

## THE ORIGIN AND DEVELOPMENT OF CANADA'S OBJECTIVE-BASED CODES CONCEPT

### INTRODUCTION

The first National Building Code of Canada was published in 1941. As preparations were underway for publication of the 1995 National Code Documents—National Building Code (NBC), National Fire Code (NFC) and National Plumbing Code (NPC)—the Canadian Commission on Building and Fire Codes (CCBFC)<sup>1</sup> decided that, after more than fifty years of evolution of Canada's code development and maintenance system, it would be good to step back and examine its current state and where it was headed. A task group was formed to develop a strategic plan<sup>i</sup> to guide the next ten years of the Commission's work. That task group heard submissions from Code users throughout the country on how the Codes themselves and the system could be improved. Although the overall consensus was that Canada's National Code Documents and the system for their development and maintenance were in pretty good shape, there were several opportunities for improvement. Some of these suggestions related to the code development system and have resulted in major changes to that system. However, this paper addresses the suggestions related to the Codes themselves and how they have been addressed.

In the suggestions received regarding needed improvements to the Codes, four themes emerged:

- The scope of the Codes needs to be clearer.
- The intent behind code requirements should be clearer.
- The Codes should be more accommodating to innovation.
- The Codes should be easier to apply to renovation.

One often hears Canada's current Codes described as prescriptive codes. But that is not accurate. They are really mixtures of prescriptive and performance requirements.

For example, a requirement for a swing-type door in a fire separation to have a latch is purely prescriptive. It tells you exactly what must be done, in physical terms, to satisfy the Code.

On the other hand, a requirement for an exit to not contain more than one percent of contaminated air in a fire situation is a performance requirement: it tells you what must be achieved to satisfy the Code, not how to do it.

It is perceived that prescriptive requirements inhibit innovation whereas performance requirements are much more accommodating to innovation. Therefore, staff of the Canadian Codes Centre (CCC) began to investigate the feasibility of converting the National Code Documents to a performance-based format.

### EVOLUTION OF THE OBJECTIVE-BASED CODES CONCEPT

The CCC played a pivotal role in the creation of CIB Task Group 11, Performance-Based Building Codes<sup>ii</sup>, which brought together representatives of countries that had adopted performance-based codes or were contemplating doing so. CCC staff were also instrumental in the creation of the Inter-jurisdictional Regulatory Collaboration Committee (IRCC)<sup>iii</sup>, which has a similar function but is restricted to representatives of national governments. Participation in these groups permitted CCC staff to learn and pass on to the CCBFC the good and bad experiences of those countries that had adopted performance-based codes. This convinced the CCBFC that rapid conversion of the National Code Documents to a performance-based format similar to that adopted in the UK, Australia and New Zealand would be extremely disruptive to the Canadian construction industry and regulatory community. A more evolutionary approach that would still achieve the benefits of performance-based codes was sought.

The approach that was settled on was to retain the existing mixture of performance and prescriptive code provisions but to tie each provision to at least one explicitly stated Code objective. The objectives of the Codes had never been explicitly stated, although they were alluded to in the prefaces.

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<sup>1</sup> The CCBFC is a committee of 40 +/- volunteers from across Canada and from all segments of the community affected by the National Code Documents—consumer representatives, architects, engineers, building officials, fire officials, plumbing officials, material suppliers, builders, etc. The CCBFC makes all the decisions regarding the content of the National Code Documents.

Thus, in order for this objective-based approach to work, it was necessary to define these objectives quite precisely. The CCBFC was determined that the exercise of defining the objectives and linking Code provisions to them should not inadvertently expand or contract the scopes of the National Code Documents—scopes that had evolved from more than 50 years of public consensus.

A number of initiatives were started and new theories proposed. As this concept of objective-based codes was entirely new, many course corrections and new starts turned out to be necessary:

### **Top-Down and Bottom-Up Analysis**

It was planned to conduct both top-down and bottom-up analysis of the Codes –

- A Task Group on Implementation of Objective-Based Codes would consider from first principles which objectives each Code should and should not address.
- The standing committees<sup>2</sup> with technical responsibility for the various parts of the Codes would analyze each provision to identify what overall objective(s) they seemed to be addressing.

However, early in the process, top-down analysis was abandoned when it identified objectives the Codes should not address, only to have the bottom-up analysis reveal several pages of provisions that seemed to address those objectives.

Thus, the objectives that were eventually declared to be the objectives of the National Code Documents were derived from a synthesis of the bottom-up analysis of all the provisions of the three 1995 National Code Documents—some 6000 sentences in all.

### **Rigour of Analysis of New Acceptable Solutions**

Early on, it was decided that the existing performance-based and prescriptive Code provisions would be included in the new format as “acceptable solutions,” a term used in the performance-based codes in other countries. It was initially reasoned that, whereas the existing Code provisions had only been included in the Codes after rigorous analysis by the standing committees with technical responsibility for the various parts of the Codes, in evaluating proposed new acceptable solutions, the standing committees would only be assessing what one **could do** as opposed to what one **must do**; therefore a less rigorous analysis would be needed. However, it was soon realized that Canadian society would expect that any solution deemed “acceptable” in the Codes would be just as safe and create as little risk to health as the existing Code provisions. Therefore no relaxation in the rigour of the analysis could be expected.

### **Role of Cost/Benefit Analysis in the Evaluation of New Acceptable Solutions**

Again, it was initially reasoned that, whereas the standing committees had always considered cost/benefit issues in evaluating the existing Code provisions, in evaluating proposed new acceptable solutions, the standing committees would only be assessing what one **could do** as opposed to what one **must do**; therefore cost/benefit issues need not be considered. However, it was realized that each acceptable solution would include a number of sub-requirements that must be satisfied for the overall solution to work acceptably and that cost/benefit issues would have to be considered in determining the stringency of these sub-requirements.

## **OBJECTIVE-BASED CODES CONCEPT AND KEY COMPONENTS**

### **Concept**

The fundamental concept behind the 2005 objective-based codes in Canada is the recognition that the acceptable solutions represent an implicit expression of the levels of building performance that are acceptable to society. Objective-based codes are articulated around acceptable solutions, which play two important roles:

1. In objective-based codes, acceptable solutions are maintained and represent one of the two compliance options. Following the technical specifications of the acceptable solutions is deemed to meet the objectives and performance expectations of the Codes. Acceptable solutions consist of

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<sup>2</sup> Although the CCBFC makes final decisions regarding the content of the National Code Documents, it is assisted by standing committees responsible for the development and updating of all technical aspects of the codes. Like the CCBFC, standing committees consist of volunteers from all segments of the construction community but have more specific technical expertise based on their respective areas of responsibility.

provisions—either prescriptive or performance-based—that have been developed over time under the code development system in place before the introduction of objective-based codes. Acceptable solutions will continue to be developed and updated under objective-based codes and will continue to offer to Code users a straightforward way of complying with the Codes.

2. The second compliance option under objective-based codes is through the use of alternative solutions, i.e. innovative solutions that differ from the specifications of the acceptable solutions. To be acceptable, an alternative solution must provide a level of performance at least equivalent to that of the acceptable solution(s) it is replacing. This very important feature aims at preventing an unintentional reduction or increase in the level of performance and quality of construction that could result from the introduction of objective-based codes. This is a clear statement that the acceptable solutions (specifications developed over the years) do set out the level of performance deemed to be acceptable to society and that objective-based codes shall not inadvertently facilitate the use of building solutions with a lower performance level. In preparation for the development of objective-based codes, the standing committees responsible for the development and updating of acceptable solutions have examined each and every Code specification with the mandate of determining their intents and application. In objective-based codes, each specification of the acceptable solutions is tied to well defined objectives and functional statements and is supplemented with detailed intent and application statements. When evaluating innovative solutions for compliance, the areas of performance to be examined are clearly identified by the objectives and functional statements attributed to each specification of the acceptable solutions. Innovative solutions are not limited to “prescriptive” solutions. Both prescriptive and performance design options are permitted but their common denominator is that an alternative solution must provide a level of performance at least equivalent to the acceptable solutions it replaces.

### **Structure and Format**

The existing structure of the Codes did not permit the incorporation of the new information provided with objective-based codes—objectives, functional statement and intent and application statements. While retaining the structure and format of current technical provisions, the Codes have been restructured around 3 divisions. The Divisions are:

Division A – Compliance, Objectives and Functional Statements

Division B – Acceptable Solutions

Division C – Administrative Provisions

**Division A.** Most of the information in Division A was not in the existing Codes and has been developed during the preparation of the objective-based codes. Division A contains the following:

- the conditions necessary to achieve compliance with the Codes,
- the objectives and functional statements, and
- the limitations on the application of certain objectives and functional statements (not all objectives and functional statements apply to all buildings).

Because the objectives and functional statements will rarely change, it is expected that Division A will not require updating with each new edition of the Codes.

**Division B.** Division B contains most of the existing Codes’ technical requirements, which are now referred to as acceptable solutions. It also references the objectives and functional statements that each acceptable solution is deemed to satisfy (an acceptable solution may address more than one objective and more than one functional statement). In an objective-based code, every acceptable solution is linked to at least one of the Codes’ objectives and one of its functional statements. Unlike Division A, Division B will be updated on a regular basis as part of the ongoing development and review processes (more information under Future of Objective-Based Codes).

**Division C.** Division C contains the administrative provisions currently found in Parts 1 and 2 of the national Codes. Provinces and territories may have different administrative provisions following from the legislative context in which they adopt codes. Placing this material in a separate division facilitates its replacement by province- or territory-specific administrative provisions.

## Key Components

It is important to have a good understanding of the terminology used in Canada's objective-based codes. The key terms with which we should be familiar are listed below, and this section provides examples of how they will be applied under the new objective-based code format. The key terms are:

- Objectives
- Functional Statements
- Acceptable Solutions
- Intent Statements
- Application Statements

**Objectives.** Objectives state what the Codes aim to achieve. The objectives define the Codes and provide the rationale behind the acceptable solutions. In light of the bottom-up analysis of the Codes and the feedback received in the two consultations<sup>iv v</sup> on objective-based codes, the CCBFC has identified the objectives of the Codes to be:

- Safety
- Health
- Accessibility (NBC)
- Fire and Structural Protection of Buildings (NBC)
- Protection of Buildings and Facilities from Water and Sewage Damage (NPC)
- Fire Protection of Buildings and Facilities (NFC)

The objectives are found in Division A of the objective-based codes. Sub-objectives (second-level and third-level objectives) provide even more detailed information about what the Codes are trying to accomplish. The NBC objective Safety has 5 second-level objectives: Fire Safety, Structural Safety, Safety in Use, Resistance to Unwanted Entry, and Safety at Construction and Demolition Sites.

The following shows the NBC objective Safety and its sub-objective Structural Safety:

### **OS Safety**

An objective of this Code is to limit the probability that, as a result of the design, construction or demolition of the *building*, a person in or adjacent to the *building* will be exposed to an unacceptable risk of injury.

### **OS2 Structural Safety**

An objective of this Code is to limit the probability that, as a result of the design or construction of the *building*, a person in or adjacent to the *building* will be exposed to an unacceptable risk of injury due to structural failure. The risks of injury due to structural failure addressed in this Code are those caused by-

- OS2.1** loads bearing on the *building* elements that exceed their load-bearing capacity
- OS2.2** loads bearing on the *building* that exceed the load-bearing properties of the supporting medium
- OS2.3** damage to or deterioration of *building* elements
- OS2.4** vibration or deflection of *building* elements
- OS2.5** instability of the *building* or part thereof
- OS2.6** collapse of the excavation

**Functional Statements.** The functional statements translate objectives into operational terms. They describe the general conditions to be achieved. A functional statement

- is expressed in qualitative terms, and
- describes the outcome required, but not how to achieve that outcome.

Any one objective can be related to one or more functional statements, and vice versa. Functional statements are likely to be useful in the evaluation process of proposed alternative solutions. The functional statements are found in Division A.

The following shows functional statements that are normally related to the NBC sub-objective Structural Safety:

### 3.2.1.1. Functional Statements

1) The objectives of this Code are achieved by measures, such as those described in the acceptable solutions in Division B, that are intended to allow the building or its elements to perform the following functions:

...

- F20** To support and withstand expected loads and forces.
- F21** To limit or accommodate dimensional change.
- F22** To limit movement under expected loads and forces.
- F23** To maintain equipment in place during structural movement.

**Acceptable Solutions.** The term "acceptable solution" designates a Code provision or a set of Code provisions. In the objective-based codes, the prescriptive and performance requirements of the existing Codes become "acceptable solutions," a term that reflects their position as one of the many possible solutions afforded under the objective-based code format. Following the technical specifications of acceptable solutions represents one way of achieving compliance with the Codes. Acceptable solutions can also be used as a benchmark against which other means of meeting the Codes' objectives and performance expectations will be assessed or compared (more information under The Concept and How Objective-Based Codes are Intended to be Used). In an objective-based code, every acceptable solution is linked to at least one of the Codes' objectives and functional statements. The acceptable solutions are found in Division B of the objective-based codes.

The following is an example of an NBC acceptable solution that, although linked to other objectives, is linked to at least the NBC sub-objective Structural Safety and to some of the functional statements that are normally related to it:

### 9.23.10.2. Bracing and Lateral Support

1) ... each exterior wall in each *storey* shall be braced with at least one diagonal brace conforming to Sentence (3).

...

- 3) Where bracing is required, it shall
  - a) consist of not less than 19 mm by 89 mm wood members,
  - b) be applied to the studs at an angle of approximately 45° to the horizontal, and
  - c) extend the full height of the wall on each *storey*.

The following is an excerpt from a table that will be in Division B of the printed version of the objective-based NBC that shows the objectives and functional statements attributed to this acceptable solution. Although this paper discusses only the portion of the analysis that is linked to the NBC sub-objective Structural Safety, this excerpt illustrates that this acceptable solution is also linked to other objectives.

Acceptable Solutions	Objectives and Functional Statements
<b>9.23.10.2. Bracing and Lateral Support</b>	
(3)	<p>[F20-OS2.1,OS2.3,OS2.5] [F22-OS2.3,OS2.5] [F20-OP2.1,OP2.3,OP2.5] [F22-OP2.3,OP2.4,OP2.5]</p> <p>[F20,F22-OH1.1,OH1.2,OH1.3] Applies to studs in an environmental separator or that support an environmental separator.</p> <p>[F22-OS3.1] [F22-OH4] Applies to studs in walls supporting floors.</p> <p>[F20,F22-OS1.2] Applies to studs in assemblies that are required to provide fire resistance.</p>

**Intent Statements.** The intent statements describe in simple terms what the acceptable solutions in Division B aim to achieve and explain the link between an acceptable solution and its attributed objective(s) and functional statement(s). This explanatory information will help Code users evaluate alternative solutions and will most likely contribute to a more consistent application of the acceptable solutions.

The intent statements are not an integral part of the Codes, but do constitute useful reference material, similar to appendix notes or information normally contained in Users' Guides or Handbooks. They will be accessible on the CD-ROM versions of the Codes as hyperlinks from each acceptable solution. Due to the sheer volume of intent statements, it is impossible to include them in the printed versions of the Codes.

The following is the intent statement that has linked the above example of an NBC acceptable solution—NBC 9.23.10.2.(3)—to NBC sub-objective Structural Safety and the related functional statements:

**9.23.10.2.(3)**

**Intent Statement.** To limit the probability of inadequate dimensions, inappropriate installation angles or inadequate lengths, which could lead to an inability to resist expected gravity and lateral loads, which could lead to excessive racking.

This is to limit the probability of:

- in all instances, structural collapse, or
- for studs in an environmental separator or that support an environmental separator, the excessive deflection, deformation, displacement or failure of required environmental separation elements, which could lead to further compromised structural integrity of environmental separators, which could lead to condensation or precipitation ingress, which could lead to deterioration.

This is to limit the probability of harm to persons.

**Application Statements.** The application statements describe the situations to which each Code provision applies and does not apply. Like the intent statements, the application statements are not an integral part of the Codes, but do constitute useful reference material. The application statements will be accessible on the CD-ROM version of the Codes as hyperlinks from each acceptable solution. Due to the sheer volume of application statements, it is impossible to include them in the printed versions of the Codes.

The following is the application statement for the above example of an NBC acceptable solution—NBC 9.23.10.2.(3):

**9.23.10.2.(3)**

**Application Statement.** Minimum dimensions, materials, orientation and extent of bracing required by Sentence 9.23.10.2.(1), in exterior walls, in wood-frame constructions to which Section 9.23. applies [see Sentence 9.23.1.1.(1) for application of Section 9.23.].

## **HOW OBJECTIVE-BASED CODES ARE INTENDED TO BE USED**

This section presents the only two methods for assessing compliance with the 2005 Objective-Based Codes.

### **Typical Code Use**

Code users who will rely on the acceptable solutions outlined in Division B, which includes the technical provisions of the existing Codes, should experience little change from the way they use the Codes today. Preparing a set of drawings or design specifications that comply with the acceptable solutions in Division B, or taking the necessary measures to satisfy the relevant acceptable solutions, will constitute full compliance with the Code in question and be sufficient to obtain approval from a regulatory official. Likewise, Code users who demonstrate compliance with the relevant provisions of a referenced standard will be deemed to have met the intent of the part of the Code in question. In these cases, a builder, designer or property owner will not likely need to reference or rely on the additional information that the objectives and functional statements provide.

However, in situations where Code users are unsure of how to apply a particular Code provision, the objectives and functional statements attributed to the applicable provisions will increase their understanding. Users of the CD-ROM version of the Codes will also be able to refer to detailed intent and application statements for more information on the relevant provisions.

### **Alternative Solutions**

Under objective-based codes, a material, system or design that differs from the acceptable solutions in Division B will be treated as an alternative solution. The additional information provided in the objective-based codes will prove most useful to those persons proposing or evaluating alternative solutions, and thus needing to know what that alternative solution must accomplish to comply with the Code in question.

The process used to evaluate alternative solutions will be very similar to that used to establish equivalency in the current Codes. The objective-based codes' objectives and functional statements are

intended to make the evaluation process much easier, for both the proponent and the regulatory official. Other explanatory information, including intent and application statements, and appendix notes, is also available.

**Performance.** Objectives and functional statements provide qualitative performance criteria only: they do not provide quantitative performance criteria that can be used in assessing the compliance of a proposed alternative solution. It is the acceptable solutions in Division B that provide the benchmark for quantitative performance against which to compare a proposed alternative solution. Assessing compliance cannot be based on the objectives and functional statements alone.

Many acceptable solutions in Division B are not framed in precise measurable terms, with specific methods for evaluating building performance. Proponents will nevertheless be required to demonstrate that their alternative solution will perform as well as the applicable acceptable solution(s) it is replacing: not "well enough" but "as well as." An alternative solution must meet, as a minimum, the quantitative and qualitative performance levels of the acceptable solution(s) it is replacing.

**Level of Performance.** When Division B offers a choice between several possible designs, it is likely that these designs do not all provide exactly the same level of performance. Therefore, the lowest of these levels of performance is the benchmark (i.e. the minimum acceptable level of performance) against which to evaluate a proposed alternative solution. It is up to the regulatory official, in dialogue with the proponent, to identify that minimum acceptable benchmark.

In many cases, establishing an overall level of performance may not be straightforward due to the fact that individual acceptable solutions have differing functionalities. In these cases, a more practical approach would be to establish that the alternative solution meets or exceeds the level of performance of the individual solutions it is intended to replace.

## **BENEFITS OF OBJECTIVE-BASED CODES**

In gauging the effectiveness of the objective-based codes, Code users will appreciate the following benefits:

- For most projects, Code users will likely rely upon the acceptable solutions in Division B—which remains essentially today's Codes—because they are familiar and satisfied with the acceptable solutions that have been in effect and proven to work for many years. The additional information—objectives, functional statements and intent and application statements—should however help Code users understand the reasons for following the acceptable solutions and contribute to a more uniform application and interpretation of the Codes.
- While many Code users may consider it is easier to keep working with the acceptable solutions, others will want to propose alternative solutions. Regulatory officials and proponents alike will now have access to information regarding the intents and applications of acceptable solutions and to the objectives and functional statements that proposed alternative solutions must satisfy.
- Generic (i.e. non-proprietary) alternative solutions that could be used across Canada will continue to be reviewed by the CCBFC's standing committees, submitted to public review, and potentially added to the applicable National Code Document as acceptable solutions. As was the case for the current acceptable solutions, intent and application statements will be developed for the new acceptable solutions, and objectives and functional statements will be attributed to them.
- Because the objectives and functional statements will rarely change, it is expected that Division A will not require updating with each new edition of the Codes. The consistency of the fundamental precepts upon which the Codes' technical requirements are based is one of the benefits of the objective-based format. In Division A, the Codes' objectives are fully articulated for the first time in the Codes' history. Division A therefore constitutes a very thorough and precise statement of the Codes' scope.

## **TRANSITION TO OBJECTIVE-BASED CODES**

### **Training for Objective-Based Codes**

In Canada, training on Codes is normally the domain of the provinces and territories and the CCBFC plays no role. However, it was realized that all jurisdictions would have common training needs related to the introduction of objective-based codes, so it was agreed that the transition training materials should be developed jointly under the aegis of a new committee under the CCBFC called the National Steering Committee on Training and Education for Objective-Based Codes. This training will introduce the new structure of the Codes and the new terminology, and provide guidance on dealing with alternative solutions.

## **Decision-Making and Fire Risk Assessment Tools**

FiRECAM™<sup>vi</sup> and FIERAsystem™<sup>vii</sup> are computer-based fire risk assessment tools that can be used to evaluate fire protection options and costs for office, apartment and light-industrial buildings. FiRECAM™ and FIERAsystem are developed by the Fire Risk Management group at the Institute for Research in Construction (IRC) of the National Research Council Canada. These tools do not establish the level of performance in absolute terms but allow the benchmarking of current Codes and can be used to determine if different fire protection options would have an impact (reduction or increase) - and the relative importance of the impact – on the overall level of fire safety performance of a building. These are decision-making tools that can be used to compare the impact of such features as sprinkler systems or smoke detectors on life safety and property preservation. FiRECAM™ and FIERAsystem are examples of the research that IRC is conducting to support Canada's move from a prescriptive to an objective-based system of construction codes. IRC is planning to extend its modeling capabilities to evaluate fire protection systems in other types of buildings, such as industrial plants, arenas and shopping malls.

## **FUTURE OF OBJECTIVE-BASED CODES**

### **Objectives**

In an objective-based code, every acceptable solution is linked to at least one of the Codes' objectives and functional statements. Therefore, a proposal to add an acceptable solution that cannot be linked to one of the established objectives would require the creation of a new objective. While these objectives are not necessarily fixed for all time, the CCBFC will only add an objective after very careful consideration, and extensive consultation with the Code community and its major stakeholders.

### **Level of Performance**

New acceptable solutions beyond those in the current Codes will be added over time through the regular updating process. A reduction or increase in the acceptable level of performance over time is possible under objective-based codes and can be achieved by the introduction or revision of acceptable solutions against which alternatives will be compared.

### **Performance-Based Codes**

Some stakeholders may perceive objective-based codes as a transitional approach towards the introduction of fully performance-based building regulations. This is not necessarily the case since some parts of the Codes might logically be left in prescriptive format and some parts of the code-using community might prefer it that way. Nevertheless, there is a general trend towards performance-based codes and objective-based codes can help guide the way along that path.

The implicit level of performance embedded in the acceptable solutions can be viewed as representing society's expectations of building performance. Converting this implicit level of performance into quantitative terms is a critical first step in the development of measurable and verifiable performance criteria that closely reflect society's expectations—the performance criteria that are essential to true performance-based codes. This is an area where research is needed to develop tools and methods, such as FiRECAM™ and FIERAsystem, that allow the quantification of the implicit level of performance of acceptable solutions. As more knowledge becomes available, more areas of the Codes may be developed into a performance path with quantitative, measurable and verifiable performance criteria, including their verification methods.

### **National Repository of Alternative Solutions**

A national repository of alternative solutions previously accepted by local authorities, or by an individual province or territory, is being contemplated. Such a repository would make additional well-considered information available on-line, result in less "reinventing of the wheel," and speed up the evaluation of other alternative solutions. Proponents and authorities having jurisdiction could more easily investigate what has been accepted by other jurisdictions and under what limitations. However, there are many issues to be addressed before such a repository can become a reality: liability of the listing authority, obligation or pressure imposed on other authorities, disclosure of proprietary information, etc.

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