

Housing research summary for 2017

The NRC shares solutions
with industry partners





Table of Contents

A message from the Director General	1
Professional commitment	2
Managing client relationships _____	2
Health	4
Chemical emissions from building materials _____	4
Balanced ventilation and its IAQ impact _____	5
Passively measuring formaldehyde emissions _____	5
Passively measuring long-term ventilation rates _____	6
Radon control in Canadian homes _____	6
Testing the removal of formaldehyde by wall and ceiling panels _____	7
Climate change	8
Climate-Resilient Buildings and Core Public Infrastructure initiative _____	8
Updating code climatic data and loads _____	9
Improving the durability of building systems and materials _____	9
Protecting homes from wildland fire _____	10
Improving flood resilience _____	10
Preventing overheating _____	11
Thermal and hygrothermal performance of highly insulated and zero-energy ready wall assemblies _____	11

Energy	12
Air ventilation systems for Arctic housing	12
Balanced ventilation effectiveness and IAQ impacts	13
CCHT Evaluation of Dual Core HRV and ERV systems	13
Canadian Centre for Housing Technology Activities	14
Update on new CCHT facilities	14
Testing combination space and water heating systems	14
Innovative building materials	16
A holistic approach to next-generation residential roofs	16
Update on CCMC product evaluations	17
New CCMC Evaluations	18
Magnesium oxide boards advisory	18
Codes Canada	20
Status of new Illustrated User's Guide to Part 9	21
Interim changes to the National Energy Code for Buildings (NECB)	21
Status of the small building validation project	22
Updates planned to farm building requirements	23
Encapsulated mass timber construction	23
Information on changes to the 2015 Codes	24
On-site seminars	24
Video presentations	24
Handbook	25
Long-term strategy for energy code development	25
Update on materials containing asbestos	26
Joint task force to study home-type care occupancies	26



A message from the Director General

The Government of Canada is committed to building a strong, prosperous Canada by supporting innovations that respond to an aging population, a changing climate, and new understanding of the health impacts of our building materials. The National Research Council of Canada (NRC) has long been a leader in high-performing, accessible building technologies and materials, and is working to help the construction industry apply this expertise.

A clean environment and a strong economy go hand-in-hand. The Government's Pan-Canadian Framework on Clean Growth and Climate Change outlines actions to grow the economy while reducing GHG emissions and making Canada more resilient to climate change. The NRC is supporting Canada's climate and energy targets with a number of research projects in this area.

Energy costs are on the rise. Now more than ever, homeowners and builders are looking for the latest energy-efficient technologies to offset rising costs without sacrificing performance. The NRC has a number of projects underway to develop and

validate energy-efficient technologies to make life a little easier across Canada, from East to West, from Ottawa to the Arctic.

At the National Research Council, much of our focus is on researching and validating technologies. But to truly deliver whole-house solutions, we also focus on developing and evaluating innovative building materials. Canadian companies come to us with their innovative solutions and we help prove their performance and code-compliance to get these products into the hands of builders and homeowners. The NRC's expertise in the latest materials and systems will help ensure their safe application.

The NRC's Codes Canada plays a vital role in building regulations by providing technical and administrative support to the Canadian Commission on Building and Fire Codes (CCBFC) and its related committees, which are responsible for the development of Codes Canada publications. Along with the CCBFC, our partners include the provincial and territorial governments and municipalities. Together, we are committed to a science-based, open and unbiased code development system.

I am proud to deliver this year's Housing Report, in which you'll read about how our broad expertise, attention to the needs of industry and regulatory authorities, and to the Canadian public is contributing to a stronger, cleaner, and greener future for Canada.

► **Richard Tremblay**
Director General of the
Construction Research Centre
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Canada



Professional commitment

Managing client relationships

The National Research Council of Canada (NRC) is the Government of Canada's premier research organization supporting industrial innovation, the advancement of knowledge and technology development, and fulfilling government mandates. At the NRC's Construction Research Centre, our diverse research facilities, expertise, and customized technical advice make us an important innovator in the construction, transportation, energy, and automotive industries.

We have business advisors available to help advise you on the range of support available at the NRC for your projects from acoustics to building envelope, fire safety, human factors and indoor environment issues. We approach your projects with integrated expertise in materials science, building engineering and performance evaluation to examine whole-building effects.

Work with us if you're interested in:

- › advancing Canadian building regulations
- › compliance assessments, allowing for commercializing more innovative building products
- › improving and harmonizing building regulations
- › collaborating on strategic research projects to help de-risk your innovative ideas
- › reducing your start-up costs and accelerating your commercial development timelines
- › accessing the NRC's facilities and experts to advance your innovations.



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Health

The Government of Canada is committed to building a strong, healthy Canada by supporting health innovations that respond to an aging population, a changing climate, and new understanding on the health impacts of our building materials. The National Research Council of Canada (NRC) has long been a leader in building emissions testing, radon research, and indoor air quality. In this section, you'll learn about our advancements to make Canadian homes and buildings healthier.

Chemical emissions from building materials

The NRC partnered with Health Canada to study the impact of construction materials on indoor air quality (IAQ) in homes newly built in accordance with the CSA O160 approach "Formaldehyde Emissions Standard for Composite Wood Panels."

Composite wood products and paints were collected during the construction of two single-detached homes by a local builder and applied at the NRC's Canadian Centre for Housing Technology (CCHT) facility. Fourteen-day emissions tests were

completed for these products and IAQ measurements were conducted in each home after construction.

The results showed that IAQ levels can be predicted within a factor of 2 of the measured levels for aldehydes, including formaldehyde, and Texanol which are typically emitted from composite wood products and paints, respectively. With this modeling approach, the main contributors were able to be identified for each chemical found indoors.

The study demonstrates the benefit of emissions testing and subsequent modeling in accordance with CSA O160.



Sampling set-up for IAQ and ventilation measurements in a newly-built home

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Balanced ventilation and its IAQ impact

Beginning in 2016, NRC researchers undertook a two-year project at the Canadian Centre of Housing Technology twin test houses to assess the potential indoor air quality (IAQ) benefits of a balanced ventilation system. The project compared the whole-building pressure, IAQ and ventilation performance of a balanced energy recovery ventilation (ERV) system against an exhaust-only ventilation system.

Testing and analysis were done during a shoulder season, a heating season, and a cooling season. The shoulder season testing was conducted in the fall of 2016 as a baseline followed by winter testing and data analysis which were completed from the end of 2016 to the beginning of 2017. The cooling season testing was completed in summer 2017 and data analysis is now in progress. The final report will be available in March 2018.

The winter testing results have shown that the house operated with an ERV was under low positive pressure (2-3 Pa) and that the house operated with an exhaust-only system was under a negative pressure (-1 to -4 Pa). The effect of positive pressure on IAQ has shown that relevant IAQ pollutants were significantly reduced in the house operated with a balanced ERV system. Concentrations of formaldehyde were reduced by 12% (partial mixing) and by 43% (no mixing). The concentrations of two volatile organic compounds such as toluene and α -pinene were significantly reduced by 15-35% and 18-44% respectively for tests done with partial mixing and with no mixing. The average weekly saving in space heating and ventilation total energy consumption varied between 4 and 10%.

The project is part of a larger effort to investigate support of ventilation and IAQ credit for better performing ventilation systems, and to find the best combination of technology to achieve the best IAQ, low energy and high value ventilation solutions.

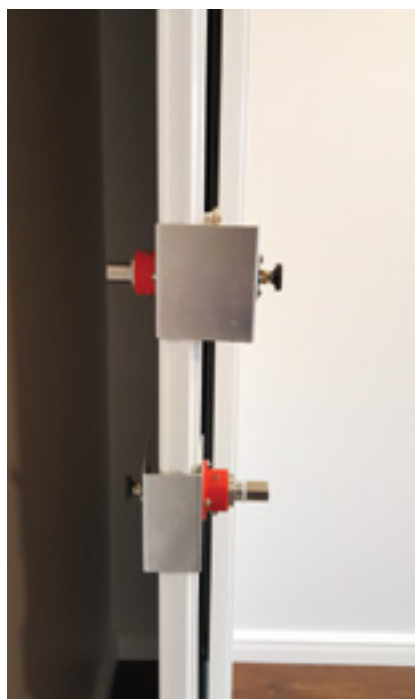
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Passively measuring formaldehyde emissions



Passive flux sampler on both sides of a closet door

Formaldehyde is one of the most recognizable indoor air pollutants owing to its telltale pungent odour. It is found in many products and is carcinogenic at high concentrations. The major source of formaldehyde indoors is composite wood products. Various laboratory methods exist to measure formaldehyde emissions from these products but, because of their complexity, they are not suitable for use in homes and buildings.

The NRC aimed to create a practical tool for measuring formaldehyde emissions in buildings by developing a passive flux sampler. This sampler can detect formaldehyde emissions from existing indoor surfaces like floors, desks, shelves, and doors.

Among five different designs tested in 2016, the design that produced emission rates comparable to those of a conventional chamber test method (e.g., ASTM D 5116) was selected for further evaluation in an NRC research house. The formaldehyde emission rates measured in the house were used to predict the indoor formaldehyde level, which showed good agreement with the measured IAQ.

Although limited to one field trial, it has been proven that the newly developed passive flux sampler is a practical and convenient technique to identify formaldehyde sources in existing buildings.

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Passively measuring long-term ventilation rates



Perfluorinated tracer gas passive emitters and samplers

Of interest to builders and building officials, the NRC is developing a way to measure long-term ventilation rates that is less costly and more convenient. Long-term ventilation information is essential for understanding indoor air quality (IAQ) and energy conservation. However, there are currently no Canadian laboratories that offer a measurement service in actual buildings.

The new measurement technique developed at the NRC in 2016 was evaluated in 2017 against conventional methods in the Canadian Centre for Housing Technology (CCHT) twin test houses and in newly constructed homes. In addition to showing comparable ventilation results to those of conventional methods, the technique demonstrated an additional advantage of measuring volatile organic compounds (VOCs) simultaneously with ventilation rates.

Further validation work is planned in 2018 for a field study involving approximately 60 residential homes.

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Radon control in Canadian homes

Since 2011, the NRC and Health Canada have been working on a study to develop safe, cost-effective solutions to minimize the health risks of radon gas exposure in Canadian homes. The study is part of the Government of Canada's National Radon Program to provide guidance for radon prevention and mitigation.

The intent of the multi-year study is to:

- › support the Canadian Commission on Building and Fire Codes Standing Committee on Housing and Small Buildings to address proposed changes to Part 9 of the NBC;
- › provide input on updating and adopting guides as standards, such as the Canadian General Standards Board (CGSB) for Radon Mitigation in Residential Buildings; and
- › help verified technologies and products get market access for the benefit of Canadian health.



Sample Switch in the Radon Infiltration Building Envelope Test System



Spray Foam Sample for the Radon Diffusion Test



Radon Diffusion Test Chamber

In response to requests from Canadian regulators, manufacturers, builders, and homeowners, the NRC has been conducting projects in Canadian homes to answer the following key question:

- 1) *Can full-size passive radon stacks control radon in the habitable space, maintain negative pressure in sub-slab areas, and create sufficient chimney effect in the stacks in Canadian homes?*

Since December 2014, British Columbia's provincial building code for Zone 1 radon-prone areas has required the installation of a full-size vertical passive radon stack extending upwards through the building and terminating above the roofline. In 2014 and 2015, the NBC Standing Committee on Housing and Small Buildings received two code change requests to include such stacks in the NBC.

To help the Standing Committee address the code change request, the NRC's radon research team is undertaking a field study of extended passive radon stacks in 5 homes in the National Capital Region. The outcomes from the field study, combined with two years of lab work in the Canadian Centre for Housing Technology and the Indoor Air Research Laboratory at the NRC, will help

determine the efficiency of these stacks for radon control. The study will further facilitate development of a passive radon stack practice guide for builders and contractors and ultimately assist the NBC Standing Committee to address the code change requests.

2) Which spray foam products can be used as a sub-slab air barrier to prevent radon entry?

The NRC has developed a “Technical Guide for Medium Density (MD) Spray Polyurethane Foam Insulation (SPUF) for Soil Gas (Radon) Control beneath Concrete Slabs-on-Ground.” Two SPUF products have been evaluated following this technical guide using the Radon Infiltration Building Envelope Test System (RIBETS) and the Radon Diffusion Test Chambers (RDTC), resulting in the successful evaluation and listing of both products by the Canadian Construction Materials Centre (CCMC), thereby helping the product gain market access.

3) Can any other materials be used as a sub-slab “radon barrier”?

The NRC’s radon research team has also evaluated the effectiveness of a foam insulation board for radon prevention using the RDTC.

4) Can a heat recovery ventilator (HRV) be used to control the indoor radon level?

Measurements were conducted in a house in Ottawa in summer 2017, and positive results were observed.

In May 2017, the NRC joined The Take Action on Radon (TAoR) team to launch Radon Action Month to improve public awareness of radon. The team also published

“Combating Radon with Scientific Research” in *Construction Canada Magazine*.

Additional reading:

[Combating radon with scientific research](#)

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Testing the removal of formaldehyde by wall and ceiling panels

Formaldehyde is volatile and potentially harmful to human health at elevated concentrations. To reduce indoor airborne formaldehyde, manufacturers have developed passive air-cleaning technologies in the form of wallboards, wallpapers, floorings, and acoustic tiles. These panels mainly act on sorptive or chemical mechanisms and claim to trap or destroy airborne pollutants, including formaldehyde, to improve indoor air quality (IAQ).

The NRC has developed a way to scientifically evaluate the performance of passive panels by testing them in the most authentic conditions, using chambers that range in size up to

31 m³. Tests will be expanded to field studies in order to fully understand the efficiency under realistic conditions.

The research will provide sound knowledge and evaluated remediation solutions for homeowners, builders, retrofitters and manufacturers to ensure that the indoor panels reduce formaldehyde concentrations in real-life conditions and follow Health Canada guidelines.

It is anticipated that selecting low-emitting building materials in combination with the appropriate use of passive panels will protect occupants against harmful concentrations of formaldehyde and provide healthier indoor environments in residential buildings in Canada.

Additional reading:

Read the article, [Passively measuring formaldehyde emissions](#), on page 5 of this publication.

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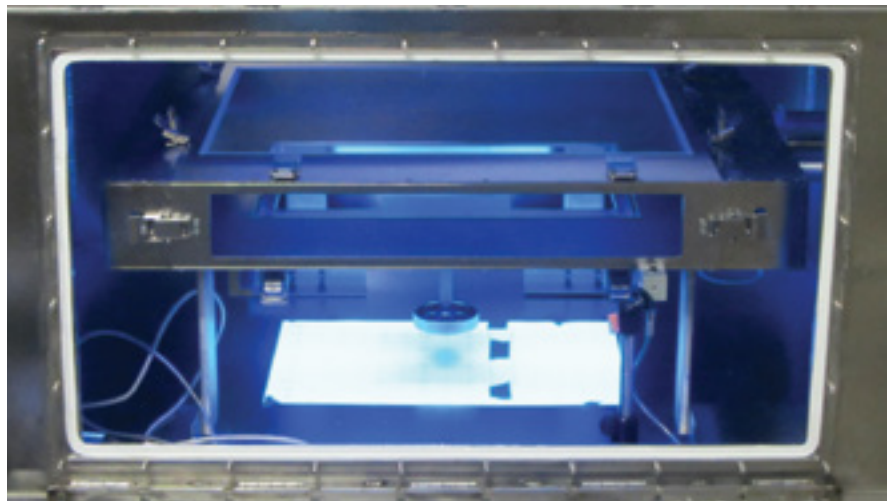
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Testing chamber



Climate change

A clean environment and a strong economy go hand-in-hand. The Government's Pan-Canadian Framework on Clean Growth and Climate Change outlines actions to grow the economy while reducing GHG emissions and making Canada more resilient to climate change. The NRC is supporting Canada's climate and energy targets with a number of research projects. In this section, you'll read about how our innovative experts are contributing to a cleaner, greener future for Canada.

Climate-Resilient Buildings and Core Public Infrastructure initiative

Canada's climate is changing, and climate model projections suggest that greenhouse gas emissions will influence the climate for decades. Canada's buildings and core public infrastructure systems, like bridges, roads, water and wastewater systems, and transit, are designed based on historical data. They are not designed to accommodate our changing climatic conditions and extreme weather events. As such, there is a growing risk of building and infrastructure failure.

The Government of Canada invested \$40 million over five years in the National Research Council to integrate climate resilience into building and infrastructure design guides, standards, and codes. The project began in 2016 to revise codes, guides and decision support tools by 2021 for residential, institutional, commercial and industrial buildings, as well as highway bridges, roads, water, wastewater and transit assets.

For residential construction, solutions will be developed to adapt new and existing homes to help mitigate the impacts of climate change as it relates to events such as urban wildfires like

those experienced in Fort McMurray in 2016 and floods seen in Calgary in 2013, and in Montreal, Ottawa and Gatineau in 2017. Improved design methods will also be developed to account for the new climatic load values (snow, wind, rain, ice) using projected climate values over the next 10, 50, 75 and 100 years. Guides integrating climate resilience into the design and rehabilitation of buildings and public infrastructure are expected to be ready for use by 2021.

Work is currently underway and several projects are described on the following pages.

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Updating code climatic data and loads

Current codes and standards for building design reference climatic data based on historical observations and based on the assumption that the climate is stationary.

Under the reality of a changing climate, the NRC's five-year climate change project will propose updates to the climatic data and related loads in national model codes, including the National Building Code, National Energy Code for Buildings, the Canadian Highway Bridge Design Code, and related standards. The work will consider the design impacts of anticipated climate change trends such as temperature, snow, rain, ice and wind, and will address extreme weather events like tornadoes and hurricanes. In doing so, the NRC plans to address:

- › the design of new resilient buildings and core public infrastructure;
- › the rehabilitation of existing buildings and core public infrastructure; and
- › the safety, maintenance, and durability of buildings and infrastructure in the face of climate change.

Proposed code changes and provisions will be prepared to address climate resilience for consideration by the Canadian Commission on Building and Fire Codes for the 2025 code cycle. New guidelines will also be developed for the retrofit of existing buildings and core public infrastructure.

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Improving the durability of building systems and materials

While the NRC works to ensure the durability of buildings in a changing climate, we must also ensure that performance is as expected; for example, the changing energy performance of insulation under different temperature conditions.

We are examining the hygrothermal performance of wall assemblies and the development of guidelines for the retrofit of existing building envelopes. Work has also begun, in conjunction with the roofing industry, to develop guidelines for commissioning and certifying in-situ roof resilience to extreme wind loads and to develop roofing guidelines for extreme weather conditions.

The NRC is also working closely with standards organizations to update standards and guidelines including: the CSA series of Canadian Fenestration Standards (CSA/CSA A440); the CSA S478 Guideline on Durability in Buildings; ULC Exterior Insulation and Finish Systems EIFS (S700A-01); and ULC Air Barriers (S700B-01).

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Protecting homes from wildland fire

Over the last decade in Canada, there has been an average of 7,084 wildland fires each year, involving 2.72 million hectares of wildland area. Between 1980 and 2007, there were 547 evacuations involving over 200,000 people due to wildland fire events. Approximately 90,000 people were evacuated during the 2016 Fort McMurray disaster alone. The estimated insured loss from this event alone is approximately \$3.8 billion (source: [FACTS of the Property and Casualty Insurance Industry in Canada 2017](#), Insurance Bureau of Canada 2017).

Wildfire urban interface incidents are likely to become more severe. The NRC is working on many initiatives to support a national effort to mitigate the risk posed by these incidents, particularly considering the increased frequency of these events as a result of climate change.

Work is underway to develop a national wildfire urban interface guide for Canada with complementary tools to facilitate use of recommendations in the guide. This will include the development of new protocols or improvements to existing protocols for modelling these incidents and testing construction components to assess their resilience to wildland urban interface fires.

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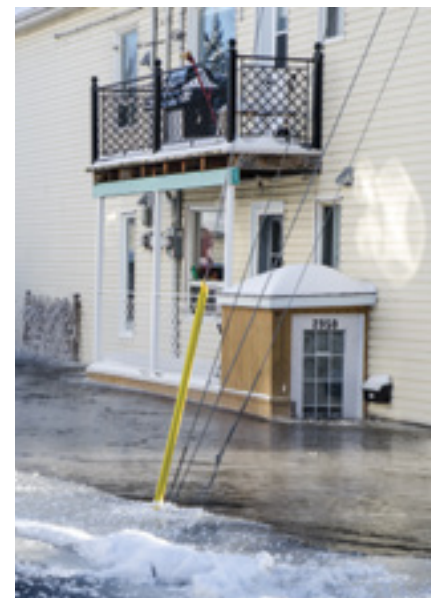
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Improving flood resilience

In July 2017, the NRC brought over 70 Canadian stakeholders and international experts together to discuss how to improve the resilience of buildings to flooding. The outcomes from the workshop are being used to generate a plan for codes and guidelines to address the flooding resilience of Canadian buildings.

A focused task group is being put in place to guide the development of code provisions and guidelines, supported by research in key areas such as performance-based design and ice jamming. Priority activities have been identified to address design criteria around flooding at a national level, including requirements for the design of buildings to resist or adapt to flood-related loads. The task group will also develop requirements for the design of building materials and systems to resist damage from flooding and required data sets to assess flash flooding in urban and fast-responding areas. Additionally, the NRC is funding the development of a new CSA guideline to protect against, reduce and mitigate the impacts of flooding in basements due to severe weather events.



The Climate-Resilient Buildings and Core Public Infrastructure (CRBCPI) initiative is also funding research at the University of Waterloo to develop two buoyant foundation prototypes for retrofit and new construction applications to demonstrate the concept and feasibility of this novel technology. From this effort, a best practice guide for amphibious foundation technology will be developed for use by municipalities, contractors and individual homeowners wishing to adopt the technology.

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Preventing overheating

In conjunction with Health Canada, the NRC will develop guidelines and potentially a tool to address overheating in buildings. These resources will help building owners and designers implement passive methods like insulation, mass, window choice and shading to prevent overheating of interior spaces during heat waves and power outages, and to ensure the health of high-risk populations.

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Thermal and hygrothermal performance of highly insulated and zero-energy ready wall assemblies



The NRC's Field Exposure of Walls Test Facility (FEWF)

In a Canadian climate, a key component of energy-efficient homes is the highly insulated wall assembly. Over the years, the walls of residential buildings have been constructed using increasingly more insulation.

This poses certain challenges to home builders, as increased insulation can incur changes in overall moisture performance and affect the durability of wall assemblies. Additionally, building code authorities require evidence that highly insulated wall systems do not adversely affect long-term insulation performance in spite of diverse climates. Other concerns included the possible effects of climate change on building design, indicating a growing need for information related to the resilience of wall assemblies for use in high-performance housing and small buildings.

In response to this need, the NRC studied the movement of heat and moisture (hygrothermal performance) through buildings of highly insulated wood frame wall assemblies to determine whether these walls perform as well as or better than requirements for houses in Section 9.36. of the National Building Code or those for buildings in the National Energy Code of Canada for Buildings when subjected to the extremes of the Canadian climate.

The insulated wall assemblies that were tested were those whose thermal performance ranged from RSI 4.8 to RSI 7.9. These wall specimens were installed in a side-by-side test bay of the NRC's Field Exposure of Walls Test Facility where they were instrumented with pressure, temperature, relative humidity, and moisture sensors in various places throughout the bay.

Both experimental and simulation results confirmed that highly insulated assemblies are capable of adequate thermal and hygrothermal performance, ensuring a building's expected longevity. In summary, mineral fiber-based thermal insulation performs better in dry climates (Edmonton, Yellowknife) whereas XPS foam insulation outperforms if used in walls located in humid climates (Vancouver, St. John's).

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Energy

Energy costs are on the rise. Now more than ever, homeowners and builders are looking for the latest energy-efficient technologies to offset rising costs without sacrificing performance. The NRC has a number of projects underway to develop and validate energy-efficient technologies to make life a little easier across Canada, from East to West, from Ottawa to the Arctic.

Air ventilation systems for Arctic housing

Extreme cold in the North can seriously affect the operation and performance of equipment such as ventilation systems in buildings. Currently, the type of ventilation units installed in Canada's North are either single core heat recovery ventilators (HRV) or energy recovery ventilators (ERV). At present, no HRVs or ERVs are designed to meet the rigorous operational requirements of the harsh Northern climate or for overcrowded buildings.

In 2016, the NRC began studying technologies that can overcome problems created by frost formation in heat and energy exchangers, which affect conventional HRVs and ERVs. The aim was to reduce the operating failures of such units, to improve the ventilation in accordance with the National Building Code, and to reduce energy consumption.

An alternative to conventional single core HRVs and ERVs is an air handling unit with a dual core unit designed with two parallel heat exchangers. This alternative uses a controlled damper to periodically direct warm return air from indoors through one core (heat exchanger) while outdoor air gains heat from the other.



Dual core air handling unit with regenerative cyclic dual core heat exchanger

The performance of this innovative technology was then evaluated in the Canadian Centre for Housing Technology (CCHT) in a side-by-side test to compare the overall performance of a house operated with a dual core unit versus a house operated with a conventional single core ERV unit. The dual core technology had higher heat transfer effectiveness providing air at up to 6°C higher than air temperature supplied by the single core ERV unit with no sign of frost problems. Unlike the conventional single core ERV unit, which must spend a few hours defrosting per day, the dual core ERV had significant energy savings at a daily average of 6%.

The project is part of a larger collaboration with industry to:

- › investigate innovative, efficient ventilation solutions for Arctic housing;
- › ensure proper ventilation while lowering energy costs; and
- › find the best ventilation technology to improve the indoor air quality of Northern housing, where 50% of families live in overcrowded housing, and reduce its impact on health in Northern communities.

Additional reading:

Evaluation of the performance of a dual core air handling unit for use in cold climates. Report # A1-009461.1

Experimental comparison of performance between single and dual core energy recovery systems. Report # A1-009461.2

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Balanced ventilation effectiveness and IAQ impacts

In 2015, the NRC began a study at the CCHT twin test houses to demonstrate and quantify the indoor air quality (IAQ) benefits of a balanced ventilation system.

NRC researchers compared the whole-building pressure, IAQ, and ventilation performance of a balanced energy recovery ventilation (ERV) system with that of an exhaust-only ventilation system (continuous exhaust from master bathroom). This phase of the study also examined the whole-house energy performance of the balanced ventilation system versus the exhaust-only scenario.

Winter testing was completed in February 2017 and cooling season testing was completed in August 2017. The report will be available in March 2018.

Additional reading:

Read the article, [Balanced ventilation and its IAQ impacts](#), on page 5 of this publication.

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CCHT Evaluation of Dual Core HRV and ERV systems

As a component of a project first launched in 2016, NRC researchers assessed a dual core energy recovery ventilator (ERV) at the CCHT twin test houses. The overall project goal was to study innovations that can overcome problems with frost formation in the heat/energy exchangers faced by conventional HRVs and ERVs in extreme cold conditions in the North.

The performance of this innovative dual core technology was first evaluated using the NRC's climatic chambers to simulate indoor and outdoor conditions in the North and identified by CSA C439. The lab tests showed very high effectiveness, above 80%, which is 10% higher than the value of other units tested at outdoor temperatures of -25°C. The technology also showed no sign of frost problems even at an outdoor temperature of -35°C and was able to provide continuous supply of outdoor air to the indoor climatic chamber.

The innovative technology tested at the CCHT addresses frost formation concerns by using a control damper to periodically direct warm air (return air from indoors) through one core heat exchanger while outdoor air gains heat from the other core. CCHT testing and data analysis was completed in winter 2016-17 and the report is now available.

Additional reading:

Read the article, [Air ventilation systems for Arctic housing](#), on page 12 of this publication.

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Canadian Centre for Housing Technology Activities



The Canadian Centre for Housing Technology (CCHT) features research houses designed to evaluate the whole-house performance of innovative technologies and control strategies under real-life conditions. The twin test houses at the CCHT offer side-by-side assessment of systems and strategies in an environment that reflects current Canadian housing. The CCHT InfoCentre contains the FlexHousing™ demonstration unit and offers testing opportunities to validate long-term technology performance. The FlexHousing™ demonstration unit is a townhouse designed to enable studies of how space can be adapted to an occupant's changing needs and provide additional facility space for studies on building-integrated photovoltaics and energy management systems. The newly built Net-Zero Test Townhouses and Microgrid Testbed will soon expand the CCHT's capacities by offering testing and validation opportunities for low-energy and microgrid strategies and technologies.

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Update on new CCHT facilities

The CCHT is expanding its facilities with the addition of semi-detached net-zero energy-ready smart homes.

The Net-Zero Energy Test Townhouses offer the multi-unit market unique and flexible opportunities to validate the energy efficiency of low-energy building envelope technologies, such as lighting, heating, cooling, ventilation, energy recovery systems, and smart energy management systems. By validating such technologies, the new facility will help manufacturers increase the market readiness of their products.

The Microgrid Testbed serves as a research platform for the assessment and demonstration of technologies in the areas of renewable energy generation, storage, distribution, and management. The facility has the capacity for district energy and electric distribution to the CCHT research houses independently or as a community. It also serves as an excellent platform for the development of electric vehicle power applications such as vehicle-to-home.

Construction of the facilities is now complete and the facility and experimental systems are being commissioned. The facility will be ready for research projects in summer 2018.

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Testing combination space and water heating systems

More than 17 years ago, Natural Resources Canada led a program to benchmark combination space and water heating systems, known as combo systems. Combo systems offer potential benefits compared to separate furnace/boilers and water heaters, including lower cost, less use of space, and higher efficiency.

The ENERGY STAR for New Homes program requires that combo systems be tested against the CSA P.9-2011 performance standard in order to be eligible as a Builder Option. Currently, this standard applies only to forced-air systems. The combo system tested most recently in the CCHT twin test houses was a pre-packaged system with a CSA P.9-2011 rated thermal performance factor equal to 0.96. It showed an average 7.3% improvement in energy performance over a two-stage 96% AFUE furnace and 0.62 EF water heater that operated separately. The test demonstrated both the ease of installation and the ease in setting up the controls to achieve optimal performance.

The CCHT research team is investigating performance metric relationships that can be applied to other configurations of combo systems to expand ENERGY STAR's scope of eligibility. The project also hopes to show how the CSA standard performance rating relates to real energy savings at the CCHT.

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Innovative building materials

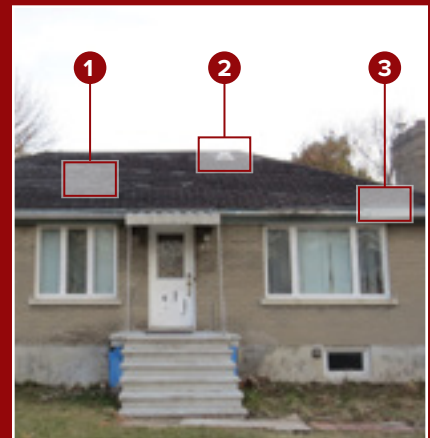
At the National Research Council, much of our focus is on researching and validating technologies. But to truly deliver whole-house solutions, we also focus on developing and evaluating innovative building materials. Canadian companies come to us with their innovative solutions and we help prove their performance and code-compliance to get these products into the hands of builders and homeowners. In this section, you will read about some of the latest materials and systems and how the NRC helps ensure their safe application.

A holistic approach to next-generation residential roofs

The roofs on Canadian homes are subjected to extreme climatic conditions in both winter and summer. Their longevity depends on the intensity of the changing climate and the resistance of the roofing materials to weather the elements.

In response to the concerns of Canadian homeowners, the NRC began a multi-disciplinary project to improve the longevity of roofs in a holistic manner. Homeowners have three common concerns, namely:

- 1) asphalt shingles degrade faster than the manufacturer's warranty since shingles are not evaluated for appropriate Canadian weather conditions, causing granule loss, cracking, blow off, curling, and clawing;



Common observations in Canadian roofs

- 2) condensation on the underside of the wood sheathing leads to mould growth, structural damage and ice damming at the eaves due to ventilation inadequacy; and
- 3) energy loss through the eaves, vents and attics due to poor air seals.



1
Mould growth on the underside of wood sheathing



2
Shingle degradation



3
Ice damming

Part 9 of the National Building Code (NBC 2015) provides material specifications as per CSA A123.5-16 for asphalt shingles made from glass felt and surfaced with mineral granules. The manufacturer warranties (20, 30, and 50-year shingles) are not considered in the CSA A123.5, nor is the durability of the materials. Thus, the labelled roof life expectancy is misleading. Wind uplift requirements in the CSA A123.5 standard omit both the requirement for cold weather performance and the correlation to the climatic data provided by the NBC 2015.

Ventilation requirements in Article 9.19.1.2. of the NBC 2015 indicate that the unobstructed vent area shall not be less than 1/300 of the insulated ceiling area. A minimum of 25% of the vents should be located at the top of the space and a minimum of 25% of the vents should be located at the bottom of the space. Also addressed is the vent's distance from the edges and intersections for the eave protection and underlayment materials to minimize and prevent precipitation ingress and ice damming.

Energy efficiency requirements are specified in Section 9.36. of the NBC 2015, as well as by the National Energy Code of Canada for Buildings (NECB) 2015. Research efforts are in progress to refine specifications for balancing ventilation and thermal performance and to define an effective thermal resistance, accounting for energy losses from flow paths, such as those in wall and roof interfaces.

By considering Canadian home-owners' three most common concerns, this project takes a holistic investigative approach. It is anticipated that this multi-disciplinary R&D project will develop practical strategies and solutions to improve the longevity of Canadian roofs.

► INFORMATION

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Update on CCMC product evaluations



Dynamic wind and wall test facility showing test specimen set-up

All product evaluation reports and listings are contained in the Canadian Construction Materials Centre's (CCMC) Registry of Product Evaluations, indexed to the Masterformat™ system used throughout North America. With this publication, thousands of subscribers have quick access to up-to-date technical and regulatory information on hundreds of evaluated construction materials, products and systems.

CCMC's Mandate

At the request of the provinces and territories, and construction regulators across Canada, the CCMC was created in 1988 to be Canada's official evaluation service for building officials and the construction industry. Formalizing this relationship, a Memorandum of Understanding was signed between the Government of Canada and provincial and territorial governments. Under this agreement, the CCMC was centralized at the National Research Council of Canada which publishes Codes Canada publications and has extensive expertise in construction research.

The CCMC's mandate is to provide a technical opinion that a product or system complies with the requirements of the national model codes, known as Codes Canada publications, as an 'alternative solution,' and to verify that a product conforms to a recognized product or material standard.

As a service under the Government of Canada, the CCMC's due diligence on all evaluations is impartial, neutral and evidence-based to protect the health and safety of Canadians first and foremost. The CCMC applies the same objective, factual and rigorous process on all evaluations and provides an expert, unbiased opinion on code and standard compliance without commercial interest in the products evaluated. Also as a federal service, the CCMC stands behind all of its technical evaluations. See next page for the latest evaluations.

New CCMC Evaluations

14057-L

Resibond GP 475CXX and GP 500CXX Series Resins, Georgia-Pacific Chemicals LLC

14058-L

St-Laurent Hardboard Siding, Fabrication St-Laurent Inc.

14059-L

Thermafiber® UltraBatt™ and Thermafiber® SAFB™ and Fire & Sound Guard™, Thermafiber Inc. / Owens Corning

14060-L

Thermafiber® Safing, FireSpan® 40 and 90, VersaBoard® 35, 40, 60 and 80, and RainBarrier® 45 and HD, Thermafiber Inc. / Owens Corning

14061-L

POWERWOOL RigiBoard™, PowerHouse Products Inc.

14062-L

Comfort-R, Thermal 3Ht and Quik-Therm™, HW Manufacturing Inc.

14063-L

EverGuard® TPO Roofing Products, GAF

14064-L

Icynene ProSeal™ LE, Icynene Inc.

14065-R

SoundSmart, Building Products of Canada Corp.

14066-R

Tyvek® ThermaWrap™ R5.0 - Air Barrier Material, E.I. DuPont Canada Company

14067-R

Wrapsulate® Foam Jacket, Elastochem Specialty Chemicals Inc.

14068-R

Demilec Air Barrier System, Demilec Inc.

14069-R

Metstar Diva, Slate, Shake, Tile, Tile 2 and DaVinci, BAT Group Inc.

14071-R

HomeGuard Titan®, Epak Inc.

14072-R

Wannate PM-200, Wanhua Chemical (America) Co., Ltd.

14073-R

CUFCA RMS, Canadian Urethane Foam Contractors Association

14074-L

WeatherBOND EPDM, WeatherBOND

14076-L

THERMALGREEN and FLORASEAL-200, SOLUTIONS Genyk Inc.

► INFORMATION

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Magnesium oxide boards advisory

The Canadian Construction Materials Centre (CCMC) is aware of premature failures of some magnesium oxide (MgO) boards in other countries. Due to the increased use of MgO boards in Canada, and the CCMC's role supporting Canada's building officials, provinces and territories, and the construction industry, we published a technical advisory on MgO boards. The advisory is for consideration during the product acceptance for building permits in local jurisdictions.

In this advisory, we address two scenarios:

- 1) the use of non-CCMC evaluated MgO boards; and
- 2) the use of CCMC-evaluated MgO boards and the associated applications, conditions and limitations.

When considering non-CCMC evaluated MgO products for approval, please consider the information provided in the advisory or request that the manufacturer obtain a CCMC evaluation report. When using CCMC evaluation reports, it is important that conditions, limitations and application requirements stated in the reports are clearly understood and followed.

Recommended reading:

[CCMC MgO Board Advisory, July 7, 2017](#)

► INFORMATION

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Get to know the newest editions of Codes Canada Publications

Codes Canada experts explain the significant technical changes in the 2015 editions of the National Building, Fire, Plumbing and Energy Codes!

13 ONLINE video presentations covering a wide range of topics

WATCH from the convenience of your own device

LEARN how the Codes are developed and how you can become involved in the process

MASTER the changes that affect your area of expertise or interest



Watch a Codes Seminar video today!
CodesCanada.ca/seminars



Codes Canada

You are the experts.

Codes Canada is driven by a collaborative code development process that relies on the voluntary contributions of construction industry experts as well as the public to ensure that the best available knowledge drives meaningful change. Change that allows construction professionals the confidence to innovate safely, reduce risks and keep compliance cost low by establishing uniform, trusted regulations that keep pace with industry change.

Canada's coordinated code development system relies on input and support from our partners and stakeholders. The NRC's Codes Canada plays a vital role in this process by providing technical and administrative support to the Canadian Commission on Building and Fire Codes (CCBFC) and its related committees, which are responsible for the development of Codes Canada publications. Along with the CCBFC, our partners include the provincial and territorial governments and municipalities.

Together, we are committed to a science-based, open and unbiased code development system.

All stakeholders, including building, fire and plumbing officials, the construction industry and the general public, provide expertise that informs the CCBFC and its committees about issues and new solutions. Together, we ensure that Codes Canada publications are responsive to new technologies, materials, construction practices, research, social policy, and the changing needs of Canadian society.

Codes Canada publications are updated through an open process in which the committees continually deliberate the merit of any future changes. With the 2020 edition of codes in their sight, committees have already started developing proposed changes based on code change requests from stakeholders. The next public review for changes to be included in the 2020 edition of the codes is scheduled for fall 2018. This is an open and continuous process. Code change requests received now will be considered for the 2020-2025 cycle. The process allows anyone who wants to request a change to the codes to do so via the Codes Canada website.

**It's your Code.
Get involved!**

[CodesCanada.ca](https://www.codescanada.ca)

Status of new Illustrated User's Guide to Part 9

A new Illustrated User's Guide: NBC 2015, Part 9 Housing and Small Buildings is scheduled for availability in spring 2018.

The new guide focuses on housing and small buildings. It is intended to make it easier for builders and designers to understand the building code as it applies to them specifically and explains the reasons and scientific background in the Part 9 requirements. The guide is revised to accommodate the changes that occurred in the last building code update. Furthermore, the updated illustrations are more consistent with common architectural drawings so that they can be more easily understood.

The new guide is available for purchase from the [NRC's Virtual Store](https://nrc.gc.ca/virtualstore) in soft cover format.

► INFORMATION

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Interim changes to the National Energy Code for Buildings (NECB)

The National Energy Code of Canada for Buildings 2017 (NECB), published by the NRC and developed by the Canadian Commission on Building and Fire Codes in collaboration with Natural Resources Canada (NRCan), is available for purchase from the NRC's Virtual Store.

The NRC and NRCan are publishing this interim edition of the NECB in response to proposals received that improve the overall energy performance of buildings over the 2015 edition. Modelling for these changes indicates a potential energy efficiency improvement between 10.3 and 14.4% over the NECB 2011.

The NECB 2017 reduces the overall thermal transmittance of roofs, fenestration and doors; reduces losses through thermal bridging in building assemblies; and, reduces the allowable percentage of skylight area. This new edition also introduces more stringent requirements for energy recovery systems and interior and exterior lighting requirements. It requires temperature controls in individual guest rooms in hotels and motels and demand control ventilation systems in commercial kitchens. In Part 4, it clarifies the lighting trade-off path requirements, and in Part 8 it makes performance compliance requirements consistent with prescriptive requirements.

The 2017 edition is an important step toward Canada's goal for new buildings, as presented in the Pan-Canadian Framework, of achieving 'Net Zero Energy Ready (NZER)' buildings by 2030. To further support this goal and facilitate access to the technical requirements for the energy-efficient design and construction of new buildings, NRC is offering free online access to the NECB 2017. Go to nrc.gc.ca/virtualstore for free access to the NECB 2017.

► INFORMATION

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Status of the small building validation project

While initially developing the energy requirements for housing and small buildings (National Building Code, 9.36.), it was difficult to model the performance of small non-residential and large residential buildings because there was no clear archetype of these buildings that fall under Part 9 of the National Building Code (NBC). In 2012, the Standing Committee on Housing and Small Buildings and the Standing Committee on Energy Efficiency in Buildings formed a joint working group to validate the energy performance of small buildings.

A Phase 1 study completed in 2015 identified 2600 buildings that fall under the description of a Part 9 small building. The most significant finding was the large variability in archetypes. The building size varies between 2400-3900 square feet. Approximately 16% of buildings identified are designed by professionals. Small multi-residential condominium/strata and apartment buildings are the most common archetype identified.

The working group is now developing a plan to ensure builders have clear, practical, adequate and appropriate code requirements for small buildings. Phase 2 of the study will identify the characteristics of typical small buildings. Builders are invited to bring their code concerns and suggestions to the working group.

Phase 3 will examine whether specific prescriptive requirements for small buildings are needed in Part 9 and whether they should remain referenced in the National Energy Code for Buildings or relocated to Part 9 of the NBC.



► INFORMATION

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Updates planned to farm building requirements

The National Farm Building Code was last published in 1995 and has not been updated since then. The farming industry has evolved and farming operations have become more complex. This has prompted an update to the provisions related to farm buildings.

Members from several standing committees formed a joint task group to review and update the provisions and examine the risks and hazards related to farm buildings. The requirements applicable to farm buildings would apply to farm buildings with low or no human occupancy. Some of the most significant recommendations of the joint task group include:

- › the introduction of farm building requirements in the National Building Code (NBC) and National Fire Code (NFC);
- › a change to the definition of the term “farm building”;
- › a phased approach to the task beginning with larger farm buildings (buildings greater than 600 m² or 3 storeys), then smaller farm buildings (not exceeding 600 m² or 3 storeys); and
- › a new major occupancy classification (Group G) with four divisions: high-hazard agricultural occupancy, agricultural occupancy not elsewhere classified in Group G, greenhouse agricultural occupancy and agricultural occupancy with no human occupancy.

The joint task group is working towards introducing technical changes in the 2020 editions of the NBC and NFC.

› INFORMATION

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Encapsulated mass timber construction

Wood is an abundant renewable resource in Canada. Developers, architects, engineers, builders and consumers across Canada have a growing interest in the positive environmental attributes and economic potential of wood construction. This interest prompted a proposal to enable the construction of tall wood buildings using Encapsulated Mass Timber Construction (EMTC) in the National Building Code (NBC) and the National Fire Code (NFC).

The Standing Committee on Fire Protection has made progress on drafting provisions to enable EMTC as an additional option for builders. The building height is proposed to be limited to 12 storeys while the building area is proposed to be limited to 6000 m² for Group C major occupancies (residential) and 7200 m² for Group D major occupancies (business and personal services occupancies). Floor assemblies and load-bearing elements in an EMTC building would be required to have a fire-resistance rating of two hours.

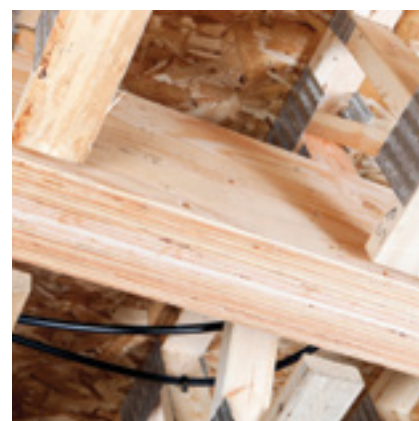
Provided that the provisions make it through the public review process, EMTC will likely be included as a new construction type in the 2020 editions of the NBC and NFC.

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A Codes Canada seminar in St. John's in partnership with CHBA Newfoundland and Training Works (January 31, 2017).

Information on changes to the 2015 Codes

The 2015 editions introduced almost 600 technical changes that made the provisions in the four model codes clearer and easier to apply, while introducing new concepts and expanding the codes to new areas.

The significant technical changes in the 2015 editions are clustered into 13 main areas:

- › Hazardous Materials and Activities – National Fire Code (NFC 2015)
- › Energy – National Energy Code for Buildings (NECB 2015)
- › Accessibility – National Building Code (NBC 2015) Part 3
- › Means of Egress – NBC 2015 Part 3
- › Stairs, Guards and Handrails – NBC 2015 Part 3 and Part 9
- › Seismic Design – NBC 2015 Part 4
- › Structural Design – NBC 2015 Part 4
- › Wind Uplift Resistance and Other Fenestrations – NBC 2015 Part 5
- › Exterior Insulating and Finishing System (EIFS), Airborne Sound Transmission, and Roofing – NBC 2015 Part 5 and Part 9
- › Heating, Ventilation, Air Conditioning (HVAC) and Plumbing – NBC 2015 Part 6 and National Plumbing Code (NPC 2015)
- › Building Envelope and Structure – NBC 2015 Part 9
- › Fire Protection – NBC 2015 Part 3 and Appendix D
- › Mid-rise Combustible Construction – NBC 2015 and NFC 2015

To help Code users understand the extent of these changes and the reasons behind them, Codes Canada has developed a variety of information products. These products are designed to offer flexibility in terms of price, venue and level of interaction.

On-site seminars

The NRC hosts full-day, on-site seminars to communicate the significant technical changes that were introduced in the 2015 code editions and allow participants to ask questions directly to Codes Canada technical advisors. Four technical advisors present 13 presentations on the significant changes and one introductory presentation on the code development system. Participants receive a printed handbook with technical details of the changes in the 2015 Codes. A half-day seminar is also available for clients who want to focus on specific subject areas. The client is responsible for arranging and paying for the logistics, including the venue, registration, marketing, and A/V equipment.

Information on each of the 13 technical presentations and the introductory presentation can be found here at CodesCanada.ca/seminars.

Availability: on-demand

Price: \$15,000 (half-day seminar) or \$25,000 (full-day seminar)

► INFORMATION

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Video presentations

These online presentations are filmed video recordings of each of the 13 technical presentations offered at the on-site codes seminars. The NRC's technical experts explain the significant technical changes that were introduced in the 2015 code editions in an easily accessible format that is more affordable than an on-site seminar.

Available on the NRC's virtual store at nrc.gc.ca/virtualstore

Price: \$25 per presentation with volume discounts available



Handbook

The handbook provides detailed information on the majority of technical changes that were implemented in all four Code publications. It can serve as a stand-alone product or be used to complement information delivered during the on-site and online Code presentations.

Available on the NRC's virtual store at nrc.gc.ca/virtualstore

Price: \$40 per handbook
(PDF or hard copy, volume discounts are available)

Long-term strategy for energy code development

All levels of government and many industry players support higher energy performance requirements in building codes. Through collaboration with partners and stakeholders, the Canadian Commission on Buildings and Fire Codes (CCBFC) is setting the direction of energy codes for new commercial, institutional and residential buildings, including houses.

Canada's premiers and Prime Minister agreed to a [Pan-Canadian Framework on Clean Growth and Climate Change](#). In support of the framework, work is underway to address the energy efficiency of the built environment. Canada's goal for new buildings, as presented in the Pan-Canadian Framework, is "net-zero energy ready" by 2030.



This goal can be reached by reducing energy consumption primarily through superior insulation levels, high-efficiency mechanical systems and minimal air leakage.

Net-zero energy ready buildings are ones that are so efficient that they can easily become net-zero energy buildings, if it makes sense to do so. For example, owners can choose to install on-site renewable energy systems to supply their remaining energy needs, provided that their walls and roof offer enough space and southern orientation.

The Canadian Commission on Building and Fire Codes' (CCBFC) strategy for energy code development proposes a realistic long-term pathway of incremental targets. This approach takes regional differences into account and provides a flexible framework for the provinces and territories while guiding the country as a whole towards the 2030 performance target. While the 2030 goal pertains to new construction only, the Pan-Canadian Framework includes a plan to develop a model energy code for existing buildings by 2022. This will be part of future Codes Canada work.

The long-term strategy not only charts a clear path to more sustainable buildings, it will also help industry plan where to build capacity, such as training contractors and professionals in energy-efficient design and construction practices. It will also help harmonize energy code requirements across Canada.

Additional reading:

[CCBFC Position Paper on a Long-Term Strategy for Developing and Implementing More Ambitious Energy Codes](#), September 14, 2016

Chapter on '[Built Environment](#)' in the '[Complementary actions to reduce emissions](#)' of the Government of Canada's [Pan-Canadian Framework on Clean Growth and Climate Change](#), December 14, 2016

► INFORMATION

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Update on materials containing asbestos

Up until the 1990s, asbestos was used for fireproofing and insulating buildings and homes against cold weather and noise.

It is now well-documented that airborne particulate asbestos can cause adverse health effects on building occupants and those handling asbestos-containing materials during installation, maintenance or demolition. These materials could release particulate asbestos when damaged, cut or drilled.

The Government of Canada recognizes that breathing in asbestos fibres can cause cancer and other diseases, and that the health risks related to asbestos-containing materials are no longer tolerated by the Canadian public.

However, in some situations, the installation of asbestos-containing materials is still permitted as an acceptable solution in the 2015 editions of the National Building Code and the National Plumbing Code. Changes are currently being proposed that would remove all references to asbestos-containing materials as an acceptable solution in code requirements and in appendices. In some cases, the code would explicitly state that asbestos-containing products shall not be used because of the potential risk to the health and safety of building occupants.

► INFORMATION

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Joint task group to study home-type care occupancies



In recent years, there has been a move toward home-type care like group homes, rather than multi-storey institutional-type care.

There is an option in the National Building Code (NBC) that is linked to occupants' ambulatory capabilities for self-preservation; however, changing mobility needs are difficult to address during the construction of a building. For example, as occupants grow older, they may suffer health setbacks and then recover.

To address this growing trend of home-type care occupancies, a joint task group with the Standing Committees on Fire Protection, Use and Egress and Housing and Small Buildings has been established. The task group will explore alternatives for providing affordable and safe care in home-type care occupancies.

These alternatives include enhanced means of egress, fire detection and alarm systems, despite the changing ambulatory conditions of occupants. The recommendations are to be based on the building features that allow occupants to exit, rather than being based on the occupants' ambulatory capabilities.

The recommendations will be available for the 2018 Fall Public Review.

► INFORMATION

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CODES CANADA

► Build on expertise



Illustrated User's Guide to NBC 2015 Part 9 Housing and Small Buildings

- Hundreds of graphics, examples and formulas.
- Updated illustrations that are more consistent with common architectural rendering and more easily understood.
- Helps builders and designers understand the National Building Code 2015 as it applies to them.

Available for purchase from the NRC's Virtual Store

www.nrc.gc.ca/virtualstore