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# Report on the Workshop on Research towards a Performance-Based Building Code

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# 1 Background

On March 9, 2022, the National Research Council of Canada (NRC) conducted a virtual workshop on Research towards a Performance-Based Building Code to support an initiative to evaluate the potential of including a performance-based approach in the National Building Code of Canada (NBC).

The main objectives of the workshop were to:

- Engage stakeholders in evaluating the potential for transitioning the NBC to become a performance-based code (PBC);
- Learn from the experiences of Canadian stakeholders and other jurisdictions on performance-based codes;
- Seek input on the desired structure of a potential future performance-based NBC, and the resource, regulatory and potential research needs to support a future PBC in Canada.

Background material providing an overview of the experiences of other countries with performance-based codes was sent to participants who had accepted NRC's invitation to attend the workshop.

This report provides a record of the event, with summaries of presentations, discussions and results. Plenary discussions related to the presentations and results from the breakout sessions are presented in detail in the Appendices.

# 2 Opening Remarks and Context Setting

## 2.1 Opening Remarks

**Dr. Ahmed Kashef, Director, Fire Safety, NRC Construction Research Centre**

Dr. Kashef framed the workshop as part of a collaborative research project between Natural Resources Canada (NRCan), Treasury Board of Canada Secretariat (TBS) and the NRC, motivated by the growing movement around the world to adopt and enhance existing performance-based codes. He noted that when objective codes were introduced in Canada in 2005, it was envisioned that they would be a transitional step toward PBCs. Recent priorities of the Provincial/Territorial Policy Advisory Committee on Codes (PTPACC) shared for this code cycle include starting to develop a policy discussion paper to help assess the feasibility and approach for possible future inclusion of performance-based codes.

## 2.2 Overview of NRC Research towards a Performance-Based Building Code

**Dr. Alex Bwalya, Senior Research Officer, Fire Safety, NRC Construction Research Centre**

**Jitender Singh, Technical Advisor, Structural Design, NRC**

The presenters offered an overview of the of the work conducted in the NRC project, focusing on the review of the Australian, New Zealand and US (ICCPC) PBCs and a preliminary analysis of the fire and life safety provisions in Part 3 of the NBC. They reviewed the regulatory frameworks, structures and

compliance paths, and reported on lessons learned. Regarding a potential PBC for earthquake design, they suggested that it could be developed by building on the objective-based framework in the National Building Code. In the long-term, the PBC could become the model code and the prescriptive NBC could be referenced as one of the compliance paths (acceptable solutions) allowed by the PBC.

### 2.3 NRCan Performance-Based Framework Survey Results

**Mr. Peter Senez, Principal and President, Senez Consulting**

Mr. Senez presented the results of a national survey commissioned by NRCan to understand the appetite for moving to PBCs. The survey found strong support for moving toward a performance-based framework for the NBC (89%). Key factors identified as important to supporting the transition included clarity of intent and uniform interpretation, defined performance levels/targets, training and resources for the authority having jurisdiction (AHJ). Resources such as a peer review process, published interpretations, and guidelines were also seen as necessary. Expected benefits of PBCs included improved clarity of intent; facilitation of more innovative designs; and support for alterations to existing buildings, energy efficiency and harmonization of building codes in Canada.

### 2.4 Overview of Research on Reimagining the International Code Council Performance Code (ICCPC)

**Dr. Brian Meacham, Managing Principal, Meacham Associates**

Dr. Meacham provided an overview of the effort undertaken by the ICC to reimagine the ICCPC in the US. The overall aim of the work was to consider the current structure of the ICCPC in the context of other performance-based (PB) building codes currently in use around the world, emerging issues and trends, and advancements in PB design, and to obtain input and perspectives from across different stakeholder groups.

A survey and round table discussions found strong agreement that it was possible to develop a robust performance-based building code system, but there was a need for quantification of performance and development of strong linkages to methods of design and verification / compliance. Findings from the stakeholder workshop were summarized and a potential reimagined ICCPC structure was demonstrated. The ICC will review the information collected and determine the next steps in due course.

## 3 Transitioning Towards Performance-Based Codes

To gain an understanding of the challenges and issues associated with implementing performance-based codes, participants moved into four small groups to address a series of specific questions.

### 3.1 Approach to Transitioning the NBC to a Performance-Based Code and Structure

**a) What structure should be used to introduce a performance-based (PB) building code in Canada?**

There was broad support for a gradual transition to a PBC. The PBC could be developed within the existing NBC in the short term, with a move in the longer term to a full PBC. Maintaining a similar structure to the current NBC would facilitate adoption. One group suggested that the PBC could be modeled after the National Energy Code for Buildings (NECB)

There was also agreement that existing prescriptive and alternative solutions compliance paths should remain in the place during the transition. However, a third performance-based compliance path could be added in the full PBC. The transition process could introduce performance-based objectives and criteria to enhance existing acceptable solutions to better quantify performance and understand the associated risks.

Aspects of the New Zealand model were preferred, including placing performance criteria within the code but leaving reference documents external. Regulation at a national level, similar to the practice in Australia and New Zealand, was also seen as important.

One group noted that a PBC would be especially useful for innovative, complex buildings. They said PBCs should only be used for complex buildings, and prescriptive code should be maintained for typical buildings. However, there were some strong concerns that a PBC may place a heavy reliance on the approval process.

Identifying lessons learnt is a priority. Further review of the experience of other countries that have adopted PBCs should be carried out to identify optimal features and challenges in implementation. The Canada Bridge Code, which uses a performance-based approach, and the Steel Design Standard, which allows performance-based options, could also be a useful source of information from within Canada.

**b) Should performance criteria be qualitative or quantitative in a future PB building code? If quantitative, then how should the performance criteria and requirements be developed? Could some of the current acceptable solutions be rationalized and be used as performance requirements?**

There was no consensus on this question. Most participants felt there should be a mix of qualitative and quantitative performance criteria, depending on the performance requirements, with a bar set for establishing quantitative criteria. Appropriate quantitative criteria should reside in the standards, based on qualitative provisions that reside in the code. Another view was to start with qualitative criteria and then enhance them with quantitative criteria, while another group preferred having quantitative criteria from the onset.

There was agreement that quantitative criteria should be verifiable, but there was concern that this may not be feasible for all performance criteria. It was noted that some acceptable solutions may be outdated and perhaps should be re-evaluated.

**c) Which other parts of the NBC should be piloted in this project along with fire and life safety (in Part 3) and earthquake design (in Part 4)?**

There was a mix of responses. Some recommended keeping it simple by starting with fire and life safety, and earthquake but ensure that the framework used for the two is scalable and can be used for

developing PBC requirements for all the other parts of the code eventually. One participant said that the Canadian Wood Council has submitted a code change request for a performance-based approach to the current heights and areas provisions under 3.2.2. of the code and that this is a potential area where PBCs could be targeted. Other parts of the code suggested for piloting included Part 5; Environmental Separation, Part 4 Structural Design, and Part 6 Heating, Ventilation and Air Conditioning, with Part 9 Housing and Small Buildings to be addressed last.

## 3.2 Resource and Regulatory Needs

**a) What resources (e.g., tools, guidelines, etc.) and capacity (e.g., design review, training, etc.) are needed to support the implementation of a PB building code?**

It was noted that many resources for the current NBC are out of date and updated ones are needed that are specific to the various jurisdictions across Canada. Resources are also needed so that problems faced today with alternative solutions do not remain under a PBC framework. Priority should be given to resources addressing areas of greatest risk. Specific resources identified included guidance materials for the transition to a PBC, training materials and opportunities for users of the code, and a common benchmark determined by the acceptable risk established for existing requirements. It was also noted that many design guidance documents are available internationally, but these would have to be adapted for the Canadian context.

In terms of capacity, broad issues include developing competency, trust and confidence in any potential PBC process. Therefore, validated design processes are needed. More qualified building officials would be needed to cope with the demands of a PBC.

**b) Who should be leading the development and delivery of these resources and capacity building activities?**

There was agreement that national leadership is needed to ensure consistency and harmonization. Several organizations were identified, including NRC, the Canadian Commission on Building and Fire Codes, and the Standards Council of Canada.

**c) Would there be a need for a third party expert review as part of the PB code compliance path and if so, should those be certified and if so, by whom?**

There was general agreement that a robust certification process and third-party peer review are critical to the success of a PBC. It was recommended that the procedures in other countries be reviewed and learned from, as should the standards of practice at professional organizations such as engineering societies. It was also suggested that the certification of professional engineers be strengthened and more responsibility be given to the design community so that they sign off on their own designs under PBC, not the AHJ.

There is a need to ensure budgets are available to conduct third-party reviews in times when municipal budgets and staff are limited. Consideration also needs to be given to oversight for the life of the building.

# 4 Identifying Research Needs

Participants were then asked to determine the research needs for both Fire Safety and Earthquake Design that will be required by the transition to performance-based codes.

## 4.1 Fire Safety Research and Development Needs

**a) What tools, methods, data and performance criteria (i.e., for design and performance evaluation) are currently available for implementing a PB building code in Canada? What specific tools, methods, data, and performance criteria from other countries that could be used? If so, what are they?**

Participants identified the following available resources:

**Canada**

- The costs and benefits from impact analysis for the Wild-Land Urban Interface (WUI) fire engineering guide that was developed by NRC (conducted by the Institute for Catastrophic Loss Reduction) could provide valuable insight, along with those associated with implementing other changes.
- Many computer-based design tools are available; however, there is a need to develop protocols to validate their outputs. It was also noted that training was essential to ensure competent usage.
- Insurance and manufacturing data exists but accessing it is the challenge.
- Some data are dated, e.g. spatial separation criteria that is based on research conducted in the 1950s.
- Standards for evaluating non-combustible materials to be adapted for use in a PBC context.

**International**

- Research from Europe (e.g., UK, Norway and Sweden) and Australia
- UK guidelines that could be applied to a PBC
- Models for evaluating performance

It was noted that tools and models available internationally would have to be adapted to the Canadian context. In addition, the capacity of experts to use existing tools properly must be increased.

**b) What are the gaps and research needs and in what areas of Part 3?**

Participants identified numerous gaps and research needs:

- Knowledge of the performance associated with current prescriptive requirements.
- Mass timber:
    - Common standards and requirements for fire testing by different manufacturers;

    - Fire performance of exposed mass timber and connections;
- Long-term impact of suppression systems in mass timber buildings
- Holistic assessments and research on the interactions between fire performance, structural performance and human behaviour.
- An examination of smoke control in current taller and more complex buildings.
- Evaluation of the socioeconomic component of human behaviour concerning fire safety design, especially for residential buildings: Consider the different priorities in the codes of other countries.
- Fire growth and spread on current materials.
- Criteria on spatial separation, standards for evaluation of combustible and non-combustible material.
- Performance of fire walls.
- Applicability of the established code for the current population, e.g., size of exit corridors.
- Effects of climate change and the move towards adaptive reuse of buildings and designing for resilience
- Assess international data to build consensus around quantitative criteria.
- PBD tools and guidelines, especially for complex buildings
- Training on effective use of available design tools

**c) What do you consider as the short-, medium- and longer-term research priorities for fire safety under a PB building code in Canada?**

Short-term priorities identified by participants included further identifying research needs and collecting data necessary for developing a solid and trustworthy approach for the framework. This can be done through modeling and quantifying performance in large- and small-scale testing. The framework and definitions for performance criteria must be developed and quantitative criteria must be defined based on science. Risk tolerance must also be defined and acceptable performance for buildings as a whole established.

A long-term priority would be to develop comprehensive quantitative criteria and design tools to facilitate a PB design approach based on first principals.

**d) For the identified needs, what are your recommendations on how to implement the research agenda (e.g., consortium, etc.)?**

Participants generally agreed on the need to establish a consortium of stakeholders to move the research agenda forward. This would include regulators, academia, consultants and industry. Some thought it should be led by industry because they know the primary implementation issues and would bring these to the forefront. It will be important to ensure the competency of the individuals and groups that will be quantifying performance.

Research should be broadly organized into the following topics: performance criteria, PBC framework, and regulatory process. Existing NRC resources should be promoted and made more accessible (i.e.,

background on how code requirements were developed that helps with comprehension). A national database for fire research results should be created to inform decisions on fire safety design.

## 4.2 Earthquake (EQ) Research and Development Needs

**a) What tools (authoritative documents, design guides, alternative solutions) currently available could be updated to work with a future PB building code in Canada?**

There seems to be many available documents that can be used as a foundation, such as:

- The Canadian Highway Bridge Design Code (CSA S6) uses a performance based design format for earthquake design
- There are many performance based design documents in the United States that we can build on, such as the PEER and LATBSDC Guidelines for PBD; also, ASCE 41, ACI 374. Engineers and Geoscientists of BC (EGBC) has developed a design guide for tall concrete buildings that includes a chapter related to performance based design
- Two research groups within NRC have developed a number of relevant documents; NRC Canadian Construction Materials Centre (CCMC) have developed documents on tall timber buildings, and NRC SRT have done work on a number of related issues.

It was noted that authoritative documents, guides and tools must be coordinated with AHJs to ensure their acceptance.

**b) Which areas in EQ design would benefit the most from the application of PB requirements and development of an ecosystem (authoritative documents, test methods and other compliance paths) to support a future PB building code in Canada?**

Strong support was expressed by a number of participants for using a PBD approach for the evaluation and repair of existing buildings, which has been identified as a high priority by the CCBFC. Prescriptive methods are not well suited for existing Buildings.

NRC has started some work in this area. It was also noted that analysis on ground motion level indicates that Canada is using higher performance levels/criteria compared to other countries such as the US or Japan. Participants recommended looking at functional recovery and the Japanese approach to rapid recovery from EQs, identifying types of risk, moving to a risk-based approach in the future PBC, and addressing issues around irregular, iconic buildings.

**c) In context of a) and b), what are the short-, medium-, and long-term research needs for implementing PB code requirements for EQ design in the PB building code and related material standards?**

Several research needs were identified without timeframes. These included using instrumentation and in-situ testing to better understand how buildings perform, and conducting research for the selection of appropriate ground motion. An understanding of the performance level associated with existing solutions is needed for the development of performance criteria for PBC. Guidelines are needed for non-

structural elements in buildings and structural provisions under Part 4 beyond seismic design should be explored. It was recommended that performance design should be applied to smaller buildings before moving on to more complex ones.

**d) For the needs identified in c) above, what are your recommendations for the next steps to implement the research agenda (e.g., consortium, etc.)?**

Participants recommended establishing a research consortium with industry, academia and government to address the key research areas that can support a PBC. Coordination of research will be critical to avoid duplication and ensure focused research activities. Investment in efforts to ensure the dissemination and implementation of findings was also recommended.

# 5 Closing Remarks

**Dr. Ahmed Kashef, Director, Fire Safety, NRC Construction Research Centre**

- In closing, Dr. Kashef thanked participants for their engagement in the workshop and stated that the valuable information gathered from the workshop will be used to inform the next steps in the future direction of the research toward a performance-based code.

# Appendix A – Workshop Agenda

**Performance-Based Building Code Workshop**

**March 9, 2022**

Virtual Meeting

11:00 **Welcome and Opening Remarks**

Dr. Ahmed Kashef, Director, Fire Safety, NRC Construction Research Centre

11:15 **Agenda and Approach to the Workshop**

Mr. Alain Rabeau, Workshop Facilitator, Intersol Group

11:25 **Overview of NRC Research towards a Performance-Based Building Code**

Dr. Alex Bwalya, Senior Research Officer, Fire Safety, NRC Construction Research Centre

11:50 **NRCan Performance-Based Framework Survey Results**

Mr. Peter Senez, Principal and President, Senez Consulting Ltd.

12:15 **Overview of Research on Reimagining the International Code Council Performance Code (ICCPC)**

Dr. Brian Meacham, Managing Principal, Meacham Associates, USA

12:40 **Break for Lunch**

13:15 **Breakout Preparation / Instructions**

13:30 **Breakout Round 1: Topics 1 and 2**

14:15 **Return to Plenary and Report Out**

14:35 **Break**

14:45 **Breakout Preparation / Instructions**

15:00 **Breakout Round 2: Topics 3 and 4**

15:45 **Return to Plenary and Report Out**

16:15 **Closing Remarks and Next Steps**

Dr. Ahmed Kashef, Director, Fire Safety, NRC Construction Research Centre

# Appendix B – Participant List

Ahmed Kashef – NRCNRC
Alex Bwalya – NRC
Amanda Robbins – NRC
André Laroche – NRC
Farrokh Fazileh - NRC
Fiona Hill – NRC
Hayley Martin - NRC
Jasmine Wang McFadden – NRC
Jitender Singh – NRC
Joseph Su – NRC
Noureddine Benichou - NRC
Reza Fathi-Fazl - NRC
Sefton Hyde-Clarke - NRC

Alain Rabeau - Intersol Group
Eileen Bistrisky – Intersol Group
Ezanne Swanepoel – Intersol Group
Greg Leonard – Intersol Group
Manal Sayid – Intersol Group
Nick Zinck – Intersol Group

Alana MacLellan - Jensen Hughes
Ali Mikael - CWC
Amal Tamim - Jensen Hughes
Andrea McChesney - Canadian Concrete and Masonry Producers Association (CCMPA)
Andrew Coles – Senez Co.
Andrew Harmsworth - GHL Consultants
Andy Metten - Bush, Bohlman & Partners LLP
Ben Coles - RJ Bartlett Engineering Ltd
Bennett Banting - CCMPA
Brian Fraser - Celerity Engineering Limited
Brian Meacham – Meacham Associates, USA
Bruno Cote - Global Affairs Canada
Carlos E. Ventura – University of British Columbia
Christian Dagenais - FPInnovations
Claire Belanger – Régie des bâtiments du Québec
Claire Fréchette - RCMP
Damien Gilles - Leroux+Cyr Inc.
Danielle Krauel - NRCan
Frederic Levesque - Technorm Inc.
Gary Sturgeon - CCMPA
Geoff W Triggs - Evolution Building Science Ltd.
Glenn Somerton -Morrison Hershfield
Helene Dutrisac - DND
Hong Tsui - LMDG
Jane Gachuche - Jensen Hughes
Jarrett Hutchinson – Province of British Columbia
Jeremy Bender - Alliance of Canadian Building Officials' Associations (ACBOA)
Jim Baker - Province of British Columbia
John Gales – York University
John Hackett - Pro-Demnity Insurance Company
John Sherstobitoff - Ausenco Engineering
Julie Tourrilhes - NRCan
Jun'ichi Jensen - Province of British Columbia
Kara Fagnou - City of Saskatoon
Keith Porter - Institute for Catastrophic Loss Reduction (ICLR)
Kelsea Walker - NRCan
Kevin Lau - City of Vancouver
Kevin To - Technorm Inc
Kieran Ager - LMDG
Kyle Duckworth - Jensen Hughes
Leonard Uku - Ontario Ministry of Municipal Affairs and Housing (OMAH)
Lindsay Ranger – Canadian Nuclear Laboratories
Mohammad Mohammad - NRCan
Marc Alam - CWC
Marc Showers - Celerity Engineering
Marcus Raitanen - Victor Insurance
Matt Farrell - ACBOA
Matt Turco - GHL Consultants
Miranda Williamson - NRCan
Modusser Tufail - Strathcona County
Mohamed Semelawy - (OMAH)
Murat Saatcioglu-University of Ottawa
Natalia Barreto - Global Affairs Canada

| | |
|---|---|
| David Lau – Carleton University<br>David Torvi - University of Saskatchewan<br>Denis Mitchell - McGill University<br>Dominic Esposito - Jensen Hughes<br>Dorian Tung - FPInnovations<br>Edmond Lin - City of Burnaby, BC<br>Erol Karacabeyli - FPInnovations<br>Ethan Philion - York University<br>Frank Lohmann – Canadian Home Builders Association<br>Rick Roos - ROCKWOOL<br>Robert Jonkman - CWC<br>Robert Malczyk - Timber Engineering Inc.<br>Robert Tremblay - Ecole Polytechnique<br>Rodney McPhee - CWC | Nathalie Lessard – Régie des bâtiments du Québec<br>Noah Fetterly - CWC<br>Pat Gallagher - Canadian Forces Fire Marshal<br>Perry Adebar – University of British Columbia<br>Pete Campbell - Public Works and Government Services Canada (PWGSC)<br>Peter Senez - Senez Consulting<br>Pierre Dionne - Régie des bâtiments du Québec<br>Reza Mirza Hessabi - MMAH<br>Simon Geraghty - Morrison Hershfield<br>Stefan Germann - Celerity Enigneering Limited<br>Trisha Ashworth - Morrison Hershfield<br>Tuna Onur - Onur Seemann Consulting, Inc.<br>Warren Badley - ACBOA<br>William Loasby - Fast & Epp<br>Y. H. Chui – University of Alberta |

# Appendix C – Plenary Discussions

## Discussion Following Overview of NRC Research towards a Performance-Based Building Code

**Were the Australian cost savings related to reduced costs to build or to reduced regulatory costs?**

- Combining the building and plumbing codes produced savings in terms of efficiencies. The approval process was more efficient and designs were approved more quickly. They shared the link to cost-benefit analysis of the Australian PBC:
  - https://www.abcb.gov.au/sites/default/files/resources/2020//ReportBenefitsbuildingregulationreformTheCIE.pdf
- Follow-up comment: In the last 10 years in Australia, the experiences were not all positive. PBCs added substantial administrative and training costs.
- Links to two relevant papers were shared:
  - https://www.abcb.gov.au/resource/report/bcr-implementation-report-december-2021
  - https://www.abcb.gov.au/resource/report/building-confidence-report-case-intervention

**What additional performance objectives were and should be considered for protecting life safety in PBCs?**

- The codes generally consider life safety and property protection. The US ICCPC has expanded the horizons to include resilience, carbon neutrality, energy efficiency and operational functions such as air quality. There is momentum to look at other societal needs more broadly.

**Regarding fire and life safety, was there analysis regarding the Part 3 section of the code? How many provisions were performance-based?**

- In the breakdown, 75% of provisions were prescriptive, 10% performance-based and the rest were mixed.

**Comment regarding scope creep**

- We may be trying to bite off too much as the scope of this effort expands.

**The earthquake provisions refer to durability. Do those codes have specific requirements related to design life and target service life?**

- Durability is expressed in the same way as other provisions. The New Zealand code says the objective for the duration of the building's life is that it will continue to meet other objectives

and functional requirements. The statements are very general, qualitative expressions. In the IPCC, the statements are again very qualitative. The idea is to keep to objective functional statements and performance requirements at a very high level and lean on the authoritative documents, which could be standards, to define what this actually means.

**Comment regarding the performance-based design code:**

- It could be a living document that could complement the National Model Codes such as in the US and New Zealand. By the end of this workshop, will we be able to clearly identify one way over another.

## Discussion Following NRCan Performance-Based Framework Survey Results

**Will alternative solutions be considered under a PBC?**

- Survey respondents did not want alternative solutions to go away because the performance-based framework is not in place now. There will be a transition to a full PBC.
- SFPE has guidance for to help code officials dealing with PB design reviews:
    - https://higherlogicdownload.s3.amazonaws.com/SFPE/93e7d31c-6432-4991-b440-97a413556197/UploadedImages/Publication_Covers/CR_SFPE_Code_Officials_Guide_PBDR.pdf

**Did you elicit the opinions of the general public? This was done in the US.**

- Implicit risk is being considered in the current Phd study being undertaken by the author of the presentation. The public expectation was originally that we would manage against city-wide conflagrations. That is not really true today. Expectations are now driven in a different context. Safety ties back to the public risk profile. With quantitative risk, you have a tool and context to say something is safe, rather than perceived safety.
- When we did the evaluation of Australia, the perception was that only once a big event happened did the public want more accountability.
- Regarding gravity loading, the general expectation of the public is that things do not fall down. When they do, it makes the news in a dramatic way. Regarding seismic lateral loading, our codes have been safe exit and life safety. Public expects that buildings are earthquake proof. There needs to be a better realization, particularly as building irregularities become more pronounced, that performance of these buildings is not very acceptable. Christchurch quake showed this.
    - Structural safety is obvious. In the fire spectrum, there are different profiles of risk. Historically, we have done a good job confining fire to a suite or floor. The problems of public perception occur when fire spreads well beyond suites. We needed to mitigate against that risk in taller wood frame buildings, which we have done. Public perception is hard to manage and we have not done a good job explaining this.

**What agency or party made the code change request?**

- We have been monitoring what has been happening overseas and the benefits of moving to PBC. There are some parallel efforts related to harmonization of codes across Canada, and we saw this as a good time to introduce the ideas of PBCs and got support from key stakeholders.

**Is "risk" the right term? Is the idea of risk more related to tolerance and perception or is the intent to actually get into the probabilities and consequences?**

- It may be a balance between quantitative and qualitative risk contexts because some parts of the code do not have easily definable, quantifiable risk, whereas others do. I would expect that there is much needed discussion in this area before a PBC is implemented.

**Would a Performance-based Code allow for criteria around the performance of a building undergoing the course of construction (such as in a fire)?**

- I would suggest to limit performance-based design to the construction of the building, not the conditions under which such building is built. In other words, prescriptive measures should be sufficient and cover all aspects of the hazards induced during construction.

**It is obvious with the presentations heard so far that once a PBD code is developed, there is a need to monitor its use and address the concerns raised to fill the gaps identified on a regular basis. This is a very useful guidance document (IFEG).**

- https://www.abcb.gov.au/sites/default/files/resources/2020//Guidelines-International-Fire-Engineering-2005.pdf

## Discussion Following Overview of Research on Reimagining the Internal Code Council Performance Code (ICCPC)

**How much uptake is there to PBC? What percent of projects use it?**

- A good target is 5% of buildings for full performance, 20% of buildings will have some level of performance. Compliance documents are prescriptive and still exist alongside the PBC.

**How long is the timeline on the ICCPC?**

- The timeline is expected to be a typical three-year document development effort. We are not doing a research phase. It will rely on expertise in the market.

**We have, with National Security & Fire Protection (NSFP), guidance on PBD for fire safety that will cover any of the provisions of Part 3.**

- Those documents are dated and tend to be high level. You really need familiarity of practice to use those documents well. For the PBD guide, there is an effort to turn it into a standard.
- Recommended reference documents:
    - https://www.sfpe.org/publications/sfpeeuropedigital/sfpeeurope17/issue17feature2?_zs=HC01d1&_zl=a99g6
    - https://codes.iccsafe.org/content/ICCPC2021P1https://www.sfpe.org/publications/sfpeeuropedigital/sfpeeurope17/issue17feature2?_zs=HC01d1&_zl=a99g6
    - Web portal for Reimagining the ICCPC project - https://www.iccsafe.org/products-and-services/performance-code/

# Appendix D – Detailed Breakout Discussion Transcript

## Transitioning Towards Performance-Based Codes

## Approach to Transitioning the NBC to a Performance-Based Code and Structure

**a) What structure should be used to introduce a performance-based (PB) building code in Canada?**

**Group A**

- Maintaining an identical structure to the current NBC will facilitate adoption, i.e. existing compliance paths should remain. It was also noted that regulation at national level, as seen in the reviewed PBC frameworks is also important.
    - Overwhelming support for a gradual transition with a PB compliance path while maintaining much of the status quo.
    - Only consider full transitioning to PBC when everything is already in place.
    - Another option would be to introduce PBC aspects to the current alternative solutions compliance path.
    - Some participants supported following New Zealand e.g. performance requirements should be in the code but reference documents can external
- Structure of code will be driven by objectives, but we are lacking the theory to select and quantify objective- the 'how' should follow from careful consideration of principles and theories of what we want the code to do
- Need a competent transition path, introducing PB aspects and objectives to enhance existing alternative solutions and to better understand the associated risks.
- There should be a further review to understand challenges faced by some countries, e.g. UK, where the introduction PBCs had limited success before deciding to introduce a PB building code in Canada.
- Conduct a further review of PBCs from about four notable countries that were early adopters to identify good features of their structures rather than developing an entirely new Canadian PB code.
- Synchronization and harmonization is critical
    - Performance of buildings across country will be different across geographies- need to harmonize performance to minimize redesign that needs to be done to suit different building officials opinions- intent of code should be done ahead of time
- Recommend polling architectural, engineering and building officials associations of various countries to see where those practitioners like or don't like the various PBC formats- pull out the good parts of what others are using to develop our own model.
- Of the international examples presented, the structure from New Zealand and the United States is preferred - performance requirements are not integrated into the building code but are contained in appropriate standards.
    - This however introduces a question of who would be responsible for approving the design criteria in performance standards

- A performance pathway should be baked into legislated in order to provide a common reference for industry and legislators.
- There were some concerns that there may be too much reliance on approval process.
- Some doubt about the readiness to move to a PBC. It didn't happen in 2005 due to lack of lack of technical expertise. The current NBC has not fully resolved existing problems e.g. competence of designs, inconsistency in selection of baselines.

**Group B**

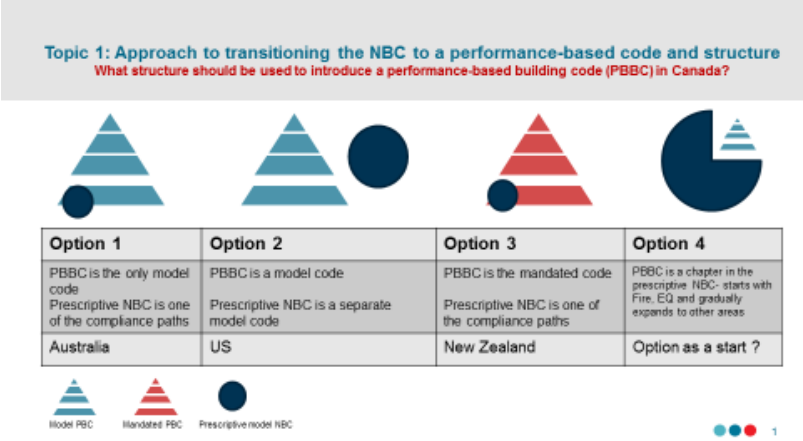
- Several participants practiced previously in New Zealand and UK as building professionals. They commented that the National Building Code of Canada (NBC) has a rather large volume and uses more legalized languages, compared to the New Zealand and UK codes. New Zealand has a more compact code; UK relies more on flexible regulatory and guidance documents. They'd like to see more digestible documents.
- Quantifying performance levels from NBC acceptable solutions could be a starting point.
- Industry is more familiar with prescriptive codes; PB codes should start with qualitative performance requirements and gradually evolve to full performance based.
- Resounding preference for prescriptive solutions to be preserved due to perceived complexity of PBD
- Suggestion to simplify NBC so that it is less voluminous, then designers don't need to address all the individual provisions that are in there now

**Group C**

- If PBC was brought to Canada, it would be really interesting for innovative, complex buildings. Performance based codes should be only used for complex buildings, and the prescriptive code should still exist for typical buildings.
- From a practitioner's viewpoint, a lot of buildings follow prescriptive provisions, which is cost effective. In those complex buildings, it is difficult to follow the current alternative solutions process because it is focused on specific item, it is difficult to address a building's performance overall.
- Therefore, we should retain prescriptive and alternative codes. However, we should add a third path for PBC where the full performance of the building is evaluated – we do need some sort of peer review process for PBC.
- To be able to easily update it in our code, it needs to sit in the compliance area of the code.
- Some areas of questions:
    - Variation of capabilities of users of the codes.
    - Need some sort of verification/peer review process.

**Group D**

- Different options were presented, as shown, including the AUS, ICCPC, NZ and others. There were even a few more options provided by the group




- A preference for Option 4: where Performance based code could be developed within NBC in the short term either within Subsection 4.1.8. while in the longer term, Option 1 (fully PBC) with Prescriptive solutions as compliance path
- Could be modeled after the Energy efficiency code and Tiered approach in Part 9 of the 2020 edition of NBCC
- Some comments regarding the readiness of the engineering community and others based on lessons learnt from AUS and NZ
- Integrated package with in NBC
- Keep prescriptive as a compliance path given what was mentioned in the ICCPC presentation on the uptake of PBC in countries that have adopted PBC as an option.

**b) Should performance criteria be qualitative or quantitative in a future PB building code? If quantitative, then how should the performance criteria and requirements be developed? Could some of the current acceptable solutions be rationalized and be used as performance requirements?**

**Group A**

- The first step to defining a PBC would be to define the performance of acceptable solutions in the existing code.
    - Performance criteria could be a combination of prescriptive and quantitative and can become increasingly quantitative as new research results become available. However, there may be a need to re-evaluate acceptable solutions as some are outdated, should be high level and take a more holistic view.
    - Some acceptable solutions could be rationalized, however many existing prescriptive provisions may not have been derived with sufficient rigor and therefore derived baselines may be excessive in some cases – hence bench-mark approach may not be the best
    - Be aware of copyright issues when referencing or using information / systems from other jurisdictions.
    - Need to have option for new system and not be restricted by current requirements, i.e. allowance of new design approaches /systems and how to do it safely.

    - Regulators should be consulted to build trust in the performance criteria that are developed
    - Strive for quantitative performance criteria - develop in partnership with industry experts. There is over 15 years of professionals with developed expertise in alternative solutions that have developed quantitative performance criteria in building design
    - The launch of a PBC would be followed by a push to develop publicly accessible guidance documents.
- As a counterpoint, we do not necessarily have to rely on the performance objectives in the existing code. These were back calibrated for new buildings based on the safety of existing buildings. However, the desired safety level of old buildings was not intentionally defined, just changed over time in response to failures.
    - An option would be to ask the public what they expect and are willing to pay for in terms of safety and reflect those expectations in a PBC.
    - Recommend challenging the assumption that the current code performance level is sufficient (i.e. we just haven't had a fire yet that disproves it). Instead, we should be proactively assessing risk using both qualitative and quantitative mechanisms.
- A participant expressed concern that a move to a PBC would place too much pressure on the enforcement side, would require those enforcing the code to be experts in a PB design approach and may lead to an externalization of costs to municipalities.
- Another concern with a qualitative criteria is that there is no real assurance that a bar has been met for authorities.

**Group B**

- Both qualitative and quantitative criteria are needed. Qualitative is needed in some areas and may require peer review.
- Review international PBCs with respect to mix of qualitative and quantitative criteria.
- Suggest to start with qualitative and then introduce quantitative requirements later
- Expand objectives and functional statements to include level of performance.

**Group C**

- Quantitative performance criteria should be introduced.
- Simple verification and tested/model to some criteria should be readily available.
- However, it is going to be difficult to quantify all performance criteria's and maybe not feasible right now.
- Qualitative criteria currently present and that's why PBC was not implemented.

**Group D**

- Extensive discussions… Mixed thoughts
- Majority agreed that performance criteria could be combination of quantitative and qualitative, depending on the performance attribute
- Appropriate quantitative criteria in Standards based on qualitative criteria in Code

**c) Which other parts of the NBC should be piloted in this project along with fire and life safety (in Part 3) and earthquake design (in Part 4)?**

**Group A**

- Adjacent property protection for a construction site fire plan
- Did not think other areas should be piloted as there will be issues that we will need addressed before moving too far.

**Group B**

- Sustainability and resiliency issues
- Height and area requirements

**Group C**

- Part of the codes that should be addressed is Part 5, NECB, Part 4, and Part 6.
- The last part to be addressed would be part 9.

**Group D**

- Keep it simple and start with fire and life safety, grow from there to other aspects of performance in the longer term
- Should be scalable
- It was pointed out that the there is a difference between alternative solutions and PBD

## Resource and Regulatory Needs

**a) What resources (e.g., tools, guidelines, etc.) and capacity (e.g., design review, training, etc.) are needed to support the implementation of a PB building code?**

**Group A**

- Some participants felt that the current lack of information to assist AHJs in their decision making process would persist even if a PBC is introduced.
- AHJs are experiencing a lack of code reference documents. Therefore training is going to be very important, i.e. support for the industry.
- There are many design guidance documents available (including internationally, e.g. from SFPE), but these would have to be integrated and adapted for the Canadian context and relevant training should be provided on using and selecting these documents.
- Would be ideal to develop a common benchmark by determining the acceptable risk implied in existing requirements.

**Group B**

- Robust review process including fire engineering briefing (up front/first buy-in by AHJ) and final approval (second buy-in by AHJ) but shouldn't be too onerous.
- One person cautioned that whatever is done shouldn't be too difficult or complex so that it's not used

- Building officials are already having trouble keeping up with changes, with more to come on accessibility. There are not enough qualified people to works on approvals under the current NBC; there is concern that they would not be able to handle a PBC.
- Qualified people are needed
- Several AHJ participants expressed concerns about additional burden by PB codes, potential inconsistency in design evaluation and approvals among AHJ's; also pointed out different legal frameworks from province to province (territory to territory).
- Professional associations should take one more roles.
- Peer review should be required for qualitative solutions where level of performance is not clear

**Group C**

- Some resources would include training, guides, and further research to allow practitioners to support the transition to PB building codes.

**Group D**

- Need to develop some authoritative documents and tools
- Develop competency, trust and confidence in any potential PBC process

**b) Who should be leading the development and delivery of these resources and capacity building activities?**

**Group A**

- The objective based code that was implemented is widely used for alternative solutions in some parts of the country, and very little in other parts, such as Ontario. The resources needed will vary from province to province due in part to legislation.
- Requires someone to provide guidance on acceptable risk and benchmarks.

**Group B**

- There are inconsistencies between municipalities and if there's a move toward PBC, it will get even harder to enforce design requirements. It is easier to enforce well-designed prescriptive requirements. And each P/T has its own legal enforcement framework.
- There was a question about whether or not the CCBFC has expressed a desire for a PBC. Have alternative solutions not worked or is there a need for PBC? Building authorities are already struggling with enforcement, compliance, inspection and oversight.

**Group C**

- It should be led at a National level in order to have consistency across Canada and to promote harmonization of codes.

**Group D**

- Leadership by CCBFC, Collaborative effort required NRC, CSA Standards, others

**b) Would there be a need for a third party expert review as part of the PB code compliance path and if so, should those be certified and if so, by whom?**

**Group A**

- Challenges with 3rd party review were mentions, in addition to fears that it will add another layer of bureaucracy, which may negatively impact cost effectiveness.
- Seeing a move to having professional FPEs on AHJ's staff to help with ability to review. Depends on resources on individual municipalities. Setting performance objectives will need to capture public's preferences and will need to involve social scientists, economists, and political scientists. Building and design professionals do not have the necessary expertise.

**Group B**

- Peer review process required depending on complexity of designs. There is much information with in fire safety engineering community (SFPE, ISO, ASCE, etc.) which should be reviewed to avoid duplication.
- Requirements need to be explored for peer review. We need to learn what worked elsewhere. Professional organizations like engineering societies already have established standards of practice and other PB tools so we need to consider/take stock of what's available already. Oversight for the life of the building needs to be considered as well.
- More responsibility needs to be given to the design community as we move toward PBC. It should be the designer that signs off on their own design, not the AHJ, under a PBC situation.
- What performance are we achieving through acceptable solutions? What's the acceptable level of performance?

**Group C**

- Definitely, a third-party review would be required. The capabilities of the end users of the code are unknown, and therefore, there is a need to ensure that all buildings certain standards.

**Group D**

- Peer review essential should be in the code,
- Professional Engineers certification should be strengthened, Integrate with curriculum at Engineering and Architectural schools

## Identifying Research Needs

## Fire Safety Research and Development Needs

**a) What tools, methods, data and performance criteria (i.e., for design and performance evaluation) are currently available for implementing a PB building code in Canada? What**

**specific tools, methods, data, and performance criteria from other countries that could be used? If so, what are they?**

**Group A**

- ICLR recently produced an impact analysis on the NRC WUI guide, which could be relevant to other building fire safety aspects: https://www.iclr.org/wp-content/uploads/2021/05/ICLR-SPA-Risk-Impact-Analysis-for-the-National-WUI-Fire-Guide-2021.pdf
- Designers are increasingly using complex tools, e.g. FEM, need to develop protocols for validating the output from models. Noted validation guides exist for fire models. This should not be limited to Canada, but be context-specific.
- Require training to be provided, as tools only as good as those who can use the tools. For data, there are gaps e.g. understanding current performance requirements and data that they were based on.
- In the area of structural design, there is a need for a common standard / approach.
- Work done by NRC on encapsulated mass timber is an example of what can be accomplished and ability to develop Canadian-specific criteria.

**Group B**

- A lot of information, tools, methods, data and experiences available around the world. We should conduct thorough reviews to learn and benefit from international experiences.
- In additional to experiences from other countries, there have been many alternative solutions approved and used in actual building projects in Canada. Studies on how AHJ's approve these projects and what acceptance criteria are used would be very useful.
- Some performance criteria could potentially be derived from the current prescriptive NBC. On the other hand, establishing criteria from the first principle should also be pursued although this would be a more difficult undertaking.
- Fire risk assessment tools such as FiRECAM, etc. should continue to be developed, validated and supported.

**Group C**

- Difficult to answer and may be challenging to deal with this. However, in Canada we have some criteria in the NBC and in standards such as spatial separation, fire resistance for different materials, means of egress, combustibility vs non-combustibility.
- The UK has guidelines which contain criteria.
- To use international criteria, we have to know where these criteria came from. We need to filter them to ensure their applicability in Canada.
- NFPA may have criteria on the reliability of fire protection systems (e.g., sprinklers reliable at 90 or 95%). We again need to be careful about applicability if adopting regional or world-wide values.
- There have been many advancements in evaluating fire safety performance. Models exist; large-scale testing on wood assemblies and compartments has been conducted; there are models for

evacuation and tenability. The missing piece is for experts to group all these together and understand how they interact in totality.

**b) What are the gaps and research needs and in what areas of Part 3?**

**Group A**

- Firewall requirements are deficient. More research is needed to quantify fire requirements for firewalls, this is regarding change to allow not combustible 2 hr firewalls in 2005 NBC
- Research on interactions of fire disciplines. Not much data to evaluate transfer corridors in egress routes, need for more interactive assessment involving structural and evacuation.
- Area of smoke control in newer complex building e.g. tall mass timber needs to be looked into
- Valuable fire data available from many international research establishments, e.g. RISE, BRE
- There is a lot of data at NRC that the code user community do not know about and should probably be better promoted for greater awareness e.g. spatial separations data is quite dated, done in the 1950s, experiments conducted at high winds.
- There are some code provisions based on older data that may need to be re-evaluated; this would be helpful to regulators.
- BRE produced a guidance document with more elaboration on origin and methodology used in developing Table in Code.
- Discussion on how can be more open to materials tested to non-Canadian standards
- Consider implication of changes to Canadian Codes on other international jurisdictions, e.g. Costa Rica, that base their codes on NBC
- In the area of mass timber, due to rapid innovation, link to mass timber fire behaviour to code requirements may not be very well established.
- If one of the intents of going to a PBC system is to improve global trade and innovation, then there is a need to think about how different standards that are used internationally could be used/referenced within Canada
- Summary of research needs:
    - Link research that has been done with under pinning code requirements
    - Connections in mass timber not address in NBC (support by more than one participant)
    - Smoke control
    - Revisiting the basis and relevance of acceptable solutions as most are historical
    - Adaptive reuse of existing buildings, especially with regard to mass timber
    - Effects of climate change

**Group B**

- Quantitative performance criteria in the area of human behavior in fire and egress (especially in residential occupancy); sociological perspectives are important considerations; statistically supported quantification for egress needs research.
- Need to study how performance based codes impact on firefighting and firefighter safety.

- We do not really know what the socially acceptable levels for life and property losses are?
- Public expectations before and after a major failure may not be consistent, which need studies.
- Need more real world data on fire growth and spread.
- Lack statistics data to support innovation and designs.
- Suggest datamining into fire loss data from insurance industry and material producers.

**Group C**

- Gaps in research on the long-term impact of water from sprinklers on wood buildings. This should be investigated.
- We may need different perspectives on the use of wood in tall buildings, e.g., testing to show burning behaviour in comparison to non-combustible materials.
- Need to define quantitative criteria based on science – maybe pilot project looking at performance over time.
- We could conduct a pilot project using performance-based design and define all the needs.
- We should use testing to quantify criteria. One option is the scaling of test results, i.e., large-scale tests can be scaled down to evaluate performance at a small-scale level.
- The question to answer when evaluating performance is: what is the acceptable performance for the whole building?
- One question on criteria is how do we quantify these criteria? For example, the 12.5 kW/m^2 for wood ignition is based on the Saint Laurent burns, what about other criteria and are the assumptions to define them correct?
- It may not be possible to fill the gaps for prescriptive requirements (all the articles in the NBC). The performance process may simplify the quantification; i.e., few quantitative criteria to evaluate the performance.
- We need to assess how design performance is evaluated and the tools that can provide consistent and accurate outcomes.
- Risk tolerances can also be used as criteria. In this case, what us acceptable by society or the public.

**c) What do you consider as the short-, medium- and longer-term research priorities for fire safety under a PB building code in Canada?**

**Group A**

- Short term- Having a better understanding of the intent of the current NBC

**Group B**

- Short-term: Conduct critical analysis of available tools, standards and design approaches etc. that are being used around the world in performance based designs to identify feasible framework and to identify what criteria could be used.
- Medium-tern: Develop data to support statistic risk analysis/assessment.
- Long term: Develop guidance documents and quantitative criteria to support first principle approach to PBD.

**Group C**

- There was no discussion on how to manage priorities of the research areas mentioned in the previous question.

**d) For the identified needs, what are your recommendations on how to implement the research agenda (e.g., consortium, etc.)?**

**Group A**

- A national research database with specific data to address certain risks could inform decisions in terms of fire safety designs.
- Existing NRC resources should be promoted and made more accessible (i.e. background on how code requirements were developed that helps with comprehension).
- A cross section of people need to be involved in implementing the research agenda- i.e. regulators, researchers, consultants

**Group B**

- Review international experiences and practices in performance-based codes and designs.
- Build consensus on whether to develop qualitative or quantitative performance
- On ways to implement a research agenda, could look to academia to undertake it, private sector industry grants, or a consortium/group think tank.
- Some thought it should be led by industry because they know the pain points and would bring these to the forefront. If the code was divorced from the regulation, then changes could be implemented right away.
- Need multiple committees, consortium and collaborations structured by research area. Areas could include criteria, framework, regulatory process
- It was recommended that a survey of practitioners on specific projects be undertaken – what they addressed and how they went about doing it to understand where PB design is being used on specific projects.
- With many performance-based designs having been materialized in actual building projects in Canada, it would be valuable to conduct case studies and surveys on how these building projects are designed and approved.

**Group C**

- A consortium is a good idea. This could be similar to the NRC mid-rise wood buildings project.
- The work could be done in collaboration with universities to increase expertise in the different areas by training high qualified personnel (e.g., students).
- A network of universities similar to the NEWBuildS project is another option.
- One item that was brought up in the discussion is the "Competency". Competency should be carefully addressed; i.e., competency in evaluating alternative performances for complex design; Education increases competency; Check the big gaps in competency requirements; Setup qualifications for different specialties.

## Earthquake (EQ) Research and Development Needs

**a) What tools (authoritative documents, design guides, alternative solutions) currently available could be updated to work with a future PB building code in Canada?**

**Group D**

- Structure of some existing PBC codes and other authoritative documents such as ASCE 24 and CSA S6, BC Tall Concrete Building Design Requirements Guide could be adopted with updates
- Performance based requirements for non-structural components must be included in the PBC, CSA S832- could be used/adapted, No-Structural part is the easiest to pursue
- Should utilize some of the existing resources and tools from the US and in Europe
- Unified procedure for the derivation of seismic force modification factors ($R_d$, $R_o$) by SC-ED should be used as an example/template and the work done by CCMC/NRC on $R_d$,$R_o$ for tall wood buildings
- Ensure that all authoritative documents, guides and tools are coordinated with AHJs to ensure their acceptance

**b) Which areas in EQ design would benefit the most from the application of PB requirements and development of an ecosystem (authoritative documents, test methods and other compliance paths) to support a future PB building code in Canada?**

**Group D**

- Need to consider the seismic upgrade and alteration/retrofit of existing buildings in any PBC given that this was identified by the Commission as a high strategic priority. NRC has started some work in that area
- Analysis done in Canada on the ground motion level indicated that we are using higher performance level/criteria compared to other countries such as the Us or Japan
- Should look at the functional recovery and Japanese approach to recover quickly from EQs.
- Need to identify the types of risks and move to a risk-based approach in the future PBC

- Low rise and medium buildings suffer most damage, biggest group- will benefit most from PBC

**c) In context of a) and b), what are the short, medium, and long term research needs for implementing PB code requirements for EQ design in the PB building code and related material standards?**

**Group D**

- Selection of appropriate ground motion. More research and tools are needed
- Should consider going beyond the seismic design and explore other structural provisions under Part 4
- Should provide some guidelines and cover the design of non-structural elements in the buildings
- Need to rationalize some of the existing historical prescriptive requirements as the first step to the development of a performance criteria for PBC. Need to understand the performance level associated with existing solutions first
- Need to have a better understand of how buildings perform though instrumentation and in-situ testing
- Apply performance design to smaller type of buildings to start with then move to more complex buildings with irregularities, etc.

**d) For the needs identified in c) above, what are your recommendations for the next steps to implement the research agenda (e.g., consortium, etc.)?**

**Group D**

- Establish a research consortium with industry, academia and government to address the key research areas that can support PBC
- Start with specific use cases, pilot these to develop PBC and expand into new areas gradually, further discussion would be needed to identify the frontrunners- tall buildings/, buildings using innovative SFRSs or materials such as mass timber, low, mid- rise buildings, complex/ irregular structures
- Coordination of research is critical to avoid duplication and ensure focused research activities
- Should also invest some efforts in ensuring the dissemination and implementation of the research findings

# Appendix E – Summarized Breakout Discussion Transcript

| | Topics | Breakout Groups | | | |
|---|---|---|---|---|---|
| 1 | **Transitioning the NBC to a PB Code and Structure** | **A** | **B** | **C** | **D** |
| 1 (a) | **Structure of the PBC in Canada** | | | | |
| | Maintain identical structure to current NBC / preserve acceptable solutions | ✓ | ✓ | ✓ | ✓ |
| | Gradual transition | ✓ | | | |
| | Reference New Zealand structure | ✓ | | | |
| | Conduct further review of PBCs from other countries | ✓ | | | |
| | Concerned about increased reliance on approval process | ✓ | | | |
| | Doubts readiness to move to PBC in Canada | ✓ | | | |
| | Quantify current NBC acceptable solutions | | ✓ | | |
| 1 (b) | **Should performance criteria be qualitative or quantitative** | | | | |
| | Combination of qualitative and quantitative | ✓ | ✓ | ✓ | ✓ |
| | Re-evaluate acceptable solutions / concerns about base-line approach | ✓ | | | |
| | Start with qualitative criteria and gradually introduce to quantitative criteria | | ✓ | | |
| 1.(c) | **Other areas of NBC to be piloted** | | | | |
| | Adjacent property protection at construction stage | ✓ | | | |
| | Sustainability and resiliency | | ✓ | | |

| | | | | | |
|---|---|---|---|---|---|
| | Heights and area requirements | | ✓ | | |
| | NBC Parts 4, 5, 6, 9 and NECB | | | ✓ | |
| 2 | **Resource and Regulatory needs** | | | | |
| 2(a) | **What resources and capacity are needed to support a PBC** | | | | |
| | There exists a lack of information to assist AHJ decisions | ✓ | | ✓ | ✓ |
| | There exists a lack of qualified staff | | ✓ | | ✓ |
| | Concerned PBC will bring additional burden to AHJs | | ✓ | | |
| | Peer review should be required | | ✓ | | |
| 2.(b) | **Who should lead the development of resources** | | | | |
| | Leadership at national level | | | ✓ | |
| | Leadership by CCBFC, NRC, Standards Council of Canada etc | | | | ✓ |
| 2.(c) | **Third party review and certification requirements** | | | | |
| | Concerns about negative impact on costs / bureaucracy | ✓ | | | |
| | Have FPEs on AHJ staff | ✓ | | | |
| | In support of peer review requirement | | ✓ | ✓ | ✓ |
| | Should be responsibility of design professional | | ✓ | | ✓ |

| | | | | | |
|---|---|---|---|---|---|
| **3** | **Fire safety research and development needs** | | | | |
| **3 (a)** | **What tool, methods and data are available** | | | | |
| | Review what is available around the world | | ✓ | ✓ | |
| | Important to have protocols to validate model outputs | ✓ | | | |
| | Provide training for design tools and methods | ✓ | | | |
| | Derive performance criteria from prescriptive provisions | | ✓ | | |
| | Develop quantitative criteria to support first principles | | ✓ | | |
| **3 (b)** | **Research gaps** | | | | |
| | Smoke control in new complex buildings | ✓ | | | |
| | Re-evaluate acceptable solutions | ✓ | | | |
| | Mass timber connections | ✓ | | | |
| | Effects of climate change | ✓ | | | |
| | Impact of PBC on firefighting and safety of fire fighters | | ✓ | | |
| | Long-term impact of sprinkler discharge in wood buildings | | | ✓ | |
| | Introduce risk tolerances | | | ✓ | |
| **3. (C)** | **Prioritisation: short- medium- and longer-term need** | | | | |

| | | | | | |
|---|---|---|---|---|---|
| | Short term: Develop better understanding of current NBC | ✓ | | | |
| | Medium-term: Develop data to support risk analysis | | ✓ | | |
| | Long-term: Develop guidance documents | | | ✓ | |
| **3. (d)** | **Implementation approach** | | | | |
| | Involve large cross-section of code user community | ✓ | | | |
| | Review international experiences | | ✓ | | |
| | Setup committees, consortia | | ✓ | ✓ | ✓ |
| | Develop collection of PBD case studies | | ✓ | | |
| **4** | **Earthquake (EQ) Research and Development Needs** | | | | |
| **4 (a)** | **What tool, methods and data are available** | | | | |
| | Provide authoritative documents to AHJs | | | | ✓ |
| | Utilize existing resources and tools from US and Europe | | | | ✓ |
| | Adopt structure of other authoritative documents | | | | ✓ |
| **4 (b)** | **Which EQ design areas would benefit from PBC** | | | | |
| | Seismic upgrade and alteration/retrofit of existing buildings | | | | ✓ |

| | | | | |
|---|---|---|---|---|
| | Low- and medium-rise buildings | | | ✓ |
| **4. (C)** | **Prioritisation: short- medium- and longer-term need** | | | |
| | More research / tools to help in ground motion selection | | | ✓ |
| | Consider other structural provisions under Part 4 | | | ✓ |
| | Experimental (in-situ) evaluation of performance | | | ✓ |
| **4. (d)** | **Implementation approach** | | | |
| | Setup committees, consortia and co-ordinate research | ✓ | ✓ | ✓ |
| | Begin with pilot case study and gradually extend | | | ✓ |
| | Publication and implementation of research findings | | | ✓ |

# Appendix F – Presentations