1 Building Codes and Regulations

Egress from buildings is a critical aspect of building design and an important part of building and fire regulations. The development of these regulations has generally been motivated by tragic losses.

A number of events, many of which have guided the development of egress provisions in codes, are discussed in more detail in Chapter 2 of this book.

The regulatory context of egress requirements has a critical effect on building design. This chapter provides a perspective on several key elements of that context, including: a brief overview of the history of the development of codes in the United States, a discussion of current codes in the U.S. and their aspects relevant to egress, a brief overview of performance-based code development in the U.S., an international perspective, and finally, some thoughts for the future (Meacham, 2000, 2004; Tubbs, 2004; Meacham et al., 2005).

History and Overview of Building and Fire Codes in the United States

Building and fire codes have been widely used in the United States for about 100 years. Although reference to fire separations and type of construction is seen in some colonial legislation (Liebing, 1987), building codes as we know them today began to be used with some consistency only in the early 1900s. There are many reasons for this. Conflagrations became a bit too common in the late 1800s. The insurance industry desired measures to help limit its losses. Also, state and local government began responding to significant fire events. In fact, code requirements developed in response to major life-loss fires in the early and mid-1900s set the stage for many of the egress provisions in use today; these will be discussed throughout this text.

LEGAL BASIS

The building regulatory system in the United States is unlike those in most other countries. A primary reason for this is that the U.S. federal government does not develop or promulgate building codes–a national government responsibility in many countries. The reason for this goes back to the U.S. Constitution.

One of the fundamental principles of the Constitution is that only a specific set of powers is delegated to the federal government; all remaining powers are reserved for the people, who, within their states, may delegate any authority they wish to state governments through state legislatures (Lowi, 1988). This was clarified by the Tenth Amendment to the Constitution, which stipulates: "The powers not delegated to the United States by the Constitution, nor prohibited by it to the States, are reserved for the States respectively, or to the people" (Zimmerman, 1983).

One important power that people have delegated to their respective states, through state constitutions, is police power–states' authority to regulate the health, safety, and general welfare of their citizens (Field & Rivkin, 1975; Burgess, 1998). Given that building codes are concerned with the health, safety, and general welfare of the public, police power is therefore the source of authority for states to enact building codes (Rhyne, 1960, as referenced in Field & Rivkin, 1975). This power can be delegated further to local or regional governments under what is known as home rule (also referred to as *ultra vires* rule or Dillon's Rule) (Mandelker & Netsch, 1977; Zimmerman, 1983; Burgess, 1998). The net result is that many states have, at some point, delegated authority for building regulation to the county or municipal level. Today, many major cities have their own building codes, separate from those promulgated by their home states. This has further fragmented the building regulatory system.

HISTORY

Building and fire regulation in the U.S. predates the United States itself. For example, certain building and fire safety requirements were mandated in New Amsterdam (1645), Virginia (1662), Boston (1683), Philadelphia (1696), and Williamsburg (1699) prior to the adoption of the U.S. Constitution (Liebing, 1987). As would be expected for the British colonies, some of these requirements, as well as many to follow, were based on the building regulations enacted in London following the Fire of London in 1666 (Liebing, 1987; Law, 1991).

The extensive building regulatory system in the U.S. evolved somewhat slowly. Because of how the government was formed, there have always been numerous jurisdictions free to regulate buildings however they saw fit, writing their own regulations while borrowing concepts from other jurisdictions. Codes could come from a state or from a locality. In early U.S. history, building regulation, if it existed at all, was a decidedly local issue.

Things began evolving more rapidly when the United States shifted from an agrarian society to a heavily industrialized one. The Industrial Revolution created many different kinds of new health and safety hazards. The shift also increased the size and density of urban areas, which made the possibility of a large loss during a single incident, such as a fire or an earthquake, more likely. Correspondingly, these types of large-scale events began to occur more frequently. Some examples are provided in Table 1-1.

TABLE 1-1

Examples of Significant U.S. Fire Losses, 1850–1915*

Year	Incident	Loss
1865	SS Sultana steamship boiler explosion/fire (Mississippi River)	1,547 deaths
1871	Chicago conflagration	$1.733 billion (in 1989 dollars)
1872	Great Boston fire	$744 million (in 1989 dollars)
1900	North German Lloyd Steamship (New Jersey)	326 deaths
1903	Iroquois Theater fire (Chicago)	602 deaths
1904	General Slocum steamship fire (New York)	1,030 deaths
1904	Baltimore conflagration	$688 million (in 1989 dollars)
1906	San Francisco earthquake and conflagration	$4.814 billion (in 1989 dollars)
1911	Triangle Shirtwaist Factory fire (New York)	147 deaths

*Hall & Cote, 1997

Such incidents began to create a public outcry for regulations, but regulations would continue to vary greatly from one jurisdiction to another.

The problems of disparate regulations, an overall lack of building and fire regulations, incompatible equipment (such as fire department hose couplings), and significant losses were clear to the insurance industry, however, which had to compensate individuals, companies, and sometimes municipalities after such losses. In 1870, the year before the Chicago conflagration, Lloyd's of London stopped writing policies in Chicago because of the haphazard manner in which construction was proceeding (Cote & Grant, 1997). Similarly, the National Board of Fire Underwriters (NBFU), established in 1866, realized that rate adjustments were insufficient for addressing the fire problem and began emphasizing safe building construction, the control of fire hazards, and improvements in water supplies and fire departments (Cote & Grant, 1997). Over time, the NBFU saw real benefits from its building and fire-safety recommendations, and in 1905 it published what is considered the first model building code for the United States.

The issues of disparate regulations among communities and incompatible equipment were not lost on the building industry, either. In 1896, after encountering problems with different pipe sizes, pipe threads, and the like, a group of automatic fire sprinkler system manufacturers and contractors organized to draft a standard on automatic fire sprinklers. This group was the initiator of the National Fire Protection Association (NFPA); its *Standard for the Installation of Sprinkler Systems* (see NFPA, 2002) became the first NFPA standard. Over time, as fire losses continued to grow, the NFPA began looking at other aspects of fire safety. Shortly after the Triangle Shirtwaist Factory fire of 1911, the NFPA initiated the Committee on Safety to Life, which subsequently published the pamphlets *Exit Drills in Factories, Schools, Department Stores, and Theaters* (1922), *Outside Stairs for Fire Exits* (1916), and *Safeguarding Factory Workers from Fire* (1918) (NFPA, 2006b).

Historically, regulations were focused on preventing and managing large city conflagrations, but large life-loss events began to shift the focus to life safety provisions. Following such non-industrial catastrophes as the 1942 Cocoanut Grove nightclub fire in Boston, which resulted in 492 deaths and multiple injuries, these pamphlets were expanded and combined to become a more general code for life safety and egress: the *Life Safety Code* (Cote & Grant, 1997). Many of these events will be discussed in greater detail in Chapter 2.

Life Safety Code

The *Life Safety Code*, NFPA 101, has had several titles through its lifetime. In 1966 the title was changed from *Exits Code* to the *Code for Safety to Life from Fire in Buildings*. The change to the present-day title *Life Safety Code* occurred with the release of the 1997 edition of NFPA 101.

Model Codes

In spite of the efforts of members of the insurance and building industries, it was not until the 1920s that the building regulatory community saw the benefits of reducing the variability in building regulations by drafting model building codes that could be adopted by local or state governments.

Model Codes

In general, a model code is a set of suggested rules, developed by a committee of individuals who have specific expertise in the regulated area, that serves as the basis or model for an enforceable regulation. In the United States there are two not-for-profit organizations that develop model building and fire codes: the International Code Council and the National Fire Protection Association. Each organization goes through a unique process of committees, meetings, and hearings for developing these documents, which include expertise from those involved in the building construction industry.

Unlike most state and federal codes, model building and fire codes and associated reference standards are not developed by government agencies, but by private-sector codes- and standards-making organizations. Until the early 1900s, there was little incentive for a local regulator to communicate beyond its jurisdiction. The complexity of the construction process forced regulators to collaborate and share knowledge. The first such grouping of building code officials was the Building Officials and Code Administrators International (BOCA), established in 1915 (Cheit, 1990; Traw & Tubbs, 1997). In 1950, BOCA published the *Basic Building Code* (BBC), which eventually became the *National Building Code* (NBC), after the American Insurance Services Group (AISG, which was formerly the NBFU) stopped publishing its own building code in the early 1980s (the NBFU had been publishing the building code since 1905). The second organization of building officials—and the first to publish a model building code—was the Pacific Coast Building Officials Conference (later to become the International Conference of Building Officials [ICBO]), which was formed in 1922 and published the *Uniform Building Code* (UBC) in 1927 (Liebing, 1987). The Southern Building Code Congress International (SBCCI) followed in 1940 (Cheit, 1990), publishing the *Standard Building Code* (SBC) in 1945 (Liebing, 1987).

By the 1970s, there were four primary model building codes in use for commercial buildings in the United States: the BBC, the NBC, the SBC, and the UBC. However, each state and many local jurisdictions reserved the ultimate authority to regulate at a level they deemed appropriate. As a result, even though the model codes offered the opportunity to provide relative uniformity in building regulations, state and local jurisdictions usually adopted a model code with local variations. Furthermore, several states and jurisdictions still developed their own building codes, and the movement in the early part of the century to develop design, installation, testing, and maintenance standards had resulted in the enforcement of over 13,000 building-related standards by the 1970s (Field & Rivkin, 1975). By the 1970s, there were some 30,000 local jurisdictions, each with the ability to regulate buildings differently, with some 13,000 applicable standards to consider. Although the movement in the late 1800s and early 1900s to minimize differences in regulations and to standardize products in order to address building construction and safety problems had helped minimize some problems, the proliferation of codes and standards actually contributed to regulatory inconsistency.

Over time, the incidence of significant fire losses and structural damage from natural events increased, and changes were made to the prescriptive requirements in response. Changes also resulted from industry lobbying, advances in technology, fear of liability, and environmental health and safety concerns. As a result, building codes and standards multiplied from tens of pages in the early 1900s to hundreds of pages by the 1970s. Although the explosion in the volume of these regulatory requirements resulted from codes- and standards-making organizations' attempts to address the needs of their constituents, the increased information and greater detail within the codes and standards began to inhibit innovation and result in undue costs to society (Field & Rivkin, 1975).

In the 1970s, efforts were undertaken to minimize differences between the four model building codes and to develop a common code format through the formation of the Council of American Building Officials (CABO) in 1972 and the Board for Coordination of the Model Codes (BCMC) in 1975 (Traw & Tubbs, 1997). Outcomes of these efforts included a common code for one- and two-family dwellings, developed in the early 1970s, and a model energy code, developed in the 1980s.

To further this effort to minimize differences, an umbrella organization called the International Code Council (ICC) was formed in 1994 by the existing three model code organizations–BOCA, ICBO, and SBCCI–with the goal of developing a single set of comprehensive and coordinated national codes focusing on performance (Traw & Tubbs, 1997). Since the creation of the ICC, an entire set of International Codes (I-Codes), based on the existing model codes published by BOCA, ICBO, and SBCCI, has been developed. There are many codes contained in the ICC family of codes, but the key codes as they relate to egress include the *International Building Code* (ICC, 2006c), the *International Fire Code* (ICC, 2006e), the *International Existing Building Code* (ICC, 2006d) and the *International Residential Code* (ICC, 2006f). There have been three editions of the IBC and IFC: 2000, 2003, and 2006. The 2003 edition was the first for the IEBC.

The NFPA has also undertaken the creation of a model building code, entitled *NFPA 5000: Building Construction and Safety Code* (NFPA, 2003b, 2006c). There are two editions of this code: 2003 and 2006. The first edition of the document was developed through a series of committees; it was accepted by the NFPA membership in May 2002 during the Technical Committee Reports sessions. The code was ultimately approved by the NFPA Standards Council at its July 2002 meeting. It is very similar in scope to the IBC. There are several other codes of interest with regard to egress that will be discussed later in this chapter. These include *NFPA 1: Uniform Fire Code* (NFPA, 2006a), *NFPA 101: Life Safety Code* (NFPA, 2006b), and *NFPA 130: Fixed Guideway Transit and Passenger Rail Systems* (NFPA, 2003a).

Scope of Building and Fire Codes

There are four main facets of building regulation: general design, construction, occupancy and maintenance, and fire and hazard prevention. In many cases, the building code is considered the "construction" code (specifying how the building should be built), and the fire code is considered the "maintenance" code (specifying how the property should be maintained to provide an environment safe from fire). Building codes are generally the driving force behind egress design. In general, the building code and related regulations are concerned with the design, construction, and occupancy of safe buildings. Modern fire codes also address initial design, construction, and occupancy through an emphasis on active fire protection systems and the interior layout and function within the building or facility. Additionally, both building and fire codes regulate hazardous materials (i.e., dangerous goods) as they pertain to the immediate effect on occupants, the hazards they may present to first responders, and the hazards created to surrounding buildings and facilities. This is typically reflected in a code's intent statement. For example, the intent statement from the 2006 IBC states:

> **101.3 Intent.** The purpose of this code is to establish the minimum requirements to safeguard the public health, safety and general welfare through structural strength, means of egress facilities, stability, sanitation, adequate light and ventilation, energy conservation, and safety to life and property from fire and other hazards attributed to the built environment and to provide safety to firefighters and emergency responders during emergency operations (ICC, 2006c).

NFPA 5000 (2006c) is another model building code and contains a purpose statement as follows:

> **1.2 Purpose.** The purpose of the Code is to provide minimum design regulations to safeguard life, health, property, and public welfare and to minimize injuries by regulating and controlling the permitting, design, construction, quality of materials, use and occupancy, location, and maintenance of all buildings and structures within the jurisdiction and certain equipment specifically regulated herein.

Typically, fire codes are concerned with immediate fire and explosion hazards and acute immediate health hazards, such as toxic gas releases, that may affect a building or its occupants, those responding to an incident, and the surrounding buildings and facilities. They are primarily concerned with the prevention and management of the impact of such an incident. Again, this focus is found in a fire code's intent statement. For example, the 2006 IFC states the following:

> **101.3 Intent.** The purpose of this code is to establish the minimum requirements consistent with nationally recognized good practice for providing a reasonable level of life safety and property protection from the hazards of fire, explosion or dangerous conditions in new and existing buildings, structures and premises and to provide safety to firefighters and emergency responders during emergency operations (ICC 2006e).

Another widely recognized fire code is NFPA 1 (2006a), whose purpose statement is as follows:

> **1.2 Purpose.** The purpose of this code is to prescribe minimum requirements necessary to establish a reasonable level of fire and life safety and property protection from the hazards created by fire, explosion, and dangerous conditions.

Application of Building and Fire Codes

The degree to which a distinction is made between building and fire code applicability and enforcement is based on several factors, including what model codes are adopted (if any), the type and extent of local revisions, and who has enforcement responsibilities.

Building codes typically contain requirements for a broad range of construction and use parameters, including structural, mechanical, electrical, plumbing, fire protection, and egress systems. They are also concerned with amenities such as sanitary facilities, natural lighting, and ventilation. Because their scope is so broad, building codes include numerous reference codes, standards, and guides. Examples include electrical, mechanical, and plumbing codes; standards for sprinkler systems, smoke detection systems, and heating, ventilation, and air-conditioning systems; and product certification standards. Although the reference codes and standards are not individually adopted into law per se, they have the force of law by being "adopted by reference" (which saves having to change the law every time any of the hundreds of standards may be changed).

Example IBC Reference to a Standard

Section 1007.4 of the *International Building Code* states the following:

> **1007.4 Elevators.** In order to be considered part of an accessible means of egress, an elevator shall comply with the emergency operation and signaling device requirements of **Section 2.27 of ASME A17.1.** Standby power shall be provided in accordance with Sections 2702 and 3003. The elevator shall be accessed from either an area of refuge complying with Section 1007.6 or a horizontal exit. **Exception:** Elevators are not required to be accessed from an area of refuge or horizontal exit in open parking garages.

By referencing the standard within the code, it automatically becomes part of the code as adopted by a jurisdiction. Chapter 35 of the *International Building Code* then lists all standards referenced and all sections that reference each standard. (In this particular case, a very specific provision of a standard is being referenced.)

Built into the codes and standards is a power for the Authority Having Jurisdiction (e.g., building or fire officials) that allows it to require things other than those mandated, or in some cases, to permit the use of methods and materials other than those specified by the codes or standards. (However, sometimes this power is restricted to an appeals board or other governmental mechanism.) In such cases, standards, methods, test reports, or other credible documents that are not referenced in the code can be accepted for use in building design and construction. Once accepted for use, these documents essentially carry the same force as reference codes and standards for a particular building.

Example Equivalency Clause

Section 104.11 of the *International Building Code* includes the following to address equivalencies:

> **104.11 Alternative materials, design and methods of construction and equipment.** The provisions of this code are not intended to prevent the installation of any material or to prohibit any design or method of construction not specifically prescribed by this code, provided that any such alternative has been approved. An alternative material, design or method of construction shall be approved where the building official finds that the proposed design is satisfactory and complies with the intent of the provisions of this code, and that the material, method or work offered is, for the purpose intended, at least the equivalent of that prescribed in this code in quality, strength, effectiveness, fire resistance, durability and safety.

Responsibilities

At the state and/or local level, there are often at least two departments with regulatory authority for building construction and fire safety: a building department and a fire department. The building department typically has the power to issue building permits, accept designs, and approve construction documents. Through the course of construction, the building department is typically responsible for ensuring that a building design meets the applicable codes, and that the actual construction meets the design documentation. Once the final building has been inspected and approved, a certificate of occupancy is issued, allowing the building to be occupied and used. Larger building departments typically have staff with expertise in all facets of building construction, including architecture, engineering, and associated trades (e.g., plumbing), and review, inspection, and approval responsibilities are delegated accordingly. In smaller departments, a single person may be responsible for all aspects of code enforcement. This single person may or may not have all the necessary expertise to deal with the spectrum of issues presented.

Once the building is occupied, the fire department typically has the power to ensure that there are no undue fire and explosion hazards and that the building continues to be safe for human occupancy. Where, based on its intended use, significant fire hazards or risks can be expected in a building, (e.g., the storage of flammable or explosive materials or the use of hazardous processes) or where fire alarm or sprinkler systems are installed, certain fire code provisions may be applied to the design and construction of the building. Often, the fire department is heavily involved with the inspection and testing of active fire protection systems during construction. In other cases, the fire code is applied primarily after the building is occupied to ensure safety–to determine that exits remain unlocked, that combustible materials are not stored in egress paths, that any installed fire alarms and sprinklers work correctly, and so on. Fire codes also have provisions for emergency preparedness that require fire drills and emergency planning in several types of occupancies. In larger fire departments, there are sometimes one or more fire protection engineers involved in review and inspection activities who may also play a much more integrated role in the initial design review. In smaller departments, this responsibility is carried out by firefighters (during company officer inspections) who may or may not have any formal education in hazard or risk assessment.

In order to be involved as a principal participant in the design of a building, most states require that architects and engineers be registered or licensed by the state. The process of registration typically requires completion of a course of study in a duly accredited architecture or engineering program, the successful completion of one or more examinations (e.g., engineering exams, by discipline, are proffered by the National Council of Examinations for Engineering and Surveying), and the payment of dues to the state. In most cases, the practice of architecture and engineering is regulated by a set of professional ethics, which require the architects or engineers to limit their work to their area of expertise and competency.

ICC Codes and Egress

The codes published by the ICC with requirements related to egress are the IBC, IEBC and IFC. Each is unique in content and structure, although they do have some similarities in format. The ICC maintains a philosophy of correlation and consistency among codes, so in some cases, provisions are actually duplicated in several different codes. For example, identical egress provisions are found in both the building and the fire codes. There are several basic similarities in framework in the I-Codes. In all the I-Codes, Chapter 1 contains administrative provisions, and Chapter 2 contains definitions. The last chapter in each of the codes contains any referenced standards.

Basic Structure of I-Codes

Each of the I-Codes includes the following:

- Administration
- Definitions
- Body of the code
- Referenced standards
- Appendices

The appendices are not considered part of the document when the code is adopted, unless the adoption mechanism specifically includes the appendices.

The following text reviews the overall framework and approach presented by the *International Building Code, International Existing Building Code,* and *International Fire Code* and highlights the portions of these codes related to egress.

INTERNATIONAL BUILDING CODE

The requirements in the IBC are intended for new construction and are not retroactive to existing buildings with the exception of Chapter 34, which provides two basic approaches for dealing with existing buildings. The code is organized such that once the occupancy and use(s) of the building are determined, the rest of the requirements associated with that use or occupancy can be applied. The code is structured so that the safety provisions, such as egress, are contained in a single chapter. The major aspects covered by the IBC are highlighted in more detail in Figure 1-1.

The chapters in the building code most relevant to egress or that have a significant effect on egress design include the following:

- Chapter 4, "Special Detailed Requirements Based on Use and Occupancy"
- Chapter 10, "Means of Egress"
- Chapter 11, "Accessibility"
- Chapter 34, "Existing Structures"

FIGURE 1-1

International Building Code Organization. *(Courtesy International Code Council. Edited by Arup. All rights reserved.)*

Chapter 4 contains uses with unique aspects that either do not fit into one particular occupancy classification (e.g., atria or high-rises) or simply bring together unique activities into a single building (e.g., covered mall buildings). A large portion of these requirements are often related to egress. Other aspects of the code also affect egress, such as the active fire protection requirements in Chapter 9 and the interior finish requirements in Chapter 8.

INTERNATIONAL EXISTING BUILDING CODE

The IEBC made its first appearance in the ICC family of codes in 2003. It provides a tool to adopting jurisdictions for dealing with existing buildings that might not otherwise be improved due to the application limits of the building and fire codes. More specifically, it provides reasonable alternatives to requirements for new construction in the main portion of the IBC. It is generally a prescriptive code and provides requirements on several levels. There are three overall methods:

- Prescriptive compliance method
- Work-area method
- Performance compliance method

Chapter 9 includes more information on existing buildings.

The core method is the work-area method, in which the level of improvement required is based on the extent of change that is occurring in the building. With this method, a simple repair for the purpose of maintenance would not require upgrades, but a reconfiguration of a space might force requirements such as the enclosure of vertical openings, for example. The code is structured with various levels of upgrades being required based on the level of changes being made to the building, including the size of the work area, which is defined as follows:

> **WORK AREA.** That portion or portions of a building consisting of all reconfigured spaces as indicated on the construction documents. Work area excludes other portions of the building where incidental work entailed by the intended work must be performed and portions of the building where work not initially intended by the owner is specifically required by this code.

The code then provides different packages of requirements depending on how the work is classified. These packages of requirements are classified as follows:

- Repair
- Alteration Level 1
- Alteration Level 2
- Alteration Level 3
- Change of Occupancy
- Addition
- Historic Building

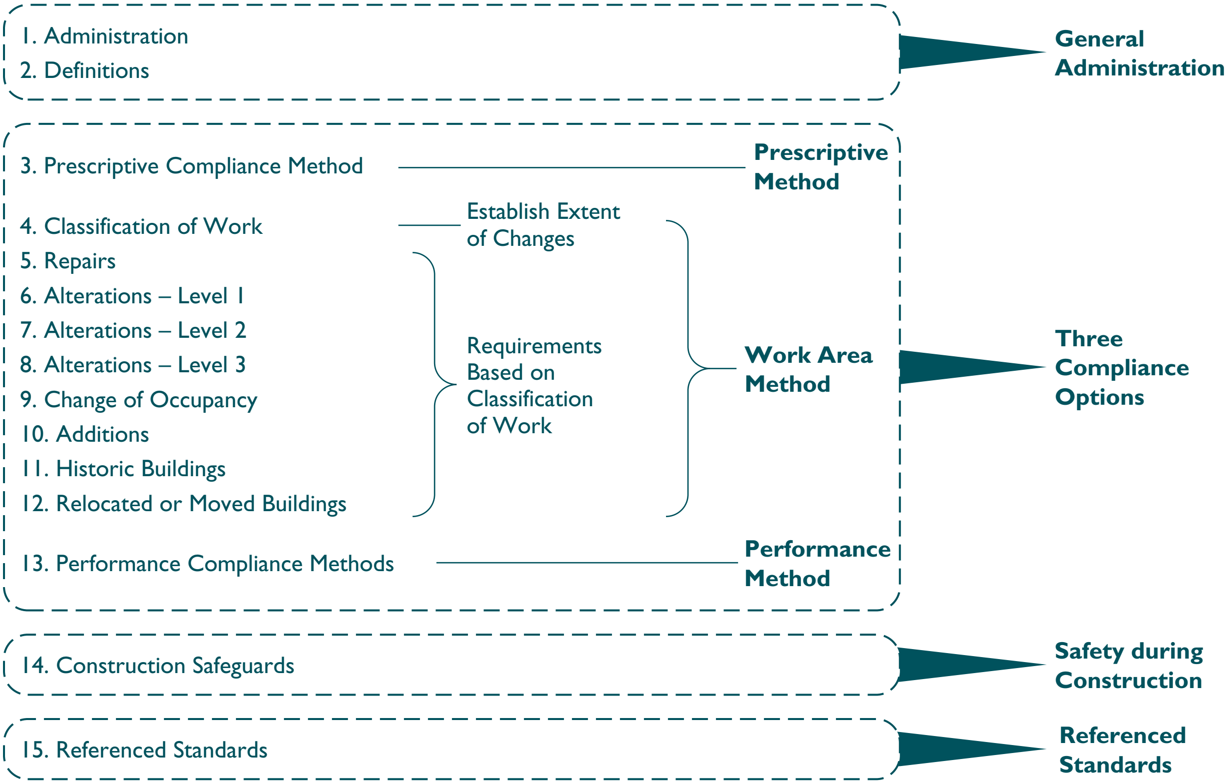

FIGURE 1-2

International Existing Building Code Organization. *(Courtesy International Code Council. Edited by Arup. All rights reserved.)*

Each of these packages discusses what changes, if any, need to be made with regard to egress. Figure 1-2 depicts the organization of this code. Additional discussion on the level of requirements for each of the above groupings is included in Chapter 8 of this book.

INTERNATIONAL FIRE CODE

The IFC focuses on the long-term maintenance and operation of buildings and also on any hazardous functions that may occur therein. Historically, new buildings were the sole concern of the building code, but there has been a recent tendency to include requirements for both new and existing buildings within fire codes. Due to variations in the application of some requirements, the code now specifically addresses whether requirements apply to new or existing construction.

The first portion of the document deals with general fire safety, egress, fire department needs, building systems such as refrigeration, emergency preparedness (fire drills, etc.), interior finish requirements, and the maintenance of fire-resistant construction. The second portion of the document addresses special functions and activities with unique fire hazards, such as the following:

- Aviation facilities
- Dry cleaning facilities
- Flammable finishes
- Semiconductor facilities

The third portion of the document addresses hazardous materials as they relate to immediate hazards posed to occupants, first responders, and surrounding buildings and facilities.

The IFC chapters of particular interest with regard to egress are as follows:

- Chapter 4, "Emergency Planning and Preparedness"
- Chapter 10, "Means of Egress"

Chapter 10 of the IBC and IFC are nearly identical; the IFC has additional provisions specific to existing buildings and maintenance of means of egress. The main driving force of egress requirements and design is the building code. The IFC is meant only to reinforce these requirements. Chapter 4, in particular, is critical for the training and preparation of occupants in order for egress systems to work as intended.

International Residential Code

Egress provisions from the *International Residential Code* are based on the IBC and other I-Codes. Unlike the IBC, however, the IRC is complete and includes all requirements within one code—that is, detailed provisions for energy efficiency, mechanical, electrical, plumbing, and fuel gas are included. Figure 1-3 depicts the organization of the IRC.

NFPA Codes

Several key codes and standards published by the NFPA will be discussed later as they pertain to egress. These documents are as follows:

- NFPA 101, *Life Safety Code* (2006b)
- NFPA 5000, *Building Construction and Safety Code* (2006c)
- NFPA 130, *Fixed Guideway Transit and Passenger Rail Systems* (2003a)
- NFPA 1, *Uniform Fire Code* (2006a)

NFPA 101, *LIFE SAFETY CODE*

Chapter 7 discusses performance concepts in NFPA 101 in more detail.

The *Life Safety Code* (NFPA 101) is one of the premier documents addressing life safety–and egress in particular–in the United States. NFPA 101 also has a performance option integrated within the code. This is discussed in more detail later in this text.

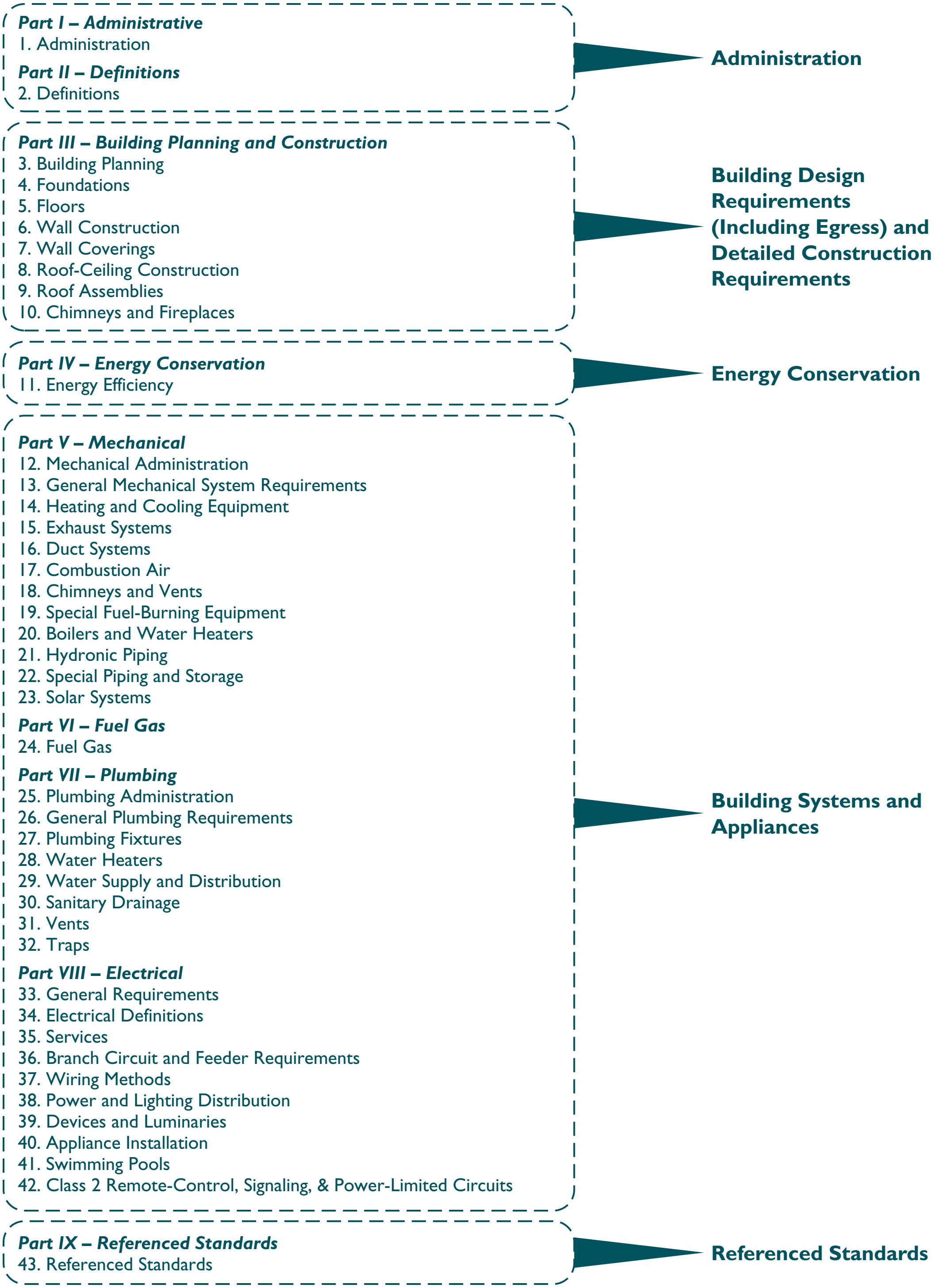

FIGURE 1-3

International Residential Code Organization. *(Courtesy International Code Council. Edited by Arup. All rights reserved.)*

The *Life Safety Code* is not intended to function as a building code. Rather its focus is life safety as it relates primarily to hazards from fire. As such, this code does not place limits on building heights and areas as building codes typically do, except where these issues specifically relate to life safety issues. The life safety provisions also provide some level of property protection benefits with regard to fire. NFPA 101 is unique in that it fully addresses new and existing facilities and also integrates requirements for fire drills and emergency planning. Both this code and NFPA 5000 are organized by occupancy. The first few chapters contain general requirements. Those chapters are followed by occupancy-specific chapters, and each occupancy chapter includes individual egress requirements. These chapters provide a package of requirements that refer back to the general provisions. See Figure 1-4 for a basic layout and the organization of the *Life Safety Code*.

NFPA 5000, *BUILDING CONSTRUCTION AND SAFETY CODE*

The first edition of NFPA 5000 was published in 2003. NFPA 5000 is a building code and addresses hazards beyond fire. It goes beyond life safety, addressing property protection as it affects public welfare. As with NFPA 101, it is organized by occupancy, and each occupancy chapter has individual egress requirements. The core egress requirements are found in Chapter 11, "Means of Egress." "Accessibility" is addressed in Chapter 12. As with NFPA 101, a performance option is integrated within the code rather than being published as an independent performance code. Figure 1-5 outlines the basic structure of the code.

NFPA 130, *FIXED GUIDEWAY TRANSIT AND PASSENGER RAIL SYSTEMS*

NFPA 130 addresses the design and construction of fixed guideway transit systems. Though it is not a building code, it is a critical document pertaining to egress. This document is performance based. Egress is limited to a time frame of 4 minutes from a station platform and a travel distance of 300 feet. A station must be designed such that it takes no longer than 6 minutes for occupants to relocate to a place of safety from the most remote portion of the platform. In addition, as part of the protection of the egress path, an emergency ventilation system that provides tenable conditions along the exit path is required. Appendix B of NFPA 130 provides information about what is considered tenable. Figure 1-6 provides the general organization of NFPA 130.

See Chapter 9 for more information regarding rail tunnels and stations.

NFPA 1, *UNIFORM FIRE CODE*

NFPA also publishes a fire code: NFPA 1. This document does not directly address egress; it refers the reader to NFPA 101 for egress provisions. NFPA 1 focuses on the long-term use of buildings and facilities and the storage and use of hazardous materials as they affect the immediate safety of occupants, emergency responders, and surrounding buildings and facilities. NFPA 1 also integrates a

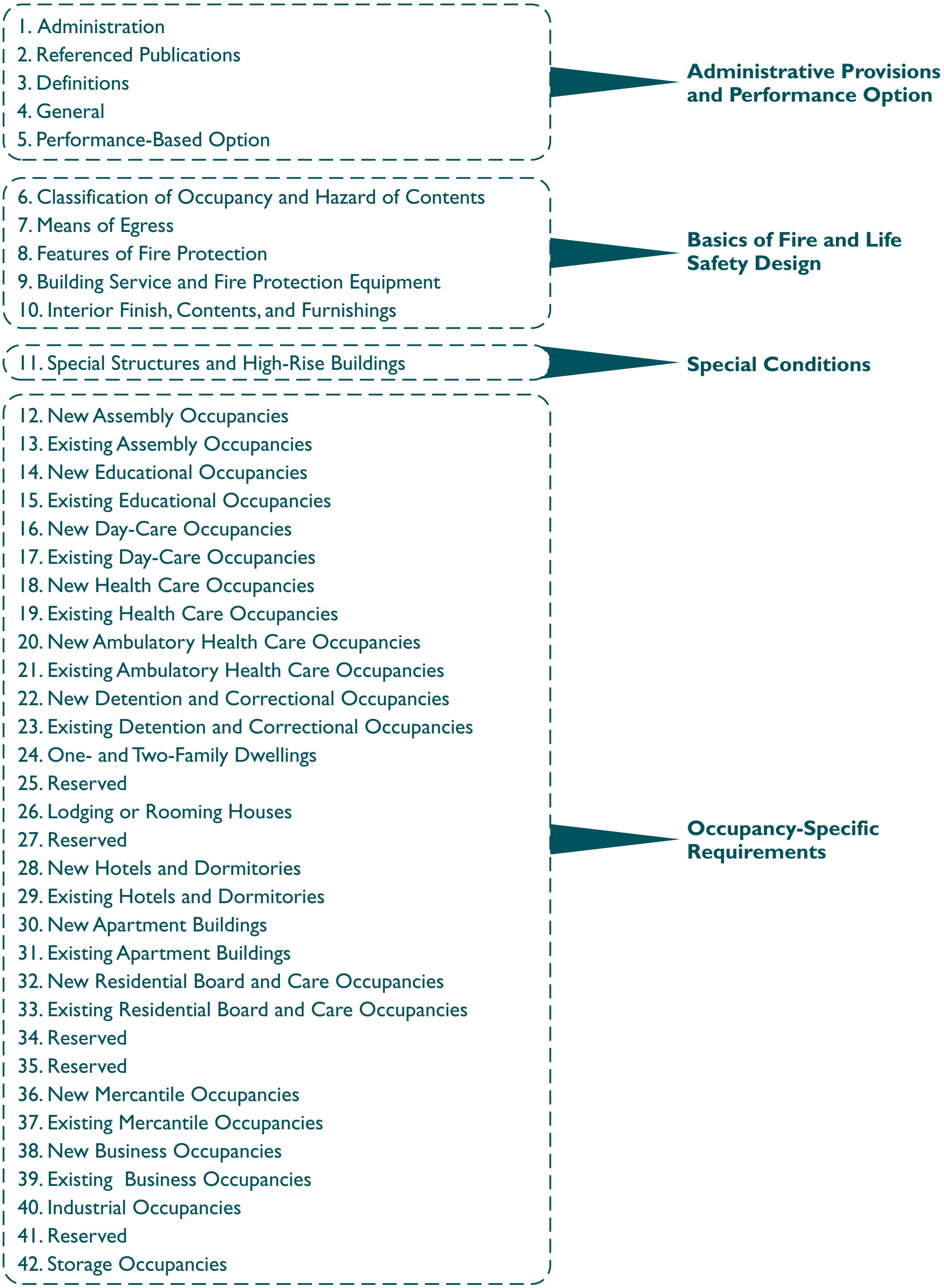

FIGURE 1-4

Life Safety Code Organization. *(Courtesy National Fire Protection Association. Edited by Arup. All rights reserved.)*

FIGURE 1-5

Building Construction and Safety Code Organization *(Courtesy National Fire Protection Association. Edited by Arup. All rights reserved.)*

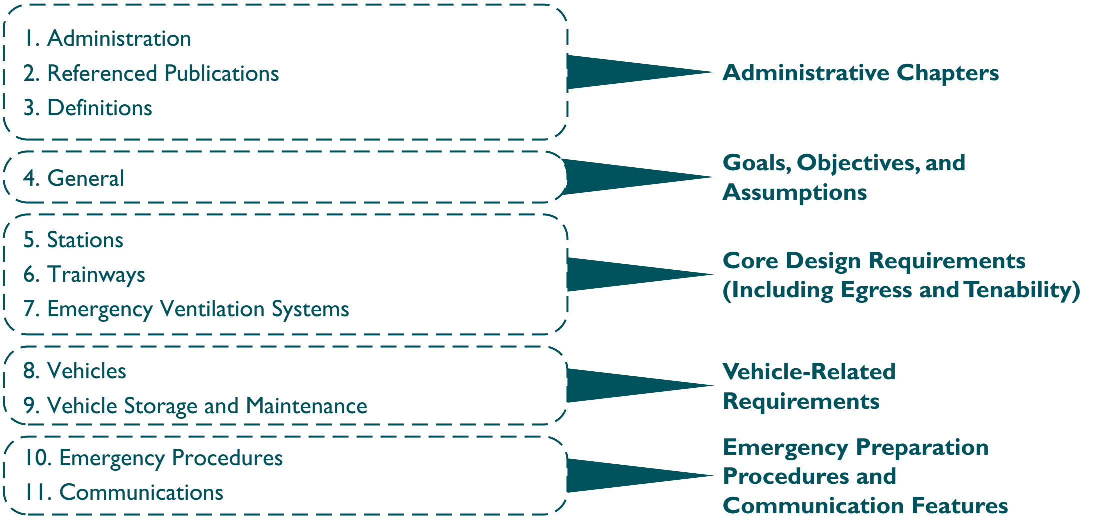

FIGURE 1-6

Fixed Guideway Transit and Passenger Rail Systems Organization. *(Courtesy National Fire Protection Association. Edited by Arup. All rights reserved.)*

performance option within the code. The performance option will be discussed in more detail later in this chapter. The basic structure of the code is as follows:

- Administrative chapters (including the performance option)
- General fire safety
- Occupancy-specific fire safety requirements
- Process-related hazards (e.g., hot work)
- Hazardous materials
- Appendices

Evolution to Performance-Based Codes

Given the prescriptive nature of traditional codes and standards, it is often difficult to determine the overall level of safety actually being provided. The sheer volume of code provisions that must be considered when designing a building means that some provisions may be forgotten, overlooked, or ignored during the design process. The codes have generally allowed the use of alternative designs, but it is not always clear if the intent of the provisions has been satisfied by these alternative approaches. There are many reasons for this; the most compelling of these is that prescriptive regulations do a poor job of identifying the intent of the provisions. Furthermore, although some prescriptive provisions have been developed based on research and test results, many, if not most, are based on empirical evidence and expert opinion. In the latter case, an appeal based on the assertion that a provision is not technically correct or applicable in a specific case may be lost if the assumption is that the code provisions are always technically correct. A possible result in this case is that a safer option may be rejected and a less safe code provision may be enforced.

In concept, performance-based regulations do not prescribe specific construction requirements (e.g., specific fire-resistance rating, maximum travel distance, minimum exit width, etc.). Rather, they provide societal goals, functional objectives, and performance requirements, and permit the use of appropriate methods and materials to be utilized for compliance with the goals, objectives, and requirements (where appropriate methods may be engineering approaches, material testing, or existing prescriptive requirements) (Meacham, 1998a). Intimately tied to the concept of performance-based regulations is performance-based engineering. In fire protection engineering, this has been defined as "an engineering approach to fire safety design based on agreed upon fire safety goals, loss objectives and design objectives; deterministic and probabilistic evaluation of fire initiation, growth and development; the physical and chemical properties of fire and fire effluents; and quantitative assessment of the effectiveness of design alternatives against loss objectives and performance objectives" (Meacham & Custer, 1995; Custer & Meacham, 1997). Similarly, in the Structural Engineers Association of California (SEAOC) *Vision 2000* report on seismic design, performance-based engineering is defined as "selection of design criteria, appropriate structural systems, layout, proportioning, and detailing for a structure and its non-structural components and contents and the assurance of construction quality control such that at specified levels of ground motion and with defined levels of reliability, the structure will not be damaged beyond certain limiting states" (SEAOC, 1995).

One of the pivotal activities in the movement toward performance-based design was the 1991 National Science Foundation–sponsored conference, Fire Safety Design in the 21st Century. The main goal set during this conference was that "by the year 2000 the first generation of an entirely new concept in performance-based building codes be made available to engineers, architects and authorities having jurisdiction . . . in a credible and useful form" (Lucht, 1991). Although the focus of this conference was fire protection and safety, the established goal initiated a much broader effort. As will be seen in the following sections, the above-stated goal was actually accomplished.

DEVELOPMENT OF PERFORMANCE-BASED BUILDING AND FIRE CODES

In the United States, the issue of performance-based fire codes remained a daunting challenge while there were still three different model code organizations drafting prescriptive model building codes and numerous standards-making organizations drafting standards to comply with the prescriptive codes. The situation changed when the International Code Council was formed to develop a single set of comprehensive and coordinated national codes focusing on performance (Traw & Tubbs, 1997). The ICC drafted and published the typical prescriptive codes, but it also initiated a separate effort to address the concept of a performance-based code. At about the same time, the NFPA made a decision to begin pursuing performance-based codes and standards as well (NFPA, 1995). With the ICC and the NFPA deciding to move to performance-based building and fire regulations and with each organization understanding the importance of addressing risk issues in the code development process, a significant opportunity arose to address previously defined regulatory system shortcomings.

With the ICC and the NFPA beginning to look toward the development of performance-based codes and standards in the 1990s, and given the general desire to reduce the number of potentially conflicting codes and standards, there was strong motivation to develop a common performance-based building regulatory system structure for the United States. In April 1996, to facilitate the development of such a system, the Society of Fire Protection Engineers (SFPE) convened the Focus Group on Concepts of a Performance-Based Regulatory System for the United States (Meacham, 1998a, 1998b).

At the time the focus group was convened, it was known that performance-based building regulations were already in use or in development abroad (Lucht, 1991). In order to avoid reinventing the wheel, a straw man regulatory system structure, based on international concepts and developments in the area, was proposed for focus group discussion (Meacham, 1998c). The focus group deliberated the proposed structure and its components and reached consensus on the structure as a model for the United States. This structure and associated concepts are summarized below.

Current prescriptive- or specification-based building regulatory systems consist primarily of a collection of codes and standards that describes how buildings should be designed, built, protected, and maintained with regard to the health, safety, and amenity of the general public. For the most part, this is accomplished using documents that prescribe (or specify) *what* is required for health, safety and amenity, *how* these requirements are to be met, and how compliance with the code is to be *verified.* Since prescriptive-based codes and standards generally combine the what, how, and verification components, they tend to be both voluminous and restrictive.

Alternatively, a performance-based regulatory system is one that generally has three *separate* components:

- **Codes,** which, through societal goals, functional objectives, and performance requirements, reflect society's expectations of the level of health and safety provided in buildings (e.g., items such as acceptable access, egress, ventilation, fire protection, electrical services, sanitary services, etc.)

- **Standards and practices,** which are separate documents, adopted by reference, that describe accepted methods for complying with the requirements of the code(s)
- **Evaluation and design tools,** which provide accepted methods for assisting in the development, review and verification of designs in accordance with engineering standards and practices

In such a system, there is a clear differentiation between the three components:

- The requirements of the code (the *what* component)
- The acceptable means for complying with the requirements of the code (the *how* component)
- The acceptable means for demonstrating that the proposed solutions comply with the requirements of the code (the *verification* component)

The ICC and NFPA projects both addressed the concept of performance-based codes and building regulatory systems. Egress—a cornerstone of modern building regulations—was a critical element dealt with in both of these efforts. The following is a brief history of the development of the basic structure of these performance provisions.

ICC

From 1996 to 2001, two separate committees (ICC's Performance Building Code Committee and, later, ICC's Performance Fire Code Committee) began the development of a performance code. These committees used the information gathered at an international level and their knowledge of building regulations on an everyday, local level to create the first stand-alone performance building and fire code for the United States. The net result of this effort was the publication of the *ICC Performance Code for Buildings and Facilities* (ICCPC) in 2001 (ICC, 2001). Since then, two more editions have been published, in 2003 and 2006. This section will provide an overview of the ICCPC. Figure 1-7 depicts the general organization of the ICCPC. The ICCPC has four main parts:

- Part I: Administrative (Chapters 1–4)
- Part II: Building (Chapters 5–15)
- Part III: Fire (Chapters 16–22)
- Part IV: Appendices (A–E)

Part I: Administrative

Part I of the document contains four chapters: those for which common approaches were found for both building- and fire code–related topics. Chapter 1 includes administrative provisions such as intent, scope, and requirements related to qualifications, documentation, review, maintenance, and change of use or occupancy. This section can be used as a framework for jurisdictions even when

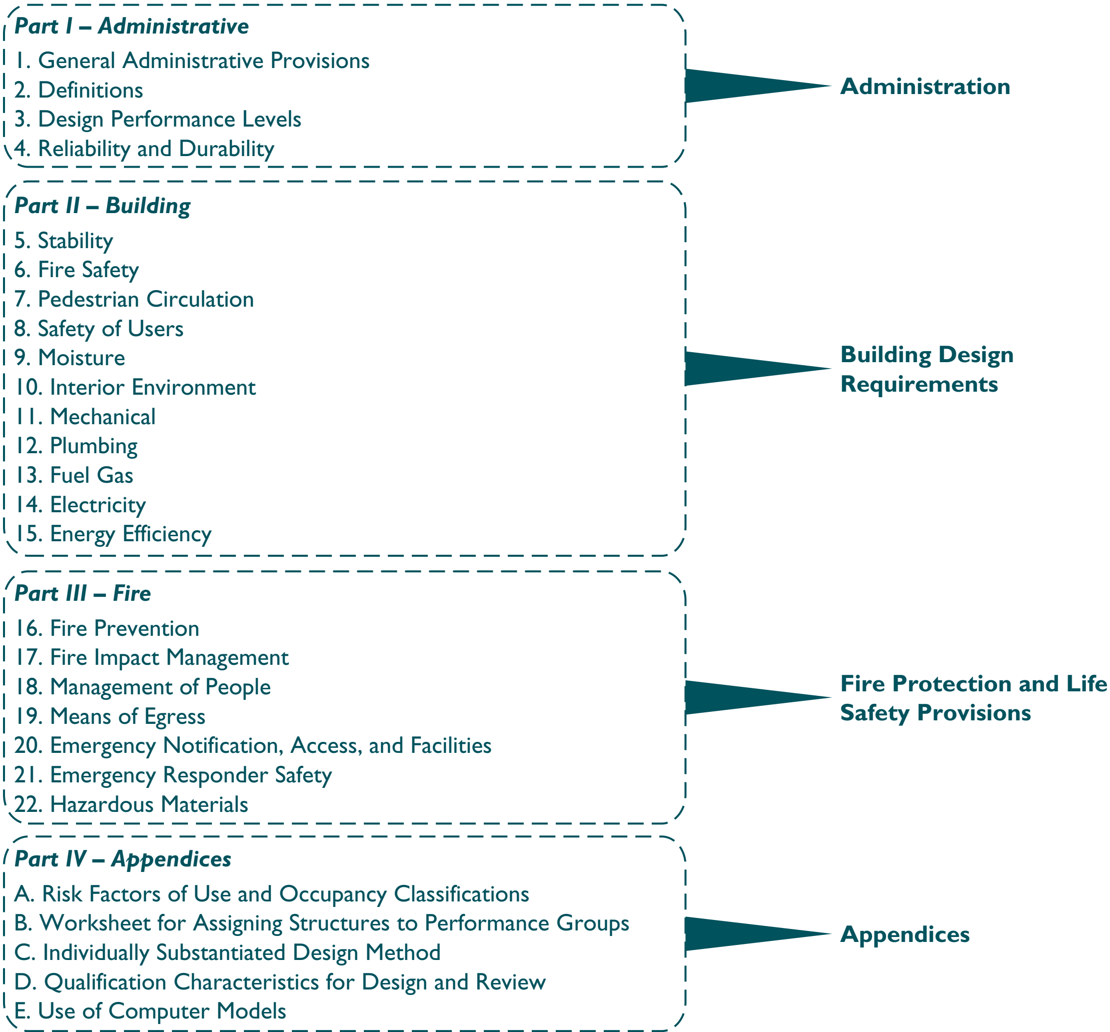

FIGURE 1-7

International Code Council Performance Code Organization. *(Courtesy International Code Council. Edited by Arup. All rights reserved.)*

the ICCPC is not adopted. Provisions for approving acceptable methods are also provided in Chapter 1. Chapter 2 provides definitions specific to the ICCPC. Chapter 3 is a critical chapter that establishes design performance levels. This chapter is the risk-level determination missing from traditional prescriptive codes. Finally, Chapter 4 addresses reliability and durability. This is not a subject dealt with explicitly in the current traditional prescriptive approaches. Reliability includes redundancy, maintenance, durability, quality of installation, integrity of the design and, generally, the qualifications of those involved with this process.

❖*Parts II and III: Building and Fire*

Parts II and III provide topic-specific qualitative statements of intent that relate to current prescriptive code requirements. The topic-specific qualitative statements are the basic elements missing from the prescriptive codes. These statements, found in Parts II and III, follow the hierarchy described below:

- **Objective.** The objective states what is expected in terms of societal goals–what society demands from buildings and facilities. It deals with aspects of performance required from a building, such as safeguarding people during escape and rescue.
- **Functional statement.** The functional statement explains the function a building must provide to meet the objective. For example, a building must be constructed to provide people with adequate time to reach a place of safety without exposure to untenable conditions.
- **Performance requirements.** Performance requirements are detailed statements that translate the functional statement into terms that can be measured and link them to those methods deemed acceptable.

❖*Part IV: Appendices*

Part IV contains the appendices to the code document. Each of the appendices relates back to specific provisions of this code. The *User's Guide to the ICCPC* (ICC, 2006h) discusses their intended application in more detail.

❖*Egress*

Egress is explicitly addressed in the ICCPC in Chapter 7, "Pedestrian Circulation," and in Chapter 19, "Means of Egress." Note that the provisions are the same in both of these chapters. The reason for including these provisions in two different chapters relates to how the code is structured to address both building code and fire code issues. The following is an excerpt from Chapter 19, including the objective, functional statement, and one of the performance requirements. Note that there are multiple performance requirements–only a limited excerpt is shown here.

SECTION 1901

MEANS OF EGRESS

1901.1 Objective. To protect people during egress and rescue operations.

1901.2 Functional statement. Enable occupants to exit the building, facility and premises or reach a safe place as appropriate to the design performance level determined in Chapter 3.

1901.3 Performance requirements.

1901.3.1 General. The construction, arrangement and number of means of egress, exits and safe places for buildings shall be appropriate to the travel distance, number of occupants, occupant characteristics, building height, and safety systems and features.

Other requirements found in the ICCPC assist in addressing egress or, more generally, people movement and safety while in a building. These include accessibility, transportation equipment (such as elevators), signage, and general occupant notification. More detail regarding the scope and use of the ICCPC can be found in the *User's Guide to the ICCPC* (ICC, 2006h) and *Performance-Based Building Design Concepts* (Meacham, 2004).

NFPA

The NFPA took a somewhat different approach than the ICC in the development of its performance building code. In fact, the NFPA does not have a model performance building code per se; there is a performance option in many of its codes and standards instead. Of particular interest are the performance options found in NFPA 5000, *Building Construction and Safety Code* (2006c), and in NFPA 101, *Life Safety Code* (2006b). This follows an early decision to keep the performance and prescriptive parts of the code in the same document, presenting the performance portion as an alternative to the prescriptive.

The NFPA embarked on the development of performance options with the formation of a performance-based support team, which is intended to provide aid to technical committees interested in integrating performance concepts in a particular code or standard. The process of introducing these concepts began with the release of a report titled *NFPA's Future in Performance-Based Codes and Standards* (NFPA, 1995). This document outlined fundamental performance concepts for consideration by the NFPA technical code development committees and encouraged the development of further documents to support these efforts. Based on this need, several primers were published; Table 1-2 lists the topics covered by each. These primers are specifically intended to serve as a resource for the NFPA technical committees. Technical committees incorporated these concepts into NFPA documents as part of their efforts to develop broad, performance-based provisions. In the late 1990s, a few technical committees took these documents and other references and began to develop performance options.

TABLE 1-2

NFPA Primers

Primer	Subject	Publication Date
1	Goals, Objectives & Criteria	1997
2	Characteristics & Assumptions	1999
3	Fire Scenarios	1998
4	Performance-Based Verification Methods	1999
5	Reliability	1999

Their approach has been to integrate performance concepts within documents such as NFPA 101 and NFPA 5000. In these two documents, the performance aspects are essentially found in Chapters 4 and 5. Chapter 4 provides the overall goals and objectives of the document, sets the framework for compliance, and applies to the entire code. In other words, the goals and objectives apply generally, but it is up to the designer to make the decision whether to take a performance or prescriptive approach. Goals and objectives are defined as follows (NFPA, 2006b):

> **Goal.** A nonspecific overall outcome to be achieved that is measured on a qualitative basis.
>
> **Objective.** A requirement that needs to be met to achieve a goal.

NFPA 101 focuses primarily on life safety, and more specifically on safety from fire and other hazards, as well as on crowd movement safety for both emergency and non-emergency situations. Because the scope of NFPA 5000 is broader than that of NFPA 101: *Life Safety Code,* there are a variety of goals beyond safety from fire, including the following:

- Safety
- Health
- Accessibility
- Public welfare

The two goals stated within the *Life Safety Code* are as follows:

> 4.1.1 Fire and Similar Emergency. The goal of this code is to provide an environment for the occupants that is reasonably safe from fire and similar emergencies by the following means:
>
> (1) Protection of occupants not intimate with the initial fire development
>
> (2) Improvement of the survivability of occupants intimate with the initial fire development
>
> 4.1.2 Crowd Movement. An additional goal is to provide for reasonably safe emergency crowd movement and, where required, reasonably safe non-emergency crowd movement.

The most relevant objective as it relates to egress is shown below. Generally, all the objectives found in NFPA 101 relate back to egress, either directly or indirectly.

> 4.2.1 Occupant Protection. A structure shall be designed, constructed, and maintained to protect occupants who are not intimate with the initial fire development for the time needed to evacuate, relocate, or defend in place.

A sample of a goal and objective related to egress found in NFPA 5000 follows:

4.1.3.1 Safety from Fire.

4.1.3.1.1 Safety from Fire Goal. The fire safety goal of this code is as follows:

(1) To provide an environment for the occupants inside or near a building that is reasonably safe from fire and similar emergencies

(2) To provide reasonable safety for firefighters and emergency responders during search and rescue operations

4.1.3.1.2 Safety from Fire Objectives.

4.1.3.1.2.1 Buildings shall be designed and constructed to protect occupants not intimate with the initial fire development for the time needed to evacuate, relocate, or defend in place.

As noted, NFPA 5000 has more goals, such as safety during building use. This particular set of goals relates to egress in terms of elements such as signage, occupant notification, and crowd movement. The following is the objective related to signage:

4.1.3.3.2.5 Buildings shall be designed and constructed to provide reasonable signage to identify hazards, means of egress, and other building safety features.

Again, Chapter 4 specifically allows either a performance or prescriptive approach. If a prescriptive option is chosen, then compliance with Chapters 1 through 4 and 6 and beyond is required. Otherwise, a performance approach would simply require compliance with Chapters 1 through 5 in both NFPA 101 and NFPA 5000. In both codes, there are some minimum prescriptive requirements that always apply. For example, there is a requirement for at least two exits. This creates a baseline that must always be met. There is also the stated assumption that the code is based on a single fire source. In most cases, a design will be a combination of prescriptive and performance approaches. NFPA 101 and NFPA 5000 specifically allow this combined approach.

Chapter 5 takes the performance approach to the next level of detail by providing performance criteria and design scenarios, which are defined as follows:

Performance Criteria. Threshold values on measurement scales that are based on quantified performance objectives.

Design Fire Scenario. A fire scenario selected for evaluation of a proposed design.

Performance criteria link the objectives to more specific and measurable requirements. The performance criterion found in NFPA 101 is as follows:

5.2.2 Performance Criterion. Any occupant who is not intimate with ignition shall not be exposed to instantaneous or cumulative untenable conditions.

Examples of several criteria in NFPA 5000 are as follows:

> 5.2.2.4 Safety from fire means shall be provided to evacuate, relocate, or defend in place occupants of buildings for a time sufficient to prevent them from exposure to instantaneous or cumulative untenable conditions from smoke, heat, or flames.
>
> 5.2.4.4 Safety during building use signs shall be provided to identify means of egress, exits, emergency safety features, potential hazards, and features intended for the safety and for the amenity of occupants with physical or sensory limitations.

The next step in the process is reviewing the design based on the related performance criteria and the associated hazards defined in the design scenarios. The application of these scenarios in reviewing an actual design will be addressed in more detail in Chapters 3 and 7 of this book. The design scenarios do not necessarily relate to egress specifically, but rather represent potential hazards that may affect the safety of occupants. The scenarios relate to occupancy-specific fires, blocked egress, exposure fires, fires in concealed spaces, shielded fires, and fire-protection feature failures. An example that focuses on the loss of an egress path follows:

> 5.5.3.2 Design Fire Scenario 2.
> Design fire scenario 2 shall be as follows:
>
> (1) It is an ultra fast-developing fire, in the primary means of egress, with interior doors open at the start of the fire.
>
> (2) It addresses the concern regarding a reduction in the number of available means of egress.

The intent is that each of these design scenarios be used to test the performance of the design. NFPA 101 and 5000 do not limit the designer to these scenarios; instead, these scenarios are seen as a baseline. Both documents also acknowledge that there may be instances in which some of the design scenarios may not be appropriate. This process will be discussed in more detail in Chapters 3 and 7.

INTERNATIONAL PERSPECTIVE

The movement in many other countries has been toward performance-based building codes. As mentioned at the beginning of this chapter, codes outside the United States tend to be developed at a federal level or are at least developed on a national level and then adopted by state, territorial, and provincial governments. A code process that operates at the national level leads to more political pressure to address international trade, deregulation, and the creation of an environment that supports innovation than does the code process in the United States. In many other countries it had historically been difficult to propose any alternative approaches to the code; therefore, a performance-based building code provided the flexibility that such regulatory systems needed. In the U.S., equivalencies have been used to fill the gap for new, more innovative approaches, but the level of comfort for applying this allowance in the code varies from one jurisdiction to another.

The movement toward performance codes has encouraged many more designs that utilize a performance-based egress analysis to demonstrate the fire safety of the occupants. This increase in engineered approaches may also be due to the development of technical tools such as people movement models and a better understanding of fire behavior through advanced computer fire modeling using computational fluid dynamics approaches. Depending on the comfort level of the approving body and the scope of the design solution, there is still a general tendency to compare these designs to the traditional prescriptive approaches usually deemed to be acceptable solutions (CIB, 2005). The following is a list of some countries that have adopted or are drafting performance-based building regulations:

- Australia
- Canada (objective-based codes)
- Japan
- New Zealand
- Norway
- Spain
- Sweden

More detailed discussions on the international code arena can be found in various publications (Meacham, 2004; Meacham et al., 2005; ICC, 2006g).

Canadian Approach

Canada took a slightly different approach to performance, and has termed its code "objective-based," knowing that not all elements of building performance are currently defined—or need to be defined. Instead, the existing technical solutions serve as a baseline for all new solutions, including those using a performance-based egress analysis. In creating this system, Canada used a fairly rigorous approach, going through every provision of the code and defining its intent. Therefore, every requirement links specifically back to an intent statement. (Bergeron, Desserud, & Haysom, 2004)

PERFORMANCE DESIGN GUIDES

The trend toward performance-based codes has been somewhat influenced by the advances in technology in areas such as structural and fire engineering. As those advances occurred, it became clearer that more traditional approaches to subjects such as egress within traditional building codes were fairly limited and did not really provide a clear indication as to what was being achieved. As tools that could better predict fire behavior and people movement were developed, the design community desired to apply them. In order to make these methods more palatable to the authorities and to provide a more consistent approach to creating a standard of practice, several design guides in the area of fire protection engineering have been developed internationally. The following are some examples of such design guides:

- *Engineering Guide to Performance-Based Fire Protection Analysis and Design of Buildings* (SFPE, 2006)
- *Application of Fire Safety Engineering Principles to Fire Safety Design of Buildings* (British Standards Institution, 2002–2004)
- *International Fire Engineering Guidelines,* Australian Building Codes Board in cooperation with ICC, Department of Building and Housing, New Zealand, and National Research Council, Canada (ABCB, 2005)

The contents of the guides vary, but each one provides a framework for a process to follow when addressing fire-engineered designs. They begin with the conceptual phase of a project and follow all the way through the operation and maintenance of the facility.

SFPE Process and Review Guides

The process presented in the *Engineering Guide to Performance-Based Fire Protection Analysis and Design of Buildings* published by SFPE is found in Chapter 3 and Chapter 7. This document provides a standard of practice for the design process for both engineers and authorities. An accompanying document titled *The SFPE Code Official's Guide to Performance-Based Design Review* (ICC, 2004) was developed to help guide authorities when reviewing performance-based designs. These documents stress the importance of involving the approving authorities as early in the process as possible. Also, there is an emphasis on the long-term operation and maintenance of a building or facility.

Linking the Processes in Performance-Based Design

A performance-based code is only one piece of a complete performance-based building regulatory framework (CIB, 2005). A complete system requires a link between the policy-level statements—objectives and functional statements—and performance requirements and technical solutions. This means understanding to what extent a building must perform and then linking to acceptable solutions, performance criteria, and verification methods. Design guides, such as those published by the SFPE, are an important part of this system. Figure 1-8 shows the linkage between components of the system and the direction of the information flow.

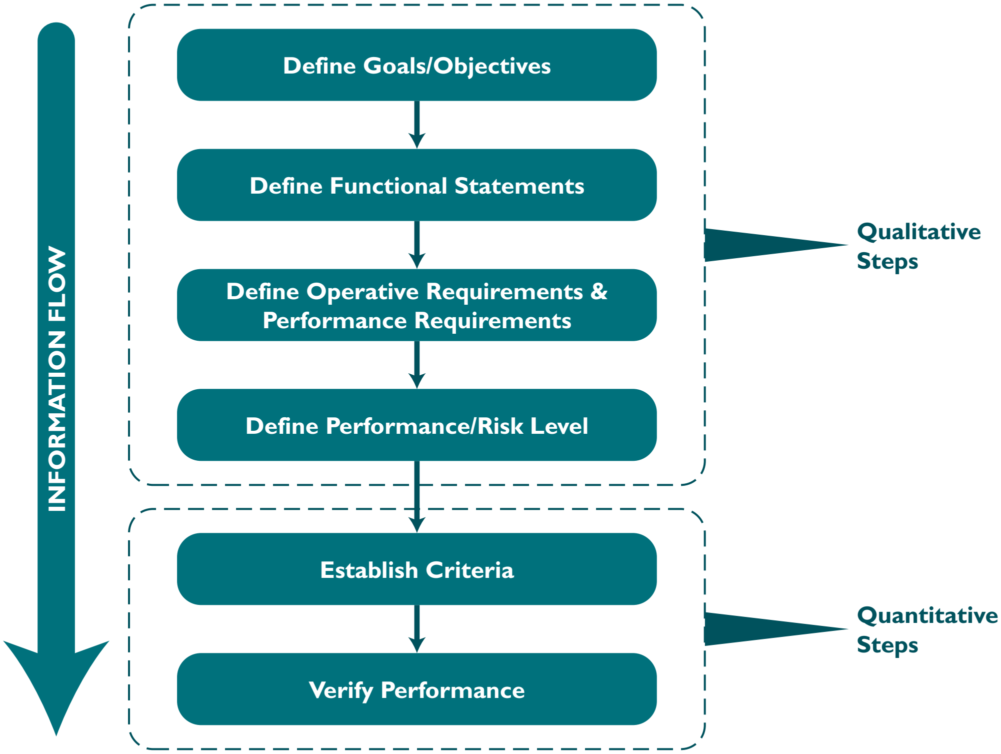

FIGURE 1-8

Performance System Model.

Looking to the Future

It is hard to predict just what the future will bring in terms of building and fire codes. Codes in the United States are becoming more national through a reduction in the number of available model building codes and an increase in the ease with which those involved in building code development and enforcement can communicate. There are many educational opportunities through a variety of venues that are slowly reducing the variation of amendments and interpretations. New technologies are also affecting building and fire departments, even those in some small jurisdictions, through the addition of such practices as electronic permitting. These educational opportunities and new technologies can help reviewing authorities keep pace with the evolving building design field.

There is a general international trend toward performance-based codes. This trend in the United States is slower, as there is no real incentive for jurisdictions to adopt such codes. These same jurisdictions will more often be faced with requests for the use of performance-based engineering to address fire hazards, which often include egress analysis through the equivalency process.

Events such as the destruction of the World Trade Center and Hurricane Katrina may not change building codes dramatically, but they have raised concerns and questions with regard to egress strategies covered in the current codes:

- Should the codes address full building evacuation?
- Should elevators be allowed for egress when they have traditionally been discouraged?
- Should stairway enclosures require special locations and protection?
- What types of hazards should be addressed for egress–is fire the only hazard?
- What about multiple buildings exiting at the same time–is that a building code concern?

To address these questions, the concept of risk needs to be explored further. Perhaps the capability for full building evacuation is important in one building due to its iconic status, but not in another, even if they are identical buildings.

There has been an ongoing debate in the code arena regarding balanced fire protection. There are some who feel that too much dependence has been placed upon active systems, so that if a major event such as an earthquake occurs, all the critical systems will be lost (Kluver, 2005). Others feel that the current approaches are still robust enough to address any concerns. This ongoing debate may have some impact on the egress requirements in the codes.

There does seem to be a trend for the addition of new objectives to building codes as societal expectations evolve. Historically, codes have focused on health, safety, and public welfare. More recently, building codes have begun to address civil liberty issues, such as providing access to all. This has had an effect on egress provisions–and will continue to do so in the future. In particular, it has focused attention on the use of elevators for egress and on requirements for providing areas of refuge. There is also movement to integrate accessibility with the rest of the code rather than treat it as a separate objective.

Another area of interest is security. To most people, security is a higher priority than fire safety, as its effects are more obvious on a daily basis. Unfortunately, it tends to conflict with fire safety strategies without proper consideration of both issues together. These areas and others will likely drive changes to egress requirements.

Tragic events such as the fire at the Station nightclub in West Warwick, Rhode Island, have a tendency to shape the requirements of the code. Evaluation of the codes after such events is always appropriate, but such changes should be made in a well-thought-out and constructive way. Hopefully, as more and more tools for analyzing fires and the movement of people become available, and as more information is obtained about human behavior, codes will be more proactive than reactive, and decisions will be based on sound technical information that can be linked more readily to societal goals.

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