GREGORY R., Educator, chemist; born Eagle Lake, Tex., Nov. 9, 1927. Education: Loyola Univ. La., B.S. 1949; Univ. Tex., Ph.D. (Chem), 1953; Loyola Univ., DSc, 1969. Prof. Exp: Mem. staff, Radiation Lab., Univ. Calif., 1953-1956; from Asst. Prof. to Assoc. Prof., 1956-1963, Chmn dept., 1968-1977, Prof. Chem., Florida State Univ. 1963-present. Concurrent Pos: Vis Scientist, Ctr Study Nuclear Energy, Belgium, 1962-1963; Fulbright Lectr., Uruguay, 1965, and Portugal, 1969; Vis. Prof., Sci Univ. Tokyo, 1978. Mem: AAAS; Am Chem Soc (chmn, Div. Nuclear Chem Technol, 1976). Res: Nuclear chemistry, physical chemistry of the actinides and lanthanides; structure of water and aqueous solutions. Chmn, Subcommittee on Nuclear and Radiochemistry of the Committee on Chemical Science, National Research Council.

GRAZIANO, ROBERT M., Corporate executive, hazardous materials specialist; U.S. citizen born May 26, 1940. Villanova University, business and social sciences (1958-1960); currently vice president, government and industry relations, OH Materials, Inc.; 1970-1979, Director, Bureau of Explosives, Association of American Railroads; 1969-1970, responsible for coordination and development of Bureau's tank car program; 1962-1968, various positions with Long Island Railroad and AAR.

HARTON, ERSKINE E., JR., Consultant (hazardous materials and system safety), Chemist; U.S. citizen born August 1919. B.S. in Chemistry, Geneva College; M.S. in Chemistry, University of Wyoming; 1979-present, Consultant; 1979, Acting

Director, Office of Program Support, Materials Transportation Bureau (MTB), U.S. DOT; 1978-1979, Chief, R&D Management Div., MTB, U.S. DOT; 1969-1979, Chemical Engineer, Technology Div., Office of Hazardous Materials Operations, U.S. DOT; 1968-1969, Chief, Hazardous Cargos Branch, National Highway Safety Bureau, U.S. DOT; 1968, Functional Manager for Hazards Identification, Safety Research and Data, National Aeronautics and Space Administration (NASA); 1967-1968, Acting Safety Director, NASA; 1961-1968, Assistant Safety Director, NASA: 1960-1962, Chemical Engineer, 2705th Air Munitions Wing, U.S. Air Force; 1955-1960, Associate Chemist, Midwest Research Institute; 1948-1955, Chemical Engineer, U.S. Bureau of Mines Petroleum & Oil Shale Expt. Station; 1942-1948, Chemist, Pure Oil Research Laboratory. Fellow, American Institute of Chemists; Past President, Washington, D.C. Chapter, System Safety Society; member, American Chemical Society, American Society of Safety Engineers, Sigma Xi-RESA and the North American Thermal Analysis Society. Certified Professional Chemist; Certified Safety Professional, Registered Professional Engineer (Illinois); Registered Professional Safety Engineer (California).

HAVENS, JERRY A., Educator; Chemical Engineer; born November 24, 1939; U.S. citizen. B.S. Chem. Engrg., University of Arkansas, 1961; M.S. Chem. Engrg., University of Colorado, 1962; Ph.D. Chem. Engrg., University of Oklahoma, 1969; Post-Doctoral Studies, Flame Dynamics Laboratory, University of Oklahoma, 1969. Instructor, Chem. Engrg., University of Oklahoma, 1967-1968; Assistant Professor, Chem. Engrg., University of Arkansas, 1970-1974; Associate Professor, Chem. Engrg., University of Arkansas, 1974-1979; Professor, Chem. Engrg., University of Arkansas, 1979-present. Member, Sigma Xi Research Fraternity; American Chemical Society; Tau Beta Pi; American Inst. of Chemical Engineers; American Assn. for the Advancement of Engrg. Education; National Fire Protection Assn.; American Society for Testing & Materials - Past Chm., Subcommittee on Thermal Stability of Condensed Phase Chemicals and Past Vice-Chm., Committee on Hazard Potential of Chemicals. SOHIO Fellowship, University of Colorado, 1962; Union Carbide Fellowship, Univ. of Oklahoma, 1966-1967; Registered Professional Engineer, Arkansas.

JEFFERSON, ROBERT M., Transportation Technology Development, federal official; Mechanical engineer; born Akron, Ohio, February 10, 1932; BSME Michigan Tech. University 1953; MBA, University of New Mexico 1964. Sandia Laboratories (24 years) and, currently, Manager, Nuclear Materials Transportation Technology Department; Transportation Technology Center and University of New Mexico (17 years) as Adjunct Professor of Nuclear Engineering. Member New Mexico Energy Institute, American Nuclear Society and of the Society's Publications Steering Committee and Admissions Committee. Listed in Who's Who in Atoms, Who's Who in the West, and Who's Who in Public Service. Past member, NAS Committee on Nuclear and Alternative Energy Sources; Chairman, 5th International Symposium on Packaging and Transportation.

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