FINAL REPORT OF CIB TASK GROUP 11
PERFORMANCE-BASED BUILDING CODES

CIB Report

Publication 206

NRC-CNRC

cib

TG 11

International Council for Building Research and Documentation

Final Report of CIB Task Group 11 Performance-based Building Codes

Institute for Research in Construction
National Research Council Canada

April 1997

Preface

CIB Task Group 11 "Performance-Based Codes" was established in the fall of 1992, with the dual objectives of providing a discussion forum and information exchange for those working on the development of performance-based building codes, and producing an outline of a practical approach to performance-based building regulatory systems. The first meeting was held in 1994 at Building Research Establishment in Garston, UK. Several key tasks for the Task Group were identified at that meeting:

- documenting experiences;
- identifying needs of building and code users;
- identifying/developing structures and frameworks;
- identify methods of compliance with performance-based codes;
- identifying needs for education; and
- discussion of simple language structures.

Sub-groups dedicated to work on those tasks were established at the first meeting. They worked through correspondence and private contacts and reported to the Task Group at its meetings. In total, four meetings were held: in Garston, UK (1994), Madrid, Spain (1994), Wellington, New Zealand (1995) and Ottawa, Canada (1996). There are 30 members in the Task Group, representing very broad territorial and professional interests.

This report, edited by Igor Oleszkiewicz of the National Research Council of Canada, offers a review of approaches taken by some countries that have embarked on the difficult task of developing and implementing performance-based building codes, and provides guidance on both conceptual and practical problems. It also offers recommendations on future CIB activities in this area.

R.P. Bowen

Coordinator, CIB Task Group 11

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Introduction

The complex maze of building regulations in place in most countries is seen by many as being overly prescriptive and, as such, an impediment to the introduction of new technologies and design concepts. In today's world of global markets, these relatively inflexible, prescriptive codes are increasingly criticized as being non-tariff barriers to trade. In some countries, to address that issue, such traditional codes are now being displaced by new, performance-based standards, building codes and regulations.

Performance-based building code is a basic concept that has been around for many years. It is, however, extremely difficult to write and implement such code effectively, because of the breadth and depth of knowledge required. The process is further complicated by the varied legal and jurisdictional structures under which such code must be functional.

To be successful, performance-based code must respond to social needs. It must be based on user needs and sound technical knowledge, and be structured in such a way that it is enforceable. The requirements must be formulated so they are usable - not only by the enforcers of the code, but also by those who make design and construction decisions. Requirements must also be verifiable, to ensure that conformance of products and systems can be determined.

There have been many efforts made to introduce performance-based concepts into building codes and standards. Some countries have legislated the functional (qualitative) level of performance concept that provides the intent of the law, offering some examples of situations that are deemed to satisfy the concepts, while others have retained a mixture of detailed performance and prescriptive requirements. The effectiveness of either approach has yet to be fully determined. What is clear, however, is that the cost can be high if the approach is not sound. It is for this reason that the task group CIB TG11 was created, to bring together people involved in research, those responsible for developing and enforcing performance-based codes, those who provide assurance of conformance, and those who must communicate the new concepts to a fragmented industry.

International Developments

One of the mandates of CIB TG11 was to document both the international progress in the evolution of building regulatory systems, and the present and planned use of performance-based building codes, including their implementation, problems and solutions. A two-level review of building regulations (some countries use regulations other than a single code) in different countries was conducted, consisting of an analysis of regulations in selected countries (UK, Australia, New Zealand, The Netherlands, US and Canada) where the performance-based approach has been applied or its application has been initiated, and a wider survey of regulations (not necessarily those that have applied the performance-based approach). Both the analysis and the results of the survey are described in Annex A.

The survey questionnaire was sent to 21 countries, of which 14 responded. The questionnaire was designed to extract pertinent information with respect to the concepts on which each regulatory system is based, as well as the compatibility of each approach taken vis-a-vis the performance concept. A number of the countries surveyed have already made a transition to performance-based regulations. It was anticipated that the survey would assist the task group in acquiring a cumulative, shared knowledge base that could help guide those looking to follow a similar path. The survey was conducted in 1994 and its summary is included in Annex A. A full Survey report has been circulated to the members of TG11.

Needs of Building Users and Code Users

Any building code, including one that is performance-based, should respond to the needs of building users and those who use the code in their professional activities, as well as be acceptable to the general public. Responsiveness to the needs of those affected by the code is particularly important when attempting any change to that code.

Building users have been defined as those whose needs are primarily directed towards occupancy of finished buildings—both new and existing. Those needs fall into two categories: general societal goals and more specific functional needs, which are associated with the purpose of the building.

Societal goals should be identified in a process that reflects broad public accountability and the best place for them to reside is in the enabling legislation. ISO Standard 6241 can be helpful in compiling a list of these goals, but some jurisdictions may also choose to include goals not included in that standard, such as protection of the environment and/or energy conservation. Functional needs, meanwhile, are largely in the domain of the professionals involved and are generally included in the contractual arrangements between the designer/builder and the owner. In some countries, however, fulfillment of certain functional needs is regulated and may be reflected in the code. A considerable effort to apply a broad approach using the performance concept to express functional needs has been led by CIB W60.

Code users have been defined as those who are primarily involved in the development or construction of buildings. They are, among others, designers, building officials, building certifiers, manufacturers, contractors, regulators, educators and researchers.

The following is a list of the characteristics of a performance-based code that users of the code require (described in more detail in Annex B):

1. Have a well-defined scope

A consequence of an ill-defined scope will be uncertainty in all subsequent decision-making processes, which will impact on all the other needs of building code users. A balance must be established between the stifling effect of an over-regulated control system and the ambiguity of an under-regulated system that would require the individual to seek redress through the courts, an expensive and time-consuming process that might encourage the introduction of more restrictive de facto controls by private sector organisations such as financiers and insurers.

2. Satisfy public expectations

People have certain expectations of buildings. Because buildings may pose a threat to their safety, health, or well-being, people seek assurances, through some form of control, that all buildings meet certain essential requirements to safeguard occupants from risk.

3. Have clarity of intent

Once the purposes of the controls have been well defined, the objectives of the code must be clearly stated and included in the code. The purposes defined in the legislation may be very general and may not be easily accessible by the majority of building code users.

4. Be easily understood

Two factors influence the extent to which a building code can be understood by all its users: the format (organisation of content) and the language.

The format must be clearly and consistently applied throughout the code, to ensure that users seeking to understand what a particular provision requires, and why, are guided to the relevant information quickly and easily.

The language used must be simple, devoid of jargon and chosen with a full awareness of the level of understanding of the average code user. It may be necessary to consider multiple language versions to ensure an adequate level of understanding is achieved in multi-cultural societies.

5. Have an appropriate classification of building uses

The classification system for buildings should evolve as a consequence of developing the code rather than being the driving force in establishing the code format.

6. Provide certainty of outcome

To implement a performance-based code, code users, particularly designers of innovative solutions, need to be able to reliably predict compliance in advance.

7. Be flexible in application

Control requirements should be flexible enough to accommodate differences in geography and culture. Approvals for new and different solutions that meet the requirements should be readily obtainable. Flexibility should be provided by enabling the controlling body to exercise responsibility with clearly established parameters to allow waivers or modifications to the code requirements.

8. Apply uniformly throughout the jurisdiction

A properly designed building control system should be universally applicable to all citizens throughout the jurisdiction. A performance-based code, because of its structure, is able to accommodate variable local conditions.

9. Apply to all buildings

Uniform application facilitates design and lowers the cost of buildings. If the objectives are properly formulated, exemptions on a class basis, such as buildings belonging to the government, cannot be justified on a technical basis. Variations to the administrative procedures can ensure that special needs, such as security, are not compromised.

10. Ensure consistency of interpretation

Designers, builders and manufacturers need consistency of interpretation to ensure certainty of the outcome.

11. Be easy to update

Revisions should be easily affected, but the revision procedure must ensure that the objectives of the original provisions are either carried forward or changed according to policy changes.

12. Be administered by a single body

Efficiencies can be generated through establishment of a single framework administered by a single body, an approach that will enhance the consistency of interpretation and aid in the resolution of disputes.

13. Not hinder innovation

There will be leaders and followers amongst building practitioners. A performance-based code is able to satisfy the needs of both. The code must provide the objectives, functional requirements and performance criteria that set the rules for innovative leaders. Others need a prescriptive route that will ensure surety of outcome, satisfied by guidance documents detailing acceptable solutions. Many designers, contractors and manufacturers are continuously striving to provide the best solution to each problem and, for them, the code must provide a transparent framework and ease of proving compliance.

14. Make use of all available resources

Building practitioners need to know all the rules in advance in order to accommodate those rules in the best possible way in the course of designing and constructing a building.

15. Apply consistent approach to risk

Control provisions should represent a balance between acceptable cost and acceptable risk.

16. Minimise disputes

The regulatory system must be designed to encourage cooperation between the parties involved and minimise the incidence of dispute and litigation. This is achieved by ensuring clarity of intent. Unlike with prescriptive controls that do not state their purpose, with performance-based codes interpreting the requirements is reduced to a question of whether or not a proposed solution complies with the intent of the code. This is a matter of technical judgment, to be ruled on by technical, rather than legal, experts, and resolving the question in a particular case should not generally involve litigation.

17. Have clarity of liability

The regulatory system needs to ensure the responsibility and hence the potential liability. The role of the official can range from that of no responsibility for technical compliance with the code and being an agent of record only, to that of requiring to be satisfied on reasonable grounds that the building work complies. The extent of liability will vary accordingly, as it will for all participants in the building control process.

Buildings are very long-lived assets, and defects may show up long after construction. The costs imposed by producers' indemnity insurance against future liability pass to the buyers of the buildings. To reduce costs, a realistic limitation period is necessary, beyond which defects resulting from design or construction are identifiable from those resulting from lack of maintenance. When the building control system allows private certifiers to operate in conjunction with the main controlling body, the building certifiers should be afforded the same level of legal protection as the controlling body.

18. Ensure cost-effective compliance

A change to a performance-based building code allows a better use of both public and private resources to regulate building activities:

- by removing unnecessary controls and costs from the regulatory system; and
- by enabling innovation, initiative and progress in the industry,

thereby producing affordable buildings without jeopardising the public interest by exposing people to unacceptable risk.

19. Ensure certainty of compliance

A building code should not include provisions that cannot be verified for compliance as part of the checking process. To include a provision as a safety net for the regulator to use as justification when something goes wrong is not acceptable to code users and undermines the credibility of the code.

20. Be applicable to changes of use and alterations

Although it is acknowledged that a building code is primarily developed to apply to new buildings, the administrative system must also allow for the application of a code to existing buildings in which a change of use has occurred or to a building that is to be altered. In practical and economic terms, it would be an unrealistic expectation for all such buildings to fully comply with the current code. Therefore a priority of objectives has to be established that identifies the most crucial to be incorporated into the supporting administrative legislation. A performance-based code, having the objectives explicitly stated, facilitates the setting of these priorities.

Frameworks

The rationale for moving from traditional prescriptive codes to those that are performance-based is that the latter are expected to be superior with respect to a number of characteristics. The following is a list of those characteristics, directly related to the structure of the code documents:

1. Ease of understanding the intent of regulation;
2. Transparency for ease of:
   a. evaluation of alternative/innovative solutions;
   b. international scrutiny within trade agreements;
3. Consistency of interface for users;
4. Ease of authoring and maintaining the code documents; and
5. Ease of representation and delivery in Information Technology (IT) systems and in supporting associated navigation and retrieval functions.

These characteristics can be aided by:

- making the intent explicit (1 & 2);
- separating intent from the means of compliance (1 & 2); and
- providing a consistent, user-friendly and logical structure of the code documents (1, 2, 3, 4, 5).

The above have been identified as the essential attributes of a framework for performance-based codes. The following have been proposed as components of such a framework:

- "Top-down" structure establishing a hierarchy of objectives and the means to achieve them;
- Presentation structure (organization/outline of the code and supporting documents);
- Primary information structure, identifying elements of information contained in or associated with individual requirements; and
- Expression structure for provisions (language and consistent patterns in expressing provisions).

"Top-down" Structure

A minimum "top-down" structure would contain two components:

- objectives; and
- acceptable ways to meet those objectives.

Implementations, or attempted implementations, of the structure are more elaborate and, in most instances, are variations of the Nordic Five Level System:

Level 1 GOALS — essential interests of the community at large with respect to the built environment

Level 2 FUNCTIONAL REQUIREMENTS — building or building element specific qualitative requirements

Level 3 OPERATIVE REQUIREMENTS — actual requirements, in terms of performance criteria or expanded functional description

Level 4 VERIFICATION — Instructions or guidelines for verification of compliance

Level 5 EXAMPLES OF ACCEPTABLE SOLUTIONS — Supplements to the regulations with examples of solutions deemed to satisfy the requirements

In this system, the first three levels represent an elaboration of the objectives component of the minimum structure, while the last two deal with the specifics of meeting the objectives.

A comparison of the Nordic Five Level System with structures applied by some of the countries (see Figure 1) that have moved or are moving to an outcome-based approach indicates conceptual commonalities and variations in their implementation.

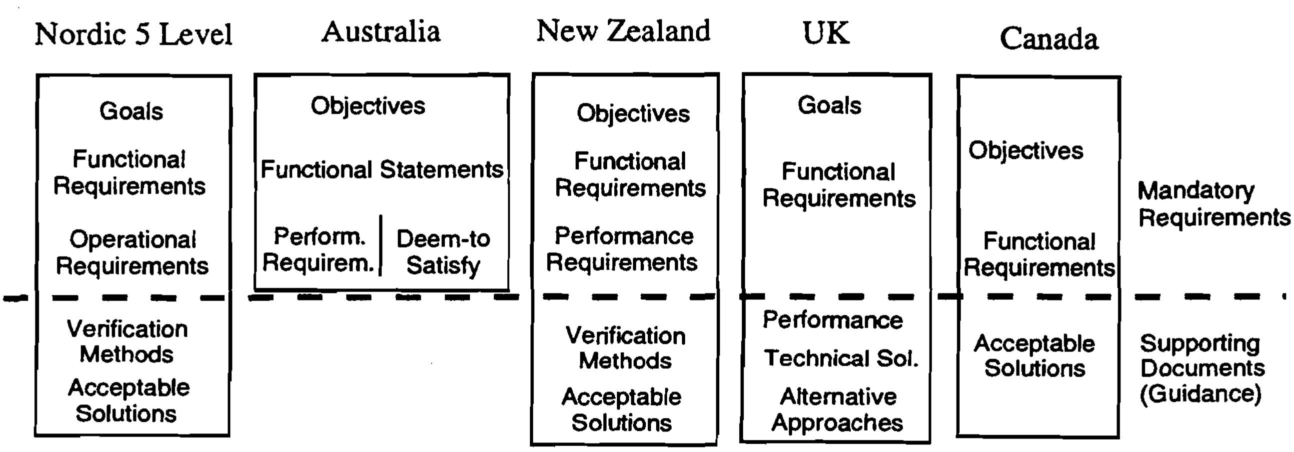

Figure 1.

The differences are largely in the degree of detail at particular levels, and in the distribution of the material between mandatory and non-mandatory documents (the options are discussed in conjunction with the presentation structure). The least formal approach has been applied by the UK (England and Wales), with very brief Goals and Functional Requirements located in the mandatory document and other components, varying in detail, located in the non-mandatory documents. With their very formal and complete structure, New Zealand's set of documents would appear to be at the other end of the spectrum.

Presentation Structure

The presentation structure is the arrangement in which the information content is presented in a code and its provisions. While the information structure, although less apparent than the presentation structure, seems to be universal, the presentation structure will vary greatly from one code to another and even within one code. The variation may be because of historical or legal reasons, and because of the user interface the code writers want to provide.

An appropriately structured outline may be used to:

- provide a consistent interface for users;
- enable authors to develop an outline for new material;
- enable authors to organize existing material or insert new material;
- ensure a consistent approach between collaborating authors;
- provide a basis for classifying and indexing material; and
- provide a basis for representation and delivery in IT systems and support associated navigation and retrieval functions.

Since the performance codes accentuate the purpose of requirements, it seems there is a need to build such codes around the hierarchy of objectives. However, many code users are focused on an entity (a particular building type or a building component) and for this reason there is a need for a compromise—a mixed structure that is rational and easy to follow, yet allows for the grouping of requirements in a user-friendly way. Annex C provides some guidelines and discusses options in the presentation structure, including possible distributions of material between the mandatory and non-mandatory documents.

Primary Information Structure

Analysis of requirements in different national building regulations indicates essential similarities in the information content, despite different appearances. A five-faceted information structure has been developed:

- INTENT: the objective of the requirement in terms of the perceived risk or potential dysfunction and the required functionality to overcome the risk or dysfunction;
- CONTEXT: the scope of the intent, typically expressed in terms of where a requirement applies and in what circumstances an exception is permitted;
- ENTITY: the building element, space or system that will be the focus of the performance/property requirement;
- PROPERTY: the performance or attribute required of the entity necessary to meet the risk/dysfunction; and
- VALUE/MEASURE: the particular prescription, credence or "deemed to comply" solution that will satisfy the required performance or ensure the required attribute.

It has been argued that VERIFICATION (information regarding means of proving compliance, such as test method, calculation method, applicable standard or other evaluation method) should be another facet of this structure. However, many Task Group members were of the opinion that this item can not stand on its own and has to be a part of either PROPERTY or VALUE, or may not be present at all. This opinion was based on the fact that the measure of properties and limits, stipulated by PROPERTY or VALUE, quite often depends on the evaluation method.

The above scheme seems to catch all the important pieces of information that one can identify as being associated with a requirement. In traditional codes, this information is seldom explicit or consistently structured.

Much attention has been paid to developing performance-based codes in such a way as to make the intent of the requirements explicit. Making other information readily available and consistently structured would further improve such codes. The above classification of the information content may be used as a guideline or check list when writing a performance-based code and supporting documents.

The Primary Information Structure also appears to be a powerful tool in the analysis of an existing code, a necessary step in the transition from a prescriptive to a performance-based code. One of the issues in such a transition is that the new code must not radically change the technical level of acceptable solutions. The existing code reflects a consensus on the level of risk and cost associated with code compliance. A new code may be different in format and procedures and allow greater freedom for the users, but the old, time-proven solutions have to be acceptable under the new code. This implies that a thorough analysis of the existing code has to be done and the results used in the development of the new code. A methodology of the analysis, based on the above described structure of the information content, has been developed and successfully applied to some of the national codes (see Annex C).

Expression

The language of codes and other aspects of expression (e.g. use of cross-references, double negation, exemptions and other excessive complications of the expression structure) have not been dealt with in detail, but they have been recognized as an important issue (see also Language section). There have been numerous complaints regarding poor expression of provisions being an impediment to understanding building codes. The problems show up clearly in the analysis of an existing code.

Language

The importance of the proper choice of language has been recognized and discussed (also in connection to code user needs), but the language issues have not been studied in depth.

The following are issues identified as requiring the attention of code writers:

- Drafters of codes and other associated documents should ensure that the recipient of a document can understand it.
- Documents should be written so that the literal meaning does not differ from the intention. This is important because, in a dispute, lawyers tend to follow the literal meaning of the law. Also, in jurisdictions comprising different languages or cultures, things assumed may be lost in translation or interpreted differently.
- The language of the code documents must correspond with their legal status. Since the legislation enabling the code varies from one jurisdiction to another, there is limited recommendation available at this level.

- In writing performance-based codes, one should be cautious of using "absolute" terms. Things that cannot be achieved or checked should not be imposed on those who must comply with the code.

Methods of Compliance

The three methods of assessing compliance with performance consist of:

- providing proof, using approved verification methods. These may consist of insitu tests of a non-destructive nature, including counting numbers of items or checking dimensions; laboratory tests, usually of a destructive nature applied to samples; or calculations using mathematical models;
- providing proof of conformity to a standard or other reference that describes a technical solution that is accepted as satisfying the required performance. Such solutions are variously described as type approvals, deemed-to-comply solutions, acceptable solutions, or accreditations; or
- providing proof through expert judgment. Performance is verified by the assessment and certification by evaluation bodies or other experts.

Education

The transition from a traditional prescriptive code to a performance-based code will only be successful if it is supported by education and training programs that are both comprehensive and ongoing. These programs must be directed at the entire spectrum of the building construction industry. This spectrum includes architects, engineers, building code and fire service officials, constructors, consumers, legal and financial professionals and elected and appointed officials (see Annex D for specific education needs).

Three elements of the education and training package have been identified:

- an introduction to the concept of performance-based codes;
- "hands-on" detailed training for practitioners in the practical application of performance-based codes; and
- code education within the technical education system that includes the universities and technical schools.

Education and training of the construction industry can be successful if strategic partnerships are established between the code writers and other interest groups. Clearly, these interest groups will include those who have direct responsibility for code education as well as those professional associations and organizations that bear some responsibility for the qualification of their members. There must also be a link to those institutions and organizations that will provide the training on an ongoing basis, and training must be provided to the trainers.

While education and training of all involved is important, the code writers and enforcement authorities must be educated first. In many jurisdictions, codes are written with the participation of a large number of people, many of whom may not be involved in the early conceptual work. These people have to be "brought up to speed" before they enter the code-writing process. The enforcement authorities bear the burden of implementation of the codes and to do that efficiently must not only be well-informed, but also convinced of the validity of the performance-based codes. In addition, because of the legal and legislative issues surrounding the transition to performance-based codes, it is equally important that education of the legal community takes place at an early stage.

Recommendations for Future Activities

There is a need for continuation of the forum that TG 11 provided, which would bring together groups that may not ordinarily be part of the CIB community (e.g. code enforcement personnel, codes and standards developers, legislators and lawyers).

TG11's limited mandate and time horizon did not allow for the investigation of a number of issues related to the broader impact of performance-based codes and standards, such as:

- legislative frameworks;
- liability;
- insurance;
- accreditation;
- qualifications;
- dispute resolution; and
- impact upon international trade;

as well as some outstanding technical issues, such as:

- the establishment of equivalent performance criteria to existing prescriptive requirements; and
- the application of research outcomes.

Therefore, it is recommended that a task group or commission be formed to investigate those issues, and that such a group have a representation similar to that of TG11.

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ANNEX A

INTERNATIONAL REVIEW OF BUILDING REGULATIONS

Introduction

One of the mandates of CIB TG11 was documenting the international progress in evolution of building regulatory systems and the present and planned use of performance-based regulations, their implementation, problems and solutions. The following offers a two level review of building regulations in different countries: an analysis of regulations in selected countries where the performance-based approach has been applied, and a wider survey of regulations (not necessarily of those that have applied the performance-based approach).

Analysis of selected building regulations

<u>UK Reform (England and Wales)</u>

Reviewed by Roger Baldwin, Building Research Establishment, UK, and Anthony C. Rackliffe, Building Control Manager, Waverley Borough, UK

In 1962 the Building Regulation Advisory Committee was set up to review the control system in England and Wales and to develop recommendations for the reform. In 1964 the Committee made general recommendations which set the pattern for debate about reforms throughout the next decade. In the 1970s it was decided that, subject to maintaining health and safety, regulations should interfere with enterprise as little as possible . The new Building Act was introduced in 1984 and the new regulations were issued in 1985.

The new regulations cover the functional requirements and occupy 25 pages (21 pages in 1991 edition). The building designer can use any legitimate method to prove compliance, but in practice will probably rely on so-called Approved Documents. Approved Documents provide specific guidance on demonstrating compliance. Acceptance is virtually automatic when they are used.

Approved Documents may give guidance in more than one form :

1. Technical Solutions. They describe particular methods of construction which will satisfy the requirements.
2. Alternative Approaches. These are based on British Standards and other authoritative material. They give a lot more guidance which may be helpful to a designer.
3. Acceptable Levels of Performance. These amplify the functional requirements of the Regulations. Not all Approved Documents have them.

In writing the Approved Documents, the opportunity has, in many cases, been taken to update the earlier Regulations, and to remove some unnecessary controls and provisions.

Although Approved Documents are not compulsory and are intended to provide guidance only, in the event of a dispute, not following the guidance may be used as evidence to show non-compliance with the Regulations.

The new system has been welcomed by designers and industry even though not all designers use the freedoms available to them.

New Zealand Reform

Reviewed by John Hunt, Building Industry Authority, Wellington, New Zealand

Before the reform, building controls in New Zealand were contained in more than 60 central government Acts and Regulations plus bylaws issued by 249 local government bodies. In addition some 240 special purpose bodies, such as harbour boards, also had control functions relating to building development.

In 1979 a research project quantified the economic impact of the plethora of building regulations with the result that the representatives of the building industry approached Government and asked to reform the system. Government set up a review group and in 1986 established the Building Industry Commission to develop a national building code that:

- would be performance-based,
- would bind the Crown (government),
- would operate within a suitable legislative framework, and
- become the single focus of all government intervention in the control of all building activities. This implied inclusion of issues such as energy efficiency and barrier-free access, besides the usual health and safety issues.

The output of the Commission was to be "determined within a suitable economic framework", and essence of which was to:

- question why government should intervene by regulation at all,
- decide if regulation was essential in the national interest,
- eliminate regulations where possible,
- rely on market forces where these were functioning, and
- if regulation was necessary, reduce the overall cost of regulation.

To assess the above factors, a "shopping list" was developed of all the subjects that were currently regulated or the Commission thought should be regulated. These were then evaluated as to whether they were needed at all, whether market forces could achieve the same result and therefore the subject could be deregulated or, if the regulation should be retained, whether the current or potential means of checking for compliance with the regulation was feasible. This latter consideration removed many of the current regulations or bylaws.

International evaluation of existing performance-based code structures led the Commission to adopt the five level structure published by the Nordic Committee on Building Regulations in 1976, in conjunction with the format of the 1985 Building Regulations in England and Wales. These set three mandatory levels consisting of Objective, Functional Requirement and Performance, supported by two non-mandatory levels for guidance being Verification Methods and Acceptable Solutions.

Once the three mandatory levels of the code were drafted by the Commission and staff, working groups were contracted to develop the verification methods and acceptable solutions. These groups were given a brief and individuals paid for their input. The products of the working groups were edited as necessary and incorporated in Approved Documents.

The acceptable solutions include detailed diagrams, which reduces the level of argument in the approval process. The disadvantage of a detailed solution is a tendency to regard it as the only solution, which may not be the case if schematic drawings were used, as in Approved Documents in England and Wales.

The Commission decided that existing standards would not become part of the law by being referenced directly in mandatory provisions of the code. This was done to avoid the confusion that different (and usually not stated) objectives of standards would introduce into regulation, and also enable Government to retain full control of what goes into the law. All standards or other documents produced within the building industry that provide guidance on means of compliance are scrutinised and if satisfactory, with or without modification, are referenced in the non-mandatory Approved Documents.

Durability provisions were included in the code to ensure that other performance criteria are achieved for prescribed periods after the commissioning of the building. To specify performance criteria that only had to be achieved only on the day of the final inspection was considered illogical on health and safety grounds. The code aims at ensuring that hidden components or those unlikely to be inspected at frequent intervals by virtue of their location will perform for reasonable periods. These are the lessor of the specified life of the building, or for:

- structural elements on which the stability of the building relies: the life of the building, being not less than 50 years,
- hidden services and fixings to the envelope: the life of the building, being not less than 50 years,
- other fixings, the envelope or other elements with moderate ease of access but which are difficult to replace: 15 years,
- linings and other fittings with ready access: 5 years.

The New Zealand experience with the reform and recommendations for potential followers can be summarised as follows:

1. Any organisation set up to undertake the reform should have no other function, i.e. not be currently involved in building controls, because the internal resistance against change may work against the reform and extend the reform period or even defeat it totally. The reform organisation must be kept small and co-ordinate the input from others with expertise to do the detailed work.
2. Ensure the benefits of the reform can be sold to politicians (increased trade, etc.).
3. The reform package should include not only the technical regulation but also the enabling legislation.
4. Set realistic time frames, employ experts and pay individuals for their expertise in return for proper performance on time. Avoid using people representing organisations and do not insist on consensus outcomes.
5. Keep the building industry informed to avoid surprises when outcomes are presented. Initiate an education programme and guidance documents prior to implementation.
6. Attempt the impossible of obtaining adequate funding to avoid programme fluctuations dictated by funding, nor curtailment of vital tasks like education.
7. Establish the scope of the controls at the start. This may be either by terms of reference or the enabling legislation. Develop the legal hierarchy with the objectives clearly evident at all times and available as a reference by all individuals working on the performance-based code. Do not produce solutions first to maintain the status quo and then find a suitable objective from which they may spring.
8. Do not attempt to cover all possible situations when preparing acceptable solutions. Once example should be sufficient, otherwise innovation may be stifled.

9. Be continually aware of what other countries are doing.
10. Be prepared to amend proposals as a result of experience.

The building code, which is contained in the Building Regulations, was enacted in 1992 and bears some similarity to the England and Wales Regulations. The Building Act is, however, much more detailed, being consistent with the aim to be the sole legislation for all building controls. The Act sets the objectives of the regulations and the structure of the regulatory system. The Act calls for making the building code (responsibility of the Governor General, by Order of Council), which prescribes the functional requirements and the performance criteria with which buildings must comply. The Act also establishes the Building Industry Authority (a Crown agency) which is responsible for preparation or approval of "documents for use in establishing compliance with building code".

The New Zealand Building Code contains the Objectives, Functions Requirements and Performances for 35 technical clauses. Few, at this stage, include quantified performance criteria.

It is usually only at the non-mandatory level of the Approved Documents that the technical details appear. Each Approved Document deals with a specific clause of the building code. The acceptable solutions contained in the Approved Documents are virtually totally prescriptive, being solutions that, if followed, are deemed to satisfy compliance with the code.

Although each of the Approved Documents is specific to a particular clause of the code, the structure of the Approved Documents is markedly different from that of the code and the Act. While the structure of the Act and the code is objective-oriented, the structure of the Approved Documents is building element-oriented, to better meet the needs of practitioners. The difference in the structure of the regulations may be seen as compromising the expected benefits when related to the 'equivalence' approach to alternative solutions. This aspect will become insignificant when existing documents referenced in Approved Documents are revised and incorporate their own specific objectives. Details provided within Approved Documents are for guidance only for that particular solution for a particular building use. For innovative or alternative solutions the requirements pertaining to particular building elements must be assessed against multiple performance criteria. These will vary for similar building elements installed in different locations within a building, in buildings of different uses, or for buildings erected in different geographical locations.

<u>Australian Reform</u>

By Igor Oleszkiewicz, Canadian Codes Centre, National Research Council Canada, based on papers by J. Blackmore (CSIRO) and Norm Bowen (Australian Building Codes Board)

Historically, Australia has had strongly individual and substantially different regulatory systems in each of it's 6 States and 2 Territories. It was not until 1964 that a committee of representatives of each of the States and the Commonwealth was formed to develop a model code for the whole of Australia. In 1971, the committee produced the Australian Model Uniform Building Code, which had no legal status but the individual jurisdictions modelled their regulations on it.

In 1982 the Australian Uniform building Regulation Co-ordinating Council (AUBRCC) was established with the aim of converting the model code into a national, performance-based code, that would have legal status in each state or territory. The first Building Code of Australia (BCA) was published in 1988, followed in 1990 by the second edition. The 1988 and 1990 editions of BCA were only partly written in performance terms. The 1996 edition of BCA was drafted adapting models developed in New Zealand, UK, Sweden and The Netherlands, and is a major step in evolution towards a performance-based code. BCA96 substantially includes the existing BCA 1990 technical requirements, with a "performance hierarchy" built around them. In 1994 AUBRCC was replaced by the Australian Building Codes Board, to provide stronger representation from the construction industry.

One of the significant decisions made during development of BCA96 was that it was not necessary for each performance requirement to be measurable. The measurability issues will be revised after BCA96 has undergone a settling period and more research is completed. Studies undertaken by the Fire Code Reform Centre will produce information which will be useful in resolving this issue in the future. BCA96 continues to allow for acceptable existing building practices through the deemed-to-satisfy provisions.

Resources, available to designers who wish to use engineered alternative solutions, include:

- the Fire Engineering Guidelines, developed by the Fire Code Reform Centre
- the Fire Brigade Intervention Model, developed by the Australian Fire Authorities Council.

Canadian Approach - Objective-Based Codes

By Igor Oleszkiewicz, Canadian Codes Centre, National Research Council Canada

Studies of the experiences with performance-based codes, of a number of countries around the world, has resulted in Canada's codes writing organization deciding to adopt a modified approach. In this approach, the emphasis is on the rationale for code requirements and not on the performance-based format of the requirements. Having a well defined rationale for a requirement invites the performance-based formulation for the requirement, but allows other types of requirement in cases where the knowledge needed to establish performance criteria is missing or a performance requirement would be impractical.

Canadian approach is organized around a logical framework which clearly states the intent (objective) of each code requirement and then relates each of these objectives to higher, and subsequently top level (root) objectives of the code. Accompanying each of the code requirements will be one or more acceptable solutions. The technical aspects of the solution will be related (linked) to the objective structure, providing guidance to the development of alternative solutions. Acceptable solutions can be either performance- or prescriptive-based. In some cases both kinds of solutions may be available to address a specific requirement within the code. Solutions complying with the present code will be acceptable under the new code. Ensuring this acceptance will provide operational continuity of the regulatory system during the transition period. It will also provide continuity of the level of risk, cost and other constrains, reflected by the present codes, the levels that the society is accustomed to and willing to live with.

The logical ("top-down" structure) as presently envisaged will consist of three basic components:

1 a structure of objectives of ever-increasing specificity;
2 mandatory requirements with specific links to objectives; and
3 guidances on methods of compliance, including acceptable solutions ("model solutions")

The objective structure will be developed from two directions: starting from identification of the intent of each existing requirement and drafting the objectives connected to the intent (bottom-up approach), and drafting a hierarchy of objectives starting from a goal such as health, safety or accessibility of buildings (top-down approach). These two approaches will have to be reconciled to form the objective structure.

The new code will be organized in two parts: Part A - containing the structure of objectives and the requirements (written for most part in qualitative terms), and Part B - containing "model solutions" and other guidances. Initially the "model solutions" will be expressed in terms of the current, usually prescriptive, code requirements. It is expected, however, that the content of Part B will expand over time as more solutions, including performance-based ones, are developed and accepted.

The Netherlands

By Nico Scholten, TNO Building and Construction Research

History

Before 1 October 1992, the technical building regulations in the Netherlands were subject of:
- The Housing Act;
- some 700 local building by-laws;
- local Connection Conditions for electrical energy;
- local Connection Conditions for gas;
- local Connection Conditions for drinking water;
- Dutch standards concerning private agreements for several technical issues as good practice, but outside the formal regulations;
- quality approvals as good practice but outside the formal regulations;
- several non-interrelated laws and decrees.

Although these by-laws were based on a Model Building By-law, considerable disparities remained between them. This and the structure of the municipal requirements caused a lack of uniformity in the regulations and to the application. As for the structure of the requirements, the by-laws mainly contained the so called 'functional requirements' and other regulations with possibilities for further requirements and exemptions.

In 1983, the dissatisfaction with the technical building regulations and the long time decisions on building permit applications often took, led to the drawing up of an Action Program for Deregulation of the (House) Building regulations. The Minister of Housing, Physical Planning and Environment announced in this Action Program, among other things, a national Building Decree and an obligatory maximum term of three months for the decision on a building permit application. The technical regulations regarding the internal layout of buildings would be given a global nature, and the technical building regulations would be rendered uniform.

The Dutch building regulation system after October 1992

In the Dutch building regulation system, the Building Decree is the central document for the technical building rules. Based on the Housing Act, that does not contain technical rules, the Building Decree is a general administrative order, issued by the central government.

With regard to some subjects, the Decree authorizes the Minister of Housing, Physical Planning and Environment to give further rules by ministerial order, namely:

- rules concerning the application of standards and connection conditions which have been referred to in the Decree. The intention of this authorization (section 416) is that the ministerial order indicates which edition of the standard or which part of it, or which edition of the connection condition is applicable. In this way a swift and flexible anticipation to the regular revisions of these documents can be effectuated;
- regulations containing technical requirements for a number of specified building aspects. There are different reasons for these authorizations. At the time the Building Decree was laid down, it was clear that for some subjects it was not still possible to give regulations in the Decree itself, e.g. because the indicated standards did not already take account of existing buildings. Further, for other subjects it was intended to create a possibility to give regulations when needed, e.g. for occasions that the harmfulness of a material becomes clear. Also here the fastness and flexibility of regulation by ministerial order plays a part;
- rules concerning the implementation of the Construction Products Directive of the EC.

In the Building Decree, standards play an important role. Wherever possible the Decree refers to standards ('NEN's') or parts of standards of the Dutch Standardization Institute. These standards have been adapted to the Building Decree requirements and contain the determination methods intended to check if the work complies with the Building Decree requirements. There are 47 standards the Decree directly refers to.

Structure of the Building Decree

The structure of the Building Decree, in particular the structure of its complex of technical regulations, has been determined by three grouping criteria, to wit:

1. the distinction between usage functions (or types of works);
2. the distinction between works to be constructed and existing works, and
3. the so-called starting points for laying down building regulations.

This design has been chosen for the purpose of enabling the users of the Decree to find efficiently the relevant regulations and to see at a glance what the intention of these regulations is.
Concerning the usage functions, conceptually the main distinction lies between construction works which are not intended for living in and other works. The latter can be distinguished in houses, residential buildings and caravans and sites. The other group - of 'utility works'- comprises both buildings and works not being buildings.

The effect of this distinction on the subdivision of the Decree is such that for each usage function there is a complex of regulations. Each complex comprises two chapters. viz. one for works to be constructed (new or alteration) and one for existing works. The regulations for buildings not intended for living in are being further elaborated in the current second phase of drawing up the Building Decree. At present, there is one complex with general regulations for all 'utility buildings' (chapters VI and VIII), and two with further regulations for special usage functions (chapters VII and IX). Only for office and accommodation buildings, both the general and the further regulations apply.

As to the third aforesaid grouping criterion, this has determined the structure within the chapters. The regulations are ordered in separate divisions, according to the main starting point or intention from which they have been given. As mentioned before, there are four of such starting points, viz. safety, health, usefulness and energy economy.

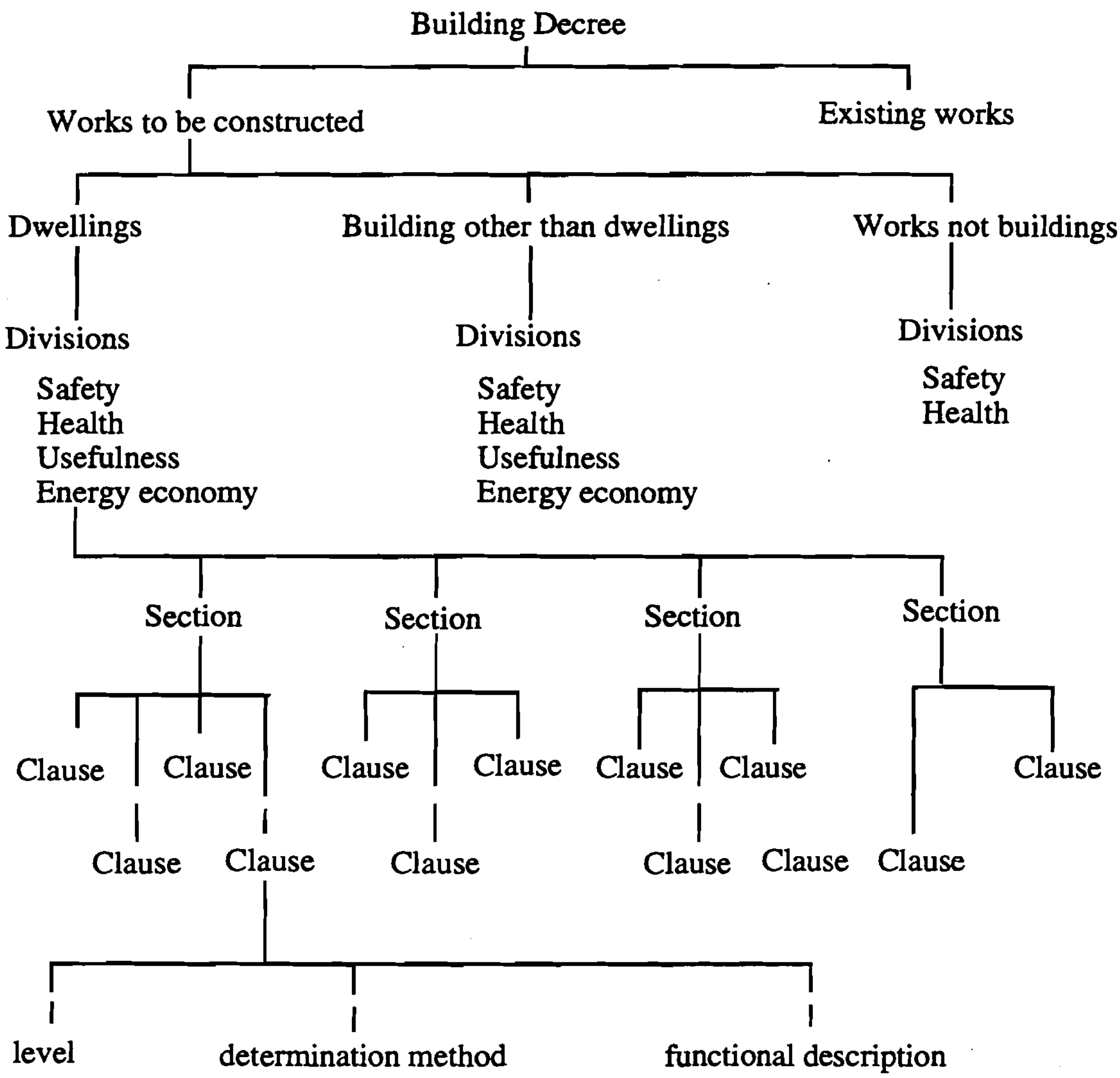


Figure 1. Structure of the Decree

For existing buildings there are no regulations from a viewpoint of energy economy. The reason for this is, that in consideration of acquired rights (formerly obtained building permits) such regulations would be too far-reaching. For construction works not being buildings, pursuant to the Housing Act, there are no regulations from the viewpoints of safety and health.

Performance requirements

The technical regulations of the Building Decree are expressed in performance requirements. In a regulation, the performance requirement is based on a functional definition. This definition expresses the intention of the performance requirement. The performance requirement consists of a limit value and a determination method. By the limit value, the level of performance is indicated that minimally has to be attained. As stated above, for the determination method the Decree usually refers to a standard of the Dutch Standardisation Institute.

For example, an analysis of section 70.1 gives the following result, in which the performance requirement is printed bold, the functional definition underlined and the determination method normal:

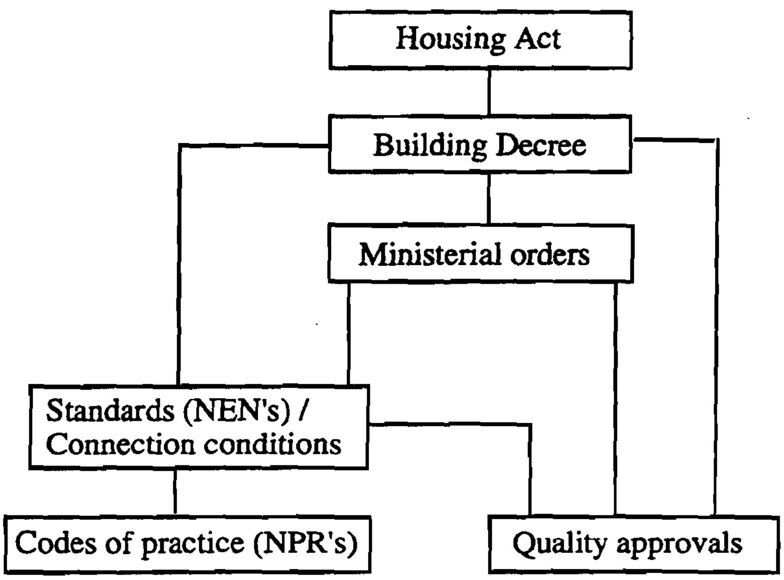
"**An external partition construction of a staying area, a toilet room or a bathroom,** in order to restrict loss of heat by transfer or conduction, **shall have a thermal resistance of at least 2,5 $m^2 \cdot K/W$**, determined in accordance with NEN 1068."

This way of formulating the regulations results from the aforementioned Action Program for deregulation. Briefly, the criteria are that a regulation has to ensure an optimal legal certainty and equality, must be unambiguous and thereby measurable and verifiable, and only in the smallest possible degree may restrict freedom and innovation.

Relations between documents

Performance requirements let the builder free in the way he will comply with them. This means there are no so-called 'deemed-to-satisfy' prescriptions. Still, there is a practical need for instructions for indication how to comply by means of current constructions. This need is met by so-called 'NPR's' (Dutch Codes of Practice), which mentions the measured or calculated performances for these constructions. The Building Decree does not refer to these NPR's, but they have been developed on the basis of standards referred to in the Decree.

Other regulatory documents the Building Decree refers to are the Model Connection Conditions of the associations of public utility companies. Quality approvals are an efficient way to check if constructions, construction products and materials comply with the requirements. The Building Decree provides that quality approvals that are recognised by the Minister of Housing have to be accepted as sufficient proof of compliance with the performance requirements (section 415).
The following figure represents the relation between the Building Decree and the mentioned documents.



Equivalence provision

Performance requirements allow an amount of freedom in designing a construction work that is maximal when adhering to the criteria of unambiguity etc. of the requirements. However, it may

occur that a solution in a building plan that is, being judged on its own merits, not inadmissible, does not fit to one or more requirements. The reason of this could be the nature or the situation of the construction work or the application of innovative materials or constructions.
For these cases the Building Decree contains the so-called equivalence provisions. Each division containing technical regulations ends with stating such a provision. If the applicant for a building permit wishes to opt for such an uncommon solution, he will have to demonstrate to the municipality that this solution corresponds with the intention and the level of the performance requirement of which limit value or determination method he wants to deviate from. Consequently, the equivalence concept does by no means serve to make possible the use of solutions of a lower quality level. The applicant may demonstrate the equivalence, e.g. by submitting a quality statement or a relevant scientific publication. He must take into account that the treatment of such an application takes more time than in regular cases.

The progress of the Dutch Building Decree

A lot of developments have been occurred since the introduction of the Building Decree (1992) and the three amendments concerning the CE-mark, Energy Performance and Lifts.
As they announced, the Ministry of Housing has worked out the second phase of the Building Decree. Furthermore, inquiries have been hold concerning the evaluation of the Housing Act and the Building Decree.
International developments, however, induce to adaptations. Next to this, a government policy has been developed relating to:

1. further integration of disabled people (accessibility);
2. a better protection of the environment (sustainability), and
3. improvement of laws by regulation of only essential requirements and let freedom to market mechanism as much as possible, deregulation and the quality of legislation.

<u>Reform of the Scottish Building Regulations</u>

By David Stone, Scottish Office, Construction Industry & Procurement Policy Division

1.1 The enabling legislation for the building control system in Scotland is contained in the Building (Scotland) Act 1959. The Act was introduced following the recommendations of the Committee on Building Legislation in Scotland (the Guest Committee) which in 1954-56 considered the plethora of provisions governing building in Scotland and devised the scope and powers necessary to achieve uniform, comprehensive and contemporary legislation. The building control system in Scotland is based on the administration by local authorities of the Building Standards (Scotland) Regulations. These regulations are made by the Secretary of State for Scotland, subject to the approval of Parliament, under powers in the 1959 Act. The essential purpose of the regulations is to safeguard the health and safety of people in and around buildings although in recent years the regulations have also been concerned with the conservation of energy and access for the disabled. The building control system applies to the construction, alteration, extension or demolition of a building or part of a building or to any change of use which attracts additional or more onerous requirements. It is a pre-emptive system, designed to ensure that proposed buildings do not contravene the regulations and that they comply on completion.

1.2 The first uniform set of regulations following the 1959 Act were introduced in Scotland in 1964. Subsequently, the regulations were regularly updated and amended to reflect technical developments and changing social conditions. However, by the early 1980s the regulations were subject to criticism as being too complex, too detailed and difficult to understand. In the light of these criticisms, and in line with initiatives in England and Wales, The Scottish Office invited building interests in Scotland to give their views on the structure and operation of the building control system and to suggest changes which might be introduced to make the system more efficient. These consultations revealed broad agreement that the basic framework of building control in Scotland worked satisfactorily but that there was scope for improvement in rationalising the regulations. Proposals for change to meet these concerns were subsequently issued in 1983 in a consultation document entitled "The Future of Building Control in Scotland". Having considered the views expressed in response to this consultation document the Government announced their plans to implement a package of measures designed to achieve, amongst other objectives, simplified and fewer regulations.

1.3 The revised regulations, the Building Standards (Scotland) Regulations 1990, were introduced on 1st April 1991 and represented a major change in format from that of the previous regulations. The new format provides for three principal components of information:

- the regulations themselves;
- a set of Technical Standards; and
- a set of deemed to satisfy provisions.

The regulations prescribe in concise, functional terms the standards required in each of sixteen subject areas. Schedules describing exemptions, classification of buildings by purpose group and rules of measurement are also included with the regulations. The regulations are then supported by a set of Technical Standards which set out the performance criteria for compliance with the regulations. The Technical Standards are in turn supported by a set of provisions which are deemed to satisfy the standards. These deemed to satisfy provisions may describe a particular specification or may reference an appropriate British Standard or other recognised national standard or technical specification.

1.4 The functional requirements of the regulations can be met in practice in three ways :-

- by compliance with the relevant standards set out in the Technical Standards;
- by conforming with the provisions deemed to satisfy the relevant standards; or
- by any other means which can be shown to satisfy the relevant standards.

The regulations and the standards set out in the Technical Standards are mandatory and apply uniformly throughout Scotland. The deemed to satisfy provisions are non-mandatory but if used properly they must be accepted by a building control authority as evidence of compliance. The document setting out the Technical Standards is the primary working document in the building control system and is organised in Parts covering the sixteen subject areas. For the convenience of users, the relevant regulations are included at the beginning of each Part together with an introduction which describes the purpose and intent of the Part. The relevant standards for the Part are then set out followed by the deemed to satisfy provisions.

1.5 The effectiveness of the new format of the 1990 regulations in meeting the objectives of simplicity in operation, consistency in interpretation and flexibility in practice is currently being assessed in a major evaluation exercise.

Spanish Reform

By Javier Serra, Ministerio de Obras Publicas

Background

Building regulations in Spain have early precedents since the Medieval times (i.e. "Las Partidas" promulgated by the King Alfonso X in the XIII Century). Lately in the XVIII, following the way of other European cities as London and Paris, the most important Spanish cities established Building Ordinances or bylaws in a more modern way. They included fire provisions too. During the XIX century more legislation for building came from cities, and the Central government was established. The legislation was aimed to implement the new hygienic trends of these times to correct the hygienic problems caused by the increase of population in towns due to immigration from the countryside.

The XX Century brought even more regulations for buildings and housing. The Ministry of Housing, created in 1957, started to draft the modern building technical regulations. It was made in a progressive way, first covering those regulations aimed at the safety of structures, then other aspects of the building requirements.

The actual framework was created in 1977 with the Royal Decree 1650/1977. It laid down the new NBE (Normas Basicas de la Edificacion or Basic Building Standards), compulsory regulations for new buildings. Since then the whole set of NBE (nowadays in the number of seven) has tackled issues as structures, water tightness, acoustics, thermal insulation and fire. Each NBE is approved, amended or revised by means of Royal decrees of the Counsel of Ministers on a proposal of the Ministry of Public Works.

Apart from that legislation, other empowered bodies have also made regulations in the field of some technologies (i.e. concrete structures) and services (i.e. lifts, gas, etc.) that are common in buildings.

The present situation

The resulting set of regulations applicable to building has become so broad and costly in compliance that its application and control for those involved in the building process (architects, developers, contractors, construction products producers etc.) has become very difficult.

The situation became so complicated that guide books and compendiums and software available on diskettes and CD-ROM aimed to help to "navigate" in this vast field of the Spanish building regulations were required.

Trends and conditions for change

Starting from the end of the 1970's new circumstances appeared that prompted an action to change and improve this situation.

First, the new 1978 Constitution of Spain gave much power to the 17 regions or Autonomous Communities. They have full competence in the field of urban planning, housing and quality in building. Hence the processes of drafting and revising the building regulations will have to involve regional authorities, fully responsible for its implementation.

The project of a Building Law is expected to be approved by the Spanish Parliament in the near future. The actual draft foresees the need to codify the set of regulations affecting buildings in a new Technical Building Code. It will have to be simple, modern and easy to apply.

Another important factor was the joining of Spain the European Community in 1986. It required the acceptance of the European rules in the field of the construction industry. The most relevant, one that will affect the building regulations, is the Construction Products Directive (89/106/CEE) or DPC. Although the DPC is aimed to provide the free movement of products, it also provides the only six essential requirements that can justify the existence of building regulations in the Member States of the European Union. This was a good reason to arrange the new technical code in Spain around these requirements and with the DPC philosophy. This implies the performance approach in both regulations and standards.

Objectives of the new Building regulations

The main ideas of this reform are that the new Technical Building Code CTE will have to fulfill the following conditions :

- be simpler and easier to understand and apply
- be easier to control and verify
- form a single book
- be drafted in the performance or objective-base approach as much as possible
- be drafted with the co-operation of the regions
- be inspired by the recent experiences of the most advanced countries (UK, Australia, New Zealand, etc.)
- be harmonized with the European regulations and standards
- be adopted progressively, revising the old ones to form part of this approach and drafting the new ones in this way, so that in a few years they could complete the code.

Time schedule for the reform

A first draft framework is expected to be ready in 1997. The revision of several old NBEs, in progress during 1997, is being made with this approach and could be ready within that year and the next.

The legal framework (the new Building Law) has been included by the Government for the legislative period and could be approved in the next few years.

That means that a comprehensive Building Code could be in full operation in the beginning of the next Century.

<u>Sweden</u>

With contribution by R. Jonsson, Lund University and Christian Leo, Boverket

The problems with using the prescriptive building code from 1980 resulted in a new code in 1988. In the area of fire safety no changes were made, due to the fact that this was considered by the government to be too difficult. In 1993 the Swedish Board of Housing, Building and Planning carried out a review of the current building regulations. The objective was to obtain European harmonization within the framework of the Board's powers to issue mandatory provisions pursuant to the Planning and Building Act (PBL). As a result of the review the regulations have been modified to accord with the structure and content of the six essential requirements for construction works which are set out in the EEC Construction Products Directive CPD (5). In addition, detailed requirements have, as far as possible, been superseded by performance requirements. Such an approach agrees also with a decision by Parliament regarding simplification of mandatory regulations.

The Swedish building code has since 1994 been performance based. The effects of this are not very clear because of the short time the code has been used in practice and that the construction business has been in recession during this period. Nearly at the same time (1995) the control system was changed. The compliance with the building code now lies solely on the building owner and no control of the technical solutions is carried out by the local authorities. This has of course changed the role of the senior fire brigade officer. There is, however one possibility for the local authorities to get some control over the technical solutions and this is accomplished by third party control. This can be asked for when the local authority does not believe in the competence of the engineers involved, and when they know from experience that a suggested design is complicated. This is unfortunately misused sometimes, so that third party control is often demanded for all fire safety engineering works. This is about to be amended by the government through issuing clearer instructions.

The main objective is that the building should be constructed so that the outbreak of fire could be prevented and the spread of fire and smoke in the building limited, and so that persons in the building could escape safely from the building or be rescued in some other way. Safe evacuation of the occupants may be achieved by giving the early warning of an incident, clear instructions, safe escape routes and if the emergency would be a fire, by initial control of the fire size. Safe escape routes as well as the initial control of the fire size may primarily be achieved by fire compartmentation. The compartmentation for preventing fire spread should be done according to the minimum requirements and no extra attention has been paid to minimize the possible property damage.

The most visible change with the performance based code has been that wooden structures are no longer limited to two-story buildings. This has led to an increased construction of apartment buildings with three to five stories. The cost of these buildings have proven to be lower with the use of wood.

The most important change is however that the discussions on fire safety during the building process have been more frequent than before. More often the solutions are based on the total fire safety for the building, and not on small details which sometimes are of no or very little importance for the overall fire safety. The knowledge of fire safety is no longer only for those "experts" who had the ability to read and understand all the details in the building "bible"- the old prescriptive code.

Other changes are the demand for documentation, increased quality in the verification process, and the increased numbers of handbooks and guidance documents.

Development of Performance-Based Building and Fire Regulatory Documents in the United States

By Brian J. Meacham, Society of Fire Protection Engineers, USA

Introduction

Throughout the United States' building and fire communities, steps have been taken toward the development of performance-based building and fire regulations. This transition has occurred in the public and the private sectors, and includes codes- and standards-making organizations, professional societies, and the Federal government. The following is a brief overview of the activities currently underway.

NFPA

The National Fire Protection Association (NFPA) is the consensus-based standards-making organization responsible for development of the National Fire Codes®, including the National Electrical Code®, the National Fire Alarm Code®, and the Life Safety Code®. In 1995, the

NFPA published the report, "*The National Fire Protection Association's Future in Performance-Based Codes and Standards*," which outlines NFPA's vision for performance-based documents. This vision is to develop documents that offer both a prescriptive-based option and a performance-based option in the same document. The user will have the choice, depending upon the situation, to select the most appropriate path. For the performance-based option, the report discusses the need to develop fire safety goals and objectives, performance requirements, and performance criteria, make assumptions concerning building use and occupants, develop design fire scenarios, and select suitable engineering tools and methods for undertaking the fire safety analysis and design. An example of how a NFPA standard might be formatted is also provided. (This report is available upon request from the NFPA.) At the present time, efforts are underway to develop performance-based options by the Life Safety Code Technical Committees, the Atomic Energy Technical Committee, the National Fire Alarm Code Technical Committees, and others. The NFPA, Quincy, MA, can be contacted directly for additional details.

ICC

Unlike other nations, the United States' building codes are not developed or promulgated by the federal government. Instead, model building codes are developed by three private organizations; the Building Officials and Code Administrators, Inc. (BOCA), the International Conference of Building Officials (ICBO), and the Southern Building Code Congress International, Inc. (SBCCI), and are adopted by individual states on a regional basis (Northeast, west of the Mississippi, and Southeast, respectively). As a means to eliminate the production of three separate model codes and minimize unnecessary regional differences, the three code-making organizations formed an umbrella organization, the International Code Council (ICC), under which to develop a single set of national codes (e.g., Mechanical, Plumbing, and Building).
As part of the development of the International Building Code (IBC) (International was selected, in part, because one of the current codes is already called the National Building Code), a Performance Committee has been established to develop a performance-based framework. Similar to the NFPA, the ICC Performance Committee is establishing intent (goal) statements, functional objectives, and performance requirements. It is not yet clear whether the ICC will include performance criteria in its documents. It is also not yet clear whether the performance-based framework will become the code, become the first part of the code, or become integrated with the prescriptive-based requirements (as in the NFPA format). Regardless, it has been stated that some form of the current prescriptive-based code will serve as one compliance option, and a performance-based option will also be available. It is expected that the performance-based option will reference an engineering guide to be developed by the Society of Fire Protection Engineers (SFPE) or some other organization. It is anticipated that some performance-based concepts will be included in the first IBC scheduled for release in the year 2000. The ICC Performance Committee secretariat, ICBO, Whittier, CA, can be contacted for additional details.

Federal Government

Agencies of the United States federal government are exempt from complying with local building and fire regulations. As such, many federal agencies develop their own regulations, and in some cases, laws. One example of this is the *Federal Fire Safety Act of 1992*. When enacted into law, the Act required that certain federal occupancies be protected by automatic fire sprinklers or *an equivalent level of safety*. In essence, this was one of the first performance-based regulations promulgated in the United States. Additional information on the Act can be obtained from the United States General Services Administration. Other federal agencies currently involved in the development of performance-based regulations include the Nuclear Regulatory Commission (NRC) and the Department of Energy (DOE). To support these efforts, the National Institute of Standards and Technology, Building and Fire Research Laboratory

(NIST/BFRL) has undertaken or supported several research programs. Additional information on the activities of each of these agencies can be obtained directly from the agency.

Professional Societies

There are a number of professional societies in the United States involved in activities in support of performance-based codes, including the American Society of Civil Engineers (ASCE), the American Society for Testing and Materials (ASTM), and the Society of Fire Protection Engineers (SFPE). At the present time, the most active of the professional societies is the SFPE. In early 1996, the SFPE convened the Focus Group on Concepts of a Performance-Based System for the United States. The intent was to bring together a broad cross-section of the United States' building and fire communities to discuss and gain consensus on the direction for a performance-based regulatory system for the United States. This effort has been successful, with the ICC Performance Committee utilizing output from the focus group in their code-making efforts. A copy of the focus group report can be obtained from the SFPE, Boston, MA.

The SFPE has also begun developing a Fire Protection Design Guide for use within a performance-based system. This, too, is a direct result of the focus group discussion and consensus. Development of the Design Guide will likely parallel similar efforts in Australia, New Zealand, the United Kingdom, and the International Organization for Standardization (ISO). Additional activities in support of a performance-based regulatory system include development of topic-specific fire protection engineering design guides, undertaking evaluations of fire models, with an emphasis on uses, applications, and limitations, and interfacing with the ICC and the NFPA in their code development activities.

The ASCE has also begun development of engineering standards that can be used within a performance-based system. This has included a join effort with the SFPE, *Standard Calculation Methods for Structural Design for Fire Conditions*, and formation of an ASCE group to look at performance-based fire safety design of structures. Similarly, the ASTM has formed a new committee, E5.33 - Fire Safety Engineering, whose goal is to support fire safety engineering practice by developing standards related to fire hazard and risk assessment, development, evaluation, and verification of engineering tools (e.g., computer fire models), and stimulating research where gaps in knowledge are identified. The efforts of the ASCE and the ASTM, in liaison with the SFPE and the NFPA, will serve to fill many of the engineering-support documents needed for a performance-based regulatory system for the United States in the coming years.

Summary

The United States has begun transitioning to a performance-based building and fire regulatory system in earnest. Several key activities are underway nationally in support of this transition, and additional activities in the area of education are planned for the near future. Furthermore, local jurisdictions have joined the movement as well, with the Commonwealth of Massachusetts set to produce what may well be the first state building code that specifically permits performance-based fire safety design alternatives. At the current pace, it is likely that performance-based concepts will be accepted in many parts of the United States soon after the year 2000.

SURVEY OF BUILDING REGULATORY SYSTEMS

The purpose of this survey was to collect information on existing regulatory systems in selected countries, as a help to those involved in the formulation and implementation of performance based building regulations. The survey was conducted in 1994.

The questionnaire was sent out to 21 countries, of which the following 14 have responded:

- Australia
- Canada
- France
- Germany
- Israel
- Japan
- The Netherlands
- New Zealand
- Poland
- South Africa
- Spain
- Sweden
- UK (England & Wales)
- UK (Scotland)

The questionnaire has been designed to extract information related to the concepts on which a regulatory system is based and its compatibility with the performance concept. Some of these countries have already made a transition to performance-based regulations and from those it was expected to acquire a share of their experience and guidance for those who would like to follow.

Definitions
The respondents were asked to adhere to the following definitions in order to avoid misunderstandings and to facilitate analysis of the survey information:

Agrément procedure - authoritative assessment of new building products with regard to compliance with regulations, durability and other necessary performances
building regulatory system - a set of legal documents and agencies regulating building industry
functional requirement - requirement defining the function that a component or a whole building must fulfill, usually in qualitative terms
general objective - a social goal with respect to buildings (e.g. health, safety)
performance requirement - description of the performance and criteria for compliance
performance based code/regulations - a code having a hierarchical structure based on general objectives and functional requirements (an *objective oriented structure*), with explicit links between the objectives and particular requirements. The requirements are formulated in performance terms, where possible and practical. Prescriptive requirements may also be used, provided that it is clear how they support the functional requirements.
prescriptive requirement - specification of acceptable solution(s)
component performance code - a code composed using performance requirements, but one that does not have the structure of a performance based code
structure of regulations, objective oriented - the structure of regulations with requirements grouped by the general objectives and functional requirements

structure of regulations, occupancy oriented - the structure of regulations with requirements grouped by the occupancy

structure of regulations, building component oriented- the structure of regulations with requirements grouped by the building components

CIB TG11 QUESTIONNAIRE

Building regulatory system in (country)

1. Enabling legislation

1.1 What is the legal basis of the regulatory system (e.g. an act of the legislative branch of the central and/or local governments)

1.2 What is the scope of the enabling legislation
- administration and enforcement
- general objectives
- functional requirements
- other, please elaborate

2. Regulations

2.1 What is the basis of the building regulations (is there a model code, who develops it, who adopts it)

2.2 What is the scope of regulations (e.g. health; safety; energy conservation; durability; serviceability; protection of the environment; protection of the property - the building in question, neighbours' property, occupants' property; consequences of massive natural disasters; man-made hazards like burglary, terrorism, riots, war)

2.3 Are objectives, functional requirements and/or performance requirements explicitly stated in the regulations ? If not stated, are they easy to establish or is it not obvious what is the end purpose of a particular requirement ?

2.4 Is the structure of the regulations objective oriented, occupancy oriented, building component oriented or mixed (please elaborate) ?

2.5 How much are the regulations integrated:
- self-contained, no references made to other documents
- references made to standards only
- references made to other approved documents

2.6 Are international standards referred to ? If not, can they be ? If they can not be- why ?

2.7 Who is responsible for managing (issuing, updating) the regulations

2.8 Who is providing significant input to the process of developing the regulations (e.g. government research organization, municipal officials, construction industry, insurance companies, designers) and what is the framework of this input (advisory board, committees, general meetings)

2.9 How is a decision made with regard to a proposed change - e.g. consensus (broad based), narrow interest consensus, authoritative decision based on broad input. In case of model code describe the process of the model code change.

2.10 How is rehabilitation and conversion of existing buildings regulated ?

2.11 How are buildings regulated during their normal use ?

3. Enforcement

3.1 Who is responsible for enforcement ? What is the role of:
- local (municipal) government
- professionals involved in design and construction

- insurance
- other (e.g. private certifiers/inspectors)

3.2 Is checking for compliance made:
- on drawings and specifications
- during construction
- after completion
- during the use of the building

3.3 What are the means of enforcing (e.g. rejection of drawings, stopping construction, preventing occupation)
3.4 Who bears the cost of checks and inspections ?
3.5 What are the penalties for non-compliance ?
3.6 What is the mechanism of appeals and arbitration ?

4. Evaluation

4.1 What is the process of accepting innovative design, technologies and materials ? Is an Agrément type procedure applied ?
4.2 Is there a national evaluation organization ?
4.3 What other organizations provide evaluation services ?

5. Education

5.1 Are there education and certification programs for building officials ? If yes, who is providing them ?
5.2 Are there education and certification programs related to codes and standards for designers? If yes, who is providing them?
5.3 Are there education and certification programs related to codes and standards for building contractors? If yes, who is providing them?

6. Trends in evolution of the regulatory system

6.1 Provide a brief outline of the history of the regulatory system in your country. Has the system been reformed recently ? If yes, why was it reformed - rationale ? Then go to 6.4
6.2 Is there a perceived need to reform the system ? If not, please elaborate on the advantages of the present system over possible options and provide comments, if appropriate, and go to 6.5.
6.3 What is expected to be achieved by the reform ?
- lower overall cost of regulation to the society
- better protection of essential needs of users
- other, please elaborate

6.4 What are the main difficulties that may be encountered in the process of reform ?
6.5 Are you aware of a similar survey being done recently ?

Questionnaire completed by:

SUMMARY OF RESULTS

Table 1. Enabling Legislation

	1.1 Document	1.2 Scope
AUSTRALIA	State Acts of Parliament, administrative regulations	Delegation of power to local councils
CANADA	Provincial Acts of Parliament	Traditionally limited to administration and enforcement; the new Building Code Act of Ontario includes "purpose" (general objectives).
FRANCE	Three separate groups of ministerial documents regarding housing, working premises and public buildings	Delegation of power to write regulations (to national authorities) and delegation of responsibility and enforcement
GERMANY	Two laws: on construction planning and on construction supervision	
ISRAEL	Act of central government ministries	administration and enforcement, general objectives, functional requirements, design specifications
JAPAN	Act of Parliament	Administration, enforcement, delegation of power to ministers to make regulations
THE NETHERLANDS	Housing Act 1991	Administration, enforcement, general objectives, functional requirements, financing of social housing
NEW ZEALAND	Building Act 1991	Administration, enforcement, general objectives
POLAND	Building Law, currently being in the process of adoption by the Parliament	Administration, enforcement, licencing of the professionals, delegation to make regulations by the central government agencies
SOUTH AFRICA	Act of Parliament, 1977	Administration and enforcement
SPAIN	Royal Decree of 1977, new Building Law under preparation	Delegation to Central Administration the power to make and revise regulations, and enforcement to local authorities
SWEDEN	Planning and Building Act, 1992	General objectives with regard to land use and buildings, administration, enforcement
UNITED KINGDOM (ENGLAND & WALES)	The Building Act 1984	Administration and enforcement
UNITED KINGDOM (SCOTLAND)	The Building (Scotland) Act 1959 and 1970	General objectives, delegation of the making of the regulations to the Secretary of State

Table 2a. Regulations

	2.1 Regulations, is there a model code?	2.2 Scope of regulations
AUSTRALIA	No model code, there is a national building code with state variations`	Safety, health, amenity; some aspects of property protection, energy conservation and protection of the environment
CANADA	Model code published by a central research agency (NRC), adopted by Provinces as is or modified	Safety, health, barrier-free access, energy conservation, separation of indoor-outdoor environment
FRANCE	There is no code as such. The regulations consist of national decrees and ministerial orders.	Health, safety, minimum level of comfort for housing
GERMANY	There is a model code, developed by a central expert commission, used by the Länder in writing their building laws.	Public safety, protection against harmful actions *(response not quite clear-security, terrorism?)* , health, order, heat retention, protection against noise and vibration
ISRAEL	There is no model code. Regulations consist of complex set of documents issued by different departments.	Health, safety, property borderlines, serviceability; objectives sometimes not very clear
JAPAN	There is no model code. Regulations are directly legislated by the Central Government.	Structural safety (including seismic and typhoon hazards), fire safety, safety in use, health
THE NETHERLANDS	Building regulations are collected in the Building Decree, based on the Housing Act and issued by the central government.	Safety, health, usefulness and energy conservation
NEW ZEALAND	There is a national code developed by Building Industry Authority, a central agency.	Health, safety, energy conservation, durability, serviceability, protection of the environment, property protection
POLAND	Centrally developed regulations are binding for the whole country so there is no need for a model code.	Safety, health, property protection,minimum level of comfort, access for disabled people, energy conservation, protection of the environment, right of third parties
SOUTH AFRICA	Regulations for the whole country were written by SABS advised by a broad based Technical Advisory Committee.	Regulations restricted to safety and health of people living or working in buildings
SPAIN	There is no model code. The new National Building Code will be compulsory for the whole country.	Safety (structural, fire and in use), health, energy conservation, noise protection
SWEDEN	Regulations are modeled on the six essential requirements of the European Construction Products Directive.	The essential requirements, energy conservation, serviceability and accessibility
UNITED KINGDOM (ENGLAND & WALES)	Building Regulations 1991, applicable throughout England and Wales, issued by the Department of the Environment	Health, safety, energy conservation and access and facilities for the disabled
UNITED KINGDOM (SCOTLAND)	There is no model code. The Building Standards Regulations and the Technical Standards apply uniformly throughout Scotland.	Fitness of materials, structural and fire safety, energy conservation, health, access, sound transmission

Table 2b. Regulations

	2.3 Objectives	2.4 Structure of regulations	2.5 Integration	2.6 References to international standards
AUSTRALIA	Yes	Objective oriented at the high level, occupancy and building element oriented at lower levels	Code + Australian Standards, other documents may be referenced	In principle yes, but so far only one, ISO, is referred to
CANADA	No	Mixed and not hierarchical structure	Code + Supplements + Canadian and US standards	In principle yes, but so far only ASTM and NFPA are referred to
FRANCE	Yes	A single code does not exist; each contributing document would have to be characterized.	"décrets" + "arrêtés", the last may refer to standards	National standards only
GERMANY	Yes	Mixed		Not directly
ISRAEL	Not always	Mixed and non-systematic	References to other regulations and standards	National standards only
JAPAN	No	Mixed, occupancy and building component oriented	Almost self-contained, few references to standards	National standards only
THE NETHERLANDS	Yes	Hierarchy: occupancy - new/existing buildings - objective - component	References to standards only with exception of utility connections for which there are approved models	Not directly
NEW ZEALAND	Yes	Objective oriented	Self contained	No references
POLAND	Yes	Objective - occupancy - component; some parts have mixed structure	Polish standards and other centrally issued documents are referenced, to be consolidated	National standards only
SOUTH AFRICA	Yes	Objective oriented	References to standards only	National standards only
SPAIN	Not always	Objective oriented, with exceptions	References to standards only	National standards only
SWEDEN	Yes	Objective - component	Code + references to standards or parts of them	National standards only
UNITED KINGDOM (ENGLAND & WALES)	Yes	Objective oriented, also part related to occupancy	Regulations are supported by 14 Approved Documents, which may refer to a standard or BBA certificate.	Indirectly
UNITED KINGDOM (SCOTLAND)	Yes	Objective oriented	Self-contained, "deem to comply" sections refer to stds and specifc.	Yes, in the "deem to comply" sections

Table 2c. Regulations

	2.7 Management, updating	2.8 Input to development	2.9 Decision on changes	2.10 Rehabilitation & conversion	2.11 Normal use of buildings
AUSTRALIA	Australian Building Code Board (ABCB)	Anyone may provide input, ABCB reviews and processes with help of States and CSIRO	Voting within ABCB, majority carries.	Compliance with broad statement of objectives is required	Regulated by administrative provisions of the States
CANADA	Canadian Commission on Building and Fire Codes (CCBFC)	Anyone may provide input, proposals are reviewed and processed by CCBFC with help of NRCC	Voting within a committee, public review, CCBFC approval	Equivalency to Code requirements	Fire safety regulated by the National Fire Code
FRANCE	Responsible Ministers	Through advisory panels made of interested parties	Ministers	Regulation not adequate	To confirm to regulations at time of construction
GERMANY	Expert commission representing Länder	Expert cttees attached to Deutsches Institut für Bautechnik	Working Team of Länder Ministers (ARGEBAU)		
ISRAEL	Ministers (Interior, Commerce, Health)	Advisory cttees attached to ministries	By voting	Regulated by local authorities	
JAPAN	Minister of Construction	Research establishments, Advisory Board to the Minister	Legislative procedure based on consensus	Compliance with current regulations	Compliance with current regulations
THE NETHERLANDS	Minister of Housing (technical requirements for buildings), local authorities (admin., demolition, recr. areas)	Research organizations, professional associations, the Ministry itself	Authoritative decision basd on broad input, must be legislated by the Parliament	Regulated by appropriate chapters of the Building Decree	Deteriorating buildings must be upgraded to meet requirements as per 2.10
NEW ZEALAND	Building Industry Authority (BIA)	Working groups advising BIA	Consensus of narrow interests	Fire secape and access as per new buildings, other not worse than before alteration	Maintenance of prescribed systems must be reported to authorities
POLAND	Ministry of Physical Planning and Construction	Ministry officials, research organizations, professional associations	Voting at general meeting; consensus sought	Compliance with current regulations or equivalency	Included in the Building Law

Table 2c Regulations, continued

	2.7 Management, updating	2.8 Input to development	2.9 Decision on changes	2.10 Rehabilitation & conversion	2.11 Normal use of buildings
SOUTH AFRICA	Minister of Trade and Industry in consultation with SABS	Not restricted but usually from local government, professional or trade organizations	Accepted if no adverse public comment received	Within the scope of regulations	Not regulated unless altered
SPAIN	General Directorate for Housing, Urban Planning and Arch.	Advisory and Standing Committees, Working Groups	Consensus	Regulations apply to altered buildings	Local authorities can control existing buildings
SWEDEN	The National Board of Housing, Building and Planning	EU directives, research, industry, building officials, designers, also internal	Authoritative decision based on broad input	Part of regulations applies to alteread buildings as well	Some services are regulated (eg.lifts)
UNITED KINGDOM (ENGLAND & WALES)	Central Government, Department of the Environment (DOE)	Policy makers, pressure groups; consult. document issued for comments	Revised document is published by DOE	Most works require building regulation consent	Public buildings only, means of fire escape
UNITED KINGDOM (SCOTLAND)	The Scottish Office Env. Dept. Building Directorate, on behalf of the Secretary of State for Scotland	Build. Stand. Adv. Cttee, BSI, other Gov. Dept., local authorities, interest groups, research bodies	Approval of revised proposal by Scottish Office Ministers and legislation by the Parliament	Same regulations as for new buildings	Not regulated by the Building (Scotland) Act

Table 3a. Enforcement

	3.1 Responsibilities	3.2 Checking for compliance
AUSTRALIA	Local government	Drawings and specifications, site visits, final inspection. Limited powers to inspect during normal use
CANADA	Local government, provincial or territorial government in remote areas	Strict for large projects in major cities, Vancouver relies on certified professionals, little in remote areas on small projects
FRANCE	Local authorities - through building permit, state authorities with regard to energy cons. and fire safety	Building permit, certification by the architect, fire inspection for public buildings
GERMANY	Local authorities	Drawings and specifications, inspections during construction (at discretion of the authority) and after completion -
ISRAEL	Local municipality (City Engineer)	Architectural (1:100) drawings, concrete strength during construction, after completion - water pressure test of plumbing, flooding and hose spray test of roofs and windows.
JAPAN	Local building official (plan check, inspection after completion, issuance of occupancy certificate), licenced architect/engineer appointed by building owner as supervisor of construction work	As per 3.1 plus inspections during use by qualified inspector appointed by building owner
THE NETHERLANDS	Local government approve plans and issue building permit	Drawings and specifications, inspections during construction and after completion by municipal inspectors (at their discretion). Buildings may be inspected during use.
NEW ZEALAND	The owner and designer bear most of responsibility, with provision for independent check (presently by territorial authority, also by private certifiers in future)	Drawings and specifications, inspections during construction. The extent of check lies with territorial authority, who can make random checks that the process is being followed.
POLAND	State Building Inspection, municipal authorities, private checkers of drawings and specifications, private inspectors representing clients, designers making inspection during construction	Drawings and specifications, calculations, compliance with fire protection requirements (by fire protection inspector), approval by providers of electricity, gas, district heating, water and sewage; inspections during construction and after completion
SOUTH AFRICA	Local authorities	Approval of plans and specifications, other documents and information submitted to local authority; inspection during construction
SPAIN	Local and regional authorities, professionals	Drawings and specifications, site visits

Table 3b. Enforcement

	3.3 Means of enforcing	3.4 Cost of checks & inspections	3.5 Penalties	3.6 Appeals & arbitration
AUSTRALIA	Conditional approval, rejection of drawings, work stop order, demolition, occupancy permit	Applicant fee	fines, court case	Independent arbiter or board of referees, State Department of Local Government, State Ombudsman, licensing boards
CANADA	Through building permits of various kinds, unsafe buildings may be demolished	Permit fees	Fines up to $100,000	Board of appeal, court action
FRANCE	Refusal of building permit, "amiable recourse", suit before administrative court	Application free of charge	Suit before penal court	Appeal before appeal court
GERMANY	Rejection of application, stopping works, sealing the site, custody of materials and equipment, demolition, prohibition of use	Building owner bears the costs	Fines up to DM 100 000	Objection to decision, action at Administrative Court
ISRAEL	Rejection of drawings, stopping construction, preventing occupation	The entrepreneur bears the cost	High fines and demolition	Appeals to the City Engineer, no arbitration
JAPAN	Rejection of drawings, stopping construction, preventing occupation	Building owner bears the costs	Suspension of license for professionals involved	Appeal to Appeal Board and to Minister of Construction
THE NETHERLANDS	Rejection of drawings, stopping construction, correction of existing building at expense of owner	Applicant pays for check, community pays for inspection	Up to 6 months or fl10,000 for construction without permit	Municipality, administrative judge, administrative jurisdiction
NEW ZEALAND	Refusal of building consent (with reason in writing), notice to rectify, preventing occupation only when building deemed to be dangerous or insanitary (must be confirmed by District Court)	Most covered by the owner	High fines; up to $NZ200,000 and $NZ20,000 per day for use of unsafe building	Appeal to Building Industry Authority, outcome can be appealed to High Court on matters of law
POLAND	Rejection of drawings, stopping construction, preventing occupation, possibility of demolition if erected without permit	Designer pays for check of drawings, inspections paid for by investor	Fines	Appeals to authorities higher than those that have made the appealed decision

Table 3b. Enforcement, continued

	3.3 Means of enforcing	3.4 Cost of checks & inspections	3.5 Penalties	3.6 Appeals & arbitration
SOUTH AFRICA	Rejection of drawings, stopping construction, preventing occupation	Applicant fee	A fine or imprisonment	Appeals to a Review Board
SPAIN	Rejection of drawings, stopping construction, preventing occupation	The client	Usual penalty is withholding occupancy permit	Accordingly to administrative law
SWEDEN	Rejection of drawings, stopping construction, preventing occupation	Application fee, additional charges for extra checks	Enforcement of changes, fine, work at owner's expense	To consecutive levels of government as well as to corresponding courts
UNITED KINGDOM (ENGLAND & WALES)	Rejection of plans, legal action. There are no powers to stop work or prevent occupation.	Fees paid by owner	Fine up to £5,000 with additional penalties if offense continues, as result of prosecution in Court, plus costs	Through the Department of the Environment or the Magistrates Court
UNITED KINGDOM (SCOTLAND)	Rejection of application, stopping work, withholding completion certificate, demolition of a hazardous building	Building warrant application fee	Fines as per 1959 Act	Sheriff Court (building warrant refusal), local authorities, Secretary of State for Scotland

Table 4. Evaluation

	4.1 Process	4.2 National organization	4.3 Other organizations
AUSTRALIA	Supporting evidence may be required by local authorities. If assessment beyond competence, than National Accreditation Scheme is applied.	No	ABSAC, universities, commercial research org., private consultants and overseas testing lab. No restrictions as to who can perform the evaluation.
CANADA	It is up to local authorities to accept a proof of compliance. Listings are provided by private laboratories, CCMC and provincial bodies	No national authoritative agency	Foreign evaluations as supporting evidence only, with not much convincing power
FRANCE	Evaluation required by insurance - Avis Technique	No central body	System of "contrôleurs techniques"
GERMANY	An approval procedure exists	At the level of Länder	Some tasks required to be performed by DIBt
ISRAEL	Similar to Agrément, Technical Opinion of the National Building Research Institute (NBRI) is required.	NBRI acts as one	None
JAPAN	By the approval of the Minister of Construction, procedure similar to Agrément	No	Building Center of Japan
THE NETHERLANDS	Decision made by local authorities. There is also Agrément system. The Minister of Housing can grant exemptions.	No	Technical institutes can be involved as consultans.
NEW ZEALAND	Alternative solutions are assessed by the territorial authority.	Building Industry Authority, their accreditation must be accepted	Many organizations and consultants
POLAND	Agrément procedure is applied	Government research organizations issue technical appraisals	Testing laboratories
SOUTH AFRICA	Agrément procedure or test, report by SABS and CSIR	No	SABS and CSIR
SPAIN	Agrément procedure is applied	Instituto Eduardo Torroja	There are other organizations involved, but only in quality control.
SWEDEN	Approval by local authorities, major departures by National Board of Planning, Housing and Building	No	None specific or continous
UNITED KINGDOM (ENGLAND & WALES)	Agrément procedure is applied	BBA	Members of the Association of British Certification Bodies
UNITED KINGDOM (SCOTLAND)	Solutions may be accepted if properly vetted by an authorized European or National testing house. Agrément procedure can be applied.	BBA	National Measurement Accreditation Service, Fire Research Station, British Standards Institution

Table 5. Education

	5.1 Building officials	5.2 Designers	5.3 Contractors/Builders
AUSTRALIA	A national system for accreditation of building surveyors has been set up by their professional association.	Under- and postgraduate courses are provided by universities & colleges.	
CANADA	There is no national program but some provinces have certification programs.	University and college courses for architects and other construction-related specialties are available.	Voluntary, ad hoc seminars
FRANCE	No specific education for building officials	Only fire safety education is provided, also for fire brigade officers.	
GERMANY	No special education is provided. Local authorities must retain an engineer and a lawyer		
ISRAEL	No		
JAPAN	Ministry of Construction qualifies candidates for building officials, disseminates information to officials.		
THE NETHERLANDS	Education provided by the Administration Academies, no certification program.	Training and education provided by a private organization for all involved in construction	
NEW ZEALAND	No national training system. Isolated courses within continuing education programs	Ad hoc seminars only	No formal programs
POLAND	No regular education programs. After each revision, a series of courses is organized by professional associations and research institutes. No cerificates are issued.		
SOUTH AFRICA	No	No	No
SPAIN	No	No	No
SWEDEN	Regulations are taught in the national school system. Certificates are issued for building officials	There are private organizations providing training for architects and technicians and issuing "diplomas"	Guild-like organizations provide training
UNITED KINGDOM (ENGLAND & WALES)	There is no mandatory programme but private institutions provide training and examinations acceptable by authorities.	Yes - through normal professional training	No, except for courses for construction managers
UNITED KINGDOM (SCOTLAND)	"	"	"

Table 6a. Trends in evolution

	6.2 Need to reform	6.3 Expected results
AUSTRALIA		
CANADA	Yes, there is a strategic plan to have a performance-based code by the year 2000	Change from an overgrown prescriptive type code to a cohesive and transparent objective-oriented one. Savings are expected in construction costs, compliance checking and education.
FRANCE	There are complains but no action so far	
GERMANY		
ISRAEL	Preparatory work to make major changes has been going on	Systematic approach, resolution of contradictions and filling gaps existing in the present regulations
JAPAN	There are suggestions from the industry and academia to move to performance code	Improved chances for innovative domestic and imported design, technology and materials
THE NETHERLANDS	Regulations have been recently reformed	
NEW ZEALAND	Regulations have been recently reformed	
POLAND	The sytem is being currently reformed	Making the sytem compatible with the market economy, use the performance concept as far as possible
SOUTH AFRICA	No need perceived at this time	
SPAIN	Yes, in part to implement the EC Construction Products Directive	Improved quality of housing and other buildings
SWEDEN	There is a process of periodical reviews, last was in the end of 1993	Harmonization with European Directives
UNITED KINGDOM (ENGLAND & WALES)	Only minor adjustments expected	
UNITED KINGDOM (SCOTLAND)	Yes	Less onerous system for users, improved procedures, improved funding, greater involvement of private sector, greater harmonization within the UK, improved response to the impact of European Directives

Table 6b Difficulties that may be encountered in the reform process

	6.4 Problem
AUSTRALIA	Multiple tiers of government involved, lengthy legislative procedures, poor understanding of implications of regulations; tendency to regulate details while loosing the view of the over-all performance
CANADA	Industries lobbying to preserve or gain their market share and to preserve investment made to meet current regulations; unknown cost of enforcement in the environment of budget cuts
FRANCE	
GERMANY	
ISRAEL	Arriving at consensus among different agencies involved
JAPAN	Resistance to change
THE NETHERLANDS	Coordination of different regulations involved; writing the new regulations in legal language; resistance to change
NEW ZEALAND	Historical mindset - the reforming body must be independent of existing government agencies; tendency to go astray in the process - objectives must be adhered to; need to promote and educate as otherwise confusion is created; need to continuously watch other countries' experience
POLAND	Perception of performance-based regulations being more difficult than the prescriptive regulations to implement and enforce
SOUTH AFRICA	Education with regard to application of functional requirements as opposed to prescriptive requirements
SPAIN	None identified at this time
SWEDEN	The mental process of change
UNITED KINGDOM (ENGLAND & WALES)	
UNITED KINGDOM (SCOTLAND)	The format must stand up to legal and Parliamentary scrutiny, the conventional language must be used; different interpretation of referred documents; time consuming process of reform; fitting into the Parliament schedule

ANNEX B

CIB TG11 PERFORMANCE BASED BUILDING CODES

NEEDS OF BUILDING CODE USERS

Needs Subgroup: J. Hunt (Chair), J. Frye, A. Cote, J. Gross, C.A. Rackliffe, J. Soucy

Introduction

This chapter of this report seeks to establish the needs of building code users in general but obviously directed at performance-based building codes. You will note that the title given above relates to 'user needs' and this must be differentiated from 'user requirements' which is a term used in international standards.

ISO 6241: 1984[1] includes a table which lists fourteen user requirements that a building should satisfy in various categories. They apply to spaces within or around buildings considered independently of their location and design. They represent a shopping list of society's objectives for building control.

On the other hand, the user needs which form the subject of this chapter represent the expectations of each user of a particular building code upon opening the document. These are the needs of a variety of users, whether they be the owner, designer, control officer, insurer, contractor, manufacturer, educator or manager, in establishing their obligation in complying with regulations.

[1]ISO 6241: 1984 Performance standards in buildings - Principles for their preparation and factors to be considered

Users of a performance-based building code need the code to:

1. Have a well defined scope.
2. Satisfy public expectations.
3. Have clarity of intent.
4. Be easily understood.
5. Have an appropriate classification of building uses.
6. Provide certainty of outcome.
7. Be flexible in application.
8. Apply uniformly throughout the jurisdiction.
9. Apply to all buildings.
10. Ensuree consistency of interpretation.
11. Be easy to update.
12. Be administered by a single body.
13. Not hinder innovation.
14. Make use of all available resources.
15. Apply a consistent approach to risk.
16. Minimise disputes.
17. Have clarity of liability.
18. Ensure cost-effective compliance.
19. Ensure certainty of compliance.
20. Be applicable to changes of use and alteration.

The italicised text in the following commentary is extracted from the report by the Building Industry Commission[2] which was the outcome of three years intensive investigation into the reform of building controls in New Zealand that lead to the introduction of a performance-based code in that country in 1992.

1. Have a well defined scope

This is the fundamental requirement of any control system and applies particularly to a building code. If the boundaries are not clearly defined, and the interface with other parts of the control system not established at the outset, confusion will reign. This affects not only all building code users but also the users of all interlinked legislation and activities. A consequence of an ill-defined scope will be uncertainty in all subsequent decision-making processes and will impact on all the other needs of building code users.

2.14 *People have certain expectations of the buildings they use, whether that use is public or private. Because buildings may pose a threat to their safety, health, or well-being in social and economic terms, people seek assurance through some form of control that all buildings meet certain essential requirements to safeguard them from risk.*

To achieve an efficient and effective building code a balance must be established between the stifling effect of an over-regulated control system and an under-regulated system that requires the individual to seek redress through the courts.

2.70 *The regulatory control system must be limited to requirements that are essential to protect the people affected that cannot be assured by private arrangements.*

The scope of the building code reflects the policy of the government and establishes the extent to which government wishes to be involved in the context of deregulation in the control of buildings. This policy is usually found in the enabling legislation and is subject to the normal procedures for scrutiny and debate that all legislation attracts.

2. Satisfy public expectations

2.15 *Where voluntary private arrangements by building owners and the industry cannot be relied on to provide assurance to the public on safeguarding them from risk, regulatory controls are imposed by Government to define building performance and procedures for compliance with essential user requirements to an extent that will satisfy reasonable community expectations.*

A building control system that is over-regulated and prescriptive stifles the industry and adds costs to buildings. On the other hand an under-regulated system forces a disadvantaged individual to seek redress through the courts, which is unlikely to be cost effective, or it encourages the introduction of more restrictive de facto controls by private sector organisations such as financiers and insurers.

2.46 *The need for a control authority to approve and inspect buildings on the community's behalf could, in theory, be replaced by regulating the arrangements between insurers and building owners and producers.*

2.47 *In practice, international experience has shown that the rules of insurance schemes, designed to protect property and minimise loss, create competing de facto*

[2] "Reform of Building Controls Volume 1: Report to the Minister of Internal Affairs" published by the New Zealand Building Industry Commission, January 1990.

control systems in which some requirements exceed existing control provisions. The intention of insurers to contain losses is also likely to lead to over concentration on avoiding property related defects, with less attention given to health related provisions and other essential public safeguards.

A balance has to be established between over-regulation and under-regulation, based upon the expectation of society, or in other words 'in the public interest'. This balance has the ability to change over time and needs to be checked at frequent intervals.

3. Have clarity of intent

Once the purposes of the controls required by society have been well defined the objectives of the building code must be clearly stated, and in a form that is understood by all users. In practice, if the purposes are defined in, say, a building act as part of central government legislation they are not easily accessible by the majority of building code users. The only way to ensure that these purposes are not lost sight of is to incorporate them as objectives at the head of each consequential set of building code requirements.

By this means the building code writer and the code users can ask and answer questions as to whether any particular requirement falls within the boundaries of the scope set by government.

The objectives can also be used to translate the traditional legal jargon of legislation into language more easily understood by the wide ranging users of a building code.

If the purposes of the controls as set by government intend protection of other people's property and remain silent on protection of the owner's own property then the objectives of the building code will draw this distinction. Accordingly, means to prevent water damage by overflow from sanitary fixtures on an upper floor to property on a lower floor of a building will be a requirement when the floors are owned by different people. Universal application of such a requirement to all buildings, regardless of ownership considerations, may well be outside the purposes of the legislation.

4. Be easily understood

Two factors influence the extent to which a building code can be understood by all its users: they are the format and the language.

The format of the building code must be one that is consistently applied throughout the whole code. It is the format that provides the skeleton on which all other constructions hang. To be effective it must ensure that at all times the user is not lost but has sufficient signposts near at hand to be reassured as to what the particular code provision requires, and why.

To satisfy the needs of international users of a code, a standard format is of great assistance. Initial work was undertaken separately by the Economic Commission for Europe (EEC) and the Nordic countries to develop building code structures, and subsequently in 1978 a common structure resulted. This comprises a limited number of levels characterising the purpose of the regulations from the comprehensive objective of the statute down to the technical solution. Such a formalised structure of five levels ensures that when an innovative solution is proposed it can easily be evaluated in terms of compliance by way of the format adopted.

2.71 *...the language of control provisions should be clear, and simple ... to ensure understanding and easy use of the system by the maximum number of people that it affects.*

Written requirements need to be as simple as the subject matter allows so that users can readily find and understand what is required. Simplicity can be achieved by reducing the number of objectives or building aspects that are controlled; provided essential requirements to meet the stated objectives of building control are not excluded.

It may be necessary to consider multiple language versions to ensure an adequate level of understanding in multi-cultural societies. Regardless, the language used must of itself be of a simple nature, devoid of jargon and chosen with full cognisance of the understanding of the building code users.

5. Have an appropriate classification of building uses

The use of a classification system for buildings covered by a building code should evolve as a consequence of developing a code rather than being the driving force in establishing the code format. The reason for this approach is that a particular building may contain many varying uses and therefore each part may have to satisfy separate parts of the building code. In such a case, a single classification becomes meaningless.

Similarly, buildings for a specific use may fall into differing classification by virtue of their size rather than by what goes on inside them, particularly from a structural or fire egress point of view.

The Building Regulations, England and Wales, do not have a classification list for buildings. They make reference to a particular type of building only when it is necessary to make a reference in respect of a particular requirement of the regulations. The approach taken is that in a performance-based code the provisions apply to all buildings unless the application is clearly limited.

In the NZ Building Regulations a classification of uses is included so that when that use is considered the applicable provisions can be identified. Hence, an extensive building complex that includes hotels, offices, shops, cinemas and all that they entail are treated in accordance with the needs of the user related to those uses. In establishing the classification of uses, distinction has been drawn between the varying duty of care provided by the people in control of other users in the spaces, and inversely the degree of dependence of the users on others, all with respect to their health and safety. Thus the building code provisions tend to be less onerous for privately owned dwellings, increasing through community buildings providing residential facilities such as hotels, to community buildings providing care to the principle users (hospitals and old people's homes) where they are unrestrained and more so to similar buildings where the users may be restrained (hospitals, drug centres and prisons). A similar approach is taken in terms of numbers of people gathered from childcare centres to classrooms to auditoriums.

6. Provide certainty of outcome

Building producers and owners need reasonable certainty as to whether or not their activities will comply with the control requirements.

Although the regulator is only interested in compliance of the completed building, for practical reasons the building official is more interested in assessing the likelihood of compliance based on the plans and specification at the building consent stage.

Experience has shown that if a particular concept justifying compliance cannot be demonstrated to the building official at the building consent stage, a likely reason is that the concept is based on management rather than building provisions.

7. Be flexible in application

Control requirements should not be rigid in application. They should be in a flexible form that accommodates differences in geography and culture, and that encourages innovation and the incorporation of new technology in building. Approvals for new and different solutions that meet the requirements should be readily obtainable.

Functional requirements need to be qualified by the limits of the application: whether they apply to all buildings or just, say, housing or commercial buildings. Similarly, the performance levels need to be qualified where this is appropriate.

Notwithstanding such qualifications situations will always arise where the provisions are inappropriate and unnecessary in order to satisfy the objective. This can be overcome in one of two ways:

Firstly, by attempting to anticipate every scenario and incorporate all the necessary provisos and exemptions. This will result in a long and complex building code in which simplicity is destroyed. Secondly, by providing for flexibility by enabling the controlling body or building official to exercise responsibility within clearly established parameters to allow waivers or modifications to the code provisions.

8. Apply uniformly throughout the jurisdiction

2.71 *The system must apply uniformly throughout the jurisdiction. Provided control provisions are confined to requirements that must be regulated in the interests of the people affected and society at large, there is no basis for variation in the system of control for demographic or geographic reasons. A properly designed system will be universally applicable to all citizens, and local variation in the system could only be detrimental to achieving its social objectives.*

9. Apply to all buildings

A building control system should apply to all buildings. Within that system flexible provisions can be incorporated to waive or modify particular provisions provided the objectives are not compromised.

Exemptions on a class basis such as buildings belonging to the government cannot be justified if the objectives are properly formulated. Where national security may be a factor variations to the administrative procedures can ensure that security is not compromised.

2.53 *To achieve national consistency and uniformity, the building control system should bind the State. Occasional State projects will, however, involve construction details which are so sensitive that it would be against the public interest to allow them to be examined for compliance as they were built; possible examples are extensions of the national computer facilities, certain military installations and maximum security prisons.*

2.57 *There appears to be no difficulty in requiring the general class of State buildings to comply with the requirements of a national code, and good reasons exist as to why they should be treated administratively in the same way as other buildings. Where building performance higher than the control provisions is desired, levels of* *daylight in schools, for example, these will be achieved by the agents for the State. Like other building owners, such agents can make contractual arrangements with their building producers and managers to meet their own requirements in the most cost-effective ways available in the industry.*

Appropriate formatting of the building code, particularly when performance-based, will lead to clarity of intent and simplicity of use. This can be easily achieved by writing the code on the basis that all the objectives apply to all buildings. Rather than introducing a series of provisos that create long and convoluted text, limits on the application of each provision can be listed separately. Such a process will make clear the obligations of the code user with regard to each objective for each class of building and application in terms of other building parameters.

10. Ensure consistency of interpretation

Building code users need consistency in the interpretation of the code to ensure certainty of outcome.

2.71 *Each regulatory control must have a clearly understood objective that is consistent with a chosen set of objectives. This is necessary for the proper interpretation of the control provision, and to ensure that neither its purpose nor requirements for other purposes will subvert the system when changes in policy objectives and new information are considered.*

11. Be easy to update

2.71 *The system must provide for maintaining control provisions in an up-to-date state, to reflect new knowledge and changes in social and economic policy. Revision should be easily effected, but the machinery for revision must be such as to ensure that the objectives of the original provisions are carried forward.*

New provisions must not be added during the course of an updating process unless it can be demonstrated that such provisions are a direct consequence of meeting a stated objective.

Consultation with all building users is a fundamental need during any updating process. Recognition of the lead times that affect the ability for all users to respond to change is essential so that there are no surprises in their application of the building code.

12. Be administered by a single body

Overall control of a building code needs to be vested in a specific body charged with being the single focus of building controls. Efficiencies can be generated through establishment of a single framework, administered by a body that can provide consistent interpretation and resolution of disputes. Differing priorities and interests can be easily evaluated when put before the one body (e.g. Dept. of Environment, England and Wales; Building Industry Authority, New Zealand; and Australian Building Codes Board, Australia).

On a day-to-day basis building designers and contractors need only to deal with a single body in order to obtain all consents required for a particular building (e.g. the local territorial authority). This in effect creates a one-stop-shop from conception to occupancy.

13. Not hinder innovation

Amongst all building practitioners will be found both leaders and followers. A performance-based building code is able to satisfy the needs of both types.

A performance-based code that consists of just the objectives, functional requirements and performance criteria will not assist the building practitioner who is a follower, i.e. one that relies on following a prescribed route that offers security of outcome, even if it results in a financial penalty.

On the other hand, many designers, contractors and particularly manufacturers are continually striving to provide the best solution to each particular problem.

The rewards for innovation will only be realised if the process is not frustrated by the inability, through lack of skill or fear of liability on the part of the approving body, to be able to assess compliance in an effective and efficient manner.

Education and general upskilling of all sectors of the building industry, particularly designers, contractors and building officials is an essential requisite of efficient administration of a performance-based building code.

14. Make use of all available resources

Many prescriptive building codes and many standards documents provided by Standards organisations include phrases such as "to the approval of the engineer or the approving body" or "to the approval of the authority having jurisdiction". This approach locks up the knowledge in the approving body concerned and inhibits development of new ideas because the rules for acceptance are unstated in advance.

Building users need to know all the rules in advance so that they can accommodate them in the best possible way in the course of designing and constructing a building. When the building code provisions are all clearly stated then the monopoly of approval held by the approving body can be broken, thus allowing the introduction of private certifiers approved by the central body responsible for the building control system. In this way specialist expertise within the building industry at large can be fully utilised.

15. Apply a consistent approach to risk

2.19 In the total building system, reducing the resources used to supply buildings (including administration and enforcement of controls) and reducing the risk of injury to people, property and the environment, result in social and economic benefits. Conversely, increasing use of resources and increasing risks result in additional costs.

2.20 Ideally every control provision should represent a balanced position between acceptable cost and acceptable risk.

2.21 Individual and community perceptions on what are acceptable risks and acceptable costs for the benefit of reducing risks vary greatly, depending on the individual person and the circumstances. Generally there is a low tolerance of involuntary risk but a high tolerance of voluntary risk. This high tolerance applies not only to decisions taken by a person on his or her own behalf - such as a rigger on a construction site or a person smoking in bed - but extends to decisions taken by people on behalf of others, such as leaving children unattended in a house or car.

2.22 *Reduction of involuntary risk at a very high cost for a possible benefit, tends to be expected by the public:*

- *in response to disaster or highly publicised accidents;*
- *where the total cost is relatively low;*
- *where the victim is likely to be a child;*
- *where it is perceived that the costs will be met by people other than those who expect to receive the benefit.*

2.23 *It would appear that there is no generally useful methodology based on probability theory and statistical data to assess risk levels, other than the traditional basis of expert judgement, public comment and relevant government policies.*

Designers, contractors and manufacturers pursuing innovative outcomes need to be able to evaluate their proposal against the performance criteria.

3.31 *For some control requirements it is possible to describe performance in quantified terms that permit the performance to be readily verified. For example, a quantified performance for a mechanical ventilation system requirement could be that the system be capable of changing the air in a room a certain number of times in an hour. Such a performance can be readily predicted by calculation and verified by test. Where possible, the building code needs to include measurable performance requirements.*

3.32 *For other control requirements suitable parameters to measure performance do not exist. Either none can be identified, or, if identified, their use and verification would be too complicated and expensive. For these requirements, expanded descriptions of the features of the building that will meet the requirements must be included in the code. Taking a fire safety example, a quantified performance related to evacuation time could possibly be given, but it would not be useful because the wide range of variables would make reliable prediction too difficult and it would require a fire to verify the performance. Performance requirements for means of escape are therefore described in terms of capacity, fire and smoke resistance and other relevant features.*

Such data may not be available to regulators at the time of writing the code but can be included over time. In setting the performance criteria the acceptable probability of the event occurring or not occurring, if not explicitly stated in the code should be available so that valid comparisons of the application of risk parameters can be made. Such tools will assist in evaluating the expectations of the public, particularly when expressed through strong lobby groups.

16. Minimise disputes

2.72 *The control system needs to be designed to encourage cooperation between the parties involved and minimise the incidence of dispute and litigation in building matters. This is achieved by ensuring clarity of intent when developing the format.*

The influence of a building code is now no longer confined within the borders of the responsible country. International trade agreements require all trade barriers to be dropped which in itself demands transparency of requirements. At the same time regional groupings of countries are increasingly developing harmonised building codes and standards.

Prior to 1978 the Nordic countries and International Standards Organisation developed independently two five level formats. A simply comparison shows that they are to all intents and purposes identical in that the five levels are:

Objectives

Functional requirement

Performance criteria

Verification method, and

Acceptable solution.

These five levels provide the necessary level of surety to enable decisions related to acceptability of building products and systems to be made internationally on a logical basis. The necessity for a logical basis applies equally to the decision making process within each country using its own building code.

3.66 Unlike prescriptive controls that do not state their purpose or performance criteria, questions of interpreting the mandatory requirements become "Does this solution comply with the Code?". This is a matter of technical fact and judgement, to be ruled on by technical rather than legal experts, and resolving the question in a particular case should not generally involve litigation.

Deletion of any one of the five levels introduces a degree of uncertainty as to the intent of the provisions.

The necessity for the five levels only becomes apparent to most code users when building proposals that vary from the norm or are innovative in their solution become the subject of doubt or dispute. It is at this stage that the five level framework comes into its own and the proposal in question can be evaluated against the established logic of the format.

As the 'Global Village' concept develops between countries, international consistency in the use of the five level format assumes increasing importance as a pre-requisite for acceptance of off-shore sourced building systems. Many disputes can be traced to variations in understanding concepts brought about by substitution of similar but different terms and modifications in format. As a primary means of eliminating misunderstanding between countries the adoption of universal terms and formats has much to offer.

In conjunction with the introduction of a performance-based code a means to resolve disputes, such as a dispute resolution forum, is essential. Discussion on the most appropriate means lies outside the scope of this report.

17. Have clarity of liability

2.35 Regulations transfer some building decisions and responsibility for them to control authorities in order to reduce the risk that private decisions will not provide adequate safeguards to protect the public interest. This transfer to the regulators of responsibility, and therefore of liability, lessens the incentives for building producers and owners to consider risks to users and others voluntarily, or to look for the most cost-effective ways to avoid those risks in a competitive market place.

2.36 *In the event of building failure or perceived lack of protection, authorities tend to add more stringent requirements and put more resources into enforcement. But regulators do not bear the cost of compliance. They are reluctant to accept new materials or innovative techniques that may increase their exposure to liability, and there is no competitive incentive to encourage more efficient control management.*

2.37 *Removing building controls that are not essential for the protection of users and the community, will encourage more use of industry expertise and help people make informed assessments of their own requirements and precautions to avoid loss, because they will no longer be able to rely on regulators to make decisions for them.*

2.38 *Providing options within the control systems that do not increase public risk offers opportunities for authorities, the industry and its clients to manage their own operations more efficiently.*

2.42 *Buildings are typically very long-lived assets, and defects may show up long after construction. The costs imposed by producers' indemnity insurance against future liability for possible defects and very long term product guarantees, pass, in the end, with all other supply costs, to the buyers of construction.*

To reduce costs and make buildings affordable, a realistic limitation period over which defects resulting from design or construction are identifiable from those resulting from lack of maintenance is necessary. A period of 10 years is considered appropriate.

In some countries the 10-year period represents a reasonable period for initial defects in a building to come to light. Records in Australia and New Zealand suggest that approximately 80% of building defect insurance claims are lodged within 7 years of construction. Whether the cause of the defect is a consequence of negligent design or construction or a lack of normal maintenance becomes increasingly difficult to ascertain as time goes on.

Surety as to when the limitation period begins is an essential element of the administrative system that is necessary to support a performance-based code. A common starting point is that established by the final acknowledgment by the controlling body that the building satisfies the objectives of the building code.

2.44 *When people have to bear the cost of fault and accidents caused by them (or not avoided by them), they have an incentive to exercise reasonable care. At common law, harm must occur before prosecution and recompense. Legal proceedings do not cure the illness or undo the injury which buildings have a considerable potential to cause. Compensation may not make good the loss or repair the damage for all those concerned.*

The building control system needs to ensure in particular the responsibility and hence the potential liability of building officials. The role of the official can range from that of no responsibility for technical compliance with the building code and being an agent of record only, to being satisfied on reasonable grounds that the building work complies. The extent of liability will vary accordingly as it will for all participants in the building control process.

Similar clarity is required within the control system as to the limitation on liability in terms of elapsed time and also the distribution of liability between the various participants.

Where the building control system allows private building certifiers to operate in conjunction with the main controlling body (usually in the form of a local territorial authority), the building certifiers should be afforded the same level of legal protection as the controlling body. The extent to which reliance on certificates produced by building practitioners is legitimate will depend on the legislative framework of each country. Of equal importance is the extent of other controlling factors outside the building code such as the mandatory registration of all building practitioners that will have a direct influence on perceived necessity for a building certifier to evaluate the credentials of the signatory of a certificate. This aspect is beyond the scope of this report.

18. Ensure cost-effective compliance

Designers, manufacturers and contractors want owners to commission new work. This will only eventuate if the building process is affordable, which in itself encourages the entrepreneur to use initiative, introduce innovation and progress in the industry. By ensuring that all requirements of the building code flow directly from the social objectives, are in accordance with the functional requirements of the building and do not exceed the established performance criteria, then the cost of compliance can be kept to a minimum. Owners are thus able to spend more discretionary money on those features from which they will gain most benefit.

2.17 *A regulatory environment which provides incentives for people to take account of the community's interest in their private dealings, is more likely to produce satisfactory outcomes with the resources available to them than prescriptive building controls imposed by authorities with little or no consideration of their economic impact.*

2.18 *A change to a performance based building code allows better use of both public and private resources to regulate building activities:*

- *by removing unnecessary controls and costs from the regulatory system*
- *by encouraging initiative, innovation and progress in the industry*
- *and thereby produce affordable buildings without jeopardising the public interest by exposing people to unacceptable risk.*

2.63 *However desirable reductions in building costs may be, they are a potential outcome rather than a primary objective of building control. A control system which meets the identified criteria can achieve lower costs by such measures as pruning out unnecessary restrictions and prescriptive controls, encouraging innovation and efficient management, and offering opportunities for initiative. It is not possible for the control system to go beyond this, because to do so would result in not satisfying the social objectives of building control.*

19. Ensure certainty of compliance

2.71 *... the public requires reasonable certainty that control provisions are being complied with.*

A building code should not include provisions that cannot be checked for compliance as part of the normal checking process. To include a provision as a safety net for the regulator to use as justification when something has gone wrong is not acceptable to code users and undermines the credibility of the code.

On the other hand the building control system needs to ensure that the cost of non-compliance is high. This is best achieved by the building authorities being able to demand rectification of non compliance in order to enable the building to become complying and to be fully incorporated into the stock of complying buildings. Such a requirement is usually sufficient penalty in itself. However, substantial penalties by way of fines, of which the majority is retained by the enforcing authority, will provide further disincentive towards non-compliance by practitioners and incentive to initiate enforcement proceedings by the controlling body.

20. Be applicable to changes of use and alteration

Whilst it is acknowledged that a building code is primarily developed to apply to new building work (and therefore to new buildings) the administrative system within which it operates must also allow for its application to existing buildings in which a change of use has occurred or the building is to be altered.

4.132 In circumstances of this kind the [legislation] would require that the building be upgraded to an extent that complied with Code requirements if the changed use was one with potential for increasing risks to safety or health within the building. The [controlling body] would judge on a case by case basis the extent of Code compliance to ensure essential safeguards.

In practical and economic terms it would be an unrealistic public expectation for all buildings to comply with all the objectives of the building code and to the full extent of the performance criteria whenever a building changed its use or underwent an alteration. As a result, a priority of objectives has to be established that identifies the most crucial to be incorporated into the supporting administrative legislation.

Where a change of use occurs there is usually the opportunity to modify the building such that it is practical to incorporate updated performance criteria. This frequently will lead to a new lease of life under its changed use. In comparison, alterations to a building may range from changing the interior fit-out to the addition of a new wing or additional stories.

An example of the selection of priorities could be that on completion of the building work:

For change of use:

> The building will comply with the building code for means of escape from fire, protection of other property, sanitary facilities, structural and fire-rating behaviour and for access and facilities for use by people with disabilities.

For alterations:

> The building will comply with the provisions for means of escape for fire and for access and facilities for people with disabilities.

In each instance the compliance of the new work is to be as nearly as is reasonably practicable to the same extent as if it were a new building, while the building as a whole is expected comply with the other provisions of the building code to at least the same extent as before the building work.

ANNEX C

CIB TG11 PERFORMANCE BASED BUILDING CODES FRAMEWORKS SUB-GROUP

INTRODUCTION

At the first meeting of TG11 (February 28 - March 1, 1994, in London), several sub-groups were established. One of them was Frameworks Sub-Group, with the following membership:

Jane Blackmore, Australia
Rachel Becker, Israel
Lyall Dix, Australia
Igor Oleszkiewicz, Canada (Chair)
Nico Scholten, The Netherlands
David Stone, Scotland
Russel Thomas, Canada

The Frameworks subgroup's mandate was to:

- identify structures and frameworks of building regulations, working on fragments of national codes of the members,
- identify characteristics of structures and frameworks that support the development of new, performance-based codes and for the analysis and conversion of existing codes.

For the purpose of this report, code is defined as a collection of normative requirements, one that is legally binding or intended to be adapted into the law. This clarification is intended to avoid misunderstanding that may be caused by the fact that in some countries, the term "code" is used in relation to a code of practice or other voluntary or guidance document.

FRAMEWORKS

The reason to move from the traditional prescriptive codes to performance-based ones is that the latter are expected to be superior with regard to a number of characteristics. The following is a list of those, directly related to the structure of the code documents:

1. Ease of understanding the intent of regulation;
2. Clarity of evaluation procedure for alternative/innovative solutions;
3. Consistency of interface for users;
4. Ease of authoring and maintaining the code documents;
5. Ease of representation and delivery in Information Technology (IT) systems and in supporting associated navigation and retrieval functions.

These characteristics can be aided by:

- making the intent explicit (1 & 2)
- separating it from the means of compliance (1 & 2)
- providing a consistent, user-friendly and logical structure of the code documents (1, 2, 3, 4, 5)

The above have been identified as the essential attributes of a framework for the performance-based codes. The following have been proposed as components of such a framework:

- "Top-down" structure establishing hierarchy of objectives and means to achieve them
- "Bottom-up" structure of the primary elements of information contained in or associated with individual requirements
- Presentation structure (organization/outline of the code and supporting documents)
- Expression structure for provisions.

<u>"Top-down" structure</u>

A minimum "top-down" structure would contain two components:

- objectives
- acceptable ways to meet the objectives.

Implemented, or attempted implementations of the framework, are more elaborate and, in most instances, are variations of the Nordic Five Level System [1]:

Level 1	GOALS - essential interests of community at large with regard to built environment
Level 2	FUNCTIONAL REQUIREMENTS - building or building element specific qualitative requirements
Level 3	OPERATIVE REQUIREMENTS - actual requirements, in terms of performance criteria or expanded functional description
Level 4	VERIFICATION - Instructions or guidelines for verification of compliance
Level 5	EXAMPLES OF ACCEPTABLE SOLUTIONS - Supplements to the regulations with examples of solutions deemed to satisfy the requirements

In this system, the first three levels represent an elaboration of the objectives component of the minimum framework, while the last two deal with the specifics of meeting the objectives.

A comparison of the Nordic Five Level System and some of the actual regulations of different countries who have or are moving to an outcome-based approach, indicates conceptual commonalities and variations in their implementation. The differences are mostly in the degree of detail at particular levels, and in the distribution of the material between mandatory and non mandatory documents (the options are discussed in conjunction with the presentation structure). The least formal approach has been applied by the UK (England and Wales), with very brief Goals and Functional Requirements, located in the mandatory document, and varying in detail other components located in the non mandatory documents. On the other end of the spectrum seems to be the New Zealand's set of documents, with their very formal and complete structure.

<u>"Bottom-up" structure</u>

Analysis of requirements in different national building regulations indicates essential similarities in the information content, despite different appearances. A five-faceted information structure has been proposed by the Sub-Group :

- INTENT : the objective of the requirement in terms of the perceived risk or potential dysfunction and the required functionality to overcome the risk or dysfunction;
- CONTEXT : the scope of the intent, typically expressed in terms of where a requirement applies and in what circumstances an exception is permitted;
- ENTITY : the building element, space or system that will be the focus of the performance/property requirement;
- PROPERTY : the performance or attribute required of the entity necessary to meet the risk/dysfunction;
- VALUE/MEASURE : the particular prescription, credence or "deemed to comply" solution that will satisfy the required performance or ensure the required attribute.

It has been argued that VERIFICATION (information regarding means of prooving compliance, such as test method, calculation method, applicable standard or other evaluation method) should be another facet of this structure. However, many Task Group members were of the opinion that this item can not stand on its own and has to be a part of either PROPERTY or VALUE, or may not be present at all. This opinion was based on the fact that the measure of properties and limits, stipulated by PROPERTY or VALUE, quite often depend on the evaluation method.

The above scheme seems to catch all the important pieces of information that one can identify as associated with a requirement. In traditional codes, this information is seldom explicit or consistently structured.

Much attention has been paid in developing performance-based codes to make the intent of requirements explicit. Making other information readily available and consistently structured would further improve those codes. The above classification of the information content may be used as a guideline or check list when writing a performance-based code and supporting documents.

Presentation Structure

The presentation structure is the arrangement in which the information content is presented in a code and its provisions. While the information structure, although less apparent than the presentation structure, seems to be universal, the presentation structure will vary very much from one code to another and even within one code. The variation may be because of historical or legal reasons, and because of the user interface the code writers want to provide.

The over-all presentation structure of a building code is defined by the concepts with which parts of the code deal and by the arrangement of those parts. The concepts belong either to the category of subject (what is regulated, e.g. building type/use, building element, etc.) or to the category of objective (e.g. safety in use, control of smoke spread, prevention of contamination of drinking water). Within each of these two categories (subject and objective) there is a hierarchy where concepts can be arranged accordingly to their generality. For any two concepts within a category, one can determine whether the first concept is (a) more or less general than the second one or (b) of the same degree of generality, e.g.:

a - "fire resistance" is less general than "fire safety"
  - "building" is more general than "house"

b - "fire safety" and "safety in use" are of the same degree of generality
  - "house" and "commercial building" are of the same degree of generality

An appropriately structured outline may be used to:

- provide a consistent interface for users;
- enable authors to develop an outline for new material;
- enable authors to organize existing material or insert new material;
- ensure a consistent approach between collaborating authors;
- provide a basis for classifying and indexing material;
- provide a basis for representation and delivery in IT systems and to support associated navigation and retrieval functions.

Since the performance codes accentuate the purpose of requirements, it seems that such codes need to be built around the hierarchy of objectives. However, many code users are focused on an entity (a particular building type or a building component) and for this reason there is a need for a compromise - a mixed structure that is rational and easy to follow, yet allowing to group requirements in a user-friendly way.

An effective organization assists the user in quickly and reliably finding the relevant provisions [2]. The following are essential five qualities of such organization:

1. Relevant: Each heading is significantly related to its provisions; it concisely expresses their scope.
2. Meaningful: The reader perceives the heading as being relevant to the provision.
3. Unique: The headings are distinct from one another to allow readers to access provisions unambiguously.
4. Complete: The total set of headings covers the entire scope and nothing more.
5. Graded: The headings show a regular gradation in scope through the levels.

Additional, desirable qualities are:

6. Progressive: The headings at any level are ordered in a pattern significant to the reader.
7. Intelligible: The depth (the number of levels) and breadth (the number of headings at one level) does not exceed the span of immediate memory of the reader.
8. Minimal: The number of headings is the minimum necessary for meaningful distribution of the content and access to it.
9. Even: The organization divides the provisions so that depth and breadth do not vary greatly from one part to another.

Not all components of a code have to be compulsory; in fact, it is usually preferred to locate the examples of acceptable solutions and other guidances in non mandatory supporting documents. Optional location of other components can also be considered. A closer look at options reveals a wide range of possible combinations of mandatory and non mandatory documents. Let's assume, for the sake of simplicity, that the regulation has three components: objectives (goals plus broad functional requirements), requirements (including verification methods where appropriate) and acceptable solutions. Assuming that each of these components may be located in a mandatory or non mandatory document, or not be present at all, one arrives at 27 possibilities (3x3x3). Of these some are obviously useless for the regulatory purpose but, as Table 1 shows, there is a rich variety to consider.

TABLE 1. Options with regard to location of Objectives, Requirement, Verification Method and Acceptable Solutions. It is assumed that Verification Method must be specified together with Requirement (except for obvious and widely accepted), as the result of evaluation is likely to depend on the method.

Option	Objec tives	Req. + Verif. Method	Solu tion	Application, comments
1	M	M	M	Performance requirement with optional prescriptive path, in mandatory document(s)
2	M	M	N	Performance regulation with non mandatory supplement providing prescriptive alternatives
3	M	M	-	Single performance based mandatory document, suitable when there is a reliable design/verification method available.
4	M	N	M	Objective based/prescriptive requirement with optional performance path
5	M	N	N	Brief mandatory part and regulation tailored for both sophisticated and non sophisticated user/design
6	M	N	-	When the mandatory part is brief and the method suitable for all users
7	M	-	M	Single mandatory requirement suitable for non-sophisticated users or when the method is too cumbersome for a single design use (e.g. requires statistical data). Solution(s) may be in menu format.
8	M	-	N	Qualitative performance req. + deem to comply solution in supporting document
9	N	M	M	Objectives (intent) explained in Annex, other-see 1
10	N	M	N	Objectives (intent) and example Solutions in Approved Document
11	N	M	-	Performance requirement with intent in Annex
12	N	N	M	Prescriptive requirement with intent and alternative performance path in Annex
13	-	M	M	Performance requirement with optional prescriptive path
14	-	M	N	Perf. requirement with examples in Supplement (as fire ratings of listed building assemblies)
15	-	M	-	Performance requirement, performance standard (e.g. fire endurance test standard)

M - in mandatory part
N - in non mandatory part (Annex, Approved Document)
\- - not present

In developing the model structures, the proliferation of the IT and its application to the use of a code, has to be taken into account. Certain structures may seem impractical when applied to printed codes, while they may offer substantial advantages in the electronic version.

Expression

The language of regulations and other aspects of expression (e.g. use of cross-references, double negation, exemptions and other excessive complications of the expression structure) has not been dealt with by this Subgroup, but it has been recognized as an important issue. There have been numerous complains regarding poor expression of provisions being an impediment to understanding building regulations.

CONVERSION TO PERFORMANCE-BASED REGULATION

Several issues have to be considered when attempting a transition from a traditional to a performance/objective-based code. One of them is that the new code must not radically change the technical level of acceptable solutions. The existing code reflects a consensus on the level of risk and cost associated with code compliance. A new code may be different in format and procedures, allow greater freedom for the users, but the old, time proven solutions have to be acceptable under the new code. This implies that a thorough analysis of the existing code has to be done and its results used in the development of the new code.

Analysis of Existing Regulation

A prescriptive code is essentially a collection of acceptable solutions that meet non-stated objectives. Such a code, being a product of evolution in response to varying needs and pressures, is usually not systematically organized and is difficult to analyze. The "bottom-up" structure for information content of code requirements has been proven to be very useful in the analysis of an existing code. This scheme seems to catch all the important pieces of information that one can identify in a regulation or, as it is often the case with the INTENT, deduct from the minutes of committees writing the regulation. The scheme provides a means to analyze and compare different (national) regulations. It can also be used as a tool to modify a given regulation.

A similar approach has been thoroughly tested for conversion of an existing Code in Australia under Fire Code Reform Project and it worked well. A slightly different nomenclature was used (designed to tie in with a series of projects, so the choice of names had to suit other constraints).

Definitions used were:

Fire-safety System	The combination of all attributes of a building that contribute to the safety of the building and its occupants if there is a fire.
System Element	A component of the fire-safety system that is specified in the BCA and for which varying levels of performance are required, depending on the nature of the building under consideration.
Building Identity	(or Building ID) A unique identification of a building or fire compartment based on usage and physical parameters.

Designator	An alpha-numeric identification for a group of requirements that relate to a particular level of performance of a specified system element.
Descriptor	A description of the performance required by the BCA of a particular system element to achieve the level of fire safety required in a particular group of buildings.
Application	Limits on the application of an acceptable solution that are not specified by the building identity (Building ID).
Acceptable Solution	A solution based on the technical requirements of the BCA that satisfies the descriptor.

The essential categories were:

Descriptor - performance requirement (Property)
Application - Context, Entity
Acceptable solution - Value/Measure

Attached are examples of the analysis of the Scottish and Dutch regulations. The "bottom-up" analysis of the current National Building Code of Canada is being conducted, using a methodology based on the outlined approach (draft manual for the analysts attached).

Synthesis of Performance-Based Regulation

Use of Analysis Results

An example of possible use in application to Canadian regulation of ventilation of dwellings is shown below, based on a new draft of a section of the National Building Code of Canada.

Section 9.32 Ventilation		
9.32.1	APPLICATION Rooms and spaces Section applies to, exceptions	*Context, Entity (in broad sense)*
9.32.2	OBJECTIVES Broadly stated, e.g. "adequate to maintain satisfactory air quality"	*Intent, Entity (building systems)*
9.32.3	REQUIREMENTS Technical but mostly qualitative, e.g. "designed to prevent condensation in or on ducts, furnaces, fans ..."	*Intent, Entity, Property, Value*
9.32.4	ACCEPTABLE SOLUTIONS Deem to comply solutions, verified by design or (in some instances) alternative, verified by test	*Entity, Property, Value, Verification*

The repeating presence of the components of the information structure (*Intent, Entity, Property, Value*) in the components of the presentation structure indicates that there is no 1:1 relationship between those structures; rather that the information components are building blocks of the presentation structure components. The *Intent* and *Entity* components belong respectively to the OBJECTIVE and SUBJECT hierarchies and, at least in this example, they are more and more specific as one moves from Application to Acceptable Solutions.

An effective approach has been applied in the Dutch regulation (see attached analysis), where the location of a provision has been systematically used to convey relevant elements of the information content.

REFERENCES

1. The Nordic Committee on Building Regulations (NKB), Report No.34: Structure for Building Regulations, November 1978

2. Harris, J. R. and Wright, R. N., "Organization of Building Standards", Building Science Series 136, National Bureau of Standards, Washington, 1981

Examples of Information Content Analysis of Scottish Regulation

CLAUSE E.2.3

E2.3 The minimum number of escape routes from a room or storey in relation to *occupancy capacity* must be in accordance with the Table to this standard -

Table to E2.3: Minimum number of escape routes in relation to occupancy capacity

Occupancy capacity of room or storey	Minimum number of escape routes
Not more than 60	1
61-600	2
over6OO	3

Minimum number of escape routes in relation to height or depth of storey

Analysis:

CLAUSE	:	E2.3
DEEM TO SATISFY	:	no
INTENT	:	to facilitate escape to a place of safety.
CONTEXT	:	every building.
ENTITY	:	escape route.
PROPERTY	:	[minimum] number.
VALUE	:	table to E2.3.
VALIDATION	:	none.

RELEVANT INFORMATION EXTRACTED FROM THE BUILDING STANDARDS (SCOTLAND) RESULATIONS 1990:

Part E
Introduction

1 The intention of this Part is to ensure that a building is so constructed that adequate means of escape from fire are available for all users of the building. It also requires the provision of certain fixed fire-fighting equipment and means of access for fire-fighting.

2. The intention of the requirements for means of escape is that everyone within a building may reach either a place of safety or, in certain circumstances, a protected zone within 21/2 minutes of becoming aware of an outbreak of fire. The requirements for the number and width of exits assume a unit width of 530 mm per person and a rate of discharge of 40 persons per minute. The allowable travel

distance (i.e. the distance which it is assumed one can travel along an unprotected escape route within the time specified) varies according to purpose group and situation.

3. The construction of a building must ensure that -

   a. every escape route leads to a place of safety, either directly or by way of a *protected* zone;

   b. every stair or ramp which forms part of an escape route is protected from fire, from smoke and hot gases which might obscure or obstruct the escape route and, in higher buildings, from the effects of weather.

   c. within those parts of a building where people are at greatest risk (between the point of origin and a protected door) the layout of the building is such as to limit that risk to the utmost practical extent; and

   d. in certain residential buildings which have only one escape route, provision is also made for rescue by way of emergency windows.

4. The intention of the requirements for facilities for fire-fighting is to ensure that suitable access is available to the outside of a building for fire-fighting and rescue vehicles from a public road, that a water supply is available and, in the case of high buildings, that suitable provision is made for fire-fighting within the building.

Part E
Regulation 13

Means of escape from fire and facilities for fire-fighting

13. (1) Every building shall be provided with -
   (a) adequate means of escape in the event of fire; and
   (b) adequate fire-fighting facilities.

(2) This regulation shall not be subject to specification in a notice served under section 11 of the act in respect of -
   (a) buildings of purpose sub-groups 1B and 1C; and
   (b) buildings to which the Fire Certificates (Special Premises) Regulations 1976(a) apply.

(a) Si 1976/2003, amended by Si 1985/1333 and 1987/37.

CLAUSE M3.1

M3.1 A *building* which is not excluded by regulation 25(2) must be provided with an adequate number of *sanitary facilities*.

Analysis

CLAUSE	:	M3.1
DEEM TO SATISFY	:	yes.
INTENT	:	to ensure the provision of suitable and sufficient sanitary facilities.
CONTEXT	:	all buildings except those covered by regulations stated in the introduction to part M, item 4 or those excluded by regulation 25(2).
ENTITY	:	sanitary facilities (defined as washbasins, baths, showers, urinals and WCs.
PROPERTY	:	[adequate] number.
VALUE	:	tables I to 3 or 7 to 11 of the relevant British Standard (see D.T.S.).
VALIDATION	:	BS 6465 : Part 1 : 1984

RELEVANT INFORMATION EXTRACTED FROM THE BUILDING STANDARDS (SCOTLAND) RESULATIONS 1990:

Part M
Introduction

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1 The intention of this Part is to ensure safe and adequate drainage from a building and the provision of suitable and sufficient sanitary facilities for certain buildings.

2. The standards in relation to regulation 24 are intended to ensure that foul water and rainwater from a building are carried to a suitable point of disposal, that the pipework and fittings by which they are carried are of suitable size and constructed to minimise the likelihood of leakage or blockage, and that the drainage system is sealed and vented in such a way as to prevent the escape of foul air into the building.

3. The standards in relation to regulation 25 are intended to ensure the minimum provision of sanitary facilities considered necessary on grounds of health and convenience.

4. There is an EC Directive on the minimum safety and health requirements for the workplace (89/654/ EEC) which is implemented in the UK by the Workplace (Health, Safety and Welfare) Regulations 1992 supported by an Approved Code of Practice. The Regulations came into force on 1 January 1993 in relation to new workplaces, modifications, extensions and conversions, but do not apply to other workplaces untill January 1996. They are administered by the Health and Safety Executive, 1 Chepstow Place, London W2 4TF. The Regulations prescribe, among other things, requirements for the provision of sanitary facilities. The requirements of Part M do not therefore apply to buildings covered by these Regulations.

Part M
Regulations 24 & 25

Drainage and *sanitary facilities*

24 (1) A building shall be provided with a drainage system sufficient to ensure hygienic disposal of discharges from the building.

(2) in this regulation discharges includes effluents, used water and the run-off of rainwater from roofs and other exposed surfaces of the building.

25 (1) A building to which this regulation applies shall be provided with adequate sanitary facilities.

(2) This regulation shall apply to all buildings other than buildings or any part of a building to which -

(a) the workplace (Health, Safety and Welfare) Regulations 1992(a) apply;

(b) section 7 of the Factories Act 1961(b) applies; or

(c) the School Premises (General Requirements and Standards) (Scotland) Regulations 1967 to 1979(c) apply.

(3) This regulation shall not be subject to specification in a notice served under section 1 1 of the Act.

(a) SI 1992/3004.
(b) 1961 c.34; section 7 was amended by 51 1974/1941 and repealed by SI 1992/3004. That repeal does not come into force until 1 January 1996 with respect to any workplace or part of a workplace which is not a new workplace or a modification, extension or conversion: see SI 1992/3004, regulation 1(3).
(c) Si 1967/1199, 1973/322 and 1979/1186.

Part M
Provisions deemed to satisfy the standards

DRAINAGE SYSTEM

(M2.1) The requirements of M2.1 will be met by a system constructed in accordance with -

a. BS 5572:1978, Clauses 1 to 12 (for sanitary pipework); and
b. BS 6367:1983, Clauses 1 to 8 and 10 to 17 (for rainwater pipes and gutters); and
c. BS 8301:1985, Clauses I to 25 (for underground drainage).

(M2.2) The requirements of M2.2 will be met by a system ventilated -

a. in accordance with BS 5572:1978, Clause 8; or

b. where the drainage system will be connected to a ventilated sewer or ventilated septic tank -an air admittance valve installed in accordance with a SBA Certificate or other recognised certification.

DISCHARGES INTO A *DRAINAGE SYSTEM*

(M2.3) The requirements of M2.3 for interception will be met by an intercepting chamber complying with Clause 12.1, 12.2 or 12.3 of BS 8301:1985.

DISCHARGES FROM A *DRAINAGE SYSTEM*

(M2.4) The requirements of M2.4 a.ii. will be met by a private sewage treatment works located and constructed in accordance with Bs 6297:1983.

PROVISION OF *SANITARY FACILITIES*

(M3. 1) The requirements of M3.1 will be met where sanitary facilities are provided in accordance with Tables I to 3 or 7 to 11 as appropriate of BS 6465: Part 1: 1984.

Information Content analysis of Dutch regulation

INTRODUCTION

The Dutch building legislation consists of: the revised Housing Act, the Building Decree and the technical documents related to this legislation. The five faceted information: intent, context, entity, property and value, can be found in this legislation. In order to give an idea of the context in which the regulations of the Decree are functioning, some information will be given about the background and the characteristics of the Building Decree and the encompassing Dutch building regulation system.

The Building Decree contains technical building regulations. These are uniform regulations on the national level, which all construction works must comply with.
Before the Building Decree came into force, the technical building matters were subject of the local building by-laws. Although these by-laws were shaped after a Model Building By-law, there remained considerable disparities between them. Because of this and the structure of the municipal requirements there was a lack of uniformity in the regulations and their application. As for the structure of the requirements, the by-laws mainly contained so-called 'functional requirements' and other regulations with possibilities for further requirements and exemptions.

In 1983, the dissatisfaction with the technical building regulations and the long time decisions on building permit applications often took, led to the drawing up of an Action Program for Deregulation of the (House) Building regulations. The Minister of Housing, Physical Planning and Environment announced in this Action Program, among other things, a national Building Decree and an obligatory maximum term of three months for the decision on a building permit application. The technical regulations regarding the internal lay-out of buildings would be given a global nature and the technical building regulations would be rendered uniform.

The building regulation system

In the Dutch building regulation system, the Building Decree is the central document for the technical building rules. Based on the Housing Act, which itself does not contain technical rules, the Building Decree is a general administrative order, issued by the central government.

With regard to some subjects, the Decree authorises the Minister of Housing, Physical Planning and Environment to give further rules by ministerial order, to wit:

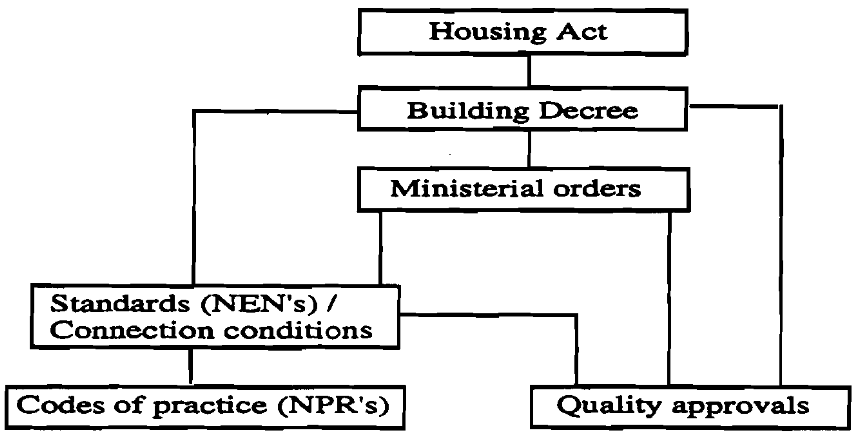
- rules concerning the application of standards and connection conditions which have been referred to in the Decree. The intention of this authorization (section 416) is that the ministerial order indicates which edition of the standard or which part of it, or which edition of the connection condition is applicable. In this way a swift and flexible anticipation to the regular revisions of these documents can be effectuated;

- regulations containing technical requirements for a number of specified building aspects. There are different reasons for these authorizations. At the time the Building Decree was laid down, it was clear, that for some subjects it as yet not possible to give regulations in the Decree itself, e.g. because the indicated standards did not yet take account of existing buildings. Further, for other subjects it was intended to create a possibility to give regulations when needed, e.g. for occasions that the harmfulness of a material becomes clear. Here too the fastness and flexibility of regulation by ministerial order plays a part;

- rules concerning the implementation of the Construction Products Directive of the EC.

In the Building Decree, standards play an important part. Wherever possible the Decree refers to standards ('NEN's') or parts of standards of the Dutch Standardisation Institute. These standards have been adapted to the Building Decree requirements and contain the determination methods by which one can check if the work complies with the Building Decree requirements. In some cases, the reason for the reference is that the standard gives a definition of a term which is used in the Decree, or that the standard contains a limit value which is too detailed and comprehensive to express in the Decree itself. There are 47 standards the Decree directly refers to.

Performance requirements let the builder free in the way he will comply with them. Still, there is a practical need for instructions that indicate how to comply by means of current constructions. This need is met by so-called 'NPR's' (Dutch Codes of Practice), which mention the performances measured or calculated for these constructions. The Building Decree does not refer to these NPR's, but they have been made on the basis of standards referred to in the Decree.
Other regulatory documents the Building Decree refers to are the Model Connection Conditions of the associations of public utility companies. In particular, reference is made to the conditions of a construction-technical nature. These conditions, in turn, refer to standards.
Quality statements (technical approvals, certificates) are an efficient way to check that constructions, construction products and materials comply with the requirements. The Building Decree provides that quality statements which are recognised by the Minister of Housing have to be accepted as sufficient proof of compliance with the relative requirements (section 415).
The following figure represents the relation between the Building Decree and the aforementioned documents.



Outside the proper building regulation system there are some other documents which have or will get a relation with the Building Decree.
In the first place, the Construction Products Directive of the EC needs to be mentioned. The Building Decree and its associated standards correspond with

the essential requirements of the Directive. In case a harmonised European standard replaces such an associated standard, as a rule the reference in the Decree will be changed to this harmonised standard (EN-NEN). Furthermore, the implementation of the Directive in the Dutch legislation is effectuated in chapter XII of the Decree.
Secondly, the Building Decree will be coordinated with the regulations concerning technical aspects of buildings, issued under other laws than the Housing Act. Examples of these are the Working Conditions Act and the educational legislation. This coordination is effectuated in the current second phase of drawing up the Building Decree.

Intent

In the Dutch building regulations the objective of the requirement in terms of the perceived risk or potential disfunction and the required functionality to overcome the risk or disfunction can be deducted from the place of the requirement.
The structure of the Building Decree, in particular the structure of its complex of technical regulations has been determined by three grouping criteria:
1. the distinction between usage function (or types of works);
2. the distinction between works to be constructed and existing works, and
3. the so-called starting-points for laying down building regulations.

Concerning the usage functions, conceptually the main distinction lies between construction works which are not intended for habitation and works which are. The latter can be distinguished in houses and residential buildings and on the other hand caravans and sites. The other group -of 'utility works'- comprises both buildings and works not being buildings. As to these buildings, the Decree till 15.12.96 distinguishes two usage functions, namely office buildings and accommodation buildings. After that date, related to energy saving, also for other building detailed requirements are given.
The effect of this distinction on the subdivision of the Decree is such that for each usage function there is a complex of regulations. Each complex comprises two chapters. viz. one for works to be constructed (new or alteration) and one for existing works.
As to the third aforesaid grouping criterion, this has determined the structure within the chapters. The regulations are ordered in separate divisions, according to the main starting point or intention from which they have been given. There are four of such starting points, viz. safety, health, usefulness and energy economy.

A further distinction is made within the divisions. Each division consists of a number of paragraphs. In each of these paragraphs the main starting points are separated in to more specific topics, e.g. the division "safety" contains the following paragraphs: structural safety, safety in use, fire safety and social safety.
Each of these paragraphs contains one ore more sections. These sections contain the actual requirements based upon the topic of the paragraph. The sections all have titles. These titles give the user information about the requirements in the section. In the paragraph fire safety, in the division safety there is for example a section "limitation of fire development" and a section "limitation of spread of fire". The sections are subdivided into clauses. The requirements are laid down in these clauses.

In most cases the requirement is a performance requirement. However the chapters concerning works not for habitation still contains functional requirements. The requirements in each clause consists of a level, a determination method and a functional description. The functional description gives the reason for the requirement. In the section "limitation of spread of fire" one of the clauses contains the descriptions for the requirement: resisting fire movement. This description is "..., in order to restrict the spread of fire, ...".

Summarizing it can be said that whit in the Netherlands building regulations the intent of a requirement can be deducted from the requirement itself in each clause (the functional description), the place of the section containing the clause (paragraph fire safety), the location of the paragraph (division safety) and the location of the division (chapter dwellings and residential buildings to be constructed).
The intent is an integral part of the building regulations.

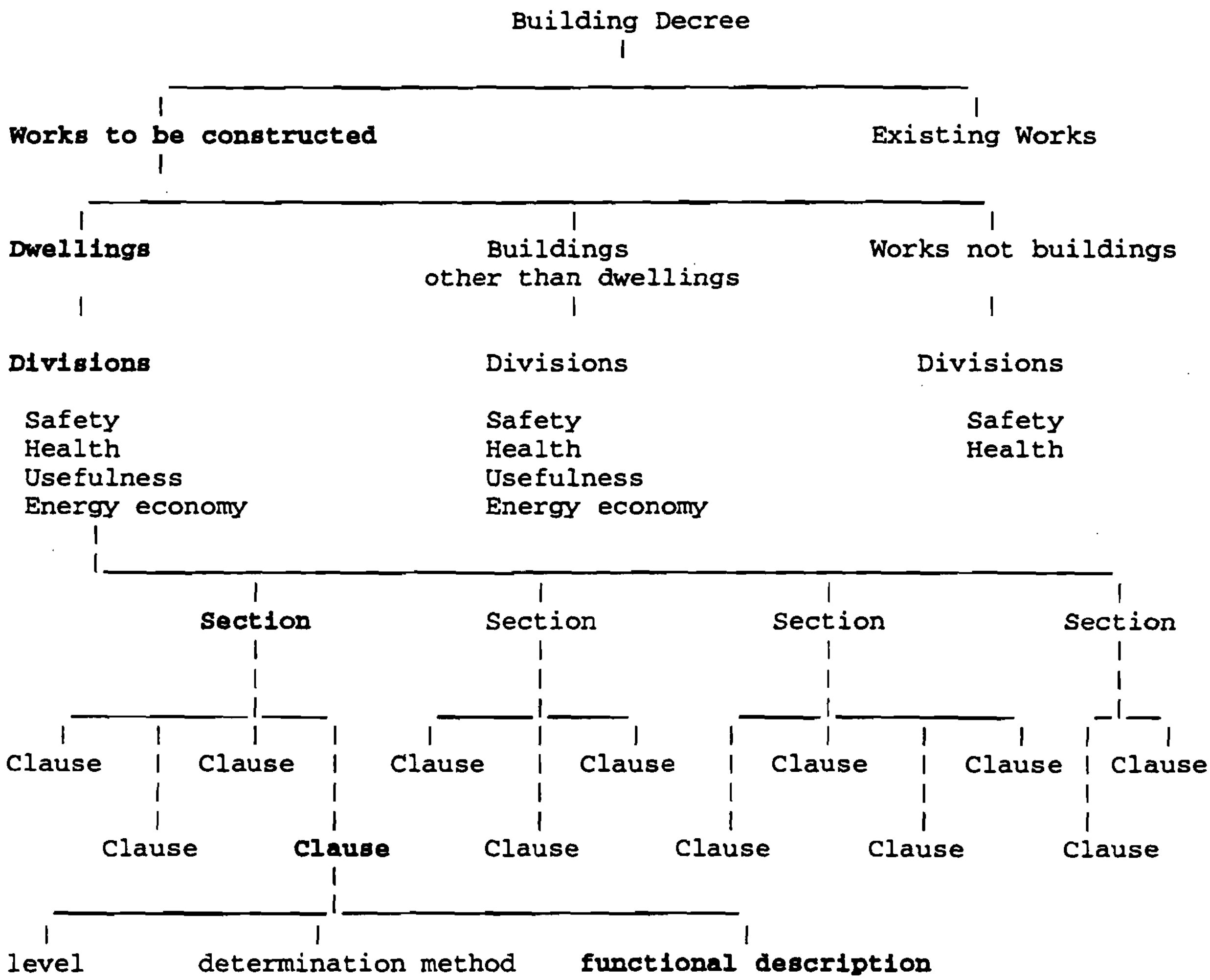


Figure 1. Intent

Context

In the Netherlands the scope of the intent, typically expressed in terms of where a requirement applies and in what circumstances an exception is permitted, can be found within the building regulations as well as the intent itself.

To determine the context of a requirement within the building regulations it is necessary to determine the place of the clause that contains the requirement. Therefore again the first step is to determine whether the requirement is found in a chapter of the Building Decree concerning works to be build or existing works. The chapter also determines the type of work a requirement applies to.

Next the clause containing the requirement gives an indication of the context. The clause can give conditions as to when the requirement is applicable. These conditions can also be given by other clauses in the same section.
An example of the first situation is clause 9 of section 14 within the chapter dwellings to be build. It is a requirement concerning the limitation of spread of fire. This clause states: "the resistance to fire movement between a dwelling or residential building and a building standing on another lot, shall be at least 60 minutes, determined accordance with NEN 6082, on the understanding **that the determination method of that resistance shall be based on a building which is identical but situated mirror-symmetrically in respect of the boundary of the lot**".
In clause 1 and 2 of section 39 also within the chapter dwellings to be build there is a requirement for the amount equivalent daylight area that is needed in a staying area in a dwelling. In clause 3 of the same section there is a condition for this determination method. The clause states: "In the determination of the equivalent daylight area, as referred to in the first and second sub-sections, **construction works and equivalent obstructions which are not situated on the lot on which the dwelling or the residential building is situated, and daylight openings in an external partition construction, in so far as those openings, measured perpendicularly to those openings, are situated at a distance of less than 2 m of the boundary of the lot, shall remain out of consideration.**".

The third possibility to determine the context of a requirement is to check within the chapter "Conditions" of the determination method. This chapter can give conditions concerning the applicability of the determination method and therefor the requirement.

The same structure to determine the scope of the intent applies for the chapters concerning existing works.

Where the building activity concerns the renovation of a work or renewal of parts of the work there are special regulations that affect the scope of an intent.
All the activities carried out on the existing building are to be referred to as works to be constructed. This means that the requirements of the chapters works to be constructed are to be met. However the burgomaster and aldermen are given a special possibility to grant exemptions of a requirement. The level can be reduced to either the level "existing works", or to the level obtained by law, or to a specially defined level.(Chapter 13 Building Decree.)

It is also possible to find conditions affecting the context in a ministerial order where the determination method given in a requirement, is not suited for existing works.

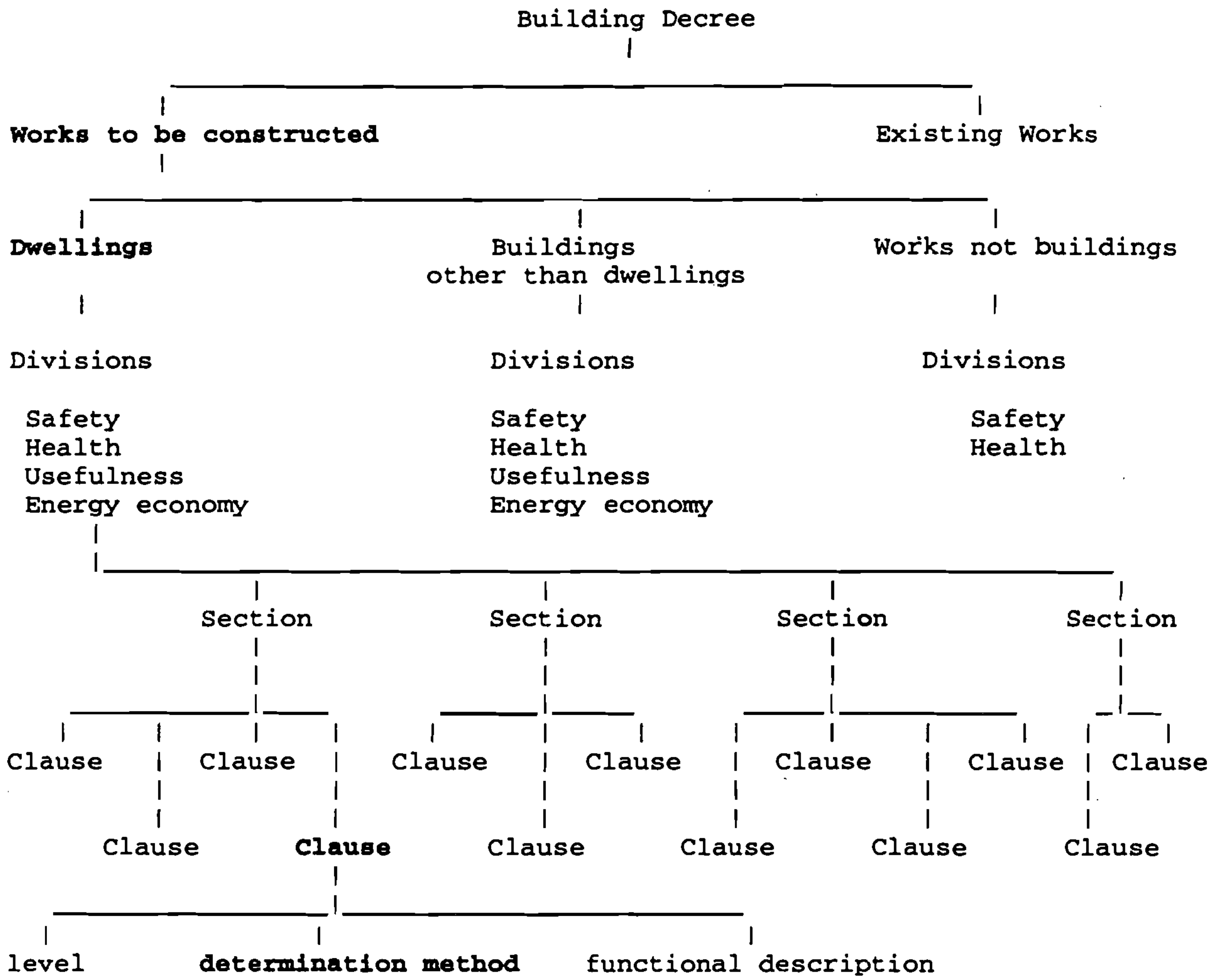


Figure 2. Context

Entity

The building element, space or system that will be the focus of the performance requirement can also be deducted from the system of the building regulations. Each clause contains the entity that has to fulfil the demand put by the requirement.

The Dutch building regulations distinguishes between five object-levels. In order to leave as much space as possible for innovation the legislator took it upon him to try and give requirements at the highest object-level possible. The five object-levels (entities) in the Netherlands building regulations are: Work (building), space, partition, construction part and material.
There is a sixth object-level. This level concerns provisions.
The entity of a requirement can be found in the clause that gives the requirement. It is the object to which the requirement is focused.

In the following examples the entity (object-level) of the requirement is given in italic. The text above the requirement states the object-level. The section and clause number is given on top of each requirement.

Building
section 16, clause 1
A dwelling with an usable area of more than 500 m^2 and a residential building, in order to enable people to reach the adjacent ground in a safe manner from the dwelling or that building in case of fire shall be provided with means of escape, the number, situation and lay-out of which shall comply at least with the requirements concerned in NEN 6082.

Space
section 15, clause 1
In a dwelling, in order to enable the adjacent ground to be reached in a safe manner from the dwelling in case of fire, there shall be between *staying rooms which are not situated on the same storey*, an internal partition construction of which the resistance to fire movement is at least 20 minutes, determined in accordance with NEN 6068.

Partition
section 39, clause 1
In the total of *the external partition constructions of a staying area*, in order to enable the admission of daylight and a view of the outside, there shall be an equivalent daylight area as referred to in NEN 2057 which, determined in accordance with that standard, shall be at least equal to 10% of the floor area of the staying area.

Construction part
section 13, clause 1
A construction part, with the exception of a roof, a floor or the top side of a staircase, in order to restrict fire development, shall belong at least to class 4 of the contribution to fire propagation as referred to in NEN 6065, determined in accordance with NEN 6082.

Material
section 33
By ministerial decree, in order to restrict the presence in or near a dwelling or residential building of a level which is unacceptable to health of toxic or irritating substances or of ionising radiation as referred to in section 1, first sub-section, sub e, of the Nuclear Energy Act (Statute Book 1963, 82), regulations can be issued concerning the use in the construction of *materials* from which those substances may emerge or from which that radiation can be emitted.

Provision
section 38, clause 1
In a dwelling or residential building, in order to have the disposal of hot water which is suitable for human hygiene, there shall be *a provision for hot water supply*, the lay-out of which shall comply at least with section 5, first sub-section, sub 2 of the Model Connection Conditions for drinkingwater of the Association of Operators of Water Companies in the Netherlands.

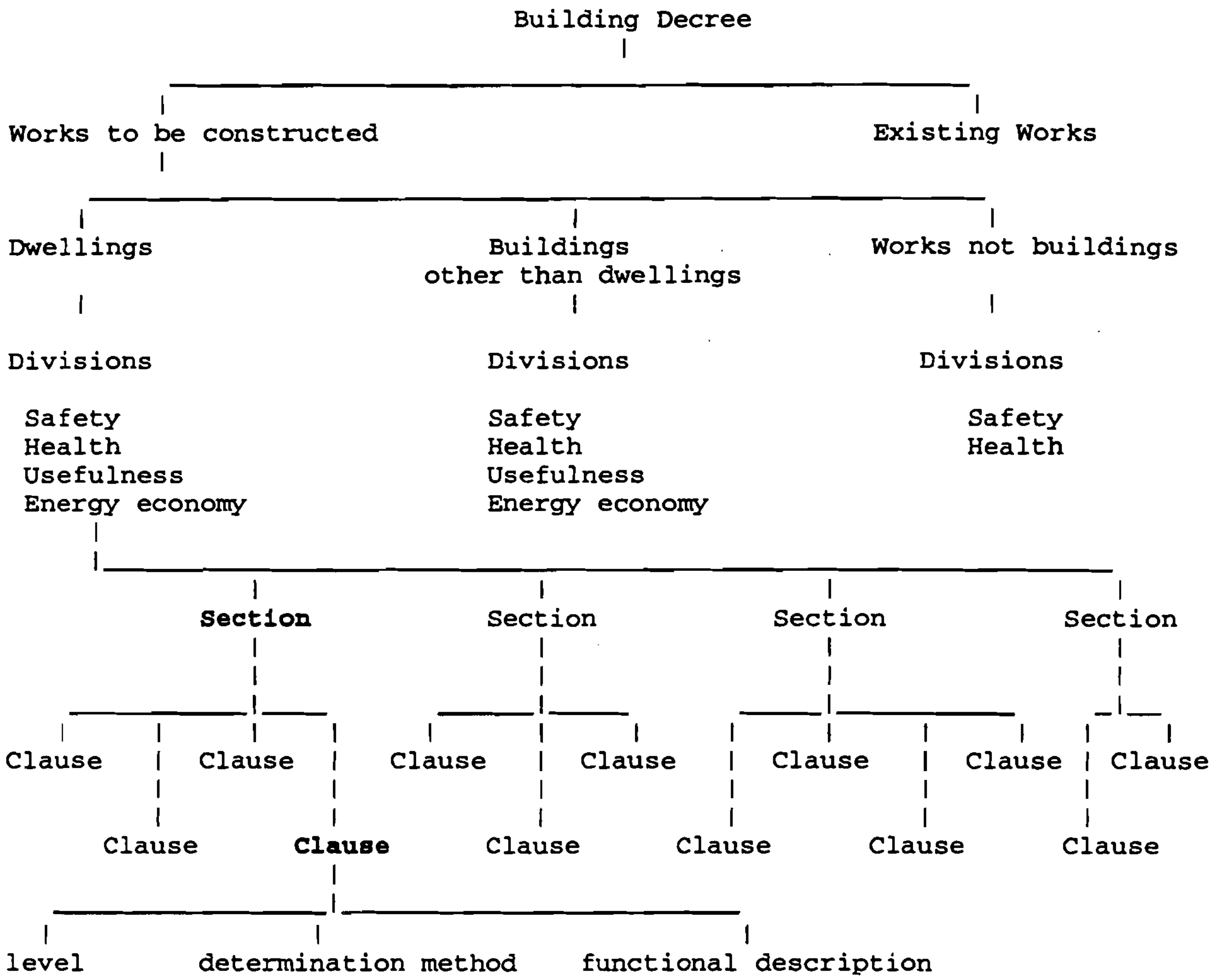


Figure 3 Entity

Property

The performance or attribute required of the entity is found in the performance requirement. In the Dutch building regulations therefore the property is found in the clause giving a requirement.
However in some situation the property can be found in the standard or in a ministerial order.
Basically the properties: presence, structure, capacity/sizes and physical performance.
Each of these properties can be divided in to several "sub-properties" depending on the requirement given.

For example presence can be divided as follows:
areas en rooms, general;
areas en rooms, common;
areas en rooms, accessibility;
areas en rooms, fire;
spaces, energy saving;
installation places, general;

installation places, common;
provisions, general;
provisions, fire;
accessibility.

Whereas physical performance can be divided as follows:
daylight an view of the outside;
noise reduction;
thermal insulation performance;
moisture;
fire resistance;
penetration of noxious substances or radiation.

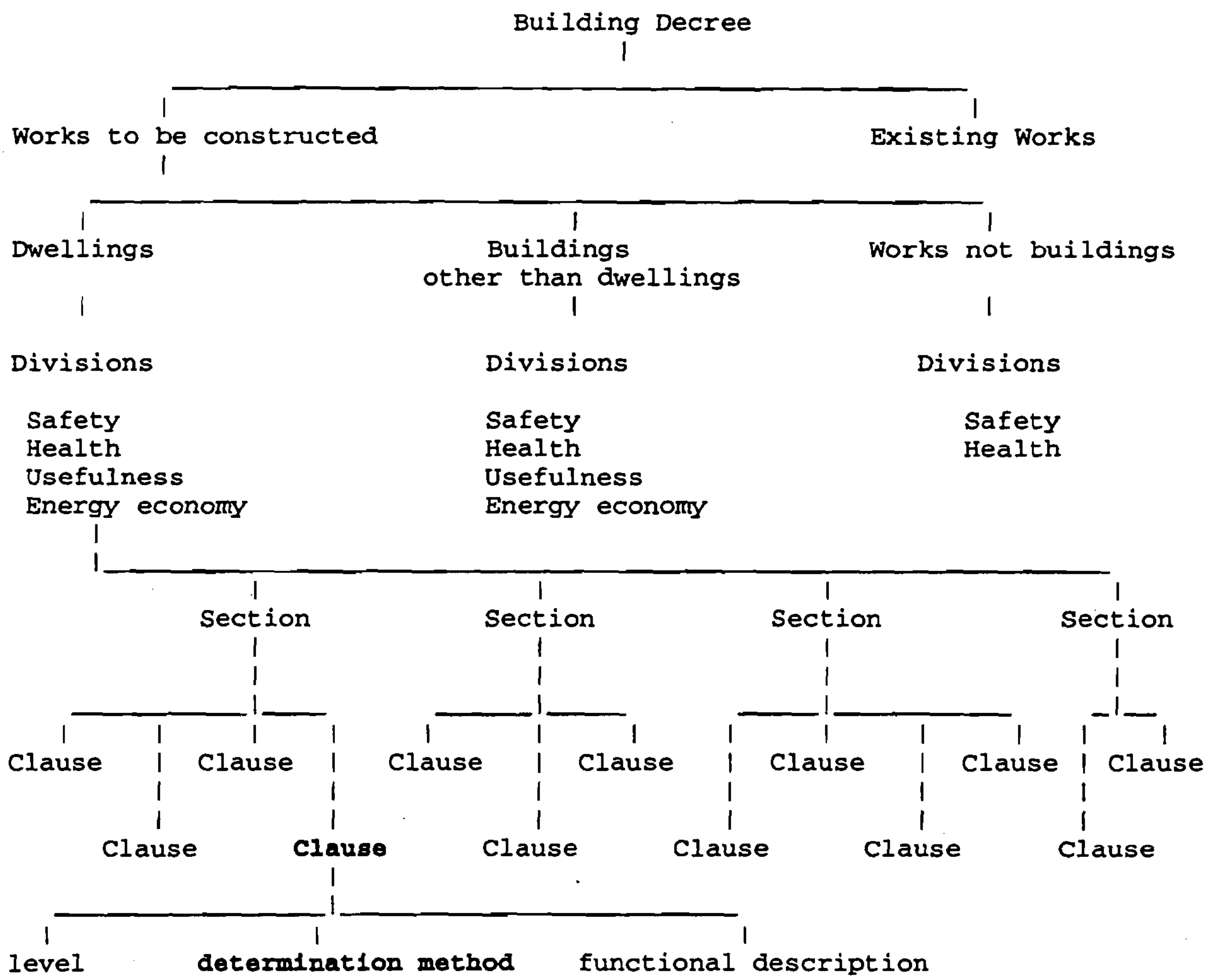


Figure 4 Property

Value

The value as the particular prescription, credence or "deemed to comply" solution that will satisfy the required performance or ensure the required

attribute is also found in the clause containing the performance based requirement.
In the Dutch building regulations the value consists of the level and the determination method. The determination method opens the possibility to verify the claimed performance and check this performance with the required performance.

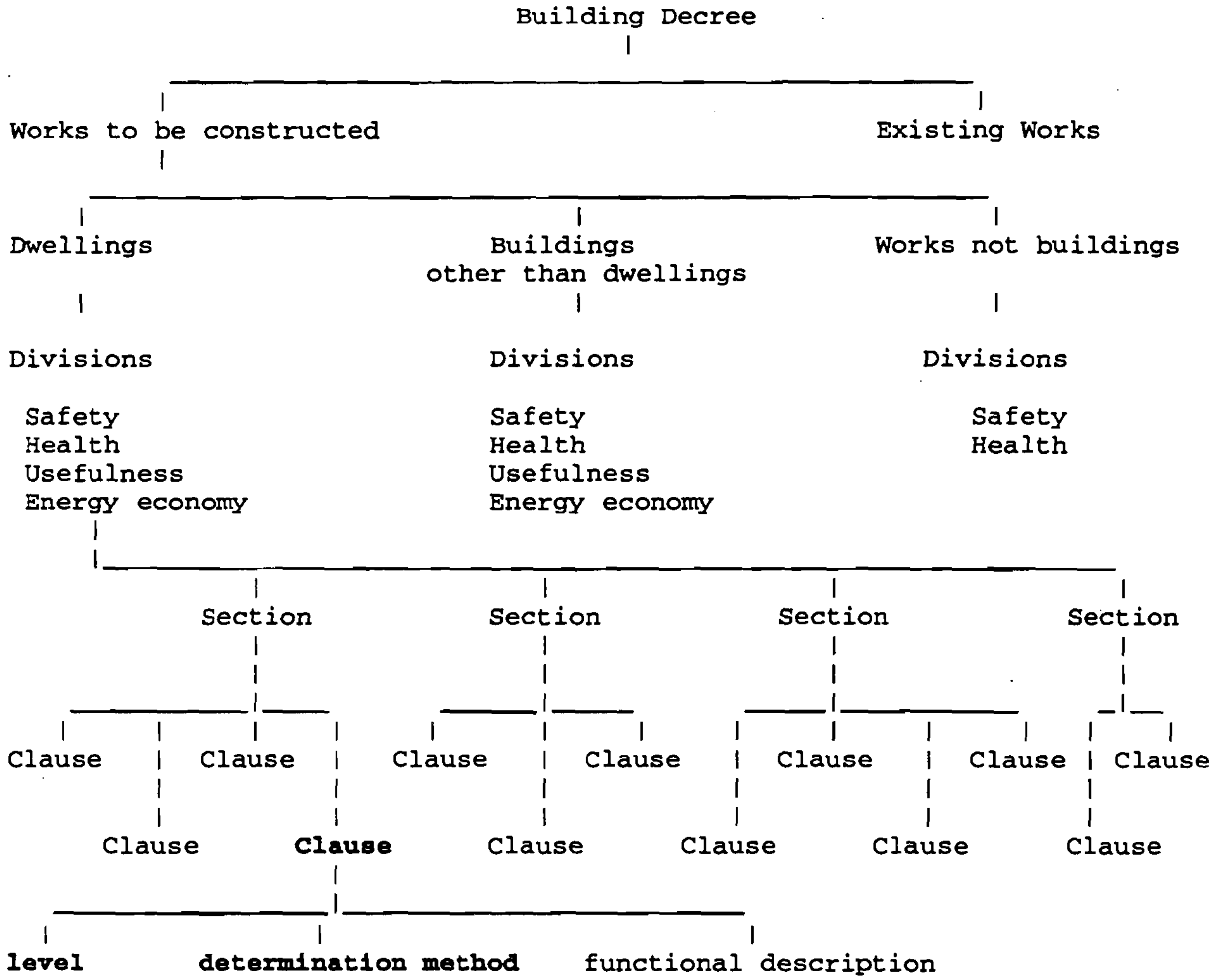


Figure 5 Value

Equivalence provisions

Performance requirements allow an amount of freedom in designing a construction work that is maximal when adhering to the criteria of unambiguity etc. of the requirements. However, it may occur that a solution in a building plan that is, being judged on its own merits, not inadmissible, does not fit to one or more requirements. The reason of this could be the nature or the situation of the construction work or the application of innovative materials or constructions.
For these cases the Building Decree contains the so-called equivalence provisions. Each division containing technical regulations ends with stating such a

provision. If the applicant for a building permit wishes to opt for such an uncommon solution, he will have to demonstrate to the municipality that this solution corresponds with the intention and the level of the performance requirement of which limit value or determination method he wants to deviate from. Consequently, the equivalence concept does by no means serve to make possible the use of solutions of a lower quality level. The applicant may demonstrate the equivalence, e.g. by submitting a quality statement or a relevant scientific publication.
For these equivalence provisions it is not possible to define value, property, entity and context. Intent can be defined by the paragraph and chapter containing the equivalence provision.

BOTTOM - UP ANALYSIS OF NATIONAL CODES

MANUAL

DRAFT

Canadian Codes Centre

January 1997

INTRODUCTION

The bottom-up analysis of the current codes has been identified by the Cnandian Commission on Building and Fire Codes Task Group as a step in the transition to Objective Based Codes. The underlining rationale for the analysis is the fact that the new codes must essentially preserve the level of requirements and the scope of the current codes, hence we must have a good understanding of these issues and have the information collated in a manageable way. This task has to be viewed in conjunction with the development of the structure of objectives, as the effects these two will have to be merged in the creation of the new codes.

GOALS OF THE BOTTOM-UP ANALYSIS

The primary goals of the analysis are:

- assignment of the intent and application statements to each provision of the code
- identification of the "root" objective of each requirement

This should be based on Appendix Notes of the Code in question, available records of the responsible committee and on the best understanding of the Bottom-up Analysis Groups, staff, and other experts that have been consulted.

Other goals are:

- tentative identification of elements of the Objective Structure that correspond to the analyzed provision.
- identification of existing provisions that do not appear to link with any of the agreed-upon "Root" objectives.
- identification of other information useful for future activities
- organizing the outcome of the analysis into a body of information (data base) in a format that will facilitate the use of this information in the process of creation of the new codes.

ITEMS TO BE IDENTIFIED IN THE ANALYSIS

Code Unit

A Code Unit is a portion of the Code that can have an intent and an application statement assigned to it. It usually is a Sentence but this may not always be the case. In some instances, the Sentence will have to be subdivided to arrive at a Code Unit. As this is a bottom-up analysis, it should be focused first on the smallest possible Units.

Type of Provision

This item classifies the analysed provision - Determination or Requirement, with their subcategories. Determination is a provision that is not directly used for checking for compliance with the code, such as definition, building classification, application statement, calculation formula etc.. Requirement is a provision directly used for checking the compliance, such as prescriptive, performance or functional requirement. Exclusion type requirements will not be treated in any other way than other requirements. Another type of provision are administrative provisions. These would most likely be beyond the scope of further analysis.
Type of provision information indicates how the further analysis can be done.

Intent
This is what the Committee intended to achieve at the time the provision was written. It has to grasp the actual intent, which may be not exactly what the words of the provision say. If the original records are not available, a best educated guess must be made. It is likely that, in some cases, while an Intent statement for a Code Unit is being derived, it will become obvious that the Unit has more than one intent. In this case, a re-evaluation of what constitutes the Unit will have to be made and a decision may be required to subdivide the Unit or to duplicate the Unit and conduct an independent analysis.

Application
This describes application and limitations of the application of the provision, such as occupancy, building height, sprinklered/nonsprinklered building, etc. The application statement should be complete and be able to stand on its own - it should be explicit and, where available, include reference(s) to application statement(s) within the Code.
Early testing of the analysis procedure has indicated that the Application and the Intent statements should be done in conjunction with each other. This approach will allow for a proper balance of information content in those statements and for shorter and more precise statements. Defined terms should be used when applicable and they should be used in the defined sense. A vocabulary of other terms, not defined in the Codes, but recommended for the use in both Application and Intent statements, will be developed and implemented by CCC Staff as the work progresses.

Root Objective
This is to indicate the root objective from the bottom-up perspective that the provision is linked to (Safety, Health, Accessibility, Durability, Property Protection, Environment Protection etc.), which may not necessarily fall within the declared scope of the Code or agree with the approved Top-Down hierarchy of objectives. The provisions that fall outside the approved scope of the document need to be analyzed and information must be provided for the decision making process.

Immediate Objective (Tentative)
This is a link to the Top-Down hierarchy of objectives, drawn from the Intent. At the early stage we need only to flag the anticipated Objectives. This will be refined during the development process of the top-down structure of objectives.

Path of Objectives (Tentative)
This is to indicate an anticipated path of objectives between the root and the immediate objectives. Such a path is likely to be outlined in the analysis process anyway and it will be useful to the top-down development process.

Functional Requirement* (Tentative)
This is an anticipated requirement. Fulfillment of this requirement would assure or contribute to, achieving the Immediate Objective.

* A *functional requirement* specifies the characteristics of elements of building, facility, process, procedure or documentation (Entity), that contribute to the achievement of the related objectives. The specification may be stated as performance criteria (quantitative) or, at least initially, in qualitative terms. Where it is desirable to do so, and knowledge permits, qualitative specifications may be replaced by performance criteria. A *functional requirement* can be subdivided as

necessary to allow for *approved solutions* that address only part of the *functional requirement*. (This is a "tentative" definition, subject to further refinement.)

Entity
Its purpose is to tag the information with key words and phrases that will allow searching the data base by the element of a building, facility, process, procedure or documentation that the Code Unit refers to. There is a precise classification of subjects available; it has to be tested whether or not it is necessary to use it. An outline of the classification is shown in Annex1.

Agent or Mechanism
This is another information tag, to allow searching by factors affecting the Entity, such as fire, gravitation load, earthquake, deterioration etc. A combination of Agents may be relevant, e.g. Fire and Gravitation or Gravitation and Impact. Agents can be classified as outlined in Annex 2.

History Notes
Notes on the history and origin of the provision, if available, may be useful in the proper identification of the intent and application of the provision.

Comments
This is additional information about the provision, such as :

- lack of connection to any of the approved first level objectives
- wording not consistent with intent
- need to be restructured/rewritten
- improper location
- inconsistent wording with other parts/documents
- provision too detailed
- provision too vague
- additional study/research needed

These comments will be provided by individuals, groups and committees carrying the analysis and reviewing the results. Input from different provider categories (e.g. Standing Committee or CCC Staff) will be stored separately, so that the author(s) can be identified for possible further clarifications.

THE PROCESS

The analysis will be accomplished in a number of iterations. The first iteration will focus on the identification of Code Units and the assignment of the Intent and Application statements to the Code Units. The following iterations will produce the remaining pieces of information, with possible refinement of those arrived at in the first iteration.

The analysis will be carried out by Bottom-up Analysis Groups (BAG), retained consultants and CCC Staff. A computerized data base has been made available to the CCC Staff . BAG members will provide input in a format of their preference and the responsible staff will transfer this information into the computerized data base.

DATA BASE

The outcome of the bottom-up analysis will be a body of information, organized into a data base.
The data base is intended to provide:

- a consistent approach to the bottom-up analysis
- a convenient repository for the analysis results
- information structured in a way that will facilitate the tasks following the initial analysis.

The data base arrangement of information is based on a classification system. As there is not just one right way to classify things (although there are rules to do it efficiently), the classification system should be looked upon as an organizing tool, that need to be customized for a particular purpose. Since we analyse existing documents, it is convenient to start following their order by inputting pieces of the document with their original designation and the associated Application and Intent. The subsequent entries belong to categories outside the original document, with their own classification which will help to extract and organize information needed for the tasks following the initial phase.

A detailed description of the computerized data base and the user instructions are provided in a separate Bottom-up Data Base Manual. The data base comprises a number of records, each dealing with particular Code Unit. Each record is made of a number of fields, containing information of a particular type (e.g. the analyzed text or the intent of the code excerpt). Annex 3 shows a list of the essential fields of the data base records and explains the type of information that those fields contain.

Annex 1

CLASSIFICATION OF ENTITY CATEGORY

- Occupancy
  - Assembly
  - Care or detention
  - Residential
    - Housing
    - Residential non housing
  - ...
- Building of noncombustible construction
- Building of combustible construction
- Building Element
  - Structural
    - Foundation
    - Column
    - ...
  - Separation
    - Environmental
    - Fire separation
    - Spacial
    - ...
  - Services
    - Heating
    - Cooling
    - Ventilation
    - Plumbing
    - Electrical
    - Fire suppression
    - ...
  - Spaces
    - Dimension
    - Layout
    - ...
- Site
  - Access facilities
  - ...
- Storage
  - Storage depending on location (outdoor/indoor/underground/...)
  - Storage system
    - Liquid storage system
      - Tanks
      - Piping and transfer
- Facility other than building
- Equipment
- Process
- Procedure
- Documentation
  - ...

Annex 2

CLASSIFICATION OF AGENTS AND MECHANISMS

- Loads (Forces)
    - Gravitation
        - Dead loads
            - Weight of structure
            - Soil pressure
        - Live loads
            - Occupancy loads
            - Snow, ice, rain
            - Hydrostatic pressure
    - Vibration
        - Earthquake
        - Traffic
        - Machinery
    - Impact
        - Hail
        - Vehicle
        - Flying debris
- Fire
    - Heat
    - Combustion products
    - Debris
    - Run-off fluids
    - Ignition
    - Fire spread
        - Fire spread by convection
        - Fire spread by conduction
        - Fire spread by radiation
    - Smoke movement
    - Exposure to means of egress
- Explosion
    - Combustion explosion
        - Gas
        - Vapour
        - Dust
    - Mechanical explosion
        - Rupture of pressurized gas containment
        - BLEVE
- Environmental differentials
    - Temperature difference
    - Humidity difference
    - Pressure difference
        - Wind pressure
        - Mechanical pressurization
        - Stack effect
- Moisture
    - Indoor

- Vapour
- Water
  - Condensation
  - Leakage
- Outside
  - Precipitation
  - Water in the ground

- Water freezing
  - Water containment bursting
  - Frost heave
  - Adfreezing
  - Freeze-thaw cycling
- Thermal expansion, contraction
- Deterioration
  - Physical (UV, erosion, wear and tear, ...)
  - Chemical (corrosion, aging of materials, ...)
  - Biological (damage by microorganisms, insects, animals)
- Generation of Effluents (waste, pollutants)
  - Indoor air pollution
    - Effluents from appliances
    - Building material emissions
  - Solid waste
  - Liquid waste
  - Outdoor air pollution
- Spillage of Toxic and Other Harmful Substances
- Human Errors
  - Movement errors (missteps, slips, ...)
  - Perception errors (e.g. due to poor visibility)
    - Judgment errors. These include errors in avoiding danger - e.g. protruding objects, difference in height, as well as errors made due to lack of sufficient knowledge.

Annex 3

ESSENTIAL FIELDS OF A RECORD OF THE DATA BASE

The following is a list of essential fields within a record, grouped accordingly to their function. The list does not show all the fields and the grouping does not necessarily follow a layout of the computer interface (there is more than one layout that a data base user may face; for more details see the Bottom-up Data Base Manual). An example of computer interface is appended.

Record management

Committee	Name of the responsible Standing Committee
BAG	Identification of Bottom-up Analysis Group
Advisor	Identification of responsible CCC Staff
Created	Date of record creation
Revised	Date of last revision
Status	Stage of the record (e.g. draft, obsolete, final)

Identification and text of the analysed code excerpt

Code Unit ID	Identification of Code Unit (analysed excerpt); includes designation of the code (e.g. B for NBC, F for NFC), its structural element (Part, Section, ... number) and additional numbering as needed.
Part#, Part Name	Self explanatory
Section#, Section Name	,,
Subsection#, Subsection Name	,,
Article#, Article Name	,,
Sentence# and Text	Analyzed sentence; it is assumed that most Code Units will be a Sentence or its portion
Code Unit Text	The actual text that is being analyzed

Analysis information

Type of Provision	Classification of Code Unit as Requirement or Determination, or a subcategory of any of these (e.g. Determination-Definition, Requirement-Performance Requirement)
Application	Application statement
Intent	Intent statement

Root Objective	Root Objective (Safety, Health, Accessibility etc.)
Objective Path	Anticipated sequence of objectives from Root Objective to the Immediate Objective
Immediate Objective	Anticipated consecutive objective linked to the intent of the Code Unit via Functional Requirement
Functional Requirement	Anticipated Functional Requirement
Entity	Entity (e.g. building element or process) that the Code Unit refers to
Agent	Agent (e.g. moisture) affecting the Entity

<u>Comments and notes</u>

BAG Members Comments	BAG notes intended primarely for consideration by Advisor
Staff Comments	Advisor comments intended for consideration by Standing Committee and for future code development
History Notes	If available and relevant to the analysis - origin of provision and its development over time
Standing Committee Comments	Recommendations an other comments of Standing Committee

ANNEX D

EDUCATION SUBGROUP, PRELIMINARY REPORT

R. Baldwin, J. Frye, W. Kukulski, D. Lucht; October 31, 1994

INTRODUCTION

CIB Task Group 11 was established·

- To provide a discussion forum and information exchange for those working on the development of performance-based codes
- To produce an outline of a practical approach to performance-based building regulatory systems

The first Task Group meeting was held in Garston, England on February 28-March 1, 1994. During that meeting, the group identified its objectives as follows:

To provide information to assist those developing performance-based building regulatory systems through:

1. Developing a framework(s) for performance-based regulatory systems;
2. Identifying sources of knowledge and tools;
3. Identifying priority areas where knowledge is not sufficient;
4. Documenting approaches & experiences;
5. Developing recommendations to CIB;
6. Developing a definition of performance codes.

This will involve:

- terminology - (look at CEB & ISO publications on this);
- Document experience to date (ask speakers to send in copies of their presentations by May I st);
- Identify models and tools;
- Identify structures and frameworks - develop examples of structure using code fragments;
- Identify User needs (building owners, users of building, etc.);
- Code users (building officials, designers, etc.) needs and experiences;
- Develop Simple Language Structure (Legal structure, - plain English, etc.);
- Education/training/promotion needs and requirements;
- Framework, approvals, etc. - innovative solutions.

The Chair divided the work among several subgroups. The Education Subgroup consists of Baldwin, Frye, Kukulski and Lucht (Chair). The Education Subgroup was assigned responsibility for 'education/training/promotion needs and requirements".

The subgroup began its work with individual members preparing their own views on several key questions including:

A. Audience -- Who needs to be educated?
B. Needs -- What is the content of needed educational messages and programs?
C. Rationale -- Why is education necessary for these audiences?
D. Educational Strategies
E. Recommendations

This preliminary report highlights what has been done to-date.

GENERAL OBSERVATIONS

While the overall scope of Task Group 11 includes safety and health performance in the broad sense, it appears that firesafety performance is a priority area of need compared to the others. The education subgroup seems to feel that more fundamental knowledge must be developed to more fully refine firesafety performance evaluation methodologies. And it was clear the subgroup also believes there are enormous needs in this area with respect to education. The subgroup agreed there is a spectrum of 'audience' needing education. These audiences include architects and engineers, building code and fire service officials, consumers, legal and financial professionals and elected and appointed officials.

The subject matter of educational programs must be matched to the audience on a "need to know" basis. Likewise, the level of subject matter detail and the educational mediums be matched with the audience.

In discussing "sources of knowledge", the subgroup developed two points of view. One has to do more with the fundamental knowledge base needed for performance-based codes to succeed. This knowledge base is most commonly developed by national research laboratories and university researchers. The second point of view is more focused on the "applications" knowledge needed by participants in the regulatory and performance design communities. This knowledge, for example, includes practical design guidance on the assumptions, uses and limitations of computer-based fire models and design methodologies.

Attachment A to this report includes a brief discussion by M.J. Frye concerning priority areas where knowledge is not sufficient. Attachment B is a matrix prepared by R. Baldwin and illustrating the matrix concept of matching audiences with educational needs and strategies.

AUDIENCES

Attachment C is a detailed listing of key players in the regulatory and performance design communities. Those felt to have priority needs include architects, fire protection/firesafety engineers and code writers.

All of the subgroup members also felt that elected and appointed public officials are high on the list of communities needing educational programs, although the level of detail is more general in nature. Because professional liability insurance has also proven to be a substantial barrier to progress, the subgroup also feels that professional liability insurers are a priority audience.

EDUCATIONAL CONTENT

Attachment D summarizes topics identified by the Education Subgroup as candidates for educational content for the various audiences indicated.

Once again, speaking of firesafety in particular, it is noted that "goals to be achieved" is a priority topic. It has been noted that building codes are generally silent or vague as to firesafety goals to be achieved. This indicates a need for knowledge development on a more fundamental level as well as communication of known performance goals to the various players in the process.

Knowledge about performance design tools available and how to use them are judged to be important topics. In addition, the subgroup feels that more educational attention is needed in helping the participants in the regulatory and performance design communities more fully understand the rationale behind building code requirements and how to write performance codes in the first instance.

RATIONALE

The subgroup was fairly prolific in identifying a host of reasons why significant education programs are needed. These are listed in Attachment E. Generally, the subgroup noted that the regulatory and performance design communities are accustomed to using prescriptive code requirements which are fairly empirical in nature. The transition to performance-based regulation and design requires considerably more knowledge, judgment and sophistication.

EDUCATIONAL STRATEGIES

Attachment F outlines a number of educational strategies identified by members of the subgroup. Generally speaking, the group feels that performance-based design concepts must be taught at the university and technical school level, especially for engineers and architectural designers. Practicing professionals can be reached through continuing education programs offered by universities, technical schools, teamed societies and trade groups.

Other educational strategies include the development and use of guidance documents including examples of deemed-to-satisfy solutions as well as prescriptive regulations for the simpler design and regulatory projects. The use of integrated user friendly computer design packages for performance-based design has also been mentioned.

MISCELLANEOUS

During the course of its discussions, the subgroup also identified a number of issues which are important to the performance design and regulatory reform movement. While these are not directly related to the scope of this subgroup, these issues have been recorded in Attachment G.

RECOMMENDATIONS

This section will include actions the subgroup recommends for implementation.

ATTACHMENT A

CIB Task Group 11 EDUCATION WORK PACKAGE
M.J. Frye 94-09-29 jfrye@ccu.umanitoba.ca

What are the priority areas where knowledge is not sufficient?

Structural design requirements are performance based, while fire protection requirements found in many codes are a mixture of prescriptive and performance requirements. For the most part, most current firesafety code requirements are based largely on:

- random experiences,
- perceived answers to problems revealed by fire experiences,
- foreign and domestic code requirements,
- published incidents of fire events,
- comments from code users.

The development of most firesafety requirements has been neither systematic nor very scientific.

Complexity of inter-related systems in firesafety.

- for many firesafety systems it is not possible to examine component parts in isolation, they often form part of a complex inter-related system,
- performance of one part often depends on the performance of other firesafety features,
- features are highly dependent on maintenance or are easily rendered inoperable,

The lack of knowledge in many of these areas makes the establishment of realistic performance levels most difficult even when the safety measures can be considered in isolation from one another.

Comprehensive engineering methodologies.

- new firesafety design methodologies are emerging, but not as yet receiving widespread use,
- they must be validated and made user friendly (computer programs must be straightforward, otherwise they will be just too hard to be used in day-to-day practice),
- validation must be by recognized third party experts,
- user base (designers and regulators) must be educated (users must be qualified),
- methodologies must be recognized by codes,
- lack of definition of acceptable levels of safety (safety factors) and means to measure whether these levels are achieved are barriers to use of these methods.

There is a concern that designers (architects and engineers) and regulators will not be competent in today's fire technology and upgrading of their firesafety engineering qualifications will be necessary. It may be necessary to establish accreditation programs graduated into a number of proficiency levels.

It must be kept in mind that many of these methodologies will not be used in many building projects. They will be of most value in complex building projects where there is often a need to evaluate alternative design solutions.

Written by J. Frye 9/29/94

ATTACHMENT B. (Matching audiences with educational needs)

R. Baldwin, August 1994

AUDIENCE (who)	NEEDS (what)	RATIONALE (why)	EDUCATIONAL STRATEGY (how)
Architects/Engineers	How to design buildings using performance criteria. Tools available. Links between designs and performance for each aspect of building design.	Many are used to working with prescriptive Regulations. They need to appreciate the freedom and flexibility offered by performance based Regulations. At the same time they need education in the greater technical demands of the design process, for example to demonstrate compliance.	Guidance documents. Integrated user friendly computer design packages. Simple rules of thumb.
Building Code Officials	How to go about drafting performance based codes. Experiences in other countries. Model performance based codes and tools for demonstrating compliance. Awareness of the benefits and problems. Legal difficulties and solutions.	Awareness needed of the benefits and pitfalls of performance based codes, legal problems and practicalities. Most are used to working with prescriptive codes. There are problems with checking designs, demonstrating compliance, setting appropriate performance levels, dealing with questions of liability, etc.	Provide model set of codes and computer codes for each aspect of performance.
Elected Office Holders	Awareness of opportunities and how to go about it.	Usually unaware of what can be achieved; the reduction in the burden of regulations and greater flexibility for designers and manufacturers to innovate.	Simple promotional material.

ATTACHMENT C. (Audience; who needs to be educated?)

Priority*	Audience	Detailed Wkg. Knowl. Grounded in Underlying Science	General Tech. Knowl. Not Fully Grounded in Science	General Awareness of Utility & Benefits
	SPECIALTY ENGINEERS			
1	FIRE PROTECTION	√		
2	Structural	√		
2	Electrical	√		
2	HVAC	√		
	Sanitary	√		
	Plumbing	√		
	Environmental	√		
	OTHER DESIGNERS			
1	ARCHITECTS		√	
2	Interior Designers		√	
2	Layout Technicians		√	
	BUILDING CODE PERSONNEL			
1	CODE WRITERS		√	
2	Administrators		√	
2	Engineers	√		
2	Plan Checkers	√		
2	Field Inspectors	√		
	Permit Issuers		√	
	FIRE SERVICE			
	Plan Checkers		√	
	Field Inspectors		√	
	Investigators		√	
	Combat Operations			√
	CONSTRUCTION			
	General Contractors			√
	Specialty Trades		√	
	Manufacturers		√	
	Suppliers		√	
	PUBLIC POLICY			
1	ELECTED OFFICIALS			√
1	APPOINTED OFFICIALS			√

Note: Items considered high priority (#l) are typed in capital letters. Items judged next lower importance are designated #2. Remaining items are not ranked.

FINANCIAL

1	INSURERS (PROFESSIONAL LIABILITY)	√
	Developers	√
	Bankers	√

CONSUMERS

	Occupants	√
	Owners	√
	Managers	√

LEGAL

	Attorneys	√
	Judiciary	√

ATTACHMENT D. (Needs; What do audiences need to learn?)

Priority

GENERAL

1 GOALS TO BE ACHIEVED (SAFETY, HEALTH, COMFORT)
2 Roles and responsibilities of participants
Building regulatory system
Legal difficulties and solutions

PERFORMANCE DESIGN TOOLS

1 WHAT TOOLS ARE AVAILABT-P?
1 HOW TO USE.
1 USER REQUIREMENTS.
Who affirms they are credible?
Assumptions and limitations?
Scientific background.

PERFORMANCE CODES

1 USER REQUIREMENTS.
1 MEANS OF EXPRESSING PERFORMANCE FOR TOTAL BUILDING AND COMPONENTS.
2 How to write performance codes.
2 Rationale behind building code requirements.
Background information on performance concepts.
Reasons performance codes should be used (cost; benefit; new, innovative products).
Experience in various countries.
Problems associated with application of performance building codes.
How to go about establishing performance-based regulatory system from public policy viewpoint.

ATTACHMENT E. (Rationale; why is this education important?)

Priority

1 HELPS ENSURE BUILDING DESIGNS MEET MINIMUM CODE REQUIREMENTS.

1 KNOWLEDGE GAPS EXIST BETWEEN AND WITHIN THE DIFFERENT CODE USER GROUPS AND THIS LEADS TO INAPPROPRIATE USE OF THE REGULATIONS, SUBJECTIVE CODE INTERPRETATIONS, CONFUSION, LITIGATION AND INCREASED CONSTRUCTION COSTS.

1 BUILDINGS HAVE BECOME MORE SOPHISTICATED AND BUILDING REGULATIONS HAVE BECOME MORE COMPLEX (IT TAKES GREATER SKILLS TO DESIGN, BUILD AND INSPECT NEW BUILDINGS).

1 MOST PEOPLE WHO ENTER THE CONSTRUCTION INDUSTRY HAVE HAD INADEQUATE TRAINING IN CODES AND CODE APPLICATION AND LATER KNOWLEDGE ACQUIRED THROUGH ON-THE-JOB TRAINING HAS LITTLE IN THE WAY OF A STRUCTURED BASE ON WHICH TO BUILD.

1 DESIGN PROFESSIONS ARE EXPRESSING CONCERNS ABOUT THEIR LEVEL OF UNDERSTANDING OF CODES.

1 BUILDING OFFICIALS WHO ARE UNFAMILL4,R WITH THE REQUIREMENTS TO BE ENFORCED OR WHO LACK AN APPRECIATION OF THE OBJECTIVES CANNOT BE EXPECTED TO BE EFFECTIVE CODE ADMINISTRATORS WITHOUT CONSIDERABLE ASSISTANCE FROM OTHERS.

1 WITHOUT AN APPRECIATION OF THE INTENT AND OBJECTIVE OF A CODE REQUIREMENT, THE ENFORCING AUTHORITY HAS LITTLE CHOICE BUT TO TAKE A NARROW LITERAL MEANING FOR EACH REQUIREMENT (I.E. CODE REQUIREMENTS TEND TO BE SEEN AS "BLACK AND WHITE" AND ACCEPTANCE OF ALTERNATIVES OR EQUIVALENCIES ARE REJECTED EVEN THOUGH THE BUILDING OFFICIAL HAS THE AUTHORITY TO ACCEPT THEM).

1 DIFFICULTIES IN INTERPRETATION OF CODE PERFORMANCE REQUIREMENTS RESULT IF THE DESIGN TECHNOLOGY REQUIRED TO MEET THE STATED PERFORMANCE LEVEL IS NOT GENERALLY KNOWN TO THE RANK AND FILE DESIGNERS.

1 THE MOVE TO VERIFIABLE PERFORMANCE-BASED REGULATIONS WILL BE A KNOWLEDGE PACED MOVE.

1 NECESSITY TO REPLACE PRESCRIPTIVE REGULATIONS (HOW TO CONSTRUCT) BY PERFORMANCE-BASED REGULATIONS (WHAT TO ACHIEVE).

1 ARCHITECTS/ENGINEERS (AE) ARE USED TO WORKING WITH PRESCRIPTIVE REGULATIONS. THEY NEED TO APPRECIATE THE FREEDOM AND FLEXIBILITY OFFERED BY PERFORMANCE-BASED REGULATIONS.

2 Many of the participants in the building construction industry have had little format training in codes.

2 Understanding of the regulatory process by the politician should improve the level of political support for the building regulatory process.

2 The manner in which codes are administered is influenced by the technical training and attitude of local building officials and the assistance available in carrying out day- to-day enforcement.

Roles and responsibilities of participants in the building construction industry are not always understood by the public at large yet consumers demand an efficient and effective building process.

There is often a lack of understanding of the services that the design professions can offer.

It is important that the public has some level of assurance that participants in the construction industry are competent in the use and application of codes and standards (users demand and deserve safe and healthy buildings).

Building trades are often a largely unregulated segment of the construction industry and there is a need for training.

Expertise of the building work force is diverse with both highly skilled experienced builders and those with little training or experience.

Infrequent users of codes often find them overwhelming and confusing because of the number of requirements that apply or seem to apply.

Improve communications facilitates knowledge transfer within the construction industry.

Technical progress.

Variety of innovative products.

AE's need education in the greater technical demands of the design process, for example to demonstrate compliance.

Building officials need to be aware of the benefits and pitfalls of performance-based codes, legal problems and practicalities. Most are accustomed to working with prescriptive codes. There are problems with checking designs, demonstrating compliance, setting appropriate performance levels, dealing with questions of liability, etc.

Elected office holders are usually unaware of what can be achieved; the reduction in the burden of regulations and greater flexibility for designers and manufacturers to innovate.

ATTACHMENT F. (Educational Strategies; how can education objective be met?)

1 THROUGH EXISTING INFRASTRUCTURE OF UNIVERSITIES, TECHNICAL SCHOOLS, LEARNED SOCIETIES, TRADE GROUPS.

1 ENCOURAGE UNIVERSITIES AND TECHNICAL SCHOOLS TO OFFER COURSES IN CODES, CODE APPLICATIONS AND PERFORMANCE DESIGN METHODS (ESPECIALLY ENGINEERING AND ARCHITECTURAL DESIGN PROGRAMS).

1 CONTINUING EDUCATION PROGRAMS OFFERED BY GROUPS CAPABLE OF REACHING AUDIENCES EFFECTIVELY.

1 INTEGRATED USER-FRIENDLY COMPUTER DESIGN PACKAGES FOR PERFORMANCE-BASED DESIGN.

1 GUIDANCE DOCUMENTS.

1 PRESCRIPTIVE REGULATIONS INDICATING DEEMED-TO-SATISFY SOLUTIONS.

2 Qualifying exams for engineers and architects test code knowledge.

Conference and symposia.

Use Internet, newsgroups to transfer information to code practitioners and designers.

International electronic educational systems; satellite; compressed video; video cassettes.

Take advantage of positive attitudes toward professionalism.

Expert systems for code applications and design.

Simple rules of thumb for design.

Credible design manuals and guides.

Demonstration projects; case studies.

Examples of deemed-to-satisfy solutions.

ATTACHMENT G. (Miscellaneous comments; not necessarily education topics).

Listed below are items identified by the subgroup as being important to the performance codes movement but not being "education" issues per se.

Regulation, verification, certification or accreditation of:

- Participants in regulatory system
- Training/education programs
- Third parties
- Design tools

Improve links between design offices and laboratories

- Prioritized research
- Develop knowledge to establish realistic performance levels
- Refine technical tools for performance assessment

Establish more political support for building quality.

Need technical support services to assist local building code officials.

Model performance building codes, computer codes and tools for demonstrating compliance.

Model legislation.

Liability insurance products.

Establish "clearinghouse" in each country for information regarding performance of various materials and subsystems (important for technical validity of performance-based codes).

International Council for Building Research Studies and Documentation

Conseil International du Bâtiment pour la Recherche l'Etude et la Documentation

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CIB is a world wide network of over 5000 experts from about 500 organisations, who actively cooperate and exchange information in over 50 Commissions including W81. Their scopes extend to all fields in building and construction related research and development. They are listed on the next page.

These Commissions initiate projects for R&D and information exchange, organise workshops, symposia and congresses and produce publications of acknowledged global repute.

It is in their ability to bring a multi-national and multi-disciplinary approach to bear on the subject matter delineated in their Terms of Reference that is their strength.

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CIB is an Association that utilises the collective expertise of its membership to foster innovations and to create workable solutions to technical, economic, social and organisational problems within its competence.

Details on Membership and Activities are obtainable from the General Secretariat at the address above.

List of CIB Task Groups (TG) and Working Commissions (W)

This list is current as at 1st July 1997. The CIB Programme Committee keeps the position under continuous review and new Groups are added and existing ones terminated according to the needs of members.

TG08	Environmental Assessment of Buildings
TG10	Computer Representations of Design Standards & Building Codes
TG11	Performance-Based Building Codes
TG13	Consequences for Buildings of Climatic Variability and Climate Change
TG15	Construction: Conflict Management and Dispute Resolution
TG16	Best Practice for Sustainable Construction
TG17	Protection Against Electromagnetic Radiation
TG19	Designing for the Ageing Society
TG20	Geographical Information Systems
TG21	Climatic Data for Building Services
TG22	Environmental Design Methods in Materials and Structural Engineering
TG23	Culture in Construction
TG24	Application of Virtual Reality in Construction
TG25	Facade Systems and Technologies
TG26	Open Building Implementation
TG27	Human-Machine Technologies for Construction Sites
TG28	Dissemination of Indoor Sciences (joint CIB-ISIAQ Task Group)
W014	Fire
W018	Timber Structures
W023	Wall Structures
W024	Open Industrialisation in Building
W040	Heat and Moisture Transfer in Buildings
W051	Acoustics
W055	Building Economics
W056	Lightweight Constructions
W057	Building Documentation and Information Transfer
W060	Performance Concept in Building
W062	Water Supply and Drainage
W063	Affordable Housing
W065	Organisation and Management of Construction

W067	Energy Conservation in the Built Environment
W069	Housing Sociology
W070	Management, Maintenance and Modernisation of Building Facilities
W072	Urban Planning: Technological Change and Urban Form
W077	Indoor Climate
W078	Information Technology for Construction
W080	Prediction of Service Life of Building Materials and Components (also RILEM 140-TSL)
W081	Actions on Structures
W082	Futures Studies in Construction
W083	Roofing Materials and Systems (also RILEM LRS)
W084	Building Non-Handicapping Environments
W085	Structural Serviceability
W086	Building Pathology
W087	Post-Construction Liability and Insurance
W088	Quality Assurance
W089	Building Research and Education
W089-WG1	Computer Assisted Leaming in Construction and Property (Working Group of W89)
W092	Procurement Systems
W094	Design for Durability
W095	Urban Infrastructure
W096	Architectural Management
W097	Building on Contaminated Land
W098	Intelligent and Responsive Buildings
W099	Safety and Health on Construction Sites

Selected CIB Publications

Some recent CIB Publications are listed below which can be ordered from the CIB General Secretariat.

These represent only a small selection of the written output from the Working Commissions and Task Groups.

The General Secretariat will be pleased to supply a complete list upon request.

Publication Number and Title

172 **W82 - Future Organisation of the Building Process**
W82 - Futures Studies in Construction
Editor W.J.P. Bakens
Trends on future perspectives for alternative models for organising the Building Process in different countries.
Price: CIB Members Hfl. 90.- Non-Members Hfl.115.-
ISBN 90-6363-005-0
Pub. 1997
275 Pages, Ill.

186 **Proceedings of the 13th CIB WORLD BUILDING CONGRESS Research and Technology Development as an Investment in the Construction Industry. Amsterdam, the Netherlands, May 1995**
Price: CIB Members Hfl.125 -, Non-Members Hfl.150.-
Pub. 1995
177 Pages

188 **W77 - Research on Indoor Climate**
W77 -Indoor Climate
Proceedings W77 Meetings, Budapest, Hungary, 1994 and Milan, Italy, 1995
Price: CIB Members Hfl.75.-, Non-Members Hfl.100.-
Pub. 1996
117 Pages

192 **W87 - A Model Post-Construction Liability and Insurance System**
W87 - Post-Construction Liability and Insurance
Price: CIB Members Hfl.65.-, Non-Members Hfl.65.-
Pub. 1996
36 Pages
ISBN 90-803022-1-X

194 **W81 - Actions on Structures - Floor Loads in Car Parks**
W81 - Actions on Structures
Price: CIB Members Hfl.35.-, Non-Members Hfl.45.-
Pub. 1997
18 Pages
ISBN 90-6363-004-2

197 **W55 - International Building Economics: Proceedings of the Seminar of CIB Working Commission W55 - Building Economics**
Editor: Prof. J.A. Rekitar

W55 - Building Economics
Price: CIB Members Hfl. 75, Non-Members Hfl. 100.-
Pub. 1996
186 Pages

198 **W78 - TG10 - Construction on the Information Highway**
Ed. 'Z. Turk
W78 - Information Technology in Construction
TG10 - Computer Representation of Design Standards and Building Codes
Proceedings of the Workshop organised by The University of Ljubljana, Faculty of Civil Engineering and Geodesy in affiliation with CIB W78 and TG10, Bled, Slovenia, June 1996.
Price: CIB Members Hfl.100.-, Non-Members Hfl.125.-
Pub. 1996
562 Pages
ISBN 961-6167-11-1

199 **W77 - A Sick Building Syndrome: The Design of Intervention Studies**
W77 - Indoor Climate
Price: CIB Members Hfl.60.-, Non-Members Hfl.75.-
Pub. 1996
66 Pages
ISBN 90-803033-3-6

201 **W81 - Actions on Structures - General Principles**
W81 - Actions on Structures
Price: CIB Members Hfl.60.-, Non-Members Hfl.75.-
Pub. 1996
46 Pages
ISBN 90-6363-002-6

202 **Economics of Technology Development for the Construction Industry by George Seaden, with Case Studies**
Price: CIB Members Hfl.50.-, Non-Members Hfl.65.-
Pub. 1996
27 Pages
ISBN 90-6363-003-4

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