CHAPTER 3

Codes and Standards for the Built Environment

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Throughout history there have been building regulations for preventing fire and restricting its spread. Over the years, these regulations have evolved into the codes and standards developed by committees concerned with safety. In many cases, a particular code dealing with a hazard of paramount importance may be enacted into law.

HISTORY OF REGULATIONS FOR THE BUILT ENVIRONMENT

King Hammurabi, the famous law-making Babylonian ruler who reigned from approximately 1955 to 1913 B.C., is probably best remembered for the *Code of Hammurabi,* a statute primarily based on retaliation. The following decree is from the *Code of Hammurabi:*

> In the case of collapse of a defective building, the architect is to be put to death if the owner is killed by accident; and the architect's son if the son of the owner loses his life.

Today, society no longer endorses Hammurabi's ancient law of retaliation but seeks, rather, to prevent accidents and loss of life and property. From these objectives have evolved the rules and regulations that represent today's codes and standards for the built environment.[1]

Early Building and Fire Laws

The earliest recorded building laws apparently were concerned with the prevention of collapse. During the rapid growth of the Roman Empire under the reigns of Julius and Augustus Caesar, the city of Rome became the site of a large number of hastily constructed apartment buildings—many of which were erected to considerable heights. Because building collapse due to structural failure was frequent, laws were passed that limited the heights of buildings—first to 70 ft (21 m) and then to 60 ft (18 m).

Later in history there evolved many building regulations for preventing fire and restricting its spread. In London, during the fourteenth century, an ordinance was issued requiring that chimneys be built of tile, stone, or plaster; the ordinance prohibited the use of wood for this purpose. Among the first building ordinances of New York City was a similar provision, and among the first legislative acts of Boston was one requiring that dwellings be constructed of brick or stone and roofed with slate or tile (rather than being built of wood and having thatched roofs with wood chimneys covered with mud and clay similar to those to which the early settlers had been accustomed in Europe). The intention of these building ordinances was to restrict the spread of fire from building to building in order to prevent conflagrations. As an inducement for helping to prevent fires, a fine of 10 shillings was imposed on any householders who had chimney fires. This fine encouraged the citizenry to keep its chimneys free from soot and creosote. Thus was the first fire code in America established and enforced.

In colonial America, the need for laws that offered protection from the ravages of fire developed simultaneously with the growth of the colonies. The laws outlined the fire protection responsibilities of both homeowners and authorities. Some of these new laws were planned to punish people who put themselves and others at risk of fire. For example, in Boston no person was allowed to build a fire within "three rods" (about 49.5 ft or about 15.5 m) of any building, or in ships that were docked in Boston Harbor. It was illegal to carry "burning brands" for lighting fires except in covered containers, and arson was punishable by death. Regardless of such precautions, in Boston and in other emerging communities, fires were everyday occurrences. Therefore, it became necessary to enact more laws with which to govern building construction and to make further provisions for public fire protection. There emerged a growing body of rules and regulations concerning fire prevention, protection, and control. From these small beginnings, various codes and types of codes have evolved in this country, ranging from the most meager of ordinances to comprehensive handbooks and volumes of codes and standards on building construction and fire safety.

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Development of Building and Fire Regulations

The rapid growth of early North American cities inspired much speculative building, and the structures usually were built close to one another. Construction often was started before adequate building codes had been enacted. For example, the year before the great Chicago fire of 1871, Lloyd's of London stopped writing policies in Chicago because of the haphazard manner in which construction was proceeding. Other insurance companies had difficulty selling policies at the high rates they had to charge. Despite these excessively high rates, many insurance companies suffered great losses when fire spread out of control.

The National Board of Fire Underwriters [NBFU; later the American Insurance Association (AIA) and now the American Insurance Services Group (AISG)], organized in 1866, realized that the adjustment and standardization of rates were merely temporary solutions to a serious technical problem. This group began to emphasize safe building construction, control of fire hazards, and improvements in both water supplies and fire departments. As a result, the new tall buildings constructed of concrete and steel conformed to specifications that helped limit the risk of fire. These buildings were called Class A buildings. In 1905 the National Board of Fire Underwriters published the first edition of its *Recommended Building Code* [later the *National Building Code* (NBC)]. This was a first and very useful attempt to show the way to uniformity.

In San Francisco in early 1906, although there were some new Class A concrete and steel buildings in the downtown section, most of the city consisted of fire-prone wood shacks. Concerned with such conditions, the National Board of Fire Underwriters wrote that "San Francisco has violated all underwriting traditions and precedents by not burning up."

On April 18 of that same year, the city of San Francisco experienced a conflagration—started by an earthquake—that killed 452 people and destroyed some 28,000 buildings. Total financial loss was $350 million, which is over $6.7 billion in estimated 2000 dollars. Although the contents of many of the new Class A buildings were destroyed in the San Francisco fire, most of the walls, frames, and floors remained intact and could be renovated (Figure 1.3.1).

Following analysis of the fire damage caused by the San Francisco disaster and other major fires, the National Board of Fire Underwriters became convinced of the need for more comprehensive standards and codes relating to the design, construction, and maintenance of buildings. With this increasing recognition of the importance of fire protection came more knowledge about the subject. Engineers started to accumulate information about fire hazards in building construction and in manufacturing processes, and much of this information became the basis for the early codes and standards.

Several chapters in this handbook have a bearing on the provisions of building codes and their enforcement. Of particular interest is Section 12, Chapter 2, "Building Construction," which contains information on the various types of construction and how they are classified in building codes as a basis for fire protection requirements.

CONCEPTS OF SAFETY VERSUS RISK

There are two broad categories of voluntary codes and standards: (1) safety codes and standards and (2) product standards. These documents are not solely a matter of science, especially safety codes and standards.[2] Codes and standards embody value judgments as well as facts and sometimes must use empirical evidence on judgment to compensate for gaps or limits in the relevant science. (Also see the *SFPE Handbook of Fire Protection Engineering*.[3]) Codes and standards oriented toward safety tend to be more complicated and extensive than product standards.

FIGURE 1.3.1 *The Great Earthquake and Ensuing Conflagration That Devastated San Francisco in 1906*

Furthermore, safety codes and standards are often adopted with the power of law and, thus, require more extensive technical advisory support.

Safety is the inverse or opposite of risk, so greater safety means the reduction or elimination of some risk to people or property or some other vulnerable entity of concern. Risk can never be entirely eliminated, and so safety is never absolute. Even short of absolute safety, any relative increase in safety will not have unlimited value. Individual, organizational, or societal decision makers must decide whether a particular increase in safety (i.e., reduction in risk) is worth more to them than what they must pay in order to achieve that safety increase.

Because financial resources are the most obvious sacrifice required to decrease risk, the trade-off involved is often called "willingness to pay." The lower risk becomes, the more it typically costs to achieve each additional constant increase in safety. In addition, part of the cost of risk elimination is the reduction of freedom. Many aspects of safety systems or materials standards have this effect, as they come to bear on the establishment of an "acceptable level" of risk.

Assessments of levels of risk are also needed with respect to cost of use of the codes and standards themselves, including complex calculations or other costs of information. If tolerance limits are exceeded, codes and standards will be modified in practice or ignored. Also, the more onerous and costly compliance becomes, the more carefully critics will examine the "degree of contribution to a safe environment" that the code or standard will bring about.

The many effects of codes and standards on what people value bring into play an aggregation of complex factors—social, economic, political, legal, business-competitive, and others—that affect how much people value safety and how much they value what may be sacrificed for safety. No solely economic, engineering, or public health approach can do justice to all these factors, many of them unavoidably or even intrinsically subjective.

One of the strengths of the voluntary consensus codes- and standards-development system in the United States is that the deliberative committee structure, which comprises a balanced representation of all affected interests, including users, consumers, manufacturers, suppliers, distributors, labor, testing laboratories, enforcers, and federal, state, and local government officials, can consider all of the diverse factors at hand and develop a consensus on an acceptable level of standardization. It has been observed that "this may be one of the greatest strengths of the present private standards-writing system, insofar as it truly represents variety, and one of the greatest insufficiencies of a governmental system."[4]

ROLE OF CODES IN THE BUILT ENVIRONMENT

A code is a law or regulation that sets forth minimum requirements and, in particular, a building code is a law or regulation that sets forth minimum requirements for the design and construction of buildings and structures. These minimum requirements, established to protect the health and safety of society, attempt to represent society's compromise between optimum safety and economic feasibility.[5] Although builders and building owners often establish their own requirements, the minimum code requirements of a jurisdiction must be met. Features covered include, for example, structural design, fire protection, means of egress, light, sanitation, and interior finish.

There are two general types of building codes. Specification or prescriptive codes spell out in detail what materials can be used, the building size, and how components should be assembled. Performance codes detail the objective to be met and establish criteria for determining if the objective has been reached; thus, the designer and builder are free to select construction methods and materials as long as it can be shown that the performance criteria can be met. Performance-oriented building codes still embody a fair number of specification-type requirements, but provisions exist for substitution of alternate methods and materials ("trade-offs"), if they can be proven adequate.

The requirements contained in building codes are generally based on the known properties of materials, the hazards presented by various occupancies, and the lessons learned from previous experiences, such as fire and natural disasters. The promulgation of modern building codes in the United States began with the disastrous conflagrations that occurred in the late nineteenth and early twentieth centuries.

For a number of years, building codes dealt mainly with structural safety under fire or earthquake conditions. Since then, codes have grown into documents prescribing minimum requirements for structural stability, fire resistance, means of egress, sanitation, lighting, ventilation, and built-in safety equipment. Typically, more than half of a modern building code usually refers in some way or another to fire protection.

Building codes usually establish fire limits or fire districts in certain areas of a municipality. Only specific types of construction are allowed within the fire limits. Such a restriction is said to reduce the conflagration potential of the more densely populated areas. Use of a given type of building construction alone, however, is not necessarily a sufficient guard against conflagration. Outside the fire limits, the restriction of certain construction types is relaxed, due to such factors as decreased building density (i.e., increased spacing between buildings). Unfortunately, as areas outside the fire limits are developed, building density increases and the fire limits frequently must be extended. In addition, without construction restrictions, areas outside the fire limits invite the erection of large buildings despite public protection that is weak or lacking.

Another example of the impact of building codes on fire protection and prevention is the establishment of height and area criteria. The criteria establish the maximum height and area of a particular building, based on its intended use. These requirements have typically varied considerably from one type of occupancy to the next. The types of building construction are important factors in establishing height and area limitations.

Other requirements found in building codes that directly relate to fire protection include (1) enclosure of vertical openings such as stair shafts, elevator shafts, and pipe chases; (2) provision of exits for evacuation of occupants; (3) requirements for flame spread of interior finish; and (4) provisions for automatic fire suppression systems. Exit requirements found in most building codes are based on requirements in NFPA *101*®, *Life Safety Code*®.

Inasmuch as a building code is actually a law, various state and local jurisdictions write their own codes. Because of the complexities of modern building code development, several organizations develop model building codes for use by jurisdictions, which can then adopt the model codes into law.

ROLE OF STANDARDS IN THE BUILT ENVIRONMENT IN THE UNITED STATES

Many requirements found in building codes are excerpts from, or based on, the standards published by nationally recognized organizations. The most extensive use of the standards is their adoption into building codes by reference, thus keeping the building codes to a workable size and eliminating much duplication of effort. Such standards are also used by specification writers in the design stage of a building to provide guidelines for the bidders and contractors.

Numerous NFPA standards are referenced by model building codes and, thus, obtain legal status where these model codes are adopted. Notable examples of such referenced NFPA standards are those that deal with extinguishing systems, flammable liquids, hazardous processes, combustible dusts, liquefied petroleum gas, electrical systems, and fire tests.

The model building codes contain appendices that list standards published by many organizations, including standards-making organizations, professional engineering societies, building materials trade associations, federal agencies, and testing agencies. The appendices are prefaced with a statement indicating that the standards are to be used where required by the provisions of the code or where referenced by the code.

Fundamentals of Voluntary Consensus

The voluntary standards development system in the United States is efficient, cost-effective, highly productive, and results in the promulgation of thousands of quality standards each year. A diverse, decentralized network of private-sector entities develops U.S. voluntary standards. Many different organizations are involved, and this is a feature that is one of the great strengths of the system.

Based on information compiled in 1996, the U.S. standardization community currently maintains approximately 93,000 standards in active status.[6] The number of U.S. standards at any given moment in time, however, is difficult to identify. Today, it is assumed that the number 93,000 is still a relatively valid estimate, since various newly created standards tend to offset a trend of the largest U.S. producer of standards, the U.S. Department of Defense, to retire more standards each year than it generates.

Standards exist for virtually all industries and product sectors. The oldest standards-developing organization in the United States is the U.S. Pharmacopoeial Convention, which published standards for 219 drugs in 1820. Today, the U.S. federal government supports the overall approach used in the United States through Public Law 104-113, which indicates that the federal government will support and (as needed) participate in the development of private, voluntary consensus documents, or if not, then to justify otherwise.

For a variety of reasons, data on the number of standards must be treated with caution. These reasons include (1) uncertainty on whether to consider as a standard a product description, specification, definition of a term, or description of a procedure; (2) the distinction between a single standard with many sections and a series of separate but related standards may be arbitrary; (3) the influence and impact of various standards on the economy can vary dramatically; (4) many documents become technologically obsolete but remain in a technically active status; (5) information on the number of state and local government standards is extremely limited and fragmented; and (6) statistical information typically does not include de facto standards (i.e., unsponsored and unwritten yet usually widely accepted standards, such as the configuration of typewriter and computer keyboards).

The 93,000 standards in the United States generally comprise 49,000 private-sector standards and approximately 44,000 federal government standards. Furthermore, private-sector standards can be further subdivided based on the type of sponsoring organization: standards-developing organizations, scientific and professional societies, and industry associations. Table 1.3.1 provides a summary of this information.[5]

In comparison to most systems, the institutional structure of the U.S. voluntary consensus standards system is highly decentralized. Approximately 700 standards developers exist in the United States, with approximately 620 engaged in ongoing standards-setting activities that are mostly organized around an academic discipline, profession, or a given industry. The remainder of the aforementioned 620 organizations typically have a small number of standards that were developed in the past, which may or may not be occasionally updated.

It is interesting to note that, of the 620 private-sector standards developers in the United States, the 20 largest developers account for a little more than 70 percent of all private-sector development. Table 1.3.2 indicates the number of

TABLE 1.3.1 *U.S. Standards and Their Developers*

	Number of Standards	Percentage
Private Sector		
Standards-Developing Organizations	17,000	18%
Trade Associations	16,000	17%
Scientific and Professional Societies	14,000	15%
Developers of Informal Standards	3,000	3%
Subtotal of Private Sector	49,000	53%
Federal Government		
Department of Defense (DOD)	34,000	37%
General Services Administration (GSA)	2,000	2%
Other	8,000	8%
Subtotal of Federal Government	44,000	47%
Overall Total	93,000	100%

TABLE 1.3.2 *Number of U.S. Standards-Developing Organizations*

	Number of Standards	Percentage
Private Sector		
Standards-Developing Organizations	40	6%
Scientific and Professional Societies	130	19%
Trade Associations	300	43%
Developers of Informal Standards	150	21%
Subtotal of Private Sector	620	89%
Federal Government		
Department of Defense (DOD)	4	1%
General Services Administration (GSA)	1	1%
Other	75	10%
Subtotal of Federal Government	80	11%
Overall Total	700	100%

Note: Numbers are rounded to the nearest 10, except for components of the federal government.

standards organizations by sector for the U.S. standards-development community.[5]

American National Standards Institute (ANSI)

The significant private-sector standards-development system in the United States is largely self-regulated, with oversight and coordination provided by ANSI, a federation of U.S. codes and standards developers, company organizations, and government users of those standards.

Originally known as the American Engineering Standards Committee, its first meeting was held on January 17, 1917, by the following founding organizations: American Institute of Electrical Engineers, American Institute of Mining Engineers, American Society of Civil Engineers, American Society of Mechanical Engineers, and the ASTM. The government Departments of War, Navy, and Commerce were soon involved, along with NFPA and other organizations. One of the first documents that was accepted and registered under the established rules as an "American Standard" was the 1920 edition of NFPA 70, *National Electrical Code®*.

In 1928 the name of the American Engineering Standards Committee was changed to the American Standards Association. This organizational title was used until 1968 when the organization became known briefly as the United States of America Standards Institute (USASI) before adopting the current title of American National Standards Institute.

Organizational membership in ANSI fluctuates, but as of 1996 it is comprised of approximately 265 U.S. professional, technical societies, and trade associations, along with 1100 U.S. companies. ANSI is able to fulfill its coordinating role for the voluntary standards system in the United States because of the support it receives from those actively involved in standards work. NFPA is an ANSI-accredited codes and standards organization, with "audited-designator status," and this results in ANSI accreditation for virtually all NFPA codes and standards. As of 1996, approximately 11,180 standards approved by ANSI were designated as "American National Standards."

ANSI coordinates and harmonizes private-sector standards activity in the United States. In order for a document to be designated an American National Standard, the principles of openness and due process must have been followed in its development, and consensus among those directly and materially affected by the standard must have been achieved. ANSI also represents the interests of the United States in the international standardization activities of the International Electrotechnical Commission (IEC) and the International Organization for Standardization (ISO).

The ANSI arrangement is unique in the ISO/IEC arena, since most countries are represented by a single organization that is either fully or partially funded by that country's national government. The United States, however, is represented by a single private organization (ANSI) that further represents the interests of numerous organizations, including private standards-development organizations (e.g., ASTM, IEEE, NFPA, etc.). This results in a complex legal and business environment involving international copyright.

Further complicating this situation is that U.S. standards developers do not limit their activities to only U.S. constituents and typically have members involved from other countries. It is not unusual for the U.S. representation or secretariats in IEC and ISO standards-developing activities to be true international standards developers in their own right.

Under ANSI procedures, all American National Standards must be reviewed and reaffirmed, modified, or withdrawn no less frequently than every five years—a requirement that ensures that voluntary standards in the United States keep pace with developing technology and innovations. Thus, the voluntary system produces quality standards that do not become outdated.

Standards-Developing Organizations (SDOs) in the United States

Authority and technical expertise in the U.S. standards-developing system is highly decentralized and linked to specific industry sectors. This has evolved based on the development of a wide range of consensus standards processes in many different standards-developing organizations (SDOs). The basic common principles of consensus codes and standards development are, thus, applied in different ways, with procedures and objectives specific to the needs of a particular industry or professional community.

Three types of organizations generally develop standards handled and administered by the private sector, as follows:[7]

Standards-Developing Organizations. These organizations typically have the development of codes and standards as one of their central activities or missions. Membership-oriented codes and standards-developing organizations are the most prominent of these organizations, and they tend to have the most diverse membership among all SDOs, since they are not limited to a particular industry or profession. These membership organizations have a notable number of international members, which is a feature of many U.S. SDOs in general, and makes the U.S. codes and standards-developing system somewhat distinct among the rest of the world. Codes and standards-developing membership organizations, because of their diverse membership, tend to have the strictest due-process requirements. Aside from membership organizations, standards development is also a key activity of certain testing and certification organizations, such as Underwriters Laboratories Inc. or the American Gas Association.

Two examples of standards-developing organizations are ASTM and NFPA, both of which are membership based. ASTM has a membership of approximately 32,000. The 132 ASTM technical committees are responsible for more than 9,900 standards, and approximately one-third of ASTM's sales of standards are to international users. NFPA, for sake of comparison, has about 75,000 members. The 235 consensus technical committees of NFPA are responsible for about 300 safety-oriented documents, which are dramatically fewer than ASTM. This difference in committee structure provides some indication of the distinction between product standards handled by ASTM and safety codes and standards handled by NFPA.

Furthermore, despite NFPA having substantially fewer documents than ASTM and some other standards developers, the total number of pages generated by NFPA (because they are mostly safety-oriented documents rather than product oriented) is often comparable and, in some cases, clearly more. As noted earlier, safety standards tend to be more complex, which leads to greater length.

The number of published standards is not necessarily an absolute indicator of overall activity level or significance, and a vivid example of this concept is the *Boiler and Pressure Vessel Code* administered by ASME. Although it is considered a single standard, it is approximately 12,000 pages in content and far exceeds the size of almost all other standards that are more commonly only several pages in length. In a similar fashion, any of the model building codes and similar safety-related documents for the built environment far exceed most other standards in terms of page count.

In fact, neither numbers nor page counts are as valid indicators of impact as would be numbers of users by document and numbers of lives and dollars affected, but both of these measures are very hard to develop.

Scientific and Professional Societies. These societies are a refined form of membership organizations that support the practice and advancement of a particular profession. The most recognized of these societies involve the engineering disciplines. A unique characteristic of these societies is that the participants, as part of their standards-development processes, typically function as individual professionals and not as specific representatives of their sponsoring organization or industry.

Prominent examples of scientific and professional societies include the American Society of Mechanical Engineers (ASME) and the Institute of Electrical and Electronics Engineers (IEEE). ASME has an international membership of more than 125,000. The ASME standards process has more than 700 committees responsible for 600 codes and standards. ASME has responsibility for the *Boiler and Pressure Vessel Code,* which comprises some 12,000 pages and is one of the most prominent single documents in the U.S. standards-development arena and in the world. IEEE has a worldwide membership of more than 315,000 engineering professionals. The approximately 680 standards published by IEEE focus specifically on areas of electrotechnology.

Industry Associations. Industry or trade associations are organizations of manufacturers, service providers, customers, suppliers, and others that are active in a given industry. The development of technical standards is specifically intended to further the interests of their particular industry sector.

The Association for the Advancement of Medical Instrumentation (AAMI) is an example of a trade organization that develops standards. Approximately 2,000 health care professionals support their activities and include representatives from industry, health care facilities, academia, research centers, and government agencies, such as the Food and Drug Administration (FDA). Industry association SDOs are likely to be more openly responsive to commercial market concerns than other types of SDOs. Other examples of industry associations include the American Petroleum Institute (API) and the National Electrical Manufacturers Association (NEMA).

INTERNATIONAL ARENA

Basics of International Standards Development

In the common lexicon of codes and standards development, and especially in the various international arenas, the term "standards" is most commonly used to characterize all the various types of standardizing documents (i.e., codes, standards, guides, policies, etc.). A quick review of the language of these documents is helpful for this discussion.

As mentioned previously, the entities that administer these standardizing activities are generally known throughout the world as "standards-developing organizations" and are commonly referred to by the acronym SDO. (The term "SDO" has been expanded in the last few years to address those SDOs that have activities or a basis in more than one country, and these are now being recognized as international SDOs, or ISDOs.[8])

"One-Country/One-Vote" versus "Full-Consensus." Arguably the most widely recognized ISDOs today are those of the "one-country/one-vote" design based in Geneva, Switzerland. Most notable among these are the IEC (International Electrotechnical Commission) and the ISO (International Organization on Standardization). These organizations enjoy a casual bureaucratic recognition by various world political organizations that is not readily available to other ISDOs. They are referred to herein as "one-country/one-vote" organizations since the prime mechanism for establishing a position on any particular subject is by a single vote from each participating country.

Perhaps the most noteworthy contrast to the "one-country/one-vote" processes are those based on principles involving "full consensus." This is characteristic of the methods used by the ISDOs of North America. Each individual person, regardless of their particular nationality, has the ability to participate directly in the issues under consideration. "Full-consensus" organizations are more democratic in their design in comparison to those organizations based on "one-country/one-vote."

North American Model. In the realm of codes and standards development, the ISDOs located in North America have certain characteristics that make them relatively unique[9]. The significant private-sector standards-development system in the United States is largely self-regulated, with certain oversight and coordination efforts provided by ANSI (American National Standards Institute), a federation of U.S. codes and standards developers, and corporate and government users of those standards.

ANSI provides accreditation for the development of documents that meet their fundamental principles for full consensus. Organizations that meet these requirements typically have elaborate processes involving volunteer committees and utilizing extensive public input. Although federal, state, and local governments usually participate, they do as would any other participant. The resulting documents are referred to as "model documents," and it is then up to any particular authority to subsequently implement the issued document as it sees fit (i.e., into law, as a specification, etc.).

Of all the attributes of the North American ISDOs, of special note is the fact that they are oriented around a particular subject matter, based on a foundation of individual participant involvement. A trademark of North American processes is that they are blind to the geographic roots of their input and, thus, they allow anyone, anywhere to participate on an equal basis.

In Search of Alternative ISDO Approaches. The developers of codes and standards based in North America are characterized, depending on the circumstances, as either an SDO or an ISDO. These organizations typically exist with a dual personality, providing for the domestic needs of their constituents, while at the same time not being exclusively dedicated to any particular collection of those constituents (i.e., serving the needs of constituents in multiple countries).

It is admittedly a virtue to have participants involved in any process that provides wide representation rather than simply a narrow or limited focus. But is there an outward boundary to such representation, and at what point does the representation become misleading? When does it become "involvement without representation"?

At the root of these questions is the effectiveness of processes based on the collective representation of very large entities such as entire nations (i.e., the "one-country/one-vote" design). This is a model that lends itself well to consideration of universal issues of sweeping impact, in which the singular voice of each country is able to speak clearly and contribute decisively to a common good.

But is this same model the most appropriate approach, or more importantly, to be considered the *only* approach, to the myriad of technical details on which civilization is built? Although it can be argued that the "one-country/one-vote" model may perhaps lend itself well to certain topics and certain types of standards-development activities, it should not be expected to be the *only* approach for all standards activities.[8] Clearly, alternative approaches exist, and one of these approaches, is the "full-consensus" approach.

The "one-country/one-vote" model does not have the flexibility to equitably address detailed technical issues in the same manner as the "full-consensus" approach. It is convenient, of course, when a particular technical topic is used in the same manner in all of the countries of the world, but the many blends of society make such a convenience a true rarity.

For example, consider the very common scenario of when a technical standard addresses a focused topic. In particular, consider a case study that has a relatively extreme focus, such as a hypothetical standard addressing harness gear for reindeer. Does it make sense for all the nations of the world to vote equally on this standard? Why should the nations at the equator have an equal vote with the Nordic nations that are clearly more familiar with—and affected by—the topic? The casual assumption that all topics exist equally in all nations, and that the "one-country/one-vote" model is the *only* approach needed, does not make sense.

Regional Nature of ISDOs. Of particular note when discussing SDOs and ISDOs are the regional organizations. These exist today, both in a formal sense and in a less than formal or de facto sense.[10]

Although many jurisdictions have country-specific SDOs, there is a tendency for them to cluster regionally to assert their collective presence. The boundaries of such regions are not always geographically clear. More commonly, they are generally based on the culture and influence of the primary participants, or at least those participants with the primary control.

Various examples exist of formalized regional standards bodies. Fitting this description are organizations such as CEN (European Committee for Standardization) for Europe, COPANT (Pan American Standards Commission) for the Americas, and PASC (Pacific Area Standards Congress) for the Pacific Rim nations. Although organizations such as these are easily distinguished, it is the nonformalized regional developers that are of interest in this discussion.

In a unified sense, all the various codes and standards developers of the United States comprise a de facto regional standards body. This is particularly the case based on the coordinating role played by ANSI. Thus, we can observe that the standards-developing organizations of the United States exist independently as SDOs, in a collective sense as a regional organization, and in a practical sense as ISDOs.

As a contrast to the North American position, the organizations of the "one-country/one-vote" design based in Geneva, Switzerland, and in particular ISO and IEC, enjoy an informal recognition by various world political organizations that is not readily available to other ISDOs. Despite their international stature, however, are implications that they are a European-based regional organization based on their operating characteristics. For example, in late 2000 it was reported that CEN and CEN-affiliated countries (33 in all) have 50 percent or more voting members on 80 percent of all ISO committees.[10]

Today, as an observation, ISO and IEC are typically considered as ISDOs, while gaining recognition as European regional SDOs. Meanwhile, the standards organizations based in the United States are typically considered as North American regional SDOs, while gaining recognition as ISDOs.

World Trade Organization (WTO) and the Technical Barriers to Trade (TBT) Agreement. The World Trade Organization (WTO) is today generally considered the foremost-recognized global organization dealing with the rules of trade between nations.[11] Its main function is to ensure that trade flows smoothly, predictably, and freely. The goal is to help producers of goods and services, exporters, and importers conduct their business.

The WTO is headquartered in Geneva, Switzerland, with a staff of approximately 500, and is represented by 140 member countries and customs territories (as of November 30, 2000) that account for over 90 percent of world trade. Over 30 other countries are negotiating membership. A its heart are the WTO agreements, negotiated and signed by the bulk of the world's trading nations and ratified in their parliaments.

Technical Barriers to Trade. The WTO's top-level decision-making body is the Ministerial Conference, and reporting to the Ministerial Conference and considered the prime operational entity is the General Council. Three other councils and various committees, working groups, and working parties report to the General Council, but of particular note of these is the Council for Trade in Goods. The Council for Trade in Goods likewise has various committees reporting to it, one of which is the Committee on Technical Barriers to Trade.

This committee is responsible for the Agreement on Technical Barriers to Trade (TBT), which tries to ensure that regulations, standards, testing, and certification procedures do not create any unnecessary obstacles. Technical regulations and industrial standards may vary from country to country, and having too many different standards makes life difficult for producers and exporters. If the standards were set arbitrarily, they could be used as an excuse for protectionism.

However, the TBT Agreement recognizes that countries have the right to establish protection at levels that they consider appropriate, and they should not be prevented from taking measures necessary to ensure that those levels of protection are met based on the need to fulfill certain legitimate objectives. These legitimate objectives include protection of human health and safety; national security; prevention of deceptive practices; protection of animal or plant life or health; and the environment.

International Standards. The TBT Agreement encourages the countries to use international standards where these are appropriate, although it does not require them to change their levels of protection as a result of standardization. As guidance for member countries, Annex 3 to the TBT Agreement provides the *Code of Good Practice for the Preparation, Adoption, and Application of Standards,* which attempts to ensure that standards do not present an obstacle to international trade.

An obvious question that comes into play when attempting to implement the TBT Agreement is "what is an international standard?" This matter was recently addressed in the Report (2000) of the Committee on Technical Barriers to Trade.[12] Included in this particular report is Annex 4, entitled "Decision of the Committee on Principles for the Development of International Standards, Guides and Recommendations with Relation to Articles 2,5 and Annex 3 of the Agreement." This annex outlines the principles and procedures that should be observed for the preparation of international standards and attempts to ensure the following essential characteristics:

(a) Transparency
(b) Openness
(c) Impartiality and consensus
(d) Effectiveness and relevance
(e) Coherence
(f) Ability to address the concerns of developing countries

The elements outlined here can be found as inherent traits in the various organizations that exist today that develop codes and standards in the international arena. For example, these elements fit the more commonly recognized international developers like ISO and IEC, but clearly others also meet or exceed these requirements, such as many of the North American codes and standards developers (e.g., NFPA and others). For certain aspects such as openness, impartiality, and consensus, the "full-consensus" approach used by North American developers arguably does a better job meeting these TBT elements than do those that use the "one-country/one-vote" approach.

ENFORCEMENT OF CODES AND STANDARDS

The types of government and the characteristics of governing authorities around the world vary considerably, yet despite the differences, there are some aspects that are common with relation to legislative adoption of codes and standards. For the sake of illustration, the following discussion focuses on this topic, based on a form of government similar to that used in the United States.

Today the life and property of every citizen is safeguarded to at least some extent by safety legislation enacted by the Congress of the United States, state legislatures, city councils, town meetings, and many other jurisdictions and levels of government. The implementation and enforcement of this legislation are in the hands of administrative agencies of government, such as federal departments and agencies, state fire marshal offices and other appropriate state agencies, and local fire departments, building departments, electrical inspectors, and so on.

In the earlier days of the United States, the protection of citizens from fire was solely the concern of the local community. Present-day fire fighting is carried on by local fire departments. Although most communities have had some type of building code since the beginning of the twentieth century, they have not had fire prevention or life safety codes until more recently.

With the need for more detailed, comprehensive standards and codes relating to the construction, design, and maintenance of buildings came the knowledge that regulations based on such codes certainly could prevent most incidents of damage to the building, its contents, and the activities therein, and reduce losses in the incidents that did occur.

Regulations relating to safety are determined and enforced by different levels of government. Although some functions overlap, federal and state laws generally govern those areas that cannot be regulated at the local level.

Nationally Based Safety Regulations

There is a substantial amount of federal regulation pertaining to safety. Under the Constitution in the United States, Congress has the power to regulate interstate commerce. This power has been interpreted to permit Congress to pass laws authorizing various federal departments and agencies to adopt and enforce regulations to protect the public from hazards.

Any federal department or agency in the United States can promulgate safety regulations only if authority to do so is granted by a specific act of Congress. These regulations have the force of law, and violations can result in legal action. In general, such federal laws can be enacted to provide (1) that all state laws on the same subject are superseded by the federal law, (2) that state laws not conflicting with the federal law remain valid, or (3) that any state law will prevail if it is more stringent than the federal law. Among the federal agencies that have the authority to promulgate fire safety regulations are the Consumer Product Safety Commission (CPSC), the Department of Health and Human Services (HHS), and the Occupational Safety and Health Administration (OSHA).

It must be recognized that model codes are only representations of possible regulations, and they do not actually become law until enacted by state and municipal legislatures.[13] The general areas of model code adoption and use in the United States can be seen in Figures 1.3.2 through 1.3.5. Although these illustrations are representative of code adoption activities in the United States, a similar approach of using model codes exists in numerous other countries. The world's most widely adopted code, NFPA 70, is adopted in virtually every state in the United States, Mexico, and numerous other countries.

Regulations of State and Local Government

Within the scope of the police power of state government in the United States is the regulation of building construction for the health and safety of the public—a power usually delegated to local governments of the state.

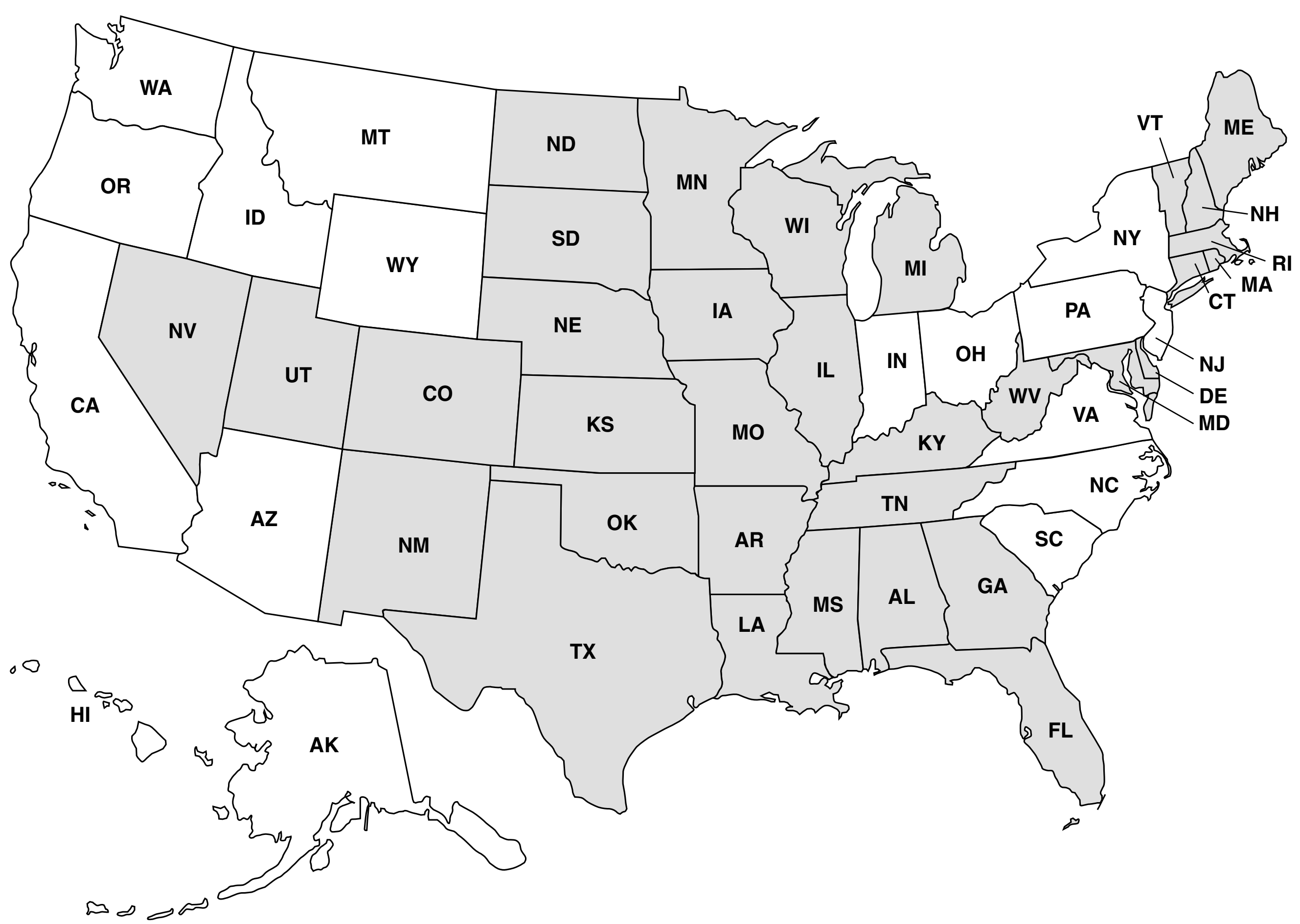

FIGURE 1.3.2 *Adoption of NFPA* 101®, Life Safety Code® *(as of 2002)*

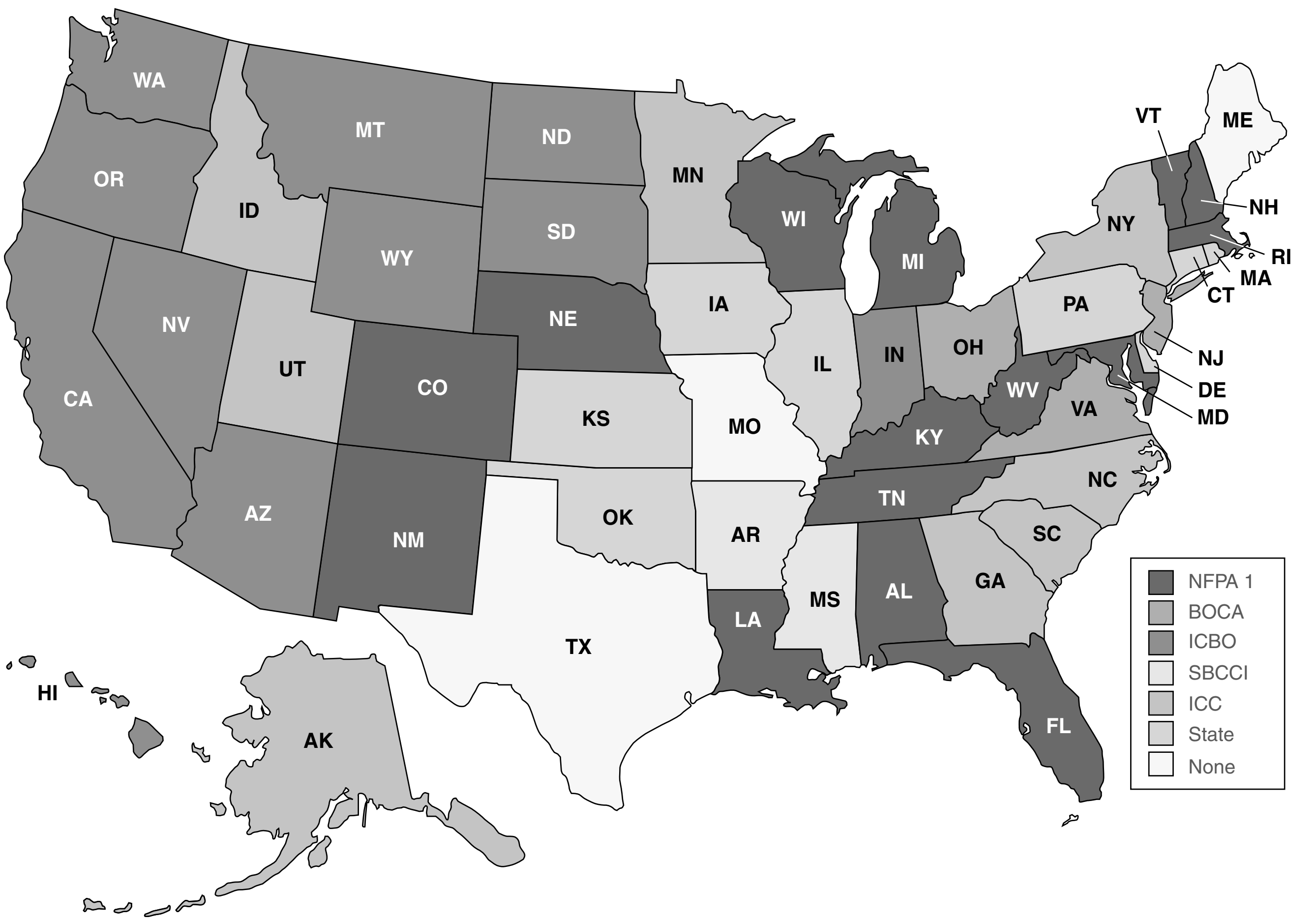

FIGURE 1.3.3 *Adoption of a Fire Prevention Code (as of 2002)*

Building code requirements usually apply to new construction or to major alterations to buildings. Retroactive application of code requirements is very rare. Building code applicability usually ends with the issuance of an occupancy permit or certificate of occupancy. The basic premise that legislation should regulate for the safety of current occupants and for current risk is not generally the province of building codes once a structure is occupied. Then after-occupancy codes or safety maintenance codes apply. Also, this usually is the point at which the authority of the building official ends and the fire official begins.

This division of authority, however, does not preclude interaction between the two officials during both a building's development and its subsequent use. In practice, many jurisdictions assign responsibilities to officials in various departments for codes whose natural "homes" are or are not in their departments. The division of authority varies considerably among communities.

In most states in the United States, the principal fire official is the state fire marshal. For the most part, the state fire marshal is the statutory official charged by law with responsibility for the administration and enforcement of state laws relating to safety to life and property from fire. Usually the state fire marshal also has the power to investigate fires and to investigate arson.

The manner in which each state handles the promulgation of building and fire regulations varies widely. In some states, each local government may have its own code, whereas in others the local authority has the option of adopting the state codes. In still others, the state codes establish the minimum requirements, below which the local regulations cannot go. Finally, in some states the local government has no choice and must adopt the state code.

These situations have resulted in a plethora of different local codes. Some of the local governments adopt one or more of the model codes or codes based on the model codes. Others draft their own local codes. This lack of uniformity has been criticized by materials producers, building designers, builders, and others, and some years ago prompted the appointment of federal commissions to study the situation and make recommendations to the administration.[14–16]

The legal procedure for adopting codes and standards into law can also vary from one enforcing jurisdiction to another. Usually, the simplest and best way is to adopt by reference. This method, applicable to public authorities as well as to private entities, requires that the text of the law or rule cite the code or standard by its title and give adequate publishing information to permit its exact identification. The code or standard itself is not

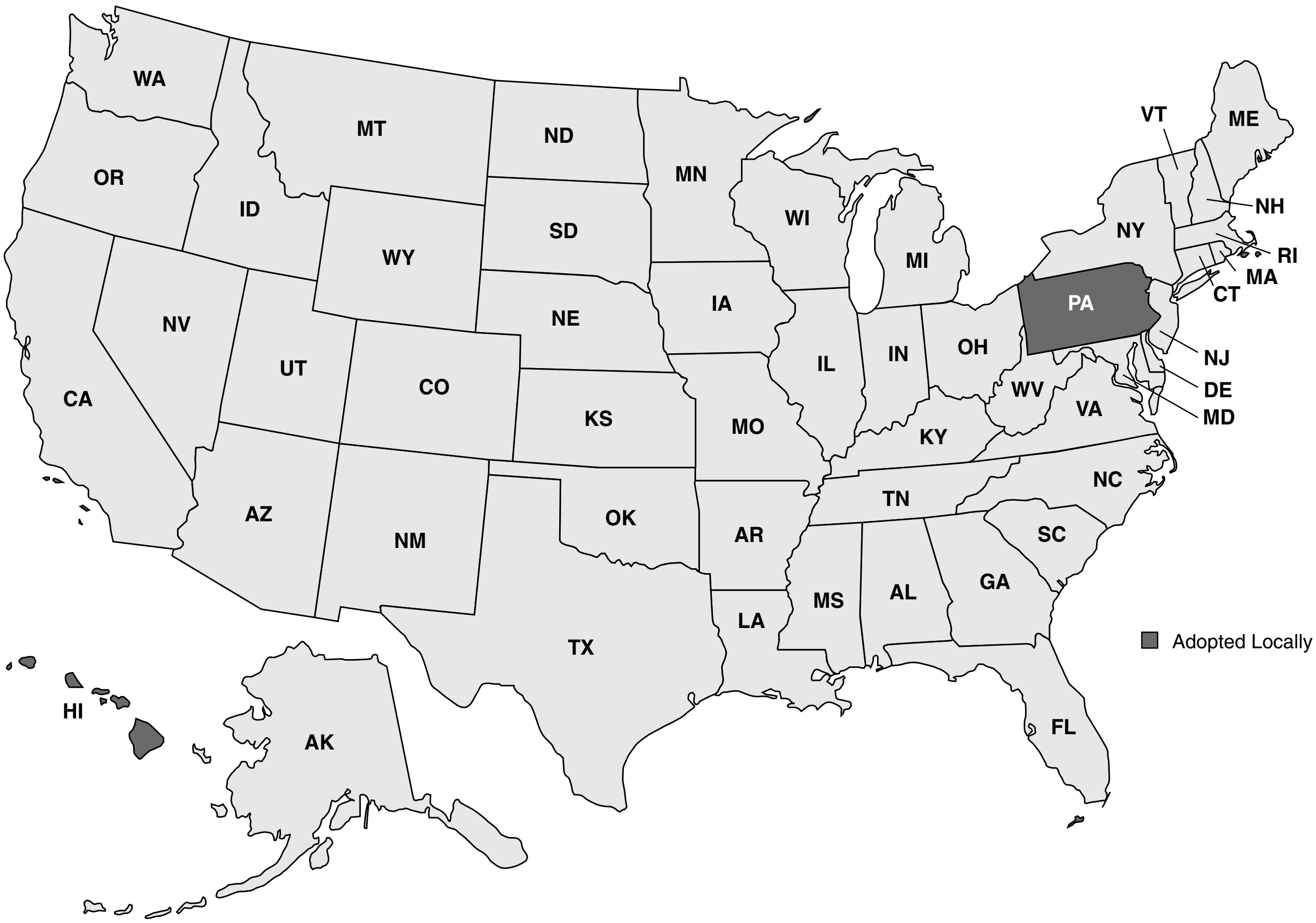

FIGURE 1.3.4 *Adoption of NPFA 70,* National Electrical Code® *(as of 2002)*

reprinted in the law. All deletions, additions, or changes made by the adopting authority are noted separately in the text of the law. Adoption of a current edition of a code or standard obviates outdated editions maintained as law until a new law referencing a new edition is adopted.

Where local laws do not permit adoption by reference, a code or standard can be adopted by transcription. This requires that the text of the adopted code or standard be transcribed into the law. Existing material can be deleted and new material added only if such material does not change the meaning or intent of the existing or remaining material. Under adoption by transcription, the code or standard cannot be rewritten, although changes can be made for administrative provisions. Because the text of the code or standard is transcribed into the law, due notice of the copyright of the document's developer is required. As a result, most code groups copyright their codes or standards to prevent misuse and unlawful use.

CODE SETS FOR THE BUILT ENVIRONMENT

Although building codes provide much focus, a variety of other related codes also readily serve the built environment. Specifically, these codes address distinct interrelated topics that are essential components in structures of all kinds.

Topics that are typically addressed include electrical, plumbing, mechanical, fuel gas, energy, and fire prevention. Yet this is not an all-inclusive list, and any particular subject that lends itself to specific and detailed criteria is eligible and, thus, the evolution of "electrical codes," "plumbing codes," "mechanical codes," and so on. Often the reference to "building codes" is intended to include, in a general sense, a reference to all of these related codes for the built environment.

Of these different related topics, fire prevention codes are somewhat unique (e.g., construction versus ongoing operation and maintenance). It often is difficult to differentiate between items that should go into a fire prevention code and those best included in a building or other related code. Generally, those requirements that deal specifically with construction of a building are part of a building or similar code administered by the building department. A fire prevention code, on the other hand, includes information on fire hazards in a building and usually is regulated by the fire official.

Requirements for exits and fire-extinguishing equipment generally are found in building codes, whereas the maintenance of such items is covered in fire prevention codes. More simply

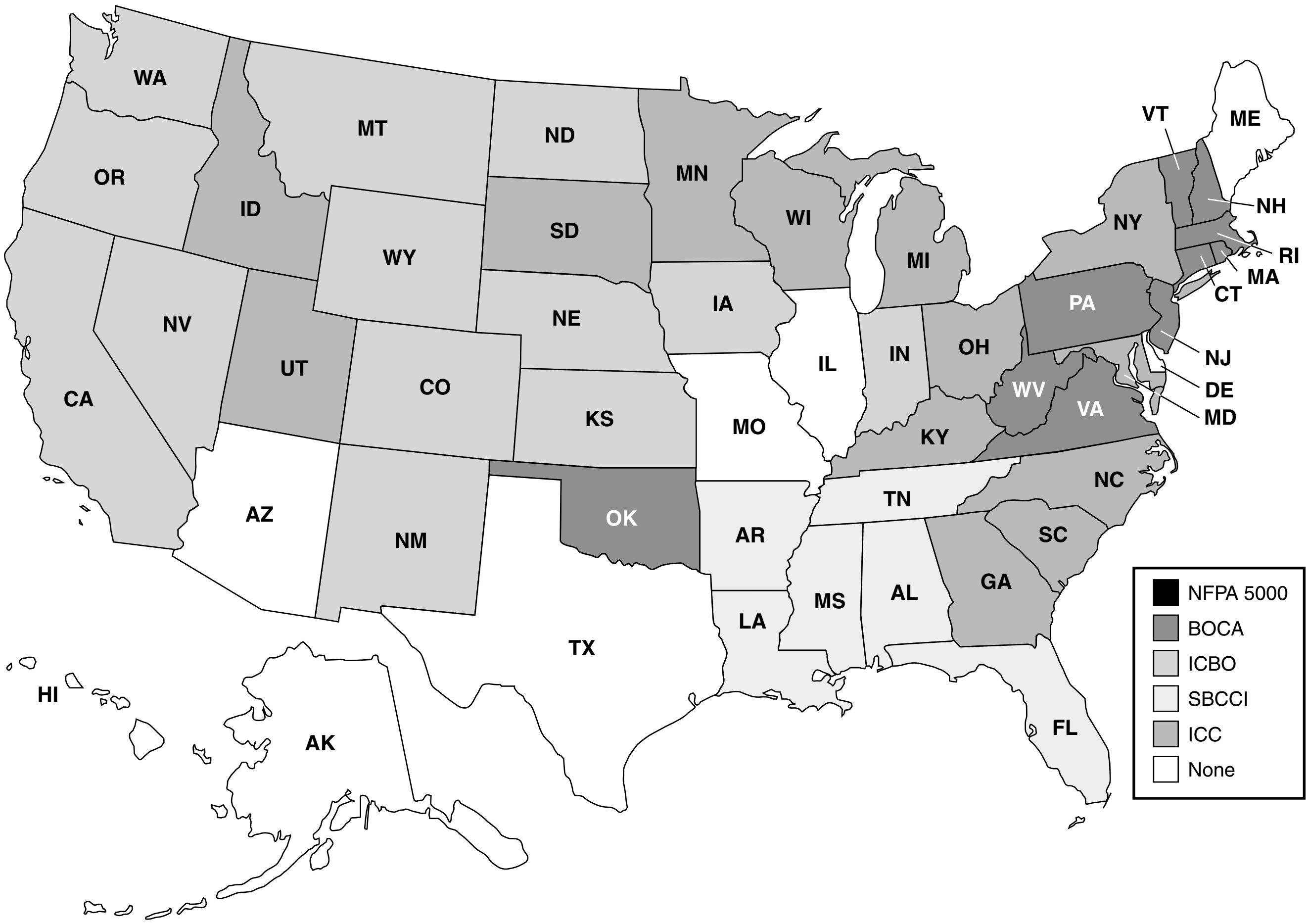

FIGURE 1.3.5 *Adoption of a Regional Model Building Code (as of 2002)*

stated, building and other related codes generally address the original design or major renovation of a building, whereas a fire prevention code usually addresses the building during its useful life after the initial construction or renovation is complete.

Comprehensive Consensus Codes

With the exception of the independent operations of some of the largest cities, the business of code development for the built community in the United States is primarily in the hands of the recognized model code organizations. The primary objectives of these organizations are to provide standardization of construction regulations and/or support of the enforcement of these regulations. In the United States, two organizations in particular are coming of age with the establishment of code sets for the built environment.

NFPA et al. A coalition of organizations led by NFPA, the International Association of Plumbing and Mechanical Officials (IAPMO), the American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE), the Western Fire Chiefs Association (WFCA), and others are developing the only full set of integrated codes and standards for the built environment under a full-consensus process.

In December 1999 NFPA embarked on a project to establish a complete set of consensus codes and standards for the built environment. NFPA had already had at its disposal a number of major codes such as NFPA 1, *Fire Prevention Code*, NFPA 54, *National Fuel Gas Code,* NFPA 70, and NFPA *101,* among others that could serve as a strong foundation for the basis of this set of consensus codes.

Other codes and related standards were not present in the NFPA system in late 1999, but it was recognized from the start that they would be crucial to rounding out the code set. The needed codes included a code that covered structural design issues and other items normally found in a building code. Although major NFPA codes like NFPA *101* covered the most salient building code issues as they relate to fire protection, other items such as general structural design, foundation and roof issues, energy conservation, and accessibility were not covered to any measurable extent in the existing NFPA codes and standards. This led to the development of *NFPA 5000*™, *Building Construction and Safety Code*™, with the 2002 edition being the first edition. Other important codes, such as a plumbing code, mechanical code, and energy code, were contributed to the set by partnering organizations.

In the setting of this coalition, model codes and standards are developed through a full, open, ANSI-accredited, consensus-based process allowing full participation of all interested groups. This has long been the hallmark of the U.S. system of codes and standards development. This unique system relies on the energies and expertise of private citizens brought together by nonprofit organizations like NFPA and its partners to forge consensus over important issues of technology and public safety. The building and construction fields have greatly benefited from this type of codes- and standards-development process. Consensus codes and standards exist today that address almost every aspect of the built environment, from life safety to electrical safety, from fuel gas to energy.

The codes and standards processes of NFPA and its partners are accredited by the American National Standards Institute (ANSI), and the features that earned that accreditation make them considerably more accessible to the general public than the processes used by other code organizations. This is also the only coalition that is based on truly national and international organizations and is not an amalgamation of regional (partial U.S.) organizations, each of which have an independent and narrow geographic focus.

ICC (International Code Council). In 1995 the International Code Council (ICC) was established. The purpose of the ICC is to combine the codes of the three traditional regional model-building code organizations into a single national model. In a sense, the ICC is coming of age as a national organization and is striving to overcome the challenges of combining three distinctly different regional organizations, each of which have uniquely inherent geographic characteristics.

The three regional organizations that comprise ICC are the Building Officials and Code Administrators (BOCA), the International Conference of Building Officials (ICBO), and the Southern Building Code Congress International (SBCCI). BOCA was originally known as the Building Officials Conference of America and published its first building code in 1950. It has traditionally had a regional focus on the Northeast and Great Lakes portions of the United States. ICBO first published its regional building code in 1927. The ICBO code has traditionally been used in the western United States but has been utilized in municipalities as far east as Indiana. Organized in 1940, SBCCI first published its building code in 1945, which has traditionally been used throughout the southern United States.

The current documents of the ICC, as well as its three sponsoring regional organizations (i.e., BOCA, ICBO, and SBCCI), are developed in a process that has traditionally been by and for building officials, which restricts involvement and final voting to the building official community. This is in contrast to the codes and standards developed and maintained in an open, full-consensus process that allows widespread involvement, such as those accredited by the American National Standards Institute and used by NFPA. In particular, the documents of NFPA and its partners are developed and maintained in an open, full-consensus process that allows widespread involvement and, thus, provides documents that are more technically balanced and economically fair.

Other Organizations Related to Code Set Activities

Wide ranges of organizations provide support, input, or involvement for the codes and standards infrastructure in North America. The following paragraphs are intended to provide information for several active groups that have not already been mentioned in earlier sections of this chapter.

AISG (American Insurance Services Group). As previously noted, the National Board of Fire Underwriters (NBFU), renamed the American Insurance Association (AIA), and now known as the American Insurance Services Group (AISG), first published the *National Building Code* in 1905. The code was used as a model for adoption by cities, as well as a basis to evaluate the building regulations of towns and cities for town grading purposes. The code was periodically reviewed by the NBFU staff, revised as necessary, and republished. The last code revision was the 1976 edition. Since then, the AISG has discontinued updating and publishing the *National Building Code,* and Building Officials and Code Administrators (BOCA) has acquired the right to use the name *National Building Code* on its regional building code. The AISG also developed a fire prevention code, most recently published in 1976, but has also discontinued the updating and publishing of this document.

ANSI (American National Standards Institute). The significant private-sector standards-development system in the United States is largely self-regulated, with oversight and coordination provided by ANSI, a federation of U.S. codes and standards-developers, company organizations, and government users of those standards.

ANSI coordinates and harmonizes private-sector standards activity in the United States. In order for a document to be designated an American National Standard, the principles of openness and due process must have been followed in its development, and consensus among those directly and materially affected by the standard must have been achieved. ANSI also represents U.S. interests in the international standardization activities of the International Organization for Standardization (ISO) and the International Electrotechnical Commission (IEC).

Association of Major City Building Officials (AMCBO). The Association of Major City Building Officials (AMCBO) was formed in 1974. This group focuses on issues of building codes, administrative techniques, and public safety in buildings. The association has 36 members and provides a national forum of city and county building officials united to discuss topics of mutual interest.

AMCBO is affiliated with the National Conference of States on Building Codes and Standards (NCSBCS). The activities of AMCBO include encouraging the development of comprehensive training and educational programs for building code enforcement personnel, providing scientific and technical resources for the improvement of building codes, and enhancing building technology and products to reduce the cost of construction and maintain safety levels.

CFPA-I (Confederation of Fire Protection Associations). CFPA-I is a body of leading fire protection organizations from around the world that have joined forces to collectively direct their resources at reducing the global fire problem and increasing life safety. By sharing experience, research, technical know-how, and fire statistics, the group aims to maximize the effectiveness of fire prevention and protection and foster improved international fire safety codes and standards. The CFPA-I typically meets in full session every three years at which time some of the more challenging global fire problems are debated. These sessions provide an opportunity to share advanced research and developments that have taken place in specific problem areas. Significant advances have been made in recent years in fire safety and the CFPA-I has provided an exceptional forum to disseminate this knowledge. At this time, one suborganization that exists within CFPA-I is the Confederation of Fire Protection Associations-Europe (CFPA-E), which is comprised of European fire protection associations.

National Conference of States on Building Codes and Standards (NCSBCS). NCSBCS is a nonprofit corporation founded in 1967 as a result of Congressional interest in reform of building codes. It attempts to foster increased interstate cooperation in the area of building codes and standards and coordinates intergovernmental code administration reforms. NCSBCS is an executive-branch organization of the National Governors Association and includes as members governor-appointed representatives of each state and territorial government. It has a working relationship with the National Conference of State Legislatures and the Council of State Community Affairs Agencies.

National Institute of Building Sciences (NIBS). NIBS was authorized by Congress in 1974, under Public Law 93-383, as a nongovernmental, nonprofit organization governed by a 21-member board of directors. Fifteen of the board members are elected and six are appointed by the president of the United States, with the advice and consent of the U.S. Senate. The institute is a core organization that serves primarily as an investigative body, offering its findings and recommendations to government and to responsible private-sector organizations for voluntary implementation. It carries out its mandated mission essentially by identifying and investigating national problems confronting the building community and proposing courses of action to bring about solutions to the problems. NIBS's activities are board based and center around regulatory concerns, technology for the built environment, and distribution of technical and other useful information.

Working under its very broad mandate, NIBS has established a Consultative Council, with membership available to representatives of all appropriate private trade, professional, and labor organizations; private and public standards, codes, and testing bodies; public regulatory agencies; and consumer groups. The council's purpose is to ensure a direct line of communication between such groups and the institute and to serve as a vehicle for representative hearings on matters before the institute.

World Organization of Building Officials (WOBO). WOBO was founded in 1984, with the primary objective of advancing education through worldwide dissemination of knowledge in building science, technology, and construction. WOBO was established because of increased participation of nations in the global marketplace; the rapid development of new international building technologies and products; and development of international standards that now make it impossible for building officials to confine their concern to activities within their own national boundaries.

SUMMARY

Codes and standards serve many purposes but foremost is their contribution to the overall betterment of civilization. Their role is particularly important as we work toward the challenges of a safer and more cost-effective built environment. In many ways, today's world is complex, and codes and standards provide a point of measurement to simplify our lives. In this sense, codes and standards provide the practical foundation for a better tomorrow.

BIBLIOGRAPHY

References Cited

1. Spivak, S. M., & Brenner, F. C., *Standardization Essentials: Principles and Practices,* Marcel Dekker Publishers, New York, 2001.
2. Cheit, R. E., *Setting Safety Standards: Regulations in the Public and Private Sectors,* University of California Press, Berkeley, CA, 1990.
3. Meacham, Brian, "Building Fire Safety Risk Analysis," *SFPE Handbook of Fire Protection Engineering,* 3rd edition, National Fire Protection Association, Quincy, MA, 2002.
4. Thomas, J., "Time to Take Stock," *ASTM Standardization News,* West Conshohocken, PA, Aug. 2000.
5. Project Report on the Second Conference on Fire Safety Design in the 21st Century, "Regulatory Reform and Fire Safety Design in the United States," Worcester Polytechnic Institute, Worcester, MA, June 9–11, 1999.
6. Toth, R. B., "Standards Activities of Organizations in the United States," NIST Special Publication 806, National Institute of Standards and Technology, Gaithersburg, MD, 1996.
7. Grant, C. C., "Common Sense and International Standards," *NFPA Journal,* Quincy, MA, Jan./Feb. 2002.
8. ANSI, "A National Standards Strategy for the United States," American National Standards Institute, New York, Aug. 2000.
9. ANSI, "American Access to the European Standardization Process," American National Standards Institute, New York, Dec. 1996.
10. Thomas, J., "Raising the Bar," *ASTM Standardization News,* West Conshohocken, PA, Nov. 2000, p. 5.
11. Liu, V., "The WTO TBT Agreement and International Standards," presentation at PASC XXIV, Seoul, Korea, April 23, 2001.
12. "Report (2000) of the Committee on Technical Barriers to Trade," WTO, World Trade Organization, Geneva, Switzerland, G/L/412, November 14, 2000.
13. Horwitz, B., "Codes and Standards: Engineers Wanted," *Consulting—Specifying Engineer,* May 2001, pp. 38–42.
14. "Building the American City," Report of the National Commission on Urban Problems, Superintendent of Documents, U.S. Government Printing Office, Washington, DC, 1968.
15. *Building Codes: A Program for Intergovernmental Reform,* Advisory Commission on Intergovernmental Relations, Superintendent of Documents, U.S. Government Printing Office, Washington, DC, 1966.
16. "Report of the President's Commission on Housing," Superintendent of Documents, U.S. Government Printing Office, Washington, DC, 1982.

NFPA Codes, Standards, and Recommended Practices

Reference to the following NFPA codes, standards, and recommended practices will provide further information on building and fire codes and standards discussed in this chapter. (See the latest version of The NFPA Catalog *for availability of current editions of the following documents.)*

NFPA 1, *Fire Prevention Code*
NFPA 30, *Flammable and Combustible Liquids Code*
NFPA 54, *National Fuel Gas Code*
NFPA 70, *National Electrical Code®*
NFPA 70A, *Electrical Code for One- and Two-Family Dwellings and Mobile Homes*
NFPA 80, *Standard for Fire Doors and Fire Windows*
NFPA 80A, *Recommended Practice for Protection of Buildings from Exterior Fire Exposures*
NFPA 88A, *Standard for Parking Structures*
NFPA 88B, *Standard for Repair Garages*
NFPA 90A, *Standard for the Installation of Air-Conditioning and Ventilating Systems*
NFPA 90B, *Standard for the Installation of Warm Air Heating and Air-Conditioning Systems*
NFPA 92A, *Recommended Practice for Smoke-Control Systems*
NFPA 92B, *Guide for Smoke Management Systems in Malls, Atria, and Large Areas*
NFPA 99, *Standard for Health Care Facilities*
NFPA *101®, Life Safety Code®*
NFPA 105, *Recommended Practice for the Installation of Smoke Control Door Assemblies*
NFPA 203, *Guide on Roof Coverings and Roof Deck Constructions*
NFPA 204, *Standard for Smoke and Heat Venting*
NFPA 220, *Standard on Types of Building Construction*
NFPA 241, *Standard for Safeguarding Construction, Alteration, and Demolition Operations*
NFPA 703, *Standard for Fire Retardant Impregnated Wood and Fire Retardant Coatings for Building Materials*

Integrated Consensus Code Set for the Built Environment (NFPA and partners)

NFPA 1, *Fire Prevention Code*
NFPA 30, *Flammable and Combustible Liquids Code*
NFPA 30A, *Code for Motor Fuel Dispensing Facilities and Repair Garages*
NFPA 54, *National Fuel Gas Code*
NFPA 58, *Liquefied Petroleum Gas Code*
NFPA 70, *National Electrical Code®*
NFPA *101®, Life Safety Code®*
NFPA 5000™, Building Construction and Safety Code™
Uniform Plumbing Code—IAPMO (NCA/NAPHCC)
Uniform Mechanical Code—IAPMO
ASHRAE 90.1, *Energy Standard for Buildings Except Low-Rise Residential Buildings*
ASHRAE 90.2, *Energy Code for New Low-Rise Residential Buildings*

Additional Readings

ASTM Standards in Building Codes, 27th ed., American Society for Testing and Materials, Conshohocken, PA, 1990.
Babrauskas, V., "Designing Products for Fire Performance: The State of the Art of Test Methods and Fire Models," *Fire Safety Journal,* Vol. 24, No. 3, 1995, pp. 299–312.
Batik, A. L., "A Layman's View of the Relationship of Standards to Product Liability," *Standards Engineering,* Dayton, OH, Jan./Feb. 1990.
Baker, D. R., "Meeting High-Rise Requirements for Fire Detection/Alarm/Suppression," *Consulting—Specifying Engineer,* Vol. 3, No. 2, 1988, pp. 56–59.
Baker, D. R., "Performance by Computer Modeling or Prescription by Model Code," *TR 86-5,* Society of Fire Protection Engineers, Boston, MA, 1986.
Belles, D. W., "History and Use of Wired Glass in Fire Rated Applications," *Journal of Applied Fire Science,* Vol. 5, No. 1, 1995/1996, pp. 3–15.
Breitenberg, M. A., *The ABC's of Standards-Related Activities in the United States,* U.S. Department of Commerce, National Bureau of Standards, Gaithersburg, MD, May 1987.
"Brief History of the Standards of Fire Cover," *Fire Research News,* Vol. 22, Winter 1999, pp. 2–4.
Bukowski, R. W., "History of NBS/NIST Research on Fire Detectors," *Proceedings* of 12th International Conference on Automatic Fire Detection "AUBE /01," March 25–28, 2001, Gaithersburg, MD, National Institute of Standards and Technology, Gaithersburg, MD, NIST SP 965, February 2001, pp. 1–12.
Bukowski, R. W., and Babrauskas, V., "Developing Rational, Performance-based Fire Safety Requirements in Model Building Codes," *Fire and Materials: An International Journal,* Vol. 18, No. 3, 1994, pp. 173–192.
"Code Change B7–97 Will Reduce Conflict between FHAA Objectives and Fire Safety," *Building Official and Code Administrator,* Vol. 31, No. 5, 1997, pp. 16–19.
Cooke, P. W., *A Review of U.S. Participation in International Standards Activities,* U.S. Department of Commerce, National Bureau of Standards, Gaithersburg, MD, Jan. 1988.
Cooke, P. W., *A Summary of the New European Community Approach to Standards Development,* U.S. Department of Commerce, National Bureau of Standards, Gaithersburg, MD, Aug. 1988.
Cooke, P. W., *An Update of U.S. Participation in International Standards Activities,* U.S. Department of Commerce, National Institute of Standards and Technology, Gaithersburg, MD, Jan. 1988.
Corcoran, D., "Fire Prevention and Building Restoration Activities," *Fire Engineering,* Vol. 146, No. 12, 1993, pp. 94–98, 100.
Corneo, E., Gallina, G., and Mutani, G., "Fire Safety in a Historical Building: A Case History," *Proceedings* of Symposium for '97 FORUM, Applications of Fire Safety Engineering, October 6–7, 1997, Tianjin, China, 1997, pp. 60–72.
Cote, R., *Life Safety Code Handbook,* 6th ed, National Fire Protection Association, Quincy, MA, 1994.
Deakin, A. G., "Fire Safety in Buildings: Standards for 1992's Europe," *Fire International,* No. 121, Feb./Mar. 1990, pp. 15–16.
Dixon, R. G., Jr., *Standards Development in the Private Sector: Thoughts on Interest Representation and Procedural Fairness,* National Fire Protection Association, Quincy, MA, 1978.
Duthinh, D., and Carino, N. J., "Shear Design of High-Strength Concrete Beams: A Review of the State-of-the-Art," National Institute of Standards and Technology, Gaithersburg, MD, NISTIR 5870, Aug. 1996.
Finnimore, B., "Need for Atria Fire Codes," *Fire Prevention,* No. 205, Dec. 1987, pp. 30–33.
Galan, S. A., "History of Underwriters' Laboratories and Plenum Cable Fire Testing and Materials Evaluation," *Proceedings* of Fall Conference, Flame Retardant Polymerics: Electrical/Electronic Applications, October 4–7, 1998, Newport RI, 1998, pp. 53–62.
Gann, R. G., "NIST/NBS Fire Research and FRCA: 25 Years of Progress," *Proceedings* of Fire Safety and Technology: Turmoil—Progress—Opportunities—1973–1998–2000, March 22–25, 1998, Atlanta, GA, Fire Retardant Chemicals Association, Lancaster, PA, 1998, pp. 77–84.
Green, M., "History of Building Code Regulations for Existing Buildings in the United States," *Proceedings* of Pacific Rim Conference and 2nd International Conference on Performance-Based Codes and Fire Safety Design Methods, May 3–9, 1998, Maui, HI, International Code Council, Birmingham, AL, 1998, pp. 39–47.
Gross, J. G., "Developments in the Application of the Performance Concept in Buildings," *Proceedings* of the CIB-ASTM-ISO-RILEM 3rd International Symposium, Applications of the Performance Concept in Building, December 9–12, 1996, Tel Aviv, Israel, National Building Research Institute, Haifa, Israel, 1996, Vol. 1, pp. 1/1–11.

Gross, J. G., "Harmonization of Standards and Regulations: Problems and Opportunities for the United States," *Building Standards,* National Institute of Standards and Technologies, Gaithersburg, MD, Mar./Apr. 1990, pp. 32–35.

Harvey, C. S., "Flexible Approach to Fire-Code Compliance," *Architectural Record,* No. 10, Oct. 1988, pp. 130–135.

Heskestad, A., "Survey of Fire Safety Activities in Scandinavia with Regard to the Introduction of Performance-Based Fire Safety Building Codes," *Proceedings* of Fire Safety Design of Buildings and Fire Safety Engineering, August 19–20, 1996, Oslo, Norway, Fire Safety Building Codes, 1996, Conference Compendium, pp. 1–2.

Hemenway, D., "Industrywide Voluntary Product Standards," Ballinger Publishing Company, Cambridge, MA.

Hosker, H., and Waters, C., "Building Regulations Determined," *Fire Prevention,* No. 224, Nov. 1989, pp. 37–38.

Hubbard, D. B., and Pastore, T. M., "New Zealand Building Regulations Five Years Later," University of Canterbury, Christchurch, New Zealand, Fire Engineering Research Report 97/9, Aug. 1997.

Johnson, P. F., "International Implications of Performance Based Fire Engineering Design Codes," *Journal of Fire Protection Engineering,* Vol. 5, No. 4, 1993, pp. 141–146.

Kaufman, S., "1990 National Electric Code—Its Impact on the Communication Industry," 38th International Wire and Cable Symposium, U.S. Army Communication Electronics Command, Atlanta, GA, 1989, pp. 301–305.

Korman, R., and Post, N. M., "The Code System, It Ain't Pretty. . . But it Works, Codes, ENR," *Construction Weekly,* June 22, 1989.

Lathrop, J. K., "Life Safety Code Key to Industrial Fire Safety," *NFPA Journal,* Vol. 88, No. 4, 1994, pp. 36–46.

"Legal Aspects of Code Enforcement: A Report on the 1993 Annual Conference Education Program," *Building Standards,* National Institute of Standards and Technologies, Gaithersburg, MD, Vol. 63, No. 1, 1994, pp. 27–30.

Lucht, D. A., Kime, C. H., and Traw, J. S., "International Developments in Building Code Concepts," *Journal of Fire Protection Engineering,* Vol. 5, No. 4, 1993, pp. 125–133.

"Major Changes to the 1995 Codes," *Consensus,* Spring 1995, p. 25.

Mawhinney, J. R., "Development of Regulations in the 1990 National Fire Code of Canada on Storage of Dangerous Goods," *Fire Technology,* Vol. 26, No. 3, 1990, pp. 266–280.

McMillen, J., "Guideline for the Fire Design of Shopping Centres," University of Canterbury, Christchurch, New Zealand, Fire Engineering Research Report 00/16, Nov. 2000.

Meacham, B. J., and Custer, R. L. P., "Performance-Based Fire Safety Engineering: An Introduction of Basic Concepts," *Journal of Fire Protection Engineering,* Vol. 7, No. 2, 1995, pp. 35–54.

Moss, D., "Fire Safety and Compliance of 1992," *FM Journal,* Jul./Aug. 1995, pp. 15–19.

Murphy, J. J., Jr., "Fire Safety Operations and Code Compliance Concerns. Part 2," *Fire Engineering,* Vol. 148, No. 1, 1995, pp. 78–82, 84, 86.

Neale, R. A., "When Code Equivalencies Don't Work," *American Fire Journal,* Vol. 48, No. 1, 1996, pp. 20–23.

Oey, K. H., and Passchier, E., "Complying with Practice Codes," *Batiment International/Building Research and Practice,* Vol. 21, No. 1, 1988, pp. 30–36.

Peralta, M., "Statement of the American National Standards Institute Concerning International Voluntary Standardization," American National Standards Institute, New York, July 25, 1989.

"Project 3: Fire Resistance and Non-Combustibility. Part 1. Objectives and Performance Levels for Fire Resistance," Fire Code Reform Centre Ltd., NSW Australia, October 1996.

Richardson, L. R., "Determining Degrees of Combustibility of Building Materials—National Building Code of Canada," *Fire and Materials: An International Journal,* Vol. 18, No. 2, 1994, pp. 99–106.

Robertson, J. C., "Development and Enactment of Fire Safety Codes," *Introduction to Fire Prevention,* 3rd ed., Macmillan, New York, 1989, pp. 112–132.

Sabatini, J., "Ensuring Code Compliance in High-Hazard Buildings," *Plant Engineering,* Vol. 44, No. 9, 1990, pp. 57–59.

Sanderson, R. L., *Codes and Code Administration,* Building Officials Conference of America, Inc., Chicago, IL, 1969.

Schirmer, C., "Helping Develop the Codes and Standards," *Fire Journal,* Vol. 84, No. 3, 1990, p. 44.

Solomon, R. E., "Preserving History from Fire. Bridging the Gap Between Safety Codes and Historic Buildings," *Old House Journal,* Vol. 28, No. 6, 2000, pp. 40–45.

Standards Activities of Organizations in the United States, National Institute of Standards and Technology, U.S. Dept. of Commerce, Washington, DC, 1991.

Steiner, V. M., "Building Codes—Bane or Blessing?" *Plant Engineering,* July 21, 1988.

Strength, R. S., "Status Report Model Building Codes 1992, NEC-93 and IEC-89," Fire Retardant Chemicals Association Fall Conference: Industry Speaks Out on Flame Retardancy: Coatings; Polymers and Compounding; Test Method Development; New Products, Technomic Publishing Co., Lancaster, PA, 1992, pp. 41–46.

Stroup, D. W., "Using Performance-Based Design Techniques to Evaluate Fire Safety in Two Government Buildings," *Proceedings* of Pacific Rim Conference and 2nd International Conference on Performance-Based Codes and Fire Safety Design Methods, May 3–9, 1998, Maui, HI, International Code Council, Birmingham, AL, 1998, pp. 429–439.

Stubbs, M. S., "The Widening Web of Codes and Standards," *AEBO Section Newsletter,* Fall 1988, National Fire Protection Association, Quincy, MA, 1988. (Reprinted from *Doors and Hardware.*)

Swankin, D. A., *How Due Process in the Development of Voluntary Standards Can Reduce the Risk of Anti-Trust Liability,* U.S. Department of Commerce, National Institute of Standards and Technology, Washington, DC, Feb. 1990.

Terio, C., *Introduction to Building Codes and Standards,* The American Institute of Architects, State Government Affairs, Washington, DC, Apr. 1987.

Todd, N. W., and Ryan, J. D., "Improving Codes by Predicting Product Performance in Real Fires," *Fire Journal,* Vol. 84, No. 2, 1990, p. 64.

Traw, J. S., "ICBO Code Interpretation Policy," *Building Standards,* Jan.–Feb. 1990.

Turner, M., "New Code Governing the Means of Escape for Disabled People," *Fire Prevention,* No. 215, Dec. 1988, pp. 36–37.

Use of Building Codes in Federal Agency Construction, Building Research Board, National Research Council, Commission on Engineering and Technical Systems, Washington, DC, 1989.

VanRickley, C. W., "Survey of Code Officials on Performance-Based Codes and Risk-Based Assessment," *Code Forum,* Jan./Feb. 1996, pp. 42–43.

Wenzel, A. B., and Janssens, M. L., "Using the Cone Calorimeter to Assess Combustibility of Building Products," *Proceedings* of FORUM 2000 Symposium, Fire Research Development and Application in the 21st Century, October 23–24, 2000, Taipei, Taiwan, 2000, pp. 1–26.

"World Trade Center Bombing May Bring Code Reviews," *Consulting—Specifying Engineer,* Vol. 13, No. 5, 1993, p. 13.

"1991 Updated: Legislation and Codes Affecting the Fire Sprinkler Industry," *Sprinkler Age,* Vol. 10, No. 11, 1991, pp. 12–15, 17.