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.