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TRAINING FOR OBJECTIVE-BASED CODES IN CANADA

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ABSTRACT

Building regulatory systems around the world are going through dramatic change in response to changing stakeholder needs and political environments. The common element resulting from the changes however is the introduction of greater flexibility for the building code users. This is achieved through the explicit statement of the objectives or goals of the regulations and an increased use of performance-based requirements. This characteristic of these new building regulatory systems is an important feature for those wanting to encourage innovation and the advancement of new technologies.

The National Construction Codes of Canada – the National Building Code, the National Fire Code and the National Plumbing Code – have generally been considered to be essentially prescriptive codes, although they include a certain number of performance solutions, especially in the structural design area.

The Canadian Commission on Building and Fire Codes (CCBFC)[2] and the staff of the Canadian Codes Centre at the National Research Council of Canada (NRC) sought a solution that would make the codes more flexible while avoiding the concerns of those who feared the loss of this "recipe-based" prescriptive approach as well as those who feared that the introduction of performance-based codes would create an "anything goes" atmosphere. The solution that emerged resulted, in September 2005, in the publication by Canada of the world's first objective-based codes. While sharing many characteristics with performance-based codes, objective-based 2005 National Construction Codes of Canada have certain key differences.

The biggest effort in developing Canada's objective-based concept involved a detailed analysis of each provision – essentially prescriptive requirements - in the three National Construction Codes to determine its exact intent and the overall code objective(s) it is there to serve. Synthesis of the results of this "bottom-up analysis" allowed the CCBFC to articulate, for the first time in the codes' 60+ year history, the exact objectives that each code addresses. The detailed analyses of all codes' provisions are published separately as User's Guides to the codes and are available on CD-ROM only.

A major point of departure between countries that have implemented performance-based building regulations and Canada's objective-based codes is how innovative designs are handled. Innovative designs are methods of complying with the regulations that differ from the acceptable

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[2] The CCBFC is a committee established by the NRC to oversee the development of the National Construction Codes of Canada. It is composed of 40 +/- volunteer members from across Canada and from all segments of the community affected by the Codes – consumer representatives, architects, engineers, building officials, fire officials, plumbing officials, material suppliers, builders, etc. The CCBFC makes all final decisions regarding the contents of the National Construction Codes.

solutions. In Canada's objective based codes innovative designs are referred to as "alternative solutions". Generally speaking there are two ways these innovative designs can be assessed for compliance against the regulations:

- in a performance-based regulatory system: assessing against the objectives and performance requirements (first principles approach), or
- in Canada's objective-based codes: comparing against the stated acceptable solutions (benchmark approach).

In order to facilitate the introduction of the new objective-based codes and help code users understand how the new information (objectives, functional statements, intent and application statements) is intended to be used, NRC and the provincial and territorial authorities formed a partnership for the development of training material. This project span over more than one year and resulted in 14 training modules primarily intended for delivery in two-day classroom sessions. The training material is also adapted for self-leaning and a "basic awareness" condensed version is posted on NRC's website. The training modules introduce participants to the objective-based codes concept and to the new information and layout of the codes. It uses many exercises and case studies and includes an examination at the end to summarize what has been learned during the two days. The training material proposes a step-by-step process for evaluating innovative designs - alternative solutions - and introduces participants to some of the tools available to determine the level of performance of a code requirement or to evaluate the level of performance of an innovative design.

Although NRC managed the project of developing the training material the provinces and territories are responsible for its delivery within their jurisdictions. The training material was initially developed for building, fire and plumbing officials and could be adapted for other audiences.

This paper will review –

- the key components of Canada's objective-based codes concept
- how objective-based codes are intended to be used
- the training material developed to support the transition to objective-based codes
- the training delivery in the various jurisdictions
- reactions and comments since the launch of the new codes in September 2005

KEY COMPONENTS OF CANADA`S OBJECTIVE-BASED CODES

The National Construction Codes of Canada – the National Building Code, the National Fire Code and the National Plumbing Code – are published in an objective-based code format for the first time in the 2005 editions. This is the result of ten years of work on an initiative that arose out of the strategic plan adopted by the Canadian Commission on Building and Fire Codes (CCBFC) in 1995[i].

Structure of the Codes

The objective-based code format organizes the National Construction Codes into three Divisions:

- **Division A**, which defines the scope of the Codes and contains the objectives, functional statements and the conditions necessary to achieve compliance;
- **Division B**, which contains acceptable solutions (formerly referred to as "technical requirements") deemed to satisfy the objectives and functional statements listed in Division A; and
- **Division C**, which contains administrative requirements.

Apart from the inclusion of technical changes resulting from the normal code development process since the last publication of the Codes in 1995, the provisions in Division B are essentially the same as the technical provisions found in the 1995 editions. However, in the 2005 Codes, each provision in Division B is linked to:

- one or more **objectives** (such as safety or health) that individual provisions help to address, and
- one or more **functional statements** (statements on the functions of the building that a particular provision helps to achieve).

In addition, each Code provision is linked to two new types of explanatory material:

- **intent statements** (detailed statements of the specific intent of the provision), and
- **application statements** (detailed statements of what the provision applies to).

Objectives

The Codes' objectives are fully defined in Section 2.2. of Division A. Most of the four top-level objectives – Safety, Health, Accessibility and Protection of Buildings and Facilities – have two levels of sub-objectives.

The objectives describe, in very broad terms, the overall goals that the Codes' provisions are intended to achieve. They serve to define the boundaries of the subject areas the Codes address. However, the Codes do not deal with all the issues that might be considered to fall within those boundaries.

The objectives describe undesirable situations and their consequences, which the Codes aim to avoid occurring in buildings and facilities. The wording of the definitions of the objectives includes two key phrases: "limit the probability" and "unacceptable risk." The phrase "limit the probability" is used to acknowledge that the Codes cannot entirely prevent the undesirable things from happening. The phrase "unacceptable risk" acknowledges that the Codes cannot eliminate all risk: the "acceptable risk" is the risk remaining once compliance with the Code has been achieved.

The objectives are entirely qualitative and are not intended to be used on their own in the design and approval processes.

Functional Statements

The Codes' functional statements are listed in Section 3.2. of Division A.

The functional statements are more detailed than the objectives: they describe conditions in the building that help satisfy the objectives. The functional statements and the objectives are interconnected: there may be several functional statements related to any one objective and a given functional statement may describe a function of the building that serves to achieve more than one objective. There is a table at the end of each Part in Division B listing the sets of functional statements and objectives that have been attributed to provisions or portions of provisions in that Part.

Like objectives, functional statements are entirely qualitative and are not intended to be used on their own in the design and approval processes.

Intent Statements

Intent statements explain, in plain language, the basic thinking behind each Code provision contained in Division B. Each intent statement, which is unique to the provision with which it is associated, explains how that provision helps to achieve its attributed objectives and functional statements. Like the objectives, the intent statements are expressed in terms of risk avoidance. They offer insight into the views of the responsible standing committees on what the Code provisions are intended to achieve.

The intent statements serve explanatory purposes only and do not form an integral part of the Code provisions: as such, they are similar in function to appendix material. Due to the sheer volume of intent statements – thousands for the National Building Code alone – they are only included in electronic versions of the Codes.

Application Statements

Application statements summarize what each Code provision does and does not apply to. They provide greater detail than the application information found in the body of the Codes.

The application statements serve explanatory purposes only and do not form an integral part of the Code provisions: as such, they are similar in function to appendix material. Due to the sheer volume of application statements – thousands for the National Building Code alone – they are only included in electronic versions of the Code.

HOW OBJECTIVE-BASED CODES ARE INTENDED TO BE USED

All this additional information in the 2005 National Construction Codes of Canada – objectives and functional, intent and application statements – is intended to facilitate the implementation of the Codes in three ways:

- **Clarity of intent:** The objectives, functional statements and intent statements linked to a Code provision clarify the reasoning behind that provision and facilitate understanding of what must be done to satisfy that provision. This added information may also help avoid disputes between practitioners and officials over these types of issues.
- **Clarity of application:** The application statement of a provision helps clarify whether the provision applies in a given situation.
- **Flexibility:** The additional information allows for flexibility in Code compliance. A person seeking to propose a new method or material not described or covered in the Code will be able to use the added information to understand the expected level of performance that their alternative solution must achieve to satisfy the Code.

Compliance with the Codes

Sentence 1.2.1.1.(1) of Division A is a very important new Sentence: it is a precise statement of the relationship between Divisions A and B and is central to the concept of objective-based codes:

> **1.2.1.1. Compliance with this Code**
> **1)** Compliance with this Code shall be achieved by
> **a)** complying with the applicable acceptable solutions in Division B (see Appendix A), or
> **b)** using alternative solutions that will achieve at least the minimum level of performance required by Division B in the areas defined by the objectives and functional statements attributed to the applicable acceptable solutions (see Appendix A).

Clause (a) makes it clear that the acceptable solutions in Division B are automatically deemed to satisfy the objectives and functional statements of Division A.
Clause (b) introduces the new term "alternative solutions." This Clause makes it clear that alternative solutions can be used in lieu of compliance with the acceptable solutions. However, to do something different from the acceptable solutions described in Division B, a builder, designer or building owner must show that their proposed alternative solution will perform at least as well as the acceptable solution(s) it is replacing. The objectives and functional statements attributed to the acceptable solution(s) identify the areas of performance where this equivalency must be demonstrated.

Clause (a): Complying with Acceptable Solutions in Division B of the Codes

Code users who will rely on the acceptable solutions outlined in Division B should experience little change from the way they used the Codes before the 2005 editions. Preparing a set of drawings or design specifications that demonstrate compliance with the applicable acceptable solutions in Division B will constitute compliance with the Code in question and should be sufficient to obtain approval from a regulatory official.
However, in situations where code users are unsure of how to apply a particular Code provision, the objectives and functional, intent and application statements attributed to the applicable provisions will increase their understanding.

Clause (b): Complying with the Codes Using 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, i.e. perform at least as well as the acceptable solution(s) it is replacing. Assessing compliance cannot be based on the objectives and functional statements alone.
Areas of performance. Objectives and functional statements provide qualitative performance criteria only: they determine what areas of performance of a proposed alternative solution must be evaluated.

Level of Performance. It is the acceptable solutions in Division B that provide the benchmark for quantitative performance against which to compare a proposed alternative solution. 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 prove that their alternative solution will perform at least as well as the applicable acceptable solution(s) it is replacing: not "well enough" but "as well as." 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.

TRAINING FOR OBJECTIVE-BASED CODES

Introduction

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 jurisdiction 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. The National Steering Committee was given the mandate to facilitate the development of transition training materials by others for the introduction of the three objective-based Codes Members of the National Steering Committee include representatives of national architecture and engineering associations, educational institutions, trades, regulatory officials associations, and municipal, provincial and federal levels of government. The NRC-IRC's Canadian Codes Centre provides project management and secretariat services to the steering committee. The National Steering Committee had its first meeting in October 2000 and led the development of the Transition Training Development Project, which is now completed with the delivery of the training material to the provinces and territories in June 2006. This training will introduce the new structure of the codes and the new terminology and provide guidance on dealing with alternative solutions.

The Transition Training Development Project

Canada's 13 provinces and territories, the Canada Mortgage and Housing Corporation, and the NRC pooled funds to develop objective-based codes transition training material for two-day course delivery to building, plumbing, and fire regulatory officials. The materials, a set for each National Construction Code – the National Building Code, the National Fire Code and the National Plumbing Code –, is also available in an independent study format. Delivery of training is a provincial/territorial responsibility and may be delegated to educational institutions or industry associations. A "basic awareness" module will also be available on the Canadian Commission on Building and Fire Codes' web site at www.nationalcodes.ca.

The National Steering Committee agreed that regulatory officials require the most comprehensive and detailed transition training. However, comprehensive content developed for them is expected to be readily adapted for delivery by others to professional and trade groups. As well, the

material developed for a formal course could be adapted for delivery in other formats; i.e., internet-based training, shorter workshops, or integration into post-secondary courses, apprenticeship programs and professional upgrading.

The National Steering Committee considered the following deliverables to constitute what is needed for a formal instructor or facilitator-led two-day adult-oriented training sessions targeted to building, fire and plumbing regulatory officials:

1. Training Needs Assessment. The training needs assessment will identify:

- Target trainees;
- Required delivery formats of the training (classroom, internet, self-study);
- Learning objectives;
- Duration of training (one, two, or three days);
- Potential delivery agents;
- Estimated costs to develop the material necessary to meet the identified needs;
- Testing and certification requirements.

2. Material to Generate Required Training Outcomes. Although the bulk of the material will be the same for the three (3) Codes, the material must be customized to include relevant Code examples, references, etc. Thus three (3) versions will be prepared. Preliminary training outcomes for regulatory officials are:

- **Overview**: The objective-based codes overview will allow the trainee to understand and apply new code terminology, structure, format and organisation.
- **Application**: This material will allow the trainee to practice applying the new information in the context of plans evaluation.
- **Evaluation of Alternative Solutions**: The trainee will be able to apply a generic framework for evaluation and documentation of alternative solutions, and will gain experience applying these evaluation criteria to sample alternative solutions.

3. Instructor/Facilitator's Guide. The National Steering Committee identified two types of trainers that deliver training to regulatory officials in Canadian jurisdictions. A *facilitator* is competent to deliver adult training, but may not have code/content expertise. An *instructor* is a content expert. The Instructor/Facilitator's guide is deemed necessary to prepare the trainer to deliver the course.

4. Testing and Evaluation Forms. There is the expectation that the objective-based codes training course will be used by some to provide professional certification or for continuing education credits. For example, regulatory officials may expect successful completion of the course to be officially recognized with a certificate or credit towards their professional designation. To this end, a test provides proof of successful training. The test will be designed to be either an optional self-test, or sufficient for credit/certification. Further, the post-course assessments will be developed and stored in a secure manner that maintains their integrity for use in a qualification system. Evaluation forms are required to provide feedback to the training developers and delivery agents for continuous improvement.

5. Pilot Testing. The National Steering Committee agreed pilot testing prior to general release of the training material is important to ensure quality and effectiveness. Pilot testing will allow the developers to modify or improve the material prior to release to the provinces and territories for delivery.

Development of Training Material

1. Training Needs Assessment – completed in December 2003. A Canadian educational institution was awarded a contract in November 2002 to assess training requirements. In a survey carried out between February and June 2003 among prospective users of the 2005 objective-based building, plumbing and fire Codes a total of 303 respondents strongly validated the need for training on key concepts.

The consultant analyzed the questionnaires and presented the following key findings:

- Respondents endorsed the training outcomes identified by the National Steering Committee;
- Classroom training is preferred by 70% (only 13% selected Web-based independent learning);
- Training modules should include case studies;
- Code authorities and practitioners want in-depth training of a day or more;
- Training should address the documentation of alternative solutions;
- User's manual should be available for those unable to attend a formal training session.

2, 3, 4 and 5. Development of Training Material – completed in summer 2005. After a competitive bid process in which 5 bids were received, a contract to develop training material for regulatory officials was awarded in spring 2004 to a Canadian consulting engineering firm who teamed with a training sub-consultant - a community college with a strong construction technology program. Briefly, the contract was awarded to accomplish the following work:

- Review background documents;
- Establish learning objectives;
- Review typical training delivered by provinces to regulatory officials;
- Develop course content for each Code (3), including
    - course material on new code information and organization, including exercises, case studies and examples, for three (3) delivery modes: Basic Awareness, Independent Learning, and Classroom/Workshop,
    - evaluation of alternative solutions (including development of a generic procedure)
    - new support tools,
    - course evaluation materials (self-evaluation and examination questions, and course feedback),
    - facilitator's guide/instructor's manual;
- Learner review and pilot testing.

After completion of the pilot testing by the consultant in spring 2005, staff of the NRC-IRC`s Canadian Codes Centre analyzed the comments received, made necessary revisions to the materials and finalized examples and case studies. A significant effort was also made in editing the English material before its delivery to the provinces and territories in June 2006. One of the provinces` contribution to the project is the translation of the training material into French, which

should be completed by the end of 2006. The deliverables will therefore be available in both French and English. The deliverables will not be internet-ready. That is, conversion to an on-line course for distance education purposes is the responsibility of the province, territory or delivery agent.

Training Material

The training material consists of 14 modules for classroom delivery over a two-day course. The course emphasizes "learning by doing" through exercises and case studies. Course attendants are encouraged to participate and share their expertise with the support of the facilitator or instructor. Each module generally has the following format:

- Introduction
- Learning Outcomes
- Course Material
- Exercises
- Case Study (if applicable)
- Summary
- Self-assessment

The 14 modules of the two-day classroom delivery course are broken down as follows:

Day 1

Module 1	Introduction to the Course
Module 2	Organization of the 2005 Code
Module 3	Applying the Code Using Division B
Module 4	Intent Statements
Module 5	Application Statements
Module 6	History of Objective-Based Codes
Module 7	Introduction to Alternative Solutions
Module 8	Summary and Case Studies

Day 2

Module 9	Alternative Solutions
Module 10	Objectives and Functional Statements
Module 11	Performance Levels
Module 12	Conditions of Approval and Document Retention
Module 13	Guided Case Studies
Module 14	Case Studies

Day 1 achieves the first two training outcomes set out by the National Steering Committee:

- **Overview**: The objective-based codes overview will allow the trainee to understand and apply new code terminology, structure, format and organisation.
- **Application**: This material will allow the trainee to practice applying the new information in the context of plans evaluation.

Although the concept of alternative solutions is introduced in Module 7 Day 1 introduces the new concepts and information in the objective-based 2005 National Construction Codes and explains how their use in the context of straight compliance with the Codes, i.e. complying with the applicable acceptable solutions in Division B.

Day 2 achieves the third training outcome set out by the National Steering Committee:

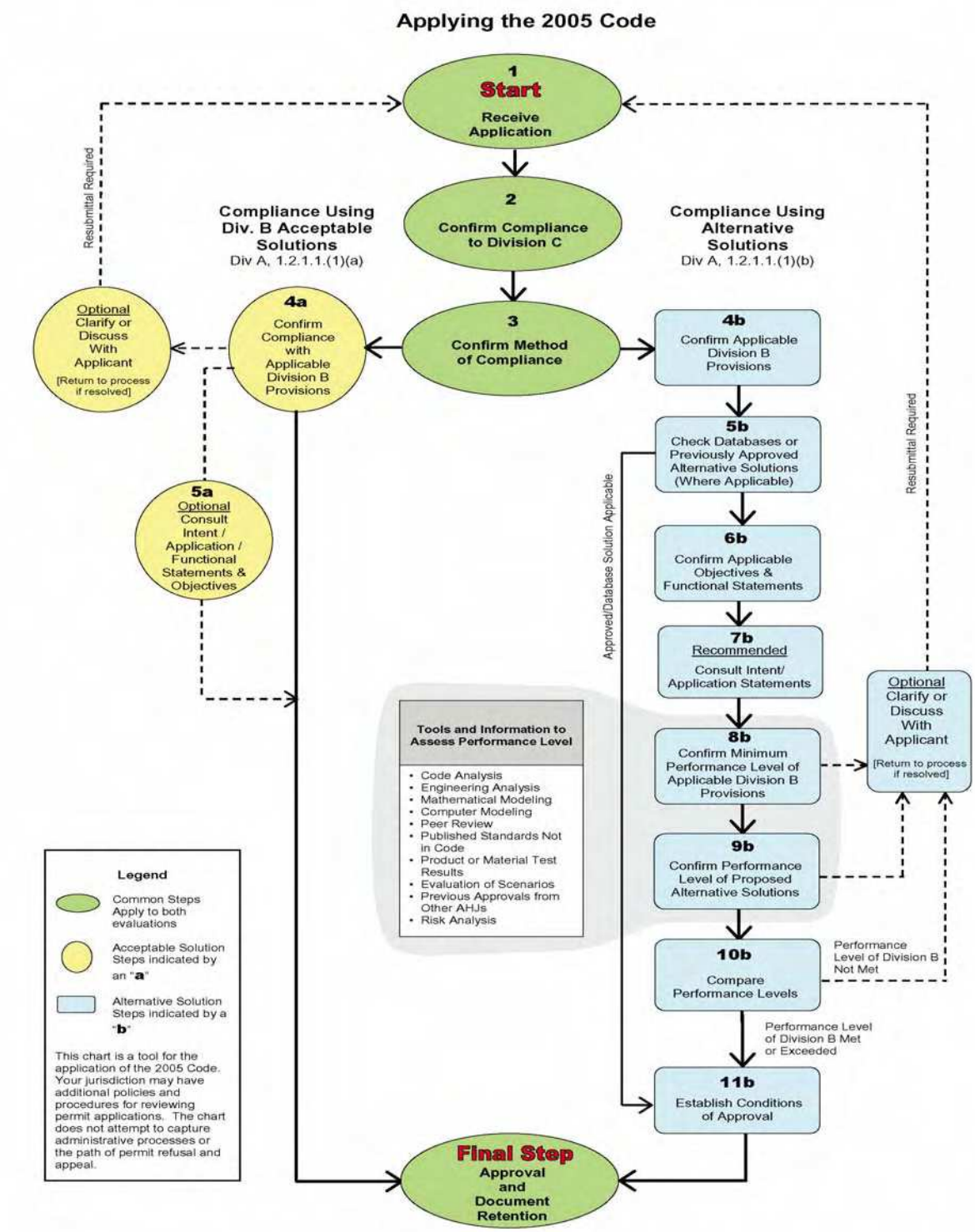
- **Evaluation of Alternative Solutions**: The trainee will be able to apply a generic framework for evaluation and documentation of alternative solutions, and will gain experience applying these evaluation criteria to sample alternative solutions.

Almost the entire Day 2 is devoted to the use of the new information in the 2005 Codes for complying with the Codes using alternative solutions. This approach requires a more elaborate process in order to determine if the proposed alternative solution does actually achieve at least the level performance of the acceptable solutions it replaces. One of the most difficult aspects of this evaluation process using alternative solutions consists in determining the implicit level of performance embedded in the acceptable solutions of the existing Codes and to compare it to the level of performance offered by the proposed acceptable solution. Module 11 offers a discussion on this issue and identifies a number of tools that are available to determine and/or compare the levels of performance. Some of the tools identified are:

- Product or material test results;
- Evaluation of scenarios (hazard analysis);
- Engineering analysis and mathematical modelling:
  - structural calculations,
  - egress analysis,
  - environmental analysis for building envelope,
  - radiation exposure calculations for limiting distance;
- Design fire analysis;
- Computer modelling;
- Previous approvals by regulatory authorities;
- Manufacturer's information;
- Published standards not referenced in the Codes;
- Research papers;
- Risk analysis;
- Performance assessment methods:
  - peer review,
  - Delphi Method,
  - panel of experts.

The following chart illustrates the evaluation processes proposed in the training material for the two compliance options of the Codes:

a) Complying with the Codes using acceptable solutions,
b) Complying with the Codes using alternative solutions.



Training Delivery

Training delivery is the responsibility of the provinces and territories. The training material is being turned over to the provinces and territories in June 2006 and it is therefore impossible to report in this paper on how this is achieved in the various jurisdictions. We are however aware of the following requests:

- Professional and industry associations have already expressed the need to adapt the material to the specific needs of their members and to develop training programs;
- NRC has been approached to support some provinces and territories, other government agencies and industry associations in their development of specific training programs. Requests to NRC are to help "training the trainers."

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