NRC·CNRC Construction

Housing Research Activity Summary 2013

National Research Council Canada
Conseil national de recherches Canada

Canada

A report prepared for the Canadian Home Builders' Association

April 2014

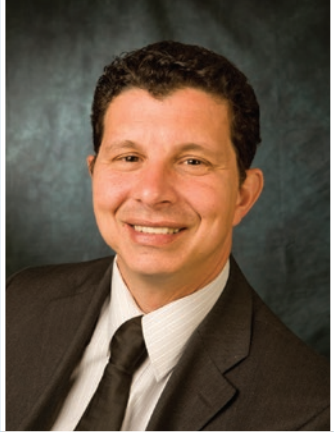
A French version of this report is **available upon request**.

Une version française de ce rapport est **disponible sur demande**.

Table of Contents

“Forecasts indicate Canada is expected to be one of the top urbanization markets by 2020. Market trends show the construction industry is experiencing an innovation boom, addressing performance issues and exploiting opportunities presented by emerging information and communication technologies, smart materials, and favorable government policies.”

Message from the General Manager of NRC Construction



I'm pleased to present this report outlining some of the key research and technical projects undertaken by the National Research Council of Canada (NRC) for the benefit of builders.

Canada's construction industry continues to adjust to the recent global economic downturn. At the same time, the industry is addressing longer-term issues such as shortcomings in productivity and building performance, and narrow profit margins caused by steadily increasing material and labour costs.

Despite these challenges, forecasts indicate Canada is expected to be one of the top urbanization markets by 2020. Market trends show the construction industry is experiencing an innovation boom, addressing performance issues and exploiting opportunities presented by emerging information and communication technologies, smart materials, and favorable government policies.

NRC consulted with partners and stakeholders to determine how it could best support the industry in its innovation efforts. We learned that we could help most by conducting research that would promote cost reduction throughout the construction life cycle, and by developing reliable procedures for validating the performance of materials, systems, products and services. In response, we have enhanced our service delivery models to create a one-stop innovation and research centre which includes:

- Technical expertise to assist firms in the development of products and systems and in the validation of their performance (e.g., fire and smoke control; automated building controls; building envelope technologies and materials; indoor air quality improvements; advances in civil engineering; enhancement of concrete materials and structures; whole system engineering and performance);
- National laboratories for partial or full-scale testing and validation;
- National services for the advancement of the National Model Construction Codes; and
- Canadian Construction Materials Centre (CCMC), providing product evaluation and support for commercialization and code compliance of products and systems.

Furthermore, we have launched four targeted programs designed to support the technical needs of the construction industry as it works to take advantage of market opportunities. They are:

- High Performance Buildings
- Building Regulations for Market Access
- Mid-Rise Wood Buildings
- Critical Concrete Infrastructure

These programs were developed to address specific technical issues and marketplace demands facing the various industry segments. They will emphasize common outcomes such as accelerated market adoption of new construction products and systems, and increased profitability through reduced regulatory compliance barriers and improved practices. Details of our activities over the past year are outlined in this report.

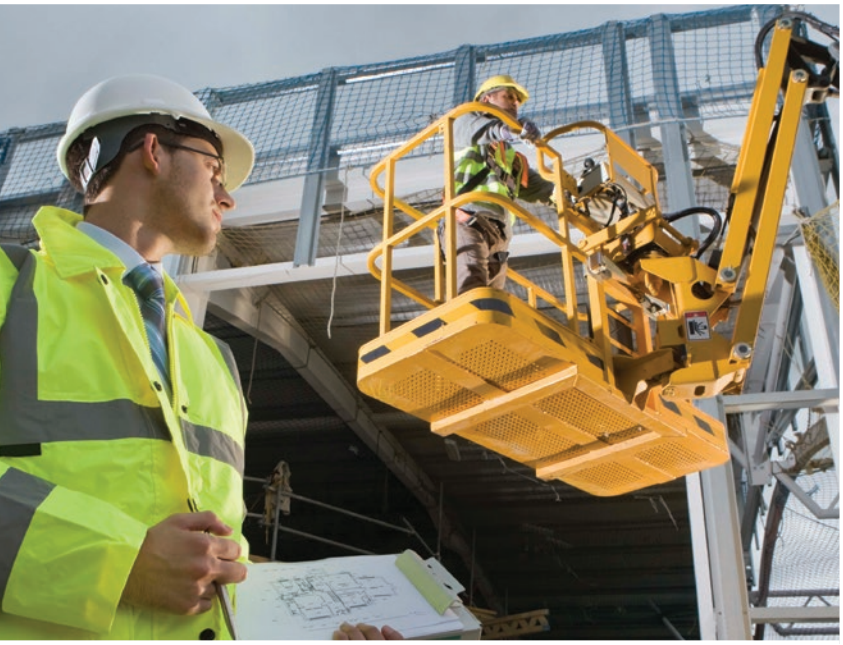
NRC has been providing a competitive advantage to the Canadian construction industry for over 65 years, particularly at the SME level. Our new programs will continue in this tradition. Builders have always been an important focus for us and we are proud to work with you, our valued stakeholders, offering you our impartial expertise and experience. As a world-class research and technology organization, we have strengthened our links with industry and we will continue to work with CHBA and help provide solutions to the challenges you face.

On behalf of NRC, I wish to thank you for your continued support and collaboration.

Morad Atif,
General Manager

New NRC Construction programs

NRC recently launched four research and technology programs to support industry's specific technical and innovation needs for residential and commercial buildings as well as urban infrastructure. Through collaborative research projects and technical services to clients and partners, these programs will support industry—from manufacturers, to designers, owners, builders and regulatory authorities—in performance validation, reduction of operating and code compliance costs, and accelerated commercialization of products, systems and services.



Building Regulations for Market Access

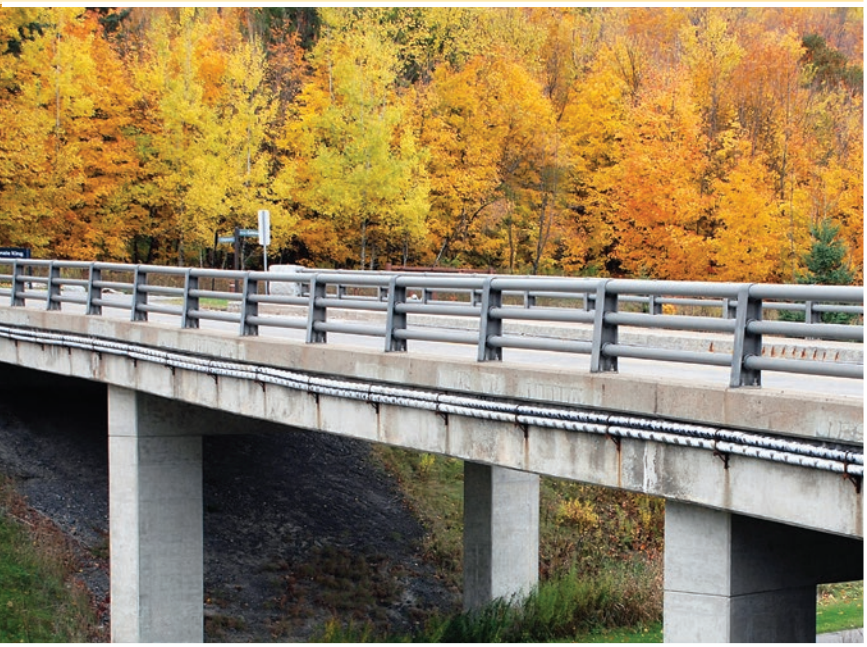
This program will help partners and clients develop and establish building regulations, alternative and perfomance-based technical solutions, and standards to help them reduce their risks and compliance costs, as well as accelerate commercialization of new building designs and products. The initial focus is on technologies that improve energy efficiency, wind and rain protection, indoor air and noise control.

High Performance Buildings

This program will support building owners and the industry at large in developing, validating and commercializing energy-saving, cost-effective retrofit technologies for commercial and institutional buildings. Many of these solutions and technologies are readily applicable or can be adjusted to residential buildings. The work entails: development, validation, and demonstration of reliable technologies for automated and integrated controls for lighting, heating, ventilating, air conditioning and occupancy; high-insulation building envelope systems with integrated photovoltaics; and platforms that enable building energy systems to interact with the Smart Grids.

Mid-Rise Wood Buildings

This program will assist industry in developing wood-based and other building products and assemblies for the 5 to12 storey building market. The program will address fire safety, structural sufficiency, acoustics, and building envelope performance for two types of building assemblies: site-built, lightweight frame assemblies for 5 and 6 storey buildings, and pre-fabricated massive timber assemblies for 7 to 12 storey buildings.



Critical Concrete Infrastructure

This program will assist infrastructure owners in developing, validating and applying high-performance, concrete-based materials and technologies to reduce rehabilitation costs of concrete infrastructure—especially high-way bridges—and extend their service life and shock resistance.

As technical needs and market opportunities evolve, we will continue to explore and develop future programs that will adapt to emerging industry needs.

Research

Performance, durability and integration of VIPs in Canadian construction

NRC has been collaborating with industry partners to help them with feasibility studies on long-term performance and durability of vacuum insulation panels (VIPs) in the extreme Canadian climate. Early experimentation results from VIP systems installed in actual buildings show very high insulating performance after multiple years of extreme weather exposure.

As part of this collaborative project, we undertook laboratory studies to support our clients with VIP material characterizations, performance evaluation of alternative core materials, and new quality control procedures through accelerated aging tests.

Through these experiments, we will establish reliable criteria for selecting materials for VIPs and develop appropriate construction details for proper installation. The ultimate goal of this project is to help industry partners develop the technical base to accelerate the integration of VIPs in the Canadian construction market, which in turn will improve its potential for energy efficiency in housing and buildings.

Information

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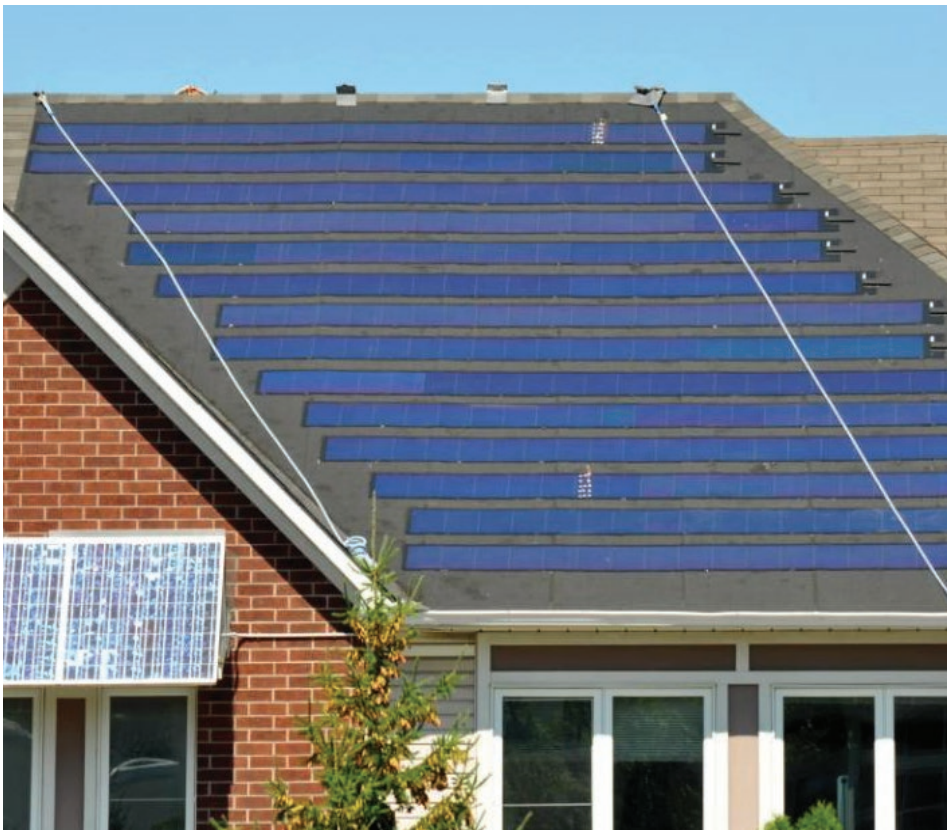
Effect of enhanced insulation on wall performance in houses

In partnership with Canada Mortgage and Housing Corporation, Natural Resources Canada and industry, NRC has undertaken a collaborative project to determine the effect of various building envelope retrofit strategies on the overall performance of conventional wood-frame walls. Specifically, we are determining the moisture and thermal performance of wood-frame walls by incorporating progressively greater levels of insulation, and then comparing subsequent energy use under each system. The findings will also help in making trade-offs between operating costs, potential and unintended moisture performance concerns, and thermal performance.

The first set of these collaborative projects was initiated in June 2013 when researchers monitored a set of three retrofit strategies installed in NRC's state-of-the-art Field Exposure of Walls Facility. Each strategy consisted of three wall specimens, and each specimen consisted of a different type of insulation. One specimen contained Expanded Polystyrene Foam: EPS – RSI 0.70 (R4), 25.4 mm (1"). The second contained Extruded Polystyrene Foam: XPS – RSI 1.76 (R10), 50 mm (2"). The third contained mineral fibre insulation: RSI 2.11 (R12), 75 mm (3"). These insulation sheathing materials were placed on the exterior of an existing conventional wood-frame wall 38 mm by 140 mm (2"x6") having a nominal thermal resistance of RSI 3.52 (R20). The specimens were exposed to Ottawa climate conditions, whereas on the interior of the facility, conditions were maintained at 20°C and 50% relative humidity.



We will investigate the response of the various retrofit walls to different outdoor and indoor conditions, as may be found in the different climatic regions of Canada, using NRC's hygrothermal model, hygIRC-C. We will assess the moisture and thermal performance of these wall assemblies, and determine the relative reductions in energy use achieved using the different retrofit strategies. As a result, we will provide our partners with recommended systems based on climatic conditions and other parameters.

The insulation levels we will investigate include a baseline wall assembly—the minimum 2011 National Energy Code for Buildings (RSI 3.27 – 4.13)—and walls designed according to the new R-2000 thermal performance levels (RSI 7.04 – 7.92). We will compare the heat, air and moisture response of these retrofit wall systems with those of the baseline.

We will share the results with partners to facilitate the adoption of high-performance residential wood-frame wall systems (EnerGuide for Houses rating system EGH 83 and 86), and to support building authorities and industry with regulations, policies and best practices on energy performance and durability of highly insulated wood-frame walls in houses.

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Roof-integrated photovoltaics

The performance of a roof-integrated photovoltaic (RIPV) is a product of the panel surface area, the system efficiency, and the insolation (solar radiation that is received at the earth's surface). The system efficiency is influenced by all components, from the solar cell to the inverter. Solar insolation depends on location and weather patterns.

In the ever growing grid-connected photovoltaic (PV) market, inverter technology has become a central component, in addition to cell and module efficiency.

Inverter technology is a critical component in overcoming the hurdles of the attachment pattern of the PV arrays, shading and other materials obscuring sun-collecting surfaces, electrically mismatched modules, wiring losses, and high cell temperatures. Addressing some of these concerns, micro- or module-level inverters are emerging as an alternative to central or string inverters.

With industry, NRC is conducting a collaborative research project on the energy potential of RIPV's new generation micro-inverters on steep slope roofing applications. Specifically, we will evaluate the energy generation of these micro-inverters and compare their performance with that of the string inverter, with emphasis on the shading and weather exposure impacts on the power generating capacity of the RIPV.

Apart from evaluating the energy performance of the RIPV systems, we are also looking into the interaction performance of the PV system with the roofing system in terms of heat and moisture performance. Results of the preliminary assessment are the first step in helping our industry part-ners pave the way to opening up markets for a new generation of PV products by identifying and overcoming technical barriers to the adoption of these technologies in Canadian climates.

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Research

Pollutant transfer from attached garages

Concentrations of some health-relevant pollutants can be higher in homes with attached garages, compared to homes where the garage is a separate structure. Pollutant transfer from an attached garage into living spaces may be due to several factors. For example, it may be a construction issue such as poor quality assurance procedures during building and retrofitting. It could also be due to occupant behaviour such as disabling self-closing doors between the house and garage, or operating gas-powered equipment or a vehicle inside the garage.

In response to this issue, NRC, in partnership with Health Canada, is conducting a joint field study in the National Capital Region to assess the effectiveness of different methods to reduce the transfer of pollutants from attached garages into adjoining living spaces. We are exploring the feasibility of a number of solutions such as the installation of exhaust fans in the garage and/or improving the airtightness of the common wall or ceiling element between the garage and the dwelling.

The results of this project will directly benefit builders and homeowners, while providing information to committees responsible for the National Building Code.

Information

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Evaluation of indoor air quality technologies and solutions

NRC is conducting a multi-year study to evaluate the performance of several technologies and solutions intended to improve indoor air quality in an energy-efficient manner. This project is part of the Government of Canada's Clean Air Regulatory Agenda. As a first phase, we are developing test protocols necessary for objective evaluation and performance comparison. To this end, we are assessing three technologies: indoor passive panels, portable air cleaners, and in-duct filtration.

In-duct filtration systems are air-cleaning devices housed in air ducts or air handling units of commercial buildings. Indoor passive panels are used as building materials but have the ability to remove volatile organic compounds in the indoor environment. Portable air cleaners, while used to remove localised air pollution sources in residences, have not been evaluated in the context of their long-term performance.

We are carrying out this project with the assistance of a technical advisory committee comprised of representatives from industry associations, federal and provincial agencies, non-government organisations, municipal governments, and standards development organizations.

Reports and related papers are available at: **www.nrc-cnrc.gc.ca/eng/reports/2013_2014/clean_air_regulatory_agenda.html**

Information

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Chemical emissions from building materials

NRC is helping the construction industry and authorities evaluate, characterize and mitigate chemical emissions from building materials and consumer products.

In 2012, we evaluated more than 50 building materials for potential major sources of indoor pollutants such as formaldehyde, acetaldehyde and acrolein under different temperature, humidity, and ventilation rates. We have developed the capacity, as well as reliable methods, to rapidly screen off-gassing chemicals from building components like wood flooring, wall paint and thermal insulation. These methods have been used successfully to detect odorous compounds from bio-based plastic materials at various temperatures.

Using this material emissions data, we have undertaken collaborative projects to support Health Canada's development of a Canadian health-based emissions standard.

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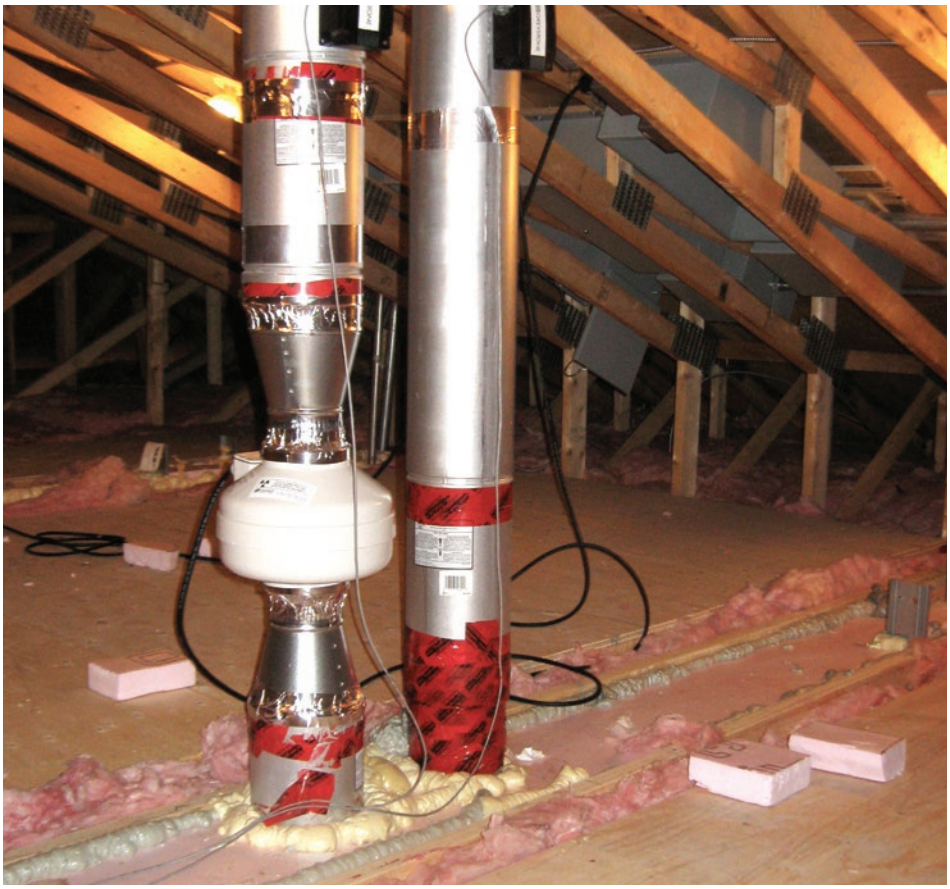
Resistance of building materials to mould

Mould growth in residential construction remains an important issue for builders and homeowners. NRC is working with industry clients to assess and improve the effectiveness of various technologies applied to materials that provide resistance to mould growth.

NRC is helping our partners develop improved, more realistic methods for evaluating the mould resistance of various building materials.



Traditionally, assessment for mould resistance is performed under constant temperature and humidity but this may not be representative of the dynamic conditions in building elements such as wall cavities. In the next series of tests, researchers will evaluate the resistance of building materials under varying dynamic conditions of temperature and humidity representative of residential indoor environments. Further industry participation is welcome.

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Reducing radon in homes

Recent scientific research performed by Health Canada's Radiation Protection Bureau estimates that approximately 3000 lung cancer deaths annually in Canada could be linked to exposure to radon indoors. About seven percent of Canadian homes have radon levels above Health Canada's guideline concentration, according to a nationwide survey.

As a result, NRC and Health Canada have undertaken a multi-year laboratory study to develop practical and cost-effective solutions to minimize health risks from radioactive soil gases and to provide guidance for prevention and mitigation of problems.

In the next three years, we will deliver findings to support answers to the following key questions commonly asked by Canadian builders or homeowners:

- Will radon discharged from mitigation exhaust fans re-enter neighbouring buildings? This aspect is especially important for densely built developments where outdoor air intakes, windows and doors are often found close to discharged air.
- To what degree can improved membranes and concrete assemblies —featuring reduced permeability for radon—reduce radon concentrations in basements or first floors?
- Will a fan, triggered by indoor radon and air pressure differences, reduce indoor radon concentrations in basements or first floors and save energy at the same time?
- Will the negative pressure created by a radon depressurization fan increase the risk of backdrafting from combustion appliances in the basement, and of pollutants migrating from an attached garage?

We will jointly release the results in the form of practical cost-effective solutions and guidance for builders and homeowners, and in reports to national code committees.

Information

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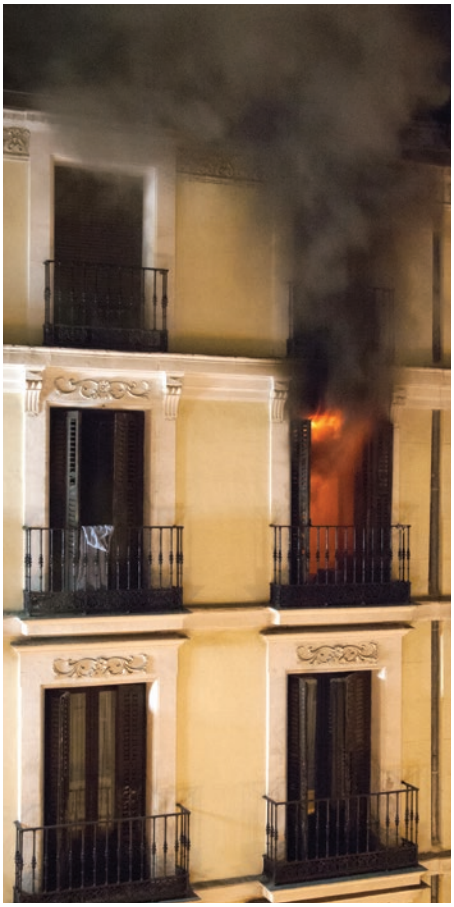

Characteristics of fires in multi-suite residential dwellings

With industry and municipal partners, NRC conducted a collaborative project to determine the characteristics of residential fires and typical combustible furnishings. Started in 2006, the initial project focused on fires that can occur in apartments, semi-detached houses, duplexes, row houses, secondary suites and residential care facilities, as these can have a great impact on adjacent suites.

The results from these extensive fire tests show that fire development and severity vary depending on the type of residential building, and differences in combustible content characteristics, ventilation, and geometric dimensions of the living spaces.

Flashover, a phenomenon that results in a fire becoming a conflagration, generally occurred in less than five minutes from ignition. In highly combustible furnishings—such as sofas and beds—it occurred in as little as 140 seconds, and was associated with a strong flame. Following flashover, the potential for a fire to cause damage and fatalities in adjacent rooms and suites is greatly increased. Temperatures as high as 1100°C to 1200°C were recorded, occurring shortly after flashover and lasting for up to 30 minutes. The peak temperature and its duration are key measures of fire severity.

Primary bedrooms resulted in the most severe fire conditions since they contained the greatest amount of combustible materials, such as mattresses, clothing and carpeting.

Designers and code authorities can draw on this huge volume of data to get a better understanding of the behaviour and impact of fires on various aspects of a dwelling. The results provide quantitative information on combustible contents in residential dwellings, rates of fire growth, and duration of the heat-intense period of a fire. Researchers also identified features of multi-suite fires for computation modeling to simulate such fires and to support better designs and fire prevention measures.

The results of the project will be documented in three research reports that will be published once finalized.

Information

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Mid-Rise Wood Buildings

NRC is collaborating with the Canadian Wood Council and FPInnovations, and partnering with Natural Resources Canada and the governments of Ontario, Quebec and British Columbia, to develop technical data to facilitate the use of wood-based structural products in mid-rise buildings. This research has focused on developing solutions to meet building code objectives in key areas, including fire safety, acoustical quality, and building envelope performance. Most of the experimental work has been completed and data is being analyzed. A series of reports are expected to be published in 2014.

Information

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CCMC at 25 — looking back, moving forward

NRC's Canadian Construction Materials Centre (CCMC) celebrated its 25th anniversary in 2013. It marked a quarter century of success in facilitating the commercialization of building products and systems through evaluation services in sup- port of regulatory compliance across Canada.

CCMC has performed over 1850 evaluations for over 250 manufacturers. There are now almost 550 products contained in the CCMC Registry.

CCMC evaluates construction products and systems for compliance with National Building Code (NBC) requirements and with provincial and territorial regulations. These evaluations enable manufacturers to gain quicker market access for their new and innovative products. They also provide builders, designers and regulatory authorities with a technical basis to specify and use these products in construction projects.

CCMC has also facilitated the introduction of Canadian building products and systems in export markets.

Through collaborative projects with industry firms and agencies, NRC will generate greater opportunities for manufacturers to develop innovative building products for energy efficiency, noise control, fire safety, indoor air quality, cladding systems and roofing technology. CCMC will support market access on these technical issues, especially in evaluating inno- vative approaches to achieving ener- gy targets of the National Energy Code for Buildings and recent ener- gy requirements incorporated into Part 9 of the NBC.

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CCMC 25

National Model Construction Codes

At its annual general meeting in spring 2013, mid-way through the current five-year code development cycle, the Canadian Commission on Building and Fire Codes (CCBFC) reviewed the work plans of its standing committees. Some new tasks were added (review of fire safety glazing standards, review of sheet steel cladding standards) and the scope of two existing tasks was expanded (spatial separation for houses, low permeance materials in the building envelope).

In fall 2013, the CCBFC began the process of renewing its own membership and that of its standing committees for the next code cycle. Chairs were appointed for each standing committee and a call was issued for volunteers to serve as standing committee members. The effective date for the chair appointments is September 1, 2014. The CCBFC also began seeking candidates to serve as Chair of the Commission itself.

The annual public review of the National Model Construction Codes took place between October 15 and December 23, 2013. Several of the proposed changes up for review have implications for Part 9 – Housing and Small Buildings in the National Building Code (NBC). The standing committee will review public comments on these changes in spring 2014 and process the changes —after considering all comments—for publication in the 2015 edition of the NBC. The following highlights describe progress on some of this work.

Airborne sound transmission

Among the proposed changes is one that addresses a new sound transmission metric—Apparent Sound Transmission Class (ASTC). ASTC is a truer measure of the actual sound level perceived by occupants, as it includes flanking noise (transmitted through the junctions of walls, ceilings and floors). The control of flanking noise is complex, requiring careful attention to detail around those junctions. Only direct sound transmission is currently addressed in the NBC.

The proposed change involves moving the sound and fire resistance ratings currently in the Appendix into the main part of the NBC, given that the assemblies in the tables are referenced as acceptable solutions in Parts 5 and 9. Parts 5 and 9 now provide for three compliance options: to measure the ASTC directly; to use prescriptive requirements based on selecting acceptable constructions in the existing tables; or to use a new calculation option. To support the use of this new calculation, NRC Construction has published an **explanatory design guide**.

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Exterior insulation and finish systems

There are currently no prescriptive requirements for exterior insulation and finish systems (EIFS) in Part 9 of the NBC, and the only compliance route for EIFS as a cladding system is through building envelope design conforming to Part 5. To address this limitation, proposed changes were developed for both Parts 5 and 9. For Part 9, the proposed changes introduce requirements that reference three new standards issued by Underwriters' Laboratories of Canada (ULC)—ULC S716.1, S716.2 and S716.3—dealing with EIFS materials, installation and design. Some limitations are proposed to ensure that rainscreen EIFS installed according to the ULC standards comply with performance requirements in high-moisture regions. EIFS that comply with the proposed Part 9 requirements will not require professional design services.

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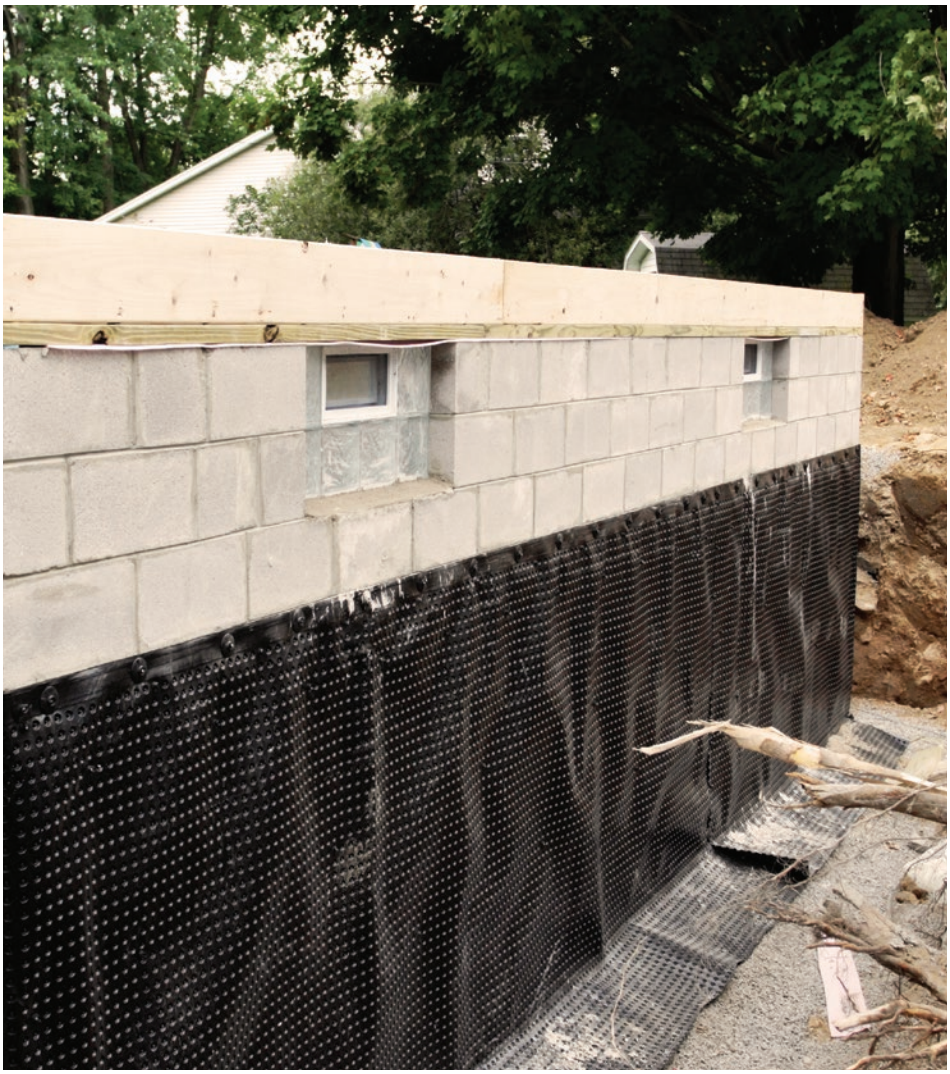

Roofing, dampproofing and waterproofing standards

The public review considered proposed changes relating to roofing, dampproofing and waterproofing standards referenced in the 2010 NBC. One change calls for deleting all dampproofing and waterproofing installation standards in Parts 5 and 9 of the NBC in favour of some key installation requirements now located in Part 9, for example requiring that materials be installed according to manufacturer instructions.

Other proposals call for clarifying what a 'roof' is, as opposed to 'roofing' and 'flashing', and adding more detail and consistency regarding the performance expected from roofs and how to demonstrate compliance.

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Low lead in Canadian plumbing fittings

The CCBFC has considered a request to integrate low-lead content requirements for products addressed in the National Plumbing Code of Canada 2010 (NPC). The CCBFC's Standing Committee on Building and Plumbing Services has a keen interest in maintaining harmonized solutions across North America.

In December 2012, a new edition of the ASME/CSA standard for plumbing supply fittings was published. It requires the same low levels of lead content as that required for U.S. products. At the same time, the CSA also published a new edition of a standard that addresses plumbing fittings, which is in line with the same low-lead content requirements. The standing committee reviewed the updated plumbing fittings standards and recommended updating the versions currently referenced in the NPC 2010 to reflect the most current editions. As a result, and subject to approval by the CCBFC, these updates were published as interim changes to the NPC 2010 at the end of 2013. As with all model code changes, it will be up to provincial and territorial regulatory authorities to consider when and how to adopt such changes into law.

The interim changes can be viewed on the national codes website on the **Second Revisions and Errata to Codes now available** page.

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National Model Construction Codes

Water-use efficiency

The fall 2013 public review provided an opportunity to comment on proposed changes to add water-use efficiency requirements to the National Plumbing Code of Canada 2015. The changes include adding a new objective, functional statements and mandatory requirements for water-use reduction features in all buildings—regardless of water source. These proposals are in line with similar requirements currently implemented in some Canadian jurisdictions, as well as water-conserving and water-efficient products already on the market.

The new objective addresses 'excessive use of water' under the NBC's Environment objective. A two-phase approach was selected to develop the technical requirements. Phase 1 involved developing mandatory requirements for water closets, urinals, shower heads and faucets, and submitting them to public review. These included, for example, setting a maximum water flow rate of 7.6 litres per minute for shower heads and a maximum water usage of 1.9 litres per flush for urinals. Although not specifically addressed, most current dual flush toilets comply with the requirements, and current market direction indicates that all dual flush toilets will comply by the time the regulations are in place in provincial/territorial jurisdictions. Composting toilets were not included, as they do not form part of the regulated plumbing system.

Phase 2, which has begun, includes developing mandatory and enabling requirements to deal with more complex issues such as rainwater harvesting and condensate recovery systems. These may affect future editions of the National Building and National Plumbing Codes.

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Stairs, ramps, handrails and guards

A large set of proposed changes submitted for public review in fall 2013 concerned new and outstanding issues related to NBC requirements for stairs, ramps, handrails and guards. Over 40 proposed changes involving stairs serving public and private spaces were submitted to resolve inconsistencies between Parts 3 and 9 of the NBC, as well as inconsistencies in terminology. Many changes increase design choices for stairs while maintaining user safety.

The changes also deal with ergonomic handrail and guard requirements, and clarify the required width and height of stairs, ramps and their landings. One key highlight likely to be well received is a proposal to specifically allow ornamentally designed guardrails in homes and other buildings.

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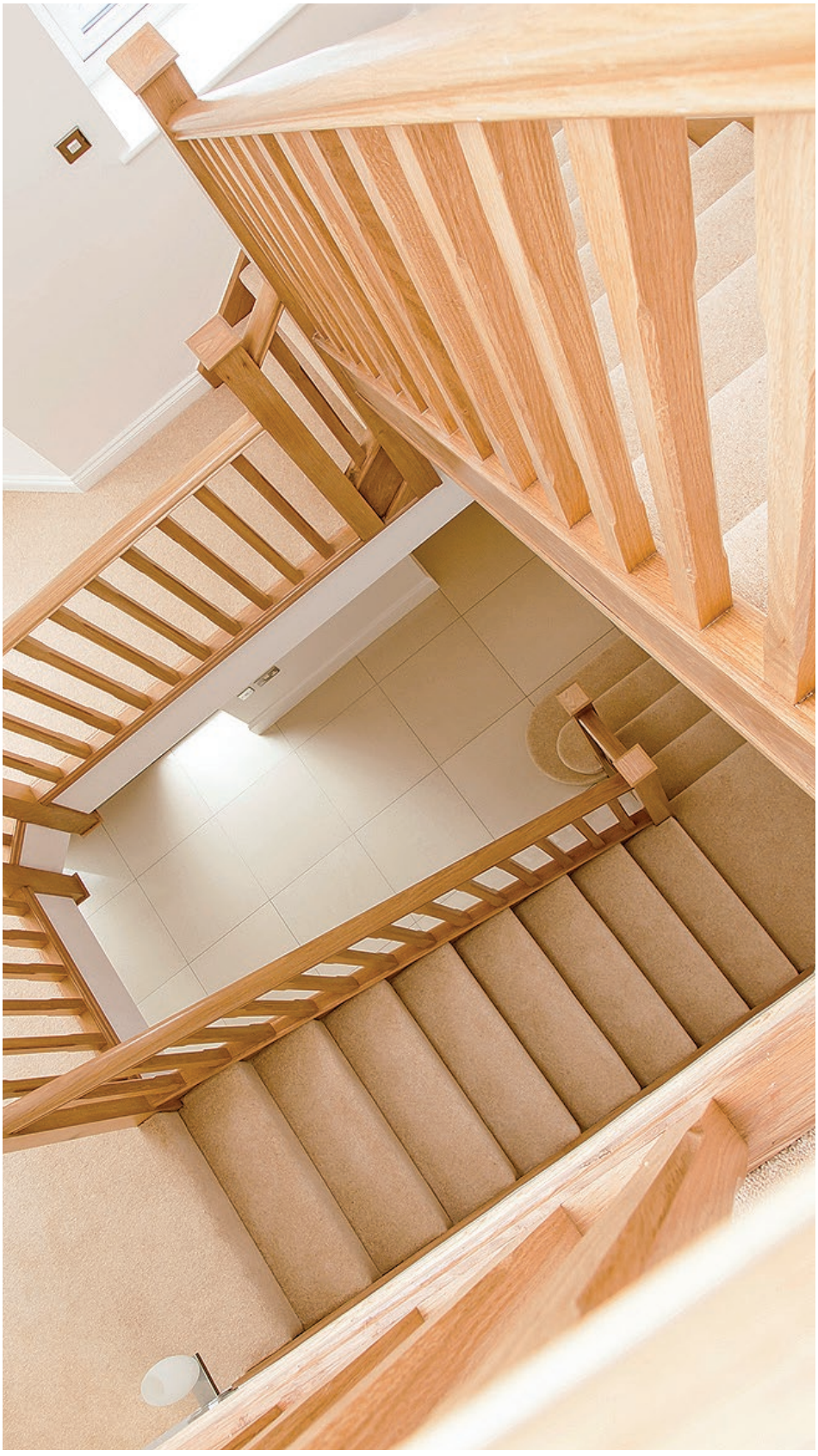
Step dimensions

The CCBFC Joint Task Group on Step Dimensions completed its examination of current tread and riser dimensions inside dwelling units. Their aim was to determine if changing the rise/run step dimensions would reduce the incidences of falls and injuries. A number of studies and reports were reviewed, as were data on hospitalizations, injuries and deaths on stairs, including the dimension of stairs that were actually resulting in falls. Based on this information and the costs associated with introducing new stair dimensions, the joint task group recommended increasing the run dimension of stairs within dwelling units, while leaving the rise dimension untouched. This change would bring Canadian regulations more in line with those of other jurisdictions. It is an acceptable solution that will improve safety while keeping increases in construction costs reasonable.

The recommendation was unanimously accepted by the CCBFC's Standing Committees on Housing and Small Buildings and on Use and Egress and submitted to the CCBFC Executive Committee in January 2014. The executive committee has recommended that the CCBFC approve this work plan item. If approved, a proposed change to Part 9 is expected to be developed and ready for public review in fall 2014.



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National Model Construction Codes

Referenced standards

The National Model Construction Codes reference hundreds of standards issued by Canadian standards development organizations (SDOs) and others. Referencing such standards is an efficient way to tap into the best available technical expertise and the latest technologies, while keeping the page count of the code documents to a reasonable minimum.

Members of the CCBFC's Standing Committees and staff within NRC's Canadian Codes Centre serve on many standards development committees. Despite this vital link, it is difficult to keep the lists of standards referenced in the National Model Construction Codes up-to-date because standards development activities do not usually coincide with code cycles.

Consequently, it has been normal practice for the CCBFC to make a formal request to the various SDOs to identify revised or new standards, as well as standards they no longer support. The request for updates to editions of standards referenced in the 2010 codes is expected to be issued early in 2014. Updates received by the Canadian Codes Centre within the specified deadlines will be included in the 2015 edition of the codes.

Adding a reference in the National Model Construction Codes to a standard not currently cited, however, is considered a technical revision and must therefore undergo the normal technical revision process. This includes a technical review by the responsible standing committees and the submission of proposed changes for public review. Only proposed changes that have already gone through this process can be included in the 2015 codes; others will have to be considered for subsequent editions.

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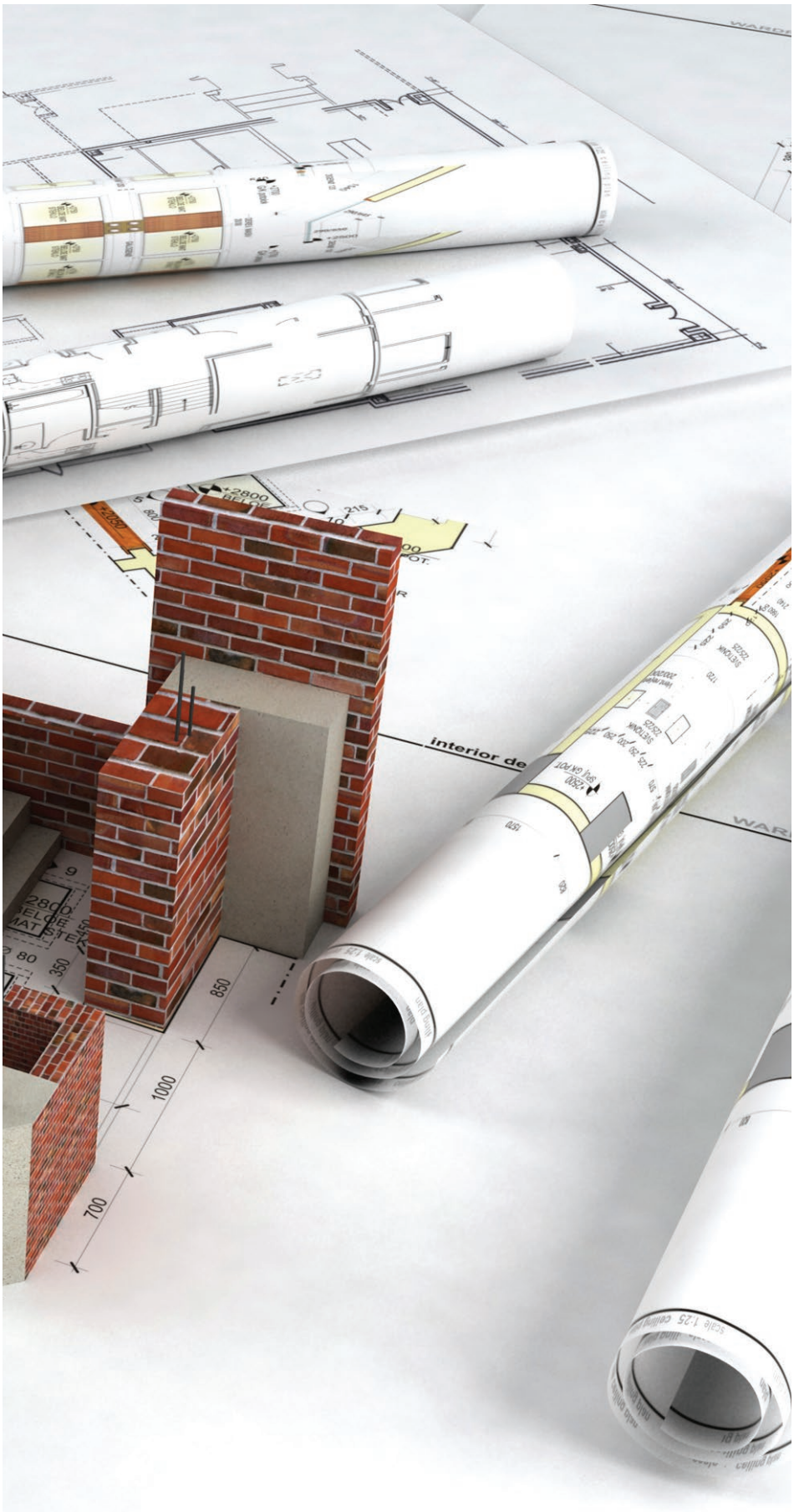

Illustrated User's Guide to Part 9 of the NBC 2010

The new Illustrated User's Guide – NBC 2010 Part 9 Housing and Small Buildings is scheduled for release in spring 2014. It combines two earlier publications, the National Housing Code of Canada 1998 and Illustrated Guide and the User's Guide – NBC 1995 Housing and Small Buildings (Part 9), into one comprehensive document. It features new material on energy efficiency requirements for housing and small buildings as well as updates to match the provisions in the NBC 2010. Its organization matches the format used in Part 9 of the NBC.

Builders will find this guide especially helpful, as it provides guidance for each Part 9 article and describes various compliance approaches, including examples and supporting formulas. Although it is not a how-to guide for home construction, relevant code information is cross-referenced and, in some cases, statistical sources are provided.

The guide will also benefit building and fire officials, who are often called on to explain or interpret the NBC's minimum requirements or determine their application to specific project conditions. Because the guide illustrates important principles of minimum ac-cepted practice, trainers and educators will find it an essential reference tool for students wishing to learn what the code requires for the design and construction of housing and small buildings.

Information

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Canadian Centre for Housing Technology

The Canadian Centre for Housing Technology (CCHT) is a partnership between the NRC, Natural Resources Canada (NRCan), and Canada Mortgage and Housing Corporation (CMHC). CCHT features a twin R-2000 house facility. A third building, the InfoCentre, includes a display area and an office space. It also contains the FlexHouse —a townhouse designed to adapt to an occupant's changing needs. Since 1999, CCHT researchers have assessed over 60 housing-related technologies, ranging from compact fluorescent light bulbs and high performance windows to natural gas-fired combined heat and power technologies and solar energy systems.

Highlights of CCHT projects during 2013 include:

FlexHouse renovation

In early 2013, renovations were made to improve some accessibility features of this demonstration house, and new themes and decor were incorporated to better highlight the rationale and function of modern FlexHousing™ design. In the process, spaces were customized for new energy-efficient appliances installed for the Smart Power System project (described in the next paragraph). The updated FlexHousing™ facility has been featured in tours of the Centre since the renovation, and has also served as a demonstration site for a number of experiments on energy management for houses. These renovations were funded by CMHC.

Smart power system with advanced energy storage

This project, which began in 2011 with funding from the Clean Energy Fund, has continued to be funded in the experimental and demonstration phase by the Program of Energy Research & Development (PERD). It explores the integration issues of energy power systems—including power generation, storage, and energy management —to minimize the energy consumption and peak power requirements. The FlexHousing™ demonstration unit at CCHT provides the test-bed.

As part of this effort, modifications to the CCHT FlexHouse were sufficiently completed in 2013 to initiate a program of experiments and demonstrations. The experimental team made use of a new low-power wireless control system and an adaptive load management circuit panel. This enables wireless communication between a central energy management system and the technologies that were recently installed, including light switches, controllable power outlets and appliances.

The energy management system was used to first simulate a variety of realistic occupant-driven scenarios of lighting and appliance usage to develop base case electrical load profiles. The same energy management system was then programmed to explore how those electrical loads could be shifted off-peak and reduced to optimize the electrical power requirements associated with operating the FlexHouse. Project partners include NRC, NRCan, Defence Research and Development Canada and Electrovaya Inc.

Cold climate air-source heat pump

Researchers evaluated the performance of a central air-source heat pump designed specifically for use in cold climate applications. This innovative heat pump was compared to a standard condensing gas furnace (94% measured efficiency). Researchers were specifically interested in how the heat pump performed in very cold weather, and how much energy the backup heat source uses in these very cold conditions. Performance curves were developed for the heat pump for temperatures down to -20°C during the winter of 2012–13. Coefficients of Performance (COPs) of 1.5 and higher were obtained under these cold conditions, when regular air source heat pumps would operate with back-up electric resistance heating only (i.e., at COP of 1).

To develop a full understanding of the heating performance of this cold-weather technology, the unit was also operated during several weeks in spring 2013 to establish shoulder season performance. Further experiments were performed in summer 2012 to establish performance characteristics under realistic air-conditioning loads. Funding for this project was provided by NRCan and CMHC. Jeremy Sager of NRCan presented

findings to the CHBA technical research committee on 20 May 2013. A final report is **available upon request**.

High velocity, two-zone combination space and water heating system

A packaged combination system consisting of a tankless water heater and matched two-zone integrated high velocity air handler was installed to supply both water heating and space heating/cooling through two-zone high velocity ductwork. The two-zone ductwork divided the supply ductwork of the upper floor of the house from the main and basement floors. The system was installed in two configurations: one made use of a buffer storage tank for domestic hot water supply and a second configuration made use of an indirect storage tank for domestic hot water supply and space heat supply.

In 2013, a number of experiments were planned and executed for this technology at the CCHT twin houses to investigate the system's performance under winter and summer conditions. The project examined the energy performance and temperature control in various zones of the house using the two different configurations and zone control strategies, comparing these against each other as well as against the standard condensing gas furnace and gas storage water heater. The results were used to inform the manufacturer of the integrated performance of each combination under realistic operating conditions.

The potential for the system to reduce summer peak loads was also specifically examined. A final report has been completed for the winter experiments and is **available upon request**. The report for the summer testing is underway and will be available on request when completed. Project partners include NRCan, NRC and Airmax/Flowmax Technologies.

Motorless counter-flow heat recovery air exchanger

NRC is evaluating the energy efficiency of furnace-fan-generated (FFG) counter-flow air exchangers with heat recovery capabilities. Unlike traditional heat recovery ventilators, FFG-based systems use the furnace fan to circulate air through the heat exchanger. An FFG-based system has been connected to the existing CCHT forced air heating system and the furnace circulation fan runs continually as per regular CCHT circulation fan operation. Researchers will investigate the overall house energy performance associated with the incorporation of the FFG-based system compared to a conventional heat recovery ventilator in both winter (2013–14) and summer (2014) conditions. Project partners are NRC and Hoyme Manufacturing Inc.

For more information on CCHT, consult the website at **http://www.ccht-cctr.gc.ca**.

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NRC Construction resources for home builders

Publication Sales Number:

1-800-672-7990 (inside Canada)
1-613-993-2463 (Ottawa-Gatineau and outside Canada)

Website information

NRC Construction has an **extensive website** with a wealth of information on our programs and collaborative opportunities, technical and advisory services, and on our research facilities.

Construction Innovation

Published three times per year, **Construction Innovation** is available free of charge on the NRC website. It provides information of new initiatives, recent research results, product evaluations and code developments to Canada's construction practitioners.

Construction Technology Updates

Construction Technology Updates are a series of short publications that provide current, practical information for builders.

Articles in construction-related magazines

NRC Construction contributes a regular building science column to Canadian Home Builder magazine. During 2013, NRC Construction articles were also published in several other trade magazines including Solplan Review and the Ontario Building Officials Association Journal.