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**The Barrett Commission
Inquiry into the Quality of Condominium Construction**

***Scope, Content and Determination of the
National Building Code of Canada and
NRC Response to the Currie Letters***

G. Adaire Chown, B. Arch.
Senior Technical Advisor
Canadian Codes Centre
Institute for Research in Construction
National Research Council Canada

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Scope, Content and Determination of the National Building Code of Canada and NRC Response to the Currie Letters

Introduction

This presentation is in response to a request from the Barrett Commission to provide information on the scope, content and determination of the National Building Code of Canada (NBC), and on NRC's response to the Currie letters . Unless otherwise noted, references to the Code in this paper are references to the NBC.

Scope

The National Building Code of Canada is a model code whose principal objective is to set out requirements and criteria to provide a minimum acceptable level of health and safety for occupants of buildings across Canada. As a model code, the NBC has no legal status unless adopted or adapted by an authority having jurisdiction. Through adoption and adaptation, it serves as the basis for all building regulation in Canada.

The primary health issues addressed in the NBC include sanitation, indoor air quality, indoor temperature and moisture conditions, and protection from noise and vibration. The safety issues addressed include structural safety, fire safety, safety in the normal use of buildings such as provided by guards and handrails, and to a limited extent, safety during construction and demolition. The NBC also provides requirements that address other issues such as accessibility and protection of buildings from fire.

The NBC does not address energy efficiency. The Model National Energy Code for Buildings and the Model National Energy Code for Houses address energy issues. Like the NBC, the Energy Codes have no legal status unless adopted or adapted by an authority having jurisdiction.

The provision of requirements in the identified subject areas does not mean that the NBC addresses each subject in all possible breadth or depth. For example, although protection from noise is addressed, this is only with respect to air-borne noise; the Code does not address impact noise. For some issues, hundreds of provisions are provided; in others, only a few. Nor do the requirements aim to eliminate all degrees of hazard. Such an effort would result in extremely expensive construction. Rather, the requirements are intended to specify the

minimum level of protection needed to provide an acceptable level of health and safety.

Bases for Requirements

Criteria specified in the NBC may be based on empirical evidence or science.

The Code recognizes that the real world is the best test laboratory and that current scientific knowledge cannot necessarily explain in detail the extent to which various mechanisms might be at work in any particular situation. Consequently, many Code provisions describe constructions that have demonstrated effective performance over time – whether or not we understand exactly why.

As we learn more about building performance, the requirements of the Code are up-dated to reflect that understanding. Great care must be taken, however, to ensure that scientific evidence is verifiable. Performance as exhibited by a computer model may not, in of itself, be adequate to support a requirement – or the elimination of one.

The Code as a whole, of course, is written by code users: designers, developers, builders, manufacturers, regulatory officials, owners and managers. It is this community at large that decides what the code should address and what levels of performance should be specified in the requirements.

Changes to the Code may be proposed by any interested party to recognize improved knowledge of design or construction, or demonstrated performance of innovations.

Changes are not made without due consideration of the existing provisions, reasons for the proposed change, and evidence that the solution will be appropriate and effective (see [Guidelines for Proposing Changes to the National Code Documents](#)).

Proposals are subject to review by one of several Standing Committees. These Committees have representation from all regions of the country and all relevant interests. Participation on the Standing Committees is not limited by geography or financial situation since all members' travel expenses are paid. BC has provided significant input to the development of the Code. With reference to the Standing Committee on Housing and Small Buildings and its membership in the period of the development of the 1980 Code to the present, an average of 18% of the members have represented BC.

Proposals are also submitted to general public review (see [How National Codes Are Developed and Updated](#)). This provides an opportunity for all interested persons to participate in the code development process.

In the development of the 1995 NBC, over 1,000 changes were proposed and over 4,000 comments were reviewed by the Standing Committees before any decisions were made.

Within the resources available, staff of the Canadian Codes Centre, and research advisors from the Institute for Research in Construction provide technical information to the Standing Committees to assist them in their deliberations. Information is drawn not only from the Institute but from a wide range of Canadian and international sources.

Contents of the NBC

In addition to the technical requirements addressing the subjects outlined previously, the NBC provides:

- general statements of application
- definitions of words and phrases that have special meaning in the context of the Code
- references to climatic information, and
- requirements for design information and design review to indicate compliance with the technical requirements.

The general statements of application, for example, those that define whether a building is subject to Part 5 Environmental Separation or Part 9 Housing and Small Buildings for building envelope design and construction, are based on building size, height and occupancy and thus reflect in general the structural, environmental, occupancy or fire loads that are likely to be imposed on the building.

Performance and Prescriptive Requirements

In its provision of technical requirements, the NBC contains both prescriptive and performance provisions. Even Part 9, which is generally considered to be prescriptive, provides performance requirements. In the context of discussions on the BC condominium failures, numerous comments on the Code have focussed on the prescriptive requirements. In evaluating the adequacy of the Code in addressing any particular concern, the focus should first be on the performance requirements.

Performance Requirements

Until 1980, building envelope requirements for larger buildings were provided in Part 4. At least as early as 1960, Section 4.7 Cladding, provided performance requirements addressing ingress of precipitation. The provisions that are most familiar were virtually unchanged from the 1965 NBC to the 1990 NBC; these are:

4.7.1.4.(1) A junction of components of an exterior surface and a junction of different exterior surfaces of a building shall be constructed to resist the entrance of rain water into the building.

...

(6) Exterior wall cladding shall be so installed that it sheds water to prevent its entry into other components of the building assembly. Where there is a likelihood of some penetration, drainage shall be provided to take the water back to the outside. ¹

Of note here is the emphasis on protection from ingress, with drainage only as a second line of defence to recognize that absolute prevention of ingress is difficult given construction tolerances and performance of building assemblies over time.

A Code for Dwelling Construction for Buildings Housing One or Two Families, the predecessor to the Residential Standards and Part 9 of the NBC, was published in 1950. That document states that:

97. General

All exterior wall covering shall be applied in such a way that all sheathing and framing beneath is effectively protected from the weather. ²

Although the application of this Code was such that it would not have applied to the BC condominium projects, it is indicative of a general long-standing understanding of the function of cladding.

Again, the more familiar requirement is currently provided as:

9.27.2.1. Required Cladding

1) Exterior walls shall be protected with cladding, including flashing, trim, and other special purpose accessory pieces required for the cladding system being used, to restrict the entry of rain and snow into the wall assembly. ³

This provision has remained effectively unchanged since 1975. While the Code requirements related to flashings and sheathing membranes acknowledge that ingress is difficult to prevent, the focus is on controlling ingress of precipitation past the cladding.

It is these performance provisions that state what must be achieved. They must be complied with regardless of whatever other provisions apply. Knowledge of acceptable construction is critical to compliance. The Code does not tell designers, builders, manufacturers or regulators all they need to know to achieve this end. The Code acknowledges the massive amount of information available on building design and construction, and recognizes demonstrated acceptable performance. It does not attempt to serve as a design guide or to describe acceptable construction details.

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- 1 National Building Code of Canada 1965, Associate Committee on the National Building Code, National Research Council Canada, Ottawa, Third Printing 1967.
 - 2 A Code for Dwelling Construction for Buildings Housing One or Two Families, Associate Committee on the National Building Code, National Research Council Canada, Ottawa, 1950.
 - 3 National Building Code of Canada, Canadian Commission on Building and Fire Codes, National Research Council Canada, Ottawa, 1995.

Prescriptive Requirements

Prescriptive requirements state, for some specific materials and components, properties and installations that are consistent with achieving the performance requirements. They are not complete or comprehensive, nor intended to be so.

For simplicity, a set of prescriptive requirements may define a solution that exceeds the required minimum performance in some cases. They are not necessarily finely tuned to loads or functions. In order to ensure that a simple solution will perform in a more demanding situation, it will likely exceed minimum performance levels necessary in less demanding situations.

For example, Sentence 9.29.5.9.(1) specifies that where screws are used to install interior gypsum board on lumber wall studs, the screws must be spaced not more than 300 mm o.c. where the studs are not more than 600 mm o.c., or not more than 400 mm o.c. where the studs are not more than 400 mm o.c.⁴ This number and spacing of screws significantly exceeds what is necessary to simply fasten gypsum board to wood framing in a wall. The requirement recognizes, however, that the gypsum board may be serving a variety of functions such as providing lateral support, racking resistance, fire protection, and support for the airtight element of the air barrier system. The Code could specify different fastening requirements depending on the function or functions served by the gypsum board in various situations. For simplicity, however, only one acceptable solution is described which will address all cases.

Conversely, in reflecting adequate or acceptable construction, prescriptive requirements do not necessarily reflect “best” practice. Consequently, the prescriptive requirements may not be consistent with recommendations presented in the literature.

As noted previously, the Code recognizes the vast amount of information available on building design and construction that has demonstrated acceptable performance. The prescriptive requirements do not attempt to duplicate this information.

At the risk of overstating a point, it has been known for at least 150 years that standard stucco applications should only be used on buildings with overhangs. A preeminent US architect, A.J. Downing, stated that:

... nothing but attention to a few simple rules is necessary to insure success in stuccoing in this country.

The first of these rules is, not to use stucco except upon buildings with projecting roofs, in order to prevent the possibility of the wall getting saturated at the eaves.⁵

4 National Building Code of Canada, Canadian Commission on Building and Fire Codes, National Research Council Canada, Ottawa, 1995. Section 9.29. Interior Wall and Ceiling Finishes.

5 Downing, A.J. The Architecture of Country Houses, Appleton & Co, New York, 1851.

Whenever a design varies from traditional approaches that have demonstrated acceptable performance, the design must be re-evaluated to ensure that an equivalent level of performance will be provided.

The prescriptive requirements do not limit solutions that might be applied in a particular case. Section 2.5. Equivalents states that:

2.5.1.1. Alternative Methods, Appliances, Systems and Equipment Permitted

1) The provisions of this Code are not intended to limit the appropriate use of materials, appliances, systems, equipment, methods of design or construction procedures not specifically described herein.

...

2.5.1.3. Equivalence Demonstrated by Past Performance, Test or Evaluation

1) Materials, appliances, systems, equipment, methods of design or construction procedures not specifically described herein, or which vary from the specific requirements of this Code, are permitted to be used if it can be shown that these alternatives are suitable on the basis of past performance, tests or evaluations. ⁶

Such statements have been provided in the NBC since 1970.

NRC Response to the Currie Letters

In addition to specific proposals for changes to the NBC, the Standing Committees also respond to general correspondence. Mr. John Berndt, Deputy Chairman of the Associate Committee on the National Building Code, received correspondence in December 1987 from Mr. Jim Currie, then Director of the BC Building Standards Branch, and subsequently, in June 1992, Mr. Jim Traynor copied to Mr. Berndt a letter addressed to Mr. Jack Robertson, then Director of the BC Building Standards Branch, referring to correspondence with Mr. Robertson and Mr. Robin Blencoe, Minister of Municipal Affairs, Recreation and Culture, and a letter of 23 December 1991 from Mr. Currie.

1987 Correspondence

Mr. Currie raised the following concerns in his letter to Mr. Berndt and in the attached paper "Airtight Houses":

1. perceived effects on air- and moisture-tightness of energy conservation requirements in the NBC and consequent jeopardizing of health and structural sufficiency

- 6 National Building Code of Canada, Canadian Commission on Building and Fire Codes, National Research Council Canada, Ottawa, 1995.

2. perceived acceptance of new low vapour-permeance sheathing materials, such as plywood, without consideration of the overall required performance of the assembly
3. lack of definition of the air barrier system in terms of vapour permeance
4. lack of compliance with the requirement for a maximum 19% moisture content in lumber
5. inadequate ventilation as a consequence of sealing the building envelope and possible entrapment of contaminants such as radon

The following comments are offered:

1. Energy Conservation

As noted previously, the NBC does not address energy conservation. The four provincial building codes that are based on the NBC do address energy conservation and differ from the NBC in this regard. Requirements specifying minimum thermal resistance values for insulation were not introduced into the BC Building Code until December 1992 and then only for houses.

The air barrier system and vapour barrier requirements in the NBC are provided to reduce the probability of excessive accumulation of moisture within the building envelope as a result of outward migration of water vapour from the interior. The vapour barrier addresses water vapour transported by vapour diffusion; the air barrier system addresses water vapour transported by air leakage. Requirements for vapour barriers have been included in the NBC since the first edition in 1941; for example:

3.2.16.2 Sheathing. -

...

(g) Other Materials.- ...

When either sheathing or the building paper is highly resistant to the transmission of water vapour, an effective vapour barrier shall be provided between the interior face of the studs and the exposed interior face of the wall.*

*A vapour barrier is desirable whenever the vapour transfer factor of either the sheathing or the building paper is less than 2.0. Such vapour barrier should have a transfer factor not greater than 0.5.

The vapour transfer factor is expressed in gm. per 24 hours per square metre per mm. vapour pressure difference. ⁷

The evolution of the Code to also include explicit requirements for air barrier systems was not in response to the energy crisis of the early 1970s. Rather, in recognition of building envelope failures, these requirements reflected a better understanding by researchers and practitioners that air leakage is the more significant moisture transfer mechanism. Requirements for air barrier systems first appeared in the 1965 Code.

- 7 National Building Code, National Research Council Canada, Ottawa, 1941. Note that this requirement and the accompanying note are repeated in several contexts.

2. Moisture Entrapment

Mr. Currie correctly identifies the potential for moisture accumulation in wall assemblies where materials installed toward the exterior have low water vapour permeance. The demonstrated effective performance of wood-frame wall assemblies that comply with all requirements of the Code, however, does not support Mr. Currie's concerns. That is, there is no evidence that assemblies with the required air barrier system and vapour barrier are subject to excessive accumulation of moisture transferred from the interior when plywood or waferboard sheathing is installed.

It is notable that, just as the requirements for vapour barriers have been included in the NBC since 1941, plywood was also recognized in the 1941 Code. While the NBC permits materials such as plywood, waferboard and oriented strandboard (OSB) as sheathing materials, it does not require their installation. That is, the assembly recommended by Mr. Currie using shiplap sheathing is also permitted by the Code.

3. Permeance of Materials in the Air Barrier System

As noted previously, the Code assumes an understanding of good construction practice. The Code permits flexibility in the design of building envelope assemblies including the location of the airtight elements of the air barrier system. The vapour permeance of materials in the air barrier system is of concern only where these materials are installed toward the colder side of the assembly. The Code provides no requirements that would preclude installation of these materials on the warm side of the assembly. For clarification, this issue was addressed in any case in the 1990 NBC and additional explanatory information was included in the Appendix to the Code.

4. Moisture Content of Lumber

Mr. Currie raises valid concerns related to lack of compliance with the limit on moisture content of lumber. If climatic and industry conditions are such that wood frame walls must be finished before the moisture content can be reduced to 19%, the Code requires that an alternative construction be used.

5. Ventilation

The issues raised by Mr. Currie with respect to ventilation do not relate to deterioration of the building envelope and are thus not discussed here.

Mr. Currie provides recommendations for what he considers to be an appropriate wood-frame wall construction. Although there is no evidence that such an assembly is required in order to provide an acceptable level of performance, there are no provisions in the Code that would preclude the construction he suggests.

Mr. Currie's correspondence was provided to the Standing Committee on Houses and Small Buildings for its consideration, and was reviewed at the Committee's Thirty-Fifth Meeting, 12 to 14 April 1988. The Minutes record that:

... some of Mr. Currie's concerns may be partially satisfied by the proposed revisions to [NBC Section] 9.26. and [Subsection] 9.33.3. and the accompanying appendix notes. It was further noted that a fairly leaky house can still be built under existing NBC requirements so that the options suggested presently exist. It was therefore agreed that no action be taken. ⁸

The referenced change to Section 9.26., Section 9.25. in the 1990 and 1995 editions, related to a provision addressing the location of air barrier system materials with low vapour permeance. The changes to Subsection 9.33.3., Subsection 9.32.3. in the 1990 NBC, related to ventilation and do not pertain to the issue of deterioration.

1991 - 1992 Correspondence

The 1991-1992 correspondence largely reiterates the concerns expressed by Mr. Currie in his 1987 letter. This correspondence was forwarded to the Standing Committee on Housing and Small Buildings and was reviewed at its Forty First Meeting, held 16 and 17 November 1992. The Minutes record that:

The Standing Committee agreed that, given

- the inventory of buildings constructed according to the Code which do not evidence problems of moisture entrapment
- the limited amount of technical detail provided by Mr. Traynor on the cases he mentions
- the requirement to use dry lumber
- the scope of the Building Code which does not address the building process, and thus any wetting of wood components that may occur during that construction period

it would be difficult, without further documentation of problems with Code-conforming buildings, to recommend any changes to the Code requirements. ⁹

In other words, and as described in the [Guidelines for Proposing Changes](#), the Standing Committees cannot respond to opinions that are not substantiated by solid technical documentation.

⁸ Minutes of the Thirty-Fifth Meeting of the Standing Committee on Housing and Small Buildings – 12 to 14 April 1988, Ottawa, 1988.

⁹ Minutes of the Forty First Meeting of the Standing Committee on Housing and Small Buildings – 16 and 17 November 1992, Ottawa, 1992.

Summary

In the context of the review of the premature failures of condominiums in BC, it should be noted that Mr. Currie's concerns focus on the control of moisture transfer from interior space into wall assemblies. All evidence pertaining to the BC condominium failures indicates that the source of moisture that has caused those failures is precipitation entering from the exterior. As noted previously, the NBC, since the beginning, has included requirements to address precipitation ingress. Furthermore, the evidence indicates that the volumes of water that have entered the failed wall assemblies are of such a magnitude that no degree of air or vapour permeance would be adequate to permit dissipation before the onset of deterioration.

Concluding Comments

The National Building Code is a living document written, in effect and in fact, by designers, developers, builders, manufacturers, regulatory officials, owners and managers, for the use of those same interests and all building users in all regions of Canada. Knowledgeable representatives from BC have actively participated in the development of the NBC — an on-going and open process to respond to the needs of building users and the Code-using community, and also to on-going technological development and innovation in design and construction. Had additional provisions been necessary to address particular conditions in BC, proposals would undoubtedly have been brought forward and addressed.