1 INTRODUCTION

1.1 Background

Building enclosure performance problems have been experienced in low-rise wood-frame buildings, as well as high-rise buildings, in the coastal climate of British Columbia. The most significant symptom of these performance problems in low-rise wood-frame buildings has been the occurrence of extensive wood decay. The *Survey of Building Envelope Failures in the Coastal Climate of British Columbia (Survey)* identified key aspects of the design, construction, operation and maintenance which led to the problems. *Woodframe Envelopes in the Coastal Climate of British Columbia – Best Practice Guide Building Technology, 1999 and 2001 (CMHC-BPG)*, was published by Canada Mortgage and Housing Corporation (CMHC) to provide the design and construction industry with the basis and impetus to avoid these performance problems in new construction. This current guide, *Building Enclosure Design Guide – Wood-Frame Multi-Unit Residential Buildings (Guide)*, builds on this previous work with updates and knowledge gained over the past 10 years.

Traditional construction using platform framing systems (as opposed to post and beam systems) has been codified in various local and national building standards. The requirements in the current *National Building Code of Canada* serve as a model for the *British Columbia Building Code 2006 (BCBC)*. The *BCBC*, including the energy efficiency provisions (Part 10) introduced in 2008, is the primary building code document referenced in the *Guide*. Differences between *BCBC* and the 2007 *Vancouver Building By-Law (VBBL)* requirements are noted where appropriate. A key change in the *BCBC,* and in the *VBBL*, has been the provision for the use of wood-frame construction in buildings of five and six-storeys. The guide also addresses building enclosure performance issues associated with these taller buildings.

Wood-frame construction systems in use today have evolved over a long period of time. Changes have been driven by the availability of materials, development of new building materials, the growth of the population (the need for more multi-unit buildings), and the pressure to use labour, materials and energy more efficiently. While this evolution has accelerated rapidly in the last 30 years, the fundamental wood-frame structural system has remained unchanged for much longer. Wood construction has been widely used because it has a proven record of performance under a wide range of climates throughout North America, when it is used in an appropriate manner with attention to detailing and durability.

While the construction of multi-unit wood-frame buildings is similar to single family wood-frame construction in many ways, there are also some key differences that are reflected within this *Guide*. Multi-unit buildings are taller; in fact five and six-storey wood-frame buildings are now possible. This means that the walls and windows are more exposed to wind and rain. In addition, this greater height means that cumulative frame shrinkage will be greater and that access for maintenance and renewals will be more difficult. As a result, design and construction of the building enclosure for multi-unit wood-frame buildings generally must accommodate greater imposed loads (or movement in the case of shrinkage), and be more durable.

1.2 Building Enclosure as a System

The building enclosure is a system of materials, components, and assemblies that physically separate the exterior environment from the interior environment(s). Environmental separator is another term used to describe the enclosure, primarily in building codes, but this more generic term also applies to separators of two different interior environments.

The typical elements of the building enclosure include roofs, above-grade walls, windows, skylights,

doors, below-grade walls and the base floor system. These elements are three-dimensional and must perform a variety of functions both as individual elements and together as an integrated system. A summary of building enclosure functions is presented below, enhanced somewhat from the list originally presented in *Requirements for Exterior Walls, Canadian Building Digest No. 48*:

- **Control rain penetration**
- **Control condensation**
- **Control air flow (including soil gas)**
- **Control water vapour flow**
- **Control interior environment**
- **Control space conditioning requirements (energy)**
- Control light, solar and other radiation
- Control noise
- Control fire and smoke
- Provide security
- Transfer structural loads
- Be durable
- Be aesthetically pleasing and marketable
- Provide privacy and views
- Be constructible
- Be maintainable

All of these functions need to be considered in the complete design of the building enclosure and they are often quite interdependent. Satisfying all of these functional requirements is a complex and iterative design process. Numerous, and often conflicting requirements, must be satisfied. In addition, although all functions must be appropriately addressed, they are not necessarily all of equal importance.

This *Guide* focuses on the functions associated with heat, air, moisture and energy control (shown bolded above). In addition, durability, maintenance, and renewal concepts are implicit considerations of these functions.

1.3 The Guide

This publication is intended to assist builders, architects, designers, engineers, consultants and contractors with the design aspect of these types of buildings throughout British Columbia. In particular, it addresses the unique challenges presented by British Columbia's coastal climate, which has inspired advancements in building envelope technology that have been adopted around the world.

Although the *Guide* is intended to reflect good practice in general, its primary focus is on the management of heat, air and moisture transfer, since moisture-related performance problems prompted this initiative. The *Guide*, therefore, does not deal specifically with structural, acoustic, fire and a variety of other parameters that may also have an impact on the design of the building enclosure. These performance criteria must be considered together with the heat, air and moisture control provisions presented here.

The *Guide* is organized to take the user from an understanding of the behaviour of wood as a material, the fundamentals of heat, air and moisture control, and energy provisions for the building enclosure, prior to presenting design guidance specific to assemblies, details, components and materials. The final chapter addresses design considerations as well as planning for maintenance and renewal of the building enclosure over its service life.

The *Guide* reflects current good practice in design and construction. Good practice in the context of this *Guide* means the balanced application of currently available technology, materials, and normal skilled workmanship to the design and construction of affordable and durable housing.

The *Guide* is not intended to be a research paper or an exploration of innovative technology. Although some of the proposed assemblies have limited field performance history in British Columbia, they are based on sound principles and are believed to be conservative for their intended uses. Most of the assemblies are being used successfully in Canada and in other parts of the world. As further research initiatives are undertaken, better understanding of performance of the assemblies may merit a review of some of the technology presented in the *Guide*.

The *Guide* is not intended to replace professional advice. When information presented in this *Guide* is incorporated into specific building projects, it must be reviewed by the project Architect and reflect the unique conditions and design parameters of each building. Use of the *Guide* does not relieve designers of their responsibility to comply with local building codes, standards and by-laws with respect to the design and construction of the building enclosure. Readers should be aware that there are requirements under both the *Architects Act* and the *Engineers and Geoscientists Act* which determine when and for what type of projects the services of such registered professionals are legally required.

The *Guide* is not intended for use with buildings of non-combustible construction, in particular those that may be taller than the six-storey buildings considered in this *Guide*. The different materials and exposure conditions in these buildings often dictate quite different and more rigorous approaches to moisture management than are presented in this *Guide*. Furthermore, the *Guide* is not intended to be applied directly to the rehabilitation of wood-frame buildings. These projects may require quite different detailing, in many cases due to the fact that much of the building form and structure already exists and cannot be changed in a cost-effective manner.

An attempt has been made throughout the document to provide the user with references to other useful reference material. In particular, the construction industry has historically been provided with good research and guidance on wood-frame design and construction practices from the Homeowner Protection Office, a branch of BC Housing, Canada Mortgage and Housing Corporation, and the National Research Council of Canada through its Institute for Research in Construction. The following are the contact addresses and numbers for these organizations. Their publication lists include many directly relevant documents.

Homeowner Protection Office
Branch of BC Housing
1701 – 4555 Kingsway
Burnaby, British Columbia, Canada V5H 4V8
Phone: 604-646-7050
www.hpo.bc.ca

Canada Mortgage and Housing Corporation
700 Montreal Road
Ottawa, Ontario, Canada K1A 0P7
Tel: 1-800-668-2642
www.cmhc-schl.gc.ca

National Research Council of Canada
Institute for Research in Construction
Publications Section
Ottawa, Ontario, Canada K1A 0R6
Phone: 1-800-672-7990
www.nrc.ca