PROGRESS TOWARD A PERFORMANCE-BASED CODES SYSTEM FOR THE UNITED STATES

by

Richard W. Bukowski
Building and Fire Research Laboratory
National Institute of Standards and Technology
Gaithersburg, MD 20899

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Richard W. Bukowski, P.E.
Senior Research Engineer
NIST Building and Fire Research Laboratory
Gaithersburg, Maryland 20899 USA

ABSTRACT

The Unites States' codes and standards are currently undergoing a complete revision to bring them eventually to a performance basis. While the process is unique to the U.S. due to its legal structure and constitution the end result is envisioned to be consistent with similar changes to codes around the world. This paper reviews the historical reasons behind the U.S. codes and standards system, current efforts to develop a single model code, and the process and schedule for the implementation of a performance code. Draft scope and intent statements from the new performance code are presented and some enforcement issues related to performance-based regulation are discussed.

INTRODUCTION

In 1996 the United States building regulatory community began a formal process of developing a performance-based system to (eventually) replace its prescriptive codes and standards. This decision, and the development process itself is more involved for the United States because of the diffuse nature of our system compared to most countries where the responsibility rests with the National authority. However, once made the numerous codes and standards development organizations in this country have begun working toward this common goal, albeit with some initial differences in individual vision of the final product.

In this paper the history and current structure of the building regulatory system will be reviewed and the ongoing activities of the codes and standards writing bodies to develop performance documents will be discussed. Potential time schedules will be presented along with some thoughts on issues yet to be resolved.

HISTORY [1]

The United States was formed in 1787 when 13 sovereign states banded together under a Constitution which recognizes a central (federal) government only for the purpose of addressing common problems. Under the Constitution most legal authority is retained by the States, including the responsibility for "public safety" including all enforcement (police) powers. Thus to this day the U.S. federal government has no direct role in the development, promulgation, or enforcement of building codes with the single exception of manufactured housing (mobile homes), because their manufacture and use often crosses state borders.

The first codes regulating construction features appeared in New York City in 1860. But the real origin of our modern codes was the Great Fire of Boston in 1872 in which 70 insurance companies were driven into bankruptcy by claims. The remaining companies formed the National Board of Fire Underwriters (NBFU) which began to develop fire safety regulations upon which insurance rates were based, and eventually their National Building Code (NBC). The NBC was widely adopted by cities because of its direct linkage to the NBFU's Municipal Grading Schedule and thus to insurance rates. Cities needed favorable insurance rates to attract and maintain investment and growth. These same forces (and some of the same people) were involved in the establishment of Underwriters Laboratories (UL) in 1894 and the National Fire Protection Association (NFPA) in 1896. Thus at the beginning of the 20th century, cities generally had codes which dealt with fire prevention and disaster response, and insurance companies had regulations intended to limit their losses by protecting property.

In 1927 differences in materials and construction in the western states led the West Coast Fire and Building Officials (later the International Conference of Building Officials) to develop the Uniform Building Code (UBC) that recognized the timber construction more prevalent in the west as compared to the steel and concrete used in the larger cities in the east. The Standard Building Code (SBC) appeared from the Southern Building Code Congress International (SBCCI) in 1946 and the BOCA (Building Officials and Code Administrators) National Building Code was first published in 1950. Thus it was regional differences in materials and construction which drove the evolution of the three model codes used today.

Life safety from fire began to capture the public interest in the early part of this century after a series of fires claimed numerous victims. The U.S. fires which had the greatest impact on the evolution of codes include:

- 1903 Iroquois Theater Chicago, IL, 602 deaths
- 1906 San Francisco earthquake/fires, 492 deaths
- 1911 Triangle Shirtwaist Factory New York City, 150 deaths
- 1929 Cleveland Clinic, OH, 125 deaths
- 1930 Ohio State Penitentiary Columbus, OH, 320 deaths
- 1940 Rhythm Club dance hall Natchez, MS, 207 deaths
- 1942 Coconut Grove nightclub Boston, MA, 492 deaths
- 1944 Circus tent Hartford, CT, 162 deaths
- 1946 LaSalle Hotel, Chicago, IL, 61 deaths
- 1946 Wynecoff Hotel Atlanta, GA, 119 deaths
- 1958 Our Lady of Angeles school Chicago, IL, 95 deaths

In each case there were inquiries and demand for stronger laws to protect the public. Each of these fires led to the development of new or revised codes and standards intended to prevent similar tragedies from occurring again. These fires further drove the shift in emphasis from protecting property and reacting to disasters, to the prevention of disasters and provisions for a protected means of egress and control of fire growth and spread to allow safe egress.

By the 1960's the insurance industry was phasing out of the code development business and in 1966 the NBFU closed its doors. The three model code organizations, run by code officials for code officials, had taken over the code development process.

THE MODEL CODE SYSTEM

Model codes are not unique to the United States. Australia and Canada both develop a model code at the national level which is adapted and adopted by the states or provinces. The difference is that model codes in the U.S. are developed by private organizations and adopted and enforced by state or local government, not the national government.

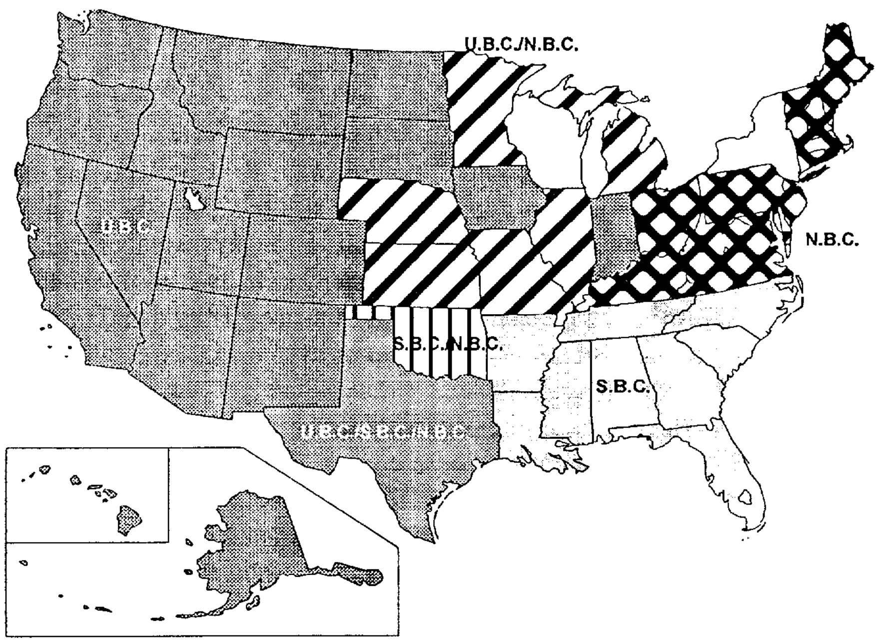

Figure 1- Current use of model codes by States

The model codes are developed under two systems. In the model building code system only active code enforcers can be committee members. The system is open in that anyone can introduce proposed changes and argue in support of or challenge any change at code change hearings which are open to all; but voting is ultimately limited to members of the model code organization who are code enforcers. This structure was adopted because the legal responsibility for the public safety rests with the code officials and they have always been reluctant to delegate that authority.

The NFPA system is referred to as a "consensus" system in that it follows the consensus process as defined by the American National Standards Institute (ANSI). This requires that the only restriction on committee membership and voting is one of balance; no more than 1/3 of voting members may represent any single interest group. Like the building codes, code changes are processed through public proposal and public comment cycles, and then debated in a public meeting at which anyone can attend and speak. A vote is taken at this meeting of NFPA members in attendance after which there is a procedural review by a balanced committee called the Standards Council, who also provide an appeals function.

A key feature of model codes is their adaptability. These codes have no force of law until adoption by a legislative body who frequently adapt the model code to local needs. This may be as straightforward as the deletion of hurricane provisions by a jurisdiction with no coastal areas or as subtle as imposing more restrictive requirements for roofing materials in a jurisdiction with a wildland fire problem. The model codes facilitate such local tailoring of the code by incorporating requirements which recognize regional needs. Examples are maps of climate and seismic zones for which different levels of performance are required.

STANDARDS

The U.S. has a system of standards which support the codes in various ways. In general a code specifies what is required and a standard describes how this is accomplished, reliably. Fire safety standards cover a myriad of topics, but can be considered to fall into several, broad categories. Standards on fire protection systems and components such as fire alarm, sprinkler systems, fire pumps, emergency power systems, etc., are all intended to assure the reliable operation of critical equipment in the event of a fire. They detail the proper installation, maintenance, and use of the equipment or systems covered which are deemed necessary to assure reliable operation.

Another category of fire standards covers the safe installation and operation of equipment and systems needed to prevent fires from starting or to limit their size or impact. Examples would include standards on ovens and furnaces, chimneys and fireplaces, power plants (nuclear or fossil fueled), and various standards on the safe storage and handling of combustible or hazardous materials.

A third category of fire standards relate to test or measurement methods or standard guides on methods for the collection of information or to define a process such as the investigation of fires or the conduct of fire hazard or fire risk assessments. These standards attempt to provide reliable and consistent information on which decisions can be made with confidence. Finally, there are product (approval) standards which detail minimum requirements for how materials and products perform under expected conditions of use.

In a performance-based system standards will need to evolve in a way that they will serve the needs of the performance code. Since the code is built around explicit objectives, the standard needs to clearly state its intent regarding the purpose of the system or feature covered. For example, alarm systems are intended to provide early detection of an unwanted fire, notification to the occupants of the need to evacuate or relocate, and notification of the fire service of the need for their assistance and, in large buildings, direct them to where they need to go. Further, an alarm system should **not** respond to conditions not associated with an unwanted fire and should **not** direct the fire service to areas other than where the fire is to be extinguished. Finally, alarm systems should be reliable and able to meet their stated objectives (or some subset thereof) during any single fault condition from a specified set.

Thus, the form of a performance standard will be first, to explicitly state its purposes and second, to provide a means to establish quantitatively what constitutes meeting those purposes. In addition, any quantitative measure of the ability of the system to fulfil its purpose needs to include the reliability of systems. This refers to the likelihood that such protective systems will perform as intended when called upon to do so. Like the code, the performance standard will have "deemed to satisfy" provisions which describe arrangements which are known to meet the intent. Current prescriptive standards are likely to comprise early "Approved Documents" for standards as well.

CONSOLIDATION OF THE SYSTEM

By the mid 1980's attention in many parts of the world began to turn toward the development of performance-based codes. Performance was discussed for many years as a way of rationalizing codes whose intent was often unclear, and as a means of making the system more cost effective. Development of fire models and engineering analysis methods needed to evaluate the fire performance of buildings enabled this transition to begin at this time.

By the early 1990's several countries including the United Kingdom and New Zealand had made the leap, and many others had committed to the process. Globalization of the building design and construction industry led to interest in harmonization of the engineering methods and the performance codes themselves. On December 4, 1994 the U.S. model code organizations led by their presidents, Jon Traw (ICBO), Paul Heilstedt (BOCA) and William Tangey (SBCCI) agreed to consolidate their model codes into a single document and to pursue the development of a performance code, all under a new organization, the International Code Council (ICC). In 1996 the ICC established a series of committees to develop the first edition of the consolidated model code; the International Building Code (IBC), to be ready for adoption by the year 2000. Also established was a Performance Criteria Committee tasked with the development of a parallel performance code.

The NFPA also recognized that their codes and standards needed to evolve to a performance basis. Following a plan developed by an in-house task group, additional staff were recruited and several committees, including the Technical Committee on Safety to Life began a process of revising their documents to fit within a performance-based regulatory framework.

There has always been some overlap between the model codes and some of the NFPA codes, especially the Life Safety Code. The model building codes regulate newly constructed buildings but include requirements for some life safety features of existing buildings, including means of egress provisions. The Life Safety Code specifies life safety features for both new and existing buildings, including means of egress provisions for both. The NFPA is on record as wanting the IBC to reference the Life Safety Code for these requirements. The IBC is inclined to retain their detailed requirements at least for the prescriptive version.

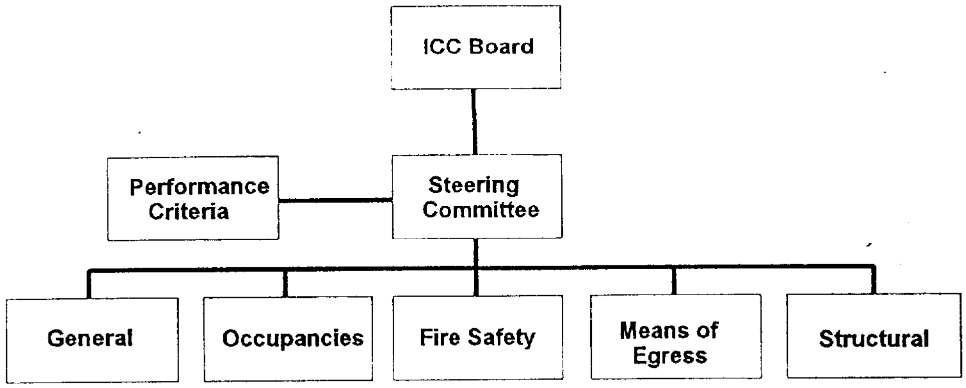

Figure 2- Organization of the IBC Drafting Committees

In the U.S. system, existing buildings are regulated by model fire codes and each of the model code organizations had there own, as well as NFPA's Fire Prevention Code (NFPA 1). The ICC planned to consolidate their three fire codes and entered into negotiations with NFPA to join in the promulgation of a single such code. This process reached its conclusion early this year and the International Fire Code (IFC) committees were formed using the same model as for the IBC development.

Other parts of the U.S. codes system includes plumbing, mechanical, fuel gas, and electrical codes. The ICC produced a International Plumbing Code (IPC) and International Mechanical Code (IMC) before beginning the IBC development. The NFPA's National Electrical Code is the generally accepted such U.S. code and will likely continue in this role without competition from the ICC. The status of NFPA's National Fuel Gas Code has not been resolved with the ICC at this writing.

THE NEW CODES

The ICC has organized a series of committees to develop the new IBC and IFC for adoption in the year 2000. Both code development activities are using the same process with some notable exceptions.

The IBC and the IFC are being developed in parallel tracks for a prescriptive version and a performance version (see figure 3). For the prescriptive version the committee structure is the traditional one; committee members are drawn only from active regulatory officials, building code or fire code enforcers, respectively. The consolidated codes are being drafted by merging of the existing codes, resolving differences which exist among the current model codes along the way.

A working draft of the IBC was released to public review in June. This version of the code will be adopted as the single model code until the performance-based version is completed.

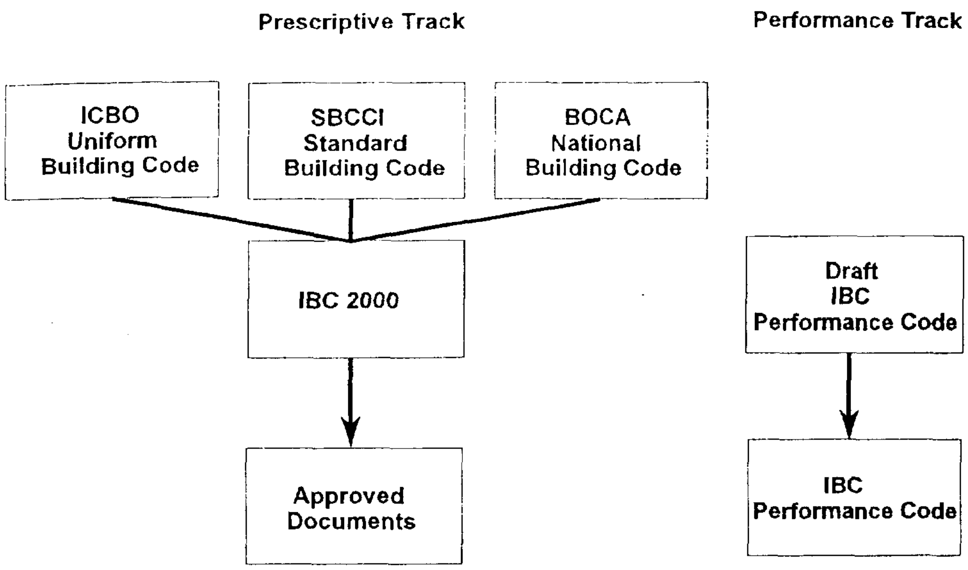

Figure 3- Parallel tracks for the IBC development

Then it is likely to become the approved documents or acceptable solution for the performance-based version.

The inclusion of NFPA 1 in the mix of fire codes required a different approach because the NFPA code development and approval process differs from that used by the model code organizations. In the NFPA process committee members can represent many interests and the approval of the document involves a vote of the entire NFPA membership present at the code change meeting at which the document is considered.

The agreement negotiated between ICC and NFPA on the IFC development allows for the draft code to proceed through both processes in parallel. Any differences that appear as a result of this are resolved by a resolution committee made up of equal number of members of both organizations.

The development of the performance versions of the IBC and IFC differ in that they are not being developed from existing codes but rather as new documents. The performance code development committees include "special experts" in voting positions; including fire protection engineers, educators, professional societies, insurance, and architects. The committees were given complete freedom to choose format, organization, and content.

The IBC Performance committee spent considerable time examining other performance codes and the entire state-of-the-art before beginning to draft language. The New Zealand code emerged as the primary model, although Canada, Australia, and the United Kingdom codes influenced some elements. The first draft of the performance code document is expected to be released for public review early in 1998.

The IFC committees are just beginning their work, so the rate at which they can make progress toward their assigned goals is as yet unclear.

The NFPA's Life Safety Code (LSC) is also undergoing a performance-based makeover. The LSC is organized into "core" chapters which deal with such general topics as means of egress, fire protection features (compartmentation, finishes and contents), and building systems (utilities and mechanical systems, detection and suppression), followed by specific requirements by building use (occupancy) generally separated into new and existing buildings.

The LSC occupancy committees were asked to develop design fire scenarios for their occupancies which represent the challenges which they expect buildings to meet. This discussion also includes scenarios which go beyond what they feel should be generally applied. These design scenarios include a characterization of the building, its fuel load, and occupants. This process is being done to establish the acceptable level of risk from fire which can be referenced in other codes.

Most of the scenarios identified by the committees are the ones that are common in the incident records for that building use. Some are rare events but involve conditions that should reasonably be planned for. Some were explicitly excluded in recognition that they go beyond the level against which society expects to be protected. These include the unanimous rejection of terrorist scenarios and rejection by all but one of a scenario in which an aircraft crashes into the building; even though such an event as happened twice in the past decade. The Health Care Committee included the crash of a helicopter on the helipad of the building since helicopter operations in marginal weather are common at trauma centers.

STRUCTURE OF THE NEW CODES

The prescriptive version of the IBC is a consolidation of the existing codes, and as such uses the "common code format" of the current codes. It is in the performance version where the major differences will appear.

The intent and scope statements drafted by the IBC performance committee are intended to apply to the entire code whether prescriptive or performance. They clarify the overall goals of the entire code at the highest level. The draft statements as currently proposed are:

Intent

> *The intent of this code is to provide a reasonable level of health, safety, and welfare, to protect the public from the risk of death or injury and to limit damage to property from unintentional and natural events which are expected to impact buildings and structures.*
>
> *Accordingly, this code intends to provide for:*
>
> > *an environment free of unreasonable risk of death or injury from fires,*

- *a structure which will withstand reasonable loads associated with normal use, and wind, snow, or earthquake or the severity associated with the location in which the structure is constructed,*
- *a design which provides reasonable means of egress and access,*
- *reasonable arrangements to limit the spread of fire both within the building and to adjacent properties,*
- *adequate ventilation and sanitation facilities to maintain the health of the occupants, and*
- *adequate arrangements for natural light, heating, cooking, and other amenities needed for the comfort of the occupants.*

Scope

To achieve its purpose this code provides minimum requirements for buildings and structures and includes provisions for structural strength, stability, sanitation, means of access and egress facilities, light and ventilation, safety to life and property from fire and, in general, to secure life safety and property from other hazards affecting the built environment. This includes the use and occupancy of all buildings, structures, facilities and premises, their alteration, repair, maintenance, removal, demolition, and the installation and maintenance of all amenities including but not limited to such services as the electrical, gas, mechanical, plumbing, and vertical transportation systems.

The performance code then follows the structure common (the so-called Nordic model) to many of the other performance codes such as New Zealand, United Kingdom, and Australia. The sections included are:

Objectives describe what you are trying to achieve in terms of building performance. At this level such objectives are topic specific and deal with a particular aspect of building performance such as "to protect people during escape and rescue operations."

Functional Statements explain in general terms what needs to take place in order for the objective to be met. For example, "means of egress shall give people adequate time to exit the building or to reach a safe place without exposure to untenable conditions and to give rescue personnel adequate access to undertake rescue and emergency management operations."

Performance Requirements are more detailed statements which tell how to meet the functional statements to in turn meet the objectives. These would cover determination of the number and size of exits, travel distances, markings, and the influence of protective systems and characteristics of occupants on the ability of the occupants to safely egress.

Guidelines/Baseline Criteria is the linkage between the performance requirements and the Acceptable Solutions. This linkage establishes the baseline for the acceptance of performance designs and sets quantitative criteria.

Acceptable Solutions are the specific methods that may be utilized to achieve the performance requirements which in turn meet the objectives of the code. To be judged acceptable the user can use a performance design approach involving calculations or testing, a prescriptive approach, or some combination of both.

It should also be noted that only the first three sections (objectives, functional statements, and performance requirements) are mandatory, with the last two (guidelines/baseline criteria and acceptable solutions) being advisory. Since most changes to the performance code will affect only the advisory portions, this will result in a significant simplification in the legal adoption process at the local level.

ENFORCEMENT ISSUES

The transition to a performance code system brings with it a number of enforcement issues which are being discussed in the committees. The current thinking is that the committee will develop use guidelines which may be a part of the code or separately published.

One such issue is the education of designers, engineers, and regulatory officials in the proper use and evaluation of the engineering analysis methods which will be used. In the U.S., the states all have engineering licensing boards and requirements for a licensed engineer to prepare or review and approve all designs associated with public buildings. These engineers are ethically bound to refrain from practice in areas in which they are not qualified. Engineers who cross this ethical line are subject to discipline including loss of their license. Designers will probably rely on engineers for technical analysis as many of them now do. Enforcers will need their own experts. The New Zealand system of mandatory peer review and private plans review are being considered.

There needs to be consensus on which analytical techniques and data are appropriate in what contexts so that the enforcers can have confidence in the methods used. This consensus must come from the engineering community itself; generally expressed in the form of a Code of Practice. Such documents have been published in New Zealand, Australia, United Kingdom, and the Nordic countries, and the Society of Fire Protection Engineers is actively pursuing such a document for the U.S. Internationally, CIB W14 TG1 (Engineering Evaluation of Building Fire Safety Performance) is working on an international consensus and ISO TC92SC4 are documenting the state-of-the-art of fire safety engineering.

Performance-based designs generally rely more on active fire protection features and less on fire rated construction. Thus, the continued, reliable operation of these systems is a crucial consideration in enforcement. Again, the performance committee is looking to New Zealand for the answer. There the building owner must be provided with an owner's manual that details the required systems, their functions and performance requirements, and their required testing and maintenance intervals. The owner must provide annual reports to the regulatory authorities documenting the successful completion of all required service by qualified personnel. This results in a "warrant of fitness" which is publicly displayed in the building.

ADOPTION SCHEDULE

The single (prescriptive) model building and fire codes, the International Building Code and the International Fire Code should be through the development process and ready for adoption by the first states early in the year 2000. Given the current rate of progress the parallel performance building code could be ready on the same schedule. However, it is likely that the performance package, including the prescriptive acceptable solutions will not be ready for consideration until 2002. The development of the performance fire code is only just beginning, so its schedule is not yet established.

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