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?

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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 developments. 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.)