VOLUNTARY INDUSTRY STANDARDS AND THEIR RELATIONSHIP TO GOVERNMENT PROGRAMS

Licensing Programs Division
Office of Commercial Space Transportation
U.S. Department of Transportation

January 1993

VOLUNTARY INDUSTRY STANDARDS
AND THEIR RELATIONSHIP TO GOVERNMENT PROGRAMS

Table of Contents

VOLUNTARY INDUSTRY STANDARDS AND THEIR RELATIONSHIP TO GOVERNMENT PROGRAMS

1. INTRODUCTION

Potential Relationship of Voluntary Industry Standards to Commercial Space Regulatory Regime

The Office of Commercial Space Transportation (OCST), in developing its program for ensuring that commercial space operations adequately protect public safety and the environment, confronts the challenge of devising an effective means for accomplishing this objective while simultaneously nurturing a healthy and internationally competitive commercial space industry. In meeting this challenge, OCST has emphasized flexibility and the use of innovative approaches, rather than simply relying on the traditional "command-and-control" regulatory strategy that characterizes many Federal regulatory programs in the health, safety, and environmental arenas.

An important aspect of OCST's flexibility in its safety regulatory approach is its interest in taking advantage of the potentially complementary role of voluntary industry safety standards. While OCST has the authority to employ an exclusively regulatory strategy in fulfilling its mission, or -- at the other extreme -- deferring in large part to voluntary standards as the means to protect public safety and the environment, there are numerous intermediate points along the spectrum. The real question is: To what extent, and how, should OCST integrate voluntary standards within its regulatory regime? Answering the "to what extent" dimension of this question requires an assessment of the breadth and qualitative adequacy of private standards in the commercial space industry. The "how" aspect focuses on the best means of integrating voluntary standards, whether it be by implicit reliance on such standards or formal incorporation of standards into OCST rules.

Extent of Standardization in Commercial Space Launch Industry

Examining these policy questions led OCST to review the state of voluntary standardization in the commercial space launch industry. What the Office found is that, although modern launch vehicles and systems embody standards developed for certain common technologies in the aviation, aerospace, and electronics industries, there are very few standards set for aspects of commercial space (e.g., vehicle/payload interfaces) that have an important impact on the commercial viability of the industry. It is apparent that the commercial space launch industry has not perceived the economic advantages that such standards can provide. This situation in part may be due to the fact that until recently there was no commercial space "industry," per se. Historically, launch operators did not operate in a truly commercial market; their products and services were subject to extensive customer (U.S. Air Force and NASA) specification.

OCST Undertakes Study of Voluntary Standardization

Before addressing the important policy issues identified above, OCST decided to step back and conduct a brief examination of how other federal agencies interact with voluntary industry standardization programs. Such an understanding, it was thought, would inform OCST in both promoting appropriate voluntary standardization efforts in the commercial space

launch industry and in incorporating such standards in its safety regulatory program in an optimal fashion. This paper summarizes some of the key insights learned from the study, providing a general understanding to OCST (and industry) as they begin to take concrete steps to further the extent of voluntary standardization in the commercial space launch industry.

In undertaking its study, OCST first conducted a brief overview of voluntary standardization programs in a wide variety of industries. Based on the results of that overview, and with the objective of focusing project research most productively, OCST selected five industries to receive more detailed scrutiny:

- Aerospace and Aviation;
- Automobile;
- Petrochemicals;
- Electronics; and
- Shipping.

OCST gathered information about the principal standardization organization(s) active in each of these industries. In addition, the cross-industry coordinating role of the American National Standards Institute (ANSI) was examined.

For each standardization body examined, a common set of information categories was used to guide research and analysis:

- Genesis of the standards program;
- Key factors in the evolution of industry standards;
- Procedural mechanisms for development/implementation/enforcement;
- Relationship of industry standards programs to government safety standards programs;
- Legal issues: and
- International issues.

OCST obtained its information from interviews with staff of each standard-setting organization. In addition, an extensive search was conducted of recent literature on the topic of voluntary standards programs. This literature search provided a broader perspective on industry standardization generally. In analyzing the information obtained, particular attention was paid to identifying common factors or elements, as well as fundamental differences, among the various industry standardization programs.

At the same time OCST's study was underway, the Office of Technology Assessment was conducting a similar, but broader examination of the impact of standardization on U.S. economic competitiveness. That study, entitled "Global Standards: Building Blocks for the Future," had a significant impact on OCST thinking as the Office was considering the role of industry standards as a complement to its safety regulatory program.

What OCST Learned From Its Study

OCST's study, although brief and preliminary in nature, yielded important insights to guide future Office participation in voluntary standards setting. First, OCST participation in, and support for, voluntary standardization efforts is consistent with U.S. government policy. Specifically, development of a regulatory regime that integrates both regulations and voluntary standards is consistent with the underlying principles of Federal regulatory policy. Executive Order 12291 (February 17, 1981), for example, proscribes Federal standards covering private goods or services except where those are needlessly unsafe or product variations are wasteful, and private standards have failed to correct the problem.

Second, OCST came to the conclusion that a role in encouraging voluntary industry standards is consistent with OCST's mandate to promote public safety. While members of the industry might be expected to promote industry standards out of their own economic self-interest, OCST's interest is in fostering private actions, including voluntary standards-setting, that furthers its own public safety objective.

Third, there are numerous and varied precedents for federal agencies both to catalyze industry standard-setting activities and to employ voluntary standards as part of, or as a complement to, mandatory government safety regulations or procurement standards. In many cases, federal agencies have helped start or accelerate standard-setting efforts by private parties, particularly in nascent industries. Once voluntary standards have been set, it is very common for government agencies to incorporate or adopt such standards as part of, or even in place of, new government safety standards. When Congress passed the National Traffic and Motor Vehicle Safety Act of 1966, the Department of Commerce was directed to review existing voluntary industry standards to determine which might appropriately be used as a basis for interim national standards. Currently, the Consumer Product Safety Commission's regulatory regime, for example, is extremely reliant on private standards. The Coast Guard relies heavily on American Bureau of Shipping rules to form basic components of the federal maritime regulatory regime.

Fourth, voluntary standardization is a common, almost ubiquitous phenomenon in U.S. industry. A number of industries in the U.S., including aerospace and aviation, have established formal standardization programs governing the manufacture of products. The objectives and format of such standards vary widely. In many cases, these standards pre-date the development of direct Federal safety regulation. In some cases, industry standards have been relied upon substantially by federal agencies in place of regulation, or as the partial basis for mandatory federal safety standards, as well as in the development of procurement specifications.

Fifth, such standardization efforts have often played a critical role in advancing (or even making possible) the commercial viability of various U.S. industries. Voluntary standards have played an especially important role in the growth and evolution of the transportation sectors of the U.S. economy. For example, a modern system of railroads, and the vast economic benefits provided by such a system, would not have been possible without early efforts to develop uniform standards covering track gauges and the interoperability of brakes and couplings. These standards made possible the interchangeability of the rolling stock of the nation's many different railroad lines. The economic importance of a standard railroad gauge is difficult to overestimate. Most of the country followed the example of northeastern

railroads in converting to a four foot eight inch gauge; economic growth in the South, however, was stymied substantially until that region's railroad companies followed suit in 1886, the year the South -- economically speaking -- "joined the Union."[1] Interestingly, at the present time, the absence of a uniform gauge for freight trains among European countries has made it difficult for U.S. package delivery services and their European competitors to duplicate on the continent the success of United Parcel Service and others in this country. [2]

The important economic contribution standards could make was also recognized early by leaders in the automotive industry. The earliest standardization efforts among automakers date to 1910. By 1921, the Society of Automotive Engineers (SAE), a previously existing organization that took on the role of standards-setter for the industry, had already published 224 sets of standards, principally focused on the dimensions of auto parts and accessories.[3] The promulgation of product standards opened the auto parts marketplace to numerous small manufacturers and reduced the dependency of the auto assemblers on a few suppliers. The importance of SAE's standards increased greatly as automotive technology progressed and the complexity of automobiles as engineering systems increased.

Voluntary standardization efforts have proven no less important in the aviation and space fields than they had earlier in the railroad and automotive industries. Several private organizations, including the Aerospace Industry Association (AIA) and SAE have played leading roles in establishing standards in the aviation industry. More recently, the American Institute of Aeronautics and Astronautics (AIAA) has become active in this arena. There has been a greater degree of standardization in aviation than in the space industry, largely due to the relative newness of space technologies. In addition, space systems incorporate many technologies pioneered in aviation, taking advantage of previously developed standards.

Space standards can be expected to increase in importance with the increasing commercialization of the space industry. Increased systems complexity, taking the industry well beyond technologies applied in aviation or even the Federal space program, will necessitate the development of new standards. In addition, as the volume of commercial space launches grows, the economic importance of standards in lowering production costs and insuring the interoperability of vehicles and equipment will grow. Finally, as the commercial space industry becomes both more international and cost-competitive, the harmonization of standards among participant countries will become a significant issue. Continued expansion of U.S. space equipment exports, which grew three-fold from 1987 to 1991 (when they were valued at $2.5 billion dollars), will depend in part on American ability to influence, as well as conform to, international standards. (The importance of standards to the international competitiveness of U.S. industry generally is emphasized in the recent OTA report.)

Finally, there is a role for OCST in helping create a framework or mechanism that will accelerate the pace of voluntary standardization in the commercial space launch industry.

---

[1]Martin, Albro. Railroads Triumphant. Oxford: Oxford University Press, 1992, p. 46.

[2]Washington Post, May 12, 1992, p. C1.

[3]Hemenway, David. Industrywide Voluntary Product Standards. Cambridge, MA: Ballinger, 1975.

The industry itself has already begun to become more cognizant of how their economic interests can be served in the standardization process; OCST can serve its safety objective by fostering momentum in this direction. What is required is to create an institutional framework, working with established standards-setting organizations, within which commercial space standardization can be encouraged and reinforced.

Next Steps

Because OCST believes that its safety regulatory objective would be greatly advanced by promoting the commercial space launch industry's own efforts to develop voluntary standards, the Office made a decision to actively encourage voluntary safety standardization efforts in the commercial space launch industry. In reaching this decision, OCST came to believe such a role is entirely consistent with the Office's statutory charter to promote public safety.

Having reached this decision, OCST has committed to two key next steps:

- To distribute its report to the standards-setting organizations examined in its study, to provide them the opportunity to provide feedback regarding important factual issues as well as findings and conclusions; and

- To reach out proactively to existing voluntary standards-setting organizations to explore what specific needs there are for voluntary standards in the commercial space launch industry and how OCST can best help create the framework or infrastructure to meet those needs.

Organization of this Paper

This paper summarizes the findings of OCST's study in three principal sections:

- Section 2 provides an overview of voluntary industry standards and how they operate. This discussion defines and categorizes various types of standards; identifies some of the benefits and potential problems resulting from standardization; outlines the process by which standards are established; discusses the relationship between voluntary industry standards and government programs; sketches the increasingly important international context in which U.S. standards programs operate; and discusses key economic and legal aspects of standards.

- Section 3 provides a comparative analysis of the industry standards programs researched in this study, summarizing the key commonalities and differences discovered among those programs.

- For those readers interested in more detail, the Appendix presents a summary of the information obtained from the standards-setting organizations researched in this project. A brief write-up is provided for each of these standardization programs. These summaries illustrate the point that there are many models that can be adapted in undertaking voluntary standardization in the commercial space industry.

2. WHAT ARE VOLUNTARY INDUSTRY STANDARDS AND HOW DO THEY WORK?

The Importance of Standardization

As has been noted in the railroad and automotive industries, standards provide one of the fundamental underpinnings of a modern economy. They ensure that parts or products made in one factory by one manufacturer will function together with complementary products made by other manufacturers as part of a technological system.

> The relationship between standards and mass production was self-reinforcing. Further advances in precision manufacturing required the development of machine tools and precision gauges, which in turn further drove the need for standards and standard measures.[4]

Standards are particularly important in so-called "high technology" systems, which are typified by a large number of parts and precise performance specifications. As summarized in a recent Office of Technology Assessment report:

Standards development today occupies the attention of a large and growing community of professionals worldwide. In the U.S. alone, over 400 private organizations had, as of 1987, promulgated over 30,000 standards covering all manner of products and services.[5] Standard-setting organizations include professional societies, trade associations, and groups solely focused on standards-related issues. Several Federal agencies, most notably the National Institute for Standards and Technology (NIST), actively follow or encourage private standardization developments. There is also a Standards Engineering Society, which publishes a journal covering a broad range of standards-related topics. Internationally, the harmonization of product and service standards has played an important role in negotiations as diverse as European economic integration ("EC '92"), the General Agreement on Tariffs and Trade (GATT), and the proposed U.S.-Mexico free trade pact.

The promulgation of standards, however, is by no means a recent preoccupation. Certain standards, such as common languages, calendars, and systems of weights and measures, provide the foundation for civilization itself. The development of modern product standards traces back to the Industrial Revolution in Great Britain. In one of the earliest examples of a standard, the British in 1841 settled on a common screwthread, called the "British Standard Whitworth Thread." In the U.S., a competing screwthread standard was set in the 1860s.[6]

---

[4]U.S. Congress, Office of Technology Assessment: Global Standards: Building Blocks for the Future. TCT-512. Washington, D.C.: U.S. Government Printing Office, March 1992, p. 40.

[5]Breitenberg, Maureen A.: "The ABC's of Standards-Related Activities in the United States." Washington, D.C.: U.S. Department of Commerce, National Bureau of Standards, May 1987, p. 1.

[6]Hemenway, David. Industrywide Voluntary Product Standards. Cambridge, MA: Ballinger, 1975, p. 3.

The persistence of different standards for basic industrial parts has created significant problems. In the case of screwthreads, incompatibility between U.S. and British screws prevented the interchanging of the two allies' tank parts in North Africa during World War II, thereby immobilizing significant numbers of vehicles at critical times. This particular problem was rectified in 1948 with the adoption of an International Screwthread Standard.[7]

One of the longest-standing debates over international standards concerns the choice of measurement systems. The contestants are the Metric System, devised during the French Revolution, and the so-called "Customary System." Although the rest of the developed world has long-since implemented the Metric System, the Customary System remains predominant in the U.S. And this despite the formal Congressional adoption of the Metric System in 1884, and several more recent pro-Metric Executive and Congressional proclamations.

Among the most taken-for-granted examples of domestic standards is the color of traffic lights. Until 1927, when the American Association of State Highway Officials, the National Safety Council, and the National Bureau of Standards collaborated to standardize the meaning of the colors green, yellow, and red as used in traffic lights, there was no color consistency from city to city, state to state. This situation obviously presented significant hazards as Americans became more mobile and increasingly undertook cross-country trips.[8]

Defining Standards

Standards have been defined in one survey of the topic as "...guidelines which are accepted for current use through authority, custom, or general consent."[9] The National Standards Policy Advisory Committee has defined standards as, "A prescribed set of rules, conditions, or requirements concerning definitions of terms; classification of components; specification of materials, performance, or operations; delineation of procedures; or measurement of quantity and quality in describing materials, products, systems, services, or practices."[10]

At the most general level, standards can be classified as either "natural" or "organized" standards.[11] The former, often referred to as "de facto" standards, evolve through informal

---

[7]ibid., p. 4.

[8]Breitenberg, Maureen A.: "The ABC's of Standards-Related Activities in the United States." Washington, D.C.: U.S. Department of Commerce, National Bureau of Standards, May 1987, p. 3.

[9]Reddy, N. Mohan and Cort, Stanton G.: "Industrywide Technical Product Standards." R & D Management, 19, 1, 1989, p. 14.

[10]Breitenberg, Maureen A.: "The ABC's of Standards-Related Activities in the United States." Washington, D.C.: U.S. Department of Commerce, National Bureau of Standards, May 1987, p. 1.

[11]The focus of this report is on standards widely adopted for use in industry. Thus, by definition, "standards" established by individual companies for their own use in manufacturing and procurement are not discussed here.

means, as a specific technology or practice becomes widely adopted. This process is often driven by the overwhelming technical superiority of a particular product or by the market dominance of its producer. The DOS operating system and the architecture of the IBM Personal Computer are recent examples of this type of informal standard.

Organized standards, also referred to as "de jure," are more the topic of this study. These standards arise through formal, consensus-oriented efforts, typically coordinated by organizations devoted to standards setting. De jure standards include both those promulgated by government and those established voluntarily by industry. One estimate is that 80 percent of standards for industrial and intermediate (as opposed to consumer) products in the U.S. are voluntary in origin.[12]

Voluntary standards fall into several basic categories in terms of their purpose or the function they serve:

- *Nomenclature/symbolic standards*, which aim to standardize the language used in describing and using emerging technologies;
- *Simplification standards*, which seek to reduce product variety, especially differences in product dimensions;
- *Uniformity/interchangeability standards* promoting the compatibility of individual products to function as part of an industrial or technological system; and
- *Performance/quality standards*, which seek to improve product reliability, durability, efficiency, safety, and environmental performance by setting minimum thresholds.

Another category of standards, those covering testing, inspection, and certification procedures, are somewhat different in nature; they concern the means by which compliance with the other types of standards is determined. Certification standards, often in the form of licensure requirements, are also the type of standard most applied to services, as opposed to products.

The Benefits/Problems Associated With Standards

Advocates of industry standards have advanced many arguments for such voluntary product norms. Principally, standards are said to:

- Promote lower product costs;
- Lower entry barriers to market participation;
- Improve product performance;
- Reduce consumers' transactions costs; and

---

[12]ibid., p. 14.

- Accelerate the diffusion of technology.

By reducing product diversity, manufacturers are able to realize economies of scale in production. Users of a standardized product, in turn, are able to reduce their costs by limiting their inventories. Users are not reliant on one or a few producers of a unique product; they can obtain additional inventory from many producers. By in effect defining what a marketable product is, standards make it possible for more firms, particularly smaller firms, to get into a market. Increased market participation increases price competition.

Quality or performance standards set a minimum threshold or floor that products must exceed. Although the performance dimensions of concern vary by industry and product, this type of threshold helps eliminate "substandard" products.

Consumers, whether they be individuals or firms, often rely on standards -- reflected in the presence of a seal, logo, or some other symbol -- to very efficiently convey important information about a product. They can tell at a glance that the product in question meets the standards relevant to their use or application; they do not have to waste scarce time conducting a detailed investigation of the product's performance specifications. Reliance on standards reduces the importance of brand names -- another traditional buyer's "crutch" in evaluating competing products. The purchase decision tends to turn on price alone. In this way, products in effect become commodities, driving prices down.

The process by which standards typically are set, involving the development of consensus among producers, users, and others concerned with a particular product, involves a great deal of sharing of information that otherwise would be kept proprietary. This process accelerates the diffusion of technical knowledge.

Although most of the literature surveyed by OCST in this project is devoted to examining these benefits of standards, and the processes by which standards are arrived at, standards and standardization programs do pose potential problems that must be considered in any survey of the field. Critics of voluntary industry standards argue they may:

- Provide an opportunity for industrial collusion or restraint of trade;
- Establish unnecessarily high performance requirements;
- Create barriers to market entry;
- Freeze or retard technological innovation; and
- Reduce consumer choices.

Anytime two or more firms in the same industry get together, concerns about collusive behavior arise. Those involved in the standards-setting process potentially have an opportunity to undercut the competitive position of nonparticipants. The Federal Trade Commission (FTC) has devoted significant resources to examining the potential anticompetitive effects of voluntary standards programs, and has promulgated rules establishing procedural due process requirements for standards-setting groups. They have been particularly concerned about the incentive firms have to "legislate in" or have "spec'd in" their own products to the disadvantage of their competitors. The often great expense involved

in participating in lengthy and intensive standards committees can limit the participation of smaller firms.[13]

Whether or not by collusive intent, standards may lock-in artificially high or excessive performance specifications. Less expensive products that objectively meet consumers' needs may be eliminated or hampered competitively in the marketplace. Specifications which exceed needs can also prevent firms from entering the market, due to financial or technical constraints; the presence of fewer firms in the market drives prices up.

Standards may also create a performance ceiling, effectively removing the incentive for firms to innovate. Depending on the degree of consumer reliance on a particular standard, the development of entirely new ways of meeting a consumer need (possibly by an entirely different industry) may be stymied. Standards which specify the design features of a product (as opposed to performance parameters) particularly inhibit the development of innovative, cheaper ways of meeting a need. Timing is also important: The premature specification of a standard can retard useful innovation.

Whatever the factors driving standardization, the effect typically is to reduce the variety of alternative products in the marketplace. Whatever the other benefits the consumer may reap from standardization, maximization of choice in itself is a value.

The Standards Development Process in the U.S.

Standards development, by its nature, is a collective process undertaken by voluntary organizations. The first standard-setting organization in this country was the United States Pharmacopial Convention, which was established in 1829 to set uniform standards for drugs.[14] As previously noted, presently there are a large number of standards-setting organizations in the U.S. (Some of the most important of these organizations are discussed in the Appendix below.) That number is multiplied when focusing on the increasing development of international or "harmonized" standards.

Compared to other developed nations, America's standardization structure is highly decentralized. Although there have been proposals to establish a Federal agency to coordinate private standardization activities, the American National Standards Institute (ANSI), a private body, remains the predominant coordinating body in the U.S. standards development process. ANSI provides the framework and process through which most U.S. standardization activity takes place. Although ANSI does not itself set standards, it reviews the standardization work of its member organizations and designates as "American National Standards" those voluntary codes and specifications that meet the Institute's consensus and other process requirements. The National Institute for Standards and Technology (NIST) (formerly known as the National Bureau of Standards), the leading Federal agency involved in standardization activities across many industry sectors, is principally an observer of private efforts and does not play a strong controlling or coordinative role.

---

[13]Federal Trade Commission, Bureau of Consumer Protection. Standards and Certification: Final Staff Report. Washington, D.C., April 1983, p. 22.

[14]U.S. Congress, Office of Technology Assessment: Global Standards: Building Blocks for the Future. TCT-512. Washington, D.C.: U.S. Government Printing Office, March 1992, p. 46.

"Grass-roots" standard-setting activity takes place within a wide variety of organizations that tend to fall within several basic categories:

- *Engineering and professional societies* (such as the American Society of Mechanical Engineers (ASME) and SAE);
- *Trade associations* (such as the American Petroleum Institute);
- *General membership organizations* (such as ASTM);
- *Consortia*, which are particularly active in the information and communications industries; and
- *Third-party certifiers* (such as Underwriters Laboratories).

U.S. standard-setting organizations vary in terms of the scope and extent of their activities and influence. Among the broadest and most important is the American Society for Testing and Materials (ASTM), which manages the development of standards in a variety of industries and disciplines. In addition, other organizations including laboratories (such as Underwriters Labs) and industrywide research consortia are active in the standards field.

There is a great degree of similarity among standards-setting organizations in the basic processes they employ. One authority on voluntary standards programs has identified five procedural aspects common to most standard-setting organizations:

- Committees and subcommittees are "balanced" to ensure that they are not dominated by any one economic interest;
- Standards are approved by a "consensus," meaning more than a simple majority, but not necessarily unanimity;
- Negative or "no" votes on proposed standards are handled quite formally, usually requiring explanations which are reviewed by the standards-setting committee and judged in terms of technical justification and persuasiveness;
- Procedures are written out, meetings are open to the public, and meeting participation is not limited in any significant way; and
- Appeal mechanisms are available within the organization to make sure procedures are followed and all points of view treated appropriately.[15]

Although consensus and openness underlie the standards-setting activities in virtually all industries, there apparently are two different "models" about what constitutes "openness." These different approaches are summarized in a recent Office of Technology Assessment report:

---

[15]Hamilton, Robert W. "Prospects for the Nongovernmental Development of Regulatory Standards," in American University Law Review, 455 Winter 1983, pp. 462-4.

> [ASTM] insists that true consensus requires the participation of all interested parties, even if this requires subsidizing some groups. On the other hand, [ANSI] as well as others argue that due process requires only that the process be open so all have an opportunity to participate. They contend that willingness to pay is an essential measure of interest in the process.[16]

This disagreement reveals friction within the U.S. standardization community. Although virtually all of the major industry-specific standards-setting organizations in the U.S. are members of ANSI, and follow basic procedural norms that ANSI has helped shape, ANSI's role as leader of U.S. standardization efforts is self-designated and not unanimously accepted. ASTM, because its standardization program spans many industries and because it directly develops standards (as opposed to ANSI's coordinative role), does not consider itself subordinate to ANSI. And many groups which, like ASTM, belong to ANSI, do not forward all or even many of their standards to ANSI for the latter's imprimatur as "American National Standards." Even in the international arena, where ANSI derives much of its authority as the lead U.S. representative to the International Standardization Organization (ISO), ASTM and other U.S. standards-setters often work directly with their industry counterparts in other countries.

Committees do the standard-setting work in most organizations. Committees are formed to draft the standard and develop a consensus. Drafts are circulated to interested parties for review and comment. Subsequent drafts address the comments until a consensus has been reached. The purpose of this iterative approach is similar to the purpose of the Federal Administrative Procedure Act (APA), to ensure due process by giving parties that are potentially affected by a rule or standard an opportunity to comment prior to implementation. However, the process differs from the Federal rulemaking procedures in that the standard-setting organizations attempt to reach a consensus position where a Federal agency may proceed with a rule in the face of strong opposition.

The need for consensus in part derives from the method of implementation. Unless a voluntary industry standard has been adopted or in some other way been incorporated in a government regulation or procurement specification, firms are not legally compelled to follow standards. However, as discussed below, in some cases, market forces may place such a high premium on standards compliance that standards enjoy virtually 100 percent compliance.

The iterative, consensus-based nature of the standards-setting process can be very time-consuming. It is unusual for standards to take less than a full year to develop from start to finish, with much longer gestation periods common -- up to seven years in some extreme cases. Overall, "the nongovernmental standards-development schedule approximates that of an administrative agency establishing its own regulatory standard under the APA."[17]

International Standardization Activity

---

[16]U.S. Congress, Office of Technology Assessment: Global Standards: Building Blocks for the Future. TCT-512. Washington, D.C.: U.S. Government Printing Office, March 1992, pp. 12-3.

[17]ibid., p. 464.

Increasingly, the focus of standardization activity is at the international level. As the volume and complexity of world trade grows, the importance of harmonized product standards -- and the cost of unharmonized standards -- also grows. Firms manufacturing products for sale internationally face the daunting task of designing their product to meet all applicable, and often conflicting, national standards for each intended market. The result is higher product costs and reduced competitiveness. National standards, whether set voluntarily by industry or by governments, can be a powerful form of non-tariff barrier. By contrast, uniform or harmonized national standards provide a "level playing field" for domestic and imported products, allowing all firms to compete on the basis of product performance.

The potential role of national standards in affecting the flow of international trade is recognized in the General Agreement on Tariffs and Trade (GATT), which has as one of its components the Agreement on Technical Barriers to Trade (also known as the "Standards Code"). This code established the first international requirements concerning the procedures used in developing and implementing standards.[18]

Harmonization of standards has been an important aspect of the "EC '92" European integration process as well as the growing North-South trade dialogue. In Europe, for example, a goal of harmonizing approximately 10,000 standards has been set, with the objective of significantly reducing product manufacturing costs. Standardization negotiations have been intensive, with each country jockeying to have their own national standard adopted as the EC standard.

The acceleration of international standardization activities has been particularly pronounced since the mid-1970s. One survey, for example, estimates that more international standards were developed in the period 1977-87 than during the previous 30 years.[19] A number of international organizations are involved in these activities, notably including the International Organization for Standardization (ISO), the International Electrotechnical Commission (IEC), the Consultative Committee on International Telephony and Telegraphy of the International Telecommunications Union (ITU), the European Committee for Standardization (CEN), the Pacific Area Standards Congress (PASC), and the Pan American Standards Commission (COPANT).

The role of the ISO in the globalization of standards is especially important. The work of ISO, which is carried on by over 20,000 experts, from all parts of the world, serving on approximately 2,300 technical groups, had resulted in over 6,000 international standards by 1987.[20]

---

[18]Breitenberg, Maureen A.: "The ABC's of Standards-Related Activities in the United States." Washington, D.C.: U.S. Department of Commerce, National Bureau of Standards, May 1987, p. 2.

[19]Reddy, N. Mohan: "Voluntary Product Standards: Linking Technical Criteria to Marketing Decisions." IEEE Transactions on Engineering Management, Vol. EM-34, No. 4, November 1987, p. 236.

[20]Breitenberg, Maureen A.: "The ABC's of Standards-Related Activities in the United States." Washington, D.C.: U.S. Department of Commerce, National Bureau of Standards, May 1987, p. 2.

ANSI is the principal U.S. point of contact with ISO; this international role, in fact, is a source of much of ANSI's domestic influence. Typically, ANSI is represented on ISO committees by technical professionals drawn from its member, standard-setting organizations. AIAA, for example, represents U.S. interests on ISO Technical Committee 20 (TC 20), which sets international standards for aircraft parts and equipment.

The U.S. serves as the secretariat for TC 20, a role which typically affords heightened influence over the standardization process. Accordingly, the over 200 standards documents produced by TC 20 embody a substantial amount of U.S. technology; this, in turn, typically translates into commercial advantage for U.S. firms. TC 20 recently has been considering space vehicle standardization proposals, with AIAA taking a lead U.S. role.[21]

Despite considerable American influence in TC 20 efforts, generally speaking U.S. firms and standard-setting organizations are not as active in the international arena as are their counterparts in Europe. One researcher estimated in 1987 that the U.S. had adopted about 20 percent of formulated ISO standards, as compared to a 65 percent adoption rate for our major trading rivals -- Britain, Germany, France, and Japan. This discrepancy implies significant potential economic vulnerability.[22]

Certification -- the evaluation of products to determine compliance with standards -- becomes important in assessing the impact of conflicting national standards. At present, for example, there are no U.S. labs qualified to test products to certify their conformance to European standards. This requires that American products be shipped to one of several approved European labs for this purpose.[23]

Relationship of Voluntary Industry Standards to Government Programs

A complex relationship exists between voluntary industry standards and government agencies. As previously noted, the U.S. standardization system is more decentralized than that of other developed countries, with considerably less involvement by national-level government agencies.

In some cases, however, Federal agencies have been involved in catalyzing industry standardization efforts. Agency representatives on the standard-setting committees of many private standardization organizations is one important way that Federal influence is brought to bear. More significantly, Federal agencies have in some cases played instrumental roles in the standardization process. The War Industries Board, for example, provided a significant impetus to standards-setting during World War I, with the objective of simplifying products to conserve materials and rationalize production processes. In another example, Herbert Hoover helped midwife product dimension standards in the lumber industry. As in the lumber

---

[21]French, James E.: "Standards Affect the Pace of International Business." Aerospace America, October 1991, pp. 52-4.

[22]Reddy, N. Mohan: "Voluntary Product Standards: Linking Technical Criteria to Marketing Decisions." IEEE Transactions on Engineering Management, Vol. EM-34, No. 4, November 1987, p. 236.

[23]Los Angeles Times, June 22, 1991, Section D, p. 2.

example, government involvement of this type has usually come in industries characterized by low concentration among both producers and consumers, making cooperation on standards difficult for firms to initiate on their own.[24]

More recently, the Federal government's role in encouraging or directly fostering industry standardization activities has been led by the National Institute of Standards and Technology (NIST), formerly the National Bureau of Standards. NIST administers the Department of Commerce's Voluntary Product Standards (VPS) program. Under the auspices of this program, NIST staff serve as the secretariat for the development of voluntary standards for selected industry products, including softwood lumber, construction and industrial plywood, and glass bottles for soft drinks. The cost of these activities is paid for by proponent trade associations or other groups. NIST also serves as an appeal mechanism for manufacturers contesting the decisions of an important private standards setter, Underwriters Laboratory (UL). UL is frequently asked by manufacturers to test products for conformance to UL-set standards; by agreement with UL and such manufacturers, NIST considers any protests or appeals filed by manufacturers whose products fail UL tests.

NIST operates the National Center for Standards and Certification Information, which provides information on U.S. and international standardization programs. NIST is a member of the International Organization for Standardization Network (ISONET), providing access to an extensive database on foreign national standards. NIST also maintains an extensive collection of reference materials on U.S. voluntary standards and government procurement specifications.

Currently, the relationship between government agencies and industry standardization principally involves government procurement procedures and regulatory programs. In the procurement arena, government agencies at all levels find themselves in the same position as individual and corporate consumers -- relying on industry standards in their purchasing decisions. A 1970 General Services Administration report found more than 4,000 private industry standards referenced in Federal procurement documents.[25] The organizations profiled in the Appendix below provide numerous examples of private standards referenced or otherwise incorporated into Department of Defense (DoD) procurement specifications. For example, approximately 500 Aerospace Industry Association standards have been incorporated by DoD in its procurement program. In recent years, DoD has put increasing emphasis on the use of existing industry standards, wherever possible seeking to increase quality and cost-effectiveness in its procurement programs.[26] The extent of government reliance on private standards is probably even greater at the state and local level, where even fewer resources exist to permit an independent evaluation of competing products.

---

[24]Hemenway, David. Industrywide Voluntary Product Standards. Cambridge: Ballinger, 1975, p. 22.

[25]Federal Trade Commission, Bureau of Consumer Protection: Standards and Certification: Final Staff Report. Washington, D.C., April 1983, pp. 28-9.

[26]DoD Directive 4120.20, "Development and Use of Non-Governmental Specifications and Standards," March 28, 1988.

In the regulatory sphere, government agencies often in effect convert "voluntary" private standards into mandated requirements through incorporation or adoption by reference of those standards in public regulations. A study performed for the Administrative Conference of the United States in 1978 documented that a majority of the then-applicable Federal, state, and local regulatory standards and codes were derived from preexisting voluntary codes, rather than original governmental action.[27]

Examples of Federal incorporation or adoption of voluntary standards abound. By 1978, for instance, the Occupational Health and Safety Administration (OSHA) had adopted or referenced over 265 ANSI-approved "National Standards" in its worker safety regulations.[28] Technical standards developed by SAE committees have been used by the Federal Aviation Administration (FAA) and the National Highway Traffic Safety Administration (NHTSA). Standards developed by ASME have been incorporated into regulations issued by DOT, EPA, OSHA, and the Nuclear Regulatory Commission (NRC).

Federal agency involvement in the development of voluntary industry standards, as well as their use of the products of voluntary standardization activities, is guided by Circular A-119, originally issued by the Office of Management and Budget in 1980. This document encourages Federal agency support of, and participation in, voluntary standardization activities when the voluntary organizations involved follow basic due process procedures.

One Federal agency, the Consumer Product Safety Commission (CPSC), has built the entire structure of its regulatory program around voluntary standards. In its early days, the CPSC often deferred promulgating mandatory product standards in cases where industry took preemptive standardization action; the threat of mandatory standards became a significant impetus to such voluntary efforts. The 1981 amendments to the Consumer Product Safety Act articulated a statutory preference for such standards by requiring the CPSC, before implementing a mandatory standard, to find that any proposals to develop alternative voluntary standards would not adequately reduce the risk of injury from a particular class of products.[29] This reliance of the CPSC on voluntary standards has led to close cooperation between the agency and various standardization groups. The CPSC has provided financial assistance to some private standards-setters and has suggested various procedural reforms, including increased representation of consumer interests, to improve the quality of standards established in the private sector.

When a Federal agency incorporates a standard or code by reference, it must cite a particular edition or version. If the code subsequently is updated by the standard-setting organization, the update is not automatically included in the Federal rule; the agency must go through notice-and-comment rulemaking to update the reference accordingly. This process must be completed before a revised standard can be adopted as a Federal regulation. Such

---

[27]Study cited in Hamilton, Robert W. "Prospects for the Nongovernmental Development of Regulatory Standards," in American University Law Review, 455 W, 1983, p. 459.

[28]ibid., p. 28.

[29]Klayman, Elliot. "Standard Setting Under the Consumer Product Safety Amendments of 1981 -- A Shift in Regulatory Philosophy," in 51 George Washington Law Review 96, November 1982, pp. 100-1.

changes ordinarily are not controversial, given the consensus-based approach employed in the voluntary standards-setting process.

At the state and local level, reliance by public regulatory agencies on private standards is even greater. The "National Electric Code" developed by the National Fire Protection Association, and the "Boiler and Pressure Vessel Code" developed by ASME, both have been widely adopted by states and localities. Observing this heavy reliance of all levels of government on ASTM-set standards, one Federal Court went so far as to call ASTM "...an essential arm, or branch, of government...."[30]

Economic Aspects of Standards

The potentially powerful economic impact of standards has been noted previously. It is these economic effects that provide the incentive for standardization activities in the first instance. The promise of lower production costs, increased product compatibility, and reduced consumer transaction costs has proven very attractive in many industries. The precedential examples of the role of standards in the growth of numerous industries, particularly in the transportation sector, are frequently cited. At the same time, critics of standardization also focus most of their concern on potential negative economic impacts, including product cost increases, excessively high (and, thus, expensive) performance requirements, barriers to market entry, and reduced consumer choice.

Sorting out the real economic effects of standards can only be done on a case-by-case basis, taking many factors unique to each product and its market into account. As a general proposition, however, it is clear that standards, once they are promulgated, can have a powerful effect on marketplace behavior. As an FTC staff report noted, "...where reliance on a particular standard or seal is significant, noncompliance becomes so competitively disadvantageous from the point of view of producers that voluntary standards become mandatory."[31]

The process by which particular standards are set provides an interesting opportunity to observe variations of microeconomic behavior on the part of firms. As previously noted, many firms invest considerable amounts of money and staff time in aggressive participation on standards-setting committees with the objective of legislating in their technology and, thus, gaining a competitive advantage. On the other hand, standards are a good example of a "free good." All firms in an industry can employ a standard, whether or not they helped create the standard; therefore, at least for small firms or firms that do not expect to gain a competitive edge, there is little economic incentive to participate in the standard-setting process.

Another interesting economic aspect of standards concerns the degree of residual variation and differentiation they permit producers. Standards can be seen as the intersection of the common knowledge of producers and the common needs or performance requirements of consumers. In this view, standards in effect define a "core" product. Individual standards will permit greater or lesser degrees of product variation, as producers seek to comply with a

---

[30]U.S. v. Johns-Manville, et al. (1964), quoted in ibid., pp. 10-11.

[31]Federal Trade Commission, Bureau of Consumer Protection: Standards and Certification: Final Staff Report. Washington, D.C., April 1983, p. 34

standard (to obtain the marketing benefits compliance provides), while at the same time attempting to differentiate their product from competitors', which also comply with the standard. They often are able to do this, since few standards satisfy every requirement of all consumers of a product. In participating in the standard-setting process, firms must decide what technical information they are willing to share, and what they will maintain as proprietary.

3. COMPARISON OF SELECTED INDUSTRY STANDARDIZATION PROGRAMS

Introduction

This section provides a summary comparison of thirteen of the fourteen standards-setting organizations researched by OCST in this project. (ANSI is not included because, as a standards-coordinating body, it is different in kind from the other groups, which actually set standards themselves.) The points of comparison include the procedural characteristics of each standardization program, the nature and scope of the organizations' programs, key factors in the evolution of their standards, the degree of their interaction with government agencies, and other aspects of standardization discussed in Section 2. The Appendix to this report provides a profile of each of the fourteen standards organizations, and can be consulted for more information about any specific program. Key points from these profiles are summarized in Exhibit 1 at the end of this section.

Common Aspects of Programs

The most striking commonality among the programs researched in this project concerns the process used to develop and implement standards. The consensus-oriented, broadly representative approach promoted by ANSI clearly provides the process paradigm for voluntary standardization organizations throughout U.S. industry. Even the one organization that does not belong to ANSI, the Truck Trailers Manufacturers Association (TTMA), subscribes to the ANSI methodology. In part this is due to the protection that a broad consensus approach can provide against antitrust and other legal challenges.

Reflecting the consensus nature of industry standards, standards-setters substantially rely on voluntary compliance. In the case of standards widely recognized by consumers, market forces powerfully reinforce companies' voluntary compliance instincts. In other cases, compliance becomes mandatory as initially voluntary standards become adopted by government agencies in either regulations or procurement specifications.

There is also a great degree of similarity in the origins of these standardization programs. In most cases, industry leaders begin focusing on standards in an effort to promote the growth of an expanding and diversifying technology. The need for uniformity and interoperability among products produced by different companies is apprehended quickly when the lack of such interoperability becomes a significant constraint on industry growth. The development of a common railroad track gauge has already been cited as an example of this phenomenon.

Safety risks can also retard industrial growth. Three of the organizations researched by OCST -- UL, the American Society of Mechanical Engineers (ASME), and the American Bureau of Shipping (ABS) -- all owe their origins (or, in the case of ASME, the origins of its

standards program) to a desire on the part of the insurance underwriting industry to manage risks effectively. UL was formed in 1894 by a group of insurers to reduce deaths, injuries, and damages due to faulty consumer products. Widespread and deadly accidents involving poorly designed and operated industrial boilers led states and insurance companies in the late 1880s to develop their own boiler codes. ASME became involved in order to rationalize and standardize these proliferating requirements. ABS's standards program was driven by maritime insurers' desire to reduce shipping losses and resulting insurance claims.

The need for consistency in product quality also has been a common motivator of standardization efforts. This concern may be focused on building the confidence of consumers in an industry's products, or on the quality of industrial goods used in the product manufacturing process. For example, the early concern among engineers about lack of uniformity in the quality of railroad components, and the threat thereby posed to the growth of the railroad industry, was an important stimulant to the creation of the American Society for Testing and Materials (ASTM). Similarly, improving the quality of fasteners was a major reason the Aerospace Industries Association (AIA) branched into standards-setting.

The need for interchangeability is an especially strong impetus for standardization programs in high-technology fields. The more complex the industrial system, the greater the number and complexity of parts, and the greater the need for parts manufactured by different companies to be able to function together. Chemical manufacturing and petroleum refining processes, for example, can involve huge numbers of specific chemical processes and very complex and idiosyncratic piping and instrumentation arrangements. Transportation vehicles such as automobiles and airplanes involve thousands, even tens of thousands of different parts. Interoperability or interchangeability among the parts made by different suppliers provides important planning and cost advantages to vehicle assemblers. These concerns were very influential in the origins of the standardization efforts of both AIA and the Society of Automotive Engineers (SAE).

Once begun, standards programs evolve largely in response to technological developments and changes in public or consumer concerns. Both the number and focus of standards change as technological systems become more complex. As the electronics industry has grown and diversified, for example, so have the standards set by such organizations as the Electronics Industry Association (EIA) and the Institute of Electronic and Electrical Engineers (IEEE). New technical achievements such as the invention of the transistor, the microchip, and fiber optics require new standardization activity.

Heightened public concern about the safety of products has had a powerful impact on the evolution of standards activity. This is particularly evident in the transportation sector, since the growth of the automotive and commercial aviation industries has been highly dependent on consumer confidence in vehicle safety. The scope of two standardization bodies, ASTM and Underwriters Laboratories (UL), especially have been affected by the evolution of public concerns. ASTM has increased its activity related to energy resources, environmental testing, and waste management as public interest in these issues has grown. Increased consumer and government concern about the safety of consumer products has led to a significant expansion in the scope of UL's standardization and testing programs.

Significant Differences Among Programs

Although the overall similarities among the standards programs researched are more significant than the differences, there is nonetheless a great degree of variety along a number of important dimensions. These differences concern the nature of the standards-setting organizations themselves, the breadth and extent of their programs, the extent of their influence within their industry, the degree of involvement with both ANSI and government agencies, and their level of international involvement.

While all but one of these groups (TTMA) are ANSI members, and all employ the ANSI standards-development process, they vary in the extent to which they submit their standards for ANSI review and approval as American National Standards. On the one hand, ASME submits many of its standards to ANSI for its approval; on the other, ABS and AIA -- although ANSI members -- do not submit their standards. Other organizations typically avoid formal ANSI review (which can add several years to the standards approval process) unless they are particularly anxious to have a given standard adopted internationally. In such cases, ANSI's role as U.S. representative to the major international standards bodies gives it important leverage.

Another obvious difference concerns the underlying nature and purpose of each organization and the role of standards setting within their mission. Many of the organizations researched are industry or trade associations (e.g., AIA, the American Petroleum Institute (API), and EIA), while others are professional societies (SAE, the American Institute of Aeronautics and Astronautics (AIAA)). In each of these cases, standards development is only a part of what the organization does. Several other of the organizations (e.g., UL, ASTM, and ABS) are devoted largely or entirely to standards-related activities. Even among trade associations and professional societies there is variation in the importance of standards activity relative to the other parts of their mission. Standards-setting is a small part of AIAA's overall mission as compared to SAE's.

Other dimensions useful for comparison purposes are the absolute size and breadth of each organization's standards program. Although it was not possible to obtain budget and staff figures for every program examined, a rough comparison is possible. On one extreme is ASTM, with a standards program budget of over $19 million in 1990. AIAA, by contrast, devotes only $300,000 of a very large overall budget to its relatively nascent standards program. The large size of ASTM's budget reflects the very broad scope of its activity; ASTM sets standards in wide range of industries and disciplines. By contrast, both AIAA and AIA focus their efforts relatively narrowly even within their industry. AIAA has chosen to emphasize space systems standards, while AIA concentrates on aviation fastener technology. SAE sets an aggressive entrepreneurial example. Originally known as the Society of Automotive Engineers, the organization now calls itself simply SAE as it has branched into other industries, most notably its extensive aviation and aerospace standardization activity.

Standards-setting organizations vary in the extent to which they dominate their industries. Standardization in the motor vehicle industry is dominated by SAE, with the TTMA playing a role only with respect to truck trailers. The ABS is likewise dominant in the maritime industry. By contrast, the aviation/aerospace, petrochemical, and electronics industries all have several standards-setting groups which play significant roles.

All of the organizations profiled in the Appendix have working relationships with government agencies at various levels. However, there are important differences in the degree and nature of such interactions. These variations concern, among other things, the extent to which their standards have been adopted by government agencies as regulatory standards or procurement specifications, the levels of government at which such incorporation predominantly occurs, and the extent of government representation in the standards development process. Largely due to the relative newness of its program, AIAA has only had three of its standards adopted or referenced by a government agency, in this case DoD procurement specifications. By contrast, AIA -- which has been in the standards business for approximately 70 years -- has had over 500 of its standards adopted by DoD for procurement purposes, and has a large number of its standards adopted or incorporated into regulations by the Federal Aviation Administration. ASTM, API, ASME, IEEE, and UL all have experienced a great degree of influence over the regulatory and procurement activities of government agencies at all levels. UL's electrical product standards and ASME's boiler code both have been extensively adopted at the state and local level into building codes and standards of practice.

ABS deserves special mention in any discussion of the interrelationship of voluntary standards and government agencies. The relationship of ABS and the U.S. Coast Guard (USCG) is more integral than that enjoyed by any of the other organizations profiled in the Appendix with any other government agency. ABS is recognized in the U.S. code as a government agency for purposes of ship classification. Pursuant to a Memorandum of Understanding, ABS personnel in effect serve as representatives of the USCG in reviewing and inspecting U.S. flag vessels. ABS serves in similar capacities for other Federal agencies, notably including the Department of Agriculture. Reflecting this degree of interaction, ABS governing bodies include significant Federal representation.

Although ANSI is the official U.S. representative to the ISO, IEC, and other international standards-setting organizations, it is the ANSI membership organizations which carry out the technical aspects of this work. The groups examined in this report vary in the extent to which they are involved in these and other international activities. For example, while ASTM maintains its ANSI membership in order to preserve international access, it focuses by far most of its energies domestically. AIA and AIAA, on the other hand, are very involved representing ANSI on ISO and IEC committees. TTMA, because it is not an ANSI member, maintains only an informal relationship to ISO. ASME has become quite aggressive internationally, seeking to establish chapters in other countries. Independent of their active involvement in ANSI, ASME also has developed cooperative agreements with counterpart organizations in other countries. Once again, however, ABS provides the most notable example of internationalism: Paralleling many of its responsibilities on behalf of the U.S. government, ABS has been authorized by more than 90 governments to administer provisions of international maritime conventions for them under the auspices of the International Maritime Organization. While other of the organizations surveyed have had their standards adopted by other countries, none enjoys ABS's degree of extraterritorial authority.

EXHIBIT 1

COMPARISON OF SELECTED INDUSTRY STANDARDIZATION PROGRAMS

Standardization Organization	Genesis of Program	Evolution of Program	Procedural Mechanisms	Relationship to Government Agencies	Legal Aspects	International Aspects
American National Standards Institute (ANSI)	• Founded in 1918 by engineering societies to facilitate standardization • Membership expanded in 1928 to include companies, trade associations, and government • Prior to 1969, developed standards directly in addition to coordination role	• Primary concern has been to promote standardization without stemming innovation • Increased technical capabilities of member organizations shifted ANSI role to coordination • Perceived need to coordinate others' activities to prevent duplication	• Consensus and broad representation of affected interests is heart of ANSI process • Standards development begins with member organization request • Three separate methods can be followed • ANSI approves the process, not the standard itself • "American National Standard" designation upon approval	• Growing government involvement over time • Over 15 Federal agencies are ANSI members • Government representatives serve on ANSI governing bodies • Government often initiates standardization through ANSI • Many ANSI-approved standards included in regulations and procurement specifications	• ANSI assumes some legal responsibility for standards of ANSI-accredited organizations • Organizations must document their adherence to ANSI process • ANSI-approved standards rarely challenged	• Main U.S. representative to ISO, IEC, and other international standards bodies
American Society for Testing and Materials (ASTM)	• Founded in 1898 to focus on railroad equipment failures • Coherent testing system needed to ensure materials uniformity	• Increasing public interest in safety, health, and environment	• Consensus-oriented, due process system • Balanced representation of interests • Extensive testing to validate results	• Assisted state DOTs on permanent and infrastructure issues • Standards incorporated by U.S. EPA, OSHA, DOT, and DOE	• 1964 court challenge decided in ASTM's favor; cited due process guarantees • No subsequent successful challenges	• Primary focus is domestic • Maintains membership in ANSI to promote its standards internationally • ASTM members serve on ISO and IEC committees
Aerospace Industries Association (AIA)	• Founded in 1919 to promote aviation • Began focusing on aircraft fasteners in 1940, with concern for quality and consistency	• Focus has broadened to include fastener materials and adhesives as well as dimensional standards • Driven by need to establish methods of defining airworthiness	• Member of ANSI but does not submit standards for ANSI approval • Uses consensus-based standards development process	• Close working relationship with FAA and DoD • 500 AIA standards listed on DoDISS • AIA standards incorporated into FAA regulations • Special liaison groups established as forum for industry and government concerns	• Experienced early trademark problems • No longer makes specific product recommendations or certifies manufacturers	• AIA is ISO secretariat for aircraft fasteners • Maintains membership in AECMA

EXHIBIT 1 (Continued)

COMPARISON OF SELECTED INDUSTRY STANDARDIZATION PROGRAMS

Standardization Organization	Genesis of Program	Evolution of Program	Procedural Mechanisms	Relationship to Government Agencies	Legal Aspects	International Aspects
American Institute of Aeronautics and Astronautics (AIAA)	• Standards program began in 1981, with focus on space systems • Focus on nomenclature, performance, equipment interface, and design practices	• Focus on increasing efficiency in space applications of aerospace technologies • Anticipation of technical trends and needs • Avoiding duplication of AIA/ SAE standardization efforts	• Follows ANSI procedures • Standards developed by committees with broad representation; entire AIAA membership may comment • Process overseen by AIAA Standards Technical Council	• Government representation on some standards committees • No AIAA standards yet incorporated into regulations • Two standards adopted for DoD procurements	• No challenges yet to AIAA standards	• AIAA is active in ISO TC-20, focusing on international space standards
SAE (Air & Space Division)	• Formed in 1916 by SAE after organization absorbed Society of Aeronautic Engineers • Produced first aeronautical standards in 1917	• Became active in aircraft standards during WW I • Standards activities have kept pace with advancing technology • Presently list over 1600 aerospace standards	• Aerospace council governs standards activities • 160 committees and subcommittees do technical work • Extensive consensus review per ANSI methodology • All standards submitted by ANSI approval	• Maintains links to DOT, FAA, NASA and DoD • 40 FAA TSOs were developed by SAE • 260 SAE standards are listed on DODISS	• SAE is a member of ANSI • All standards are prepared by consensus and reviewed for antitrust and due process issues	• Air and Space Division is U.S. administrator of ISO TC-20, Aircraft and Space Vehicles • SAE is Secretariat for two ISO subcommittees
SAE (Land & Sea Division)	• Established in 1905 to promote automotive standards • Focused on industry needs, not on engineering discipline	• First standard council appointed in 1910 • Intent was to promote interchangeability and simplified production processes • Presently list over 1100 automotive standards	• Standards devised in four councils and 600 technical committees • Standards are voluntary • SAE also produces specifications, technical reports, and material standards • All standards submitted for ANSI approval	• Works with DOT, FHWA, NHTSA, DOE, DOD, and NIST • Approximately 80 SAE standards are incorporated in Federal Motor Vehicle Safety Standards	• Consensus methodology is used to ensure broad-based review of standards • Staff members comprehensively review proposed standards for potential legal questions	• SAE members sit on four ISO ground vehicle councils • Maintains links to foreign automotive organizations

EXHIBIT 1 (Continued)

COMPARISON OF SELECTED INDUSTRY STANDARDIZATION PROGRAMS

Standardization Organization	Genesis of Program	Evolution of Program	Procedural Mechanisms	Relationship to Government Agencies	Legal Aspects	International Aspects
Truck Trailers Manufacturers Association (TTMA)	• Incorporated in 1941 as industry-based association • Makes "recommendations" rather than standards to emphasize voluntary nature • Focus more on procedures for certain situations (including testing) than equipment specifications	• Increased highway movement of freight brought need for practice guidelines in trailer design • Recommendations now cover truck tank trailers, cargo trailers, and other trailer technology	• Not member of ANSI, although follows consensus-based process • Recommendations are devised in two engineering committees comprised of industry representatives • Two or three rounds of balloting to achieve consensus	• TTMA maintains links to OHMT and NHTSA • TTMA recommendations are cited in Federal regulations	• Recommendations are voluntary and broad • Meant only as basis for industry cooperation • Recommendations have not been legally challenged	• TTMA maintains informal relationship with ISO • Foreign trailer manufacturers are members of TTMA
American Petroleum Institute (API)	• Established in 1919 by oil industry • Began standards work in 1923 on oil-related topics	• Standards were set in response to oil-industry need for predictable quality and performance of equipment • Standards broadened to address safety concerns • There are over 400 API standards	• API is a member of ANSI • Committees use consensus methods to develop standards for design and manufacture of equipment • API Monogram Program is a quality assurance program to ensure production techniques meet API specifications	• API has worked with EPA, DOT, OSHA, USCG and the USGS • Approximately 70 API standards have been adopted in regulations • API code has been adopted by state governments	• Draft proposals are screened to preclude antitrust issues • API is an ANSI member and devises consensus-based standards	• API members sit on ISO committees • Currently working to have API standards adopted internationally
American Society of Mechanical Engineers (ASME)	• ASME was founded in 1880 and began standards writing in 1884 • Standards intended to bring uniformity to machine design, performance, and operations • Standards were also intended to promote public safety and economic growth	• Rash of boiler accidents caused ASME to assume standards responsibilities in this field • Broad engineering expertise has led ASME to produce standards in all areas of machine design	• ASME has over 120 committees producing standards • Draft standards are reviewed by the Council on Codes and Standards and 10 ASME Technical Boards • ASME distributes draft codes to concerned parties to achieve consensus • ASME is a founding member of ANSI and submits its standards for that organizations approval	• DOT, EPA, OSHA, NRC and DoD have incorporated or referenced ASME standards • State agencies have also adopted ASME code into their regulations	• ASME standards not subject to recent challenge • Hydrolevel case focused on conflict-of-interest by ASME volunteers in interpreting standard to harm competitor	• ASME is currently establishing international chapters • Has signed agreements of cooperation with engineering societies in UK, Japan, PRC, and other countries

EXHIBIT 1 (Continued)

COMPARISON OF SELECTED INDUSTRY STANDARDIZATION PROGRAMS

Standardization Organization	Genesis of Program	Evolution of Program	Procedural Mechanisms	Relationship to Government Agencies	Legal Aspects	International Aspects
Manufacturers Standardization Society (MSS)	• MSS formed in 1910 by pipe and fitting manufacturers • First standards were pipe interface requirements • In 1924 standards activities broadened to include product quality issues	• MSS produces standards for tests and materials of industry products • Covers 23 distinct pipe, valve, and fitting areas of technology	• MSS has 23 technical committees • Proposed standards are voted on by ballot • The MSS Coordinating Committee reviews standard for consistency and format, then issues it for publication • MSS is an ANSI member but has only one standard included in American National Standards	• MSS standards are used for regulatory and procurement purposes by DoD, DOT and OSHA • Of 56 MSS standards, 19 are DoDISS-listed	• MSS has not faced antitrust litigation regarding its standards	• An MSS member serves as chairman of ISO TC-153, General Purpose Valves
Electronics Industry Association (EIA)	• EIA was founded in 1924 to promote electronic parts interchangeability through standards	• EIA's standards-writing scope has widened over time as electronic technology has advanced • EIA technical standards address issues concerning testing, design, and interface requirements for electrical and electronic systems • Standards are produced by EIA in nine different categories	• EIA has 275 technical committees working on standards • Committees have members from user groups, manufacturers, and sometimes government to ensure a balance of interests • A consensus approach is used to develop and review all standards • EIA is a member of ANSI and submits its standards to review when deemed appropriate	• EIA works with DOT, DoD and FCC on standards-related issues • Federal regulations reference and adopt many EIA standards	• Through its ballot and appeals process, EIA has avoided antitrust litigation	• EIA is a member of IEC • Some 50 EIA standards have been adopted internationally
Institute of Electrical and Electronics Engineers (IEEE)	• IEEE established in 1884 • Formed as a professional society promoting electrotechnology • Wrote first industry standard in 1890	• Group now writes standards in all areas of electrotechnology • Standards topics cover 30 areas, including computers, communications, and electronics • Has over 600 active standards	• IEEE is a founding member of ANSI • Has six-step standards development method to ensure technical rigor and consensus • Not all IEEE standards are submitted to ANSI for approval	• IEEE has worked with DoD, DOT, NASA, and DOC • Standards are used in procurement specifications and cited in regulations • 35 IEEE standards have been adopted by DoD	• IEEE standards are voluntary • Follows consensus process to preclude antitrust actions	• IEEE is active in ISO and IEC • Seven IEEE standards have been adopted by ISO

EXHIBIT 1 (Continued)

COMPARISON OF SELECTED INDUSTRY STANDARDIZATION PROGRAMS

Standardization Organization	Genesis of Program	Evolution of Program	Procedural Mechanisms	Relationship to Government Agencies	Legal Aspects	International Aspects
Underwriters Laboratories (UL)	• UL was established in 1894 • Produced testing standards for commercial electrical products • Standards written to promote consumer product safety	• UL develops testing standards for many different types of consumer products • UL lists over 2,000 standards	• UL is an ANSI member and employs consensus process; however, not all UL standards are submitted to ANSI • Proposed standards are reviewed by manufacturers, trade organizations, and UL committees staff • Representatives of industry, government, and academia sit on Engineering Councils to review draft standards	• UL works closely with DoD, USCG, OSHA, and CPSC • UL code is incorporated or referenced by Federal regulations	• Manufacturers voluntarily submit their products to UL testing • NIST may act as arbiter if test results are questioned	• UL is involved with ISO and IEC • Has reciprocal agreements with foreign standards groups
American Bureau of Shipping (ABS)	• Association founded in 1862 • Published first rules for vessel design and construction by 1891	• ABS has become a classification agency that certifies vessels or structures as being fit for intended service • Goal is protecting life and property at sea through standards • Standards are promulgated to improve structural and mechanical integrity of ships • Standards have evolved from wooden ship rules to modern maritime applications	• ABS sets standards through 18 technical committees • Membership is a cross-section of the shipping industry • Classification involves a comprehensive, four-step process • ABS is an ANSI member but does not publish standards through ANSI	• ABS has a particularly strong relationship with USCG, with ABS personnel serving as inspectors • ABS rules form part of USCG regulations • ABS also works with USDA, DoD, and Department of Interior	• ABS is authorized by government to perform inspections, surveys, and other duties • Federal authorization to perform certain duties has prevented antitrust litigation	• ABS is authorized by 90 governments worldwide to administer safety conventions • ABS has 15 overseas committees ABS • ABS is involved with the International Maritime Organization of the U.N.

VOLUNTARY INDUSTRY STANDARDS
AND THEIR RELATIONSHIP TO GOVERNMENT PROGRAMS

RESEARCH CONTACTS

- American National Standards Institute (ANSI)
  Marilyn Hernandez (212) 642-4915

- American Society for Testing and Materials (ASTM)
  Laurel O'Brien (215) 299-5400

- American Institute of Aeronautics and Astronautics (AIAA)
  James French (202) 646-7439

- Aerospace Industries Association (AIA)
  Lisa Balay (202) 371-8464
  Don Calvert (202) 371-8462

- Society of Automotive Engineers (SAE), Air and Space Division
  Sandy Dillner (412) 776-4841
  Bill Wagner

- Society of Automotive Engineers (SAE), Land and Sea Division
  Aleita Wilson (412) 772-7158

- Truck Trailer Manufacturers Association (TTMA)
  Richard Bowling (703) 549-3010

- American Petroleum Institute (API)
  Lisa Hofmann (202) 682-8147
  Jim Creer (214) 748-3842

- American Society of Mechanical Engineers (ASME)
  David Soukup (212) 705-7397
  Karen Ciciora (212) 605-8738

- Manufacturers Standardization Society of the Valves and Fittings Industry (MSS)
  Olen Thornton (703) 281-6613

- Electronics Industry Association (EIA)
  Cecilia Fleming (202) 457-4900

RESEARCH CONTACTS (Continued)

- Institute of Electrical and Electronics Engineers (IEEE)
  - Terry deCourcelle (908) 562-3807
  - Michelle Curtis (908) 562-3823

- Underwriters Laboratories (UL)
  - Otilie Moll (516) 271-6200 x550

- American Bureau of Shipping (ABS)
  - Tom Tucker (212) 839-5000
  - Steve Arnston
  - Glenn McGuill

VOLUNTARY INDUSTRY STANDARDS
AND THEIR RELATIONSHIP TO GOVERNMENT PROGRAMS

BIBLIOGRAPHY OF WRITTEN SOURCES

American Institute of Aeronautics and Astronautics. The Future of Aerospace Standards. Washington, D.C., 1990.

American Bureau of Shipping. History of the American Bureau of Shipping. New York, N.Y., 1991.

American National Standards Institute. Procedures for the Development and Coordination of American National Standards. New York, N.Y., 1987.

American Petroleum Institute. Report to the Membership. Washington, D.C., 1991.

American Society of Mechanical Engineers. The Why and How of Codes and Standards. New York, N.Y., 1983.

American Society for Testing and Materials. 1990 Annual Report. Philadelphia, PA, 1990.

Breitenberg, Maureen A. "The ABC's of Standards-Related Activities in the United States." Washington, D.C.: U.S. Department of Commerce, National Bureau of Standards, May 1987.

Burgess, John. "Competing in A Diverse Market: U.S. Firms Seek Unity on Product Standards in Europe," in Washington Post, December 2, 1991, p. A6, p. A1.

Electronics Industry Association. Manual of Organization and Procedure. Washington, D.C., 1989.

Federal Trade Commission, Bureau of Consumer Protection. Standards and Certification: Final Staff Report. Washington, D.C., April 1983.

French, James E. "Standards Affect the Pace of International Business," in Aerospace America, October 1991, pp. 52-4.

Greenblatt, Sandra P. "American Society of Mechanical Engineers, Inc. V. Hydrolevel Corp.: Vicarious Liability Equalizes the Treatment of Business Enterprises and Nonprofit Associations Under Antitrust Laws," in 38 University of Miami Law Review 741, July 1984, pp. 741-68.

Hamilton, Robert W. "Prospects for the Nongovernmental Development of Regulatory Standards," in American University Law Review, 455 Winter 1983, pp. 455-69.

Hemenway, David. Industrywide Voluntary Product Standards. Cambridge, MA: Ballinger, 1975.

Institute of Electrical and Electronic Engineers. A Guide to IEEE Standards Development. New York, N.Y., 1989.

BIBLIOGRAPHY OF WRITTEN SOURCES (Continued)

Klayman, Elliot. "Standard Setting Under the Consumer Product Safety Amendments of 1981 -- A Shift in Regulatory Philosophy," in 51 George Washington Law Review 96, November 1982, pp. 96-112.

Los Angeles Times, June 22, 1991, Section D, p. 2.

Martin, Albro. Railroads Triumphant. Oxford: Oxford University Press, 1992.

Manufacturers Standardization Society. Information Brochure. Vienna, VA, 1992.

Pearse, James N. "U.S. Participation in International Standards Activities: ANSI Testimony Presented to the National Institute of Standards and Technology of the U.S. Department of Commerce," in Standards Engineering, May/June 1990, p. N/A.

Putnam, Hayes and Bartlett, Inc. Impact of Private Voluntary Standards on Industrial Innovation. Volume I: Final Report. Prepared for National Bureau of Standards, Washington, D.C., January 1983.

Reddy, N. Mohan. "Voluntary Product Standards: Linking Technical Criteria to Marketing Decisions," in IEEE Transactions on Engineering Management, Vol. EM-34, No. 4, November 1987, p. 236-43.

Reddy, N. Mohan and Cort, Stanton G. "Industrywide Technical Product Standards." in R & D Management, 19, 1, 1989, pp. 13-25.

Rosenberg, Ernest S. "Standards and Industry Self-Regulation," in California Management Review, Fall 1976, pp. 79-90.

Society of Automotive Engineers. Cooperative Engineering Program. Warrendale, PA, 1988.

Stremba, Henry J. "The Home That Standards Built," in ASTM Standardization News, June 1988, p. 56.

Sullivan, Charles D. Standards and Standardization: Basic Principles and Applications. New York: Marcel Dekker, Inc., 1983.

Swankin, David A.: How Due Process in the Development of Voluntary Standards Can Reduce the Risk of Anti-trust Liability. Washington, D.C.: National Institute of Standards and Technology, 1990.

Truck Trailers Manufacturers Association. TTMA Publication Brochure. Alexandria, VA, 1992.

Underwriters Laboratories. Testing for Public Safety. Northbrook, IL, 1990.

U.S. Congress, Office of Technology Assessment: Global Standards: Building Blocks for the Future. TCT-512. Washington, D.C.: U.S. Government Printing Office, March 1992.

BIBLIOGRAPHY OF WRITTEN SOURCES (Continued)

U.S. Department of Commerce, National Institute of Standards and Technology. Research. Services. Facilities. Washington, D.C., date N/A.

U.S. Department of Defense. DoD Directive 4120.20, "Development and Use of Non-Governmental Specifications and Standards," March 28, 1988.

U.S. Office of Management and Budget, "Circular No. A-119 Revised," Transmittal Memorandum No. 1, October 26, 1982.

APPENDIX

ANALYSIS OF SPECIFIC INDUSTRY STANDARDS PROGRAMS

This appendix provides a summary description of specific standard-setting and standard-coordinating organizations in the aerospace, automotive, petrochemical, consumer electronics, and maritime industries. It includes a discussion of the genesis of the standards programs, and delineates key factors that have led to standardization in that particular industry. This analysis also examines the procedural mechanisms that control standards development, shows the relationship of standards organizations to government agencies, discusses the legal aspects of standards formulation, and examines each standards program in its international context. This review is based on discussions and data collected from the organizations listed below:

- American National Standards Institute (ANSI)
- American Society for Testing and Materials (ASTM)
- Aerospace Industries Association (AIA)
- American Institute of Aeronautics and Astronautics (AIAA)
- Society of Automotive Engineers (SAE), Air and Space Division
- Society of Automotive Engineers (SAE), Land and Sea Division
- Truck Trailer Manufacturers Association (TTMA)
- American Petroleum Institute (API)
- American Society of Mechanical Engineers (ASME)
- Manufacturers Standardization Society of the Valves and Fittings Industry (MSS)
- Electronics Industry Association (EIA)
- Institute of Electrical and Electronics Engineers (IEEE)
- Underwriters Laboratories (UL)
- American Bureau of Shipping (ABS)

The appendix begins with an examination of the American National Standards Institute (ANSI), which serves as an umbrella group that oversees the standard-setting work of other technical and trade organizations. ANSI differs from the other standards organizations reviewed here, in that it does not concern itself with specific lines of research or the technical content of standards it approves. Instead, it devotes its efforts to administration of the overall development process.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI is a privately operated nonprofit organization that coordinates standard-setting work in the United States. ANSI provides the framework and process through which standards developers may conduct research and validation, but does not itself engage in the technical formulation of codes. ANSI accredits qualified organizations to develop standards using methods that are intended to ensure due process and consensus among interested parties. Once approved by ANSI, standards become part of the American National Standards, the body of code promulgated through ANSI's voluntary-consensus system. In 1990, over 1,300 American National Standards were approved, with ANSI standards program

expenditures of $2 million for national activities and $5 million for international efforts. ANSI presently consists of approximately 1400 institutional members representing industry, government, labor, as well as technical and trade organizations. ANSI funds itself through membership fees and the sale of standards documents.

Genesis of Program

ANSI was established in 1918, a time of expanding industrialization, by a group of engineering societies (including ASME, ASCE, and IEEE) interested in establishing an institutional apparatus for drafting standards. Originally organized as the American Engineering Standards Committee, the group set out to promote and facilitate the use of technical standards by industry. In 1928 the committee was reorganized as the American Standards Society, and opened its membership to include corporations, trade associations, and government agencies. Up until the 1960s ANSI actually devised standards itself, but by 1969 the emphasis had become the coordination of other organizations, standards development process, and the organization was rechartered into its present form.

Evolution of Program

A number of elements have played significant roles in the evolution of ANSI as it stands today. Early on, it was recognized by the technical professions that standardization would be vital to commerce and manufacturing, as well as the safety and welfare of the public. The primary concern was to promote standardization without stemming innovation. From the outset, the breadth of work conducted by ANSI members placed an emphasis on the administrative responsibilities of the organization. Coordinating the standards research of such diverse groups as the electrical engineering and marine engineering communities underscored the importance of developing an approval system. In the late 1920s, when ANSI membership was opened to include technology users and industry, it became an explicit organizational goal to develop standards that would not be unduly burdensome to any one business. Until the 1960s ANSI played the dual role of standards developer and administrator, with ANSI staff conducting technical studies and performing management duties. With its growing and increasingly sophisticated membership, ANSI realized that technical expertise resided with its constituent organizations and withdrew from standards creation. ANSI then devoted itself to developing techniques for promoting and administering a consensual and voluntary standards regime.

Procedural Mechanisms

As a coordinating organization, ANSI provides a process through which standards are developed. At the center of the ANSI process is the concept of consensus. Proposed standards are comprehensively reviewed by parties that have expertise and interest in the field. ANSI provides a forum through which differences among the membership are resolved and comments are incorporated. ANSI initiates its process upon request from a member organization conducting work in specific standardization issues. Standards developers seeking ANSI approval must be accredited through ANSI as meeting the requirements of the consensus process. A standards developer may be accredited to use one or more of the following methods to establish consensus:

- The *Accredited Standards Committee* consists of individuals representing a cross-section of industry concerned with similar standards. All committees

have a Secretariat or other overseeing body, which is responsible for coordination within the committee. Members of the committee write and vote on a standard, which is then sent to ANSI for approval.

- The *Accredited Organization* is a multi-member group with standards procedures established and approved internally. These organizations have their own committees, which are created to address specific proposals for new standards and are open to affected members of the industry. The committee devises a standard, and submits it for internal approval, after which it becomes an organizational standard (such as an SAE standard). The organization then sends the standard to ANSI for review, publication, and approval, at which point it becomes an ANSI standard (such as an ANSI/SAE standard). Standards which are approved in this manner are known as American National Standards.

- The *Accredited Sponsor for Canvass* method is used for smaller scale efforts. A person or group (producers, users, general public) concerned about an issue can seek approval to develop a standard. The person or group becomes an accredited ANSI sponsor and must then develop a canvass list of those parties (organizations, committees, other standards developers, individuals, etc.) affected by the standard and interested in participating in its development. In a process with many iterations, the sponsor writes the standard and sends it to members of the canvass list who review the standard and return it to the sponsor, which incorporates the comments and sends it out again. When a final draft has been approved by the participants, the sponsor sends it to ANSI for approval and publication.

Once a standard has been approved by the developing organization, ANSI must give its approval in order for the standard to become an "American National Standard." Upon receipt of the standard, ANSI publishes an announcement about the standard in its magazine *Standard Action*. ANSI ensures that all comments received from that announcement, as well as comments received by the developing organization, have been properly addressed. In granting approval for a standard, ANSI does not look at the standard itself, but rather examines the process through which it was developed. Development of a standard may take from two to four years.

As part of its coordinating responsibilities, ANSI helps standards developers avoid the problem of drafting standards that conflict with others already approved. It also endeavors to preclude duplication of effort by separate groups working in the same discipline. The objective of this management activity is to increase efficiency in the overall standard-setting process. Much of this coordination work is done by ANSI's Executive Standards Council.

Reporting directly to the Executive Standards Council are the Standards Boards, which have primary responsibility for standards activities within ANSI for given industrial sectors. Among their functions, Standards Boards monitor the work of standards developers, review and assess applications for new standards work, coordinate research to avoid duplication of effort, accredit new standards developers, and provide supervisory support to ensure that all standards work is consistent with ANSI practice. Members of Standards Boards include standards users such as companies and regulatory agencies, academic organizations, standard developers, and other groups that have demonstrated interests in a standards topic.

Standards Boards, designed to represent a "balance of interests," are the mechanism through which conflicts are resolved.

Relationship of Program to Government

Government involvement with ANSI has become extensive over the years as standards have become increasingly important to public safety and commerce. Sixteen Federal agencies or departments presently are members of ANSI, including the Departments of Defense, Energy, and Housing and Urban Development; the National Aeronautics and Space Administration; and the National Institute of Standards and Technology. Government representatives serve on ANSI boards such as the Government Member Council and the Board of Directors. In addition, Government/ANSI coordinating committees have been established to provide a forum for discussing governmental standards activities and interests. The Occupational Safety and Health Administration and the Consumer Product Safety Commission have been especially involved in this area.

Government agencies will often request ANSI to work on specific standards issues. ANSI reviews such requests to determine if the request is cogent and if the topic already has been addressed. If ANSI determines that work on the topic is needed, ANSI-accredited technical committees commence with the research.

ANSI-approved standards have been adopted or referenced by government agencies in the areas of safety, health, public welfare, transportation, communications, procurement, and cost-reduction measures. An increasing number of ANSI-sanctioned standards are being included in the Department of Defense Index of Standards and Specifications (DoDISS).

Legal Aspects

The ANSI system of standards development has been devised with the intent of minimizing the possibility of antitrust litigation against ANSI, it's constituent members, and standards developed through ANSI's approved process. Since ANSI accredits its standard-setting membership, it assumes legal responsibility for litigation concerning those standards which have been approved as American National Standards. In turn, in order to receive and retain ANSI accreditation, a member organization assumes certain responsibilities, including accurate recordkeeping of its standards activities, conformance to ANSI-approved standards review and response procedures, provision of active support and maintenance of standards once developed, and review of standards for technical accuracy at least once every five years. ANSI provisions stipulate that failure to comply with any of these requirements is cause for revocation of ANSI endorsement. The comprehensive nature of the ANSI consensus process is illustrated by the fact that ANSI-sanctioned standards have rarely been challenged in court.

International Aspects

ANSI's involvement in the international standards community occurs primarily through its membership in two non-treaty organizations, the International Standardization Organization (ISO) and the International Electrotechnical Commission (IEC). Through its United States National Committee (USNC), ANSI is the main U.S. representative to these organizations. ANSI delegates in the ISO and IEC include technical and administrative personnel, drawn largely from ANSI-member organizations, who represent U.S. interests in dealing both with content and procedural standards issues. ANSI's influence in U.S. standards community derives largely from its central role in international standards activities.

ISO was founded in 1946 as a federation of standards organizations from 86 countries. ANSI was one of the founding members, and has been active in the ISO efforts to develop, coordinate, and promote international standards. There have been 7,400 ISO standards published to date in all fields excluding electrical and electronic engineering.

IEC was formed in 1906 and develops international standards relating to electrical and electronics engineering. There are 44 national committees within IEC, and 32 technical committees and subcommittees. ANSI participates in some manner in over 95 percent of the technical committees of the ISO and IEC.

In addition to these two primary standards bodies, ANSI participates in several other standards organizations:

- The European Committee for Standardization (CEN) and the European Committee for Electrotechnical Standardization (CENELEC) are the European private sector organizations that have been charged by the European Commission with the task of standards development within the European Community (EC).

- The European Organization for Testing and Certification (EOTC) is the private sector organization responsible for issues relating to conformity assessment.

- The Pacific Area Standards Congress (PASC) offers non-European Community nations a forum to enhance their ability to participate in ISO/IEC activities relevant to Europe. ANSI is an active member in PASC.

- The Pan American Standards Commission (COPANT) coordinates and promotes South American standards. ANSI has just renewed membership in COPANT.

- ANSI also maintains a cooperative relationship with the European Telecommunications Standards Institute (ETSI).

- ANSI has signed a cooperative agreement with the Chinese Association for Standardization of the People's Republic of China, in the interest of exchanging official publications and promoting frequent technical consultations.

- The ANSI federation has entered into agreement with the Japanese Industrial Standards Committee (JISC) and the Japanese Standards Association (JSA), to encourage access to standards, testing, and certification processes.

- ANSI currently has strong ties to the Canadian Standard Association (CSA) and is exploring similar relationships with Mexican standards organizations.

In order to establish closer ties to the EC and to participate more fully in European standardization activities, ANSI in 1989 launched its EC'92 program; a key element of which was the establishment of an ANSI office in Brussels. This office publishes *ANSI Global Standardization Reports*, which provide U.S.industry with the most up-to-date information on European standards, testing, and certification. A major effort of ANSI has been to strongly encourage U.S. industry to fully cooperate in the process of international standards development.

U.S. companies conducting business in the international arena are facing issues of standardization on various fronts. Procedural as well as technical problems will need to be addressed. For example, sterilization of health care products has emerged as an area of technology in need of international standards. An ISO Technical Committee (ISO/TC-198) has been formed to deal with this issue, and representation of U.S. interests are being coordinated through ANSI. In terms of procedural issues, ANSI continues to promote its standards-development methodology on the international stage through publications, seminars, and conferences.

STANDARDS-SETTING ORGANIZATIONS

American Society for Testing and Materials (ASTM)

Genesis of Program

The American Society for Testing and Materials (ASTM) is a nonprofit organization with the objective of serving as a management system for the development of standards in a wide variety of industries and disciplines. ASTM members work voluntarily to conduct research and prepare standards under the auspices of the organization. ASTM is a founding member of ANSI and promotes the consensus method of setting standards. As a standards-setting organization, ASTM directly guides research and takes responsibility for the technical aspects of its standards, whereas ANSI provides only the standards approval process for independent standard-writing organizations. ASTM has membership of 33,000 individuals and organizations in academia, business, and government. Close to 85 percent of ASTM's funding comes from the sale of publications, primarily including standards documents. The balance comes from annual administrative fees levied against members. In 1990, ASTM had an operating income of over $21 million and expenditures of over $19 million in areas that include publication of standards and standards technology training.

Founded in 1898 as the U.S. section of an international organization, ASTM set out to address problems with materials performance in industrial applications. Specifically, failures in railroad components and equipment such as rails, wheels, and axles were evidence that steel producing methods in the U.S. were not adequate. To ensure materials uniformity, a coherent

system of testing was needed. It was agreed that the best way to accomplish this objective was through standard specifications. By 1913, ASTM committees were conducting work in the areas of corrosion, protective coatings, lubricants, and petroleum products. ASTM presently does standards research and development in virtually every technical field ranging from health care services to electronics.

ASTM feels that its philosophy of retaining technical expertise within its organization facilitates the standard-development process and is the primary distinguishing feature between itself and ANSI. ASTM further believes that the most effective way of achieving true standards consensus is through a system that actively guides, encourages, and performs the technical research. As a result, ASTM formed a subsidiary organization in 1987. The Institute for Standards Research was founded to identify, develop, and manage areas of research on topics as diverse as medical and dental implants to classification schemes for advanced ceramics.

Evolution of Program

ASTM evolved in direct response to the realization by technical professionals and industry that standards were required to regulate commercial and industrial expansion. Up until the late 1950s ASTM had concentrated its efforts in the traditional areas of engineering and industrial applications. By this time, however, public interest in safety, health and environmental issues provided the impetus for ASTM to establish technical committees covering consumer products, energy resources, environmental testing, waste recovery, and other non-traditional fields. These committees have produced a broad array of standards, from ambulance crew training requirements to specifications for protective clothing.

Procedural Mechanisms

In response to the basic principle of voluntary consensus standards in the U.S., ASTM has developed a standards process based on the following tenets:

- Participation of all parties interested in the use and/or development of a standard;
- Balanced representation of interests during the standards-writing process;
- Extensive testing to validate technical results; and
- Due process procedures and balloting to allow for broad involvement and input during standards review.

Applying these tenets, ASTM produces standards of six different types:

- *Standard Test Method*: A definitive procedure for operations that yield test results.
- *Standard Specification*: A statement of requirements to be satisfied by a material, product, system, or service.

- *Standard Practice*: A definitive procedure for operations that do not yield test results.

- *Standard Terminology*: A document that defines nomenclature and symbols.

- *Standard Guide*: Options or instructions that do not specify a course of action.

- *Standard Classification*: A systematic arrangement of materials, products, systems or services into groups.

A standards activity is initiated when a written request is submitted by a member to ASTM headquarters. This request should describe the proposed action and list parties that might have an interest it. ASTM then conducts a review to determine if the activity is within ASTM's purview, if there is adequate interest in the action, and if parallel activities are being conducted by other organizations. Once these basic requirements have been satisfied, the process may continue as follows:

- A series of conferences is held to define the scope, title, and structure of the new standards. All interested individuals and organizations that can reasonably be identified are invited to participate in this step.

- A new committee may be formed to conduct the work or an existing ASTM committee may be given the responsibility. A committee must receive ASTM Board of Director approval for a standard's title and scope before work continues. A committee must have a balanced membership (i.e., users, producers, academia) to insure that all interests are served.

- The technical committee submits the work to one of its subcommittees. These subcommittees, which are intended to represent the highest degree of technical expertise, are further subdivided into task groups.

- A task group will prepare a draft standard, which is then reviewed by the governing subcommittees through letter ballots. Subcommittee approval leads to main committee review, also by letter ballot.

- Upon main committee approval, the draft standard is submitted to ASTM for further balloting. Dissenting votes must include reasons for the voter's objections, which must be directly addressed by the standards developer before the draft can go on in the process.

- Once consensus has been reached, the ASTM Committee on Standards verifies that proper procedures were followed and due process was achieved. Only with this final approval can an ASTM standard be published.

ASTM publishes its standards in the *Annual Book of ASTM Standards*. Standards remain under the jurisdiction of the originating technical committee, which is responsible for keeping it technically current. Generally, a standard will take two years to develop, but some have been produced in eight months to a year.

Relationship of Program to Government

ASTM has had working relationships with a number of Federal as well as state government agencies. At the state level, ASTM has assisted various departments of transportation in areas such as pavement management technology and bridge service life improvement techniques. At the Federal level, ASTM has worked closely with the EPA, OSHA, the Consumer Protection Safety Commission, DOE and DOT. ASTM has produced standards for groundwater quality and radon levels that have been incorporated by EPA. DOT often cites ASTM standards for roadway construction and materials, and DOE has worked with ASTM in the development of standards for geothermal energy since 1979.

Legal Aspects

ASTM procedures have been devised to preclude violation of antitrust laws. However, a complaint was filed in 1964 against ASTM in the Philadelphia U.S. District Court contending that testing requirements for asbestos cement piping restricted entry into the United States market. After a 78-day trial and review, the judge's opinion stated that ASTM's "procedure [makes] it most unlikely that the views of one member or group of members could predominate over the consensus of the opinion of the committee as a whole." This decision established a precedent that has helped preserve the integrity of ASTM standard against subsequent legal challenges, none of which have been successful, according to ASTM.[32]

International Aspects

Notwithstanding the organization's international origins, ASTM has been involved primarily with standards activities in the U.S. As international standards have become increasingly important, however, ASTM has taken the position that direct U.S. industry involvement in ISO and IEC is essential for U.S. products to remain competitive in foreign markets. ASTM further believes that the most effective way of promulgating international standards is through a consensus methodology as practiced by itself and other U.S. standards organizations. Despite philosophical differences between the organizations, ASTM maintains membership in ANSI in an effort to promote its interests and standards on the international stage. Having organizational standards incorporated as part of ANSI National Standards is often a direct, although not the only route to international acceptance, and is a primary reason that ASTM continues to submit some of its standards to ANSI for approval. ASTM members serve on ISO and IEC technical committees and a number of ASTM standards have been adopted by these organizations in electronics testing and materials evaluation.

AEROSPACE AND AVIATION INDUSTRY

Three associations that develop standards for the aerospace industry were reviewed. Each addresses different aspects of the industry. The Aerospace Industries Association (AIA) concentrates its standards efforts in the field of aircraft fasteners. The American Institute of Aeronautics and Astronautics (AIAA) primarily focuses on standards relating to equipment interfaces, software requirements, and operational characteristics of primarily space systems. The Society of Automotive Engineers (SAE), Air and Space Division does work in a wide

[32]Unnamed case cited in Stremba, Henry J.: "The House That Standards Built." ASTM Standardization News, June 1988.

variety of areas including: materials, equipment requirements, calibration, and fuels to name but a few.

Aerospace Industries Association (AIA)

Genesis of Program

AIA was founded in 1919 by members of the nascent aircraft industry to promote American aviation. Originally, AIA published standards in a wide variety of fields relating to aircraft production and operations. Guidelines were set for manufacturing processes, aircraft electrical systems, and components design. In 1940, AIA's focus shifted to aircraft fasteners when companies within the industry identified the need for standards for aeronautical bolts, screws, and rivets. This move was driven by the need to establish consistent methods of defining aircraft airworthiness (to which fasteners are critical), and fostering economic efficiency in aircraft manufacture.

Evolution of Program

Since aviation's earliest days, most aircraft manufacturers have been dependent on outside vendors to provide fasteners for their aircraft. Historically, a major problem had been that the quality and capabilities of these fasteners had varied significantly from vendor to vendor, making it difficult for airplanes to meet design specifications consistently, or forcing manufacturers to buy fasteners from only one predictable source. The industry wanted to remedy this situation by applying standards to fastener design and manufacture. In 1940, AIA began its standards work in fasteners. At first, the standards were mostly dimension specifications and materials requirements, but as the technology evolved, standards topics expanded to include composites, high temperature adhesives and other areas. Today, most of AIA's work involves aircraft, but some of its areas of research are applicable to spacecraft design. Specifically, a recent AIA standard on robotics manufacturing, "NAS 875, Industrial CNC for Drilling, Reaming, and Counter-sinking" may be of direct use in future large scale production of spacecraft components.

Procedural Mechanism

Members of AIA sit on the association's Standards Committee. The Committee conducts ongoing studies to define new standards that may be needed. A request for a standard from this Committee, users, or manufacturers is sent to the Steering Committee for review. Once approved, a sponsor is assigned responsibility for writing and drawing up the new or revised standard. The sponsor is a committee member who has volunteered or has been appointed for this duty. Once finished, the standard is sent back to the Steering Committee for comments and approval. After the standard is approved by the Committee, it is sent to the checker, an individual responsible for ensuring that all AIA procedures are met, that all comments have been addressed, and that calculations have been done properly. After the final approval by the checker and the Steering Committee, the standard is issued for publishing and distribution.

Although AIA is a member of ANSI, AIA standards are not submitted to the ANSI approval process. AIA's position is that its internal standard-setting procedures are sufficient to ensure consensus and technical validity. AIA maintains membership in ANSI to stay abreast of international standards efforts in the field of aerospace fasteners.

Relationship of Program to Government

AIA's involvement with the Federal government has been primarily through DoD and the FAA. Approximately 500 AIA standards are currently listed on DoDISS for procurement purposes, including codes for fasteners, aircraft control knobs, and aircraft tubing and cables. FAA has referenced or incorporated AIA standards covering life vests, oxygen masks, and other commercial aviation technologies. AIA standards are often developed in close cooperation with Federal agencies. Special liaison groups within AIA have members from both industry and government to coordinate lines of standards research of common interest. In this way, manufacturers are better able to respond to specific needs identified by Federal agencies.

Legal Aspects

In the early stages of standards setting, AIA experienced legal problems with trademarks. Products which met AIA standards were labelled as such with an AIA trademark. AIA was involved in several antitrust lawsuits because AIA was approving the quality of certain producers, and thus recommending their products over those of others. As a result of this experience, AIA currently does not maintain any list of qualified parts (those produced by a specific group of manufacturers). AIA is very aware of the need to remain strictly a standards-setting group, and not involve itself in certifying specific companies. Additionally, AIA adheres closely to its consensus method of setting standards. It actively encourages feedback during the standard development process to afford all concerned parties the chance to influence the final product.

International Aspects

AIA is an active participant in international aircraft standards efforts. Presently, AIA serves as ISO Secretariat for Aircraft Fastener Standards, which gives it great influence in this area. AIA also has a close working relationship with the European Association of Aerospace Manufacturers (AECMA), a French-based international organization involved in aircraft issues. AECMA members include major European aircraft manufacturers like Airbus, and it is in AIA's interest to present its position on fasteners and other issues in this forum because these foreign aircraft manufacturers often employ AIA standards.

American Institute of Aeronautics and Astronautics (AIAA)

Genesis of Program

AIAA was established over 60 years ago to promote engineering and scientific research in aviation and space. Its origins as an engineering society closely associate it with that academic discipline, but AIAA also has worked extensively with the aerospace industry to enhance productivity in that field.

AIAA began its standards program in 1981 with the intent of assisting engineers, scientists, and other aerospace professionals with accurately identifying and defining the characteristics of space systems and components. Standards developed by AIAA establish common nomenclature, performance parameters, equipment interface specifications, and design practices in areas ranging from metrication (the adoption of the metric system) to human factors. The AIAA presently spends approximately $300,000 per year on its standards activities.

Evolution of Program

In the early 1980s, senior AIAA officials recognized the need for greater efficiency in design and research efforts with regard to space applications of aerospace technologies. It was felt that the best way of achieving "economy of effort" in this area was through a comprehensive standards program. Such a program would help further AIAA's organizational goals of anticipating space technology trends, creating and disseminating technical information, and helping to formulate national aerospace policy. By 1981, using the ANSI methodology, AIAA had produced its first standard on terminology for space structures. In 1987, AIAA's standards program was fully accredited by ANSI and the organization began its standards work in earnest. To date, AIAA has produced 10 space standards documents in software (2), hardware (3), and other areas (5), including coordinate systems, atmospheric environments, and design approaches. Ten additional standards are presently in process with 7 due for publication in the spring/summer of 1992.

Since the beginning, AIAA has concentrated its standards-setting efforts on space issues to avoid duplicating the work of other organizations with aircraft standards programs. This role has come as a result of negotiations between AIAA and other aerospace standards organizations such as SAE and AIA. As these groups' standards developing efforts broaden, however, areas of standards responsibilities will need to be re-examined and clearly defined to avoid redundant work.

Part of AIAA's mission in formulating standards is to anticipate technical developments and needs, a goal which is accomplished through the input of AIAA's membership. This kind of professional advice often leads to development of special reports such as "The Future of Aerospace Standards" and "Orbital Debris Mitigation: Technical, Legal and Economic Aspects," which in turn may lead to important standards research. Anticipatory standards research is, of course, influenced by industry and government interests, but is not wholly dependent upon it. For example, cancellation of the Orbital Maneuvering Vehicle (OMV) program was a blow to space robotics research, but standards work continues within AIAA in this area of technology.

Presently, AIAA has 50 active standards projects, with 33 Committees on Standards (COS) and study groups doing work in astrodynamics, reliability, serviceable spacecraft, and other areas. It is expected that these numbers will increase as new areas of research are identified.

Procedural Mechanisms

AIAA conducts its standards-setting efforts in conformance with ANSI-approved methods. First, a need is identified, then study groups meet to evaluate possible standards and topic areas. The process of developing a standard begins with a call to members and an announcement in AIAA's magazine, *The Standard Bearer*. A new committee is organized for each new standards topic. Those interested parties who are able to commit themselves to long-term participation become members of the committee. Standards-developing committees are composed of members of industry, Federal agencies, and academia. While it is not necessary for the members of the individual committees on standards to be AIAA members, the committee chairperson must be.

A Committee on Standards' first task is to write the scope of the proposed standard. This scope must be submitted to and approved by the Standards Technical Council, a standing group appointed based on their technical expertise. A major portion of the scope is a justification outlining the need for the new standard, to whom it will apply, what exactly it will entail, and how it will be implemented. The committee does not actually begin discussion of the proposed standard until the scope has been approved.

Committees on Standards are required to meet at least twice a year, though some committees meet more often. The committees must also provide that some of their meetings be open to the public for input. When the committee has met several times, and feels it is ready to distribute a draft of the standard, a written document is first circulated to the committee itself, and then to the membership of AIAA. The draft is also announced in *The Standard Bearer*. Comments from review materials are returned to the committee, and the document must be edited to reflect all comments. This cycle may be repeated several times before the committee is satisfied with its standard document.

Once the committee has finalized its document, it is sent back to the Standards Technical Council, which is responsible for ensuring that all comments have been adequately responded to, and that consensus was reached during the development of the document. If the standard is to be produced solely as an AIAA standard (common for reference directories or other non-technical documents), AIAA will publish it. If it is to be an ANSI standard (all technical documents), it is sent to ANSI for a 90-day review, during which ANSI ensures that all of its requirements have been met. The standard is then published as an ANSI/AIAA standard.

Relationship of Program to Government

While AIAA has worked with several Federal agencies on specific technical topics, cooperative standards work has not been extensive due to the relative youth of the group's standards program. Two AIAA standards have been adopted by DoD for procurement purposes ("Standard for Aerodynamic Decelerator and Parachute Drawing," and "Guide to Standard and Reference Atmosphere Models") and a third is referenced in the licensing examination for parachute packers. No AIAA standards have yet been incorporated into Federal regulatory requirements.

At present, FAA and AIAA jointly are involved in standardization work in satellite navigation for aircraft. This developmental research is collaborative in nature (not under contract) and is proceeding through AIAA's Committee on Standards for Guidance, Navigation and Control as part of its scheduled work program.

Legal Aspects

As part of its requirements for ANSI accreditation, AIAA must conform to the consensus methodology. To date, there have been no challenges to AIAA standards. However, as standards begin to prescribe specific design approaches and operational practices, the prospect of such challenges increases. Already, AIAA's standards committees are expanding their work with special studies and project research in areas such as "Standards Requirements for a Future Multi-Mission Infrastructure" and a "Guide for Unit Interface Design for Serviceable Spacecraft." While advancing efficiency, interchangeability, and commonality in future space-related operations, these standards and others like them may be perceived by some as commercially constraining.

International Aspects

AIAA maintains active membership in the International Standardization Organization (ISO). The focus of ISO's space standards work, and AIAA's primary involvement in that organization, is through Technical Committee 20, Aircraft and Space Vehicles (ISO/TC-20). In 1989, TC-20 created a working group to specifically assess space standardization needs. AIAA representatives are members of this group, as are participants from France, Germany, Italy, and the former Soviet Union. France has been particularly interested in promulgating international space standards because of its lead role in the European Space Agency (ESA). French government and industry leaders feel that commercial opportunities can best be promoted through the clear definitions and methodologies that standards provide. Present international standards efforts include work in space data systems; other areas under consideration for standardization research are manned space flight and space debris issues.

Society of Automotive Engineers (SAE), Air and Space Division

Genesis of Program

SAE has its origins in the early years of the automotive industry. In 1905, automotive manufacturers, engineers, and others involved in this new industry established the Society of Automotive Engineers to promote standardization and to generally nurture the field of transportation technology. To the founders of SAE, "automotive" was defined as "anything that moves on the earth, under the earth, in the water, on the water, and in the air." In 1916

SAE acted to fulfill this broad charter by expanding to include the Society of Aeronautic Engineers, which became SAE's Aeronautic and Aircraft Engine Divisions. From the beginning, their responsibilities were centered on developing standards for aircraft parts and performance.

Evolution of Program

The Aeronautics Division became very active in developing standards upon the United States entry into World War I. Specifications and standards were required for military aircraft and SAE became involved in setting code for everything from aircraft bolts to instruments. By 1921 the division was producing aeronautical material specifications, propeller standards, and aircraft accessory specifications. The organization went on to develop an Aeronautical Drafting Manual to establish uniform methods of presenting visual data, the first such standard in the industry.

SAE's standard-setting activities kept pace with advancing aircraft technology so that the organization was soon developing standards for helicopters, jet engines, and avionics. The evolution of aeronautical technology to include space systems has led to SAE's efforts in spacecraft and satellites, including standards for hardware and software. At present there are over 1,600 aerospace standards listed by SAE with approximately 130 new and revised documents issued in 1991. SAE has budgeted almost $2 million for fiscal year 1992 for its aerospace standards program. Examples of standards presently listed by SAE Air and Space are "Automatic Pilots for Subsonic Aircraft" and "Actuation System Data for Launch and Missile Vehicles."

Procedural Mechanisms

SAE Air and Space Division is organized under the Aerospace Council which reports to the Technical Board. Beneath these two governing bodies are some 160 committees and subcommittees that have primary responsibility for writing standards. These groups and their 6,000 members operate under clearly defined guidelines requiring due process and consensus during the standards development process.

When a request for a standard has been made by a concerned party (manufacturer, user, or government agency) the issue is assigned by the governing councils to a standing committee with responsibility for that area. Committee expertise ranges widely and includes electromagnetic compatibility, aerospace metals, fiber optics, and rocket reliability and certification to name but a few. The committee researches the subject and prepares a standard through the consensus method. Parties that might be affected by the standard are allowed to comment on the results before a proposal is finalized. When a final version of the proposed standard is ready, it is sent to the parent committee for review and, ultimately, to the Aerospace Council for approval. SAE Air and Space Division publishes different standards types, including recommended practices and aerospace information reports all of which are prepared following the requirements for due process and consensus that form part of the conditions for membership in ANSI.

Relationship of Program to Government

SAE Air and Space maintains active relationships with a number of government organizations to coordinate standardization and research efforts. DOT, FAA, NASA and DoD

have worked extensively with SAE in the past. For example, over 40 FAA Technical Standing Orders (TSOs) were originally developed by SAE technical committees, and SAE has been requested by FAA to produce or update technical documents on such topics as "Aircraft Engine Containment." At present over 260 SAE standards are listed on DODISS as procurement specifications. As a further sign of the close working link between government and SAE, NASA and the Air and Space Division recently co-sponsored a space standards needs assessment workshop at the Johnson Space Center.

Legal Aspects

SAE submits all of its aerospace standards for ANSI recognition, and over the last year some 300 Air and Space-developed codes have completed the ANSI process and have been listed as American National Standards. SAE governing councils review standards extensively to resolve potential legal difficulties before final approval is granted. By adhering to strict due process and consensus procedures, SAE seeks to avoid antitrust litigation, to this point successfully.

International Aspects

SAE Air and Space Division is the administrator of the U.S. advisory group to ISO Technical Committee 20 - Aircraft and Space Vehicles. It also serves as secretariat for two ISO subcommittees on "Air Cargo and Ground Equipment" and "Aerospace Fluid Systems and Components." A number of SAE aerospace standards are under consideration as de facto standards by ISO. These activities along with the direct links that SAE has to international aerospace standards organizations, such as the European Association of Aerospace Manufacturers (AECMA) and the European Organization for Civil Aviation Electronics (EUROCAE), ensure that U.S. standards interests are represented abroad.

AUTOMOTIVE INDUSTRY

This section focuses on two standard-developing organizations in the motor vehicle industry. The primary standard-setting group for passenger automobiles is the Society of Automotive Engineers (SAE), whose standards cover every aspect of this field, from design to performance. The Truck and Trailer Manufacturers Association (TTMA), which has been included to represent the trucking industry, develops standards related to the design and construction of truck trailers.

Society of Automotive Engineers (SAE), Land and Sea Division

Genesis of Program

As stated in the previous section covering SAE's Air and Space Division, the organization was originally founded in 1905 with a focus on automotive technology and issues. The society was established to meet the needs of engineers within the fledgling automotive industry rather than within a specific engineering discipline. The intent was to bring together mechanical, civil, and electrical engineers working in the automotive field, as well as manufacturers and suppliers, to define, through standards, the design and performance of their industry's products.

Evolution of Program

SAE's first official standards committee was appointed in 1910. The 13 divisions comprising this committee immediately set out to produce standards that would optimize automotive design and mass production. Parts interchangeability, simplified production processes, and dimensional standards were some areas in which this SAE committee directed its efforts. By 1913, SAE published its first handbook on standards which included subjects ranging from "navigation motors" to "yoke and eye rod ends."[31]

Over the years SAE's standard-setting activities have broadened to accommodate the ever-widening spectrum of technologies applied to ground transportation. Currently, SAE Land and Sea Division's 600 technical subcommittees produce over 100 new ground vehicle standards per year and list a total of 1100 standards dealing with components and systems for passenger cars, truck tractors, buses, and motorcycles. Some examples of SAE Land and Sea Division automotive standards are "Passenger Car Side Door Latch Systems" and "Motor Vehicle Seat Belt Assembly Installations."

Procedural Mechanisms

As with Air and Space standards, SAE Land & Sea Division standards are also devised under the auspices of the SAE Technical Board. The primary difference between the two divisions is the make-up of their constituent technical committees. Land and Sea Division is comprised of five separate groups, four of which are responsible for different areas of ground transportation technology including: construction, agricultural and off-road machinery, motor vehicles, trucks and buses, and miscellaneous technology development. These councils are further broken down into some 600 committees and subcommittees which cover such areas as human factors, powertrains, fuels and lubricants, and braking systems. The fifth group in the Land and Sea Division is responsible for marine standards. The Marine Technical Committee devotes itself to standards for pleasure craft only. This differs from the American Bureau of Shipping, which covers commercial, military, and civil marine applications, and which will be discussed in detail in a later section.

The process of formulating a standard within SAE Land and Sea Division begins when users, manufacturers, or other relevant organizations and individuals identify the need to standardize some aspect of automotive technology. When the request for a standard is received, it is reviewed by the governing technical board and then sent down to the appropriate parent committee. From here, it is directed to the subcommittee that oversees the specific technology covered by the standard request. This subcommittee conducts the research and writes the standard proposal. The proposal is then sent back to the parent committee and the Land and Sea Council for review and approval. It is the responsibility of these last two groups to ensure that due process and consensus procedures have been followed. SAE produces standards of various types for ground vehicles. Recommended practices, materials specifications, technical information reports, as well as design and performance standards are generated to provide guidance in virtually every aspect of ground vehicle fabrication and function. As with the Air and Space Division, Land and Sea Division submits its standards to ANSI review.

---

[31] Rumbaugh, Max E.: "SAE Takes Equal-Partner Approach to Standards Development." ASTM Standardization News, July 1991.

Relationship of Program to Government

SAE Land and Sea Division has a strong relationship with a number of Federal agencies that include DOT, the Federal Highway Administration, the National Highway Traffic Safety Administration, DOE, DOD, and NIST. Approximately 150 SAE vehicular standards are cited by various U.S. government regulatory agencies, and 30 standards are listed on DODISS for procurement purposes. Types of standards incorporated by the government range from procedures for collision tests to requirements for sealed beam headlamps. Worthy of particular note are the 80 some SAE technical reports that have been incorporated into NHTSA Federal Motor Vehicle Safety Standards. These requirements, which cover such topics as driver's visual range guidelines and vehicle seating definitions, and the fact that government representatives are active members of SAE's Motor Vehicle Council, illustrate the close working link between Federal agencies and the Land and Sea Division of SAE.

Legal Aspects

SAE Land and Sea Division makes every effort to ensure that consensus is achieved when formulating its voluntary standards. Every major committee maintains at least one staff member to monitor potential legal problems with proposed standards and to make certain that all questions of a legal nature are adequately addressed. Also, SAE's membership in ANSI places upon it the requirement to meet the stringent consensus procedures of that organization. To date, over 500 SAE automotive standards have been approved by ANSI as American National Standards.

International Aspects

SAE maintains connections to the international automotive community by various means. Through its ANSI membership, SAE has representatives on four ground vehicle councils in the ISO, including TC 22 (Road Vehicles), TC 70 (Internal Combustion Engines), TC 96 (Cranes and Related Lifting Equipment), and TC 127 (Earthmoving Machinery).

SAE maintains direct links to such organizations as the International Symposium on Automotive Technology and Automation (ISATA) and the International Automotive Society of France (SIA). In this manner, SAE identifies international trends and innovations in the automotive arena and ensures its participation in multi-national efforts to devise technical standards.

Truck Trailer Manufacturers Association (TTMA)

Genesis of Program

TTMA, incorporated in 1941, is an industry-based professional association that publishes recommended practices for the construction and design of truck trailers. Member companies aid in development of these recommendations. TTMA uses the term "recommendations" rather than standards because the recommendations rely on voluntary compliance and often cover procedural issues (e.g., how to respond to a situation) rather than equipment specifications. With the onset of World War II, manufacturers realized there would be a large government allocation of materials and resources to the industry and formed TTMA to generate an interest in the industry as well as to provide guidance to both the manufacturer and the end-user of truck trailers.

Evolution of Program

Through the late 1940s and 1950s, the U.S. became increasingly dependant on automotive travel. By 1956, with the enactment of the Interstate and Defense Highway Act, it was clear that motor vehicles had become the preeminent mode of travel. As more freight was moved by truck along the growing Interstate Highway System, the industry took steps to provide manufacturers and users with recommended practices and guidelines relating to the operation, manufacture, and performance of truck trailers. The TTMA published and continues to promulgate its recommendations to reflect industry-wide technical advances made by the manufacturers. TTMA is comprised of truck trailer, tank trailer, cargo container, and container chassis fabricators. Examples of TTMA-recommended practices include, "A Guide for Periodic Inspection of Trailers," "Air Brake Application and Release Test," and "Tank Trailer Ladders and Walkways."

Procedural Mechanisms

Through its recommendations TTMA hopes to provide guidance for manufacturers and users, rather than to direct or prescribe technology. A part of its primary functions is to provide a forum and an information clearinghouse for the industry. TTMA guidelines and practices are the result of extensive manufacturer involvement in the standards development process.

Recommendations are established through two engineering committees composed of TTMA members. One committee covers tank trailers and the second covers all other types of trailers. These committees propose and draft recommendations. After final approval by the committee, recommendations go through two or three rounds of review by member companies before being reviewed by the TTMA Board of Directors. Once approved by the Board, a proposal is published as a recommended practice of TTMA and distributed to its members. Since all TTMA recommendations are voluntary, manufacturers do not have to abide by them. TTMA is not a member of ANSI, but it maintains an SAE liaison committee to keep apprised of that organization's truck and trailer-related standards.

Relationship of Program to Government

TTMA maintains links to various offices within the Department of Transportation including the Office of Hazardous Materials Transportation (OHMT) and the National Highway Traffic Safety Administration (NHTSA). TTMA recommendations can be found referenced in Federal regulations. For example, TTMA's "Procedure for Testing In-Service Cargo Tank Manhole Covers" is cited in 49 CFR 171.7.

Legal Aspects

The voluntary nature of TTMA's recommendations has shielded the group from antitrust litigation to date. The guidelines themselves are broad enough to provide latitude in the approach to design. TTMA's practices are meant to be only a basis for industry cooperation.

International Aspects

TTMA maintains an informal relationship with ISO to keep abreast of international trailer standards activities. TTMA also has as members trailer manufacturers and suppliers from Canada, France, The Netherlands, and Germany, which provide it with greater international perspective and visibility in this field.

PETROCHEMICAL INDUSTRY

The petrochemical industry, which manufactures products from oil distillates and byproducts, produces fuel products, and refines petroleum for various uses, depends extensively on special equipment to conduct its business. This section discusses three standard-setting organizations that develop standards to regulate this equipment. It should be noted that the standards of all three organizations are frequently applied to other industries that use similar equipment. The American Petroleum Institute (API) develops work practices and management guides in addition to hardware standards. In this manner, it tries to cover industry procedures as well as equipment requirements. The American Society of Mechanical Engineers (ASME) concentrates its standards efforts in equipment design and performance test code. The Manufacturers Standardization Society (MSS) specifically develops standards for valves and fittings.

American Petroleum Institute (API)

Genesis of Program

API was established in 1919 as a trade association to represent the interests and address the concerns of the oil industry. At the turn of the century, widening use of oil and oil-based products by the U.S. commercial, transportation, and industrial sectors caused oil producers to realize that achieving uniformity in their production processes was in the interest of business and the public. Safety and economic efficiency could be increased through oil industry cooperation and, with these goals in mind, API was formed. API began setting standards in 1923 to fill gaps in technical knowledge related to oil production. Accidents during drilling, refining, and other operations had caused deaths and injuries that might have been avoided if equipment had been of a guaranteed level of quality. To address this

problem, API began to write standards for pipes, materials, and fittings associated with oil production.

Evolution of Program

As oil production equipment and procedures became more complex and sophisticated, the scope of API standard-setting efforts broadened to include operational guidelines, standard safety procedures, and performance requirements for these systems.

At present, there are over 400 API standards, ranging from alloy requirements for pipes to performance standards for high pressure transmission lines. Not only do such standards ensure safety during operations, but they lower industry costs. Without such industry-wide standards, each producer would be forced to develop specifications for their own equipment.

Procedural Mechanisms

As a member of ANSI, API follows procedures to ensure consensus when developing its standards. API issues standards for all types of equipment used in the petrochemical industry through committees composed of professionals in various fields related to the industry. Ideas for standards may come from industry or government representatives. Industry members may feel it is necessary to standardize certain equipment or practices and suggest to the relevant API committee that a standard be developed. Various government agencies have contacted API committees to develop standards for given situations. For example, both DOT and OSHA have asked API to develop pipeline standards to be used in safety regulations. These codes have been on such topics as welding procedures and valve design.

A suggestion for standardization is presented to the appropriate committee within API. A working group of eight to ten members drafts a proposed standard, which is submitted to a full subcommittee for balloting. Members of the subcommittee either approve, approve with comments, or disapprove the proposal. The working group then revises the proposal, taking all of the comments into account. If, because the comments are extensive, the proposal is drastically changed, a resubmission to the committee might be required. Upon acceptance by the subcommittee, the proposal is submitted to the main committee for final review. In addition to legal reviews, health, safety, and environmental reviews may be required before final approval. The standard is then submitted for formal publication but does not take effect until it has been issued. API-recommended practices are reviewed every five years or sooner if new technology requires their modification.

An example of a standard published by API is "Specifications for Subsurface Sucker Rod Pumps and Fittings," providing dimensional requirements to assure interchangeability of all component parts. API also develops guidance (e.g., for inspection of refinery equipment) and recommended practices (e.g., for electrical installation at petroleum processing plants).

API standards are voluntary, and it is the responsibility of the purchasers of the equipment to ensure that the manufacturer has complied with API recommendations. The exception to this is the API Monogram Program. This quality assurance program ensures that manufacturers worldwide can consistently manufacture production equipment and materials to API specifications. When a company initially applies for API certification, third party auditors

conduct an on-site inspection of the facilities. API's professional staff reviews the audits and decides whether to issue the license. Licensed manufacturers undergo an unscheduled on-site review after one year, and then every three years. Noncompliance may be dealt with in a number of ways, ranging from recommendations for changes to immediate revocation of API certification.

Relationship of Program to Government

API has worked with many Federal agencies on standards issues over the years. Government organizations such as EPA, DOT, OSHA, USCG, and the U.S. Geological Survey have adopted some 70 standards into regulations. These include specifications for oil storage tanks, pipe transmission systems, and construction requirements for off-shore drilling rigs. These standards have been used in procurement specifications and in regulations at the Federal level. Some 30 states also have adopted API codes into law.

Legal Aspects

Legal reviews are conducted during the development of all API standards. As a preventative method, draft proposals are screened to reduce the likelihood that antitrust or other legal issues might be raised against API standards. For example, the use in a draft standard of any trade names that have become used commonly throughout the industry would be removed -- the word "teflon" would be removed and replaced with its scientific name. Additionally, API makes every effort to develop standards based on industry consensus. To date, as an ANSI member, this approach has precluded antitrust action against API.

International Aspects

API is currently working to have many of their standards adopted by the ISO. API committee members sit on ISO committees through ANSI's U.S. National Committee to provide the standards API has already developed to that organization and aid in the development of new international standards. If such efforts are successful, those firms doing international business can operate without the higher costs associated with increased inventories necessary when standards differ among countries.

American Society of Mechanical Engineers (ASME)

Genesis of Program

ASME is a nonprofit professional society with the goal of promoting mechanical engineering and technological progress in terms of machine design and construction, power generation, and production programs as they apply to industry. Areas in which ASME conducts research include energy resources, the environment, transportation, materials and structures, and manufacturing.

In 1884, four years after the Society was founded, ASME began its standards program. At the time, machine design, performance, and operation lacked uniformity, making it difficult for industry to specify and purchase equipment to suit its needs. ASME organized committees that included research engineers, product manufacturers, and product users in an attempt to "balance" the standards development process. It was clear that coherent standards would be the only way of regulating the operation and quality of the technology that was being introduced into late-19th Century American society.

As part of its responsibilities, ASME has established a standards-development program with the purpose of fostering economic growth and public safety. ASME is a founding member of ANSI and endorses the use of voluntary standards. Currently ASME has over 600 codes and standards in print, all of which have been developed using the consensus process. Examples of ASME code that are part of ANSI National Standards include safety codes for elevators and escalators, the boiler and pressure vessel code, and the B-31 piping code. These last two codes are used extensively in the petrochemical industry.

Evolution of Program

Concern for public safety was a driving force behind the evolution of ASME's standards program. The proliferation of steam boilers in the late 1800s brought a wave of accidents that forced industry and government to act. By the 1880s, 50,000 deaths and 2 million injuries were being reported per year due to exploding boilers. In response to public calls for action, states began to formulate boiler codes. At the same time, insurance companies eager to limit accident settlements were also writing and implementing boiler codes. The resulting confusion brought all the concerned parties to the conclusion that a single entity should assume the role of standards developer. ASME assumed this role and published its first formal pressure vessel code in 1915.

Since then, ASME has produced standards in a wide variety of mechanical engineering fields. These areas include quality assurance methods for nuclear power plants, specifications for machine designs such as compressors and pumps, and recommended testing practices for various industrial systems.

Procedural Mechanisms

The ASME Board of Governors has delegated all activities concerning standards and codes to its 20-member Council on Codes and Standards. The Council oversees the work of 10 boards which cover the areas of primary ASME standards activities. These boards work in such areas as pressure technology, safety, performance test codes, metrication, and include a group specifically dedicated to international standards issues.

Reporting to the boards are over 120 committees which are directly responsible for a specific technology from piston rings to drawing requirements. These committees and their subcommittees are where standards are actually devised. Once a final draft has been completed the standard is sent up through the ASME echelons. Once consensus has been achieved, and upon the recommendations of the ASME Supervisory Board and ANSI, the standard is submitted to public comment. When all issues have been addressed satisfactorily and in accordance with ANSI/ASME protocol, the draft is approved as a standard and published.

Relationship of Program to Government

Because of ASME's broad expertise and experience in developing standards, many Federal and state agencies have incorporated and referenced ASME code. DOT, EPA, DoD, OSHA, NRC, and others presently use such ASME standards as: "Nondestructive Testing" (CFR 29), "Cast Iron Flanges and Flanged Fittings" (CFR 49), and the "Pressure Vessel and Boiler Code" (CFR 10) in procurement specifications as well as regulations.

States have also incorporated ASME code into their regulations. At present, every state except Alabama, New Mexico, and South Carolina has adopted at least one section of the ASME Pressure Vessel Code. In some cases, ASME representatives have been authorized by the state to conduct inspections and surveys to confirm compliance with the law.

Legal Aspects

As a member of ANSI, ASME strictly adheres to the tenets of consensual standards development, and takes active steps to preclude litigation against itself and its standards. If legal issues were to arise, however, ANSI would serve as a buffer between ASME and legal actions. In recent history, no litigation has been initiated against ASME standards. However, ASME was included in the Hydrolevel case (see footnote 29) in which ASME committee member interpreted ASME standard to commercial detriment of a competitor.

International Aspects

ASME has established an Advisory Board dedicated to promoting international cooperation in standards development. Working both independently and through ANSI, this group is taking such steps as signing agreements of cooperation with engineering societies in the United Kingdom, Japan, the People's Republic of China, and other nations. Another of ASME's current major international initiatives is the establishment of ASME chapters outside of North America.

Manufacturers Standardization Society of the Valves and Fittings Industry (MSS)

Genesis of Program

In 1910, the Committee of Manufacturers on Standardization of Valves and Fittings formed to help foster development of codes for valves, value activators, flanges, and other pipe-associated technology. As industry expanded its use of piping, it became evident that pipe manufacturers were designing and building valves and fittings of widely varying quality and dimensions. In order to promote business and efficiency, many of these manufacturers joined together to write interface standards. In 1924, the committee was formally reorganized as the MSS and began to broaden its standards-setting activities.

Evolution of Program

As a trade association, MSS has been interested in developing standards that would promote use of their products. The best way of accomplishing their goal has been to establish levels of quality and performance that would consistently satisfy customer needs. The MSS standards program reflects the need to include test procedures and materials requirements in the manufacture of valves and fittings. This need arose from failures of equipment which resulted in steam pipe and liquid transport pipe accidents at the turn of the century. Presently, MSS works in 23 distinct areas of pipe, valve, and fitting technology, and has produced 56 standards.

Procedural Mechanisms

MSS is comprised of 23 technical committees identified by the specific subject matter of the committee responsibilities. The committees are made up of professionals in various fields related to the industry. A proposal is submitted to the Coordinating Committee of the Board of Directors describing the proposal, justification, and the scope or breadth of the standard. At its next quarterly meeting, the Coordinating Committee determines the need for the proposed standard. If there is a sufficient amount of interest or need for the type of standard proposed, it is assigned to the appropriate technical committee for development.

The technical committee then develops the proposed standard. Committee members send their ballots to the Executive Director, who tallies the votes. The committee chairman is provided with all comments against the proposal. The committee must then work out a compromise. Upon final approval by the committee, the MSS coordinating committee receives the proposal and reviews the proposals for consistency with the standards of other agencies and Federal regulations. Standards are then published and provided to member companies. Standards published by MSS include: "Pressure Testing of Steel Valves" and "Techniques and Specifications for Piping Hangers and Supports."

MSS standards are voluntary and it is up to the purchasers of the equipment to ensure that the manufacturer has complied with MSS recommendations. Although MSS is an ANSI member, only one of its standards has been submitted for ANSI approval.

Relationship of Program to Government

MSS standards have used by various Federal agencies through citation or incorporation in regulations and procurement specifications. Of the 56 MSS standards, 19 have been adopted by DoD for procurement purposes. Other U.S. government agencies that have referenced MSS codes include DOT and OSHA. Examples include "MSS SP-44, "Steel Pipe Line Flanges" and MSS SP-75, "Specification for High-Test Wrought Welding."

Legal Aspects

MSS consults extensively with user organizations in developing its standards. By making recommendations to potential purchasers, and taking their comments and concerns into consideration, MSS feels that it can adequately meet user needs while maintaining economic manufacturing practices. MSS has not yet faced antitrust litigation resulting from its standardization activities.

International Aspects

MSS takes an active role in promoting U.S. industrial interests in international forums. The U.S. serves as secretariat of ISO's Committee on General Purpose Values (TC 153) and an MSS representative serves as committee chairman. Society members have also served on many ISO working groups and subcommittees addressing valve, pipe, and fittings issues.

ELECTRONICS INDUSTRY

In this section, three standard-setting organizations are examined with respect to their role within the electronics industry. The Electronics Industry Association (EIA) produces standards for electronic components such as tubes and transistors. The Institute of Electric and Electronics Engineers is a professional association that develops standards that cover electronics performance, reliability, safety, and design. The last electronics organization surveyed, Underwriters Laboratories (UL), primarily concerns itself primarily with standards for electronic product performance, testing, and safety.

Electronics Industry Association (EIA)

Genesis of Program

EIA was founded in 1924 by users and manufacturers of commercial electronics parts. This group was established to promote electronic parts interchangeability, and write component specifications within the growing radio and commercial electronics business. Although not initially a professional society per se, early involvement with the electrical and electronic engineering discipline ensured the technical rigor of all EIA standards and specifications.

Evolution of Program

EIA's standards activities have expanded markedly over the years as the scope of electronics technology has broadened. The evolution of EIA closely mirrors the evolution of technology: from tube, resistor, and capacitor specifications, to transistor requirements and, most recently, to work in fiber optics. In response to specific changes in hardware, EIA has formed groups to address standards issues in those areas. Additionally, the ever-increasing complexity of electrical and electronics systems has led EIA to conduct standards work in areas like configuration control, interface requirements, and digital systems synchronization.

EIA has established nine broad categories in which it presently produces standards and other technical publications. These are:

- General
- Consumer Electronics
- Telecommunications
- Component Parts (Passive)
- Solid State Products
- Electronic Displays and Tubes
- Industrial Automation
- Design Automation
- Government Electronics

Procedural Mechanisms

Standards are promulgated through 275 EIA technical committees that have jurisdiction over different sectors of the electronics industry. The committees are composed of members of EIA, user groups, manufacturers, and, in some cases, government representatives. Committee members or the chairperson of a committee may initiate the setting of a new standard. Once there is a consensus on the nature of the standard, the committee prepares a written proposal to be submitted to the EIA engineering department.

The committee submits a statement of the scope of the standards project, a title for the project, and a request for assignment of a project number. After reviewing the proposal, the EIA engineering department assigns a number to the project and contacts organizations or members who will be affected by the development of the standard to allow them the opportunity to participate in the process.

After the proposed standard is assigned a project number, the committee works with EIA staff engineers to develop and write the standard. Once written, the proposed standard is available for review and comment by interested parties for a period of 30 days. If it is deemed appropriate, the document is submitted simultaneously to ANSI for review. It then returns to the committee, which responds to the comments and modifies the proposed standard, if necessary. At this point, it is resubmitted to ANSI and to an EIA executive committee composed of the chairpersons of each technical committee.

If approved by both organizations, the standard becomes an ANSI and an EIA standard. It may then be listed and published by both groups. EIA publishes nearly 1,000 standards and engineering publications, with over 5,000 members participating on EIA

technical committees. EIA submits a standard to ANSI review when it wishes it to be listed as an American National Standards.

Relationship of Program to Government

EIA has had a long working relationship with a number of Federal organizations, including the DOT, DoD, and the FCC. Many of its standards are part of Federal regulations either by reference or direct incorporation. These include various TV channel interference standards for the FCC, mobile communications standards for DOT, and telephone link standards for DoD. Often, EIA-devised standards are adopted or referenced in their ANSI forms. As part of its standards-development process, EIA encourages government participation, but limits government membership on any one technical committee to no more than 10 percent. This measure is taken to ensure the balance that is central to EIA's standard-setting regime.

Legal Aspects

EIA standards are subjected to the system of development prescribed by ANSI. Through its process of balloting and appeals, EIA attempts to address concerns and issues that emerge in developing standards. The overall standards process may take two years and its comprehensive nature allows for dissenting input throughout. Interested parties are therefore offered ample opportunity to comment, with the result being that no antitrust litigation has been initiated against EIA standards in recent times.

International Aspects

EIA is active in standards activities with the IEC. As a member of ANSI, EIA represents U.S. interests in the international commercial electronics arena. EIA encourages its industry members to participate in international standards issues such as interface specifications and parts commonality. To date, over 50 EIA-developed standards have been adopted as international standards.

Institute of Electrical and Electronics Engineers (IEEE)

Genesis of Program

IEEE can trace its roots to 1884 when a number of electrical engineers formed a professional society devoted to the science and technology of electricity, electronics, and allied disciplines. Among the organization's self-defined responsibilities was the setting of standards. In 1890, the group published its first industry standard, proposing the name "henry" for the unit of self-induction. Since that time the organization has committed a significant part of its efforts to standards development. At present, IEEE publishes over 20 percent of the world's standards and literature on electrotechnology.

Evolution of Program

IEEE in its present form was chartered in 1963, when it merged with the Institute of Radio Engineers. This move broadened the scope of IEEE's work to include communications technology. From that point on, IEEE conducted standards research in areas such as broadcast technology, frequency control, and antennas. IEEE now does standards in over 30 fields of the electronics discipline and has expanded its efforts to include new technologies as they emerge. Computers, microwave theory, and superconductivity are areas to which IEEE has dedicated some of its resources. Today, IEEE has over 600 active standards and publishes approximately 60 new ones each year. The group is constantly exploring new areas of electrotechnology to include in its standards efforts. IEEE has over 300,000 members representing industry, government, and individuals interested in advancing all aspects of electrotechnology.

Procedural Mechanisms

IEEE is a founding member of ANSI and actively supports the consensus method of developing standards. The IEEE standards development process is composed of six steps that are meant to ensure involvement of all parties that might be affected by a standard. The need for a standard may be identified by a member of IEEE or by someone outside of the organization.

The proposal for a standard is submitted to the Standards Activity Board, which assesses the merit and need for this standard. If the Board decides that further action is needed, it assigns the proposed standard to a Standards Coordinating Committee. At this level, the scope of the standard is defined, and a Technical Committee assumes responsibility. The Technical Committee establishes a subcommittee to do the technical work. Once a draft is written, it is submitted to a ballot process which entitles dissenting parties to comment. It becomes the Technical Committee's responsibility to either incorporate or otherwise address points brought out during balloting. Once a final version of the standard is prepared, it is submitted to the IEEE Standards Board for review. This group is the approval authority for all IEEE standards and is made up of consumers, government representatives, manufacturers, and other relevant organizations and individuals. Upon approval, the IEEE Publication Board will print and distribute the document.

If a standard is intended to become an American National Standard, submittal to ANSI is required. This may happen in parallel to the IEEE process, or after a standard has been approved by IEEE, depending on which specific ANSI method of approval is chosen.

Relationship of Program to Government

IEEE has been extensively involved with many Federal agencies, including DoD, DOT, NASA, and DOC. Their standards are often cited by or incorporated into regulations and have been used in procurement specifications. Approximately 35 IEEE standards have been adopted by DoD, including "Specifications for Electrical Interfaces," "Standards for Surge Arresters," and "Standards for Electrical Relays."

Legal Aspects

Use of IEEE standards is wholly voluntary. Perhaps reflecting IEEE's effort to ensure that its standards represent a consensus of all concerned interests, legal challenges have not occurred to date. IEEE maintains that it rigorously follows a clearly documented standards-development process and routinely disapproves codes which have not been developed accordingly.

International Aspects

Via its membership in ANSI, IEEE is an active participant in ISO and IEC efforts to formulate international standards. It is often the goal of IEEE technical groups to set standards that will be accepted readily in the international arena. Seven IEEE standards have been adopted by ISO in the field of information processing.

Underwriters Laboratories (UL)

Genesis of Program

UL was established in 1894 by members of the insurance industry to help reduce or prevent bodily injury, loss of life, and property damages resulting from poor design or manufacture of consumer products. UL's primary area of research was in electrical system safety, which applied to the growing number of electrical appliances which were finding their way into consumer homes at the turn of the century. UL pursued its goal of promoting consumer safety in two ways: through testing of products submitted directly by manufacturers, and through preparing "Standards for Safety" that described generic UL requirements for product families.

Evolution of Program

UL has expanded its areas over the years to accommodate the broadening consumer market and the changing public perception of safety needs. In addition to electrical and electronic equipment, UL now investigates mechanical products, building materials, construction systems, fire protection equipment, burglary prevention systems, and marine products.

As government interest in consumer producer issues has grown, many manufacturers have become increasingly eager to submit their products to some kind of neutral validation procedure. As a result, UL has produced safety standards for goods as diverse as drip-type coffee makers and asphalt shingles. UL presently lists over 2,000 standards.

Procedural Mechanisms

UL standards are prepared in accordance with the procedures promoted by ANSI, of which UL is a member. Proposed standards are presented to concerned manufacturers, trade organizations, and UL Engineering Councils for extensive review. To be accepted as an American National Standard, a UL standard must undergo the ANSI approval process. Not all UL standards are submitted to ANSI for approval.

A standard proposal may be initiated by any party interested in the relevant area of research. The proposal is reviewed by the governing UL Engineering Council to determine if

its topic merits further study. If this step is successfully completed, the proposal is sent down to the appropriate Engineering Group where the technical content and format are set.

The UL Engineering Councils are comprised of six major Engineering Departments responsible for broad areas of technology. Those departments are further divided into Engineering Groups which do the actual technical work. When a group completes the development of a standard, it sends it up for review through the Engineering Department and finally to the governing Engineering Council where it is reviewed for adherence to format and process. Representatives of industry, government, and academia sit on the Councils to ensure a broad consensus. Once the review process is completed to the satisfaction of UL, and all dissenting comments have been addressed, the standard will be listed and published. The entire standard-setting process may take as long as two years.

Relationship of Program to Government

UL has had working agreements with various U.S. government agencies for a number of years. DoD, the USCG, OSHA, DOC, and the Consumer Product Safety Commission (CPSC) have all had representatives on various UL committees and have used UL-developed standards in regulations and procurement specifications either by reference or adoption. Examples include fuel line standards for the Coast Guard, hazardous environmental electrical equipment standards for DoD, and the many consumer product standards for the CPSC.

Legal Aspects

UL standards are developed through a consensual procedure that provides for comment by the public, industry and government. An extensive review process ensures that all interested parties are given a forum to voice their concern. It is also important to note that manufactures voluntarily submit their products to UL for testing and if disagreement arises over test results, the issue can be referred to the National Institute of Standards and Technology (NIST) for appeal. NIST will then act as arbiter and have both parties agree in writing to accept and abide by its findings.

International Aspects

In addition to its involvement with ISO and IEC through membership in ANSI, UL has established reciprocal agreements with many foreign standards organizations, including the Standards Association of Australian, the Japan Standards Association, and the Canadian Standards Association. These relationships have been formed to foster harmonized international standards in UL's areas of interest.

SHIPPING

This last section is devoted to examining the standard-developing duties of the American Bureau of Shipping (ABS). This organization is significant because it not only promulgates standards in the shipping industry but also has authorization from the U.S. and some foreign governments to carry out enforcement of those standards. Additionally, ABS has been sanctioned to monitor international and national maritime conventions, and perform other statutory services for various governmental organizations.

American Bureau of Shipping (ABS)

Genesis of Program

The ABS began as the American Shipmaster's Association in 1862, during the clipper ship era. The original intent of the Association was to achieve a high degree of efficiency and character among the free masters and officers of maritime vessels. The Association developed tests to determine their knowledge of nautical science and seamanship. Each applicant found qualified was issued a "Commission of Competency" by the Association.

The Association early on adopted a system for surveying, rating, and registering vessels. By 1891, the Association had published rules for several types of vessels and formed several technical committees that published and edited rules for various types of ship structures. In 1898, the Association changed its name to the American Bureau of Shipping (ABS). Today, the ABS is comprised of ten regional business centers and has 159 offices in major ports and industrial centers in 86 countries.

The goal of the ABS is to promote the safety of life and property at sea by promulgating rules and standards. ABS establishes and administers these rules for the design, construction, and periodic survey of ships and other marine structures. Classification certifies adherence to these rules, thus ensuring that a vessel possesses the structural and mechanical integrity required for its intended service.

Evolution of Program

In the mid-1800s, after a series of marine disasters, the underwriting industry recognized a need for the establishment and administration of safety standards for the design, construction, and maintenance of ships and other marine structures. The response to this need was a nonprofit organization charged with improving the structural and mechanical safety of ships.

The first standards prepared by what would become the ABS were Rules for Building and Classing Wooden Vessels. As technology and industry sophistication progressed, standards were produced in response. The evolution of standards reflects the historical changes in shipping: "Rules for Building and Classing Iron Vessels" (1877), "Rules for Construction and Classification of Boilers for Steam Vessels" (1891), and the recent "Rules for Building and Classing High Speed Craft (1988), which includes provisions for air-cushion vehicles and surface effects ships. Today, ABS publishes 16 different rules and 30 guides,

and works to keep rules and standards current with advancing technology and, where appropriate, develop new ones for emerging technology.

Procedural Mechanisms

ABS develops and upgrades its rules through a structure of 18 technical committees, two panels, and 15 overseas technical committees. Each committee and panel is composed of government representatives, individuals in the underwriting, ship-owning, ship-building, naval architecture, naval engineering, and other related fields.

As a full ANSI member, ABS has representatives on various ANSI-sanctioned standards committees. ABS subscribes to ANSI-approved standards by reference, but as ANSI does not administrate maritime-specific standards, the reverse is not true. Therefore, ABS-developed and published standards remain solely the responsibility of ABS.

In addition to its standards-writing work, ABS has the function of serving as a classification agency for marine structures and equipment. The process of classification certifies that the rules for design, construction, and maintenance have been met and that the ship or structure in question is fit for its intended service. ABS classification involves four steps:

- Technical plan review;
- Construction surveys;
- Acceptance by ABS Classification Committee; and
- Subsequent periodic surveys for maintenance of class.

Upon an initial request that a vessel be classified, the shipyard or design agent presents design drawings and calculations to ABS engineers. A detailed review of the structural and mechanical details is completed to verify compliance with the rules and determine whether the design is suitable for production.

ABS field surveyors then monitor the construction process to verify that the approved plans are being followed, good workmanship practices are used, and rules are adhered to in all respects. ABS representatives witness materials and structures tests as well as the installation of principal mechanical and electrical systems.

When completed, a vessel undergoes sea trials attended by ABS field surveyors and, if the vessel passes this test, its credentials are presented to the ABS Classification Committee. If all of the rules have been satisfied, the vessel is accepted into class and a formal certification is issued.

Once the vessel is in operation, ABS performs periodic surveys to verify that the class standards are upheld throughout its service life. Classification renewal dates are explicit, but a ship operation has three months before and after that date in which to comply with class requirements. If the ship fails to meet ABS specifications, there are two levels of enforcement that may be imposed. The first, suspension of class, means that a ship may operate, but that certain maintenance procedures are required within a specified time period. The second level, cancellation of class, indicates that a ship is no longer fit for service, and may not operate wherever ABS classification is required.

Relationship of Program to Government

ABS and the U.S. Coast Guard (USCG) have had a close working relationship for a number of years. In 1981, by a formal Memorandum of Understanding, ABS was authorized by the USCG to perform plan review and inspection on their behalf for new U.S. flag vessels. USCG regulations (Title 33 and 46 of the CFR) reference ABS codes in 150 different sections. In many cases, the USCG has formally adopted ABS rules as their standard (e.g., 45 CFR Sec. 31.10-1, "Inspection of Hulls, Boilers, and Machinery").

ABS is actively involved with a number of other U.S. government agencies and their programs. These range from the Department of Agriculture (ABS certifies shipboard refrigeration equipment for imported fruit) to the Department of the Interior (ABS classification documents are part of the approval process for offshore drilling from mobile drilling units). DoD requires that commercial-type ships built for its Military Sealift Command be constructed and classified according to ABS rules. The Code of Federal Regulations contains 24 direct references to ABS with respect to agencies other than the U.S. Coast Guard.

The extent of the relationship between the U.S. government and the ABS is further illustrated by the fact that both the Coast Guard Commandant and the Maritime Administration Administrator sit on the ABS Board of Managers. Other government officials are members of ABS rulemaking and management committees.

Legal Aspects

ABS has been given authority by the U.S. government to perform certain functions pertaining to rulemaking, issuance of certificates, inspection and surveys, and other statutory services. For example, under Title 46 of the U.S. Code (Section 3316), ABS is recognized as an agency of the United States to perform classification of U.S. vessels. Further, some sections of the code stipulate that an ABS action constitutes Federal agency action (e.g., 46 CFR Section 91.37-20, concerning cargo gear plans; which indicates that ABS approval constitutes USCG approval). This level of government authorization coupled with the fact that many ABS standards are part of Federal code have precluded antitrust litigation against ABS.

International Aspects

ABS is authorized by more than 90 governments to administer provisions of international safety conventions on their behalf. These agreements, which were established under the auspices of the International Maritime Organization (IMO), include the Tonnage Convention, Load Line Convention, Marine Pollution Prevention Convention, and the Safety of Life at Sea Convention. In this role, ABS conducts surveys, issues certificates, and performs administrative duties for countries that might otherwise not have the expertise or resources to do so for themselves.

The nature of the shipping industry dictates an international perspective. ABS rulemaking technical committees include members from 15 nations that possess extensive technical experience and know-how in the marine sciences. In this way, ABS ensures ship operators and builders that standards and rules are international in scope from their inception.