The Role of Standards In a Performance-based Building Regulatory System

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INTRODUCTION

Building regulatory systems consist of regulations adopted into law through whatever legislative or administrative procedures are appropriate to the legal system in place, supported by standards that provide the detail on what is considered necessary or sufficient to be considered in compliance. Regulations embody the public expectations for how buildings and facilities are expected to perform and as such represent public policy. Regulators, who develop and enforce regulations, are empowered to act in the public interest to set this policy and are ultimately responsible to the public in this regard.

Standards can provide details of methods and evaluation criteria too complex to include within the regulations themselves. Standards, as more technical documents, rely on significant input from technical experts and often are developed by private groups who may have financial interests in the items covered. Standards employed in regulatory contexts should be developed in a fair and open manner and many countries have mechanisms in place to ensure that standards do not restrain trade or limit competition. In recent years the importance of harmonized standards is recognized in the context of facilitating international trade.

This paper is one of a series of discussion papers developed by the Interjurisdictional Regulatory Collaboration Committee (IRCC) and the International Council for Building Research and Innovation (CIB) Task Group TG37, Performance Based Building Regulatory Systems intended to address evolving issues related to building regulatory reform. The IRCC members are the chief building regulatory officials or drafters of a number of countries that are developing or have implemented, performance-based building regulations. IRCC activities involve the sharing of common experiences and developing issues involving public policy and regulatory framework and infrastructure. With a somewhat broader membership, CIB TG37 works closely with the IRCC on related technical issues. A set of papers was presented at the CIB World Building Congress 2001 in Wellington, New Zealand and these topics are developed further in a set of papers (including this one) presented at the 4th International Conference on Performance-Based Codes and Fire Safety Design Methods, Melbourne, Australia, 2002.

THE TRADITIONAL ROLE OF STANDARDS

Standards have traditionally played an important role in building regulations. Standards are frequently cited in regulations as either mandatory or advisory references as a condition on how a specific requirement can be satisfied. Standards used in building regulation cover a range of topics but are usually in one of the following categories:

- Test or measurement standards that provide information on the acceptability (pass/fail), performance category usually under some standard condition (e.g., Class A, 1-hour), or to provide data that can be used to determine acceptability or performance.
- Procedural standards that detail with how products or systems are to be installed, used, maintained, tested, or operated to be fit for the intended use, safe or reliable.
- Interoperability standards that set out a procedure or arrangement that allows products to fit or work together.
- Standards of professional practice, generally accepted methods of analysis or design, qualifications, processes and documentation thereof.

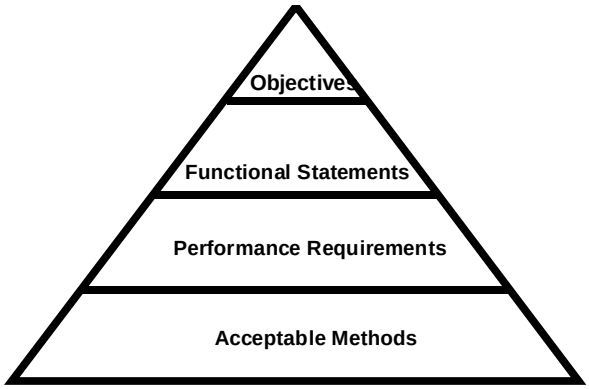
Standards traditionally provide the detailed criteria for acceptability or compliance with the intent of the regulation. For example, regulations will require the provision of fire protection systems or fuel gas systems that are installed, maintained, and used in accordance with some (cited) standards that assure the safety and reliability of these systems. The citation avoids the need for providing detailed criteria within the regulation, and allows for the technical details to be developed and maintained by technical experts in the field in support of the regulatory objectives.

Standards themselves are not adopted as regulations but rather become law indirectly by mandatory reference within regulations. In legal systems such as in the United States, mandatory references are to specific editions of standards to avoid illegal delegation of legislative authority to the standards development bodies. This assumes that the regulatory development or adoption process includes a review of the standard and certification of its applicability, which may or may not be the case. But in general, in the traditional (prescriptive) building regulatory system the code official responsible for the determination of compliance with the regulations also has the authority to accept or reject any portion of mandatory references to standards.

DEVELOPMENT OF PERFORMANCE-BASED REGULATORY SYSTEMS

As building regulatory systems undergo the fundamental change to performance-based, standards will take on a more integrated role that will require changes in the standards development and adoption process of a similar, fundamental nature[1]. Where standards are generally “best practice” documents that are interpreted both by the user and by the regulatory official, regulations are an embodiment of public policy in law and must be enforced by the public officials. Where standards cross this line to regulation, the documents themselves as well as their development process will need to meet a higher level of public involvement than even the so-called “consensus” standards process provides.

Performance-based regulations specify outcomes rather than specific solutions. They are typically formatted as a hierarchical structure (figure 1) in which the top level contains objectives expressed as qualitative statements. These objectives break down into functional statements (also qualitative) of sub-objectives that must be achieved to attain the objective. Following this are performance requirements that provide quantitative measures of when the functions, and thus the objectives, are satisfied. Finally come acceptable methods that can include verification methods recognized as appropriate for verifying the required performance or "deemed to comply" solutions that generally include the former, prescriptive solutions. Where standards are unavailable or inappropriate, such as for the acceptance of innovative materials or methods, there exist systems for *technical approvals* to give guidance on meeting functional requirements. These technical approvals are issued by special bodies such as the British Board of Agrèment or, in the US; by the Evaluation Services organizations affiliated with the model code development bodies.



CHANGING ROLE OF STANDARDS

Standards will play a crucial role in these performance-based systems in providing the links from the qualitative statements to the quantitative criteria[2]. Standards will provide the performance metrics for materials, products, and systems by which their performance in the context of their use can be determined. Standards will also provide "deemed to comply" solutions for specific functions cited. These roles are fundamentally different from those of prescriptive systems and these differences will require changes in the standards development and adoption methods.

The provision of performance metrics is another new role for standards in performance based regulatory systems. PBRS are based on the ability to evaluate the performance of buildings (and their components and systems) in the context of their use. Such evaluation can be performed at various levels, including testing, expert judgment, experience, and prediction. Where performance prediction is employed it is usually based on models or calculation methods that incorporate product-specific data taken in some standard apparatus (performance metrics). An important role of standards development organizations that is currently undressed is the need for such performance metrics for materials, products, and systems that are coupled to predictive models or calculation methods.

Where standards are cited as verification methods, test or measurement methods, or in the measurement of performance metrics, they do not themselves provide a distinct solution to a function or objective. Rather they provide data to be combined with judgment by a designer or regulator, and the role of the standard is no different than today. However, when standards are cited as acceptable (deemed to comply) solutions to demonstrate compliance with a performance level cited in the regulation, in most performance-based regulatory systems these solutions *must*

be accepted by the regulator. Here, the standard itself becomes a regulation and must follow a similar development process including the "due diligence" criteria normally applied in regulatory development[3,4].

REFERENCES TO SOFTWARE

This concept also applies to references to software and calculation methods in standards and regulations. Proprietary software can be cited as a verification method but could not be an acceptable (deemed to comply) solution because of the previously mentioned problem of illegal delegation of legislative authority. That is, proprietary software can be changed by the developer without the possibility of the thorough public review required of regulations. Openly documented software referenced by specific version could be an acceptable solution if it provides a complete solution for the purpose. For example, hydraulic calculation software results in all of the design parameters for a fire sprinkler system and thus provides a complete solution. Fire models require assumptions and judgment that can affect the outcome and these must be reviewed and approved by the regulatory authority for appropriateness. Thus, fire models would not qualify as acceptable solutions but can be used as verification methods.

As countries adopt PBRS many of the prescriptive standards currently in place will continue to be of value as verification methods or acceptable solutions, but others will become obsolete. There will be a crucial need for standards that address performance metrics for materials, products, and systems that are associated with predictive methods that can assess performance in context. And the standards development process itself will need to change where standards have the status of regulations. If the traditional standards development bodies do not adapt, others will spring up to fulfill these needs. The national and global benefits or PBRS are too great for any other outcome.

PERFORMANCE STANDARDS

Within the framework of a performance-based regulatory system, standards are needed to fulfill two important functions. First, are needed standards for methods to determine or evaluate the performance level of buildings, systems, or products, which might be called *performance statement standards*. Second are standards that give specific performance levels of buildings, systems, or products that can be classified as a type of product standard, which might be called *performance specification standards*.

Both types of standards may be utilized within a performance-based regulatory system. The involvement of regulators is crucial to the development of performance standards due to the public policy aspects represented. Performance statement standards need to be based on an understanding of the relationship between the performance aspects of the standardized methodology and those required in the regulations. That is, the compatibility or equivalency between the performance requirement in the regulation and the performance delivered by the standard must be maintained where different aspects of performance are applied. Performance specification standards may become acceptable solutions for performance-based regulatory systems by providing examples of acceptable systems or products. Other appropriate performance specifications using different performance metrics should also be allowed.

While performance standards are crucial to the practicability of performance-based regulation their misapplication could result in problems when they arbitrarily limit the range of acceptable solutions. Performance standards need to be sensitive to national and cultural norms and practices where these are not inconsistent with the regulatory objectives. An example is the use of indigenous materials in construction. Marble is a common building material in Italy, stone in the UK, wood in the US and Canada. An Italian standard on flame spread on finish materials that assumes marble to be used would be out of place in the US where such materials are traditionally uncommon.

Standards and the Performance System Model

The Performance System Model (PSM)[5] represents a refinement of the hierarchy shown in Figure 1 that adds an explicit specification of the performance/risk level as a link between the qualitative goals, functional statements and operative (performance) requirements and the quantitative performance criteria and verification methods. The addition of this link is in part in recognition that the expectations of the owner or even of a society for a particular building, can vary.

The concept of varying expectations for building performance is not new. Agricultural buildings characterized by low (building and contents) value and low life safety risk (usually due to only occasional occupancy) are often unregulated. Conversely, buildings like hospitals and schools are highly regulated both due to the value of the building to society and to the special concerns for their more vulnerable occupants. In structural engineering these concerns have traditionally been addressed through a safety factor multiplier called *importance factor*.

The addition of the performance/risk level makes clearer the need for performance standards that can be used to assess the performance of buildings, systems, or products at the levels demanded by the regulators and society. Culture and tradition often dictate methods and performance levels for buildings and the constraints thus imposed cannot be ignored in the name of international harmonization. Technological solutions common in developed countries are often impractical in the developing world because of a lack of infrastructure. Performance standards should provide the flexibility of alternate means to meet their objectives under a range of such constraints.

The PSM highlights the need for more communication between the regulators and the standards developers. If performance standards are to address the appropriate level of regulatory expectation the regulators need to provide clear direction and linkages to the goals and the intent of the regulations. If this is not provided the technical community sets the performance criteria, usually based on historical practice. More appropriate is the process outlined in the *SFPE Engineering Guide to Performance-Based Fire Protection Analysis and Design of Buildings*[6] that involves the key stakeholders; owner, manager, tenant, regulator, insurance, designer, emergency responder, etc. in making the decisions.

Standards for Global Acceptance

One of the advantages to performance-based regulatory systems is the universality of the description of needs or requirements in terms of measurable performance. Nowhere is this more evident than in the regulation of the fire performance of building materials and systems.

Until recently fire was not well understood and fire test methods were designed more for repeatability and reproducibility rather than rigor and robustness. Such test methods only produce a measure of the performance of materials and products in the test rather than in use. Such political solutions are not useful in a performance-based regulatory system and are inappropriate as standards for global acceptance.

In a recent position paper from the FORUM for International Cooperation in Fire Research, Croce[7] suggests a set of options for "end use approval of products and services in ascending order of sophistication and effectiveness are:

1. Ad hoc tests
2. Use of small and/or intermediate-scale tests correlated with large-scale tests
3. Property data coupled with a first-principle model of an intermediate-scale test that can be correlated with large-scale end-use tests
4. Property data combined with models of the end use application."

The first represents the current state of many fire tests referenced in building regulations and which is "widely recognized as inadequate."

The second describes the approach most often used in current test method development. While better than the first Croce cautions, "results can still be misleading if the correlation with large-scale test results is not adequately broad in range and/or end use."

The third, "makes better use of scientific knowledge than do the first two options, does not rely on difficult correlations between small-scale and large-scale results, is achievable in a reasonable time frame and may serve adequately until option 4 is available. It also should be easy to understand by the user, the practitioner and the regulator."

"The fourth option is the ideal approach, using material properties and other scenario-based quantities as input to comprehensive end use computer models. Currently, we do not know enough for most situations to use this approach. Temperature-dependent material properties are proving to be quite difficult to measure, existing models are relatively limited and broadly applicable end use computer models are becoming more complex. Hence, validation and verification is extremely critical. As computing power advances, this option should become easy to use for the practitioner."

The paper concludes with a FORUM position:

"The FORUM position for evaluating products for global acceptance is as follows:

- Approval tests become ingrained. Once established, it is difficult if not impossible to remove or even revise them. They also create burdensome legacy issues.
- FORUM members should encourage and advocate use of the most practicable scientifically-based technology.
- In moving from prescriptive towards performance-based codes and standards, more scientifically-based tests are required to provide data needed for predictive models.

- The intent is to move towards the provision of tools – accurate data, tests, models – as a basis for equitable performance levels needed to support performance-based codes and standards.
- Rather than acceding to tradition, researchers and practitioners bear the responsibility to demonstrate the value of using most practicable technology.
- Research laboratories need to serve the interests of all stakeholders – product manufacturers, product users, practitioners, testing laboratories, insurers, regulatory agencies, society.
- Research laboratories have the further responsibility to advance science needed to progress toward the most scientifically-based approach for accepting products.

The FORUM takes this position because it recognizes that adoption of an inadequate test doesn't necessarily improve safety, can add an unreasonable burden of cost to manufacturers of products and eventually adds to the panoply of ad hoc tests. Globalization, though not complete, is coming fast. Currently there are three major markets – the European Union, the Americas and Asia/Pacific. Failure to press the FORUM position in one market may preclude options for others, resulting in a continuation of parochial/preferred tests in different market areas and the often-wasteful search for a meaningful way to compare different tests."

THE REGULATORY STANDARDS DEVELOPMENT PROCESS

As standards take on the characteristics of regulations, either by mandatory references or deemed-to-satisfy status, it may be legally necessary for the standards development process to incorporate some of the "due diligence" aspects of regulatory development. While different legal systems and legislative responsibilities in different countries will affect what steps must be taken, there are some common issues that will generally apply. The following borrows heavily from a recent publication fro EU titled *Legal Aspects of Standardization in the Member States of the EC and EFTA*[8].

Participation

The standards development process must be generally open and transparent. While limits may be placed on direct participation based on demonstrated expertise in the related technologies, maintenance of a balance of represented interests, and practicalities of committee size, the process usually incorporates an unrestricted means for public proposals and comments and the documentation of technical reasons for rejection or modification. Such open processes are even more important where the standard is a mandatory reference in regulation or is the basis for international trade.

In the United States, the Office of Management and Budget Circular A-119 (1998) states that "Consistent with Section 12(d) of Public Law 104-113, the ``National Technology Transfer and Advancement Act of 1995" (hereinafter ``the Act"), this Circular directs agencies to use voluntary consensus standards in lieu of government-unique standards except where inconsistent with law or otherwise impractical. It also provides guidance for agencies participating in voluntary consensus standards bodies. The circular also states that "A voluntary consensus standards body is defined by the following attributes: (i) Openness; (ii) Balance of interest; (iii) Due process; (vi) An appeals process. (v) Consensus, which is defined as general agreement, but not necessarily unanimity, and includes a process for attempting to resolve objections by interested parties, as long as all comments have been fairly considered, each

objector is advised of the disposition of his or her objection(s) and the reasons why, and the consensus body members are given an opportunity to change their votes after reviewing the comments. See http://ts.nist.gov/ts/htdocs/210/215/fr-omba119.htm

Public access to standards

Traditionally standards developers have derived a significant faction of their operating revenue from the sale of standards and this revenue stream is protected by obtaining copyrights on the documents. Catalogs and newsletters or official journals provide public notification of the existence of new or revised standards. However it can be argued that the full texts of mandatory standards must be publicly available. Depending on the legal system and the scope of the standard accessibility in the offices of the standards developing body and in public libraries may be sufficient.

Public Review

The ability of the public to participate in the standards development process and to have access to the standard is necessary but not sufficient when the standard becomes a regulation. Due diligence in the development of regulations requires either as part of the development or the implementation (depending on the mechanisms of legal adoption used and the legal system in place) public hearings and debate, notification and education of the public and of authorities to provide consistent enforcement. These regulatory processes have not normally been practiced with standards but may be legally required when standards take on regulatory power. The U.S. regulatory procedures require publication of the intent to reference or use a standard in the Federal Register and the provision of a specific comment period for public review.

Good practice

Design professionals such as licensed or registered engineers and architects are ethically bound to follow the current, best practice generally accepted in the profession (state-of-the-art) but are not bound to employ methods that are generally considered experimental or not fully developed. Standardization may be one method by which a methodology moves into generally accepted practice; that is, when a standard is agreed and published the subject is no longer considered developmental. This may then represent one more method by which standards take on mandatory or regulatory authority.

STANDARDS IN INTERNATIONAL TRADE

Standards are increasing recognized as crucial to international trade. The European Union (EU) continues to invest significant resources in the harmonization of standards among member countries as a prerequisite to free trade. International trade agreements (World Trade Organization Technical Barriers to Trade Agreement) deal with standards by giving preference to international standards over national norms for products and services in international trade. International standards are not defined, however, as being developed by a specific body.

National Standards Bodies

Most countries have a single, national standards developing body, creating standards that are assumed to represent the national position. These bodies may or may not be affiliated with the national government. Examples are British Standards Institute (UK), AFNOR (France), DIN (Germany), and Standards Australia. EU created CEN (Comitè Europeèn Normalisation) and

CENELEC to represent the collective EU view (but the individual national bodies continue to function) and member countries are forbidden to develop national standards where CEN standards are under development. Likewise, CEN is expected to defer to international standards, usually interpreted narrowly as ISO (International Organization for Standardization). IEC has a similar agreement with CENELEC.

The situation in the US is different and this may lead to problems in the international standards arena. While the US has a national standards body, the American National Standards Institute (ANSI), most US standards are developed by a myriad of private organizations. There is a public consensus process whereby a standard can be designated the "American National Standard" by ANSI and only one such designation is granted on any topic, there is no consensus that this represents a national position. Thus, since several variations of similar standards often exist there is no clear US position evident in international standards work.

Harmonized standards

Much of the effort in EU has been to harmonize existing standards. In some cases completely different standards existed for the same purpose. Where attempts to correlate them failed it was necessary to develop completely new approaches. An example is with material flammability tests. Several countries had very different test methods and they could not be correlated. The UK, Germany, and France held tenaciously to their traditional tests. Eventually the Single Burning Item (SBI) test was developed and is now on track to become a CEN standard. While the SBI has been criticized on technical grounds it serves the purpose of a harmonized test to regulate the flammability of building materials in European trade.

A potential problem exists with the movement of the CEN standard for the SBI into ISO. This would mean that the SBI would become (in theory) the preferred test method for regulating material flammability in international trade both within and outside of Europe. Non-European countries are not interested in abandoning their traditional test methods for a European political solution with outstanding technical criticisms.

This highlights an important issue with respect to the mandating of international standards in trade. Not all solutions are technically sound and political solutions can collide with cultural norms and customs. A well-known example comes again from the EU when they issued harmonized regulations for food safety that included mandatory temperature limits for food storage. The regulation set limits for meat and for dairy products in which there was no overlap in the acceptable range of temperatures for each class. As a result, is a traditional Italian food made of braided meat and cheese that, under the new rules, could not be sold because there was not a common, allowable storage temperature.

CONCLUSIONS

Standards are evolving as a part of the movement toward performance-based building regulatory systems. Demands placed on standards to link explicitly to both the performance goals and to the operative (performance) requirements are resulting in standards for performance metrics that are scientifically rigorous and robust. At the same time performance standards must provide the flexibility to accommodate cultural and traditional practices where they provide appropriate alternatives that meet the societal objectives embodied in local regulation. This is especially

important where standards take on special status under international trade agreements. Finally, standards that take on regulatory authority through mandatory reference or as deemed-to-satisfy solutions must follow regulatory ‘due diligence” procedures consistent with their new status.

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