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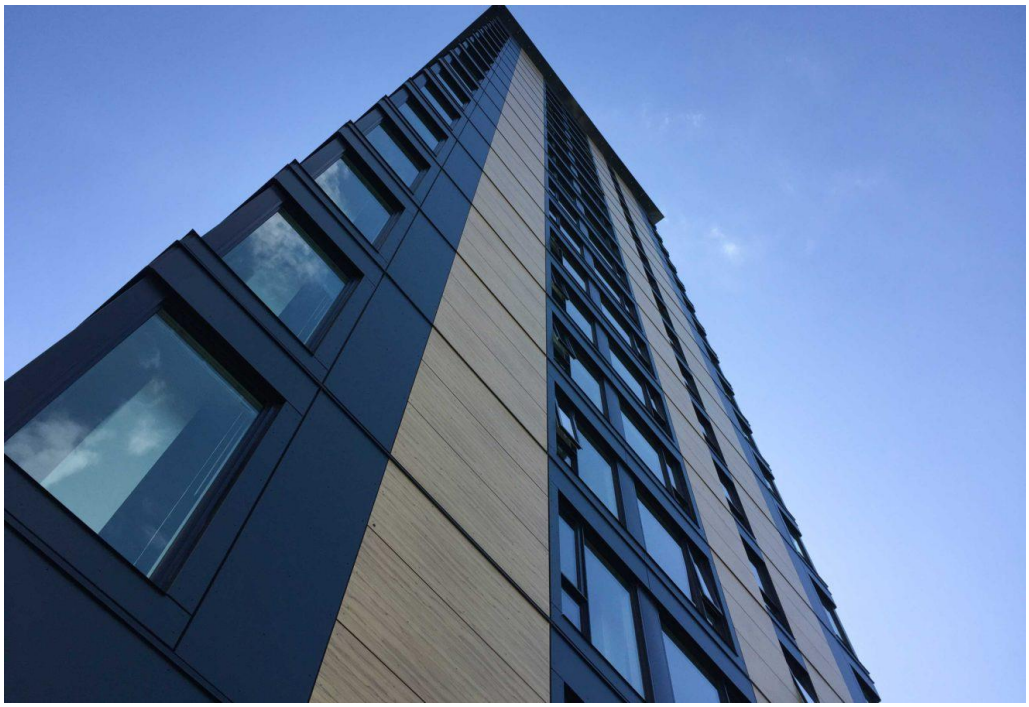
TRANSFERABILITY OF 2021 INTERNATIONAL BUILDING CODE TALL WOOD BUILDING PROVISIONS TO THE NATIONAL BUILDING CODE OF CANADA



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APPENDICES

DISCLAIMER

This report has been prepared by **GHL** CONSULTANTS LTD (GHL) and FAST + EPP (F+E) for Forestry Innovation Investment (FII). The purpose of this report is to study the transferability of the 2021 International Building Code (IBC) mass timber building provisions to the 2020 National Building Code of Canada (NBCC). The formulation of the analysis employed by the report and opinions offered are based on the science of fire engineering (GHL), structural engineering (F+E), and review of the available literature. Although an effort has been made to address all relevant considerations, this report cannot be considered exhaustive. Responsibility for Code changes remains with the appropriate Code authorities. GHL and F+E shall not be responsible for any loss of any kind that may arise due to any construction, building or structure relating to the work in this report, or any Code or construction regulation change. Should this report be made available to other organizations that have regulatory capacity in construction of buildings and structures, this disclaimer shall equally apply. This report is intended to be purely technical in nature. Any inquires on this report shall be directed to:

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EXECUTIVE SUMMARY

The acceptable solutions in Division B of the 2020 NBCC limit the height of Groups C and D buildings of sprinklered encapsulated mass timber construction (EMTC) to 12 storeys in building height, and a measured building height of 42m. The recently published 2021 IBC contains provisions to permit buildings of mass timber construction under the IBC Type IV construction, surpassing the NBCC provisions by maximum building height, building area, occupancy groups, and interior exposed timber. The IBC mass timber buildings are permitted to have a building height of maximum 18 storeys, depending on the occupancy group. Within Type IV construction, four subdivisions are described to have varying maximum permissible building height, area factors, fire resistance rating (FRR), and interior exposed timber.

Through a comparison of mass timber provisions of both Codes, relevant research reports, test reports, industry standards, this report documents the consequential and inconsequential differences and developed conclusions on whether the NBCC can adopt the IBC provisions, and with what modifications so that the new provisions may fit the NBCC context.

As the target audience of this report is more familiar with the NBCC structure, this report begins with a general discussion of the IBC to bring the readers into familiarity to it, so that the inevitable IBC language later used in the report can be taken in context. The report then discusses the main test project that produced the required fire data, which substantiated the IBC Code change. The 12-storey mass timber buildings currently permitted by both the NBCC and the IBC are compared. The topics include building height (in meters), building area, fire resistance rating and interior exposed timber. Expanding on the findings from the 12-storey comparisons, 9 and 18-storey IBC mass timber buildings are discussed to show the features the IBC employed to permit these building types. In addition to the construction requirements, the report also discusses the difference in approaching other important topics including Exterior Walls, Concealed Spaces, Firestopping, Joints, and Fire Safety During Construction.

The structural portion of this report similarly introduces the relevant Building Codes in the US and material design standards used for structural design in typical and fire cases. The report compares the design loads and load combinations applied in the US building codes (IBC and ASCE 7) and the NBCC. It subsequently compares the design approaches between the US National Design Specification (NDS) for Wood Construction and the Canadian National Standard for Engineering design in wood (CSA O86), with a focus on the evaluation of char and fire design strength. Additional discussions include seismic force resisting systems from both building codes and standards, and other critical design elements including connections and applicability of the wood design standards for taller buildings. It is the conclusion of this report that the use of the O86 and the NBCC provides a similar level of safety to the equivalent US codes and specifications, with a particular focus on fire design.

It is the conclusion of this report that, because of the research substantiating the IBC Code changes, as well as the shared research effort between the NBCC and the IBC, the mass timber Code provisions from the IBC can generally be adopted by the NBCC with some modifications. This report recommends the existing 12-storey EMTC permitted for Groups C and D to be extended to 18-storeys and 9-storeys. In addition to Occupancy Groups C and D, Groups of reasonably similar fire risk, including A-2, B-3, E, F-2, and F-3 are also recommended based on the IBC provisions, though with shortened building heights. For simplicity building areas are recommended to remain with the NBCC limits, noting that change in both the height limits and the area limits should be considered reasonable next steps in Code evolution.

ABBREVIATIONS AND TECHNICAL TERMS

Abbreviations

AHC: Ad Hoc Committee
ASD: Allowable Stress Design
CL: Companion Load
CLT: Cross-Laminated Timber
CCBFC: Canadian Commission on Building and Fire Codes
EMTC: Encapsulated Mass Timber Construction
FRR: Fire Resistance Rating
GLT: Glue-Laminated Timber
GWB: Gypsum Wallboard; fire resistant Type X gypsum wallboard.
IBC: International Building Code
ICC: International Code Council
IFC: International Fire Code
LRFD: Load and Resistance Factor Design
LSD: Limit States Design
NBCC: National Building Code of Canada
NLT: Nail-Laminated Timber
SCL: Structural Composite Lumber
SLS: Service Limit States

Technical Terms

The following provides a description of technical terms to aid general understanding of this report. These are not to be taken as official definitions for building code application.

Fire Resistance Rating (FRR): the time in minutes or hours that a material or assembly of materials will withstand the passage of flame and the transmission of heat when exposed to fire under specified conditions of test and performance criteria, or as determined by extension or interpretation of information derived therefrom as prescribed in applicable Codes.

Encapsulation Rating: the time in minutes that a material or assembly of materials will delay the ignition and combustion of encapsulated mass timber elements when exposed to fire under specified conditions of test and performance criteria or otherwise prescribed in applicable Codes.

Limit States Design (LSD): those conditions of a building structure that result in the building ceasing to fulfill the function for which it was designed. An LSD structure is designed to support all loads likely to occur during its life with an appropriate level of reliability. See also Load and Resistance Factor Design (LRFD).

Ultimate Limit States (ULS): limit states concerning safety are called ultimate limit states (ULS) and include exceeding the load-carrying capacity, overturning, sliding and fracture.

Service Limit States (SLS): those limit states that restrict the intended use and occupancy of the building are called serviceability limit states (SLS) and include deflection, vibration, permanent deformation and local structural damage such as cracking.

Load and Resistance Factor Design (LRFD): see limit states design (LSD).

Allowable Stress Design (ASD): A method of proportioning structural members such that elastically computed stresses produced in the members by nominal loads do not exceed specified allowable stresses.

Companion Load (CL): A specified variable load that accompanies the principal load in a given load combination.

1. INTRODUCTION

The performance of mass timber building elements in fire and structural has been recognized by the construction industry for many years. With a predictable char rate, mass timber by its material property is able to retain its structural integrity under fire. From the perspective of seismic activities, the forces exerted onto the structure are proportional to its weight, and wood is lighter than other major building materials. The ductility of wood also allows the structure to dissipate the energy in an earthquake.

During a Code cycle of the 2020 NBCC, the Code, in recognition of the fire performance of mass timber, introduced two new Construction Articles in Subsection 3.2.2 that allow the construction of up to 12-storey mass timber buildings for Major Occupancy Groups C and D. Also introduced in this revision were Subsection 3.1.6, to define the construction requirements of EMTC buildings. This unique Code language placed Canada in a leading position in North America for tall buildings of mass timber construction.

Prior to official release of the 2020 NBCC, these provisions and related changes proposed for the NBCC had been incorporated in the 2018 BC Building Code, the City of Vancouver in the Vancouver Building Bylaw 2019, and in Alberta and Quebec.

Like the NBCC, the preceding 2018 IBC at the time, permitted light wood frame buildings with gypsum wallboard (GWB) protection under Type III-A and III-B construction; however, is restricted to a maximum 6 storeys tall for buildings with some exception for special structures. Buildings that are not less than 12 storeys tall fall under Type I construction, which require the use of noncombustible building elements with some exceptions.

1.1 Ad Hoc Committee on Tall Wood Buildings

While Canada was in the process of moving forward with the EMTC revision, the International Code Council (ICC) in 2016 created an Ad Hoc Committee on Tall Wood Buildings (AHC) to explore the building science and conduct research on tall mass timber buildings. The research covered the topics of fire and structural performances of tall mass timber buildings, including full-scale testing and the possible Code implications. Subsequently, based on the AHC research, Code changes were proposed to the ICC. All proposals brought to the ICC were approved with or with minor revisions. Three new Construction Types were introduced: Types IV-A, IV-B and IV-C through the publication of the 2021 edition of the IBC. These Construction Types allow construction of buildings of mass timber design, with substantial building height and building area for all of the Occupancy Groups covered by the IBC. The greatest building height permitted within the IBC for mass timber buildings is now 18 storeys.

While the ICC Code process is different from the Canadian Code Process, it is noted that the membership of the ICC AHC which recommended the Code changes proposals to the ICC, was a broadly diverse group of Architects, Engineers, Fire Protection Experts, Scientists, Building and Fire Officials, and Industry representatives. Ms Julie Frappier, Eng, with Nordic Structures, was a Canadian member of the AHC and was consulted in preparation of this report.

The Code development process and the fairness of the system and resistance to lobby groups can be argued on both sides; that is, that the Canadian or American system is more biased. However, the composition of the AHC can be considered relatively similar to the composition of a Code Committee under the Canadian Commission on Building and Fire Codes (CCBFC). The membership roster is appended in *Appendix A* of this report.

It is worth noting as provided in the Preface of the 2020 NBCC, the Code development process is carried out by members of all facets forming the CCBFC and its standing committee. Changes brought forward to the NBCC during each Code change cycle are determined on a consensus basis by the members. It is inevitable that judgement and level of comfort of recognized learned individuals in the subject field form an integral part of the consensus for these Code change decisions, where scientific or evidence-based research is not available. This is inherent for both Canadian and US committees.

It is significant that the American Wood Council and the AHC followed the construction of Tallwood House at UBC quite closely, as can be seen from the reference documentation provided on the America Wood Council website. Andrew Harmsworth, co-author of this report and Fire Engineer of Record for Tallwood House, presented the design of Tallwood House to the AHC at an early meeting in the spring of 2016. Further, given the simplicity of email and internet communication, committee members and related staff were open in sharing fire test data and information between the two countries. Hence, it is not surprising that the conclusions were similar on both sides of the border.

It is useful to understand that the IBC AHC that developed the IBC Code changes adopted the following key principals:

- No collapse under reasonable scenarios of complete burn out of fuel without automatic sprinkler protection.
- No unusually high radiation exposure from the subject building to adjacent properties to present a risk of ignition under reasonably severe fire scenarios.
- No unusual response from typical radiation exposure from adjacent properties to present a risk of ignition of the subject building under reasonably severe fire scenarios.
- No unusual fire department access issues.
- Egress systems designed to protect building occupants during design escape time with a factor of safety.
- Highly reliable fire suppression systems to reduce risk of failure during reasonably expected fire scenarios – degree of reliability proportional to evacuation time (height) and risk of collapse.

These key principals above are based on the objectives included in the Meeting #1 of the AHC of Tall Wood Buildings on July 6-8, 2016.

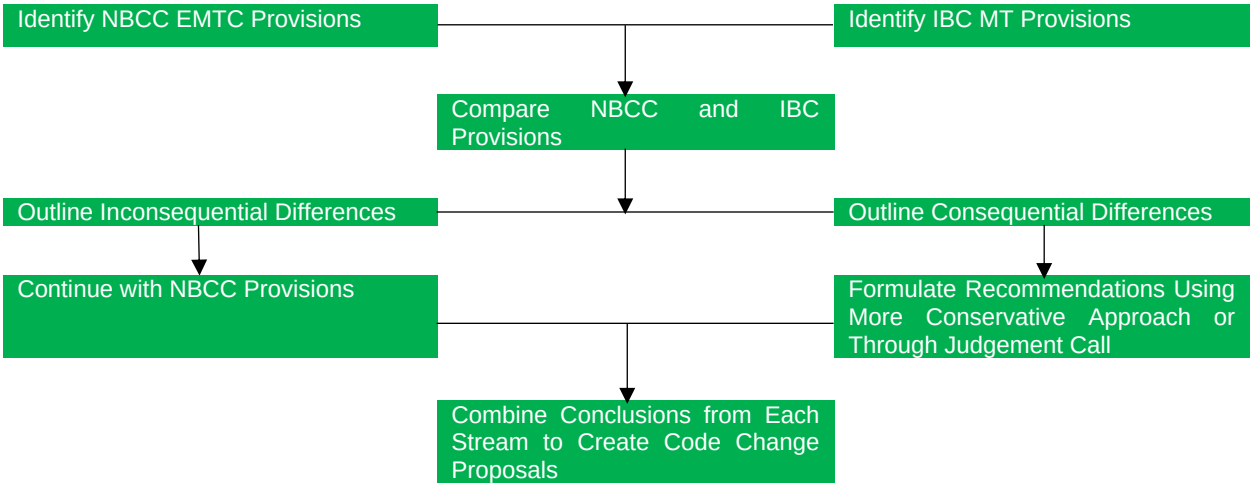
1.2 Purpose of This Report

The purpose of this report is to study the new IBC Code changes and determine if similar permissions can be implemented in the NBCC without an extensive research effort. The report will take the IBC into context for its audience, explore the ICC-AHC research findings, compare the current NBCC 12-storey construction provisions to those of the IBC mass timber buildings, examine structural implications, and discuss the high-level approaches to address challenges. This report will conclude with recommendations of possible Code change proposals for the NBCC.

This report will primarily concentrate on buildings under the Residential and Business occupancies that are sprinklered throughout to parallel those Groups currently permitted by the NBCC, and will also assess other occupancy Groups, as appropriate.

1.3 Methodology

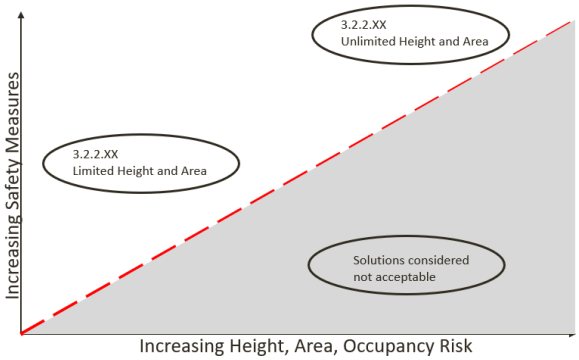
The methodology of this report was to identify differences in the two Codes, compare differences, identify which were consequential and which were not. For the consequential differences, discussion is presented and recommendations made. The approach can be summarized in the following diagram:



2. BUILDING CODE AND FIRE

2.1 Building Height and Area – Subsection 3.2.2 of the NBCC

Building height and area are addressed in the NBCC in Subsection 3.2.2 of Division B. By definition, Division B is simply a set of solutions for different building types, classified by occupancy, height and area, that have been deemed, through the Code Development Process managed by Codes Canada, to provide the level of performance relative to the objectives and functional statements that the Code requires. Inherently these solutions, essentially the Articles of Subsection 3.2.2, are not all the same and do not all provide the same level of performance. The question is simply, *"Do these solutions fit within the realm of solutions that provide the required, but not clearly defined, level of performance?"* Although not defined, it is important to note that there are 'solutions' that do not fall within the realm of acceptable, for example a 12-storey light timber building. These are not 'acceptable solutions.



It is not a requirement of the Code that all these solutions provide the same level of performance, or that they have the same details. However, for simplicity of application, it is important to correlate the details and related Code provisions to maintain readability of the Code and facilitate enforcement.

The question being asked here is whether the solutions in the IBC fall within the set of acceptable solutions of the NBCC, and what related changes are needed in other parts of the NBCC. This report reviews Part 3 and Part 4 of the NBCC. Specific mass timber provisions of IBC are identified and compared to relevant acceptable solutions of NBCC. For example, if a particular IBC provision is more permissive than that of NBCC, the IBC provision is considered to fall within the set of acceptable solutions of NBCC.

2.2 Referenced Standards

Published test standards are often used to evaluate the performance of building materials, assemblies, or construction conditions. Many of these test standards referenced by the NBCC and the IBC originate from various publishers and have different designations. However, many standards used in Canada and the US are sufficiently similar, such that they may have corresponding performance objectives, and in some cases the same or similar acceptance criteria; test laboratories are often capable of meeting the test criteria of both the Canada and US standards with a single effort due to the similar test conditions and conditions of acceptance of the standards.

Table 1 below intends to establish a general comparison of a number of standards employed by these Codes in the context of mass timber buildings.

Table 1: Comparison of Referenced Standards

Performance Metric	Canada	US
Fire-Resistance Rating	CAN/ULC-S101	ASTM E119 or UL 263
	▪ All three standards follow the same time-temperature curve. ▪ Similar test assembly dimension requirements. ▪ Similar conditions of acceptance requirements. ▪ Minor differences include superimposed load calculation, application. ▪ Can be accepted as sufficiently similar in the context of Mass Timber.	
Encapsulation Rating	CAN/ULC-S146	None
	▪ See Section 2.3.2 of this report – IBC simplifies this as contribution to FRR.	
Firestopping	CAN/ULC-S115	ASTM E814 or UL 1479
	▪ All three standards follow the same time-temperature curve. ▪ Similar conditions of acceptance requirements for F, T and H. ▪ Can be accepted as sufficiently similar in the context of Mass Timber.	
Closures	CAN/ULC-S104	NFPA 252, UL 10B, UL 10C
	▪ All four standards follow the same time-temperature curve. ▪ UL 10B uses similar furnace pressure conditions to CAN/ULC-S104; NFPA 252 and UL 10C use more severe furnace pressure conditions. ▪ Fire door testing per the IBC can generally be accepted as meeting the minimum requirement of the NBCC. While the IBC fire door testing is more onerous than the NBCC, we do not believe this is significant in the analysis as discussed later in this report.	

Performance Metric	Canada	US
Roofing	CAN/ULC-S107	ASTM E108
	▪ Both standards are very similar with minor differences in unit conversions. ▪ Roofing testing per the IBC can generally be accepted as meeting the minimum requirement of the NBCC.	
Flame Spread	CAN/ULC-S102 and CAN/ULC-S102.2	ASTM E84 or UL 723
	▪ The standards are not equivalent despite similar test apparatus is used. ▪ For cellulosic materials, values are typically within 5% across both standards, and can be considered equivalent. Substantial differences are found for materials that melt.	
Exterior Wall Flame Propagation	CAN/ULC-S134	NFPA 285
	▪ The standards are not equivalent, though they intend to address a similar exterior wall condition. ▪ Substantial differences include test apparatuses, assembly requirements and conditions of acceptance. ▪ While the standards are different, we do not believe this should affect the analysis, as discussed later in this report.	
Joint Systems	None	ASTM E1966 or UL 2079
	▪ The NBCC does not reference a standard that specifically addresses fire-resistance joint systems for fire-rated assembly intersections. ▪ The NBCC does however require that the integrity of fire separations be maintained. There are proposals for inclusion of requirements for joint protection in the 2020 NBCC.	
CLT Material	▪ ANSI/APA PRG 320, "Standard for Performance-Rated Cross-Laminated Timber."	

2.3 The IBC Context

The IBC is noticeably different compared to the NBCC, particularly in its structure and concept of approach. Chapters of the IBC are topic- or material-driven, where the Canadian Codes follow an objective-based structure.

As most readers of this report are anticipated to be more familiar with the NBCC and related provincial Codes, this section of the report intends to bring the readers into context for the IBC by contrasting a number of topics to demonstrate how the NBCC compares to the IBC generally.

2.3.1 *Types of Construction*

The 2020 NBCC contains three Types of Construction: Combustible (including Heavy Timber), Noncombustible and Encapsulated Mass Timber Construction (EMTC). The IBC on the other hand, contains 5 major Types. Each Type is assigned a Roman numeral, from I to V.

Table 2 summarizes how the NBCC and IBC compare in how the Codes define Types of Construction.

Table 2: Comparison of Construction Types

	2020 NBCC	2021 IBC
Combustible Construction	Defined under Subsection 3.1.4	Types III and V defined under Section 602.3 and 602.5; Type IV-HT Heavy Timber construction under Section 602.4.4
Noncombustible Construction	Defined under Subsection 3.1.5	Types I and II defined under Sections 602.1 and 602.2
Encapsulated Mass Timber Construction	Defined under Subsection 3.1.6, (referred to by Articles 3.2.2.48 and 3.2.2.57)	Types IV-A, -B, and -C defined under Sections 602.4.1-602.4.3 Newly introduced in 2021 IBC
Heavy Timber Construction	Specified as a type of combustible construction under Article 3.1.4.7	2018 IBC contained only Type IV- Heavy Timber

Prior to the 2021 edition, IBC Types I, II, III and V Construction are each divided into -A and -B subdivisions; the -A subdivisions typically have higher construction requirements than those of -B and thus, allow higher building height and area. Prior to the 2021 edition of the IBC, Type IV did not have any subdivisions and was only intended for heavy timber construction (IV-HT). Following the approval of the mass timber Code change proposal in the 2021 cycle, Type IV is now divided into 4 subdivisions, including Types IV-A, -B and -C for mass timber, in addition to the existing -HT. Type IV-A has the highest FRR requirements, the most stringent protection features and thus, with the highest allowable building height and area than those of -B and -C.

FRR requirements of both NBCC and IBC for structural protection are based on regimes of hazard as described below.

Table 3: Comparison of FRR for Structural Protection

	2020 NBCC	2021 IBC
Hazard of Building Size	Division B Subsection 3.2.2, a function of occupancy, but primarily height	Chapter 6, a function of type of construction and indirectly a function of occupancy based on Chapter 5, but primarily as a function of building height
Hazard of Use (Occupancy Types) and Control (Suite)	Division B Subsection 3.1.3, major occupancy fire separations	Chapter 5, occupancy separation requirements

The required FRR for structural protection can be directly correlated to occupancy, which is then applied to buildings as a function of height and type of construction with assumptions of degree of containment and firefighting intervention. These principles are the same for NBCC and IBC, but with variations.

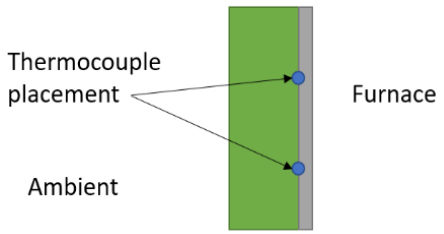
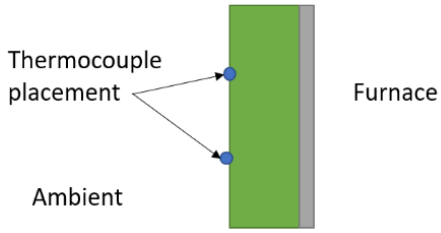
Significant to this discussion is that the 1990 and prior editions of the NBCC include provisions for 3h fire protection for large mercantile and industrial buildings. A decision was made to reduce this to 2h based on the provision of monitored and supervised sprinklers in all large buildings. This is detailed in a publication by the NRC[1].

[1] *Report of the Part 3 Joint Task Group on Automatic Sprinkler Systems to the Standing Committee on Fire Protection and the Standing Committee on Occupancy*, A.J. Aikman, March 1993.

2.3.2 *Fire-Resistance and Encapsulation Ratings*

With the introduction of the EMTC provisions in the NBCC, a new term "encapsulation rating" was defined in addition to FRR. The general requirement is that building elements with exposed timber are to be encapsulated with an approved material and provide a certain rating based on the time until char of timber would occur. It should be noted that encapsulation rating is the time in minutes that a material or an assembly of materials will delay the ignition and combustion of mass timber elements, which is not equivalent to FRR in NBCC. The rating can be achieved by using prescribed materials or through testing per CAN/ULC-S146. Interior protection of mass timber buildings under the IBC, when required, is evaluated per the criteria of ASTM E119 or UL 263, through prescriptive materials, testing, analytical methods or alternative solutions.

Table 4: FRR and Encapsulation Ratings

	NBCC Encapsulation Rating	**IBC Fire Resistance Rating**
Test Standard	CAN/ULC-S146	ASTM E119 or UL 263
Furnace Time-Temperature	Same	
Test Configuration	Horizontal only	Horizontal or vertical, depending on the element
Thermocouple Location	At the interface of encapsulation material and timber substrate Encapsulation Rating 	On the unexposed side of the assembly Fire-Resistance Rating 
Acceptance Condition	Average 250C Singular 270C	Based on contribution to the FRR similar to the Component Additive Method of Appendix D.

Fundamentally, the fire exposure conditions to the protection material have comparable temperatures. Encapsulation rating specifically requires the assembly to be evaluated in the horizontal position, and the IBC method simply follows ASTM E119 or UL 263, which allows both horizontal and vertical positions. The IBC does not specify how temperature rise is measured when evaluating the protection materials, it is however acknowledged that, in terms of FRR, the NBCC prescribes the same rating in minutes for the GWB as the IBC.

Table 5: Prescriptive Protection Times

	Equivalent FRR per NBCC Prescription (min)	**IBC Prescriptive (min)**
12.7mm (1/2in)	25	25
15.9mm (5/8in)	40	40

It is important to note that the NBCC prescriptive installation method of GWB for the prescribed encapsulation rating requires a maximum 400mm screw spacing. It is likely that this was based on the 400mm requirement per the Appendix D provisions. The IBC however, prescribes a maximum screw spacing of 305mm. It is understood that denser screw spacing is generally more secure for fire-resistive design. It is noted the 305mm spacing is consistent with the recommendations of Annex B of the CSA-O86 Engineering Design in Wood.

However, it is noted that in CSA O86-19, 15.9mm Type X GWB is assigned a time contribution of 30min instead of 40min. Also, 12.7mm Type X GWB is assigned a time of 15min for any large-cross-section wood elements, while two layers of 12.7mm Type X GWB a time of 60min for cross-laminated timber. The CSA Technical Committee is currently evaluating these inconsistencies.

Based on the similar FRR prescribed for GWB across the NBCC and the IBC, it can be concluded that the FRR approach employed by the IBC for interior protection is comparable to that of the NBCC. It is later discussed in this report that the IBC requires a minimum 80min FRR protection time on the interior for Type IV-A and -B construction; this in comparison is more conservative than the NBCC encapsulation approach in terms of encapsulation rating, as further discussed under Section 2.6.2 of this report.

The IBC specified that 2/3 of the FRR be provided by passive noncombustible materials; this specification is understood to be by consensus. To demonstrate, it is understood that IBC Type IV-A being fully protected, some of the FRR must come from the noncombustible protection; IBC Type IV-C on the other hand, as it is fully exposed on the interior, the FRR comes from the mass timber. Notwithstanding that, for simplicity it would be appropriate to require an 80min encapsulation for buildings between 13 and 18 storeys, or perform significant additional analysis on the level of encapsulation. It is noted that for CLT, 50min encapsulation rating may be deemed sufficient protection, but some recent testing has indicated that additional encapsulation may be appropriate for NLT.

It has been identified that the IBC provision for 2/3 of the rating to come from the encapsulation was a compromise committee decision, with some members willing to rely on char alone, and others thinking the fire rating should come entirely from the GWB encapsulation.

2.3.3 *Occupancy Groups*

Occupancy classifications under the IBC are more granular compared to the NBCC. One example is the further division of residential occupancy by the IBC based on the occupant type. For reference, Table 6 below is a direct comparison of Occupancy Classifications between the NBCC and the IBC.

Table 6: Group Occupancy Classifications

IBC Classification	Description	NBCC Similar
A-1	Assembly with fixed seating	A-1
A-2	Food and/or drink consumption	A-2
A-3	Worship, recreation or amusement, or other assembly uses not covered in Group A	
A-4	Indoor sporting events	A-3
A-5	Outdoor sporting events	A-4

IBC Classification	Description	NBCC Similar
B	Office, professional or service-type transactions	D
E	Educational purposes, by six or more persons	A-2
F-1	Moderate hazard factory industrial	F-2
F-2	Low hazard factory industrial	F-3
H-1	High hazard: denotation	F-1
H-2	Deflagration	
H-3	Combustion	
H-4	Health hazard	
H-5	Semiconductor fabrication and comparable research and development areas	
I-1	Custodial care for more than 16 persons, 24h basis	B-2 or B-3
I-2	Medical care for more than five persons, 24h basis	B-2
I-3	Inhabited by more than five persons under restraint or security	B-1
I-4	Custodial care for more than five persons, less than 24h basis	B-2 or B-3
M	Mercantile	E
R-1	Containing sleeping units, transient	C
R-2	Containing sleeping units, permanent	
R-3	Those not classified under R-1, R-2 or R-4	
R-4	Custodial care, 24h basis, more than 5, but not more than 16 persons	B-3
S-1	Moderate hazard storage	F-2 or F-3
S-2	Low hazard storage	
U	Utility and miscellaneous	F-3 based on fuel load

2.3.4 *Mass Timber Buildings in the IBC – Building Height*

As discussed above, the NBCC provisions allow construction of 12-storey mass timber buildings of Groups C and D Occupancy under Articles 3.2.2.48 and 3.2.2.57. To draw a direct comparison, this report intends to examine the construction requirements of the Group B and R Occupancies under the IBC, to compare with those included in the NBCC. Table 7 below summarizes the maximum building height of these occupancies.

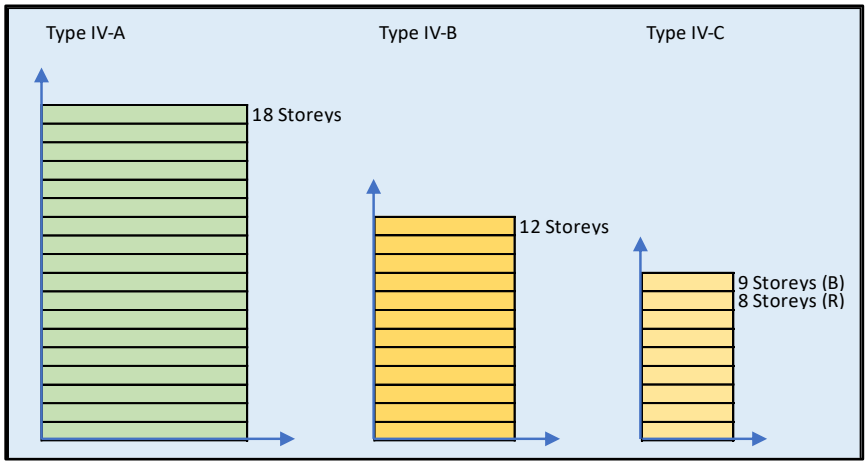
As this report is focused on tall mass timber buildings, for simplicity, the use of sprinklers is assumed. Similarly, the report omitted the issues related to one and 2-storey buildings.

Table 7a: Type IV Mass Timber Building Height (storeys)

	Maximum Building Height (number of storeys)		
Occupancy Classification	IV-A	IV-B	IV-C
B	18	12	9
R-1, R-2	18	12	8
R-3, R-4	18	12	5

Table 7b: Type IV Mass Timber Building Height (m)

	Maximum Building Height		
Occupancy Classification	IV-A	IV-B	IV-C
B and R	82m / 269ft	55m /180ft	26m / 85ft



This report in Section 2.5 expands on the information given above to compare the construction limitations of the NBCC EMTC buildings and the IBC mass timber buildings under Business and Residential occupancy groups.

2.3.5 *Building Area*

Building area under the IBC is a complex topic compared to the NBCC. Instead of prescribing a maximum, the IBC employs equations that calculate "allowable area". The allowable area is an aggregate area of all floors of a building, which does not directly translate to building area by the NBCC's current definition. This is similar to the concept of number of streets faced applicable to nonsprinklered buildings under the NBCC. It is noted that the 2005 NBCC removed the limit on building area based on street faced for sprinklered buildings, and applied the allowable area for buildings facing 3 streets for any sprinklered building, regardless of the number of streets faced. This item was specifically addressed in the Minutes of the 20th meeting of the Standing Committee on Fire Protection of March 21, 22, and 23, 1994, as follows:

In addition, the following was proposed relative to firefighting access to buildings, and relates to a Code Change Proposal reviewed in the Eighteenth Meeting of the Standing Committee on Fire Protection [220]:

> **It was noted that sprinklered buildings that face three streets are given extra credit in permitted area (normally permitted on the basis of increased access for fire fighting) and yet the fire fighting access requirements are waived for sprinklered buildings. It is recommended that Subsection 3.2.2. be changed to permit the same total building area for facing three streets, but not require the three streets.**

The Committee agreed to include the proposed changes in the Second Series of proposed changes for public review.

(Reference page 172 of the report, *The Historical Development of the Building Size Limits in the National Building Code of Canada* by Keith Calder of Sereca Consulting Inc. of March 19, 2015, prepared for the Canadian Wood Council)

These changes were subsequently included in the NBCC 2005.

For the purpose of a straightforward analysis, a building assumed to be of single occupancy and uniform in shape (e.g., square) was assessed.

To calculate building area, a building area factor is selected from Table 506.2, depending on the major occupancy, type of construction, building height, and use of sprinklers. By following the equations under 506.2.1, an allowable area is calculated. The allowable area is the aggregate floor area of the building. Through the lens of the NBCC, per the definition, the building area is the calculated allowable area divided by the number of storeys, for a building that is uniformly shaped.

For example, an 18-storey, sprinklered building of Group R-2 (Apartment) major occupancy is calculated as the follows:

- Under Type IV-A, the allowable area factor (A_t) is 184,500.
- Given the building is greater than 3 storeys, Equation 5-2 under 506.2.1 is used:
  - $A_a = [A_t + (NS \times I_f)] \times S_a$
- NS is the tabular allowance area factor for a nonsprinklered building (regardless of whether the subject building is sprinklered. In this case, the NS is 61500.
- I_f is the frontage factor. For comparison with the NBCC, maximum frontage factor is used. The rationale is that the NBCC does not limit building areas for sprinklered buildings based on frontage, and that all buildings under the NBCC are to face a street. In this case, the I_f is 0.75.
- S_a is either 3 or 4 as described under 506.2.1. In this case, the building is sprinklered, S_a is 4.
- The calculated A_a is 925000 sf. This is the aggregate floor area of all storeys.
- As the imagined building is 18 storeys tall, each floor is 51250 sf, which is 4761 m^2.
- As the building is uniformly shaped, the building area, as defined by the NBCC, is 4761m^2.

Using the same calculation method, an 18-storey, sprinklered building of Group B (Office) major occupancy has a maximum building area of 8361m^2.

As demonstrated, the IBC building area for uniformly shaped buildings is generally more conservative than that permitted in the NBCC for residential buildings, and is less conservative for office buildings. For instance, a sprinklered 12-storey Group R-2 building of the Type IV-B construction has a maximum building area of 4761m^2; Article 3.2.2.47 of the NBCC permits an EMTC Group C building to have a

building area of 6000m^2, for any building height not more than 12 storeys. On the other hand, shorter buildings under the IBC can have more building areas than those permitted by the NBCC when calculated using the method above.

Table 8 is a summary of a comparison of 12-storey Residential and Office buildings between IBC Type IV-B and NBC EMTC. Type IV-B is used as it is a more direct comparison given this building type permits maximum 12 storeys.

Table 8: Building Area Comparison

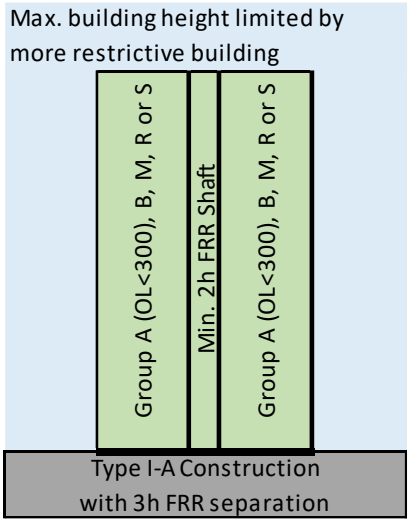
	IBC Type IV-B (m^2)	NBCC EMTC (m^2)
Office	8361	7200
Residential	4761	6000

The IBC is either more or less conservative than the NBCC for building areas. In addition, it is noted that the above calculation assumes uniformly shaped buildings. A thin tower situated above a larger podium may not exceed the allowable area under the IBC, and may exceed the prescribed building area under the NBCC. Given the complex approach to building areas in the IBC, the approach taken in Report intends to maintain the current EMTC building areas and not explore the IBC options at this time.

It is noted that reconsideration of building area was on the agenda for the 2005 NBC. However, this was deferred to the next Code cycle and does not yet appear to have occurred. (Reference: The Historical Development of the Building Size Limits in the National Building Code of Canada by Keith Calder, dated March 19, 2015).

2.3.6 *Podiums*

The provision of NBCC Article 3.2.1.2 permits a building containing a storage garage to be separated from the remainder of the building as a separate building by a "3.2.1.2 slab". The limitation is that the occupancy group below the 3.2.1.2 slab is to be a storage garage. Under the IBC, a similar approach is taken except the separation is above grade for occupied space, and there are no restrictions on the group occupancy on the lower building other than high-hazard industrial (H – similar to a Group F, Division 1 occupancy in the NBCC), but only that the lower building is of Type I-A construction:



The building height is restricted by the building having the smaller allowable height measured from grade. For example, if the upper building is Type IV-A, which has a maximum building height of 82m, although unlimited building height is permitted for the lower Type I-A building, the sum of the heights of the lower building and upper building cannot exceed 82m.

The Podium approach was not further reviewed as it is considered outside the scope of this review.

2.3.7 *High Buildings*

Both the IBC and NBCC have high building provisions. For mass timber buildings, NBCC provisions are more conservative than those of the IBC in terms of height dimension, given that EMTC buildings are considered to be high buildings greater than 18m, whereas the 2021 IBC defines "high-rise buildings" as a building with an occupied floor located more than 22.9m (75ft) above the lowest level of fire department vehicle access.

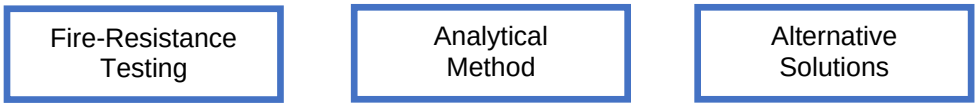
2.3.8 *Approach to Fire Resistance Rating*

The FRR of a building element indicates the time the element can withstand the impact of fire while maintain its required structural integrity when exposed to fire under specified conditions of test and performance criteria, or as determined by extension or interpretation of information derived therefrom.

Under the IBC, FRR is determined by three avenues:

- Fire-resistance testing in laboratory setting.
- Analytical method.
- Approval of alternative method according to Section 104.11.

Three avenues to determine FRR under the IBC:



Evaluating FRR of assemblies through testing is accepted by the IBC and NBCC. Due to the similarity of the tests, accredited laboratories typically are able to address both Codes through a single test. Minor differences between each standard are not discussed as they are outside the scope of the report and do not affect the outcome of the report.

Likewise, analytical methods including using documented or prescriptive designs, designs that are calculated or determined through engineering analysis, or listed designs by an approved agency are accepted by both Codes.

The IBC and NBCC permit alternative solutions to be used in achieving the objective of the Code.

It is understood in the industry that, unlike light wood frame members, mass timber building elements including beams, columns, walls and ceiling panels possess inherent FRR. The mass timber's ability to char is a pertinent feature of its fire resistance. When protected by a noncombustible covering material, additional fire-resistance is implemented. Under IBC Section 722.7.1, the assigned time of ½in (12.7mm)

and 5/8in (15.9mm) GWB are provided. Pertaining to the NBCC, the assigned times are given in CSA O86, and these times are expected to change so that they match the NBCC Appendix D assignments. For the purpose of FRR calculation, since GWB used in Canada and the US are governed by the same standards, it can be concluded that the same increase in FRR can be achieved using both the IBC and NBCC methods.

2.4 ICC Ad Hoc Committee Research

The ICC Board created the ICC AHC on Tall Wood Buildings in December 2015. The purpose of this group was to conduct research on the science, feasibility of tall wood buildings, and subsequently act on proposing Code changes to accommodate tall wood buildings in the IBC. The AHC contained professionals including building and fire officials, architects and engineers, fire protection specialists, representatives from construction materials manufacturing, and other construction-related professionals. There were four work groups for a total of four topics: Definition and Standards, Fire, Structural, and Codes.

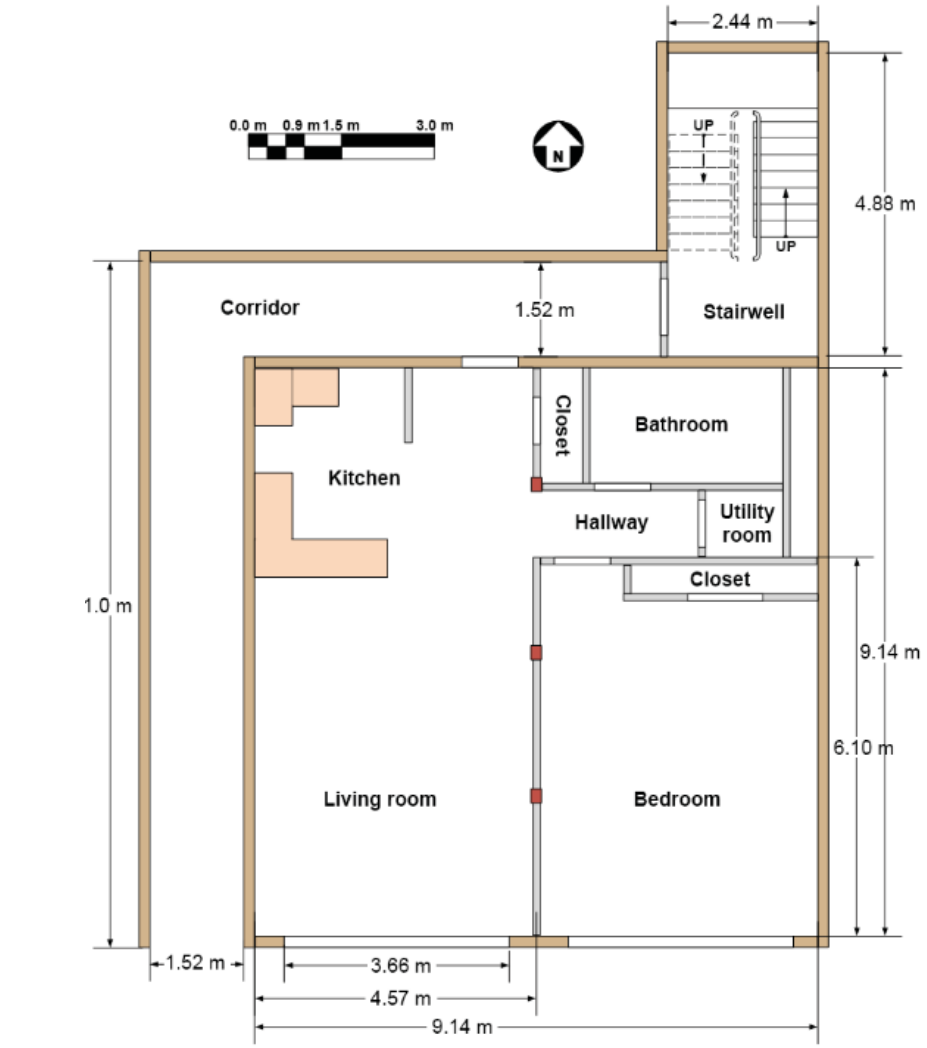
The performance objectives of tall wood buildings were set to be to following:

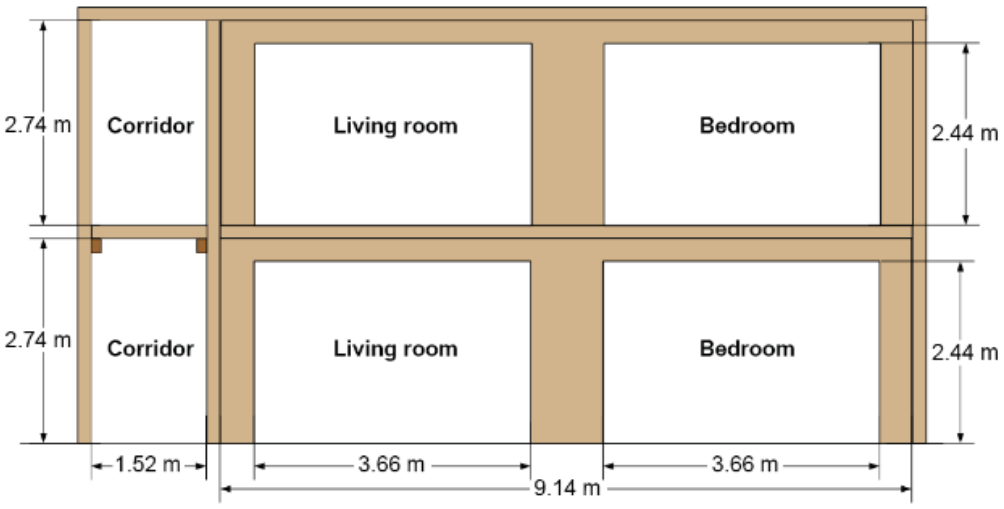
- No collapse under reasonable scenarios of complete burn out of fuel without automatic sprinkler protection.
- No unusually high radiation exposure from the subject building to adjacent properties to present a risk of ignition under reasonably severe fire scenarios.
- No unusual response from typical radiation exposure from adjacent properties to present a risk of ignition of the subject building under reasonably severe fire scenarios.
- No unusual fire department access issues.
- Egress systems designed to protect building occupants during design escape time with a factor of safety.
- Highly reliable fire suppression systems to reduce risk of failure during reasonably expected fire scenarios – degree of reliability proportional to evacuation time (height) and risk of collapse.

2.4.1 *Fire Tests*

The AHC conducted five large-scale fire tests to confirm that the fire protection performance intended by the IBC could be retained by the mass timber building elements. Each test was conducted on a two-level, apartment-style structure built of CLT members. The structure contained a one-bedroom apartment, an L-shaped corridor, and a set of stairs connecting the two levels.

Each structure was fully furnished with common mechanical, electrical and plumbing services, penetrations, doors, windows, and furniture.


2.44 m
0.0 m 0.9 m 1.5 m 3.0 m
N
UP
UP
4.88 m
Corridor
1.52 m
Stairwell
Closet
Bathroom
Kitchen
Hallway
Utility room
Closet
1.0 m
9.14 m
6.10 m
Living room
Bedroom
1.52 m
3.66 m
4.57 m
9.14 m


2.74 m
Corridor
Living room
Bedroom
2.44 m
2.74 m
Corridor
Living room
Bedroom
2.44 m
1.52 m
3.66 m
3.66 m
9.14 m

Each structure contained a different amount of unprotected timber, with the first test having none, and the last two tests having the most. It is noted that all exposed walls are not in direct view of each other; the last two tests contain exposed wall and ceiling at 90 degree angle. The first three tests reached flashover, the fourth test utilized a sprinkler system for suppression, and the fifth utilized a sprinkler system but with a delayed activation.

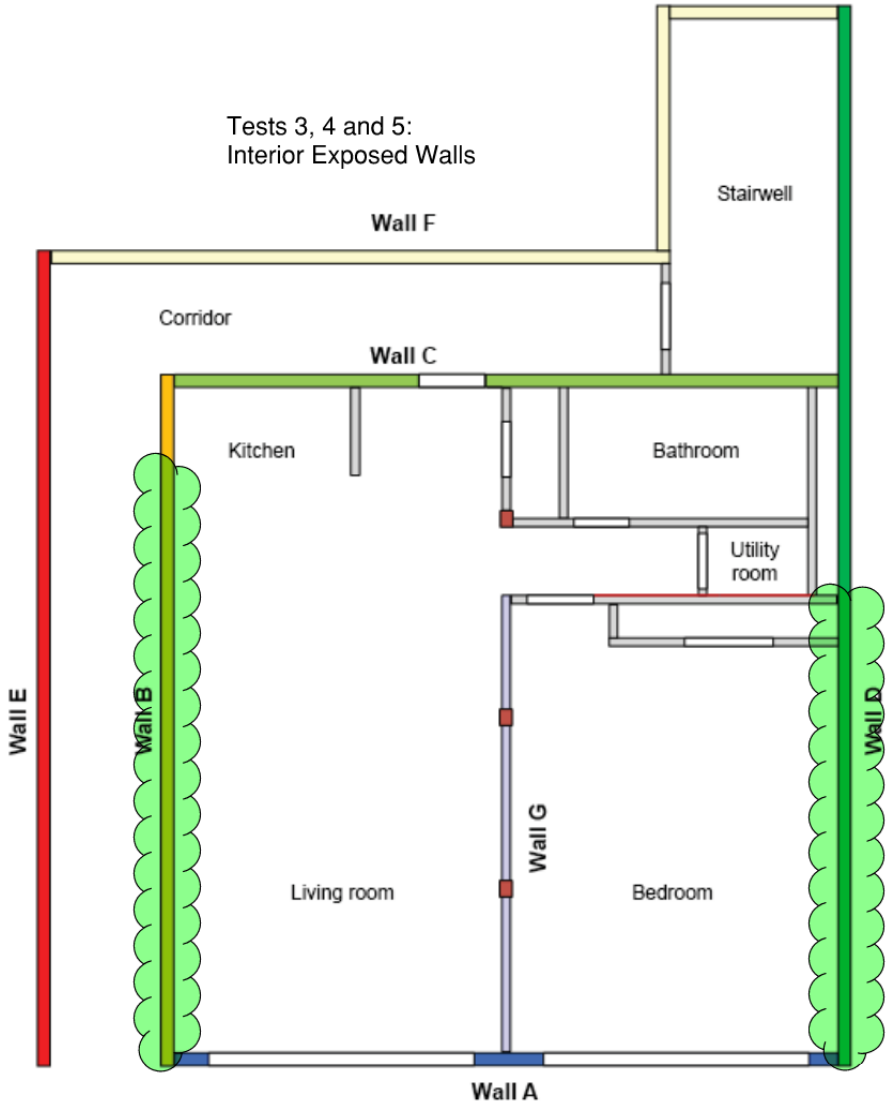
Table 9: AHC Test Summary

	Test 1	Test 2	Test 3	Test 4	Test 5
Test Structure	2-storey, apartment style structure with corridor, constructed using CLT				
Interior Timber Exposure	0%	30% of total ceiling area	Wall: Marked on diagram below	Wall: Marked on diagram below Ceiling: 30% of ceiling area	
Sprinklers Activation	None	None	None	2:37	23:00[2]
Flashover Living Room	13:27	11:42	12:37	None	None
Flashover Bedroom	17:20	17:20	17:00	None	None
Flames in Hallway	26:51	30:38	13:06 (installation error)	None	9:00[3]
Compartment Door[1] Fails	57:46	63:59	29:42 (installation error)	None	None

[1]Fire door used was 20min FPR.

[2]Sprinkler was manually activated.

[3]Apartment door was open at the start of the test.



The test results demonstrated that the tested timber structures achieved an overall negative compartment temperature trend, and an overall negative trend of compartment heat release rate.

It is significant that Canadian tests indicated two layers of ½in Type X GWB was sufficient to lead to burnout, although compartments were not as large as the US test compartments. Further, the tests were conducted with older type CLT with heat sensitive adhesives, demonstrating delamination under certain conditions. The current CLT product standard specified in the NBCC, *ANSI/APA PRG 320-2018: Standard for Performance-Rated Cross-Laminated Timber* requires CLT constructed with the new heat resistant adhesives, such that performance is significantly better.

2.4.2 *Development of Type IV Construction Requirements*

The fire tests conducted by the AHC propelled the subsequent IBC Code change proposals. The proposals began with Type IV-B, which was modelled after the existing Type I-B in its FRR, building height and area provisions. Type I-B, under certain circumstances, is allowed a reduced FRR from 2h to 1h. The AHC took on a more conservative approach and did not propose that such reduction to be permitted on the Type IV-B buildings. In this light, Type IV-B buildings were proposed to have the same building height, area, and FRR without any reduction permissions.

Type I-A buildings have unlimited building height and area. Although Type IV-A construction is given the same FRR provisions, the AHC determined that the building height and area for Type IV-A were to be limited, unlike those of Type I-A. In general, a multiplier of 1.5 was applied to the height developed for Type IV-B to provide reasonable height provisions for Type IV-A.

Type IV-C has the same FRR requirements as those of Type IV-B. The major difference is that Type IV-C permits 100% exposed timber on the interior, similar to Type IV-HT buildings. In this light, Type IV-C buildings are permitted the same building height in feet to Type IV-HT but are allowed additional number of storeys in recognition of Type IV-C's FRR and additional fire protection provisions.

Using a similar approach, the building area factors were developed by the AHC. Fire safety risk for each new construction type was examined and compared with Type IV-HT. A multiplier was developed for each new type to reflect the additional fire protection provisions.

In summary and with a level of generalization, the AHC took the following approach to determine the building height and area factors for Type IV buildings:

Table 10: Type IV Mass Timber Building Area and Height Factors

Building Height in Feet	Building Height in Storeys	Building Area Factors
Type IV-A = 1.5 x Type IV-B		Type IV-A = 3.00 x Type IV-HT
Type IV-B		Type IV-B = 2.00 x Type IV-HT
Type IV-C = Type IV-HT	Type IV-C ≥ Type IV-HT	Type IV-C = 1.25 x Type IV-HT
Type IV-HT (unchanged)		

It is understood that these multiplication factors were based on committee consensus of what is reasonable, rather than values derived on a technical basis.

2.5 Comparison of 12-Storey Mass Timber Buildings

This section of the report intends to compare the 12-storey mass timber buildings prescribed in the NBCC and the IBC. Specifically, buildings allowed under Articles 3.2.2.48 (Group C) and 3.2.2.57 (Group D) are compared to Type IV-B buildings for Groups B and R. For the purpose of a direct comparison, other occupancy groups allowed under the IBC Type IV-B construction are not addressed in this section.

Table 11: NBCC Construction Article to IBC

2020 NBCC	2021 IBC
3.2.2.48	Type IV-B, Group R
3.2.2.57	Type IV-B, Group B

The table below is a summary of how the 12-storey mass timber buildings compare.

Table 12: Construction Requirements of NBCC EMTC and IBC Type IV-B

	2020 NBCC		2021 IBC	
	3.2.2.48	3.2.2.57	Type IV-B, Group B or R	
Maximum Number of Storeys	12	12	12	
Maximum Building Height	42m (138ft)	42m (138ft)	55m (180ft)	
Maximum Building Area (m^2) (Building Area Factor for IBC)	6000	7200	Group B	Group R
			8361[3]	4761[3]
Sprinklers	Yes		Yes	
FRR-Floor (h)	2		2	
FRR-Roof (h)	Not prescribed [1]		1	
FRR-Mezzanine (h)	1		Not specified	
FRR-Loadbearing (h)	Not less than that supported		2	
Interior Nonloadbearing Walls (h)	Not specified		0	
Exterior Nonloadbearing Walls (h)	Determined by spatial separation		Rating determined as the greater of: 1. Table 601 for type of building element based on building construction type 2. Table 601 for exterior bearing walls based on construction type 3. Table 705.5 for exterior walls based on fire separation distance	
Exterior Protection	Limitations on combustible materials in exterior walls and cladding requirements - further discussed in latter sections in this report		Minimum 40min FRR; all materials are noncombustible except water-resistive barriers	
Interior Protection / Encapsulation	50min Encapsulation Rating		Protection time 80min FRR	
Unprotected Wood	Beams, columns and arches: 10% of the total wall area Walls [2]: 35% Ceiling: 10%-25%		Ceilings and Beams: 20% of the floor area Walls and Columns: 40% of the floor area - further discussed in latter sections in this report	
Minimum Wood Element Size	Per Table 3.1.6.3		Not specified	

1 Roof rating is not specified by NBCC under these construction articles. This is consistent with the code approach of not prescribing roof rating where a building is sprinklered throughout for other non EMTC buildings.

2 Subject to limitations on direction faced for walls.

3 Calculated for a uniformly shaped, 12-storey building. Shorter buildings will have greater building areas per the definition of NBCC.

From the table above, there are several observations drawn to highlight some important differences between the NBCC and IBC provisions.

It is noted that although the maximum building height in number of storeys is 12 for both Codes, the maximum building height in metres of those of IBC is significantly taller. Residential (Group R in the IBC), is further divided into subgroups, have varying maximum building area factors. The NBCC on the other hand, takes a blanket approach under Group C.

It is noted that the NBCC Task Group on Combustible Construction's working Group 3 – Building Size Review in their report of January 27, 2017, responded on the issue of the EMTC maximum of 12 storeys question as follows:

> #5 Why is the limit to the proponent's proposal 12 storeys (CWC PC 5, 6)?
>
> The proponent, the CWC, acknowledged that the 12 storey limit was considered a reasonable next step in the progression of the NBC after the results of the work by the SC-FP on mid-rise (6-storey) combustible construction, which was introduced in the NBC 2015. The proponent also related this targeted building height of 12 storeys to discussions around the 'equivalency' to noncombustible construction issue. In that regard, the proponent noted that the basis for their 12 storey building height and related area limits (Group C – 6,000 m^2/Group D – 7,200 m^2) was linked to the requirements for 6 storey noncombustible buildings (and not buildings of unlimited Height/unlimited Area). It was also noted that the Quebec Design Guide on Tall Wood Buildings had chosen 12 storeys and that several tall wood building projects proposed or being built here in Canada and abroad were in the 10-12 storey range.

Having chosen a height of 12 storeys as a 'reasonable next step in the progression of the NBCC, the report notes the task group simply chose a relatively standard 3.5m floor to floor height. The height limit was related to concerns with the potential of an excessive number of mezzanine levels.

In addition to the building height allowance in the IBC, Type IV-B buildings also permit 20% of unprotected wood on ceilings or 40% on walls. Where both portions of ceilings and portions of walls are unprotected, the total allowable unprotected area is determined proportionally:

$$\frac{U_{unprotected\_ceiling\_areas}}{U_{allowable\_unprotected\ \_ceiling\_areas}} + \frac{U_{unprotected\_wall\_areas}}{U_{allowable\_unprotected\_wall\_areas}} \leq 1$$

Another notable difference is the FRR requirement of roofs and mezzanines. The IBC provisions require the roof of the buildings to be minimum 1h rated, Moreover, the IBC does not address the FRR requirement of mezzanines, where the NBCC is explicit in its requirement.

In a similar approach to the NBCC, the IBC considers two criteria for the FRR requirement on exterior walls: type of construction and fire separation distance (known as Limiting Distance in the NBCC). The FRR requirements on loadbearing elements, including exterior walls, are not less than those supported. Nonloadbearing walls, on the other hand, may be required an FRR depending on the fire separation distance. See the Section on exterior walls in this report for a further discussion.

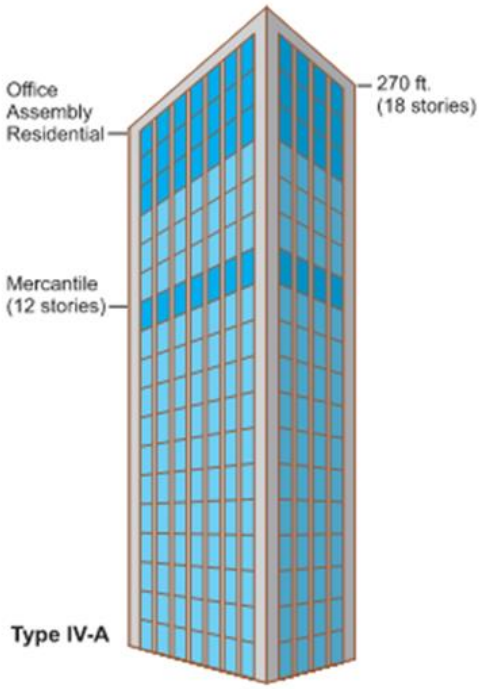
In summary, construction requirements of Type IV-B for Groups B (Business) and R (Residential) buildings under the IBC are relatively comparable to those prescribed by the NBCC 12-storey EMTC Articles. There are a number of important exceptions in maximum permitted building height, area, exposed interior and permitted types of occupancy. The IBC provisions are significantly more ambitious and generous in these aspects. One significant reason is that through the Code change, the Type IV provisions were proposed to be conceptually comparable to those of Type I, the most stringent noncombustible type. The Types I and IV parallel is also evident by their almost identical respective FRR requirements (see 2021 IBC Chapter 6, Table 601). Therefore, Type IV effectively attempts to match those construction allowances by Type I, while also maintains a conservative approach on building height and area.

The summary of the comparison in Section 2.5 are the follows:

- Building Height: The NBCC is equal to IBC in number of storeys; the NBCC is more conservative in meters.
- Building Area: See 2.3.5 of this Report.
- Interior Exposed Timber: The NBCC is slightly more conservative.
- Interior Protection: The NBCC is less conservative (NBCC: two layers of 12.7mm Type X GWB, 50min encapsulation rating; IBC: two layers of 15.8mm Type X GWB, 80min FRR).

2.6 Types IV-A and IV-C Buildings and the NBCC

To extend the comparative effort of the NBCC 12-storey EMTC buildings with IBC Type IV-B, the IBC Type IV-B is compared to Types IV-A and IV-C. The NBCC 12-storey EMTC is therefore indirectly compared to these IBC Types.



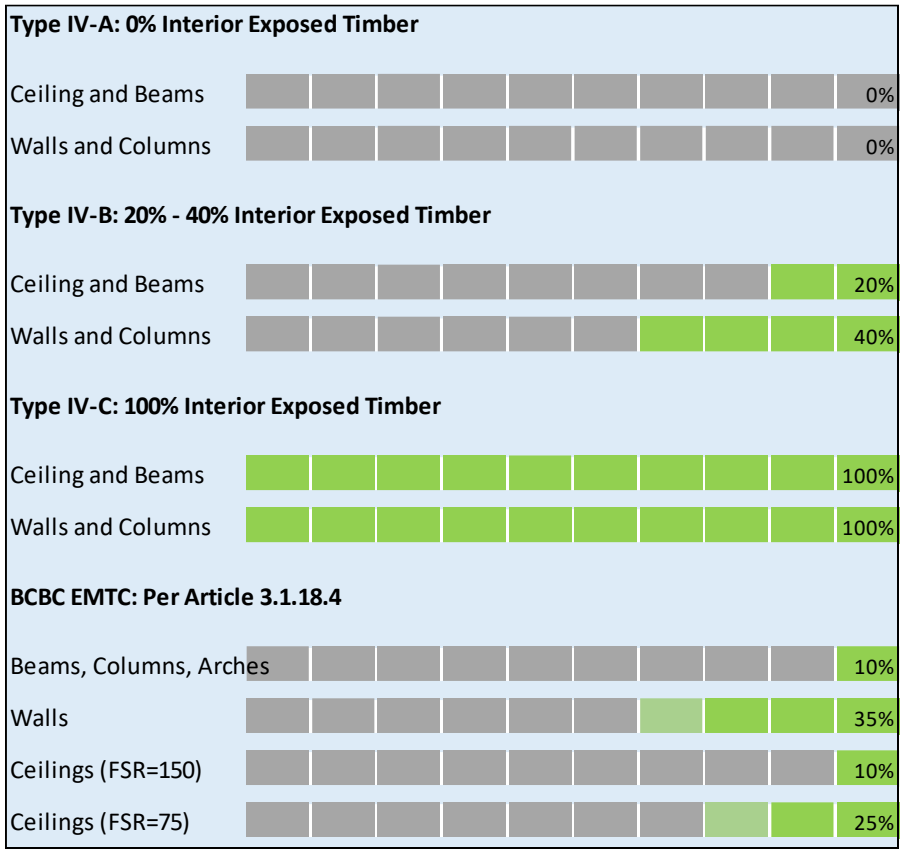
2.6.1 *18 and 9 Storey Mass Timber Buildings*

Now that a parallel is established between the prescriptive 12-storey mass timber buildings in the NBCC and the IBC, it is useful to explore the requirements of 18- and 9-storey buildings currently prescribed by the IBC. For reference and context, the most stringent IBC Type I-A is also included for comparison. The table below is a summary of how these buildings compare.

Table 13: Construction Requirements of IBC Type I-A and Type IV Buildings

	Type I-A, Group B or R	Type IV-A, Group B or R	Type IV-B, Group B or R	Type IV-C, Group B or R
Maximum Number of Storeys	Unlimited	18	12	B: 9 R-1: 8 R-2: 8 R-3: 5 R-4: 5
Maximum Building Height (m)	Unlimited	82	55	26
Maximum Building Area (m2)	Unlimited (except for H)	See Table 506.2. Limited. Maximum allowable area in the order of -A, -B and -C; Group B allotted larger area than R.		
Sprinklered (Yes/No)	Yes			
FRR-Floor (h)	2	2	2	2
FRR-Roof (h)	1½	1½	1	1
FRR-Mezzanine (h)	Not specified			
FRR-Loadbearing (h)	3	3	2	2
Interior Nonloadbearing Walls (h)	0	0	0	0
Exterior Nonloadbearing Walls (h)	See Table 705.5 1h maximum for B or R at the most restrictive fire separation distance. (This is discussed under the Section 2.7.)			
Protection (encapsulation)	N/A	80	80	0, one layer 5/8in Type X GWB for shafts
Interior Unprotected Wood (%)	N/A	0%	Horizontal: 20% Vertical: 40%	100%
Superimposed Occupancies	Not specified			

Relative to Type I-A buildings, which in most cases allow unlimited building height and area, the Type IV-A building takes a more conservative approach, despite having the same FRR requirements for building elements. Types IV-B and -C are permitted with less stringent FRR and more exposed interior wood areas with decreased maximum building heights and areas. Type IV-B and -C essentially have the same FRR construction requirements except IV-C allows up to 100% exposed timber on the interior.



There are several Construction Articles in the NBCC that permit buildings of unlimited building heights and areas. These provisions prescribe minimum 2h FRR of floor assemblies, so that those elements supporting the floor assemblies are prescribed to have minimum 2h FRR. Type I-A buildings under the IBC, on the other hand, prescribe minimum 3h of vertical supporting elements.

In comparison with Type IV-B discussed above compared to the NBCC 12-storey, Type IV-A contains elements of higher FRR and does not permit any unprotected interior. Type IV-C contains elements of the same FRR but allows up to 100% unprotected interior. Additionally, Type IV-A prescribes FRR of primary structural frame and bearing walls up to 3h, higher than the FRR required by the supported element. The NBCC only prescribes up to the FRR to be the same of that supported. The Primary Structural Frame as defined by the IBC includes all of the following structural members:

1) The columns.
2) Structural members having direct connections to the columns, including girders, beams, trusses and spandrels.
3) Members of the floor construction and roof construction having direct connections to the columns.
4) Members that are essential to the vertical stability of the primary structural frame under gravity loading.

Other than firewalls and a few other specific conditions where 3h FRR is required such as occupancy separation between Group F1 and D or E, certain underground conditions, unsprinklered electric vault, etc., the highest FRR required by the NBCC is generally 2h.

Canadian Codes prior to 1995 typically required 3h FRR for higher challenge occupancies, Groups E and F-2. In the 1995 Code cycle the considerations were given to improved sprinkler system reliability through such as supervision that a 2h FRR was sufficient for the high challenge occupancies, and the maximum FRR for all occupancies was reduced to 2h, with the exception of firewalls and other specific conditions as described above. It is our opinion that this logic remains applicable and use of 2h FRR remains valid, even for Group E or F-2 occupancies. Further, the EMTC provisions of the 2020 NBCC permit a Group E occupancy on the first and second floor. This would indicate that the Standing Committee considered a 2h FRR sufficient for a high challenge consistent with an E or F-2 Occupancy.

The AHC did not re-assess required FRR, they simply adopted the FRR specified in the IBC for Type I occupancies of 18 storeys. It is noted that in the IBC the rating of the supporting structure is specified independently of the floor, and even at 18 storeys, Floor FRR remain 2h.

2.6.2 *Interior Protection / Encapsulation*

As discussed above, Type IV buildings divided into -A, -B or -C not only differ by the FRR provisions, but also the interior protection requirements. Essentially the term 'Interior Protection' is equivalent to the NBCC term Encapsulation. Type IV-C uniquely allows 100% unprotected interior occupied spaces and its maximum building height and area are consequently reduced. Although the NBCC EMTC buildings permit roughly similar percentage of exposed timber than that of Type IV-B, it is important to note that the interior protection required by Type IV-B is minimum 80min FRR, which is achieved by two layers of 15.9mm Type X GWB. The NBCC, on the other hand, requires 50min, achieved by two layers of 12.7mm Type X GWB.

In effect, the NBCC interior protection provisions for EMTC buildings are less conservative compared to those of the IBC Type IV-B.

It is important to note that both the IBC and NBCC testing on which the changes were based used the old style CLT, not the newer CLT per ANSI/APA PRG 320-2018, which requires heat resistant adhesives (the former could delaminate, resulting in more exposed wood). It is significant that more recent testing in both Canada and the US are indicating that with the new CLT, the amount of exposed timber can be significantly increased. There are proposed changes of this nature currently being reviewed for the NBCC. As a consequence, adopting an 18-storey building fully encapsulate provision similar to the IBC would be conservative. It should be noted Codes Canada is currently reassessing permitted exposed timber in EMTC based on this improved performance of the newer CLT.

It is significant that Canadian studies of encapsulation values indicate that while studies of wood frame walls would confirm the 80min contribution to a fire rating, such as ULC design U301, consisting of two layers of 5/8in Type X GWB on wood studs, the encapsulation rating for two layers of 5/8in Type X GWB is only 60min as determined by the NRC report, "*Solutions for mid-rise wood construction: encapsulation time data from NRC Fire-Resistance Projects: report to Research Consortium for Wood and Wood-Hybrid Mid-Rise Buildings."*[2] The difference between testing for encapsulation rating and fire-resistance rating is discussed in detail under 2.3.2 of this Report.

[2] (Lougheed, G.D.; Su, J.Z.; Bénichou, N. https://nrc-publications.canada.ca/eng/view/ft/?id=a8ad663c-2bc6-4e6a-88d7-fbcd602433b2)

2.6.3 *Exits*

Under 602.4, the IBC prescribes mass timber interior exit and elevator hoistway enclosures to be protected per Section 602.4.1.2 in buildings with an occupied floor located more than 75ft above the lowest level of the Fire Department access, up to 12 storeys or 180ft above grade plane. The protection required is full protection with material that has time assigned of not less than 80min. Exits and elevator hoistways in buildings greater than 12 storeys or 180ft above grade plane are prescribed to be constructed using noncombustible materials – similar to that of Brock Commons at UBC.

It is noted that the NBCC prescribes minimum enclosure fire resistance ratings and maximum flame spread ratings for exits and elevator hoistways (25 and 75, respectively). This may be achieved by providing mass timber encapsulation with gypsum board. However, the NBCC does not specifically prescribe a more onerous type of construction for a building permitted to be constructed of a less onerous type.

In general, the prescribed solution by the IBC is considered to be more conservative than that of the NBCC. On the other hand, it has been demonstrated through a full-scale mass timber fire test that a tested mass timber elevator hoistway did not encounter fire spread from a neighbouring compartment with a high fuel load as the fire origin. The same performance can be expected for exit stair towers. It is also significant to note that the tested mass timber structure was constructed using first generation CLT, which commonly encountered delamination under fire conditions. CLT delamination occurs when the adhesive loses strength so that charred timber, which would otherwise serve as an insulator for the fresh timber behind, falls off thus exposing fresh timber. It is noted that the delamination effect is mostly resolved with CLT members now using heat-resistant adhesives.

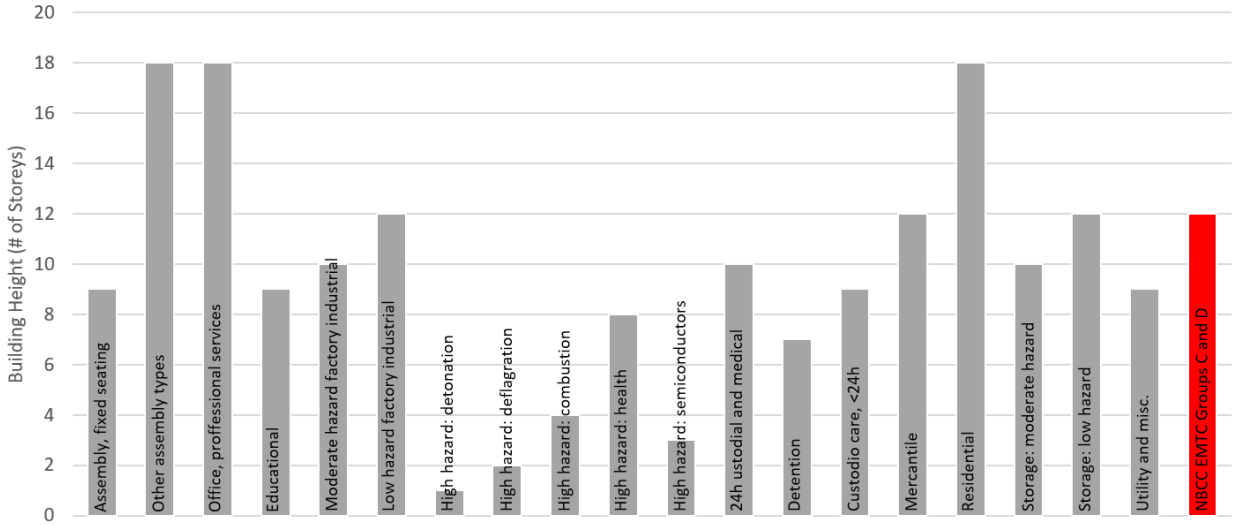
The test is documented in a report entitled “Full-scale Mass Timber Shaft Demonstration Fire – Final Report” prepared by FPInnovations.

As such, to prescribe exit and elevator shafts of noncombustible construction for buildings taller than 12 storeys in the NBCC is not considered necessary. However, it is recommended that full encapsulation is provided within exits, shafts including elevator hoistways, and concealed spaces.

2.6.4 *Other Occupancies*

The maximum allowable building height and area for Type IV constructions vary by the type of occupancy intended, depending on the inherent risk of each occupancy group, although to our knowledge the technical rationale behind the correlation between occupancy types and allowable building height and area is not well documented. The chart below is a general comparison of each occupancy group for the IBC Type IV-A buildings. It is established that, in general, multiplication factors were applied in developing the constraints. Therefore, the comparative demonstration for Type IV-A can be roughly correlated to Types IV-B and -C. Sprinklered buildings are assumed.

Chart 1: Type IV-A and EMTC Building Height per Occupancy



Note: A-5 (e.g., stadiums) is not discussed.

With respect to building area, we do not perceive a demand for buildings exceeding the 6000m² for Group C and 7200m² for Group D. As context, a typical block in Vancouver is 80m by 120m or 8000m², so a very small percentage of buildings would exceed these maximum areas. Given the time constraints on the study, area was therefore not further considered in this study. However, these limits on area should be considered a reasonable step, consistent with the discussion above on the choice of 12 storeys.

The summary of the comparison in this Section are as follows:

- Building Height: NBCC is more conservative in permissible number of storeys and actual building height measured in meters.
- Building Area: See 2.3.5 of this Report.
- Fire Resistance Rating: Although the NBCC does not currently permit 18-storey EMTC buildings, the FRR required on vertical loadbearing elements are 2h, where the IBC requires 3h for the primary structural frame and bearing walls of Type IV-A buildings (between 13 and 18 storeys or of higher building area).
- Interior Exposed Timber and Interior Protection: The NBCC is more conservative for 9-storey buildings (100% permitted by IBC); the NBCC does not permit 18-storey buildings.

2.7 Exterior Walls

2.7.1 *FRR Provisions*

FRR provisions in the NBCC and IBC on exterior walls are driven by two factors: loadbearing and limiting distance (NBCC) / fire separation distance (IBC). Should both factors apply, FRR is determined by the most stringent requirement. It is then important to establish that if the exterior wall is loadbearing, the FRR provision will always exceed those prescribed by spatial separation, as all floor FRR are 2h for NBCC and IBC tall wood buildings, and that for Residential and Business type occupancies, the highest FRR requirement per spatial separation is 1h, regardless of the construction Article/Type.

Per the NBCC, FRR of exterior walls are rated from the interior, the same can be said for the IBC but with one exception. Under the IBC, exterior walls of buildings with a fire separation distance not more than 3048mm are to be rated from both interior and exterior sides. Differing from the NBCC, the exterior wall temperature rise required by ASTM E119 or UL 263 under the IBC may not apply, or may apply with a correction factor, depending on the limitation of protected openings in the exterior wall; while a correction factor for temperature rise exists in the NBCC per Sentences 3.2.3.1.(9) and (10), it is rarely used.

2.7.2 *Protected and Unprotected Openings*

The table below is a summary the provisions on protected and unprotected openings:

Table 14: Factors to Determine % of Openings in Exterior Walls

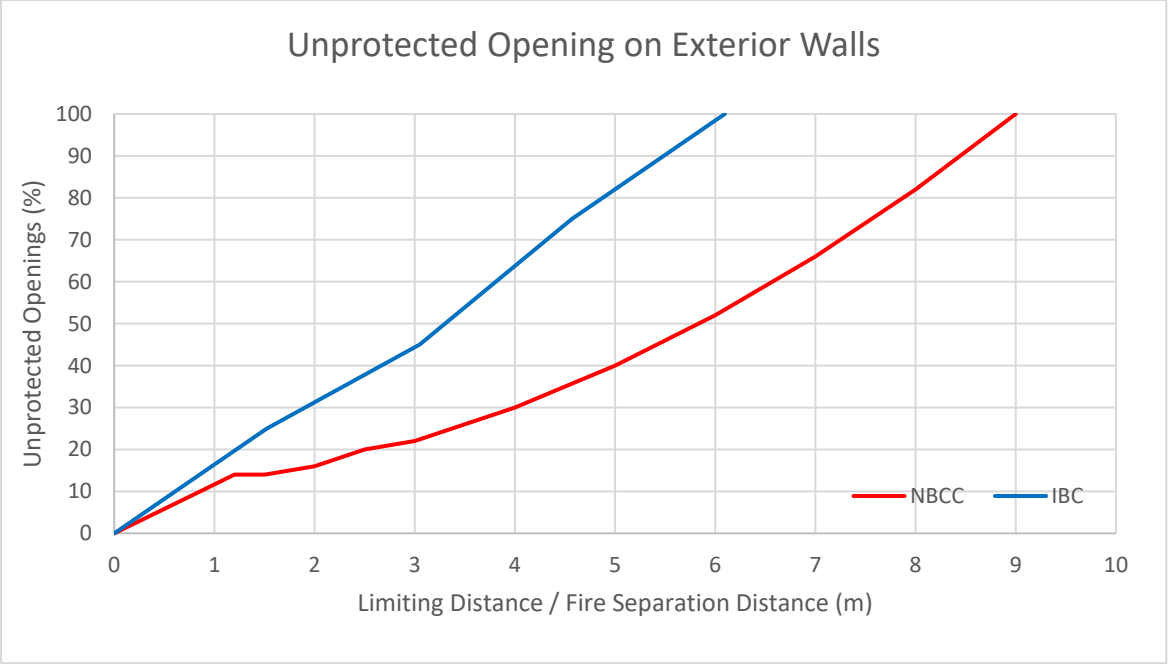
	NBCC	IBC
% of Unprotected Openings	Limiting Distance Sprinklers Building Occupancy Exposing Building Face Area	Fire Separation Distance Sprinklers
% of Protected Openings	Not discussed	
Mass Timber Impact	No specific provisions for EMTC	Specific provisions for mass timber (Type IV)

(NBCC: Building dimensions are also considered for unsprinklered buildings. This is outside of the scope of the report. This report assumes buildings discussed are sprinklered.)

For the purpose of comparison and contrast, and that the report is centred around tall buildings, the Table below uses the NBCC provisions for sprinklered buildings with exposing building face area not less than 150m^2 to juxtapose with the IBC provisions, which do not consider the exposing building face area.

Using tables given in the Codes and by some interpolation to fill gaps, the chart below summarizes the percentage of unprotected openings allowed by each Code per the distance limitation/separation.

Chart 3: Permissible Unprotected Openings



The trends can be visually concluded to be near-linear due to their low parabolicity. The IBC provisions for percentage of unprotected openings, as demonstrated, are more generous than those of the NBCC; although it is admitted that the IBC is more conservative by providing limitation on percentage of protected openings on the exposing building face.

2.7.3 *Use of Combustible Material on Exterior Walls*

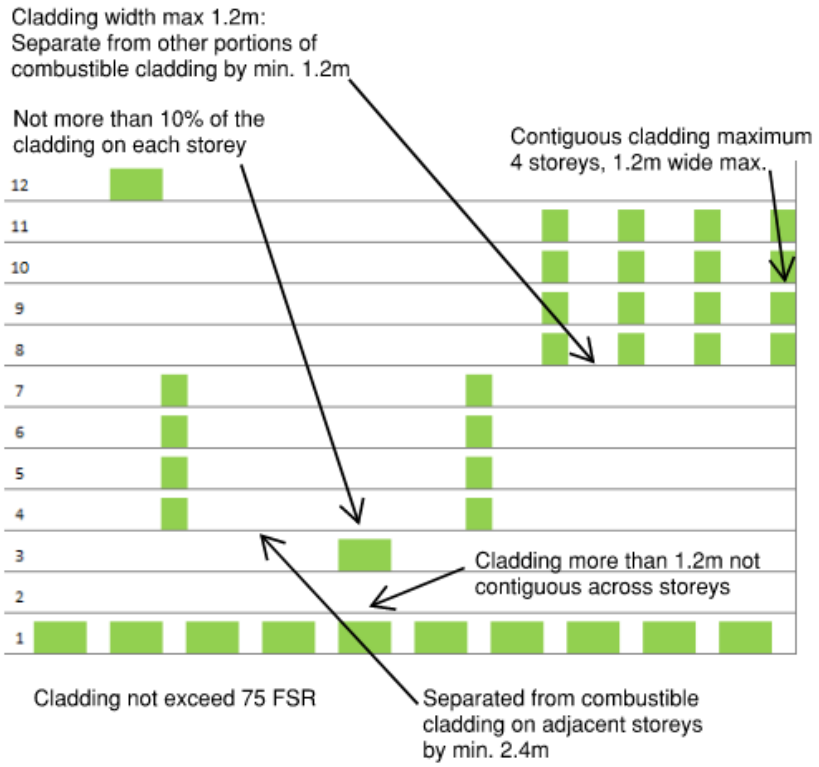
The IBC requires that exterior wall materials used are those permitted by the building's Type of Construction (IBC Section 705.4). Based on the provisions for Types IV Construction (excluding IV-HT), exterior loadbearing and nonloadbearing walls are to be of mass timber or noncombustible construction. For exterior wall covering, combustible materials are not permitted for use except water-resistive barriers meeting flame spread and combustibility criteria and NFPA 285.

The NBCC provisions in comparison offer slightly more flexibility in the permitted materials. Exterior wall assemblies containing combustible components meeting CAN/ULC-S134, conforming with those prescribed by Appendix D-6 or meeting Article 3.1.5.6 (3 storeys or less, sprinklered, wall protected by masonry or concrete). Combustible exterior wall cladding materials are also permitted per Article 3.1.6.9. Based on these provisions discussed, the NBCC is more relaxed on combustible materials being allowed on the exterior walls, even when compared to the IBC 12-storey Type IV-B.

2.7.4 *Exterior Cladding*

Noncombustible exterior cladding is permitted on both IBC and NBCC mass timber buildings. The IBC, however, does not provide specific provisions on permissible combustible cladding for mass timber buildings. It is understood that the NBCC provides specific provisions on combustible exterior cladding.

The concept is illustrated on the diagram below:



The test standards (CAN/ULC-S134 and NFPA 285) that evaluate combustible components on the exterior wall are not directly comparable between the NBCC and IBC. It cannot be concluded which standard in comparison is more severe. Both standards in their respective jurisdictions are accepted to evaluate flame propagation on exterior walls. Therefore, this report assumes the sufficiency of these standards to be satisfactory per each Code without further discussion.

Based on this comparison the Canadian requirements are considered as equal or more conservative, such that this difference can be considered of inconsequential and have no bearing on adoption of the IBC provisions.

2.8 Building Details

This section of the report intends to compare the provisions of the model Codes on concealed spaces, connections and joints, and firestopping.

2.8.1 *Concealed Spaces*

Concealed spaces of combustible construction in Types IV mass timber buildings are required to be protected. Concealed spaces in Types IV-A and -B are required of minimum 80min of protection time, which is the same as the required protection time for interior spaces; concealed spaces in Type IV-C are required of minimum 40min of protection time, despite that Type IV-C is permitted to have 100% exposed timber on the interior. The logic is that concealed spaces may not be accessible to responding firefighters or sprinklers.

Under the NBCC, the protection of concealed space requirement is minimum 25min, or 12.7mm Type X GWB. Options of filling the concealed space with mineral fibre, provide sprinklers and fireblocking are also permitted. The concealed spaces are limited to be within structural elements meeting the dimensional requirements.

2.8.2 *Connections and Joints*

The IBC addresses the FRR of connections for Type IV mass timber buildings through two options:

- Testing per ASTM E119 or UL 263, where the connection is a part of the tested assembly.
- Engineering analysis to show that the connection does not exceed the temperature rise limitation.

Fire resistant joints that have been tested per ASTM E1966 or UL 2079 are required to be installed per the listing criteria.

The IBC also addresses the joint between the exterior curtain wall with floor assembly through a referenced test standard ASTM E2307. Joint systems used are typically listed and are previously evaluated to this standard. The NBCC does not specifically address this condition.

Connections and joints of building elements are not specifically addressed by the NBCC; however, protection is specifically addressed in CSA O86, Engineering Design in Wood as follows:

> **B.9 Connections**
> Connections that are critical to support the gravity loads acting on the structure shall be designed to have at least the same fire-resistance rating as the elements they support. Connections in which the steel is located within the effective cross-section of the wood element shall be considered properly protected.
> **Note:** *Additional information can be found in the American Wood Council's Technical Report 10 and in EN 1995-1-2.*

Given that this is equally applicable to a 12- or 18-storey building, no specific changes are considered warranted with respect to transfer of the IBC provision, and the differences can be considered inconsequential. Addition of an Appendix note referring the user to Annex B of CSA O86 for protection of connections may be appropriate.

2.8.3 *Firestopping*

The IBC and NBCC have similar firestopping requirements for through or membrane penetrations. It is noted that the test standards referenced by both Codes are sufficiently similar and systems can typically be evaluated to both Codes with a single test effort such that differences are, in our opinion, inconsequential.

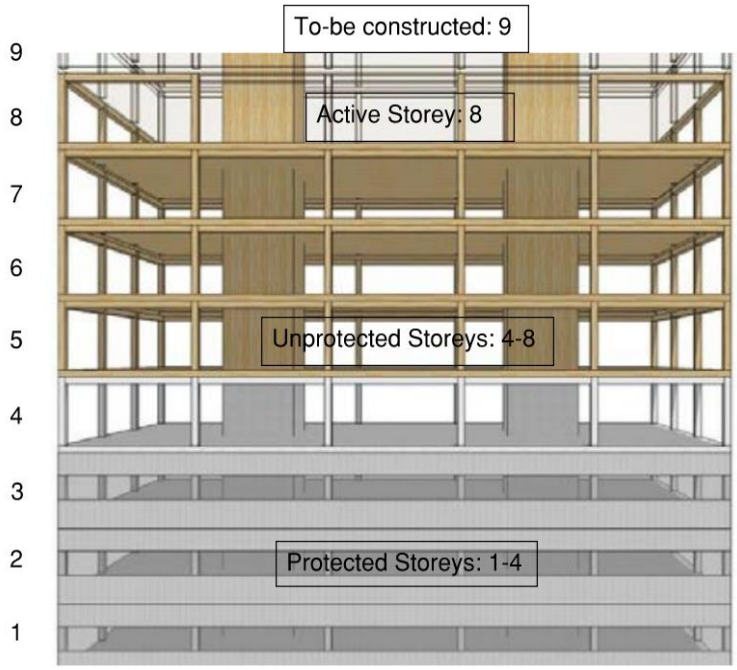
2.9 Fire Safety During Construction

Mass timber buildings are vulnerable during construction. Therefore, implementing fire safety features during construction is important. Fire safety during construction provisions are contained in the 2020 National Fire Code of Canada (NFCC). The provisions take four approaches as a combined effort to establish the principal fire safety features of EMTC buildings under construction. The approaches are site water supply and piping, egress, protection of openings, and limitations on exposed wood. Similarly, the 2021 IFC also contains fire safety requirements for Types IV-A, -B and -C buildings that are designed to be greater than 6 storeys under construction. The table below is a summary-comparison of the two Fire Codes:

Table 15: Fire Safety Features of Mass Timber Construction Sites

Topic	NFCC	IFC
On-site Water Supply	Availability of adequate water supply for firefighting upon combustible or EMTC materials arrival on site	Availability of water supply for fire department operations, as approved by the Fire Code official and Fire Chief
Fire Department Connections	Standpipe and other connections requirements for each new level	Standpipes provided per IFC Section 3313
Egress	Stairways provisions with openings protected	-
Openings	Door assemblies to increase fire protection	-
Limitations on Exposed Wood	Protected by material with minimum 25min encapsulation rating	Building elements to be protected up to the storey that is 4 storeys less than the active storey under construction.
	Not more than 20% of underside area exposed	
	Not more than 35% of total structural mass timber walls within each storey exposed	
	Not more than 4 of the uppermost adjoining storeys unprotected	
	Guidance for Protection of Adjacent Buildings	
Exterior Wall Protection	No protection specified	Exterior wall coverings required by IFC 3303.5.

There are many similarities between the provisions of both Fire Codes, that the intent is to provide sufficient water supply, and fire department access to water supply for firefighting. Buildings are also required to be protected by noncombustible encapsulation/protection sheets. Although there are some differences in language employed, the minimum required by both Fire Codes is 12.7mm Type X GWB. Both Fire Codes also require the protection of storeys that are maximum 4 storeys below the active storey under construction.



The NFCC provisions are applicable to all EMTC buildings, where the IFC provisions are only applicable to those more than 6 storeys high. The rationale is that the existing Type IV-HT buildings are not required of such construction safety features, and therefore mass timber buildings not taller than 6 storeys are assumed to have an acceptable level of safety. The NFCC in this light is more conservative in comparison, except for exterior walls protection.

The NFCC also contains other features that the IFC does not discuss as shown on the table above. Therefore, it can be generally stated that the BCFC fire safety provisions for mass timber buildings under construction are more conservative than those of the IFC.

We note that there is a major research project currently underway to examine construction fire risk for EMTC and assess where changes may be feasible to reduce this onerous requirement.

3. STRUCTURAL

3.1 Codes and Standards Approach to Tall Wood Building in USA

A summary of the various design references and design documents in US and Canadian Codes is provided below:

Building Codes – General Requirements and Design Loads

	USA	CANADA
Loading Requirements and Material Standards References	*International Building Code 2021* (IBC 2021)	*National Building Code of Canada* (NBCC 2020)
Building Load Definition, Design, and Design Load Combinations	*Minimum design loads for Buildings and Other Structures* (ASCE 7-16) *International Building Code 2021* (IBC 2021)	*National Building Code of Canada* (NBCC 2020) – Division B – Part 4

Material Design Standard – Timber Design

	USA	CANADA
Member Design	*National Design Specification for Wood Construction* (NDS 2018) Note: section properties for CLT must come from supplier PRG 320 certifications	*Engineering Design in Wood, National Standard of Canada* (CSA O86-19)
Timber Properties	Glulam Beams & Columns: *NDS Supplement Design Values for Wood Construction* CLT panels: Refer to supplier ICC approvals and APA PRG 320 Certification	All members and panels: *Engineering Design in Wood, National Standard of Canada* (CSA O86-19) CLT panels: although the standard provides generic properties, refer to supplier APA PRG 320 Certification
Fire Design	*National Design Specification for Wood Construction* (NDS 2018) Sect. 16 AWC Technical Report 10 (TR10) Calculating the Fire Resistance of Exposed Wood Members	*Engineering Design in Wood, National Standard of Canada* (CSA O86-19) Annex B
Lateral Element Design	*Design Provisions for Wind and Seismic* (SDPWS 2021)	*Engineering Design in Wood, National Standard of Canada* (CSA O86-19)

Material Grading and Production Standards

	USA	CANADA
CLT	APA PRG 320-19 *Standard for Performance-Rated Cross-Laminated Timber*	APA PRG 320-19 *Standard for Performance-Rated Cross-Laminated Timber*
Glued Laminated Timber	ANSI 117-2015 *Standard Specification for Structural Glued-Laminated Timber of Softwood Species*. ANSI A190.1-2017 *Standard for Wood Products – Structural Glued-Laminated Timber.*	CSA 0122-06 *Structural Glued-Laminated Timber*
Lumber Grading*	The American Lumber Standard Committee Incorporated (ALSC) National Grading Rule Committee (NGRC)	National Lumber Grading Association (NLGA) Standard Grading Rules For Canadian Lumber

* Note : The NLGA Standard Grading Rules for Canadian Lumber incorporates the National Grading Rules for Dimension Lumber. Therefore, all dimension lumber in Canada and the United States is graded to uniform requirements.

In Canada, CSA O86 recognizes certain US species combinations as being equivalent to Canadian species combinations for determining design values. As an example, US Douglas Fir-Larch is considered equivalent to Canadian Douglas Fir – Larch and US Hem-Fir is considered equivalent to Canadian Hem-Fir, per Clause 6.2.1.3 and Table 6.2.1.3 of the CSA O86-14.

3.2 Applied Loads Comparison in the Canadian and US Building Codes and Standards

In any structural design, the NBCC is the primary source of information for loading for a system. The 2020 NBCC offers load combinations based on LSD for ULS and SLS cases. Comparatively, the 2021 IBC and the associated ASCE 7-16 offer load combinations for both Allowable Stress Design (ASD) and Load and Resistance Factor Design (LRFD) for strength design.

For comparison's sake, the 2021 IBC LRFD load combinations and the 2020 NBCC LSD ULS load combinations are compared. For completeness, all load combinations are provided, but the focus of the structural design section will be on the gravity load cases. For a general discussion on lateral design, refer to the Section 3.5. For clarity, the lateral load cases are shown in grey.

2020 NBCC	2021 IBC
LSD	LSD/LRFD
1.4D	1.4D
1.25D+1.5L+1.0S/0.4W	1.2D+1.6L+0.5(L_r/S/R)
1.25D+1.5S+1.0L/0.4W	1.2D+1.6(L_r/S/R) + (f_1L/0.5W)
1.25D+1.4W+0.5(L/S)	*1.2D+1.0W + f_1L + 0.5(L_r/S/R)*
1.0D+1.0E+0.5L + 0.25S	*1.2D+1.0E + f_1L + f_2S*
0.9D+1.4W	*0.9D+1.0W*
1.0D+1.0E	*0.9D+1.0E*

Notes:
Soil and hydrostatic pressure are not addressed here as they will typically not be restrained by timber structures.
f_1 is typically 0.5 except for public assembly areas and garages.
f_2 is typically 0.2 except where roods do not shed snow (ex: saw tooth roofs).

A few key differences in the load combinations are apparent:

- The NBCC companion loads are conservative compared to the IBC load combinations.
- The wind companion loads in gravity cases appear less conservative than the US load combination. This will be discussed in more detail.
- The primary wind load approach for lateral loading is significantly different. This is based on a fundamental difference in the return period and gust second length of the wind load considered. As the lateral considerations are not the primary consideration of this document this is not discussed further.

3.2.1 *Live Loads*

Live loads are defined as loads due to use and occupancy and are directly provided for areas with varying usage in both the NBCC and the IBC. A few key examples are provided:

Occupancy	NBCC	IBC
Residential	1.9 kPa	40 psf (1.91 kPa)
Corridors	4.8 kPa	100 psf(4.79 kPa) at ground level same as occupancy at upper levels
Offices (above ground floor)	2.4 kPa	50 psf (2.39 kPa)
Assembly (w/o fixed seats)	4.8 kPa	100 psf (4.79 kPa)
Balconies	4.8 kPa	1.5(Interior load) ≤ 100 psf (4.79 kPa)

The IBC includes a minimum Lr for live roof loads (typically 20psf), similarly the NBCC is specifying a roof live load of 1.0 kPa (21psf). This effectively eliminates the possibility of no live or snow load on the roof. This is not functionally relevant in Canada, as generally snow load governs the design.

In general, the loads to correspond between the Codes, and in some cases the Canadian Code appears to be conservative.

3.2.2 *Live Load Reduction*

Live load reductions are commonly used for in both Canadian and US design. The NBCC and the IBC both define live load reductions, and both provide limitations on the use of live load reduction depending on Occupancy. For example, neither Code allows for live load reductions for assembly occupancies (NBCC CL 4.1.5.8(1), and IBC Table 1607.1). In general, the formulations are similar, and the live load reduction factors derived from the Canadian Code appear to be conservative.

Table 16: Live Load Reduction

	NBCC	IBC
Minimum Live Load		0.4L for members supporting 2+ floors 0.5L for other members
Minimum Tributary Area	20m²	37.16m²

	NBCC	IBC
Live Load Reduction Factor	$0.3 + (9.8/A_{trib})^{0.5}$	$0.25 + 4.57/(Kll \times A_{trib})^{0.5}$ For KLL ≥ 2 (most cases) $0.25 + (10.44/A_{trib})^{0.5}$
Examples	40m² → 0.79 100m² → 0.61 500m² → 0.44	40m² → 0.76 100m² → 0.57 500m² → 0.40

3.2.3 *Partitions*

The IBC CL 1607.5 also states that in buildings where the partitions are not permanent (such as office buildings where floors will be leased out), partitions shall be taken as a live load of at least 15psf (0.72 kPa) unless the applied live load is 80psf (3.83 kPa) or greater. The resulting applied LSD load for the second LSD load combination would be 24psf (1.15 kPa). Comparatively, the NBCC CL 4.1.4.1 notes that partitions should be considered as dead load and they shall be not less than 1 kPa. The resulting LSD load for the second LSD load combinations would be 1.25 kPa. Despite the difference in application of partitions load type, the resulting applied load in the NBCC is conservative compared to the IBC.

3.2.4 *Fire Design Load Combinations*

Neither the IBC nor the NBCC specifically defines fire case design loads. Instead, the material standards define these either directly or indirectly. The Canadian Wood Standard, CSA O86-19, directly defines the fire load case in Annex B CL B.1.4 stating that specified loads should be used. Comparatively, the NDS indirectly defines the load combinations in Chapter 16 by providing provisions for fire design based on ASD loads only. These are effectively equivalent for floor and roof gravity loading.

3.2.5 *Code Applied Load Recommendations*

Based on the assessments the recommendation would be to use the Canadian applied LSD loads for the design of both typical gravity and fire cases. In general, the applied loads provided in the NBCC seem to be equivalent or conservative compared to those provided in the IBC. Direct application of the Canadian loads would not result in a less conservative design.

3.3 General Member Design and Tall Timber Requirements

In general, there are no provisions in the CSA O86 timber design standard that would preclude its use on building up to 18 storeys (or more). The extent design guidance provided for gravity design is similar to that provided in the US National Design in Wood (NDS) standard, which is the referenced design standard use for the tall timber construction provisions provided in the IBC 2021.

This report outlines the specific approaches from each standard for the fire design of structural elements and encapsulation. It also provides a brief discussion on lateral system approaches possible for use on these types of tall timber construction both for the 2020 NBCC Encapsulated Mass Timber Construction (EMTC) provisions, as well as the 2021 IBC Tall Timber Construction provisions. A brief outline of other considerations important in the design of tall timber structures is briefly discussed here.

3.3.1 *Connection Limitations*

Connections are critical elements of any structure, and timber is no exception. Like any structure, it is important to ensure that the connections implemented on the structure can tolerate the interstorey drift of the system. Although this is a requirement in both the ASCE 7 and the NBCC for all buildings, it can become a major focus of taller building construction, particularly if flexible lateral systems are implemented.

Another significant consideration required for timber connections is to ensure that the element shrinkage is not going to pose a concern for splitting. This splitting is most likely to occur as a result of shrinkage perpendicular to grain and therefor the overall spacing between a group of fasteners perpendicular to the grain of the member, particularly when fastened to either a steel plate and another wood member with a different grain orientation. The NDS addresses this issue by providing spacing limitations based on an initial specified moisture content. Comparatively, the Canadian Code provides a more generic approach allowing the designer to calculate estimate shrinkage based on supplier and construction information regarding moisture contents and compare that against the construction tolerances in their connection. Both approaches result in similar maximum fastener group widths for various fasteners based on construction tolerances at the NDS initial moisture content, but the CSA O86 approach offers designers more flexibility.

3.3.2 *General Shrinkage Over Building Height*

As the height and number of storeys increases, it becomes increasingly important to consider cumulative shrinkage over the height of the buildings, particular at elevators or at interfaces with other construction materials. This can be a major design concern. The NDS does not specifically address the requirement to consider cumulative shrinkage, nor does it provide specific guidance on evaluating the shrinkage in wood either parallel or perpendicular to grain. Comparatively, the Canadian Code CSA O86 Annex A does provide specific requirements to consider shrinkage and provides guidance on calculating the expected shrinkage of any given element both parallel and perpendicular to grain.

3.4 Fire Design of Members and Connections

This section compares the Canadian and US fire design approaches. The NDS sect 16.2 provides design procedures for exposed wood members in US and CSA-O86 Annex B of provides design procedures for exposed wood members in Canada. Both standards address the various components of fire design including:

- Char calculations
- Fire resistances for GWB if used to protect timber members partially or fully.
- Fire design for strength calculations
- Fire protection of connections

3.4.1 *Char Calculation*

The NDS standard in the US and the CSA O86 standard in Canada calculate char in slightly different ways, but both approaches are based on the same testing. Both calculation methods endeavor to provide char rates that are then modified to account for components like corner rounding and/or heat affected zones. The char depth is calculated based on an exposure time. In the US standard, the char depth is increased to the "Effective char depth" to account for the heat affected zone and corner rounding. Comparatively, in Canada, the heat effective zone is added in separately after calculating a nominal char depth modified to account for corner rounding where applicable.

3.4.1.1 *Char Comparison for Glue-Laminated Timber Members*

Char rate calculations in both standards are based on a constant rate of burn with additional factors or layers to account for the effective char depth on all exposed surfaces based on a given exposure time.

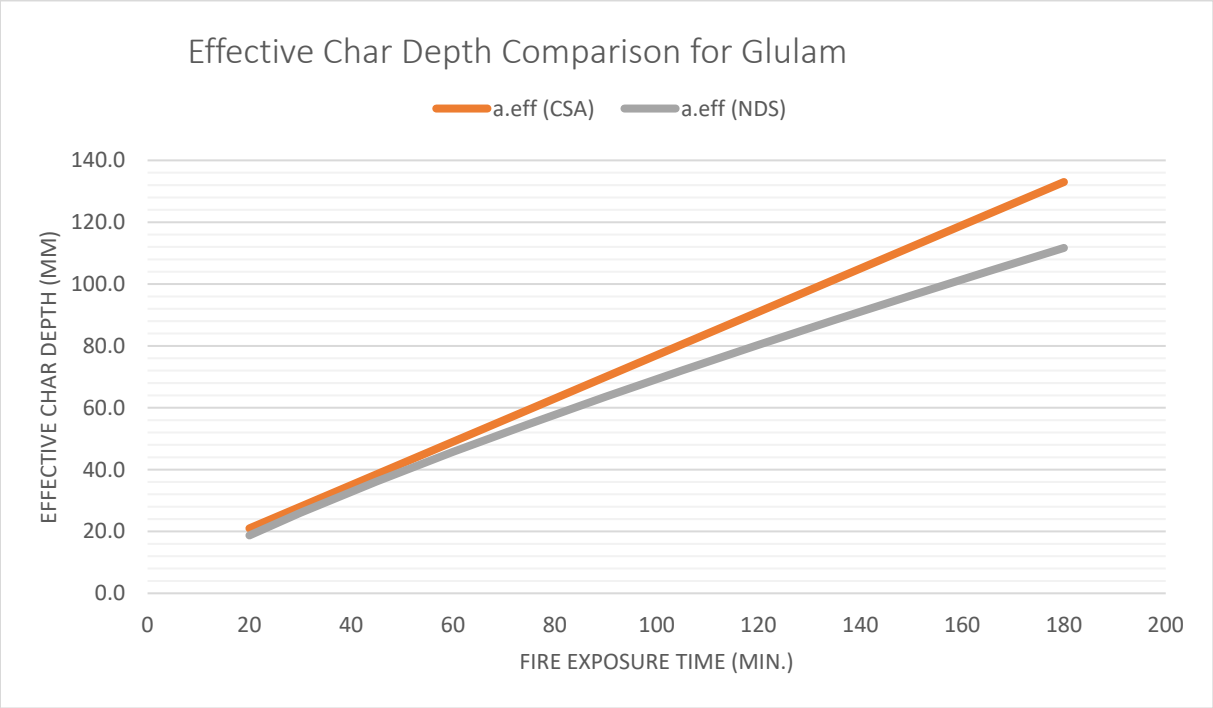
Table 17: Char Approach

NDS Char approach (CL 16.2.1)	**CSA O86 Annex B Char Approach (B.4.3)**
Exposure time, t = (hr.) Nominal char rate, β_n = 1.5 in./hr. (0.635mm/min) Non-lin char rate for exposure time, $\beta_t = \beta_n$ in./hr.$^{0.813}$ (16.2-1) Calculated char depth, $a_{char} = \beta_t t^{0.813}$ (16.2-2) The effective char depth, $a_{eff} = 1.2a_{char}$ (16.2-4)	Exposure time, t = (min) GLT/ SCL notional char rate, β_n = 0.70 mm/min Notional char depth, $x_{c,n} = \beta_n t$ (B.4.4) zero strength layer depth, $x_{c,n}(t > 20min) = 7mm$ (B.5) The effective char depth, $x_{eff} = x_{c,n} + x_t$

The table and graphic summarize the effective char depth for NDS and CSA O86 for typical required fire resistance time:

Table 18: Char Depth and Effective Char Depth Comparison for Glulam Members

Required Fire Resistance (h)	**NDS 2018**		**CSA O86-19**		**Difference between O86 and NDS effective char depth**
	Char Depth, a_{char} (mm)	**Effective Char Depth, a_{eff} (mm)**	**Char Depth, $x_{c,n}$ (mm)**	**Effective Char Depth, $x_{c,n}+7$ (mm)**	
1h	38.1	45.7	42.0	49.0	+3.3mm (7%)
1.5h	53.0	63.6	63.0	70.0	+6.4mm (10%)
2h	66.9	80.3	84.0	91.0	+10.7mm (13%)
3h	93.1	111.7	126.0	133.0	+21.3mm (19%)



It appears that CSA O86 is always more conservative than NDS for the calculated effective char depth of glulam. This becomes more significant as the duration of fire exposure increases. This may be due to the relatively large increase associated with the corner rounding effect. For char rates up to 90min, is 6.4mm or less (1/4in), only slightly more than fabrication tolerances of glulam. The CSA standard for tolerance on beam width of:

- Beam Width: +/- 2 mm (CSA / ANSI)
- Beam Depth: CSA Standard: +/- 6mm per beam. Alternatively, +/- 0.4 mm per lamination

It is also important to note that both design standards and their associated fabrication standards (APA/ANSI 117 in the US, and CSA O122 in Canada) require special layups for non-homogeneous glulam members to achieve the associated fire ratings. These standards require additional outer tension laminations relative to the specific exposure times.

NDS approach (→Sect 16.2.4.)	CSA O86 Annex B (→B.2.2)
GLT layup shall comply with Special Provisions for Structural Glued Laminated Softwood Timber Beams Sect 16.2.4. This section precise requirements for the outer tension lamination according to time exposure.	Clause B.2.2 specify provisions for Glued-Laminated timber layup.

3.4.1.2 *Char Comparison For Non-CLT Mass Timber Panels (ex. GLT or DLT)*

The NDS does not make special provisions for panels compared to individual members, applying the same effective char factors across the board. Comparatively, the Canadian standard applies a reduced char rate for elements that are not susceptible to corner rounding.

Table 19: Char Comparison for Non-CLT Mass Timber Panels

NDS Char approach (CL 16.2.1)	CSA O86 Annex B Char Approach (B.4.3)
Exposure time, t = (hr.)	Exposure time, t = (min)
Nominal char rate, β_n = 1.5 in./hr. (0.635mm/min)	One dimensional char rate, β_0 = 0.65 mm/min
Non-lin char rate for exposure time, $\beta_t = \beta_n$ in./hr.$^{0.813}$ (16.2-1)	One char depth, $x_{c,0} = \beta_0 t$ (B.4.3)
Calculated char depth, $a_{\text{char}} = \beta_t t^{0.813}$ (16.2-2)	zero strength layer depth, $x_{c,n}(t > 20min) = 7mm$ (B.5)
The effective char depth, $a_{eff} = 1.2a_{char}$ (16.2-4)	The effective char depth, $x_{eff} = x_{c,0} + x_t$

Table 20: Char Depth and Effective Char Depth Comparison for Timber Panels (excluding CLT)

	NDS 2018		CSA O86-19		Difference between O86 and NDS effective char depth
Required Fire Resistance (h)	Char Depth, a_{char} (mm)	Effective Char Depth, a_{eff} (mm)	Char Depth, $x_{c,0}$ (mm)	Effective Char Depth, $x_{c,o}$+7 (mm)	
1h	38.1	45.7	39.0	46.0	+0.3mm (1%)
1.5h	53.0	63.6	58.5	65.5	+1.9mm (3%)
2h	66.9	80.3	78.0	85.0	+4.7mm (6%)

Similar to glulam beams or columns, the calculated effective char depth for one-way span capable mass timber panels is always higher in CSA O86 compared to NDS. The table above also demonstrates that the difference between the calculated effective char is at most 4.7mm (3/16in). This represents only slightly more than typical fabrication tolerances of glulam panels, (taken as the beam width tolerance from the CSA glulam fabrication standard).

3.4.1.3 *Char Comparison for CLT*

Unlike the GLT beams and columns, for one-way panel effective char depths there are some significant differences between the NDS and O86 results. A summary of the calculation approach is provided. Ultimately O86 provides a consistent char rate for char depths beyond the first glue line, whereas the NDS offers a non-linear char rate based on the lamination thickness of each lamination.

Table 21: Char Comparison for CLT Mass Timber Panels

NDS Char approach (CL 16.2.1)	**CSA O86 Annex B Char Approach (B.4.3)**
Exposure time, t = (hr.) Nominal char rate, β_n = 1.5 in./hr. (0.635mm/min) Non-lin char rate for exposure time, $\beta_t = \beta_n$ in./hr.$^{0.813}$ (16.2-1) Calculated char depth, $a_{char} = n_{lam}h_{lam} + \beta_t(t - (n_{lam}t_{gi}))^{0.813}$ Number of charred lams, n_{lam} (rounded down) Lam thickness, h_{lam} (in.) Exposure time require to reach glue, $t_{gi} = \frac{t}{t_{gi}}$ (hr) (16.2-3) The effective char depth, $a_{eff} = 1.2a_{char}$ (16.2-4)	Exposure time, t = (min) One dimensional char rate, β_0 = 0.65 mm/min CLT notional char rate, β_n = 0.80 mm/min One-dimensional char depth, $x_{c,0} = \beta_0 t$ (B.4.3) Notional char depth, $x_{c,n} = \beta_n t$ (B.4.4) zero strength layer depth, $x_{c,n}(t > 20min) = 7mm$ (B.5) The effective char depth, $x_{eff} = x_{c,0} + x_t < h_{lam\_bot}$ The effective char depth, $x_{eff} = x_{c,n} + x_t \geq h_{lam\_bot}$ Lam thickness, h_{lam} (mm)

A comparison of the resultant char depth for different fire resistance requirements and various lamination thicknesses, assuming all laminations are a consistent thickness are provided below for both the NDS and O86.

Table 22: Effective Char Depth Comparison for CLT Panels

NDS 2018 – CLT Effective Char Depths, a_{eff} (mm)									
Required Fire Resistance (h)	**lamination thickness, h_{lam}(mm)**								
	15.9	19.1	22.2	25.4	31.8	34.9	38.1	44.5	50.8
1h	55.9	55.9	53.3	50.8	50.8	48.3	45.7	45.7	45.7
1.5h	86.4	78.7	78.7	76.2	76.2	71.1	71.1	71.1	66.0
2h	111.8	109.2	104.1	101.6	99.1	96.5	91.4	91.4	91.4
CSA O86 – CLT Effective Char Depths, $X_{c,n}$ (mm)									
Required Fire Resistance (h)	**lamination thickness, h_{lam}(mm)**								
	15.9	19.1	22.2	25.4	31.8	34.9	38.1	44.5	50.8
1h	55.0	55.0	55.0	55.0	55.0	55.0	55.0	46.0	46.0
1.5h	79.0	79.0	79.0	79.0	79.0	79.0	79.0	79.0	79.0
2h	103.0	103.0	103.0	103.0	103.0	103.0	103.0	103.0	103.0

A summary of the difference in char shows that for thicker laminations, O86 provides a more conservative effective char depth than the NDS. In comparison, the effective char depth calculated is less conservative for thin laminations in O86 compared to the NDS.

Table 23: Differences between Effective Char Depth between Standards

Required Fire Resistance (h)	lamination thickness, h_{lam}(mm)								
	15.9	19.1	22.2	25.4	31.8	34.9	38.1	44.5	50.8
1h	-0.9	-0.9	1.7	4.2	4.2	6.7	9.3	0.3	0.3
1.5h	-7.4	0.3	0.3	2.8	2.8	7.9	7.9	7.9	13.0
2h	-8.8	-6.2	-1.1	1.4	3.9	6.5	11.6	11.6	11.6

For all panels with laminations 22.2 or thicker, the char rate for all fire resistances is less than 2.0mm (typical fabrication tolerance). For panels with thinner laminations, the char depth found from O86 is consistently less conservative, particularly for the 2h fire resistance cases.

Two of the most common CLT panel layup in North America are investigate for different exposure time:

- CLT panel comprised of 35mm thick laminations.
- CLT panel comprised of alternate 35mm and 17mm thick laminations.

Based on Table 24, the case with consistent 35mm laminations is conservative (ie. More char is applied) based on the O86 results. If we look specifically at the effective char depth at a 2h exposure, for the second case with alternating 35mm and 17mm laminations.

Table 24: Typical North American Panel Effective Char Depth Comparison

Required Fire Resistance (h)	All 35mm thick laminations			35mm and 17mm laminations alternating		
	NDS	CSA O86	Difference	NDS	CSA O86	Difference
1h	48.3	55.0	+6.7	51.1	55.0	+3.9
1.5h	71.1	79.0	+7.9	74.4	79.0	+4.6
2h	96.5	103.0	+6.5	100.3	103.0	+2.7

The char depth for all typical exposures is conservative per the Canadian standard in all cases.

In all cases, the char evaluation provided are based on fire tests completed several years ago in which significant delamination was observed. This delamination resulted in new flashover and increased char in the panels as shown which is represented in the increased smeared char rate based provided in O86, or in the increased char for each glue-line crossed provided in the NDS. Since that testing has been completed there have been major changes to the CLT fabrication standard, requiring specific glues that prevent this delamination effect. Recent testing has shown that the delamination is in fact reduced, effectively reducing the char depth.

Both the char calculation methods provided in the Canadian and US standards has been shown to be conservative compared to the results of the recent testing using modern fabrication standards.

3.4.1.4 *Char Depth Recommendations*

Based on the evaluation of char depth calculations between the timber design standards in the US (NDS) and Canada (CSA O86) for non-cross laminated elements (glulam, GLT, NLT, and DLT included), the O86 effective char values are more conservative (i.e. more char is applied resulting in a smaller post-fire section size) and would result in an equally or more safe design if applied directly.

For CLT, standard panels currently fabricated in North America also provide more conservative effective char depths when calculated based on the Canadian Standard. For CLT panels with consistently thinner laminations, the char depth is less conservative when calculated using the Canadian Standard approach compared the US Standard. Despite this, based on recent glue requirement updates in the CLT fabrication standard, PRG 320-2018, and recent testing, both char evaluation methods provide consistently conservative effective char depths for all lamination thicknesses.

3.4.2 *Gypsum Rating Comparison*

Gypsum ratings approaches also vary slightly between the standards and Codes. The 2021 IBC provides resistance ratings due to encapsulation using Type X gypsum. The wood design standard, O86-19, Annex B, also provides fire resistance duration for encapsulation using Type X gypsum.

Table 25: Gypsum Rating Comparison

2021 IBC Sect. 722.7

FRR of mass timber.

Table 2: Encapsulation Ratings per 2021 IBC

Summarized from Table 722.7.1.(2)		
Protection contribution	Gypsum board thickness	
30 min	1/2"	(12.7mm)
40min	5/8"	(15.9mm)

Note: when encapsulation is provided, at least 2/3 of the FRR needs to be provided by the encapsulation. The remaining 1/3 can be achieved through inherent fire resistance of the mass timber element.

CSA O86 Clause B.8.1

Fire resistance of fire-rated Type X gypsum board:

Table 3: Encapsulation Ratings or CSA O86

Summarized from Sect B.8.1			
Required Fire Resistance (min.)	Number of layers of gypsum	Layer thickness of the gypsum board	Applied to
15min	1	12.7mm	GLT & CLT
30min	1	15.9mm	GLT & CLT
60min	2	15.9mm	GLT & CLT
60min	2	12.7mm	CLT only

Note: B.8.2 also gives fastening requirements of the gypsum board to the wood element

We note that technical data exist, and updates to CSA-O86 Annex B are proposed to increase the FRR contribution of one layer of 15.9mm GWB to 40min and two layers of GWB to 80min to match the US Codes and standards.

For more discussion on the differences in the fire resistances of encapsulation refer to Section 2.3.2.

3.4.3 *Fire Strength Comparison*

The US and Canadian wood design standards use different approaches for determining the strength of any given member for fire design. The US standard, NDS Chapter 16, applies a fire strength factor intended to convert from design strength to average member strength; it does not include several of the factors typically used in design, including the duration factor. The Canadian standard, O86 Annex B, applies all the typical design factors, including a duration factor set as short term, as well as fire resistance factor which is also intended to convert from specified to mean strength. The NDS also provides no guidance on several key aspects of member design for fire, including shear and compression perpendicular to grain.

3.4.3.1 *Comparison of Glulam Strength*

To understand the impact of these differences, strengths comparisons are provided in the following Table for glulam. Canada and the US both have separate fabrication standards (CSA 0122 and APA/ANSI 117 respectively) corresponding to their design standards (CSA O86 and NDS, respectively). As a result, the grades in the design standards do not align perfect. Note that the Canadian standard provides a considerably abbreviated list of standard glulam grades compared to the NDS. O86 provides 12 different glulam grades, 8 intended for primarily bending use, and 4 intended for axial loading.

Comparatively, the NDS provides 88 different grades of glulam, 56 grades for glulam intended for bending and 32 grades for glulam intended for axial loading. The NDS includes more species as well as both higher and lower stress grades than those provided in the O86. For comparison purposes a typical bending grade of glulam and a typical axial grade of glulam will be compared.

Beam Member (Bending)

	Glulam Grade	Specified/ASD Bending Strength	Fire Design Factor	Volume Factor	Beam Stability Factor	Column Stability Factor	Format Conversion Factor	Resistance Factor	Time Effect Factor	Factored Strength for fire design	Strength Difference
		fb	Kfi / Cfi	Kz / Cv	Kl / Cl	Kc / Cp	Kf	ϕ	Kd / λ	F'x	
NDS	**24F-1.8E (D-Fir)**	2400psi (16.6 Mpa)	2.85	*	*	-	-	-	-	47.2 Mpa	0.3 Mpa (0.6%)
CSA 086	**24f-EX (D-Fir)**	30.6 Mpa	1.35	*	*	-	-	1	1.15	47.5 Mpa	

* : Geometry Factor - Addressed similarly in both Codes, not developped here
- : Non applicable

Column Member (Compression)

	Glulam Grade	Specified/ASD Bending Strength	Fire Design Factor	Volume Factor	Beam Stability Factor	Column Stability Factor	Format Conversion Factor	Resistance Factor	Time Effect Factor	Factored Strength For fire design	Strength Difference
		fb	Kfi / Cfi	Kz / Cv	Kl / Cl	Kc / Cp	Kf	ϕ	Kd / λ	F'x	
NDS	**EWS 3-L2D (D-Fir)**	2300psi (15.9 Mpa)	2.58	*	*	-	-	-	-	40.9 Mpa	6.0 Mpa (14.7%)
CSA 086	**16c-E (D-Fir)**	30.2 Mpa	1.35	*	*	-	-	1	1.15	46.9 Mpa	

Column Member (Tension)

NDS	**EWS 3-L2D (D-Fir)**	1450 psi (10.9 Mpa)	2.85	*	*	-	-	-	-	28.5 Mpa	-6.8 Mpa (-23.9%)
CSA 086	**16c-E (D-Fir)**	14.0 Mpa	1.35	*	*	-	-	1	1.15	21.7 Mpa	

* : Geometry Factor - Addressed similarly in both Codes, not developped here
- : Non applicable

Note that the bending and tensile strengths provided are either very close or more conservative in the Canadian standard. Comparatively, the compression strength is less conservative based on the Canadian design approach. This may be accounted for in the calculation of the column buckling strength, which is also done separately. The Column buckling strength relies on an evaluation of the 5th percentile elastic stiffness of the material; this value is modified with a similar fire design factor in the US standard, along with the charred element dimensions, whereas the Canadian standard uses an unmodified elastic stiffness align with the charred element dimensions. The result is a much more conservative estimation of the buckling factor in the Canadian standard.

3.4.3.2 *Comparison of CLT Strength*

Both the Canadian and US design standard reference the same fabrication standard for CLT, PRG 320-2018 (or later). In general, the strength of the panels are established based on the properties of the laminations uses. Both visually grade lumber and machine stress rated lumber can be used to fabrication CLT, providing two effective grades of CLT, V-rated and E-rated respectively. To understand the impact of these differences, strengths comparison are provided in the following Tables for V-graded and E-graded CLT. Because the NDS does not provide a complete approach for fire design strength, only bending, tension and compression parallel to grain will be investigated as other strengths have no fire adjustment factors in the NDS.

For V-Graded CLT

CLT Grade - Specified Strength

	5 PLY (175mm) V2M1.1 CSA	5-PLY(175mm) V2M1.1 NDS	
Bending	11.8 Mpa	875 psi	(6.0 Mpa)
Tensile	5.5 Mpa	450 psi	(3.1 Mpa)
Compression	11.5 Mpa	1150 psi	(7.9 Mpa)

			Fire Design Factor	Volume Factor	Beam Stability Factor	Column Stability Factor	Format Conversion Factor	Resistance Factor	Time Effect Factor	Factored Strength for fire design	Strength Difference
			Kfi / Cfi	Kz / Cv	Kl / Cl	Kc / Cp	Kf	ϕ	Kd / λ	F'x	
Bending Strength	NDS	fb0	2.85	-	*	-	-	-	-	17.2 Mpa	3.2 Mpa (15.7%)
	CSA	fb0	1.5	-	*	-	-	1	1.15	20.4 Mpa	
Tensile Strength	NDS	ft0	2.85	-	-	-	-	-	-	8.8 Mpa	0.6 Mpa (6.3%)
	CSA	ft0	1.5	-	-	-	-	1	1.15	9.5 Mpa	
Compression Strength	NDS	fc0	2.58	-	-	*	-	-	-	20.5 Mpa	-0.6 Mpa (-3.0%)
	CSA	fc0	1.5	-	-	*	-	1	1.15	19.8 Mpa	

* : Geometry Factor - Addressed similarly in both Codes, not developped here
- : Non applicable

For E-Graded CLT

CLT Grade - Specified Strength

	5 PLY (175mm) E1M5 CSA	5-PLY(175mm) E1M5 NDS	
Bending	30.4 Mpa	2100 psi	(14.5 Mpa)
Tensile	17.7 Mpa	1575 psi	(10.9 Mpa)
Compression	19.9 Mpa	1875 psi	(12.9 Mpa)

			Fire Design Factor	Volume Factor	Beam Stability Factor	Column Stability Factor	Format Conversion Factor	Resistance Factor	Time Effect Factor	Factored Strength for fire design	Strength Difference
			Kfi / Cfi	Kz / Cv	Kl / Cl	Kc / Cp	Kf	ϕ	Kd / λ	F'x	
Bending Strength	NDS	fb0	2.85	-	*	-	-	-	-	41.3 Mpa	2.4 Mpa (5.4%)
	CSA	fb0	1.25	-	*	-	-	1	1.15	43.7 Mpa	
Tensile Strength	NDS	ft0	2.85	-	-	-	-	-	-	31.0 Mpa	-5.5 Mpa (-17.7%)
	CSA	ft0	1.25	-	-	-	-	1	1.15	25.4 Mpa	
Compression Strength	NDS	fc0	2.58	-	-	*	-	-	-	33.4 Mpa	-4.8 MPa (-14.4%)
	CSA	fc0	1.25	-	-	-	-	1	1.15	28.6 MPa	

* : Geometry Factor - Addressed similarly in both Codes, not developed here
- : Non applicable

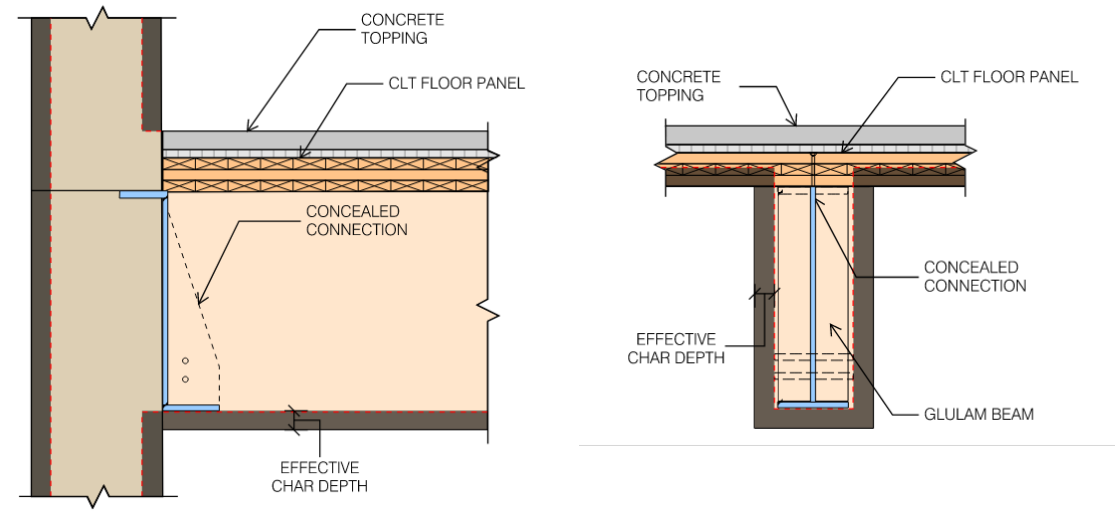
For E-rated CLT, the fire design strength of the material is either more conservative in the Canadian Standards or is consistent (i.e. within approximately 5%) between standards. Comparatively, for V-rated CLT, the fire design strength of the material is either consistent between standards or less conservative in the Canadian Standard (for bearing). It should be noted that the fire conversion factor in the NDS provides no variation between a machine stress rated base material and a visually graded material, using the same fire design factor intended to convert from design to average member strength. The higher reliability in strength present in machine stress rated would theoretically lead to a smaller fire design factor. This approach has been taken in the Canadian standard.

3.4.4 *Fire Rated Connection Comparison*

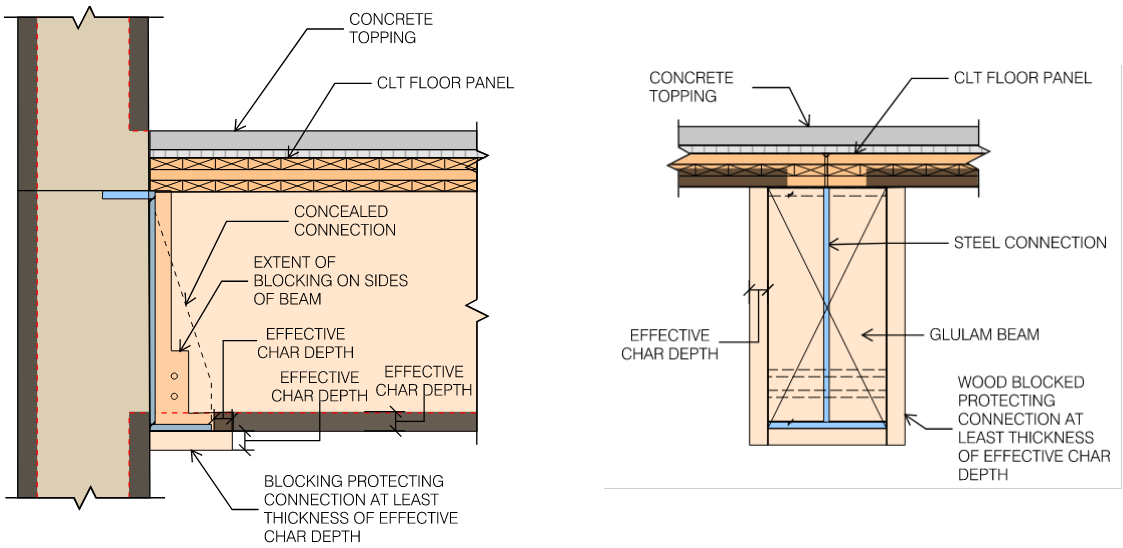
In addition to FRR requirements for structural wood members connections between members these members (e.g., beam-to-column connections) must have sufficient protection to provide the same FRR.

Both standards, NDS in Sect 16.3. and CSA O86 in clause B.9, specify that connectors shall be protected from fire for the same exposure or fire rating requirements at the members. Both standards specifically note that providing wood to protect the connections is an acceptable approach that the connectors and fasteners shall be protected either by wood, gypsum or approved coating. Protection with wood can be

achieved by either embedding the connection within the wood member depth as shown below where the entirety of the connection, including fasteners, does not extend into the effective char depth. Alternately the fire protection with wood can also be achieved by providing wood protection around steel elements outboard of the wood member as shown below.

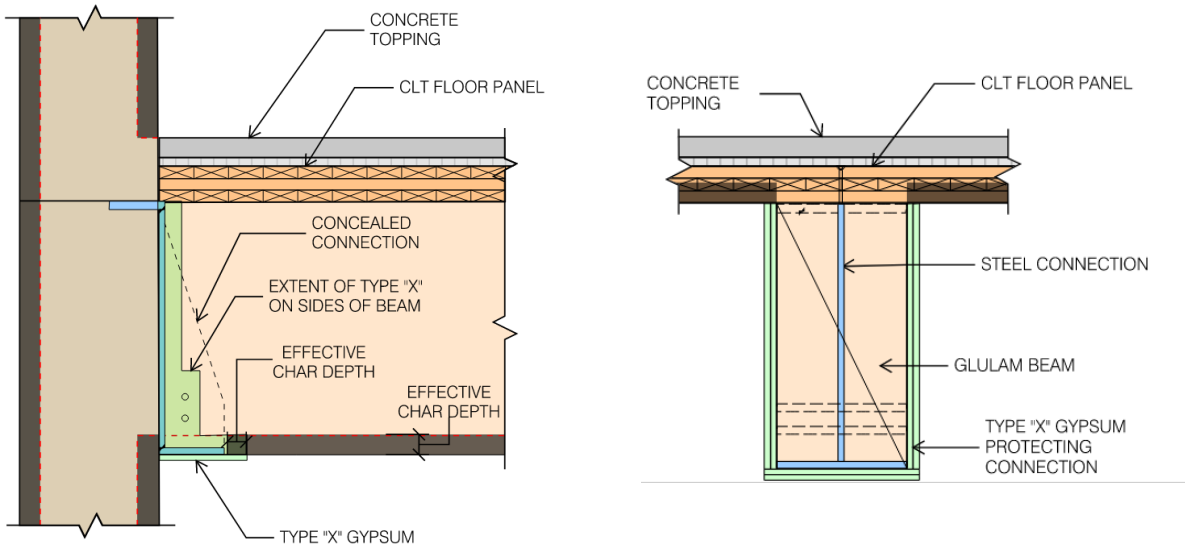


Fire Rated Connection achieved by embedding the connector within the un-charred depth of wood.



Fire Rated Connection achieved by providing wood blocking at connections.

Finally, fire protection can also be achieved by providing an appropriate thickness of gypsum Type X around the connection as shown below.



Fire Rated Connection achieved by local encapsulation with Type X gypsum.

3.5 Lateral System

Although timber lateral systems are included in both Codes, there are significant limitations. The IBC and ASCE 7-16 effectively only provide wood frame plywood shearwalls as an allowable timber lateral system. This system neither meets the requirements of the 2020 NBCC EMTC provisions, nor does it meet the requirements of the 2021 IBC Tall Timber Construction provisions.

Mass timber lateral systems are relatively new across North America. Although these provisions could meet the size requirements necessary for EMTC of Tall Timber Construction provisions in the NBCC and IBC respectively, they are not equally represented in both Codes, and come with significant limitations.

3.5.1 *CLT Diaphragms*

CLT diaphragms have been included in the CSA O86 standard since the 2014 update 1 release. They have also recently added to the SDPWS 2021. The Canadian Standard requires that the diaphragm, drags, chords, and any transfer elements be capacity protected as non-dissipative elements to the 95th percentile of the probable strength of the lateral system. They also require that the lateral resistance of CLT diaphragms be governed by the connections or fasteners and that the strength of the CLT panels being stronger even than the non-dissipative connections in the diaphragm. The SDPWS requires that chords and drags be designed for the diaphragm design loads increased by a factor of 2.0 and the splines be designed for the base diaphragm design loads. It also allows for a reduction for fastener yielding connections.

In most cases, the differences between the diaphragm design approach between the US and Canadian codes and standards will often result in a more conservative (ie. stronger) diaphragm. The capacity protection of diaphragms in the Canadian standard aligns with the general recommendations for all diaphragms per the NBCC for all diaphragms. Comparatively the IBC requires that diaphragms be designed to meet specific diaphragms forces general greater than the design forces, but less than the capacity protection approach required in Canada.

3.5.2 *CLT Shearwalls*

CLT shearwalls have been included in the CSA O86 standard since the 2014 update 1 release. They have only recently been included in the 2020 NBCC. Comparatively, CLT shearwalls are not included in either the 2021 IBC or the ASCE 7-16. It has been recently added to the SDPWS but with significantly less guidance on common design approach than the guidance provided in O86.

CLT shearwalls are also significantly limited in height in the 2020 NBCC. In seismic zones there is a height limit of 20m applied, and in non-seismic zones a limit of 30m. These height limits largely exclude the use of CLT shearwalls from tall timber construction. Even in non-seismic zones, the height limitations are less than a typical building height for a 12-storey building, and well below the building height for an 18-storey building.

3.5.3 *Timber Braced Frames*

Moderately Ductile Timber Braced Frames and Limited Ductility Timber Braced Frames are included in the 2020 NBCC. Comparatively no mention is made of timber braced frames on any kind in the 2021 IBC or the ASCE 7-16.

Timber braced frames are limited to either 20m for moderately ductile frames, or 15m for limited ductility frames in the 2020 NBCC. These stringent limits effectively exclude the use of timber braced frames from Code compliant tall timber construction.

3.5.4 *Hybrid Systems*

Hybrid systems are any application of a combination of timber structure and other non-timber construction. Given the limitations associated with timber lateral systems as discussed above, one common hybrid approach is the use of either a steel or concrete lateral system along with a timber gravity system. Steel Brace Frames of Concrete core shearwall systems have been particularly common with taller timber construction in North America to date.

The application of a non-timber lateral system could be done entirely within the Canadian Code, regardless of the gravity system without impacting the expected safety and reliability of that specific lateral system.

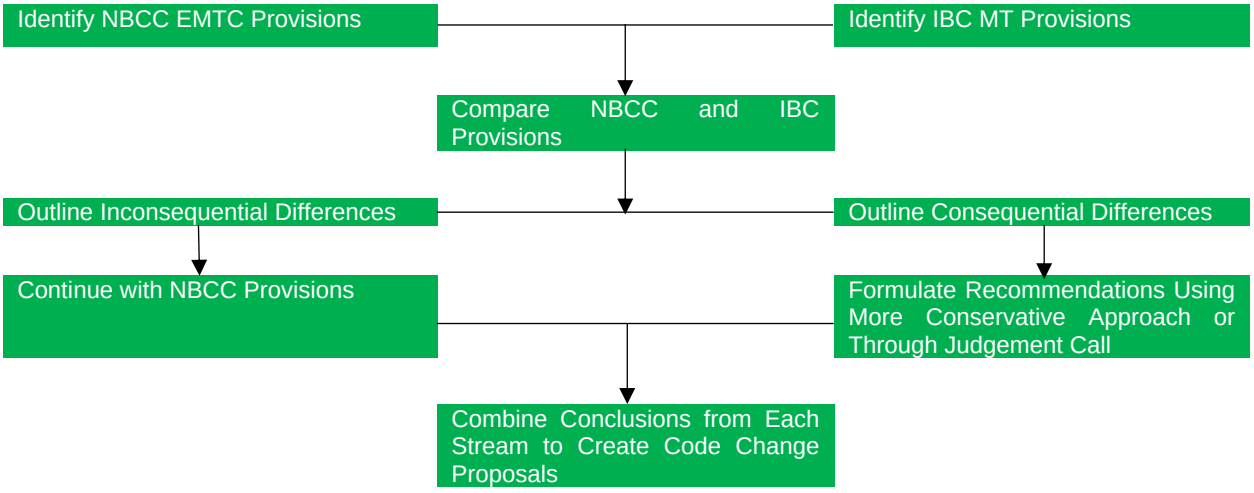
3.6 Structural Summary

With respect to Part 4 of the NBCC and CSA-O86, it is our opinion that transfer of the fire related provisions for building size and area provided in the IBC 2021 Tall Wood Provisions can be applied directly. The NBCC part 4 application of loads and load combinations are conservative, or the differences are sufficiently minor when compared with the US Building Codes (IBC and ASCE 7). Similarly, the Canadian National Standard for Engineering Design in Wood (CSA O86) is either conservative of with sufficiently minor differences when compared with the National Design Specification or Wood Construction (NDS). There are also some cases where the Canadian Codes and Standard is ahead of the US Codes and Standards.

4. SUMMARY AND RECOMMENDATIONS

4.1 Recommendations Process

This report used the following methodology to arrive set of recommendations for possible Code change directions and proposals.



4.2 Summary of Comparative Differences

The following is a summary of the comparative differences determined as inconsequential. Therefore, the NBCC provisions that address each topic can remain without further changes.

4.2.1 *Inconsequential Differences*

1. Flame spread of exterior wall

    a. The approach to address combustible materials on exterior wall by each Code is different as the referenced standards (CAN/ULC-S134 and NFPA 285) are not comparable. Notwithstanding this, these in our opinion are not related to the issue of EMTC construction as Articles 3.1.6.9 and 3.1.6.10 already prescribes noncombustible cladding and construction, or cladding conforming to Articles 3.1.5.5 or 3.1.5.6 which are effectively performance standards independent of the material.

2. Fire Door Performance

    a. Although the IBC employs fire door test standards that utilize positive furnace pressure, and thus is considered to be more severe, the evaluation of door test standards is outside the scope of this report and is not mass timber specific. Current NBCC referenced fire door performance method is assumed to be sufficient. This difference is, in our opinion not specifically relevant to the question of EMTC buildings and inconsequential to the question at hand.

3. Unprotected Openings

    a. The NBCC permits less unprotected openings at the same limiting distance than the IBC; the IBC however limits the amount of protected opening. This difference is not specific to the topic of mass timber. Current NBCC provisions are in our opinion conservative and therefore considered inconsequential.

4. Methodology of Encapsulation and Fire Resistance

    a. The NBCC referenced encapsulation standard evaluates the protection material slightly differently than the IBC. However, this is considered inconsequential as both Codes assign the same protection time to the GWB; that is, 50min for two layers of 1/2in (12.7mm) GWB.

    b. It is significant that the effectiveness of the encapsulation that the NBCC and IBC were based on the old style CLT with heat sensitive adhesives.

4.2.2 *Consequential Differences*

1. Building Height and Area

    a. IBC Type IV permits taller buildings.
    b. IBC approach to building area is vastly different than that of the NBCC.

2. Occupancy Groups

    a. IBC Type IV permits all occupancy groups sprinklered.

3. Interior Protection

    a. Where interior protection is required, the IBC requires up to 80min of GWB protection (two layers of 15.9mm Type X) compared to the 50min required of the NBCC (two layers of 12.7mm Type X).

4. FRR of Floors

    a. Type IV-A require 3h of FRR, where FRR in the NBCC is 2h maximum.

The consequential differences will be discussed below.

4.3 Building Height and Area

With the same occupancy groups including Business and Residential, the IBC permits taller buildings than those of NBCC. Building area, on the other hand, is more complex. Given the discussion under Section 2.3.5 of this report, demonstrates that the current NBCC building areas can remain. In addition to the research conducted by the AHC, the tie between Types I and IV is another main factor to solidify these IBC construction provisions. Noncombustible construction under the NBCC is not less ambitious than those of IBC, that unlimited height and area buildings can be constructed per Code for all occupancy groups except F-1.

It is recommended that the NBCC endeavour to recognize mass timber construction, when erected with modern mitigation features, offer an acceptable level of performance that merit less restrictive construction limitations:

- Mass timber without protection possesses inherent fire-resistance.
- Test data by the ICC-AHC and NRC are available to the industry.
- Sprinklers are able to contain the fire in its origin compartment very effectively.
- Fire department response time greatly improved with modern technologies.
- EMTC fire safety measures during construction established by the Fire Code, and is evolving.
- Mass timber products manufactured today offer a high level of precision and quality suitable for tall wood buildings.

The Code cycle that implemented the EMTC provisions in the 2020 NBCC employed data of mass timber with a previous generation of adhesives. These products exhibited a delamination tendency, that when the adhesive was heated by fire, its strength was lost. However, with the new generation of heat-resistant adhesives, and as demonstrated through an NRC research effort, the delamination occurrence is mitigated. In other words, the EMTC provisions have room to grow to be more ambitious than they are.

Therefore, it is the finding of this report that Code changes for Group C and D EMTC buildings can move forward, that resemble the IBC Types IV-A, -B and -C provisions, at a minimum.

Considering the fact that the 2020 NBCC EMTC provisions are based on research conducted on mass timber products using temperature-sensitive adhesives, the new provisions for Groups C and D EMTC buildings should offer more permitted interior exposed timber.

4.4 Occupancy Groups

The NBCC EMTC provisions are limited to Groups C and D only in the 2020 cycle. In a review of the 2020 NBCC, Subsection 3.2.2 construction articles, it is found that buildings of noncombustible construction that are sprinklered throughout are permitted to have unlimited building height and area, given that the building elements possess the required FRR for all occupancy groups with the one understandable exception of Group F-1.

In this light, the NBCC recognizes that, in terms of building height and area, the permitted occupancy groups of sprinklered, noncombustible construction have similar levels of risk. The NBCC also acknowledges that EMTC is not equal to combustible construction, but a type of its own with advantages that combustible construction does not possess. This Report recommends creating provisions to permit construction of EMTC buildings for low-risk occupancy groups, on the basis of:

- Existing adequate research conducted by ICC-AHC, NRC, and other research efforts.
- The Code's perspective on allowing unlimited building height and area across occupancy groups (except F-1) for noncombustible, sprinklered buildings.
- Modern building safety features that are effective to contain fire (sprinklers), ability to alert occupants and fire departments (fire alarm system), and detection (sprinklers and smoke detectors)

4.5 Interior Timber Exposure

The possible Code provision for mass timber buildings taller than 12 storeys to a maximum 18 storeys is recommended to have no exposed timber on the interior. Permissions of exposed timber on these buildings can be pursued by alternative solutions at the discretion of the local AHJ. In recognition of the effectiveness of quick-response sprinklers combined with reduced building height and area, mass timber buildings of 9 storeys or shorter are recommended to be permitted to have 100% exposed interior timber, parallel to the IBC. Provisions for mass timber buildings of maximum 12 storeys can remain as they are.

It is noted that there are Code change proposals currently being reviewed at the Standing Committee level for the NBCC with respect to increasing the amount of permissible exposed timber.

4.6 Non-Sprinklered Mass Timber Buildings

In addition to sprinklered buildings, the IBC also permits mass timber buildings without sprinklers, but with lower building height, or with occupancy restrictions, in comparison to those sprinklered. As mentioned above, the research effort for this report concentrated on sprinklered buildings. Many of the findings and recommendations of this report are based on the industry's common understanding of the effectiveness of automatic sprinkler systems. At this time, unsprinklered options are not recommended for mass timber buildings under the NBCC.

4.7 Recommendations to the NBCC

4.7.1 *Summary Table*

The following Tables are summaries of the recommendations based on the findings of this report. The NBCC is recommended to adopt the IBC Type IV-A, -B and -C construction provisions to establish construction Articles for 18, 12, and 9-storey EMTC buildings. In the context of the report, terminology of 18, 12, or 9-storey intend to represent the three tiers of construction levels that are recommended to be established in the NBC, since the NBCC does not use similar terms such as "Type IV" in its language.

The report recommends no changes in the building areas of the newly proposed EMTC construction articles and keeping the current building areas permitted to 12-storey EMTC buildings for Groups C and D occupancies for buildings up to 18 storeys.

In addition, this report recommends EMTC construction for low-risk, simple major occupancies. Occupancies with specific challenges such as Group B-1 (contained use), or Group F-1 (high fuel load) are not contemplated at this moment.

Table 26: Summary of Recommendations

Recommendations to the NBCC	
Building Height	18-storey and 9-storey provisions in addition to those of 12-storey
Building Area	Existing EMTC building areas remain unchanged; new EMTC provisions to follow the same approach as the 2020 NBCC EMTC development
Occupancy Groups	Permit EMTC construction for low-risk groups including Groups A-2, B-3, F-2, and F-3, in addition to the existing Groups C and D

Recommendations to the NBCC	
Fire Resistance Rating **Floor, Mez, Walls**	18-storey: 2, 1, (same as supported) 12-storey: 2, 1, (same as supported) 9-storey: 2, 1, (same as supported)
Interior Protection	18-storey: Minimum two layers of 15.9mm Type X GWB 12-storey: Minimum two layers of 12.7mm Type X GWB 9-storey: No interior protection required
Interior Timber Exposure	18-storey: Exposed timber permitted by alternative solution only 12-storey: Remain as is 9-storey: 100% exposure permitted

Table 27 contains the recommended building heights per each NBCC occupancy group. The building height in storeys is based on what is currently permitted in the IBC, sprinklered. Physical building height measured in meters can assume a floor height of 3.5m, measured between the floor of the first storey and the uppermost floor level, same as the current EMTC provisions under Subsection 3.2.2.

Table 27: Recommended Building Height and Occupancy Group

NBCC Occupancy	IBC Occupancy	Building Height (Storeys)
A-2	A-2, A-3	18, 12 and 6 Storeys
B-3	I-2 Condition 1, R-4	10, 6 and 4 Storeys
C	R-1, R-2, R-3	18, 12 and 8 Storeys
D	B	18, 12 and 9 Storeys
E	M	12, 8 and 6 Storeys
F-2	F-1, F-2	10, 7 and 5 Storeys
F-3	S-2	12, 8 and 5 Storeys

In consideration of making recommendations to expand the building height of EMTC buildings, a Summary Report documenting the findings of the NBCC Working Group was referenced. One of the questions that was addressed within this summary inquired on the limitation of maximum 12 storeys of the EMTC buildings. The Working Group considered that the 12-storey limit as a reasonable next step in the progression of the NBCC after the 6-storey light frame buildings were introduced. In today's context, as 12-storey EMTC provisions have been introduced, and the completion of the 18-storey Brock Commons project, and the introduction of 18-storey mass timber buildings in the IBC, we recognize that 18-storey is the new reasonable next step for the development of the Code.

Based on our findings in the report, we recommend the following next steps for the development of the NBCC.

Development of 18-storey provisions within the NBCC is recommended based on those prescribed to the IBC Type IV-A, while maintaining the same building areas as currently permitted within the NBCC. As a more conservative approach, the proposed 18-storey EMTC buildings are recommended to have a minimum encapsulation rating of 60min equivalent to the 80min 'contribution to the FRR of the IBC' provided by two layers of 15.9mm Type X GWB. Permissions of minimum encapsulation rating of 50min (two layers of 12.7mm Type X GWB) on the 18-storey EMTC buildings may be considered with further research.

Additional review of the IBC provision for 3h FRR for the frame is appropriate, however based on the philosophy of the NBC that a 2h FRR is sufficient to contain a fire in a building of any height and area, it is recommended that the NBC 2h FRR provision be retained.

The NBCC to consider developing 9-storey building provisions based on those prescribed to the IBC Type IV-C, while maintaining the same building areas as currently permitted within the NBCC. The proposed 9-storey EMTC buildings are recommended to have fully exposed timber on the interior, with exceptions to address particular conditions, such as exits for example, which are to be identified upon further studies. The current Code permits 6-storey wood frame buildings with 1h FRR and given that 12-storey EMTC is required of 2h FRR, the maximum 9-storey EMTC provisions are recommended to require 1½h FRR, as this is an interpolated fire-resistance rating between 6-storey 1h FRR light frame structures and 2h FRR EMTC structures.

Building height of EMTC buildings can be derived based on floor height. This can be further researched in a separate study.

The NBCC is recommended to consider expanding permitted EMTC occupancy groups, particularly to all light hazard occupancies such as A-2, B-2, and F-3; high occupancy groups such as F-2 and E could be considered based on the allowable heights in the IBC.

Based on the above, a series of potential Code Change Proposals have been developed, attached in *Appendix B*.

5. CONCLUSION

This report documented a study on the transferability of the 2021 International Building Code mass timber provisions to the National Building Code of Canada. The study included a review of the International Building Code Ad Hoc Committee fire tests, comparison of the existing National Building Code of Canada 12-storey encapsulated mass timber construction buildings with the International Building Code Type IV buildings, approach on fire resistance and interior protection, exterior wall and building details. The report also documented a review of the Structural comparisons and analysis. Following the discussion above, this report generally concludes that the International Building Code mass timber provisions can be adopted to the National Building Code of Canada, and with careful, more conservative modifications where the International Building Code is less conservative. Substantiated by the discussion contained within, this report made recommendations on possible Code changes that can be applicable to the National Building Code of Canada. Other areas such as podium buildings and increased building area will require additional studies.

Enclosures

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Appendix A

International Code Council Ad Hoc Committee Composition

Ad Hoc Committee on Tall Wood Buildings (AHC-TWB)

Carl F. Baldassarra, P.E.
Principal
Wiss, Janney, Elstner Associates, Inc.
Northbrook, IL

Kenneth E. Bush
Rep: National Association of State Fire Marshals
Chief Fire Protection Engineer
Maryland State Fire Marshal's Office
Easton, MD

Sean DeCrane
Lead Regulatory Engineer
Building & Life Safety Technologies
UL LLC
Cleveland, OH

Stephen J. DiGiovanni, P. E., CHAIR
Fire Department Protection Engineer
Clark County Department of Building and Fire Prevention
Las Vegas, NV

Sam Francis
Rep: American Wood Council (AWC)
Retired from AWC
West Grove, PA

Julie Frappier, P.E.
Director, Technical Services
Nordic Structures
Montreal, Quebec

Patrick Granson
Deputy Director Permitting and Plan Review
Mecklenburg County Code Enforcement
Charlotte, NC

Jonathan Humble, AIA, NCARB, LEED-AP BD & C
Regional Director
American Iron and Steel Institute
West Hartford, CT

Susan H. Jones, FAIA, LEED AP BD+C
Rep: The American Institute of Architects
Architect
atelierjones
Seattle, WA

Paul Shipp, P.E., Ph.D.
Principal Research Associate
USG Corporation
Libertyville, IL

Jonathan C. Siu, PE, SE, VICE CHAIR
Principal Engineer/Building Official
City of Seattle; Seattle Department of Construction and Inspections
Seattle, WA

Stephen V. Skalko, PE
Rep: Masonry Alliance for Codes and Standards
Principal and Consulting Engineer
Stephen V. Skalko, P.E. & Associates, LLC
Macon, GA

Matthew A. Timmers, S.E.
Rep: Structural Engineers Association of CA/So. California
John A. Martin & Associates
Los Angeles, CA

Andrew Tsay Jacobs, LEED AP, EIT
Director of Building Technology Lab
Perkins+Will
Los Angeles, CA

John L. Walser
Battalion Chief, Fire Prevention Services
Fairfax County Fire and Rescue Department
Fairfax, VA

Felix I. Zemel, CBO
Rep: Town of Dover, MA
Principal
Pracademic Solutions
Needham, MA

Board Liaison
David J. Spencer, CBO
Operations Manager
City of Woodinville
Covington, WA

Staff Secretariat
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Appendix B

Code Change Proposals

Fast + Epp

TABLE OF CONTENTS

PREFACE

The Code Change Requests contained in this Appendix are substantiated by the finding of the Transferability Report by GHL Consultants and Fast + Epp, of June 7, 2021.

These requests simply provide options that, based on the report, could be transferred from the International Building Code (IBC) to the National Building Code of Canada (NBCC) with relatively minimal change.

In our opinion, all proposed Articles are justified and supported by the IBC process. In some cases, the IBC derived solutions may be overly conservative, such as the 5 storey F-3 encapsulated mass timber construction (EMTC) at 2h fire resistance rating, where the NBCC permits combustible, 45min fire resistance rating for 4-storey F-3 structures. The scope of the Report does not contain a review of market demand, or assessing if these Articles are overly conservative.

The suggested next step is a review of market demand, and along with a cost-benefit analysis, for each of the proposed construction Article.

We also note that there is ongoing research on acceptability of interior exposed timber based on recent testing. Code changes on increasing interior exposed timber are already being reviewed by the Standing Committee – Fire Protection.

These changes will need to be incorporated in Requests to Codes Canada. This Report has not reviewed the editorial changes that will be required, such as the references to Subsection 3.2.6, noting that the Group D EMTC buildings over 18m are high buildings, should be required for all EMTC buildings.

APPENDIX A-1: TABLE 3.1.3.1.

Function

Which of these functions apply?

☒ Building / Fire / Plumbing official

☒ Builder / Contractor

☒ Designer / Architect / Engineer

☒ Supplier / Manufacturer

☒ Building owner / Manager

☒ Home owner / General public

☐ Other

Code change request

Code change

☒ To the existing code provision

☐ Add new code provision

Document

2020 National Building Code

Code reference of the requested change: Article, Sentence, etc. (e.g. 9.32.3.5.)

Article 3.1.3.1.

Subject

Notes to Table 3.1.3.1.

Problem

2020 NBCC will permit construction of 12-storey EMTC buildings for Groups C and D Occupancies. The NBCC Working Group considered that the 12-storey limit as a reasonable next step in the progression of the NBCC after the 6-storey light frame buildings were introduced. Based on the findings of the Report on Transferability of 2021 IBC Tall Wood Provisions to the NBCC by GHL Consultants and Fast + Epp of June 7, 2021, a number of possible next steps were identified to incorporate this Code Change Request.

With the request of the addition of new EMTC construction articles in Subsection 3.2.2., Notes to Table 3.1.3.1. will need to be revised.

Request change / addition

What wording do you propose for the change?

Table 3.1.3.1. Major Occupancy Fire Separations

Notes to Table 3.1.3.1.:

(1) Section 3.3. contains requirements for the separation of occupancies and tenancies that are in addition to the requirements for the separation of major occupancies.

(2) See Sentence 3.1.3.2.(1).

(3) Where the *building* or part thereof is constructed in accordance with Article 3.2.2.XXEMTC., Article 3.2.2.48EMTC., Article 3.2.2.XXEMTC. or Article 3.2.2.50., a *fire separation* with a 2 h *fire-resistance rating* is required between the Group C and Group A, Division 2 *major occupancies*.

(4) Where the *building* or part thereof is constructed in accordance with Article 3.2.2.XXEMTC., Article 3.2.2.57EMTC., Article 3.2.2.XXEMTC or Article 3.2.2.58., a *fire separation* with a 2 h *fire-resistance rating* is required between the Group D and Group A, Division 2 *major occupancies*.

(5) See Sentence 3.1.3.1.(2).

(6) See Sentence 3.1.3.2.(2).

(7) Where the *building* or part thereof is constructed in accordance with Article 3.2.2.XXEMTC., Article 3.2.2.48EMTC or Article 3.2.2.XXEMTC., a *fire separation* with a 2 h *fire-resistance rating* is required between the Group C *major occupancy* and *storage garages*.

(8) Where the *building* or part thereof is constructed in accordance with Article 3.2.2.XXEMTC., Article 3.2.2.57EMTC. or Article 3.2.2.XXEMTC, a *fire separation* with a 1 h *fire-resistance rating* is required between the Group D and Group E or Group F, Division 2 or 3 *major occupancies*.

Justification / explanation

The Transferability Report contains extensive discussion on the rationale of the transferability of the IBC Type IV-A, IV-B, and IV-C provisions to the NBCC. The Report, substantiated by a study on the comparative differences of the IBC and the NBCC in the Fire and Structural perspectives, concluded that the NBCC can adopt the IBC Type IV-A, IV-B, and IV-C provisions with careful, and in most cases, more conservative modifications.

With the request of the addition of new EMTC construction articles in Subsection 3.2.2., Notes to Table 3.1.3.1. will need to be revised.

Objective(s)

Which of the Code's objectives does the requested change address?

OP1.2, OS1.2, OS1.5

APPENDIX A-2: REFERENCES TO EMTC CONSTRUCTION ARTICLES

Function

Which of these functions apply?

☒ Building / Fire / Plumbing official

☒ Builder / Contractor

☒ Designer / Architect / Engineer

☒ Supplier / Manufacturer

☒ Building owner / Manager

☒ Home owner / General public

☐ Other

Code change request

Code change

☒ To the existing code provision

☐ Add new code provision

Document

2020 National Building Code

Code reference of the requested change: Article, Sentence, etc. (e.g. 9.32.3.5.)

Sentences 3.1.11.5.(4)., 3.1.15.2.(5)., 3.2.2.6.(1), 3.2.2.7.(1)., 3.2.2.11.(2)., 3.2.2.18.(1)., Sentence 3.2.3.7.(2)., 3.2.5.12.(8)., 3.2.6.1.(2)

Subject

Sentences that Involve EMTC Construction Articles

Problem

2020 NBCC will permit construction of 12-storey EMTC buildings for Groups C and D Occupancies. The NBCC Working Group considered that the 12-storey limit as a reasonable next step in the progression of the NBCC after the 6-storey light frame buildings were introduced. Based on the findings of the Report on Transferability of 2021 IBC Tall Wood Provisions to the NBCC by GHL Consultants and Fast + Epp of June 7, 2021, a number of possible next steps were identified to incorporate this Code Change Request.

With the request of the addition of new EMTC construction articles in Subsection 3.2.2., the above-referenced Sentences will need to be revised to include the new EMTC construction articles.

Request change / addition

What wording do you propose for the change?

For each Sentence referenced above, in addition to the existing 3.2.2.48EMTC and 3.2.2.57EMTC, include all new 3.2.2.XXEMTC construction articles.

Justification / explanation

The Transferability Report contains extensive discussion on the rationale of the transferability of the IBC Type IV-A, IV-B, and IV-C provisions to the NBCC. The Report, substantiated by a study on the comparative differences of the IBC and the NBCC in the Fire and Structural perspectives, concluded that the NBCC can adopt the IBC Type IV-A, IV-B, and IV-C provisions with careful, and in most cases, more conservative modifications.

With the request of the addition of new EMTC construction articles in Subsection 3.2.2., the above-referenced Sentences will need to be revised to include the new EMTC construction articles.

Objective(s)

Which of the Code's objectives does the requested change address?

APPENDIX A-3: ARTICLE 3.1.18.4.

Function

Which of these functions apply?

☒ Building / Fire / Plumbing official

☒ Builder / Contractor

☒ Designer / Architect / Engineer

☒ Supplier / Manufacturer

☒ Building owner / Manager

☒ Home owner / General public

☐ Other

Code change request

Code change

☒ To the existing code provision

☐ Add new code provision

Document

2020 National Building Code

Code reference of the requested change: Article, Sentence, etc. (e.g. 9.32.3.5.)

Article 3.1.18.4.

Subject

Article 3.1.18.4. Encapsulation of Mass Timber Elements

Problem

2020 NBCC will permit construction of 12-storey EMTC buildings for Groups C and D Occupancies. The NBCC Working Group considered that the 12-storey limit as a reasonable next step in the progression of the NBCC after the 6-storey light frame buildings were introduced. Based on the findings of the Report on Transferability of 2021 IBC Tall Wood Provisions to the NBCC by GHL Consultants and Fast + Epp of June 7, 2021, a number of possible next steps were identified to incorporate this Code Change Request.

With the request of the addition of new EMTC construction articles in Subsection 3.2.2., and that some of the proposed EMTC buildings require full encapsulation, and others permit 100% interior exposed timber, the provision of mass timber encapsulation under Article 3.1.18.4. is required to be revised.

Request change / addition

What wording do you propose for the change?

3.1.18.4. Encapsulation of Mass Timber Elements

(See Note A-3.1.18.3.)

1) Except as provided in Articles 3.1.18.5., 3.1.18.10. and 3.1.18.15., where *buildings* or parts thereof conforming to Articles 3.2.2.XXEMTC., 3.2.2.XXEMTC., 3.2.2.XXEMTC., 3.2.2.XXEMTC., 3.2.2.XXEMTC., 3.2.2.XXEMTC., and 3.2.2.XXEMTC., the exposed surfaces of structural timber elements conforming to Article 3.1.18.3. shall be protected from adjacent spaces in the building, including adjacent concealed spaces within wall, floor and roof assemblies, by material or assembly of materials conforming to Sentence (4) that provides an encapsulation rating of not less than 60 min.

(See Note A-3.1.18.4.(1).)

2) Except as provided in Sentences (5) to (8), Sentences 3.1.18.3.(4) and 3.1.18.14.(2), and Articles 3.1.18.5., 3.1.18.10. and 3.1.18.15., where *buildings* or parts thereof conforming to Articles 3.2.2.XXEMTC., 3.2.2.XXEMTC., 3.2.2.48EMTC., 3.2.2.57EMTC., 3.2.2.XXEMTC., 3.2.2.XXEMTC. and 3.2.2.XXEMTC., the exposed surfaces of structural timber elements conforming to Article 3.1.18.3. shall be protected from adjacent spaces in the building, including adjacent concealed spaces within wall, floor and roof assemblies, by a material or assembly of materials conforming to Sentence (2) that provides an *encapsulation rating* of not less than 50 min.

(See Note A-3.1.18.4.(2).)

3) Except as provided in Sentences 3.1.18.3.(4) and 3.1.18.14.(2), and Articles 3.1.18.5., 3.1.18.10. and 3.1.18.15., where *buildings* or parts thereof conforming to Articles 3.2.2.XXEMTC, 3.2.2.XXEMTC, 3.2.2.XXEMTC, 3.2.2.XXEMTC, 3.2.2.XXEMTC, 3.2.2.XXEMTC, 3.2.2.XXEMTC, the exposed surfaces of mass timber within a suite need not be protected from adjacent spaces in the *building*, including adjacent concealed spaces within wall, floor and roof assemblies, by a material or assembly of materials conforming to Sentence (4).

(See Note A-3.1.18.4.(3).)

4) Except as provided in Sentence 3.1.18.9.(1), the material or assembly of materials referred to in Sentence (1) shall consist of

a) gypsum board,

b) gypsum concrete,

c) *noncombustible* materials,

d) materials that conform to Sentences 3.1.5.1.(2) to (4), or

e) any combination of the materials listed in Clauses (a) to (d).

5) Except as provided in Sentence (5), the exposed surfaces of mass timber beams, columns and arches within a suite or *fire compartment* need not be protected in accordance with Sentence (1), provided

a) their aggregate surface area does not exceed 10% of the total wall area of the perimeter of the suite or fire compartment in which they are located, and

b) the *flame-spread rating* on any exposed surface is not more than 150.

(See Note A-3.1.18.4.(5) to (8).)

6) Except as provided in Sentences (5) and (6), the exposed surfaces of mass timber walls within a *suite* need not be protected in accordance with Sentence (1), provided

a) each exposed surface faces the same direction, and

b) the *flame-spread rating* on any exposed surface is not more than 150.

(See Note A-3.1.18.4.(5) to (8).)

7) The aggregate exposed surface area of mass timber elements within a *suite* permitted in Sentences (3) and (4) shall not exceed 35% of the total wall area of the perimeter of the *suite*.

(See Note A-3.1.18.4.(5) to (8).)

8) The exposed surfaces of mass timber ceilings within a *suite* need not be protected in accordance with

Sentence (1), provided their aggregate area does not exceed

a) 10% of the total ceiling area of the *suite*, where the exposed surfaces have a *flame-spread rating* not more than 150, or

b) 25% of the total ceiling area of the *suite*, where

i) the *suite* contains no mass timber walls with exposed surfaces, and

ii) the exposed surfaces of the mass timber ceiling have a *flame-spread rating* not more than 75.

(See Note A-3.1.18.4.(5) to (8).)

Justification / explanation

The Transferability Report contains extensive discussion on the rationale of the transferability of the IBC Type IV-A, IV-B, and IV-C provisions to the NBCC. The Report, substantiated by a study on the comparative differences of the IBC and the NBCC in the Fire and Structural perspectives, concluded that the NBCC can adopt the IBC Type IV-A, IV-B, and IV-C provisions with careful, and in most cases, more conservative modifications.

With the request of the addition of new EMTC construction articles in Subsection 3.2.2., and that some of the proposed EMTC buildings require full encapsulation, and others permit 100% interior exposed timber, the provision of mass timber encapsulation under Article 3.1.18.4. is required to be revised.

Objective(s)

Which of the Code's objectives does the requested change address?

OP1.2, OS1.2

APPENDIX A-4: ARTICLE 3.1.19.2.

Function

Which of these functions apply?

☒ Building / Fire / Plumbing official

☒ Builder / Contractor

☒ Designer / Architect / Engineer

☒ Supplier / Manufacturer

☒ Building owner / Manager

☒ Home owner / General public

☐ Other

Code change request

Code change

☒ To the existing code provision

☐ Add new code provision

Document

2020 National Building Code

Code reference of the requested change: Article, Sentence, etc. (e.g. 9.32.3.5.)

Article 3.1.19.2.

Subject

Article 3.1.19.2. Encapsulation Materials

Problem

2020 NBCC will permit construction of 12-storey EMTC buildings for Groups C and D Occupancies. The NBCC Working Group considered that the 12-storey limit as a reasonable next step in the progression of the NBCC after the 6-storey light frame buildings were introduced. Based on the findings of the Report on Transferability of 2021 IBC Tall Wood Provisions to the NBCC by GHL Consultants and Fast + Epp of June 7, 2021, a number of possible next steps were identified to incorporate this Code Change Request.

With the request of the addition of new EMTC construction articles in Subsection 3.2.2., and that some of the proposed EMTC buildings 60 min encapsulation rating, Article 3.1.19.2. is required to be revised to assign the amount of gypsum board for the required 60 min encapsulation rating.

Request change / addition

What wording do you propose for the change?

3.1.19.2. Encapsulation Materials

(See Note A-3.1.19.2.)

1) Gypsum-concrete topping and concrete not less than 38 mm thick are deemed to have an *encapsulation rating* of 50 min when installed on the upper side of a mass timber floor or roof assembly.

2) Two layers of Type X gypsum board each not less than 12.7 mm thick are deemed to have an *encapsulation rating* of 50 min when installed on a mass timber element; two layers of Type X gypsum board each not less than 15.9 mm thick are deemed to have an encapsulation rating of 60 min when installed on timber element, provided they

a) are mechanically fastened directly to the mass timber element with

i) screws of sufficient length to penetrate the mass timber element not less than 20 mm spaced not more than 400 mm o.c. and 20 mm to 38 mm from the boards' edges, or

ii) screws fastened to wood nailing elements or resilient metal or steel furring channels not more than

25 mm thick spaced not more than 400 mm o.c.,

b) are installed with the joints in each layer staggered from those in the adjacent layer,

c) are attached by a minimum of two rows of fasteners in each layer,

d) are installed in conformance with ASTM C 840, "Application and Finishing of Gypsum Board," except that their joints need not be taped and finished, and

e) conform to

i) ASTM C 1396/C 1396M, "Gypsum Board," or

ii) CAN/CSA-A82.27-M, "Gypsum Board."

(See Note A-3.1.19.2.(2).)

Justification / explanation

The Transferability Report contains extensive discussion on the rationale of the transferability of the IBC Type IV-A, IV-B, and IV-C provisions to the NBCC. The Report, substantiated by a study on the comparative differences of the IBC and the NBCC in the Fire and Structural perspectives, concluded that the NBCC can adopt the IBC Type IV-A, IV-B, and IV-C provisions with careful, and in most cases, more conservative modifications.

The IBC specifies an 80 min contribution to fire resistance rating, which for two layers of 15.9mm Type X gypsum boards translates into a 60 min encapsulation rating.

With the request of the addition of new EMTC construction articles in Subsection 3.2.2., and that some of the proposed EMTC buildings require full encapsulation, and others permit 100% interior exposed timber, the provision of mass timber encapsulation under Article 3.1.18.4. is required to be revised.

Objective(s)

Which of the Code's objectives does the requested change address? No objectives are directly referenced by this Article under Division B.

APPENDIX A-5: GROUP C, UP TO 18 STOREYS, SPRINKLERED

Function

Which of these functions apply?

☒ Building / Fire / Plumbing official

☒ Builder / Contractor

☒ Designer / Architect / Engineer

☒ Supplier / Manufacturer

☒ Building owner / Manager

☒ Home owner / General public

☐ Other

Code change request

Code change

☐ To the existing code provision

☒ Add new code provision

Document

2020 National Building Code

Code reference of the requested change: Article, Sentence, etc. (e.g. 9.32.3.5.)

Subsection 3.2.2.

Subject

Article 3.2.2.XXEMTC. Group C, up to 18 storeys, Sprinklered

Problem

2020 NBCC will permit construction of 12-storey EMTC buildings for Groups C and D Occupancies. The NBCC Working Group considered that the 12-storey limit as a reasonable next step in the progression of the NBCC after the 6-storey light frame buildings were introduced. Based on the findings of the Report on Transferability of 2021 IBC Tall Wood Provisions to the NBCC by GHL Consultants and Fast + Epp of June 7, 2021, a number of possible next steps were identified to incorporate this Code Change Request, including extending EMTC permissions to other occupancy groups.

Request change / addition

What wording do you propose for the change?

3.2.2.XXEMTC. Group C, up to 18 storeys, Sprinklered

1) A *building* classified as Group C is permitted to conform to Sentence (2), provided

a) it is *sprinklered* throughout,

b) it is not more than 18 *storeys* in *building height*,

c) it has a height not more than 63 m measured between the floor of the first *storey* and the uppermost floor level, excluding any floor level within a rooftop enclosure that is not considered as a *storey* in calculating *building height* in accordance with Sentence 3.2.1.1.(1), and

d) it has a *building area* not more than 6000 m^2.

2) Except as provided in Article 3.2.2.16., the *building* referred to in Sentence (1) is permitted to be of *encapsulated mass timber construction* or *noncombustible* construction, used singly or in combination, and

a) except as provided in Sentence (3), floor assemblies shall be *fire separations* with *fire-resistance rating* not less than 2 h,

b) *mezzanines* shall have a *fire-resistance rating* not less than 1 h, and

c) *loadbearing* walls, columns and arches shall have a *fire-resistance rating* not less than that required for the supported assembly.

3) In a *building* that contains *dwelling units* that have more than one *storey*, subject to the requirements of Sentence 3.3.4.2.(3), the floor assemblies, including floors over *basements*, that are entirely contained within these *dwelling units* shall have a *fire-resistance rating* not less than 1 h but need not be constructed as *fire separations*.

4) Group A, Division 2 *major occupancies*, Group E *major occupancies* and *storage garages* located in a *building* or part of a *building* within the scope of this Article are permitted to be constructed in accordance with this Article, provided

a) the Group A, Division 2 *major occupancy* is located below the fourth *storey*,

b) the Group E *major occupancy* is located below the third *storey*, and

c) the *storage garage* is located below the fifth *storey*.

Justification / explanation

The Transferability Report contains extensive discussion on the rationale of the transferability of the IBC Type IV-A (mass timber, 18-storey, Residential) provisions to the NBCC. The Report, substantiated by a study on the comparative differences of the IBC and the NBCC in the Fire and Structural perspectives, concluded that the NBCC can adopt the IBC Type IV-A provisions with careful, and in most cases, more conservative modifications.

Objective(s)

Which of the Code's objectives does the requested change address? OP1.2, OP1.3, OS1.2, OS1.3

APPENDIX A-6: GROUP C, UP TO 8 STOREYS, SPRINKLERED

Function

Which of these functions apply?

☒ Building / Fire / Plumbing official

☒ Builder / Contractor

☒ Designer / Architect / Engineer

☒ Supplier / Manufacturer

☒ Building owner / Manager

☒ Home owner / General public

☐ Other

Code change request

Code change

☐ To the existing code provision

☒ Add new code provision

Document

2020 National Building Code

Code reference of the requested change: Article, Sentence, etc. (e.g. 9.32.3.5.)

Subsection 3.2.2.

Subject

Article 3.2.2.XXEMTC. Group C, up to 8 storeys, Sprinklered

Problem

2020 NBCC will permit construction of 12-storey EMTC buildings for Groups C and D Occupancies. The NBCC Working Group considered that the 12-storey limit as a reasonable next step in the progression of the NBCC after the 6-storey light frame buildings were introduced. Based on the findings of the Report on Transferability of 2021 IBC Tall Wood Provisions to the NBCC by GHL Consultants and Fast + Epp of June 7, 2021, a number of possible next steps were identified to incorporate this Code Change Request, including extending EMTC permissions to other occupancy groups.

Request change / addition

What wording do you propose for the change?

3.2.2.XXEMTC. Group C, up to 8 storeys, Sprinklered

1) A *building* classified as Group C is permitted to conform to Sentence (2), provided

a) it is *sprinklered* throughout,

b) it is not more than 8 *storeys* in *building height*,

c) it has a height not more than 28 m measured between the floor of the first *storey* and the uppermost floor level, excluding any floor level within a rooftop enclosure that is not considered as a *storey* in calculating *building height* in accordance with Sentence 3.2.1.1.(1), and

d) it has a *building area* not more than 6 000 m^2.

2) Except as provided in Article 3.2.2.16., the *building* referred to in Sentence (1) is permitted to be of *encapsulated mass timber construction* or *noncombustible* construction, used singly or in combination, and

a) except as provided in Sentence (3), floor assemblies shall be *fire separations* with *fire-resistance rating* not less than 2 h,

b) *mezzanines* shall have a *fire-resistance rating* not less than 1 h, and

c) *loadbearing* walls, columns and arches shall have a *fire-resistance rating* not less than that required for the supported assembly.

3) In a *building* that contains *dwelling units* that have more than one *storey*, subject to the requirements of Sentence 3.3.4.2.(3), the floor assemblies, including floors over *basements*, that are entirely contained within these *dwelling units* shall have a *fire-resistance rating* not less than 1 h but need not be constructed as *fire separations*.

4) Group A, Division 2 *major occupancies*, Group E *major occupancies* and *storage garages* located in a *building* or part of a *building* within the scope of this Article are permitted to be constructed in accordance with this Article, provided

a) the Group A, Division 2 *major occupancy* is located below the fourth *storey*,

b) the Group E *major occupancy* is located below the third *storey*, and

c) the *storage garage* is located below the fifth *storey*.

Justification / explanation

The Transferability Report contains extensive discussion on the rationale of the transferability of the IBC Type IV-C (mass timber, 8-storey, Residential) provisions to the NBCC. The Report, substantiated by a study on the comparative differences of the IBC and the NBCC in the Fire and Structural perspectives, concluded that the NBCC can adopt the IBC Type IV-C provisions with careful, and in most cases, more conservative modifications.

Objective(s)

Which of the Code's objectives does the requested change address? OP1.2, OP1.3, OS1.2, OS1.3

APPENDIX A-7: GROUP D, UP TO 18 STOREYS, SPRINKLERED

Function

Which of these functions apply?

☒ Building / Fire / Plumbing official

☒ Builder / Contractor

☒ Designer / Architect / Engineer

☒ Supplier / Manufacturer

☒ Building owner / Manager

☒ Home owner / General public

☐ Other

Code change request

Code change

☐ To the existing code provision

☒ Add new code provision

Document

2020 National Building Code

Code reference of the requested change: Article, Sentence, etc. (e.g. 9.32.3.5.)

Subsection 3.2.2.

Subject

Article 3.2.2.XXEMTC. Group D, up to 18 storeys, Sprinklered

Problem

2020 NBCC will permit construction of 12-storey EMTC buildings for Groups C and D Occupancies. The NBCC Working Group considered that the 12-storey limit as a reasonable next step in the progression of the NBCC after the 6-storey light frame buildings were introduced. Based on the findings of the Report on Transferability of 2021 IBC Tall Wood Provisions to the NBCC by GHL Consultants and Fast + Epp of June 7, 2021, a number of possible next steps were identified to incorporate this Code Change Request, including extending EMTC permissions to other occupancy groups.

Request change / addition

What wording do you propose for the change?

3.2.2.XXEMTC. Group D, up to 18 storeys, Sprinklered

1) A *building* classified as Group D is permitted to conform to Sentence (2), provided

a) it is *sprinklered* throughout,

b) it is not more than 18 *storeys* in *building height*,

c) it has a height not more than 63 m measured between the floor of the first *storey* and the uppermost floor level, excluding any floor level within a rooftop enclosure that is not considered as a *storey* in calculating *building height* in accordance with Sentence 3.2.1.1.(1), and

d) it has a *building area* not more than 7 200 m^2.

2) Except as provided in Article 3.2.2.16., the *building* referred to in Sentence (1) is permitted to be of *encapsulated mass timber construction* or *noncombustible* construction, used singly or in combination, and

a) except as provided in Sentence (3), floor assemblies shall be *fire separations* with *fire-resistance rating* not less than 2 h,

b) *mezzanines* shall have a *fire-resistance rating* not less than 1 h, and

c) *loadbearing* walls, columns and arches shall have a *fire-resistance rating* not less than that required for the supported assembly.

3) In a *building* that contains *dwelling units* that have more than one *storey*, subject to the requirements of Sentence 3.3.4.2.(3), the floor assemblies, including floors over *basements*, that are entirely contained within these *dwelling units* shall have a *fire-resistance rating* not less than 1 h but need not be constructed as *fire separations*.

4) Group A, Division 2 *major occupancies*, Group E *major occupancies* and *storage garages* located in a *building* or part of a *building* within the scope of this Article are permitted to be constructed in accordance with this Article, provided

a) the Group A, Division 2 *major occupancy* is located below the fourth *storey*,

b) the Group E *major occupancy* is located below the third *storey*, and

c) the *storage garage* is located below the fifth *storey*.

Justification / explanation

The Transferability Report contains extensive discussion on the rationale of the transferability of the IBC Type IV-A (mass timber, 18-storey, Business) provisions to the NBCC. The Report, substantiated by a study on the comparative differences of the IBC and the NBCC in the Fire and Structural perspectives, concluded that the NBCC can adopt the IBC Type IV-A provisions with careful, and in most cases, more conservative modifications.

Objective(s)

Which of the Code's objectives does the requested change address? OP1.2, OP1.3, OS1.2, OS1.3

APPENDIX A-8: GROUP D, UP TO 9 STOREYS, SPRINKLERED

Function

Which of these functions apply?

☒ Building / Fire / Plumbing official

☒ Builder / Contractor

☒ Designer / Architect / Engineer

☒ Supplier / Manufacturer

☒ Building owner / Manager

☒ Home owner / General public

☐ Other

Code change request

Code change

☐ To the existing code provision

☒ Add new code provision

Document

2020 National Building Code

Code reference of the requested change: Article, Sentence, etc. (e.g. 9.32.3.5.)

Subsection 3.2.2.

Subject

Article 3.2.2.XXEMTC. Group D, up to 9 storeys, Sprinklered

Problem

2020 NBCC will permit construction of 12-storey EMTC buildings for Groups C and D Occupancies. The NBCC Working Group considered that the 12-storey limit as a reasonable next step in the progression of the NBCC after the 6-storey light frame buildings were introduced. Based on the findings of the Report on Transferability of 2021 IBC Tall Wood Provisions to the NBCC by GHL Consultants and Fast + Epp of June 7, 2021, a number of possible next steps were identified to incorporate this Code Change Request, including extending EMTC permissions to other occupancy groups.

Request change / addition

What wording do you propose for the change?

3.2.2.XXEMTC. Group D, up to 9 storeys, Sprinklered

1) A *building* classified as Group D is permitted to conform to Sentence (2), provided

a) it is *sprinklered* throughout,

b) it is not more than 9 *storeys* in *building height*,

c) it has a height not more than 31.5 m measured between the floor of the first *storey* and the uppermost floor level, excluding any floor level within a rooftop enclosure that is not considered as a *storey* in calculating *building height* in accordance with Sentence 3.2.1.1.(1), and

d) it has a *building area* not more than 7 200 m^2.

2) Except as provided in Article 3.2.2.16., the *building* referred to in Sentence (1) is permitted to be of *encapsulated mass timber construction* or *noncombustible* construction, used singly or in combination, and

a) except as provided in Sentence (3), floor assemblies shall be *fire separations* with *fire-resistance rating* not less than 2 h,

b) *mezzanines* shall have a *fire-resistance rating* not less than 1 h, and

c) *loadbearing* walls, columns and arches shall have a *fire-resistance rating* not less than that required for the supported assembly.

3) In a *building* that contains *dwelling units* that have more than one *storey*, subject to the requirements of Sentence 3.3.4.2.(3), the floor assemblies, including floors over *basements*, that are entirely contained within these *dwelling units* shall have a *fire-resistance rating* not less than 1 h but need not be constructed as *fire separations*.

4) Group A, Division 2 *major occupancies*, Group E *major occupancies* and *storage garages* located in a *building* or part of a *building* within the scope of this Article are permitted to be constructed in accordance with this Article, provided

a) the Group A, Division 2 *major occupancy* is located below the fourth *storey*,

b) the Group E *major occupancy* is located below the third *storey*, and

c) the *storage garage* is located below the fifth *storey*.

Justification / explanation

The Transferability Report contains extensive discussion on the rationale of the transferability of the IBC Type IV-C (mass timber, 18-storey, Business) provisions to the NBCC. The Report, substantiated by a study on the comparative differences of the IBC and the NBCC in the Fire and Structural perspectives, concluded that the NBCC can adopt the IBC Type IV-C provisions with careful, and in most cases, more conservative modifications.

Objective(s)

Which of the Code's objectives does the requested change address? OP1.2, OP1.3, OS1.2, OS1.3

APPENDIX A-9: GROUP A-2, UP TO 18 STOREYS, SPRINKLERED

Function

Which of these functions apply?

☒ Building / Fire / Plumbing official

☒ Builder / Contractor

☒ Designer / Architect / Engineer

☒ Supplier / Manufacturer

☒ Building owner / Manager

☒ Home owner / General public

☐ Other

Code change request

Code change

☐ To the existing code provision

☒ Add new code provision

Document

2020 National Building Code

Code reference of the requested change: Article, Sentence, etc. (e.g. 9.32.3.5.)

Subsection 3.2.2.

Subject

Article 3.2.2.XXEMTC. Group A-2, up to 18 storeys, Sprinklered

Problem

2020 NBCC will permit construction of 12-storey EMTC buildings for Groups C and D Occupancies. The NBCC Working Group considered that the 12-storey limit as a reasonable next step in the progression of the NBCC after the 6-storey light frame buildings were introduced. Based on the findings of the Report on Transferability of 2021 IBC Tall Wood Provisions to the NBCC by GHL Consultants and Fast + Epp of June 7, 2021, a number of possible next steps were identified to incorporate this Code Change Request, including extending EMTC permissions to other occupancy groups.

Request change / addition

What wording do you propose for the change?

3.2.2.XXEMTC. Group A-2, up to 18 storeys, Sprinklered

1) A *building* classified as Group A-2 is permitted to conform to Sentence (2), provided

a) it is *sprinklered* throughout,

b) it is not more than 18 *storeys* in *building height*,

c) it has a height not more than 63 m measured between the floor of the first *storey* and the uppermost floor level, excluding any floor level within a rooftop enclosure that is not considered as a *storey* in calculating *building height* in accordance with Sentence 3.2.1.1.(1), and

d) it has a *building area* not more than 6000 m^2.

2) Except as provided in Article 3.2.2.16., the *building* referred to in Sentence (1) is permitted to be of *encapsulated mass timber construction* or *noncombustible* construction, used singly or in combination, and

a) except as provided in Sentence (3), floor assemblies shall be *fire separations* with *fire-resistance rating* not less than 2 h,

b) *mezzanines* shall have a *fire-resistance rating* not less than 1 h, and

c) *loadbearing* walls, columns and arches shall have a *fire-resistance rating* not less than that required for the supported assembly.

3) In a *building* that contains *dwelling units* that have more than one *storey*, subject to the requirements of Sentence 3.3.4.2.(3), the floor assemblies, including floors over *basements*, that are entirely contained within these *dwelling units* shall have a *fire-resistance rating* not less than 1 h but need not be constructed as *fire separations*.

4) Group E *major occupancies* and *storage garages* located in a *building* or part of a *building* within the scope of this Article are permitted to be constructed in accordance with this Article, provided

a) the Group E *major occupancy* is located below the third *storey*, and

b) the *storage garage* is located below the fifth *storey*.

Justification / explanation

The Transferability Report contains extensive discussion on the rationale of the transferability of the IBC Type IV-A (mass timber, 18-storey, Assembly) provisions to the NBCC. The Report, substantiated by a study on the comparative differences of the IBC and the NBCC in the Fire and Structural perspectives, concluded that the NBCC can adopt the IBC Type IV-A provisions with careful, and in most cases, more conservative modifications.

Objective(s)

Which of the Code's objectives does the requested change address?

OP1.2, OP1.3, OS1.2, OS1.3

APPENDIX A-10: GROUP A-2, UP TO 12 STOREYS, SPRINKLERED

Function

Which of these functions apply?

☒ Building / Fire / Plumbing official

☒ Builder / Contractor

☒ Designer / Architect / Engineer

☒ Supplier / Manufacturer

☒ Building owner / Manager

☒ Home owner / General public

☐ Other

Code change request

Code change

☐ To the existing code provision

☒ Add new code provision

Document

2020 National Building Code

Code reference of the requested change: Article, Sentence, etc. (e.g. 9.32.3.5.)

Subsection 3.2.2.

Subject

Article 3.2.2.XXEMTC. Group A-2, up to 12 storeys, Sprinklered

Problem

2020 NBCC will permit construction of 12-storey EMTC buildings for Groups C and D Occupancies. The NBCC Working Group considered that the 12-storey limit as a reasonable next step in the progression of the NBCC after the 6-storey light frame buildings were introduced. Based on the findings of the Report on Transferability of 2021 IBC Tall Wood Provisions to the NBCC by GHL Consultants and Fast + Epp of June 7, 2021, a number of possible next steps were identified to incorporate this Code Change Request, including extending EMTC permissions to other occupancy groups.

Request change / addition

What wording do you propose for the change?

3.2.2.XXEMTC. Group A-2, up to 12 storeys, Sprinklered

1) A *building* classified as Group A-2 is permitted to conform to Sentence (2), provided

a) it is *sprinklered* throughout,

b) it is not more than 12 *storeys* in *building height*,

c) it has a height not more than 42 m measured between the floor of the first *storey* and the uppermost floor level, excluding any floor level within a rooftop enclosure that is not considered as a *storey* in calculating *building height* in accordance with Sentence 3.2.1.1.(1), and

d) it has a *building area* not more than 6000 m^2.

2) Except as provided in Article 3.2.2.16., the *building* referred to in Sentence (1) is permitted to be of *encapsulated mass timber construction* or *noncombustible* construction, used singly or in combination, and

a) except as provided in Sentence (3), floor assemblies shall be *fire separations* with *fire-resistance rating* not less than 2 h,

b) *mezzanines* shall have a *fire-resistance rating* not less than 1 h, and

c) *loadbearing* walls, columns and arches shall have a *fire-resistance rating* not less than that required for the supported assembly.

3) In a *building* that contains *dwelling units* that have more than one *storey*, subject to the requirements of Sentence 3.3.4.2.(3), the floor assemblies, including floors over *basements*, that are entirely contained within these *dwelling units* shall have a *fire-resistance rating* not less than 1 h but need not be constructed as *fire separations*.

4) Group E *major occupancies* and *storage garages* located in a *building* or part of a *building* within the scope of this Article are permitted to be constructed in accordance with this Article, provided

a) the Group E *major occupancy* is located below the third *storey*, and

b) the *storage garage* is located below the fifth *storey*.

Justification / explanation

The Transferability Report contains extensive discussion on the rationale of the transferability of the IBC Type IV-B (mass timber, 12-storey, Assembly) provisions to the NBCC. The Report, substantiated by a study on the comparative differences of the IBC and the NBCC in the Fire and Structural perspectives, concluded that the NBCC can adopt the IBC Type IV-B provisions with careful, and in most cases, more conservative modifications.

Objective(s)

Which of the Code's objectives does the requested change address?

OP1.2, OP1.3, OS1.2, OS1.3

APPENDIX A-11: GROUP A-2, UP TO 6 STOREYS, SPRINKLERED

Function

Which of these functions apply?

☒ Building / Fire / Plumbing official

☒ Builder / Contractor

☒ Designer / Architect / Engineer

☒ Supplier / Manufacturer

☒ Building owner / Manager

☒ Home owner / General public

☐ Other

Code change request

Code change

☐ To the existing code provision

☒ Add new code provision

Document

2020 National Building Code

Code reference of the requested change: Article, Sentence, etc. (e.g. 9.32.3.5.)

Subsection 3.2.2.

Subject

Article 3.2.2.XXEMTC. Group A-2, up to 6 storeys, Sprinklered

Problem

2020 NBCC will permit construction of 12-storey EMTC buildings for Groups C and D Occupancies. The NBCC Working Group considered that the 12-storey limit as a reasonable next step in the progression of the NBCC after the 6-storey light frame buildings were introduced. Based on the findings of the Report on Transferability of 2021 IBC Tall Wood Provisions to the NBCC by GHL Consultants and Fast + Epp of June 7, 2021, a number of possible next steps were identified to incorporate this Code Change Request, including extending EMTC permissions to other occupancy groups.

Request change / addition

What wording do you propose for the change?

3.2.2.XXEMTC. Group A-2, up to 6 storeys, Sprinklered

1) A *building* classified as Group A-2 is permitted to conform to Sentence (2), provided

a) it is *sprinklered* throughout,

b) it is not more than 6 *storeys* in *building height*,

c) it has a height not more than 21 m measured between the floor of the first *storey* and the uppermost floor level, excluding any floor level within a rooftop enclosure that is not considered as a *storey* in calculating *building height* in accordance with Sentence 3.2.1.1.(1), and

d) it has a *building area* not more than 6000 m^2.

2) Except as provided in Article 3.2.2.16., the *building* referred to in Sentence (1) is permitted to be of *encapsulated mass timber construction* or *noncombustible* construction, used singly or in combination, and

a) except as provided in Sentence (3), floor assemblies shall be *fire separations* with *fire-resistance rating* not less than 2 h,

b) *mezzanines* shall have a *fire-resistance rating* not less than 1 h, and

c) *loadbearing* walls, columns and arches shall have a *fire-resistance rating* not less than that required for the supported assembly.

3) In a *building* that contains *dwelling units* that have more than one *storey*, subject to the requirements of Sentence 3.3.4.2.(3), the floor assemblies, including floors over *basements*, that are entirely contained within these *dwelling units* shall have a *fire-resistance rating* not less than 1 h but need not be constructed as *fire separations*.

4) Group E *major occupancies* and *storage garages* located in a *building* or part of a *building* within the scope of this Article are permitted to be constructed in accordance with this Article, provided

a) the Group E *major occupancy* is located below the third *storey*, and

b) the *storage garage* is located below the fifth *storey*.

Justification / explanation

The Transferability Report contains extensive discussion on the rationale of the transferability of the IBC Type IV-C (mass timber, 6-storey, Assembly) provisions to the NBCC. The Report, substantiated by a study on the comparative differences of the IBC and the NBCC in the Fire and Structural perspectives, concluded that the NBCC can adopt the IBC Type IV-C provisions with careful, and in most cases, more conservative modifications.

Objective(s)

Which of the Code's objectives does the requested change address?

OP1.2, OP1.3, OS1.2, OS1.3

APPENDIX A-12: GROUP B-2, UP TO 7 STOREYS, SPRINKLERED

Function

Which of these functions apply?

☒ Building / Fire / Plumbing official

☒ Builder / Contractor

☒ Designer / Architect / Engineer

☒ Supplier / Manufacturer

☒ Building owner / Manager

☒ Homeowner / General public

☐ Other

Code change request

Code change

☐ To the existing code provision

☒ Add new code provision

Document

2020 National Building Code

Code reference of the requested change: Article, Sentence, etc. (e.g. 9.32.3.5.)

Subsection 3.2.2.

Subject

Article 3.2.2.XXEMTC. Group B-2, up to 7 storeys, Sprinklered

Problem

2020 NBCC will permit construction of 12-storey EMTC buildings for Groups C and D Occupancies. The NBCC Working Group considered that the 12-storey limit as a reasonable next step in the progression of the NBCC after the 6-storey light frame buildings were introduced. Based on the findings of the Report on Transferability of 2021 IBC Tall Wood Provisions to the NBCC by GHL Consultants and Fast + Epp of June 7, 2021, a number of possible next steps were identified to incorporate this Code Change Request, including extending EMTC permissions to other occupancy groups.

Request change / addition

What wording do you propose for the change?

3.2.2.XXEMTC. Group B-2, up to 7 storeys, Sprinklered

1) A *building* classified as Group B-2 is permitted to conform to Sentence (2), provided

a) it is *sprinklered* throughout,

b) it is not more than 7 *storeys* in *building height*,

c) it has a height not more than 24.5 m measured between the floor of the first *storey* and the uppermost floor level, excluding any floor level within a rooftop enclosure that is not considered as a *storey* in calculating *building height* in accordance with Sentence 3.2.1.1.(1), and

d) it has a *building area* not more than 6000 m^2.

2) Except as provided in Article 3.2.2.16., the *building* referred to in Sentence (1) is permitted to be of *encapsulated mass timber construction* or *noncombustible* construction, used singly or in combination, and

a) except as provided in Sentence (3), floor assemblies shall be *fire separations* with *fire-resistance rating* not less than 2 h,

b) *mezzanines* shall have a *fire-resistance rating* not less than 1 h, and

c) *loadbearing* walls, columns and arches shall have a *fire-resistance rating* not less than that required for the supported assembly.

3) In a *building* that contains *dwelling units* that have more than one *storey*, subject to the requirements of Sentence 3.3.4.2.(3), the floor assemblies, including floors over *basements*, that are entirely contained within these *dwelling units* shall have a *fire-resistance rating* not less than 1 h but need not be constructed as *fire separations*.

4) Group A, Division 2 *major occupancies*, Group E *major occupancies* and *storage garages* located in a *building* or part of a *building* within the scope of this Article are permitted to be constructed in accordance with this Article, provided

a) the Group A, Division 2 *major occupancy* is located below the fourth *storey*,

b) the Group E *major occupancy* is located below the third *storey*, and

c) the *storage garage* is located below the fifth *storey*.

Justification / explanation

The Transferability Report contains extensive discussion on the rationale of the transferability of the IBC Type IV-A (mass timber, 7-storey, Care) provisions to the NBCC. The Report, substantiated by a study on the comparative differences of the IBC and the NBCC in the Fire and Structural perspectives, concluded that the NBCC can adopt the IBC Type IV-A provisions with careful, and in most cases, more conservative modifications.

Objective(s)

Which of the Code's objectives does the requested change address? OP1.2, OP1.3, OS1.2, OS1.3

APPENDIX A-13: GROUP B-2, UP TO 5 STOREYS, SPRINKLERED

Function

Which of these functions apply?

☒ Building / Fire / Plumbing official

☒ Builder / Contractor

☒ Designer / Architect / Engineer

☒ Supplier / Manufacturer

☒ Building owner / Manager

☒ Homeowner / General public

☐ Other

Code change request

Code change

☐ To the existing code provision

☒ Add new code provision

Document

2020 National Building Code

Code reference of the requested change: Article, Sentence, etc. (e.g. 9.32.3.5.)

Subsection 3.2.2.

Subject

Article 3.2.2.XXEMTC. Group B-2, up to 5 storeys, Sprinklered

Problem

2020 NBCC will permit construction of 12-storey EMTC buildings for Groups C and D Occupancies. The NBCC Working Group considered that the 12-storey limit as a reasonable next step in the progression of the NBCC after the 6-storey light frame buildings were introduced. Based on the findings of the Report on Transferability of 2021 IBC Tall Wood Provisions to the NBCC by GHL Consultants and Fast + Epp of June 7, 2021, a number of possible next steps were identified to incorporate this Code Change Request, including extending EMTC permissions to other occupancy groups.

Request change / addition

What wording do you propose for the change?

3.2.2.XXEMTC. Group B-2, up to 5 storeys, Sprinklered

1) A *building* classified as Group B-2 is permitted to conform to Sentence (2), provided

a) it is *sprinklered* throughout,

b) it is not more than 5 *storeys* in *building height*,

c) it has a height not more than 17.5 m measured between the floor of the first *storey* and the uppermost floor level, excluding any floor level within a rooftop enclosure that is not considered as a *storey* in calculating *building height* in accordance with Sentence 3.2.1.1.(1), and

d) it has a *building area* not more than 6000 m^2.

2) Except as provided in Article 3.2.2.16., the *building* referred to in Sentence (1) is permitted to be of *encapsulated mass timber construction* or *noncombustible* construction, used singly or in combination, and

a) except as provided in Sentence (3), floor assemblies shall be *fire separations* with *fire-resistance rating* not less than 2 h,

b) *mezzanines* shall have a *fire-resistance rating* not less than 1 h, and

c) *loadbearing* walls, columns and arches shall have a *fire-resistance rating* not less than that required for the supported assembly.

3) In a *building* that contains *dwelling units* that have more than one *storey*, subject to the requirements of Sentence 3.3.4.2.(3), the floor assemblies, including floors over *basements*, that are entirely contained within these *dwelling units* shall have a *fire-resistance rating* not less than 1 h but need not be constructed as *fire separations*.

4) Group A, Division 2 *major occupancies*, Group E *major occupancies* and *storage garages* located in a *building* or part of a *building* within the scope of this Article are permitted to be constructed in accordance with this Article, provided

a) the Group A, Division 2 *major occupancy* is located below the fourth *storey*,

b) the Group E *major occupancy* is located below the third *storey*, and

c) the *storage garage* is located below the fifth *storey*.

Justification / explanation

The Transferability Report contains extensive discussion on the rationale of the transferability of the IBC Type IV-B (mass timber, 5-storey, Care) provisions to the NBCC. The Report, substantiated by a study on the comparative differences of the IBC and the NBCC in the Fire and Structural perspectives, concluded that the NBCC can adopt the IBC Type IV-B provisions with careful, and in most cases, more conservative modifications.

Objective(s)

Which of the Code's objectives does the requested change address? OP1.2, OP1.3, OS1.2, OS1.3

APPENDIX A-14: GROUP B-2, UP TO 1 STOREY, SPRINKLERED

Function

Which of these functions apply?

☒ Building / Fire / Plumbing official

☒ Builder / Contractor

☒ Designer / Architect / Engineer

☒ Supplier / Manufacturer

☒ Building owner / Manager

☒ Homeowner / General public

☐ Other

Code change request

Code change

☐ To the existing code provision

☒ Add new code provision

Document

2020 National Building Code

Code reference of the requested change: Article, Sentence, etc. (e.g. 9.32.3.5.)

Subsection 3.2.2.

Subject

Article 3.2.2.XXEMTC. Group B-2, up to 1 storey, Sprinklered

Problem

2020 NBCC will permit construction of 12-storey EMTC buildings for Groups C and D Occupancies. The NBCC Working Group considered that the 12-storey limit as a reasonable next step in the progression of the NBCC after the 6-storey light frame buildings were introduced. Based on the findings of the Report on Transferability of 2021 IBC Tall Wood Provisions to the NBCC by GHL Consultants and Fast + Epp of June 7, 2021, a number of possible next steps were identified to incorporate this Code Change Request, including extending EMTC permissions to other occupancy groups.

Request change / addition

What wording do you propose for the change?

3.2.2.XXEMTC. Group B-2, up to 1 storeys, Sprinklered

1) A *building* classified as Group B-2 is permitted to conform to Sentence (2), provided

a) it is *sprinklered* throughout,

b) it is not more than 1 *storeys* in *building height*,

c) it has a height not more than 3.5 m measured between the floor of the first *storey* and the uppermost floor level, excluding any floor level within a rooftop enclosure that is not considered as a *storey* in calculating *building height* in accordance with Sentence 3.2.1.1.(1), and

d) it has a *building area* not more than 6000 m^2.

2) Except as provided in Article 3.2.2.16., the *building* referred to in Sentence (1) is permitted to be of *encapsulated mass timber construction* or *noncombustible* construction, used singly or in combination, and

a) except as provided in Sentence (3), floor assemblies shall be *fire separations* with *fire-resistance rating* not less than 2 h,

b) *mezzanines* shall have a *fire-resistance rating* not less than 1 h, and

c) *loadbearing* walls, columns and arches shall have a *fire-resistance rating* not less than that required for the supported assembly.

3) In a *building* that contains *dwelling units* that have more than one *storey*, subject to the requirements of Sentence 3.3.4.2.(3), the floor assemblies, including floors over *basements*, that are entirely contained within these *dwelling units* shall have a *fire-resistance rating* not less than 1 h but need not be constructed as *fire separations*.

Justification / explanation

The Transferability Report contains extensive discussion on the rationale of the transferability of the IBC Type IV-C (mass timber, 1-storey, Care) provisions to the NBCC. The Report, substantiated by a study on the comparative differences of the IBC and the NBCC in the Fire and Structural perspectives, concluded that the NBCC can adopt the IBC Type IV-C provisions with careful, and in most cases, more conservative modifications.

Objective(s)

Which of the Code's objectives does the requested change address?

OP1.2, OP1.3, OS1.2, OS1.3

APPENDIX A-15: GROUP B-3, UP TO 10 STOREYS, SPRINKLERED

Function

Which of these functions apply?

☒ Building / Fire / Plumbing official

☒ Builder / Contractor

☒ Designer / Architect / Engineer

☒ Supplier / Manufacturer

☒ Building owner / Manager

☒ Homeowner / General public

☐ Other

Code change request

Code change

☐ To the existing code provision

☒ Add new code provision

Document

2020 National Building Code

Code reference of the requested change: Article, Sentence, etc. (e.g. 9.32.3.5.)

Subsection 3.2.2.

Subject

Article 3.2.2.XXEMTC. Group B-3, up to 10 storeys, Sprinklered

Problem

2020 NBCC will permit construction of 12-storey EMTC buildings for Groups C and D Occupancies. The NBCC Working Group considered that the 12-storey limit as a reasonable next step in the progression of the NBCC after the 6-storey light frame buildings were introduced. Based on the findings of the Report on Transferability of 2021 IBC Tall Wood Provisions to the NBCC by GHL Consultants and Fast + Epp of June 7, 2021, a number of possible next steps were identified to incorporate this Code Change Request, including extending EMTC permissions to other occupancy groups.

Request change / addition

What wording do you propose for the change?

3.2.2.XXEMTC. Group B-3, up to 10 storeys, Sprinklered

1) A *building* classified as Group B-3 is permitted to conform to Sentence (2), provided

a) it is *sprinklered* throughout,

b) it is not more than 10 *storeys* in *building height*,

c) it has a height not more than 35 m measured between the floor of the first *storey* and the uppermost floor level, excluding any floor level within a rooftop enclosure that is not considered as a *storey* in calculating *building height* in accordance with Sentence 3.2.1.1.(1), and

d) it has a *building area* not more than 6000 m^2.

2) Except as provided in Article 3.2.2.16., the *building* referred to in Sentence (1) is permitted to be of *encapsulated mass timber construction* or *noncombustible* construction, used singly or in combination, and

a) except as provided in Sentence (3), floor assemblies shall be *fire separations* with *fire-resistance rating* not less than 2 h,

b) *mezzanines* shall have a *fire-resistance rating* not less than 1 h, and

c) *loadbearing* walls, columns and arches shall have a *fire-resistance rating* not less than that required for the supported assembly.

3) In a *building* that contains *dwelling units* that have more than one *storey*, subject to the requirements of Sentence 3.3.4.2.(3), the floor assemblies, including floors over *basements*, that are entirely contained within these *dwelling units* shall have a *fire-resistance rating* not less than 1 h but need not be constructed as *fire separations*.

4) Group A, Division 2 *major occupancies*, Group E *major occupancies* and *storage garages* located in a *building* or part of a *building* within the scope of this Article are permitted to be constructed in accordance with this Article, provided

a) the Group A, Division 2 *major occupancy* is located below the fourth *storey*,

b) the Group E *major occupancy* is located below the third *storey*, and

c) the *storage garage* is located below the fifth *storey*.

Justification / explanation

The Transferability Report contains extensive discussion on the rationale of the transferability of the IBC Type IV-A (mass timber, 10-storey, Care) provisions to the NBCC. The Report, substantiated by a study on the comparative differences of the IBC and the NBCC in the Fire and Structural perspectives, concluded that the NBCC can adopt the IBC Type IV-A provisions with careful, and in most cases, more conservative modifications.

Objective(s)

Which of the Code's objectives does the requested change address? OP1.2, OP1.3, OS1.2, OS1.3

APPENDIX A-16: GROUP B-3, UP TO 6 STOREYS, SPRINKLERED

Function

Which of these functions apply?

☒ Building / Fire / Plumbing official

☒ Builder / Contractor

☒ Designer / Architect / Engineer

☒ Supplier / Manufacturer

☒ Building owner / Manager

☒ Homeowner / General public

☐ Other

Code change request

Code change

☐ To the existing code provision

☒ Add new code provision

Document

2020 National Building Code

Code reference of the requested change: Article, Sentence, etc. (e.g. 9.32.3.5.)

Subsection 3.2.2.

Subject

Article 3.2.2.XXEMTC. Group B-3, up to 6 storeys, Sprinklered

Problem

2020 NBCC will permit construction of 12-storey EMTC buildings for Groups C and D Occupancies. The NBCC Working Group considered that the 12-storey limit as a reasonable next step in the progression of the NBCC after the 6-storey light frame buildings were introduced. Based on the findings of the Report on Transferability of 2021 IBC Tall Wood Provisions to the NBCC by GHL Consultants and Fast + Epp of June 7, 2021, a number of possible next steps were identified to incorporate this Code Change Request, including extending EMTC permissions to other occupancy groups.

Request change / addition

What wording do you propose for the change?

3.2.2.XXEMTC. Group B-3, up to 6 storeys, Sprinklered

1) A *building* classified as Group B-3 is permitted to conform to Sentence (2), provided

a) it is *sprinklered* throughout,

b) it is not more than 6 *storeys* in *building height*,

c) it has a height not more than 21 m measured between the floor of the first *storey* and the uppermost floor level, excluding any floor level within a rooftop enclosure that is not considered as a *storey* in calculating *building height* in accordance with Sentence 3.2.1.1.(1), and

d) it has a *building area* not more than 6000 m^2.

2) Except as provided in Article 3.2.2.16., the *building* referred to in Sentence (1) is permitted to be of *encapsulated mass timber construction* or *noncombustible* construction, used singly or in combination, and

a) except as provided in Sentence (3), floor assemblies shall be *fire separations* with *fire-resistance rating* not less than 2 h,

b) *mezzanines* shall have a *fire-resistance rating* not less than 1 h, and

c) *loadbearing* walls, columns and arches shall have a *fire-resistance rating* not less than that required for the supported assembly.

3) In a *building* that contains *dwelling units* that have more than one *storey*, subject to the requirements of Sentence 3.3.4.2.(3), the floor assemblies, including floors over *basements*, that are entirely contained within these *dwelling units* shall have a *fire-resistance rating* not less than 1 h but need not be constructed as *fire separations*.

4) Group A, Division 2 *major occupancies*, Group E *major occupancies* and *storage garages* located in a *building* or part of a *building* within the scope of this Article are permitted to be constructed in accordance with this Article, provided

a) the Group A, Division 2 *major occupancy* is located below the fourth *storey*,

b) the Group E *major occupancy* is located below the third *storey*, and

c) the *storage garage* is located below the fifth *storey*.

Justification / explanation

The Transferability Report contains extensive discussion on the rationale of the transferability of the IBC Type IV-B (mass timber, 6-storey, Care) provisions to the NBCC. The Report, substantiated by a study on the comparative differences of the IBC and the NBCC in the Fire and Structural perspectives, concluded that the NBCC can adopt the IBC Type IV-B provisions with careful, and in most cases, more conservative modifications.

Objective(s)

Which of the Code's objectives does the requested change address? OP1.2, OP1.3, OS1.2, OS1.3

APPENDIX A-17: GROUP B-3, UP TO 4 STOREYS, SPRINKLERED

Function

Which of these functions apply?

☒ Building / Fire / Plumbing official

☒ Builder / Contractor

☒ Designer / Architect / Engineer

☒ Supplier / Manufacturer

☒ Building owner / Manager

☒ Homeowner / General public

☐ Other

Code change request

Code change

☐ To the existing code provision

☒ Add new code provision

Document

2020 National Building Code

Code reference of the requested change: Article, Sentence, etc. (e.g. 9.32.3.5.)

Subsection 3.2.2.

Subject

Article 3.2.2.XXEMTC. Group B-3, up to 4 storeys, Sprinklered

Problem

2020 NBCC will permit construction of 12-storey EMTC buildings for Groups C and D Occupancies. The NBCC Working Group considered that the 12-storey limit as a reasonable next step in the progression of the NBCC after the 6-storey light frame buildings were introduced. Based on the findings of the Report on Transferability of 2021 IBC Tall Wood Provisions to the NBCC by GHL Consultants and Fast + Epp of June 7, 2021, a number of possible next steps were identified to incorporate this Code Change Request, including extending EMTC permissions to other occupancy groups.

Request change / addition

What wording do you propose for the change?

3.2.2.XXEMTC. Group B-3, up to 4 storeys, Sprinklered

1) A *building* classified as Group B-3 is permitted to conform to Sentence (2), provided

a) it is *sprinklered* throughout,

b) it is not more than 4 *storeys* in *building height*,

c) it has a height not more than 14 m measured between the floor of the first *storey* and the uppermost floor level, excluding any floor level within a rooftop enclosure that is not considered as a *storey* in calculating *building height* in accordance with Sentence 3.2.1.1.(1), and

d) it has a *building area* not more than 6000 m^2.

2) Except as provided in Article 3.2.2.16., the *building* referred to in Sentence (1) is permitted to be of *encapsulated mass timber construction* or *noncombustible* construction, used singly or in combination, and

a) except as provided in Sentence (3), floor assemblies shall be *fire separations* with *fire-resistance rating* not less than 2 h,

b) *mezzanines* shall have a *fire-resistance rating* not less than 1 h, and

c) *loadbearing* walls, columns and arches shall have a *fire-resistance rating* not less than that required for the supported assembly.

3) In a *building* that contains *dwelling units* that have more than one *storey*, subject to the requirements of Sentence 3.3.4.2.(3), the floor assemblies, including floors over *basements*, that are entirely contained within these *dwelling units* shall have a *fire-resistance rating* not less than 1 h but need not be constructed as *fire separations*.

4) Group A, Division 2 *major occupancies*, Group E *major occupancies* and *storage garages* located in a *building* or part of a *building* within the scope of this Article are permitted to be constructed in accordance with this Article, provided

a) the Group A, Division 2 *major occupancy* is located below the fourth *storey*,

b) the Group E *major occupancy* is located below the third *storey*, and

c) the *storage garage* is located below the fourth *storey*.

Justification / explanation

The Transferability Report contains extensive discussion on the rationale of the transferability of the IBC Type IV-C (mass timber, 4-storey, Care) provisions to the NBCC. The Report, substantiated by a study on the comparative differences of the IBC and the NBCC in the Fire and Structural perspectives, concluded that the NBCC can adopt the IBC Type IV-C provisions with careful, and in most cases, more conservative modifications.

Objective(s)

Which of the Code's objectives does the requested change address? OP1.2, OP1.3, OS1.2, OS1.3

APPENDIX A-18: GROUP E, UP TO 12 STOREYS, SPRINKLERED

Function

Which of these functions apply?

☒ Building / Fire / Plumbing official

☒ Builder / Contractor

☒ Designer / Architect / Engineer

☒ Supplier / Manufacturer

☒ Building owner / Manager

☒ Homeowner / General public

☐ Other

Code change request

Code change

☐ To the existing code provision

☒ Add new code provision

Document

2020 National Building Code

Code reference of the requested change: Article, Sentence, etc. (e.g. 9.32.3.5.)

Subsection 3.2.2.

Subject

Article 3.2.2.XXEMTC. Group E, up to 12 storeys, Sprinklered

Problem

2020 NBCC will permit construction of 12-storey EMTC buildings for Groups C and D Occupancies. The NBCC Working Group considered that the 12-storey limit as a reasonable next step in the progression of the NBCC after the 6-storey light frame buildings were introduced. Based on the findings of the Report on Transferability of 2021 IBC Tall Wood Provisions to the NBCC by GHL Consultants and Fast + Epp of June 7, 2021, a number of possible next steps were identified to incorporate this Code Change Request, including extending EMTC permissions to other occupancy groups.

Request change / addition

What wording do you propose for the change?

3.2.2.XXEMTC. Group E, up to 12 storeys, Sprinklered

1) A *building* classified as Group E is permitted to conform to Sentence (2), provided

a) it is *sprinklered* throughout,

b) it is not more than 12 *storeys* in *building height*,

c) it has a height not more than 42 m measured between the floor of the first *storey* and the uppermost floor level, excluding any floor level within a rooftop enclosure that is not considered as a *storey* in calculating *building height* in accordance with Sentence 3.2.1.1.(1), and

d) it has a *building area* not more than 6000 m^2.

2) Except as provided in Article 3.2.2.16., the *building* referred to in Sentence (1) is permitted to be of *encapsulated mass timber construction* or *noncombustible* construction, used singly or in combination, and

a) except as provided in Sentence (3), floor assemblies shall be *fire separations* with *fire-resistance rating* not less than 2 h,

b) *mezzanines* shall have a *fire-resistance rating* not less than 1 h, and

c) *loadbearing* walls, columns and arches shall have a *fire-resistance rating* not less than that required for the supported assembly.

3) In a *building* that contains *dwelling units* that have more than one *storey*, subject to the requirements of Sentence 3.3.4.2.(3), the floor assemblies, including floors over *basements*, that are entirely contained within these *dwelling units* shall have a *fire-resistance rating* not less than 1 h but need not be constructed as *fire separations*.

4) Group A, Division 2 *major occupancies* and *storage garages* located in a *building* or part of a *building* within the scope of this Article are permitted to be constructed in accordance with this Article, provided

a) the Group A, Division 2 *major occupancy* is located below the fourth *storey*,

b) the *storage garage* is located below the fifth *storey*.

Justification / explanation

The Transferability Report contains extensive discussion on the rationale of the transferability of the IBC Type IV-E (mass timber, 12-storey, Mercantile) provisions to the NBCC. The Report, substantiated by a study on the comparative differences of the IBC and the NBCC in the Fire and Structural perspectives, concluded that the NBCC can adopt the IBC Type IV-A provisions with careful, and in most cases, more conservative modifications.

Objective(s)

Which of the Code's objectives does the requested change address?

OP1.2, OP1.3, OS1.2, OS1.3

APPENDIX A-19: GROUP E, UP TO 8 STOREYS, SPRINKLERED

Function

Which of these functions apply?

☒ Building / Fire / Plumbing official

☒ Builder / Contractor

☒ Designer / Architect / Engineer

☒ Supplier / Manufacturer

☒ Building owner / Manager

☒ Homeowner / General public

☐ Other

Code change request

Code change

☐ To the existing code provision

☒ Add new code provision

Document

2020 National Building Code

Code reference of the requested change: Article, Sentence, etc. (e.g. 9.32.3.5.)

Subsection 3.2.2.

Subject

Article 3.2.2.XXEMTC. Group E, up to 8 storeys, Sprinklered

Problem

2020 NBCC will permit construction of 12-storey EMTC buildings for Groups C and D Occupancies. The NBCC Working Group considered that the 12-storey limit as a reasonable next step in the progression of the NBCC after the 6-storey light frame buildings were introduced. Based on the findings of the Report on Transferability of 2021 IBC Tall Wood Provisions to the NBCC by GHL Consultants and Fast + Epp of June 7, 2021, a number of possible next steps were identified to incorporate this Code Change Request, including extending EMTC permissions to other occupancy groups.

Request change / addition

What wording do you propose for the change?

3.2.2.XXEMTC. Group E, up to 8 storeys, Sprinklered

1) A *building* classified as Group E is permitted to conform to Sentence (2), provided

a) it is *sprinklered* throughout,

b) it is not more than 8 *storeys* in *building height*,

c) it has a height not more than 28 m measured between the floor of the first *storey* and the uppermost floor level, excluding any floor level within a rooftop enclosure that is not considered as a *storey* in calculating *building height* in accordance with Sentence 3.2.1.1.(1), and

d) it has a *building area* not more than 6000 m^2.

2) Except as provided in Article 3.2.2.16., the *building* referred to in Sentence (1) is permitted to be of *encapsulated mass timber construction* or *noncombustible* construction, used singly or in combination, and

a) except as provided in Sentence (3), floor assemblies shall be *fire separations* with *fire-resistance rating* not less than 2 h,

b) *mezzanines* shall have a *fire-resistance rating* not less than 1 h, and

c) *loadbearing* walls, columns and arches shall have a *fire-resistance rating* not less than that required for the supported assembly.

3) In a *building* that contains *dwelling units* that have more than one *storey*, subject to the requirements of Sentence 3.3.4.2.(3), the floor assemblies, including floors over *basements*, that are entirely contained within these *dwelling units* shall have a *fire-resistance rating* not less than 1 h but need not be constructed as *fire separations*.

4) Group A, Division 2 *major occupancies* and *storage garages* located in a *building* or part of a *building* within the scope of this Article are permitted to be constructed in accordance with this Article, provided

a) the Group A, Division 2 *major occupancy* is located below the fourth *storey*,

b) the *storage garage* is located below the fifth *storey*.

Justification / explanation

The Transferability Report contains extensive discussion on the rationale of the transferability of the IBC Type IV-B (mass timber, 8-storey, Mercantile) provisions to the NBCC. The Report, substantiated by a study on the comparative differences of the IBC and the NBCC in the Fire and Structural perspectives, concluded that the NBCC can adopt the IBC Type IV-B provisions with careful, and in most cases, more conservative modifications.

Objective(s)

Which of the Code's objectives does the requested change address?

OP1.2, OP1.3, OS1.2, OS1.3

APPENDIX A-20: GROUP E, UP TO 6 STOREYS, SPRINKLERED

Function

Which of these functions apply?

☒ Building / Fire / Plumbing official

☒ Builder / Contractor

☒ Designer / Architect / Engineer

☒ Supplier / Manufacturer

☒ Building owner / Manager

☒ Homeowner / General public

☐ Other

Code change request

Code change

☐ To the existing code provision

☒ Add new code provision

Document

2020 National Building Code

Code reference of the requested change: Article, Sentence, etc. (e.g. 9.32.3.5.)

Subsection 3.2.2.

Subject

Article 3.2.2.XXEMTC. Group E, up to 6 storeys, Sprinklered

Problem

2020 NBCC will permit construction of 12-storey EMTC buildings for Groups C and D Occupancies. The NBCC Working Group considered that the 12-storey limit as a reasonable next step in the progression of the NBCC after the 6-storey light frame buildings were introduced. Based on the findings of the Report on Transferability of 2021 IBC Tall Wood Provisions to the NBCC by GHL Consultants and Fast + Epp of June 7, 2021, a number of possible next steps were identified to incorporate this Code Change Request, including extending EMTC permissions to other occupancy groups.

Request change / addition

What wording do you propose for the change?

3.2.2.XXEMTC. Group E, up to 6 storeys, Sprinklered

1) A *building* classified as Group E is permitted to conform to Sentence (2), provided

a) it is *sprinklered* throughout,

b) it is not more than 6 *storeys* in *building height*,

c) it has a height not more than 21 m measured between the floor of the first *storey* and the uppermost floor level, excluding any floor level within a rooftop enclosure that is not considered as a *storey* in calculating *building height* in accordance with Sentence 3.2.1.1.(1), and

d) it has a *building area* not more than 6000 m^2.

2) Except as provided in Article 3.2.2.16., the *building* referred to in Sentence (1) is permitted to be of *encapsulated mass timber construction* or *noncombustible* construction, used singly or in combination, and

a) except as provided in Sentence (3), floor assemblies shall be *fire separations* with *fire-resistance rating* not less than 2 h,

b) *mezzanines* shall have a *fire-resistance rating* not less than 1 h, and

c) *loadbearing* walls, columns and arches shall have a *fire-resistance rating* not less than that required for the supported assembly.

3) In a *building* that contains *dwelling units* that have more than one *storey*, subject to the requirements of Sentence 3.3.4.2.(3), the floor assemblies, including floors over *basements*, that are entirely contained within these *dwelling units* shall have a *fire-resistance rating* not less than 1 h but need not be constructed as *fire separations*.

4) Group A, Division 2 *major occupancies* and *storage garages* located in a *building* or part of a *building* within the scope of this Article are permitted to be constructed in accordance with this Article, provided

a) the Group A, Division 2 *major occupancy* is located below the fourth *storey*,

b) the *storage garage* is located below the fifth *storey*.

Justification / explanation

The Transferability Report contains extensive discussion on the rationale of the transferability of the IBC Type IV-C (mass timber, 6-storey, Mercantile) provisions to the NBCC. The Report, substantiated by a study on the comparative differences of the IBC and the NBCC in the Fire and Structural perspectives, concluded that the NBCC can adopt the IBC Type IV-C provisions with careful, and in most cases, more conservative modifications.

Objective(s)

Which of the Code's objectives does the requested change address?

OP1.2, OP1.3, OS1.2, OS1.3

APPENDIX A-21: GROUP F-2, UP TO 10 STOREYS, SPRINKLERED

Function

Which of these functions apply?

☒ Building / Fire / Plumbing official

☒ Builder / Contractor

☒ Designer / Architect / Engineer

☒ Supplier / Manufacturer

☒ Building owner / Manager

☒ Homeowner / General public

☐ Other

Code change request

Code change

☐ To the existing code provision

☒ Add new code provision

Document

2020 National Building Code

Code reference of the requested change: Article, Sentence, etc. (e.g. 9.32.3.5.)

Subsection 3.2.2.

Subject

Article 3.2.2.XXEMTC. Group F-2, up to 10 storeys, Sprinklered

Problem

2020 NBCC will permit construction of 12-storey EMTC buildings for Groups C and D Occupancies. The NBCC Working Group considered that the 12-storey limit as a reasonable next step in the progression of the NBCC after the 6-storey light frame buildings were introduced. Based on the findings of the Report on Transferability of 2021 IBC Tall Wood Provisions to the NBCC by GHL Consultants and Fast + Epp of June 7, 2021, a number of possible next steps were identified to incorporate this Code Change Request, including extending EMTC permissions to other occupancy groups.

Request change / addition

What wording do you propose for the change?

3.2.2.XXEMTC. Group F-2, up to 10 storeys, Sprinklered

1) A *building* classified as Group F-2 is permitted to conform to Sentence (2), provided

a) it is *sprinklered* throughout,

b) it is not more than 10 *storeys* in *building height*,

c) it has a height not more than 35 m measured between the floor of the first *storey* and the uppermost floor level, excluding any floor level within a rooftop enclosure that is not considered as a *storey* in calculating *building height* in accordance with Sentence 3.2.1.1.(1), and

d) it has a *building area* not more than 6000 m^2.

2) Except as provided in Article 3.2.2.16., the *building* referred to in Sentence (1) is permitted to be of *encapsulated mass timber construction* or *noncombustible* construction, used singly or in combination, and

a) except as provided in Sentence (3), floor assemblies shall be *fire separations* with *fire-resistance rating* not less than 2 h,

b) *mezzanines* shall have a *fire-resistance rating* not less than 1 h, and

c) *loadbearing* walls, columns and arches shall have a *fire-resistance rating* not less than that required for the supported assembly.

3) In a *building* that contains *dwelling units* that have more than one *storey*, subject to the requirements of Sentence 3.3.4.2.(3), the floor assemblies, including floors over *basements*, that are entirely contained within these *dwelling units* shall have a *fire-resistance rating* not less than 1 h but need not be constructed as *fire separations*.

4) Group A, Division 2 *major occupancies*, Group E *major occupancies* and *storage garages* located in a *building* or part of a *building* within the scope of this Article are permitted to be constructed in accordance with this Article, provided

a) the Group A, Division 2 *major occupancy* is located below the fourth *storey*,

b) the Group E *major occupancy* is located below the third *storey*, and

c) the *storage garage* is located below the fifth *storey*.

Justification / explanation

The Transferability Report contains extensive discussion on the rationale of the transferability of the IBC Type IV-A (mass timber, 10-storey, Industrial) provisions to the NBCC. The Report, substantiated by a study on the comparative differences of the IBC and the NBCC in the Fire and Structural perspectives, concluded that the NBCC can adopt the IBC Type IV-A provisions with careful, and in most cases, more conservative modifications.

Objective(s)

Which of the Code's objectives does the requested change address? OP1.2, OP1.3, OS1.2, OS1.3

APPENDIX A-22: GROUP F-2, UP TO 7 STOREYS, SPRINKLERED

Function

Which of these functions apply?

☒ Building / Fire / Plumbing official

☒ Builder / Contractor

☒ Designer / Architect / Engineer

☒ Supplier / Manufacturer

☒ Building owner / Manager

☒ Homeowner / General public

☐ Other

Code change request

Code change

☐ To the existing code provision

☒ Add new code provision

Document

2020 National Building Code

Code reference of the requested change: Article, Sentence, etc. (e.g. 9.32.3.5.)

Subsection 3.2.2.

Subject

Article 3.2.2.XXEMTC. Group F-2, up to 7 storeys, Sprinklered

Problem

2020 NBCC will permit construction of 12-storey EMTC buildings for Groups C and D Occupancies. The NBCC Working Group considered that the 12-storey limit as a reasonable next step in the progression of the NBCC after the 6-storey light frame buildings were introduced. Based on the findings of the Report on Transferability of 2021 IBC Tall Wood Provisions to the NBCC by GHL Consultants and Fast + Epp of June 7, 2021, a number of possible next steps were identified to incorporate this Code Change Request, including extending EMTC permissions to other occupancy groups.

Request change / addition

What wording do you propose for the change?

3.2.2.XXEMTC. Group F-2, up to 7 storeys, Sprinklered

1) A *building* classified as Group F-2 is permitted to conform to Sentence (2), provided

a) it is *sprinklered* throughout,

b) it is not more than 7 *storeys* in *building height*,

c) it has a height not more than 24.5 m measured between the floor of the first *storey* and the uppermost floor level, excluding any floor level within a rooftop enclosure that is not considered as a *storey* in calculating *building height* in accordance with Sentence 3.2.1.1.(1), and

d) it has a *building area* not more than 6000 m^2.

2) Except as provided in Article 3.2.2.16., the *building* referred to in Sentence (1) is permitted to be of *encapsulated mass timber construction* or *noncombustible* construction, used singly or in combination, and

a) except as provided in Sentence (3), floor assemblies shall be *fire separations* with *fire-resistance rating* not less than 2 h,

b) *mezzanines* shall have a *fire-resistance rating* not less than 1 h, and

c) *loadbearing* walls, columns and arches shall have a *fire-resistance rating* not less than that required for the supported assembly.

3) In a *building* that contains *dwelling units* that have more than one *storey*, subject to the requirements of Sentence 3.3.4.2.(3), the floor assemblies, including floors over *basements*, that are entirely contained within these *dwelling units* shall have a *fire-resistance rating* not less than 1 h but need not be constructed as *fire separations*.

4) Group A, Division 2 *major occupancies*, Group E *major occupancies* and *storage garages* located in a *building* or part of a *building* within the scope of this Article are permitted to be constructed in accordance with this Article, provided

a) the Group A, Division 2 *major occupancy* is located below the fourth *storey*,

b) the Group E *major occupancy* is located below the third *storey*, and

c) the *storage garage* is located below the fifth *storey*.

Justification / explanation

The Transferability Report contains extensive discussion on the rationale of the transferability of the IBC Type IV-B (mass timber, 7-storey, Industrial) provisions to the NBCC. The Report, substantiated by a study on the comparative differences of the IBC and the NBCC in the Fire and Structural perspectives, concluded that the NBCC can adopt the IBC Type IV-B provisions with careful, and in most cases, more conservative modifications.

Objective(s)

Which of the Code's objectives does the requested change address? OP1.2, OP1.3, OS1.2, OS1.3

APPENDIX A-23: GROUP F-2, UP TO 5 STOREYS, SPRINKLERED

Function

Which of these functions apply?

☒ Building / Fire / Plumbing official

☒ Builder / Contractor

☒ Designer / Architect / Engineer

☒ Supplier / Manufacturer

☒ Building owner / Manager

☒ Homeowner / General public

☐ Other

Code change request

Code change

☐ To the existing code provision

☒ Add new code provision

Document

2020 National Building Code

Code reference of the requested change: Article, Sentence, etc. (e.g. 9.32.3.5.)

Subsection 3.2.2.

Subject

Article 3.2.2.XXEMTC. Group F-2, up to 5 storeys, Sprinklered

Problem

2020 NBCC will permit construction of 12-storey EMTC buildings for Groups C and D Occupancies. The NBCC Working Group considered that the 12-storey limit as a reasonable next step in the progression of the NBCC after the 6-storey light frame buildings were introduced. Based on the findings of the Report on Transferability of 2021 IBC Tall Wood Provisions to the NBCC by GHL Consultants and Fast + Epp of June 7, 2021, a number of possible next steps were identified to incorporate this Code Change Request, including extending EMTC permissions to other occupancy groups.

Request change / addition

What wording do you propose for the change?

3.2.2.XXEMTC. Group F-2, up to 5 storeys, Sprinklered

1) A *building* classified as Group F-2 is permitted to conform to Sentence (2), provided

a) it is *sprinklered* throughout,

b) it is not more than 5 *storeys* in *building height*,

c) it has a height not more than 17.5 m measured between the floor of the first *storey* and the uppermost floor level, excluding any floor level within a rooftop enclosure that is not considered as a *storey* in calculating *building height* in accordance with Sentence 3.2.1.1.(1), and

d) it has a *building area* not more than 6000 m^2.

2) Except as provided in Article 3.2.2.16., the *building* referred to in Sentence (1) is permitted to be of *encapsulated mass timber construction* or *noncombustible* construction, used singly or in combination, and

a) except as provided in Sentence (3), floor assemblies shall be *fire separations* with *fire-resistance rating* not less than 2 h,

b) *mezzanines* shall have a *fire-resistance rating* not less than 1 h, and

c) *loadbearing* walls, columns and arches shall have a *fire-resistance rating* not less than that required for the supported assembly.

3) In a *building* that contains *dwelling units* that have more than one *storey*, subject to the requirements of Sentence 3.3.4.2.(3), the floor assemblies, including floors over *basements*, that are entirely contained within these *dwelling units* shall have a *fire-resistance rating* not less than 1 h but need not be constructed as *fire separations*.

4) Group A, Division 2 *major occupancies*, Group E *major occupancies* and *storage garages* located in a *building* or part of a *building* within the scope of this Article are permitted to be constructed in accordance with this Article, provided

a) the Group A, Division 2 *major occupancy* is located below the fourth *storey*,

b) the Group E *major occupancy* is located below the third *storey*, and

c) the *storage garage* is located below the fifth *storey*.

Justification / explanation

The Transferability Report contains extensive discussion on the rationale of the transferability of the IBC Type IV-C (mass timber, 5-storey, Industrial) provisions to the NBCC. The Report, substantiated by a study on the comparative differences of the IBC and the NBCC in the Fire and Structural perspectives, concluded that the NBCC can adopt the IBC Type IV-C provisions with careful, and in most cases, more conservative modifications.

Objective(s)

Which of the Code's objectives does the requested change address? OP1.2, OP1.3, OS1.2, OS1.3

APPENDIX A-24: GROUP F-3, UP TO 12 STOREYS, SPRINKLERED

Function

Which of these functions apply?

☒ Building / Fire / Plumbing official

☒ Builder / Contractor

☒ Designer / Architect / Engineer

☒ Supplier / Manufacturer

☒ Building owner / Manager

☒ Homeowner / General public

☐ Other

Code change request

Code change

☐ To the existing code provision

☒ Add new code provision

Document

2020 National Building Code

Code reference of the requested change: Article, Sentence, etc. (e.g. 9.32.3.5.)

Subsection 3.2.2.

Subject

Article 3.2.2.XXEMTC. Group F-3, up to 12 storeys, Sprinklered

Problem

2020 NBCC will permit construction of 12-storey EMTC buildings for Groups C and D Occupancies. The NBCC Working Group considered that the 12-storey limit as a reasonable next step in the progression of the NBCC after the 6-storey light frame buildings were introduced. Based on the findings of the Report on Transferability of 2021 IBC Tall Wood Provisions to the NBCC by GHL Consultants and Fast + Epp of June 7, 2021, a number of possible next steps were identified to incorporate this Code Change Request, including extending EMTC permissions to other occupancy groups.

Request change / addition

What wording do you propose for the change?

3.2.2.XXEMTC. Group F-3, up to 12 storeys, Sprinklered

1) A *building* classified as Group F-3 is permitted to conform to Sentence (2), provided

a) it is *sprinklered* throughout,

b) it is not more than 12 *storeys* in *building height*,

c) it has a height not more than 42 m measured between the floor of the first *storey* and the uppermost floor level, excluding any floor level within a rooftop enclosure that is not considered as a *storey* in calculating *building height* in accordance with Sentence 3.2.1.1.(1), and

d) it has a *building area* not more than 6000 m^2.

2) Except as provided in Article 3.2.2.16., the *building* referred to in Sentence (1) is permitted to be of *encapsulated mass timber construction* or *noncombustible* construction, used singly or in combination, and

a) except as provided in Sentence (3), floor assemblies shall be *fire separations* with *fire-resistance rating* not less than 2 h,

b) *mezzanines* shall have a *fire-resistance rating* not less than 1 h, and

c) *loadbearing* walls, columns and arches shall have a *fire-resistance rating* not less than that required for the supported assembly.

3) In a *building* that contains *dwelling units* that have more than one *storey*, subject to the requirements of Sentence 3.3.4.2.(3), the floor assemblies, including floors over *basements*, that are entirely contained within these *dwelling units* shall have a *fire-resistance rating* not less than 1 h but need not be constructed as *fire separations*.

4) Group A, Division 2 *major occupancies* and Group E *major occupancies* located in a *building* or part of a *building* within the scope of this Article are permitted to be constructed in accordance with this Article, provided

a) the Group A, Division 2 *major occupancy* is located below the fourth *storey*,

b) the Group E *major occupancy* is located below the third *storey*.

Justification / explanation

The Transferability Report contains extensive discussion on the rationale of the transferability of the IBC Type IV-A (mass timber, 12-storey, Industrial) provisions to the NBCC. The Report, substantiated by a study on the comparative differences of the IBC and the NBCC in the Fire and Structural perspectives, concluded that the NBCC can adopt the IBC Type IV-A provisions with careful, and in most cases, more conservative modifications.

Objective(s)

Which of the Code's objectives does the requested change address?

OP1.2, OP1.3, OS1.2, OS1.3

APPENDIX A-25: GROUP F-3, UP TO 8 STOREYS, SPRINKLERED

Function

Which of these functions apply?

☒ Building / Fire / Plumbing official

☒ Builder / Contractor

☒ Designer / Architect / Engineer

☒ Supplier / Manufacturer

☒ Building owner / Manager

☒ Homeowner / General public

☐ Other

Code change request

Code change

☐ To the existing code provision

☒ Add new code provision

Document

2020 National Building Code

Code reference of the requested change: Article, Sentence, etc. (e.g. 9.32.3.5.)

Subsection 3.2.2.

Subject

Article 3.2.2.XXEMTC. Group F-3, up to 8 storeys, Sprinklered

Problem

2020 NBCC will permit construction of 12-storey EMTC buildings for Groups C and D Occupancies. The NBCC Working Group considered that the 12-storey limit as a reasonable next step in the progression of the NBCC after the 6-storey light frame buildings were introduced. Based on the findings of the Report on Transferability of 2021 IBC Tall Wood Provisions to the NBCC by GHL Consultants and Fast + Epp of June 7, 2021, a number of possible next steps were identified to incorporate this Code Change Request, including extending EMTC permissions to other occupancy groups.

Request change / addition

What wording do you propose for the change?

3.2.2.XXEMTC. Group F-3, up to 8 storeys, Sprinklered

1) A *building* classified as Group F-3 is permitted to conform to Sentence (2), provided

a) it is *sprinklered* throughout,

b) it is not more than 8 *storeys* in *building height*,

c) it has a height not more than 28 m measured between the floor of the first *storey* and the uppermost floor level, excluding any floor level within a rooftop enclosure that is not considered as a *storey* in calculating *building height* in accordance with Sentence 3.2.1.1.(1), and

d) it has a *building area* not more than 6000 m^2.

2) Except as provided in Article 3.2.2.16., the *building* referred to in Sentence (1) is permitted to be of *encapsulated mass timber construction* or *noncombustible* construction, used singly or in combination, and

a) except as provided in Sentence (3), floor assemblies shall be *fire separations* with *fire-resistance rating* not less than 2 h,

b) *mezzanines* shall have a *fire-resistance rating* not less than 1 h, and

c) *loadbearing* walls, columns and arches shall have a *fire-resistance rating* not less than that required for the supported assembly.

3) In a *building* that contains *dwelling units* that have more than one *storey*, subject to the requirements of Sentence 3.3.4.2.(3), the floor assemblies, including floors over *basements*, that are entirely contained within these *dwelling units* shall have a *fire-resistance rating* not less than 1 h but need not be constructed as *fire separations*.

4) Group A, Division 2 *major occupancies* and Group E *major occupancies* located in a *building* or part of a *building* within the scope of this Article are permitted to be constructed in accordance with this Article, provided

a) the Group A, Division 2 *major occupancy* is located below the fourth *storey*,

b) the Group E *major occupancy* is located below the third *storey*.

Justification / explanation

The Transferability Report contains extensive discussion on the rationale of the transferability of the IBC Type IV-B (mass timber, 8-storey, Industrial) provisions to the NBCC. The Report, substantiated by a study on the comparative differences of the IBC and the NBCC in the Fire and Structural perspectives, concluded that the NBCC can adopt the IBC Type IV-B provisions with careful, and in most cases, more conservative modifications.

Objective(s)

Which of the Code's objectives does the requested change address? OP1.2, OP1.3, OS1.2, OS1.3

APPENDIX A-26: GROUP F-3, UP TO 5 STOREYS, SPRINKLERED

Function

Which of these functions apply?

☒ Building / Fire / Plumbing official

☒ Builder / Contractor

☒ Designer / Architect / Engineer

☒ Supplier / Manufacturer

☒ Building owner / Manager

☒ Homeowner / General public

☐ Other

Code change request

Code change

☐ To the existing code provision

☒ Add new code provision

Document

2020 National Building Code

Code reference of the requested change: Article, Sentence, etc. (e.g. 9.32.3.5.)

Subsection 3.2.2.

Subject

Article 3.2.2.XXEMTC. Group F-3, up to 5 storeys, Sprinklered

Problem

2020 NBCC will permit construction of 12-storey EMTC buildings for Groups C and D Occupancies. The NBCC Working Group considered that the 12-storey limit as a reasonable next step in the progression of the NBCC after the 6-storey light frame buildings were introduced. Based on the findings of the Report on Transferability of 2021 IBC Tall Wood Provisions to the NBCC by GHL Consultants and Fast + Epp of June 7, 2021, a number of possible next steps were identified to incorporate this Code Change Request, including extending EMTC permissions to other occupancy groups.

Request change / addition

What wording do you propose for the change?

3.2.2.XXEMTC. Group F-3, up to 5 storeys, Sprinklered

1) A *building* classified as Group F-3 is permitted to conform to Sentence (2), provided

a) it is *sprinklered* throughout,

b) it is not more than 5 *storeys* in *building height*,

c) it has a height not more than 17.5 m measured between the floor of the first *storey* and the uppermost floor level, excluding any floor level within a rooftop enclosure that is not considered as a *storey* in calculating *building height* in accordance with Sentence 3.2.1.1.(1), and

d) it has a *building area* not more than 6000 m^2.

2) Except as provided in Article 3.2.2.16., the *building* referred to in Sentence (1) is permitted to be of *encapsulated mass timber construction* or *noncombustible* construction, used singly or in combination, and

a) except as provided in Sentence (3), floor assemblies shall be *fire separations* with *fire-resistance rating* not less than 2 h,

b) *mezzanines* shall have a *fire-resistance rating* not less than 1 h, and

c) *loadbearing* walls, columns and arches shall have a *fire-resistance rating* not less than that required for the supported assembly.

3) In a *building* that contains *dwelling units* that have more than one *storey*, subject to the requirements of Sentence 3.3.4.2.(3), the floor assemblies, including floors over *basements*, that are entirely contained within these *dwelling units* shall have a *fire-resistance rating* not less than 1 h but need not be constructed as *fire separations*.

4) Group A, Division 2 *major occupancies* and Group E *major occupancies* located in a *building* or part of a *building* within the scope of this Article are permitted to be constructed in accordance with this Article, provided

a) the Group A, Division 2 *major occupancy* is located below the fourth *storey*,

b) the Group E *major occupancy* is located below the third *storey*.

Justification / explanation

The Transferability Report contains extensive discussion on the rationale of the transferability of the IBC Type IV-C (mass timber, 5-storey, Industrial) provisions to the NBCC. The Report, substantiated by a study on the comparative differences of the IBC and the NBCC in the Fire and Structural perspectives, concluded that the NBCC can adopt the IBC Type IV-C provisions with careful, and in most cases, more conservative modifications.

Objective(s)

Which of the Code's objectives does the requested change address?

OP1.2, OP1.3, OS1.2, OS1.3

November 15, 2023 **Our File:** 2300222 Transferability Report Review

Office of Mass Timber Implementation
Ministry of Jobs, Economic Development and Innovation
5th Floor, 800 Johnston Street
PO Box 9835 Stn Prov Govt
Victoria, BC
V8T 5C3

Attention: Trudy Rotgans, Executive Director - Projects

Re: Technical Review of Evaluating the Transferability of the Tall Wood Building Provisions from the 2021 International Building Code: The Canadian Context

This letter details Senez Consulting Ltd.'s (SenezCo) technical review of the "Transferability of 2021 International Building Code Tall Wood Building Provisions to the National Building Code of Canada, Memo," dated June 7, 2021, and revised September 22, 2021 (the Transferability Report). The Transferability Report was prepared by GHL Consultants Ltd. (GHL).

1.0 INTRODUCTION AND SCOPE

The technical review of the Transferability Report was requested by the Office of Mass Timber Implementation (OMTI) and was conducted in general conformance with the Professional Practice Guideline, "Fire Protection Engineering Services for Building Projects," version 2, dated October 20, 2021, (FPPG) issued by Engineers & Geoscientists British Columbia (EGBC). As noted in Section 4.1.8 of the FPPG:

1. The terms of the peer review should be established and be acceptable to relevant agencies or stakeholders, prior to commencement of the review.
2. The peer review should be conducted in accordance with the Society of Fire Protection Engineers (SFPE) publication Guidelines for Peer Review in the Fire Protection Design Process (SFPE 2020).

The approach to a technical (peer) review was discussed with OMTI and the following scope (terms) of review was established:

- The review is limited to the fire safety aspects of the Transferability Report.
- Determine reliability of conclusions or work.
- Review assumptions, processes, methods.
- Work cooperatively with authors of the Transferability Report.
- Confirm the work meets the objectives and is aligned with current standards of practice.
- Check for omissions in processes and results.

- Assess reliability of assumptions.

In addition, as noted by the EGBC FPPG, the review documented in this letter has been conducted in conformance with the SFPE Guidelines for Peer Review in the Fire Protection Design Process. Details of the technical review are discussed in the following section of this letter.

2.0 TECHNICAL REVIEW AND COMMENTS

The Transferability Report was reviewed based on the terms detailed in **Section 1.0** of this letter and the review comments are included in **Table 1** in **Attachment No. 1** to this letter. Each review comment includes the following:

1. The reference in the Transferability Report upon which the comment is made.
2. The excerpt from the Transferability Report upon which the comment is based.
3. The SenezCo review comment.
4. The expected action, which includes the following:
    a) Validation: this 'action' confirms the appropriateness of the assumptions/analysis provided in the excerpt from the Transferability Report and in some cases provides additional supporting technical information.
    b) Recommendation: this 'action' requests additional context to add additional clarity or to address a suggested editorial revision associated with the excerpt from the Transferability Report.
    c) Response: this 'action' identifies information in the excerpt from the Transferability Report that requires additional technical support or correction.
5. The GHL comment and action (suggested Transferability Report revision) in response to the SenezCo review comment.
6. The SenezCo comment in follow-up to the GHL comment and action. This comment identifies whether the GHL comment/action has addressed the original SenezCo comment (Item 3 above).
7. The final action notes whether the GHL comment and revision to the Transferability Report as 'complete' or 'incomplete' based on Item 6 above. Note that there are no 'incomplete' final actions for any of the comments.

Note that some fire safety aspects of the Transferability Report do not have corresponding comments. These aspects were technically reviewed and considered to be technically appropriate with respect to the 'terms' detailed in **Section 1.0** of this letter and therefore comments for these aspects were not necessary.

The technical review of the Transferability Report was conducted in several steps. The first step included the technical review of the Transferability Report and preparation of the review comments that included Item Nos. 1 to 4 above. These comments were then shared with GHL and a follow-up meeting with GHL included a discussion of the approach to the technical review and expectations of responses to the comments. GHL provided responses to the comments in the form of an updated version of the Transferability Report (Revision 3, dated September 20, 2023) with MS Word 'track changes' and corresponding 'comments' for each revision that referenced the SenezCo comment the revision was intended to address. SenezCo conducted a technical review of the changes to Revision 3 of the Transferability Report with respect to the original SenezCo comments.

A secondary review of the revised Transferability Report identified whether the revised parts of the Transferability Report appropriately addressed the SenezCo comments with respect to the terms detailed

in **Section 1.0** of this letter and the final action for each comment was noted. This secondary review included Item Nos. 5 to 7 above. Following this review, all comments, with the exception of one (Comment No. 22), were identified as 'complete' as a final action. The one comment (Comment No. 22) that was not listed as 'complete' was discussed with GHL who proposed an additional revision to the Transferability Report to further address the original SenezCo comment. The additional revision in response to this comment, documented in **Attachment No. 1**, was considered to address the terms detailed in **Section 1.0** of this letter and was therefore listed as 'complete'.

The result of the technical review identifies that the revised Transferability Report is in conformance with the terms detailed in **Section 1.0** of this letter.

3.0 CONCLUSION

This letter documents the results of a technical review of the Transferability Report, revised September 20, 2023 (Revision 3) and confirms that the revised Transferability Report adequately addressed our comments with respect to the terms detailed in **Section 1.0** of this letter.

Senez Consulting Ltd.
EGBC Permit to Practice 1002662

Prepared By:

Keith Calder, M.Eng., P.Eng.

Attachment No. 1:

Transferability Report Review Comments

Table 1: Transferability Report Review comments.

No.	Transferability Report Reference	Excerpt (Transferability Report)	SenezCo Comment	Action	GHL Comment	SenezCo Comment	Final Action
1	General	Throughout	It is recognized that the date of the Transferability Report predates the publication of the 2020 NBC and numbering of requirements changed from draft versions of the NBC to the final version. It is recommended that the Transferability Report be reviewed and updated with respect to the current published version of the 2020 NBC.	Recommendation	No specific comment. Changes made throughout the Transferability Report.	The revisions address this comment.	Complete
2	Page 5, Paragraph 1	"It is worth noting that, given limited resources, the Code development process is inherently one of assessing the science and assessing obvious levels of performance; however, a large part of the process is that the committee, representing recognized learned individuals in the subject field, is 'comfortable' with the safety of the proposed Codes. There are decisions that Canadian and US committees made based on level of 'comfort', and inherently they were not the same. Put another way, every element of the Code would be performance based, but such a task is monumental, so the committees have to defer to what they know and what they are comfortable with."	This paragraph is non-technical and somewhat detracts from technical rationale used in the development of code requirements and the EMTC requirements of the IBC in particular. It is recommended that this paragraph be deleted or re-written to align with the language of the NBC with respect to the "consensus" process. See the Preface of the NBC.	Recommendation	"It is worth noting as provided in the Preface of the 2020 NBCC, the code development process is carried out by members of all facets forming the CCBFC and its standing committee. Changes brought forward to the NBCC during each code change cycle are determined on a consensus basis by the members. It is inevitable that judgement and level of comfort of recognized learned individuals in the subject field form an integral part of the consensus for these code change decisions, where scientific or evidence-based research is not available. This is inherent for both Canadian and US committees."	The reference to the Preface of the 2020 NBCC as the source of this comment is noted.	Complete
3	Page 5, Paragraph 3, all bullets	"It is useful to understand that the IBC AHC that developed the IBC Code changes adopted the following key principals: • No collapse under reasonable scenarios of complete burn out of fuel without automatic sprinkler protection. • No unusually high radiation exposure from the subject building to adjacent properties to present a risk of ignition under reasonably severe fire scenarios. • No unusual response from typical radiation exposure from adjacent properties to present a risk of ignition of the subject building under reasonably severe fire scenarios. • No unusual fire department access issues. • Egress systems designed to protect building occupants during design escape time with a factor of safety. • Highly reliable fire suppression systems to reduce risk of failure during reasonably expected fire scenarios – degree of reliability proportional to evacuation time (height) and risk of collapse."	These items were presented as "possible performance objectives" by a member of the Committee during Meeting #1 of the Ad Hoc Committee – Tall Wood Buildings (ACTWB) on July 6-8, 2016. The 6 items in the Transferability Report are a summarized version of the objectives included in the ACTWB Meeting #1 minutes. (See file: 060816-minutes-twb.pdf).	Validation	"These key principals above are based on the objectives included in the Meeting #1 of the AHC of Tall Wood Buildings on July 6-8, 2016."	Additional text noted.	Complete

No.	Transferability Report Reference	Excerpt (Transferability Report)	SenezCo Comment	Action	GHL Comment	SenezCo Comment	Final Action
4	Page 7, Paragraph 1	“The question being asked here is whether the solutions in the IBC fall within the set of acceptable solutions of the NBCC”	Additional descriptive text is recommended to identify the work completed within the Transferability Report. More specifically, “fall within the set” requires additional context that informs the comparison/evaluation undertaken in the report.	Recommendation	“Specific mass timber provisions of IBC are identified and compared to relevant acceptable solutions of NBCC. For example, if a particular IBC provision is more permissive than that of NBCC, the IBC provision is considered to fall within the set of acceptable solutions of NBCC”	The additional text provided by GHL addresses this comment.	Complete
5	Page 7, Paragraph 2	“so that they can be employed interchangeably”	“Interchangeably” suggests that one test can be utilized in place of another, which is not the case. As noted in the Transferability Report, Testing agencies can often perform one test to demonstrate that a material achieves the acceptance criteria of multiple test standards, but typically with a degree of judgment or technical assessment. Alternative language is suggested: “such that they have corresponding performance objectives, and in some cases the same or similar acceptance criteria”	Recommendation	“such that they may have corresponding performance objectives, and in some cases the same or similar acceptance criteria”	Revised text addresses this comment.	Complete
6	Page 7, Table 1	None	ANSI/APA PRG 320, “Standard for Performance-Rated Cross-Laminated Timber.” [Sentence 3.1.6.3.(3) of Div. B of the NBC, §2303.1.4 of the IBC]	Response	“ANSI/APA PRG 320, ‘Standard for Performance-Rated Cross-Laminated Timber.’”	Standard added.	Complete
7	Table 2, “Encapsulated Mass Timber Construction”	Defined under Subsection 3.1.18, Articles 3.2.2.48EMTC and 3.2.2.57EMTC	Encapsulated mass timber construction is only defined under Subsection 3.1.6. Articles 3.2.2.48. and 3.2.2.57. reference Subsection 3.1.6. Recommend changing the text to: “Defined under Subsection 3.1.6., (referenced by Articles 3.2.2.48. and 3.2.2.57.)	Recommendation	“Defined under Subsection 3.1.6, (referred to by Articles 3.2.2.48 and 3.2.2.57)”	New text addresses this comment.	Complete
8	Table 2, “Heavy Timber Construction”	“Heavy Timber defined under Subsection 3.1.7”	Heavy timber is not a separate type of construction in the NBC, but a specification under “Combustible Construction,” Article 3.1.4.7. Recommend changing the text to “Specified as a type of combustible construction under Article 3.1.4.7.”	Response	“Specified as a type of combustible construction under Article 3.1.4.7”	New text addresses this comment.	Complete
9	Page 9, Paragraph 1	“Prior to the 2021 edition, IBC Types I, II, III and V Construction are each divided into -A and -B subdivisions; the -A subdivisions typically have higher construction requirements than those of -B and thus, allow higher building height and area. Prior to the 2021 edition of the IBC, Type IV did not have any subdivisions and was only intended for heavy timber construction (IV-HT). Following the approval of the mass timber Code change proposal in the 2021 cycle, Type IV is now divided into 4 subdivisions, including Types IV-A, -B and -	Agree	Validation		No response required.	Complete

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		C for mass timber, in addition to the existing -HT. Type IV-A has the highest FRR requirements, the most stringent protection features and thus, with the highest allowable building height and area than those of -B and -C."					
10	Page 9, Paragraph 2	"Fire resistance rating requirements for building elements in the IBC are primarily driven by the Type of Construction, with some minor exceptions. Building Height and Building Area are driven by both the Type of Construction and Occupancy Classification. FRR requirements in the NBCC are determined by the Major Occupancy Classification in addition to the Type of Construction."	The purpose of this paragraph is not clear. FRR requirements of both the IBC and NBC are based on regimes of hazard including: 1. The hazard of building size: a) 2021 IBC, Chapter 6, a function of type of construction and indirectly a function of occupancy based on Chapter 5, but primarily as a function of building height. b) 2020 NBC, Subsection 3.2.2., a function of occupancy, but primarily height. 2. The hazard of use (occupancy) and control (suite), primarily occupancy: a) 2021 IBC, Chapter 5, occupancy separation requirements b) 2020 NBC, Subsection 3.1.3., major occupancy fire separations FRR can be directly correlated to occupancy, which is then applied to buildings as a function of height and type of construction with assumptions of degree of containment and firefighting intervention. These principles are the same for IBC and NBC, but with variations. Recommend deleting this paragraph or updating based on the information above.	Response	"FRR requirements of both NBCC and IBC for structural protection are based on regimes of hazard as described below." Plus Table 3	New text and table address this comment.	Complete
11	Page 9, Paragraph 3	"Significant to this discussion is that the 1990 and prior editions of the NBCC include provisions for 3h fire protection for large mercantile and industrial buildings. A decision was made to reduce this to 2h based on the provision of monitored and supervised sprinklers in all large buildings."	Agree. This is detailed in "Report of the Part 3 Joint Task Group on Automatic Sprinkler Systems to the Standing Committee on Fire Protection and the Standing Committee on Occupancy," National Research Council Canada, Prepared by A.J. Aikman, March 1993.	Validation	"This is detailed in a publication by the NRC . Report of the Part 3 Joint Task Group on Automatic Sprinkler Systems to the Standing Committee on Fire Protection and the Standing Committee on Occupancy, A.J. Aikman, March 1993."	Additional text noted.	Complete
12	Page 10, Paragraph 4	"Based on the similar FRR prescribed for GWB across the NBCC and the IBC, and the fact that the encapsulation	Agree.	Validation	"~~and the fact that the encapsulation rating allows a higher temperature rise~~	Deleted text noted.	Complete

No.	Transferability Report Reference	Excerpt (Transferability Report)	SenezCo Comment	Action	GHL Comment	SenezCo Comment	Final Action
		rating allows a higher temperature rise when exposed to similar temperature conditions, it can be concluded that the FRR approach employed by the IBC for interior protection is comparable to that of the NBCC."	Even though the performance is not defined in the IBC as it is in the NBC (i.e., limit temperatures associated with combustion of the mass timber), the resulting solutions are similar.		~~when exposed to similar temperature conditions,~~"		
13	Page 10, Paragraph 4	"It is later discussed in this report that the IBC requires a minimum 80min protection time on the interior for Type IV-A and -B construction; this in comparison is more conservative than the NBCC encapsulation approach."	The 80 min protection time is associated with greater building height than permitted by the NBC for similar occupancy classifications; therefore, is not necessarily more conservative. Recommend updating or providing more context to the term "conservative"	Response	"in terms of encapsulation rating, as further discussed under Section 2.6.2 of this report."	Additional text provides context to "conservative" through reference to Section 2.6.2.	Complete
14	Pages 11 and 12, Table 5	"Group Occupancy Classifications"	Agree	Validation		No response required	Complete
15	Page 12, Tables 6b and 6c	"Type IV Mass Timber Building Height (m)" and "Type IV Mass Timber Building Area (m2)"	The heights are listed in metres and areas in square metres It is recommended that the heights be listed in feet and metres, and the areas be listed in square feet and square metres.	Response	Table 6c removed	Comment no longer applicable – Table 6c removed.	Complete
16	Page 12, Table 6c	Occupancy Classification – second R3	Should the second "R3" be "R4"?	Response	Table 6c removed	Comment no longer applicable – Table 6c removed.	Complete
17	Page 12, Table 6c and diagram	Occupancy Classification – area for Type IV-C is listed as 7134	Table 506.2 of the 2021 IBC identifies an allowable area of 76,875 ft², which is 7142 m²	Response	Table 6c removed	Comment no longer applicable – Table 6c removed.	Complete
18	Page 14, Paragraph 2	"The Podium approach was not further reviewed as it is considered outside the scope of this review."	Noted and not reviewed	Information		No response required	Complete
19	Page 14, Paragraph 3	"Both the IBC and NBCC have high building requirements. NBCC provisions are more conservative than those of the IBC, given that EMTC buildings are considered to be high buildings greater than 18m."	The 2021 IBC defines "high-rise building" as "A building with an occupied floor located more than 75 feet (22 860 mm) above the lowest level of fire department vehicle access." The application of the provisions may be more conservative in the NBC, but the specific measures required for a high building have not been compared. For the IBC, a response to a question on the mass timber code proposals identified the timing of the initiation of suppression operations on the upper levels of a high-rise building as a concern. However, the concern was more specific to building height and not other hazards that might be associated with a high building (See document: TWB-Response-to-Concerns-Raised-at-Hearings_8_1_18-_Posted.pdf)	Response	"in terms of height dimension" … "whereas the 2021 IBC defines "high-rise buildings" as a building with an occupied floor located more than 22.9m (75ft) above the lowest level of fire department vehicle access."	New text addresses comment	Complete
20	Page 14, Paragraph 4	"The FRR of a building element indicates the time the element can withstand the impact of fire while maintain its required structural integrity."	This comment suggests more of a direct link between FRR and actual performance time.	Recommendation	"when exposed to fire under specified conditions of test and performance criteria, or as determined by extension or	New text addresses this comment	Complete

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			Additional text is recommended stating the following [2020 NBC definition of fire-resistance rating]: "…when exposed to fire under specified conditions of test and performance criteria, or as determined by extension or interpretation of information derived therefrom."		interpretation of information derived therefrom"		
21	Page 15, Paragraph 3	"The AHC conducted five large-scale fire testing…"	"The AHC conducted five large-scale fire tests…"	Response	"five large-scale fire tests"	Revised text addresses this comment.	Complete
22	Page 18, Paragraph 1	"The key objective to achieve is to determine if mass timber buildings can withstand a typical fire until complete burn-out of building contents and reach self-extinguishment of the fire, with or without any fire suppression system."	The key objective identified in the Transferability Report does not align with the purpose stated in the "Compartment Fire Testing of a Two-Story Mass Timber Building" report. More specifically, the report notes the following: *The tests examined the effect of exposed walls and ceilings on a realistic, full-size apartment to better understand the contribution of CLT to a compartment fire, life safety of occupants, and firefighter safety. Additionally, two tests examined the effect of automatic sprinkler systems.* *Test Variables* *Three variables were considered in this test series: (1) the amount and location of exposed mass timber surfaces, (2) the opening in Wall A (open or covered with glass), and (3) a fire sprinkler system (installed or not installed).* The report does not address burn-out or self-extinguishment and the results focus on events (i.e., onset of flashover), heat release rate, temperatures and heat flux. It is recommended that the summary of the test be updated.	Response	"The series of fire tests provides insight as to how and if mass " In a follow-up discussion and email from Luke Kong of GHL (October 16, 2023), the paragraph discussing the test has been replaced by the following: "The test results demonstrated that the tested timber structures achieved a post-flashover negative compartment temperature trend (compartment cooling), and a post-flashover negative trend of compartment heat release rate (compartment burn out)."	Revised text addresses this comment.	Complete
23	Page 19, Paragraph 1	"The proposals began with Type IV-B, which was modelled after the existing Type I-B in its FRR, building height and area provisions. Type I-B"	Confirmed. Based on ACTWB Meeting #4 notes, August 21-23, 2017 and also in the following Draft Code Change Proposals: • Developed: 7/23/17, Revised: 8/8/17; 8/10/17;10/2/17, File name: Table 504.	Validation		No response required	Complete

No.	Transferability Report Reference	Excerpt (Transferability Report)	SenezCo Comment	Action	GHL Comment	SenezCo Comment	Final Action
			• Developed: 6/23/17, Revised: 8/10/17; 10/06/17, File name: Table 504.4 • Developed: 8/22/16, Revised: 9/29/16; 11/2/16;11/11/16; 11/23/16; 12/9/16; 02/17/17; 03/17/17; 04/05/17; 05/03/17; 07/13/17; 07/27/17; 08/30/17; 09/29/17; 10/12/17, File name: Section 602.4 Type of Construction				
24	Page 19, Paragraph 1	"Type I-B, under certain circumstances, is allowed a reduced FRR from 2h to 1h. The AHC took on a more conservative approach and did not propose that such reduction to be permitted on the Type IV-B buildings. In this light, Type IV-B buildings were proposed to have the same building height, area, and FRR without any reduction permissions."	Confirmed. Based on ACTWB documents: • TWB Proposals, "403.3.2 High rise sprinkler water supply", IBC: 403.3.2 • "ICC Ad-Hoc Committee Tall Wood Buildings Code, Heights and Areas and Performance-based Work Group," Report to Committee: September 16, 2016. • "Type of Construction Comparison" Table	Validation		No response required	Complete
25	Page 19, Paragraph 2	"In general, a multiplier of 1.5 was applied to the height developed for Type IV-B to provide reasonable height provisions for Type IV-A. Type IV-C has the same FRR requirements as those of Type IV-B. The major difference is that Type IV-C permits 100% exposed timber on the interior, similar to Type IV-HT buildings. In this light, Type IV-C buildings are permitted the same building height in feet to Type IV-HT but are allowed additional number of storeys in recognition of Type IV-C's FRR and additional fire protection provisions. Using a similar approach, the building areas were developed by the AHC. Fire safety risk for each new construction type was examined and compared with Type IV-HT. A multiplier was developed for each new type to reflect the additional fire protection provisions." and "Table 8: Type IV Mass Timber Building Area and Height Factors"	Confirmed. Based on ACTWB documents: • Developed: 7/23/17, Revised: 8/8/17; 8/10/17;10/2/17, File name: Table 504. • Developed: 6/23/17, Revised: 8/10/17; 10/06/17, File name: Table 504.4 • Developed: 3/3/17, Revised: 4/25/17; 5/22/17; 6/21/17; 7/7/17; 7/18/17; 8/9/17; 9/29/17; 10/9/17, File name: TABLE 506.2 • "Type of Construction Comparison" Table	Validation		No response required	Complete
26	Page 19, Paragraph 6	"It is understood that these multiplication factors were based on committee consensus of what is reasonable, rather than values derived on a technical basis."	This is not explicitly noted in the ACTWB documents but is consistent with committee discussions.	Validation		No response required	Complete

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27	Page 19, 20	"Specifically, buildings allowed under Articles 3.2.2.48EMTC (Group C) and 3.2.2.57EMTC (Group D) are…" "Table 9: NBCC Construction Article to IBC" "Table 10: Construction Requirements of NBCC EMTC and IBC Type IV-B" etc.	See Comment No. 1	Response	"EMTC" removed from 3.2.2. article references	Revised text addresses the comment.	Complete
28	Page 20	"Table 10: Construction Requirements of NBCC EMTC and IBC Type IV-B"	See Comment No. 15 regarding units	Response	Imperial value and units added in brackets	Additional text addresses the comment.	Complete
29	Page 20	"Table 10: Construction Requirements of NBCC EMTC and IBC Type IV-B," Row: "FRR-Roof (h)" "Not discussed"	The EMTC Committees in Canada may not have discussed this point, but also are likely just relying on the decision to eliminate a roof FRR where a building is sprinklered. Suggest adding a note with respect to this consideration.	Response	Note added: "Roof rating is not specified by NBCC under these construction articles. This is consistent with the code approach of not prescribing roof rating where a building is sprinklered throughout for other non EMTC buildings."	Additional text addresses the comment.	Complete
30	Page 20	"Table 10: Construction Requirements of NBCC EMTC and IBC Type IV-B," Row: "FRR-Mezzanine (h)" "Not discussed"	The ACTWB Committee may or may not have discussed this item. Suggest changing to "Not specified"	Response	"Not specified"	Revised text addresses the comment.	Complete
31	Page 20	"Table 10: Construction Requirements of NBCC EMTC and IBC Type IV-B," Row: "Interior Nonloadbearing Walls (h)" "Not discussed"	Suggest changing to "Not specified"	Response	"Not specified"	Revised text addresses the comment.	Complete
32	Page 20	"Table 10: Construction Requirements of NBCC EMTC and IBC Type IV-B," Row: "Exterior Nonloadbearing Walls (h)" "Determined by fire separation distance"	The rating for exterior nonloadbearing walls in the IBC is determined as the greater of: 1. Table 601 for the type of building element based on type of construction of the building 2. Table 601 for exterior bearing walls based on type of construction 3. Table 705.5 for exterior walls based on fire separation distance Suggest listing the items above without IBC table reference (or reference discussion on Page 21)	Response	"Rating determined as the greater of: 1. Table 601 for type of building element based on building construction type 2. Table 601 for exterior bearing walls based on construction type 3. Table 705.5 for exterior walls based on fire separation distance"	Revised text addresses the comment.	Complete
33	Page 20	"Table 10: Construction Requirements of NBCC EMTC and IBC Type IV-B," Row: "Exterior Protection" "Encapsulation 50min"	This note is too simplistic. Some options may utilize the same materials that are specified to achieve a 50 min encapsulation rating, but the exterior protection requirements were not formulated directly on the basis of encapsulation. The solutions were formulated on existing validation methods, or combinations of these methods, some of	Response	"Limitations on combustible materials in exterior walls and cladding requirements - further discussed in latter sections in this report"	Revised text addresses the comment.	Complete

No.	Transferability Report Reference	Excerpt (Transferability Report)	SenezCo Comment	Action	GHL Comment	SenezCo Comment	Final Action
			which allow for a protective barrier similar to that required for an encapsulation rating. Suggest identifying the protection options including cladding and components in exterior walls.				
34	Page 20	"Table 10: Construction Requirements of NBCC EMTC and IBC Type IV-B," Row: "Unprotected Wood" "Beams, columns and arches: 10% of the total wall area Walls: 35% Ceiling: 10%-25%"	Suggest addition that there are limitations on direction faced for walls	Response	"further discussed in latter sections in this report" And note: "Subject to limitations on direction faced for walls"	Additional text addresses the comment.	Complete
35	Page 20	"Table 10: Construction Requirements of NBCC EMTC and IBC Type IV-B," Row: "Unprotected Wood" "Ceilings and Beams: 20% of the floor area Walls and Columns: 40% of the floor area"	Suggest addition that there are area limitations on wall/ceiling combinations (or reference discussion on Page 21)	Response	"further discussed in latter sections in this report"	Additional text addresses the comment.	Complete
36	Page 20	"Table 10: Construction Requirements of NBCC EMTC and IBC Type IV-B,"	Suggest adding a row that compares wood element sizes	Response	New table row added for size of wood elements	Additional text addresses the comment.	Complete
37	Page 22, Paragraph 1	"In summary, construction requirements of Type IV-B for Groups B (Business) and R (Residential) buildings under the IBC are relatively comparable to those prescribed by the NBCC 12-storey EMTC Articles"	Agree in principle	Validation		No response required.	Complete
38	Page 23	"Table 11: Construction Requirements of IBC Type I-A and Type IV Buildings" Row: "Maximum Number of Storeys" "Unlimited" for Type I-A"	Type I-A is unlimited for most occupancies, but not all. Suggest adding a note, or limiting the scope of comparison to Type I-A, Group B or R	Response	"Group B or R"	Additional text addresses the comment.	Complete
39	Page 23	"Table 11: Construction Requirements of IBC Type I-A and Type IV Buildings" Row: "FRR-Mezzanine (h)" Blank	Suggest not leaving table cell blank. Add something like – "Not specified"	Response	"Not specified"	Additional text addresses the comment.	Complete
40	Page 23	"Table 11: Construction Requirements of IBC Type I-A and Type IV Buildings" Row: "Superimposed Occupancies" Blank	Suggest not leaving table cell blank. Add something like – "Not specified"	Response	"Not specified"	Additional text addresses the comment.	Complete
41	Page 25, Paragraph 1	"Other than firewalls, the highest FRR required by the NBCC anywhere is 2h"	This is true with respect to Subsection 3.2.2., but not otherwise: • Sentence 3.1.3.1.(1) and Table 3.1.3.1. of the 2020 NBC require a fire separation with a 3-hour fire-resistance rating between F1 and D/E major occupancies. • Subclause 3.2.2.15.(2)(b)(i) for storeys below ground used as Group	Response	"Other than firewalls and a few other specific conditions where 3h FRR is required such as occupancy separation between Group F1 and D or E, certain underground conditions, unsprinklered electric vault, etc., the highest FRR required by the NBCC is generally 2h."	Additional text addresses the comment.	Complete

No.	Transferability Report Reference	Excerpt (Transferability Report)	SenezCo Comment	Action	GHL Comment	SenezCo Comment	Final Action
			E or Group F, Division 1 or 2 occupancies. • Clause 3.6.2.7.(2)(a) for an electrical vault not protected by an automatic fire extinguishing system Suggest adding additional notes for "other than…"				
42	Page 25, Paragraph 1	"Should the NBCC permit up to 18-storey mass timber buildings, the FRR of the vertical supporting elements warrants consideration"	No technical rationale for this statement. Suggest providing a technical rationale other than the requirement being in the IBC.	Response	Referenced sentence deleted.	Revised text addresses the comment.	Complete
43	Page 25, Paragraph 1	"Canadian Codes prior to 2005 typically required 3h FRR for higher challenge occupancies, Group E and F-2. In the 2005 Code cycle the decision was made…"	This change was made between the 1990 NBC and the 1995 NBC. Suggest the following change: "Canadian Codes prior to 1995 typically required 3h FRR for higher challenge occupancies, Group E and F-2. In the 1995 Code cycle the decision was made…"	Response	Text revised as noted	Revised text addresses the comment.	Complete
44	Page 25, Paragraph 1	"In the 2005 Code cycle the decision was made that the probability of sprinkler failure in combination with the probability of firefighters not being able to control a fire was sufficiently low that a 2h FRR was sufficient for the high challenge occupancies, and the maximum FRR for all occupancies was reduced to 2h, with the sole exception of firewalls."	See Comment No. 41 with respect to "…sole exception of firewalls" With respect to "probability of sprinkler failure in combination with the probability of firefighters not being able to control a fire was sufficiently low." The Committee minutes at the time do not consider firefighter ability to control a fire with respect to this change, but only with respect to early notification to the fire department. See below. A code change reviewed during the 1995 NBC code cycle recommended relaxing the floor assembly rating from 3 to 2 hours for E, F1 and F2 occupancies. The reason for the change was noted as: *Considering the reliability of the sprinkler system. 3 hrs fire rating for floor assemblies seems unjustified.* The Committee Response was as follows:	Response	…~~decision was made that the probability of sprinkler failure in combination with the probability of firefighters not being able to control a fire was sufficiently low~~considerations were given to improved sprinkler system reliability through such as supervision that a 2h FRR was sufficient for the high challenge occupancies, and the maximum FRR for all occupancies was reduced to 2h, with the sole exception of firewalls and other specific conditions as described above. that a 2h FRR was sufficient for the high challenge occupancies, and the maximum FRR for all occupancies was reduced to 2h, with the sole exception of firewalls and other specific conditions as described above.	Revised text addresses the comment.	Complete

No.	Transferability Report Reference	Excerpt (Transferability Report)	SenezCo Comment	Action	GHL Comment	SenezCo Comment	Final Action
			Committee Response The committee noted that writer's request floor assemblies that are currently required sprinklered building. It was observed that occupancies in the major part of Subsection permit a relaxation of floor assembly rating occupancies where: • the building is sprinklered, • the sprinkler system is electrically 3.2.4.16.(5), and • the operation of the sprinkler syste department in conformance with S This change was eventually incorporated into the specific Articles under Subsection 3.2.2. rather than Article 3.2.2.12. Additional Rationale: and business and personal service resistance ratings for mercantile a have been reduced from 3 hours t change by the Standing Committe accepted on the basis of the impro requirements for monitoring and fact that separations are not requi space, between these occupancies to have a 2 hour fire-resistance rat This was also reviewed and supported by a "Joint Task Group on Automatic Sprinkler Systems" at the time, who noted that: *Although not contained in the formal recommendations, the proposed revisions to Subsection 3.2.2. include changes that would reduce the requirement for a 3 hour fire-resistance rating to 2 hours for buildings used for mercantile and medium hazard industrial occupancies that have monitored and supervised sprinkler systems.* Therefore, it is recommended that the comment be edited with respect to firefighting capability, or the source of that portion of the statement be referenced.				
45	Page 25, Paragraph 1	"It is our opinion that this logic remains applicable and use of 2h FRR remains valid, even for Group E or F-2 occupancies. Further, the EMTC provisions of the 2020	Agree in principle	Validation		No response required.	Complete

No.	Transferability Report Reference	Excerpt (Transferability Report)	SenezCo Comment	Action	GHL Comment	SenezCo Comment	Final Action
		NBCC permit a Group E occupancy on the first and second floor."					
46	Page 25, Paragraph 6	"It is significant that Canadian studies of encapsulation values indicate that while studies of wood frame walls would confirm the 80min contribution to a fire rating, such as ULC design U301, consisting of two layers of 5/8in Type X GWB on wood studs, the encapsulation rating for two layers of 5/8in Type X GWB is only 60min as determined by the NRC report, 'Solutions for mid-rise wood construction: encapsulation time data from NRC Fire-Resistance Projects: report to Research Consortium for Wood and Wood-Hybrid Mid-Rise Buildings.'"	This is an important point. It is recommended that the encapsulation test be compared to the ASTM E119 test to identify where the differences may be occurring. This could be a result of test apparatus differences, measurement locations and performance criteria.	Response	"The difference between testing for encapsulation rating and fire-resistance rating is discussed in detail under 2.3.2 of this Report. "	Additional text and reference to Section 2.3.2 addresses the comment.	Complete
47	Page 26, Paragraph 1	"The maximum allowable building height and area for Type IV constructions vary by the type of occupancy intended, depending on the inherent risk of each occupancy group"	This statement suggests a technical rationale for height/area differences as a function of occupancy. If the rationale is known, this should be stated. If the rationale is not known, this should also be stated. While it appears based on differences between occupancy types that a rationale was used, in general the values were determined qualitatively with ad hoc variations.	Response	"although. to our knowledge the technical rationale behind the correlation between occupancy types and allowable building height and area is not well documented"	Additional text addresses the comment.	Complete
48	Page 26, Paragraph 1	"It is established that, in general, multiplication factors were applied in developing the constraints. Therefore, the comparative demonstration for Type IV-A can be roughly correlated to Types IV-B and -C"	Confirmed. Based on ACTWB documents: • Developed: 7/23/17, Revised: 8/8/17; 8/10/17;10/2/17, File name: Table 504. • Developed: 6/23/17, Revised: 8/10/17; 10/06/17, File name: Table 504.4 • Developed: 3/3/17, Revised: 4/25/17; 5/22/17; 6/21/17; 7/7/17; 7/18/17; 8/9/17; 9/29/17; 10/9/17, File name: TABLE 506.2	Validation		No response required.	Complete
49	Page 26, Paragraph 2	"Significant is that the NBCC permitted areas are much smaller than the IBC permitted areas for almost all occupancies except for H"	Variation of area by height noted by OMTI	Response	Building Area: ~~Although philosophy on area and frontage is different as discussed above, building areas are fundamentally similar (80% to larger).~~ See 2.3.5 of this Report.	Revised text and updated Section 2.3.5 address the comment.	Complete
50	Page 27, Bullet 2	"Building Area: NBCC is significantly more conservative."	Variation of area by height noted by OMTI	Response	Building Area: ~~Although philosophy on area and frontage is different as discussed above, building areas are fundamentally similar (80% to larger).~~ See 2.3.5 of this Report.	Revised text and updated Section 2.3.5 address the comment.	Complete
51	Page 29, Paragraph 1	"…except water-resistive barriers meeting flame spread and combustibility criteria, including NFPA 285"	Suggest adding (in bold) "except water-resistive barriers meeting flame spread and combustibility criteria, **and** including NFPA 285"	Response	"criteria and~~, including~~ NFPA 285"	Revised text addresses the comment.	Complete

No.	Transferability Report Reference	Excerpt (Transferability Report)	SenezCo Comment	Action	GHL Comment	SenezCo Comment	Final Action
52	Page 31, Table 12, "IFC" Column, "Limitations on Exposed Wood" Row.	"Building elements to be protected up to the storey that is 4 storeys less than the active storey under construction."	2021 IFC 3303.5 also requires exterior wall coverings. The NFC does not specifically require protection of exterior components during construction.	Response	New table row added to address exterior wall coverings in the IBC	Additional text addresses the comment.	Complete
53	Page 32, Paragraph 3	"Therefore, it can be generally stated that the BCFC fire safety provisions for mass timber buildings under construction are more conservative than those of the IFC."	See Comment No. 52	Response	"…except for exterior walls protection"	Additional text addresses the comment.	Complete
54	Page 50, Section 4.2.1, Item 1a	"In our opinion the 10% combustible cladding with area and spacing limitations permitted in 3.1.18.7 is relatively insignificant and can be left unchanged."	Unless technical rationale is provided, it is recommended that this statement be deleted.	Response	Statement was deleted.	Revised text addresses the comment.	Complete
55	Page 51, Section 4.2.2, Item 1a	"IBC Type IV permits taller buildings with greater building area."	Variation of area by height noted by OMTI	Response	"b. IBC approach to building area is vastly different than that of the NBCC"	Additional text addresses the comment.	Complete
56	Page 52, Section 4.4, Bullet 2	"The Code's perspective on equal levels of risk across occupancy groups (except F-1) for noncombustible, sprinklered buildings."	The NBC does not assume an equal level of risk across occupancy groups for noncombustible sprinklered buildings. Re-wording of this statement is recommended.	Response	"The Code's perspective on ~~equal levels~~allowing unlimited building height and area ~~of risk~~ across occupancy groups (except F-1) for noncombustible, sprinklered buildings"	Revised text addresses the comment.	Complete
57	Page 53, Paragraph 3	"the IBC also permits mass timber buildings without sprinklers, but with higher building height, area, or occupancy restrictions"	In comparison to?	Response	"In addition to sprinklered buildings, the IBC also permits mass timber buildings without sprinklers, but with ~~higher~~ lower building height, or with occupancy restrictions, in comparison to ~~2022 NBCC~~those sprinklered."	Revised text addresses the comment.	Complete
58	Page 53, Paragraph 3	"As all buildings in Canada over 3 storeys in height or 1500m² in building area are required to be sprinklered, unsprinklered options are not recommended."	This statement is overly simplistic and not accurate. See Articles 3.2.2.58., 3.2.2.83., 3.2.2.85. of the 2020 NBC.	Response	"~~As all most buildings in Canada over 3 storeys in height or 1500m² in building area are required to be sprinklered,~~At this time, unsprinklered options are not recommended for mass timber buildings under the NBCC."	Revised text addresses the comment.	Complete
59	Page 53, Table 23, "Occupancy Groups" Row	"Permit EMTC construction for low-risk groups including Groups A-2, B-3, F-2, and F-3, in addition to the existing Groups C and D."	Why not additional occupancies?	Response	"In addition, this report recommends EMTC construction for low-risk, simple major occupancies. Occupancies with specific challenges such as Group B-1 (contained use), or Group F-1 (high fuel load) are not contemplated at this moment."	Additional text addresses the comment.	Complete
60	Page 54, Paragraph 1	"The proposed 9-storey EMTC buildings are recommended to have fully exposed timber on the interior."	Needs identification of exceptions. What about concealed spaces? Exits?	Response	"…with exceptions to address particular conditions, such as exits for example, which are to be identified upon further studies."	Additional text addresses the comment.	Complete
61	Page 54, Paragraph 1	"The current Code permits 6-storey wood frame buildings with 1h FRR and given that 12-storey EMTC is required of 2h FRR, the 9-storey EMTC provisions are recommended to require 1½h FRR."	Please provide technical rationale.	Response	"the maximum 9-storey EMTC provisions are recommended to require 1½h FRR, as this is an interpolated fire-resistance rating between 6-storey 1h FRR light frame structures and 2h FRR EMTC structures."	Additional text addresses the comment.	Complete