Evaluating Stakeholder Concerns About Proposed Single Egress Stairs

Residential Buildings in Canada, and What the Data Tells Us

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Executive Summary

- Changes are being considered to the British Columbia, Ontario and National Building Codes in Canada to permit single egress stairs in residential buildings of three to eight storeys.
- The purpose of this report is to summarize the views of proponents and opponents of this change, explore the findings of relevant research and data, and identify issues and vulnerabilities not currently addressed elsewhere.
- Proponents note that single egress stairs will increase design flexibility and reduce costs for new low-rise and mid-rise residential buildings to help address the housing crisis, and are already permitted in some jurisdictions in the United States, the United Kingdom, Europe, Australia and other locations.
- Proponents say current codes are outdated and modern fire protection systems, such as smoke alarms and sprinklering, provide sufficient protection to remove a second stairway.
- The proposals include fire safety measures including a maximum of four units per storey, a maximum of 60 people served by a single exit, a maximum floor area of 150 sq.m. per unit, sprinklering throughout the building, increased fire protection ratings for dwelling unit entrance doors (from 10 minutes to 45 minutes), and fire alarms triggered by the sprinklers.
- The proposed building code changes have received widespread and vocal opposition from Canadian, U.S. and international fire associations, who say the move toward single-stair residential buildings has circumvented the traditional building code consensus process that ensures that changes reflect the interest of all parties.
- Opponents note that examples from abroad of single-stair buildings do not account for significant differences between those locations and Canada, including building materials, geography and fire department capacity.
- A single egress may be blocked for a variety of reasons, including maintenance, parking of mobility devices or e-bikes using lithium-ion batteries, or by smoke or debris during a fire. Research of Canadian apartment building fires showed 9% originated in the means of egress—such as hallways and stairwells—and that smoke affected primary access routes in more than 42% of the fires.
- Second stairwells play a critical role in fighting fires and are used for staging, access and running hose. During a firefight, second staircases are generally not available to evacuees.
- Redundancy is the foundation of fire protection because individual systems may and do fail. Research of Canadian apartment fires showed problems with smoke alarms in almost 9% of fires, while in 7.3%, automatic extinguishing equipment did not work because the fire was too small or other reasons. The 2022 Winters Hotel fire in Vancouver, B.C., where two people perished in a building equipped with a sprinkler and fire alarm system, demonstrates the vulnerabilities of fire protection systems.

- The proposed 60-person maximum load per storey will be essentially unenforceable because residential dwellings cannot be inspected for the enforcement of occupant load without reasonable cause.
- With the aging population comes more people with mobility, hearing and sight impairments. Research on Canadian apartment building fires showed that in over half of the unintentional residential fire deaths studied, the individual was age 70 and up. As well, in 14% of unintentional residential fire deaths, there were mobility-related issues (e.g. use of crutches or wheelchair) or cognitive impairments (e.g. dementia). Other research showed a declined benefit of smoke alarms and sprinkler systems for older people.
- The report concludes by noting that due to the import and wide-ranging implications of building code changes, it is not a process to be rushed, considered incremental or driven by single-issue agendas. The report reveals a range of vulnerabilities in the arguments in favour of the proposed change. It is imperative that any changes to the building code be made in close collaboration with the fire service.

Research Objectives and Methodology

In light of proposed amendments to building codes in Ontario, B.C. and Canada to allow single stair egress in residential buildings of three to eight storeys, the purpose of this report is to summarize the views of proponents and opponents, explore the findings of relevant research and data, and identify issues and vulnerabilities not currently addressed in the single egress stair building proposals.

The scope of this report is as follows:

- Summary of single egress research by the Canadian Commission on Building and Fire Codes and other bodies.
- Review of relevant fire safety and statistical research from sources including:
    - Canada's National Fire Incident Database
    - Statistics Canada
    - University of the Fraser Valley, B.C.
    - Research organizations in the United Kingdom and Europe
- Summary of official single egress positions by professional fire associations from Canadian, United States and international organizations.
- Discussion

Please note: This is an evolving issue, with research, articles and official positions continuing to be published at time of writing. Research was selected for this paper for the purpose of identifying and illustrating key concerns related to residential fire and life safety to contribute to the discussion and consideration of single egress buildings.

Problem Statement

Canadian governments at all levels are taking steps to address growing housing supply and affordability challenges, including streamlining regulations for housing construction.

As one example, the Governments of Ontario and British Columbia and submissions to the Canadian Commission on Building Codes (responsible for the National Building Code) are considering building code amendments to allow single egress stair (SES) designs for buildings between three and eight storeys. At present, building codes across Canada require two means of egress for most multi-unit residential buildings of three storeys or more.

The proposed changes would substantially change how some mid-rise residential buildings are constructed across the country, affecting many Canadians for generations to come. The matter is controversial in many ways, with both proponents and the opponents presenting public statements and research to support their views.

Research in this area is limited, and what is lacking in this critical debate is the inclusion of an impartial review of existing quantitative fire and statistical data to identify potential vulnerabilities and unanswered questions.

Single Egress Research

Available research on the topic is discussed below.

Code Change Requests to Canadian Commission on Building and Fire Codes [1]

On April 18, 2022, Conrad Speckert of LGA Architectural Partners and David Hine of David Hine Engineering Inc. submitted the following code change requests (CCRs) to the Canadian Commission on Building and Fire Codes:

- Part 9 – Single Egress for Multi-unit Residential Buildings up to 3 Storeys
- Part 3 – Single Egress for Multi-unit Residential Buildings up to 6 Storeys

The intent of the CCRs are amendments to the National Building Code of Canada (NBC) to permit the construction of single-exit multi-unit residential buildings of up to three storeys or six storeys, with additional life safety measures and limits on occupant load and number of dwelling units per storey served by a single exit.

The CCRs say the current NBC requirement for two means of egress in multi-unit residential buildings over two storeys may be outdated based on modern fire safety practices in combustible (e.g., wood-based) construction. By prohibiting single egress designs at this scale, the CCR says, the NBC limits the feasibility of "missing middle" housing (up to three storeys) or mid-rise housing (up to six storeys), preventing more sustainable growth and affordable housing options.

The CCR recognizes the need for two means of egress for larger buildings and non-residential occupancies, but says requiring a second egress is a prohibitive burden for smaller multi-unit residential projects, given that one exit is permitted in many other jurisdictions:

- The United States model building allows for single exits in R-2 occupancies up to three storeys above grade with a maximum of four dwelling units per storey.
- The City of Seattle (SBC 2018: 1006.3.3.7 Single Exits) allows single exits in R-2 occupancies up to six storeys above grade with a maximum of four dwelling units per storey. New York City is similar with a maximum floor area per storey (NYC Building Code 2014: 1021.2.5 Single Exits).
- Australia (NCC 2015 Vol. 1: D1.2) requires two exits for residential buildings of more than 25m in height. New Zealand (C/AS2 - 3.13.1.) requires two exits for buildings above 25m in height if the building is sprinklered, and above 10m in height if the building is not sprinklered.
- The United Kingdom (Building Regulations 2010 – Fire Safety: Approved Document B) does not establish a maximum building height for single exit residential buildings, only a maximum occupant load of 60 people per storey and a maximum travel distance. *(The CCR does note that in response to the inquiry into the Grenfell Tower fire (a 2017 fire in London in a single-*

staircase high-rise in which 72 people perished), the Royal Institute of British Architects and London Fire Brigade have requested further study of high-rise residential buildings with single exit stair designs. See below for more on this.)

According to the CCR, the proposed code change includes reasonable limitations and additional life safety measures, based on acceptable solutions in the NBC, a review of building codes in other jurisdictions, as well as literature and studies of fire safety in residential buildings.

For example, for occupants with disabilities, the CCR says the proposed life safety measures (particularly sprinklering and better closures) sufficiently improve fire safety and protection to the degree that they can remain in their suite during an emergency.

Key proposed code changes for fire safety and protection

- A total occupant load of 60 people served by the single exit, same as 9.9.8.2.
- No more than four dwelling units per storey, based on U.S. IBC 2015, 1006.3.2 Single Exits.
- A maximum floor area of 150m^2 per dwelling unit, based on a proposed criteria for sprinklered floor areas.
- Requiring sprinklering throughout the building (NFPA 13-R, referring to 3.2.5.12).
- Increased minimum fire-protection rating of dwelling unit entrance door closures from a 20-minute rating to 45-minute rating, similar to the closure ratings required by several European jurisdictions.
- Requiring a fire alarm system without exception, which is also triggered by the required sprinklering.

The CCR noted that requiring sprinklering of balconies may also be an appropriate life safety measure to add.

***Unlocking livable, resilient, decarbonized housing with Point Access Blocks*, City of Vancouver** [2]

Seattle-based Larch Lab completed a report for the City of Vancouver in December 2021 on Point Access Blocks (PABs)—single-stair residential buildings of typically three to 10 storeys. The report discusses the benefits of PAB construction and its long history in Europe, while noting that historically PAB buildings were constructed of solid materials: brick, stone, and later concrete.

The report noted that construction detailing and the use of concrete floors allow for compartmentation (e.g., fire-resistant floors or walls between units) to slow or contain fires, an approach that could be used with mass timber construction.

According to the report, a common PAB building design in Europe is a multi-storey building with two or more units centred around a central building core or stairway, with the second means of egress being aerial rescue by the fire brigade. Typically, most units span the full depth of the building, providing cross ventilation and daylight on two or more sides.

Design options include a single-loaded corridor (stairways access an exterior-side internal corridor or exterior passageway on each storey) or double-loaded corridor (the access corridor is in the middle of the building with units on both sides).

Fire safety and protection

The report points to the German approach to containment and egress as a model, including limited floor areas and travel distance to exit points, and building height contingent on aerial rescue vehicle capacity.

The report also notes the requirement for fire sprinklers as an added layer of safety, and that accessibility could be improved with the addition of elevators—historically not included in the typically walk-up PAB buildings in Europe.

Conclusion and recommendations

The report's conclusion notes: "While construction practices for low-rise and mid-rise multifamily buildings in Europe and Japan has historically been very different than Canada, the rise of innovative products like Cross Laminated Timber, which can easily meet a 2-hour fire rating, offers an opportunity to revisit outdated fire and building codes."

The recommendations included:

- Making any changes to City of Vancouver City building bylaws in conjunction with fire officials.
- Taking an incremental approach to legalizing PABs, initially allowing up to three or four storeys and adding more floors over time as code officials and fire departments become accustomed to this building type.
- Participating in discussions and roundtables with fire and building code professionals from Vancouver and other countries to learn and share knowledge.
- Prioritizing the education of professionals and the public.
- Considering a design competition to expand awareness and get teams of small-scale developers, architects, and planners thinking about how to apply this housing type.
- Pairing PAB policies with other climate actions, such as mirroring designs in other cities with a sizeable portion of the lot reserved for common outdoor space such as yards and playgrounds, relaxing parking requirements, and exempting bike storage from Floor Space Ratio calculations.

Single Stair Egress: Evaluating Stakeholder Concerns Across Canada, **University of the Fraser Valley** [3]

Published in April 2024 by the University of the Fraser Valley in British Columbia, *Single Stair Egress: Evaluating Stakeholder Concerns Across Canada* by Garis, L. reviewed fire and medical data relevant to proposed amendments to the B.C., Ontario and National Building Codes to allow a single means of egress in residential apartment buildings up to three or six storeys.

Sources of information included data from Canada's National Fire Incident Database from 2005 to 2015, with fire reports representing 72% of the Canadian population as of July 2014, and a recent Statistics Canada study of circumstances surrounding unintentional fire deaths from 2011 to 2020 that used the Canadian Coroner and Medical Examiner Database (CCMED).

Relevant findings from the CCMED

- Of 220 fire-related deaths per year in Canada, 81% are unintentional.
- 68% of the deaths were due to smoke inhalation.
- In just over half of unintentional residential fire deaths, the individual was age 70 and up.
- In 14% of unintentional residential fire deaths, there were mobility-related issues (e.g. use of crutches or wheelchair) or cognitive impairments (e.g. dementia).
- In about half of unintentional residential fire deaths, there was at least one modifiable factor, such as smoking materials (20%), alcohol or drugs (33%), or lack of a working smoke alarm (14%).

Relevant findings from the National Fire Incident Database

- About 12% of residential fires in Canada from 2005 to 2015 were in apartment buildings.
- Each year, there were an average of 2,237 fires in residential apartment buildings from 2005 to 2015 (a total of 23,394 over the 11-year period).
- Deaths or injuries occurred in these residential apartment building fires 95.8% of the time. The total number of injuries and deaths were 2,020, including 11 deaths and 2,009 injuries.

Fire origin and spread:

- In almost 9% of residential apartment fires, the fire originated in the building's means of egress, including hallways or corridors (43%), exterior stairway (3%), interior stairway (27%), lobby entrance (19%) and elevator (5%).
- 34.5% of residential apartment fires were confined to the object of origin and 24.5% to the room or part of room of origin.
- Smoke affected primary egress routes for more than 42% of residential apartment fires, including the corridor (23.5%), stairwell (18.7%) and elevator (0.4%).
- More than 11% of the damage caused by residential apartment fires extended beyond the building of origin. 6% was confirmed to the floor level of origin, 41% to the room of origin and 32% to the part of the room of origin.

Fire causes:

- 39% of residential apartment fires were reported as being started by smokers' materials or open flames. The next largest categories of known ignition sources are electrical distribution equipment (3.3%) and other electrical equipment (3.2%).

- For 33% of residential apartment fires, wood or paper products were the first material to ignite. The next largest categories are building components (14.5%), clothing or textiles (6.4%) and furniture or furnishings (5.7%).

Fire protection and detection:

- 36% of residential apartment fires were reported to be detected by smoke alarms, detectors or heat alarms, and 1.5% were reported to be detected by an automatic sprinkler system or some other automatic system.
- Smoke alarm activation in the room of origin was identified in 23.4% of residential apartment fires, and activation in another location was identified in 30.8%. Problems with alarms, such as poor location, no/dead batteries or other reasons, were noted for 8.6% of fires.
- All occupants evacuated safely upon hearing a smoke alarm in 36% of residential apartment fires, and most but not all residents evacuated safety in 18%. In about 10% of the fires, residents did not evacuate because they didn't hear an alarm, had physical and mental challenges, were under the influence of drugs or alcohol, or another reason.
- 39% of residential apartment fires were in buildings with no sprinkler protection, while 8.5% were in buildings with full or partial sprinkler protection.
- Automatic extinguishing equipment operated in 2.7% of residential apartment fires. For another 7.3%, the equipment did not operate because the fire was too small to trigger it or some other reason. In 35% of the fires, there was no equipment in the room of origin.
- 35% of residential apartment fires were extinguished by the occupant, 38% by the fire department, and 18.1% burned out.
- 72% of the fires were in areas served by a full-time fire department and 22.2% by a combined full-time and volunteer department.

***Smoke, Stacks and Second Stairs*, Fire Protection Association [4]**

Published in July 2023 by the UK's Fire Protection Association, *Smoke, Stacks and Second Stairs* by Sikorski, R. examines different methods of enabling safe exit routes from high-rise buildings in the wake of the June 2017 Grenfell Tower fire in London in which 72 residents died.

The article notes that second staircases may increase the safety of users to some extent, as the increased capacity will facilitate the operations of the fire brigade, but they are associated with high costs and do not completely protect escape routes against smoke.

A more effective method of ensuring the absence of smoke is the use of pressurisation systems that actively prevent smoke inflow to protected spaces. While these systems traditionally had numerous physical, design, and reliability challenges, advances in Poland have helped to create systems that deal with the stack effect and wind impact, are self-adapting and self-testing, offer flexibility in design, and are reliable in terms of all the components working together. This makes it a very robust solution for securing a single staircase.

The article concludes that these systems should not be seen as an alternative to a second staircase, but rather a complement to fixed measures, such as compartmentation or an additional escape route. Both solutions are not mutually exclusive and can combine well to increase safety. But if the economic criterion excludes the use of both at the same time, then those responsible for the construction process should have the ability to make a fact-based analysis of all the solutions, together with their impact on safety. The prescriptive forcing of one may exclude the more effective solution.

Fire Safety and Statistical Research

Valuable insights can be gleaned from fire safety and statistical research from Canada and around the world. A selection of relevant research is described below.

***Strategies for evacuation of occupants from high-rise residential buildings involved in fire*, United Kingdom government** [5]

Published in February 2024, the study *Strategies for evacuation of occupants from high-rise residential buildings involved in fire* for the UK government Home Office reports on live evacuation testing research conducted by the University of Lancaster to test the efficiency of various evacuation strategies in high-rise residential buildings during fire incidents where it is untenable for residents to shelter in place and a full evacuation is required.

Research questions addressed by the study included strategies likely to lead to the fastest evacuation of a high-rise residential building, the extent that evacuation strategies lead to congestion in stairwells, the impact of evacuees with impairments, further factors that could affect live evacuations, and the accuracy of modeling software to simulate live evacuation testing.

Live operational tests of five evacuation strategies were conducted using fire and rescue services staff as well as volunteers:

- A full simultaneous evacuation using the building's Evacuation Alert System (EAS) (single staircase).
- A full evacuation with door-knocking alerts without an EAS (single staircase).
- A full evacuation using an EAS phased bottom-up from above the fire (single staircase).
- A full evacuation using an EAS phased top-down from above the fire (single staircase).
- A full simultaneous evacuation using an EAS (two staircases – one for evacuation and one for firefighting).

Key findings

- Two staircases are more likely to support a faster evacuation than one staircase. When using two staircases, evacuation times were shorter than for all other evacuation strategies.
- Using an EAS results in faster evacuation than a door-knocking system, however, it did lead to more congestion than door-knocking.

- Evacuees moving at a slower pace caused congestion in staircases, but this was less of a factor when two staircases were used.
- The higher the floor where residents with physical impairments lived, the greater impact on evacuation speeds by those following them on the stairs. Evacuees with physical impairments were further slowed by obstacles on the floor, such as hoses.
- Movement speed varied by floor, with faster speeds recorded at lower levels and slower speeds at the top and middle of the building, close to the fire, where obstacles are more likely to be present.
- Modeling software showed promise in accurately predicting outcomes using data from live operational tests, but results were more accurate for the single-stair strategies than the two-stair strategy.
- The results of phasing evacuations bottom-up or top-down from above the fire were inconclusive.

***Means of Escape in Residential Buildings*, United Kingdom government** [6]

Published in March 2024, *Means of Escape in Residential Buildings* by Spearpoint et al. is part of research carried out for the UK Government following the June 2017 fire at the Grenfell Tower residential high-rise in London that resulted in the deaths of 72 residents. The report contributes to research that forms part of the recommended technical review by the Building Safety Regulator at the Health and Safety Executive for the statutory guidance for fire safety in buildings in England.

The project investigated evacuation strategies related to the effectiveness of physical design measures, fire detection and alarm systems, and human behaviour in relation to high-rise residential buildings. It used a combination of literature surveys, expert input, surveys and interviews, and an extensive set of evacuation simulations. The work focused on the impact of various specific measures on evacuation performance, namely detection, notification, the width and number of stairs, and the provision of elevators as a means of evacuation.

The findings from the study have allowed for an investigation of key design, procedural and response factors to deliver quantitative information that can enable a competent professional to evaluate the evacuation performance of high-rise residential buildings.

The study objectives were to:

- Review physical measures that can be included in buildings likely to affect the means of escape as part of a fire safety strategy, and summarize the different fire safety design approaches from around the world for each of the measures.
- Understand future design and residential building use trends.
- Identify expected resident performance during evacuation and associated influencing factors.
- Establish methodology and findings from interviews with Fire Rescue Services and residents, and resident surveys.

- Establish exemplar building floorplates for the simulation of a typical building through a probabilistic assessment of the relevant data.
- Develop a method to quantify the effectiveness of evacuation strategies.
- Bring together the findings of the research and identify the pros and cons of evacuation strategies that have been analyzed.

Conclusions

- Stay put / shelter in place: If this strategy is used, it is important the nature of the incident and building status is clearly communicated to residents at an early stage, given they are likely to learn of the incident online or from neighbours. Delayed communication could result in residents staying put and then collectively deciding to evacuate within a narrow timeframe, increasing the chances of congestion on the stairs and exposure to fire products and emergency responders.
- Detection and notification: Providing incident information to residents is key to enhancing their situational awareness and decision-making. Voice notification coupled with suitable detection reduced evacuation times and stair access in all of the study scenarios. Voice notification can go beyond alerting residents to providing them with guidance and instructions. Automatic detection and alarm systems provide early warning to residents but on their own, may lead to reducing the number of residents who stay put. While the automatic systems reduce notification delays, use of Evacuation Alert Systems (activated by emergency responders) may enable a more effective stay put strategy.
- Single stair: A single stair that has sufficient accommodation for building occupants and provides a place of safety can achieve an adequate means of evacuation. A wider single stair provided a modest reduction in evacuation time and enabled people to pass slower-moving evacuees. A wider single stair may also address concerns about ensuring emergency responders may go up the same stairs without impeding evacuation.
- Multiple stairs: Introducing a second stair benefited overall evacuation time and access to the stairwell when demand for the stairs exceeded occupancy capacity between floors (e.g., floors with building amenities or additional people) or when there were impediments (e.g., slow-moving evacuees, emergency crews coming up the stairs, or if one stair is affected by fire or smoke). For lower-rise buildings, a second stair provided a lesser benefit for evacuation performance than taller buildings.
- Elevators: Provision of an emergency elevator sped up the evacuation of those who could not use the stairs unassisted (e.g., those in wheelchairs). The benefit of providing elevators as a means of building evacuation increase with building height.
- Accessibility: Consideration should be given to changing demographics and the growing proportion of residents with movement impairments. As this proportion increases, the benefit of alternative means of egress might increase, but would require management in some form, such as prioritized access.

***Fatal Residential Fires: Prevention and Response*, Lund University** [7]

Published in January, 2020, *Fatal Residential Fires: Prevention and Response* is the doctoral thesis of Runefors, M. at Sweden's Lund University. Based on a review of six studies on fire fatalities, the paper assesses the effectiveness of fire safety measures such as smoke alarms, sprinkler systems, detector-activated sprinklers and fire-resistant clothes and furniture for different groups of people—especially older adults, older smokers, and people with alcohol abuse problems, who make up a disproportionate proportion of fire fatalities in Sweden.

Relevant findings

- The risk of dying from fires increases with age, and smoking plays a significant role in risk. For older smokers, the risk of dying is 45 times that of the general population, whereas for older non-smokers, the relative risk is less than three times that of the general population, even for the oldest group (age 85-plus).
- The primary object of ignition differed between groups, influencing the most effective target for fire resistance. Fire-resistant clothes were highly effective for the oldest group (age 85-plus), while fire-resistant sofas were effective for men aged 50 to 84. Fire-resistant bedding was effective for adults aged 50 to 84 but less effective for those 85-plus.
- For smoke alarms, the highest benefit per installation was found for male smokers ages 50 to 84. However, the benefit of smoke alarms was quite low for those 85-plus.
- Sprinkler systems have decreased effectiveness with age and the presence of smoking. However, the benefit of installation still increases with age and smoking, with the highest benefits among those under age 50.
- Detector-activated sprinkler systems in bedrooms and living rooms were very effective in preventing fire fatalities, especially among smokers. The benefit per installation among smokers aged 85-plus was the highest for all measures.
- Prevention of fire fatalities needs to differentiate between different groups: older adults with reduced mobility, people with alcohol addition, and the general public.
- The number of fire fatalities in residential occupancies would have increased by 58% in the studied year without an adequate fire service response.
- Response time was also very important, with a decreasing trend in the probability of rescue with increase in response time.
- Breathing apparatus is required to perform rescues in 40% of the fires, and is helpful in 98% of the rescues.

***Fire Protection System(s) Performance in the Residential Building Environment*, University of the Fraser Valley** [8]

Published in March, 2019 by the University of the Fraser Valley, *Fire Protection System(s) Performance in the Residential Building Environment* summarizes the findings from an analysis of

the fire protection performance of sprinkler systems and smoke alarms in residential and multi-level residential buildings in the provinces of British Columbia, Alberta, Saskatchewan, Manitoba, Ontario and New Brunswick from 2005 to 2015. The primary focus is on the relationship between the presence of protective devices, civilian and firefighter casualties, and fire containment in residential buildings.

Key findings related to multi-family residential buildings:

- Overall, death and injuries were notably less frequent in apartment buildings that had sprinklers and a smoke alarm. The odds of a death was 3.2 times greater in buildings with sprinklers and smoke alarms than those without. Fires in sprinklered buildings were contained to the room of origin 93.5% of the time and required fire department intervention in 35.5% of the incidents, compared to close to half for buildings without sprinklers or alarms.
- When fire protection systems fail, there is a significant impact on fire spread. For example, if a smoke alarm failed in a building that is partially or fully sprinklered, the percentage of fires that extended beyond the room of origin were twice that of fires in buildings with functioning alarms and sprinklers.

TABLE 4: FIRES, FIRE RELATED CAUSALITIES DEATHS, INJURIES, FIRE DEPARTMENT INVOLVEMENT AND EXTENT OF FIRE SPREAD CLASSIFIED AS RESIDENTIAL APARTMENT USE, 2005 TO 2014.

Smoke Alarm Working	Partial and/ or Full Sprinkler	Fires (%)Total	Injuries (%)Total	Injury Rate per 1,000 Fires (95% CI)	Death (% Total)	Death Rate per 1,000 fires (95%CI)	% Fire Department Extinguish (95% CI)	% Beyond Room of Origin (95% CI)
Yes	Yes	1,807	145	80.2	6	3.3	33.5%	6.5%
		4.7%	*3.8%*	*(67.7 - 92.8)*	*1.7%*	*(0.7 - 6.0)*	*(25.2% - 41.8%)*	*(2.8% - 10.2%)*
No	Yes	1,312	78	59.5	4	3.0	34.1%	13.9%
		3.4%	*2.1%*	*(46.7 - 72.2)*	*1.1%*	*(0.1 - 6.0)*	*(24.3% - 44.0%)*	*(7.6% - 20.3%)*
Yes	No	15,649	1,836	117.3	138	8.8	36.2%	6.7%
		40.7%	*48.3%*	*(112.3 - 122.4)*	*38.7%*	*(7.4- 10.3)*	*(33.2% - 39.1%)*	*(5.5% - 8.0%)*
No	No	19,685	1,740	88.4	209	10.6	33.4%	13.0%
		51.2%	*45.8%*	*(84.4 - 92.4)*	*58.5%*	*(9.2 - 12.0)*	*(30.9% - 35.9%)*	*(11.4% - 14.6%)*
Total		38,453	3,799	98.8	357	9.3	34.6%	10.2%
		100%	*100%*	*(95.8 - 101.8)*	*100.0%*	*(8.3 - 10.2)*	*(32.7% - 36.4%)*	*(9.2% - 11.2%)*

Note: 234 cases had missing injury data and 66 cases had missing sprinkler data, these cases were excluded from analysis

***Fire Safety Ambassador: Content and Timing of Fire Safety Training and Inspections on First Nations Communities and Decision-support Tool*, National Indigenous Fire Safety Council [9]**

Published in January 2022, a study by Clare, J. and Robinson, P. entitled *Fire Safety Ambassador: Content and Timing of Fire Safety Training and Inspections on First Nations Communities and Decision-support Tool* for the National Indigenous Fire Safety Council provides insights and adds a new depth of understanding about the impact of human behaviour on fire safety training.

The report considers proven approaches in North America and around the world through the lens of Clare's PhD in Applied Cognitive Psychology, drawing on available data for First Nations populations living on-reserve in Canada and research by the British Columbia Injury Research and

Prevention Unit on fire prevention in vulnerable and Indigenous communities. From a cognitive psychology standpoint, coupled with research on training in other contexts, the study pointed out two main factors for consideration:

- The "knowing-doing gap," in which new knowledge does not influence how people act, as discussed by F. Joyner in the 2015 paper *Bridging the knowing/doing gap to create high engagement work cultures*, and
- The "wear-off effect," in which benefits of training wear off over time, as described by M. Compton and V. Chein in the 2008 paper *Factors related to knowledge retention after crisis intervention team training for police officers*.

These factors are not limited to vulnerable and Indigenous populations. Recommendations included conducting resident fire safety education in regular intervals to ward off the "wear-off effect" and providing opportunities for hands-on resident fire safety training to address the "knowing-doing gap."

Official Positions by Fire Associations

Over the past year, Canadian, U.S. and international fire associations have been releasing official positions opposing single-stair multi-family buildings due to significant fire and life safety concerns, including:

- Canadian Association of Fire Chiefs
- International Association of Fire Chiefs
- National Association of State Fire Marshals
- Ontario Association of Fire Chiefs
- Ontario Professional Fire Fighters Association
- Fire Chiefs' Association of British Columbia
- BC Professional Fire Fighters Association
- International Fire Chiefs Association
- International Association of Fire Fighters
- Metropolitan Fire Chiefs Association

The following is a selection of excerpts of official positions, which continue to be issued at the time of the writing of this report. See the References section for website addresses, if available, for the full statements.

Excerpt: National Association of State Fire Marshals, U.S., March, 2024 [10]

The paper notes: "NASFM strongly opposes any changes that are below the minimal requirements found in the national consensus codes and standards**.** To be more specific, we do not support

reducing the required number of exit passage ways in multifamily dwellings as required by codes. Finally, we implore all stakeholders to continue to collaborate and find workable solutions that maintain fire and life safety as the highest priority."

The paper identifies the following risks:

1. Providing a single means of egress places residents and firefighters in danger.
2. Many fire departments lack personnel and equipment required to combat these types of fires and evacuate large numbers of people.
3. Providing access to only a single-entry way for emergency forces negatively impacts rescue and fire suppression efforts especially if the single exit is obstructed, not to mention if people are escaping from that same pathway. This really diminishes the emergency responder's tactical options.
4. Many of these proposed multi-family dwellings serve our most vulnerable populations and place them at a greater risk by degrading the standard of living and life safety.
5. Nationally developed consensus codes and standards are promulgated based on real data from past tragedies to include fire deaths, injuries and large dollar losses. In addition, modern fire science and technologies are used, all to create layered protection in buildings ensuring and enhancing safety. To take parts and pieces of the code and ignore other parts will have devastating consequences.

Excerpt – Fire Chiefs' Association of British Columbia, Canada, and International Fire Chiefs Association, March 2024 [11]

These two organizations endorsed the same position paper calling for the retention of the requirement for a second staircase as defined in the BCBC for multi residential structures. The paper notes, "This position is vital to enable fire and emergency services to respond effectively to incidents, safeguarding both occupants and firefighters."

Key points:

- The requirement for two separate staircases in multi residential buildings is grounded in research and the consensus code process. This provision ensures vital redundancy in egress options, crucial for occupant evacuation and firefighter access during emergencies.
- Modern hazards, such as those posed by lithium-ion battery-powered devices, underscore the need to be able to exit a building quickly and safely in an emergency. The proliferation of such risks necessitates stringent adherence to building codes that prioritize occupant and firefighter safety, with a second staircase serving as a cornerstone of this protective framework.
- The provision of two staircases enhances the efficiency, convenience, and inclusivity of residential living environments. It mitigates congestion, promotes equitable access for individuals with mobility challenges, and fosters a more welcoming community for all residents.

- While critics may raise concerns about construction costs and usable floor space, the benefits of retaining the two-staircase requirement far outweigh these considerations. Moreover, amendments to model codes can impact insurance ratings and lead to increased costs and unnecessary risks for both the public and emergency responders.

Excerpt: Joint Statement by International Association of Fire Fighters and Metropolitan Fire Chiefs Association, June, 2024 [12]

The statement says allowing residential structures to be built with exemptions or modifications contrary to decades of research and investigation will jeopardize safety.

"Put simply, lives will be endangered. History is filled with examples of incidents where a single means of egress and blocked egress resulted in trapped occupants and loss of life. More concerning is that some state, provincial, and local legislatures are considering reducing established critical life-saving features by circumventing the national code development consensus process. The national code development process ensures equal, non-biased dialogue between all stakeholders to find consensus. Circumventing the code development process jeopardizes the public, building occupants, and first responders."

The paper also notes the same five risks included in the National Association of State Fire Marshals position paper above.

Excerpt – Ontario Association of Fire Chiefs, January 2024 [13]

The paper notes: "The present discussion over the acceptance and use of single staircase is contrary to the evolution of building codes and standards established in North America. An integral element to survival in a fire situation is a protected secondary means of escape for occupants to reach a place of safety. As a last resort, a protected area of refuge can be used until rescue by first responders is available.

As such, the OAFC is unable to endorse any reduction in exiting or reduction in the fire safety systems provided to protect firefighters and occupants within a building."

The paper describes a typical firefighting scenario to illustrate the risks:

> In the event of a low rise, mid-rise or high-rise fire, firefighters will position themselves in a staging area two floors below the fire floor (where possible and floor-dependent). Firefighters will then take control of an exit stairwell, having connected to the standpipe system and running the hose up the stairwell. This ensures firefighters are equipped with water when making entry to the fire floor, with the hose line providing a screen of protection from the heat of the fire where necessary. In the event of a bail out, the firefighters can follow the hose line to the exit stairwell. The stairwell that is used to move the fire hose up then becomes contaminated, as the fire hose inherently blocks the door open at the floor it was connected and at the fire floor, making this stairwell unusable for the purpose of evacuating occupants. This leaves the alternate stairwell to be assigned as the evacuation/exit stairwell for occupants. The alternate stairwell is maintained smoke-free (by pressurizing the stairwell and maintaining control of the doors) so it remains safe to evacuate occupants.

Firefighting operations also involve several firefighters advancing upwards, often with additional equipment. Use of the same stairwell by both firefighters and occupants has two life safety impacts: a) firefighters and equipment occupies available space in the stairwell, thereby impeding and slowing the egress of occupants, and b) descending occupants impede and slow fire operations.

In the event of a single stairwell, these fundamental fire attack strategies are not possible and set back firefighter strategy development by 40 years. Further, by removing the ability to engage the fire attack from a lower floor, the ability for firefighters to fight the fire has been significantly impacted and their safety further threatened.

Discussion

Notwithstanding the need for more affordable housing options across Canada, the research brings up a variety of crucial issues to consider as part of the decision-making process about changing building codes in Canada.

Current B.C., Ontario and National Building Codes require all buildings to have at least two exits from each floor. A single exit stair is permitted only if the building:

- Is not more than two storeys in height,
- Not more than 60 persons served by the exit stair,
- The floor area is between 150 and 300 sq.m. depending on type of occupancy, and
- Travel distance to the exit stair is not more than 10 to 25m. depending on occupancy.

See the Single Stair Exit Research section above for a summary of the proposed code change permitting single-stair multi-family buildings.

A Concerning Change in Process

Several of the fire association position papers note that changes to building codes in Canada have traditionally involved a consensus process to ensure the changes reflect all parties' interests.

The move toward single-stair residential buildings has circumvented this process. It is driven by developers, builders and urban planners, leading to local exceptions and allowances that jeopardize occupant and firefighter safety—despite widespread and vocal opposition from the fire service that is responsible for keeping communities safe.

As noted in the joint statement by the International Association of Fire Fighters and Metropolitan Fire Chiefs Association, "The national code development process ensures equal, non-biased dialogue between all stakeholders to find consensus. Circumventing the code development process jeopardizes the public, building occupants, and first responders."

What Works in Some Locations May Not Work Everywhere

Europe vs. Canada

Single-stair proponents often point to Europe as an example of the successful execution of single-stair multi-family residential buildings. Yet their own examples also illustrate key differences between Europe and North America.

Building materials are one such difference. The Larch Lab paper on Point Access Blocks for the City of Vancouver [2] notes that historically in Europe, these buildings were constructed of solid materials: brick, stone, and later concrete.

This is not common in Canada. In B.C. in particular, lightweight wood-frame buildings are most common. There is no compartmentation between units in mid-rise buildings that would stop a fire from spreading rapidly. If this was to be a requirement, it would considerably add to the cost and complexity of construction, which runs counter to the argument in favour of single-stair buildings.

Another issue is the fire protection required to protect single-stair buildings. Larch Labs noted that the Point Access Block designs in Germany are predicated on aerial capability by local fire crews to serve as a second exit. This approach recognizes the importance of an alternate way out if the main exit is not available.

Further, it is reliant on a rapid response with a ladder truck. In urban municipalities, the building lots suited to the development of single-stair buildings are becoming more land locked which limits access—for fire crews to perform aerial rescues of trapped occupants.

Additionally, Canada's sprawling geography results in populations spread out over large distances, with significant differences in the level of fire protection. While many live in urban centres, a large proportion of the population lives in smaller communities protected by volunteer fire departments with limited resources that must travel large distances. This often means longer response times as well as varying aerial capability.

There is abundant literature linking fire department response to survival in residential fires. Runefors, M. of Lund University [7] noted that the number of fire fatalities in residential occupancies would have increased by 58% in the studied year without an adequate fire service response. Response time was also very important, with a decreasing trend in the probability of rescue with increase in response time.

Further, Runefors noted that the capacity of the emergency responders was also crucial to successful rescues. Breathing apparatus was required to perform rescues in 40% of the fires.

UK Adds Requirement for Second Staircases

The UK has revisited its building regulations in the wake of the Grenfell Tower fire, and in 2024 made second staircases mandatory in all new residential buildings in England over 18 metres high (about six storeys) as of September 30, 2026. *The Building Regulations 2010: Amendments to the Approved Documents* [15] were published in March to provide technical guidance for the new requirement.

While this change still allows for single-stair buildings up to six storeys, it does recognize the value of a second staircase for fire and life safety, which is also affirmed by the two UK government research papers discussed earlier in this report.

A Second Staircase Makes a Difference

It should be noted that the fire safety research often referenced by proponents of single-stair buildings generally relates to buildings constructed under current building codes with two egress stairs. As such, the death and injury data may not apply to buildings without the added protection offered by a second stairway.

It is reasonable to expect that from time to time, a building stairwell may not be fully usable for a variety of reasons. It may be closed for renovations or maintenance activities. Residents or visitors may have parked mobility devices or bicycles on the landing, including e-devices with lithium-ion batteries that pose an explosion hazard. People may be moving large items up or down the stairs, blocking the way.

During a fire, the lone staircase may be filled with smoke or debris, or may be the scene of the fire itself. As noted in the University of the Fraser Valley (UFV) report on single egress buildings by Garis, L. [3], 9% of fires in apartment buildings originated in the means of egress, including hallways or stairwells, while only about a quarter of the studied fires were contained to the room of origin *(these were a mix of sprinklered and non-sprinklered buildings; see the Fire Safety Equipment is Not Perfect section below for fire spread data in sprinklered-only buildings)*. In addition, smoke affected primary egress routes for more than 42% of residential apartment fires. In total, 68% of the deaths were due to smoke inhalation.

Further underscoring the presence of smoke in egress routes, Runefors, M. of Lund University noted that breathing apparatus is required to perform rescues in 40% of the fires, and is helpful in 98% of the rescues.

The UFV report on single egress stairs [3] also illustrates the dangers associated with fires in apartment buildings. Of the average of 2,237 fires in residential apartment buildings that occurred each year from 2005 to 2015, deaths or injuries occurred 95.8% of the time.

In terms of evacuation time, the presence of two staircases makes a difference. The report for the UK Government on evacuation strategies in high-rise buildings [5] demonstrated that two staircases are more likely to support a faster evacuation than one staircase. Evacuees moving at a slower pace caused congestion in staircases, but this was less of a factor when two staircases were used.

The report by Spearpoint, M. et al. on means of escape for the UK government also identified evacuation benefits for multiple staircases [6]. It noted that introducing a second stair benefited overall evacuation time and access to the stairwell when demand for the stairs exceeded occupancy capacity between floors (e.g., floors with building amenities or additional people) or when there were impediments (e.g., slow-moving evacuees, emergency crews coming up the stairs, or if one stair is affected by fire or smoke). This benefit was stronger in taller builders than shorter buildings.

The Role of Staircases in Firefighting

The description of a typical multi-family residential firefighting operation in the Ontario Association of Fire Chiefs position paper [14] describes the necessity a second stairwell for firefighting staging area, access and running hose. During a firefight, this second staircase is essentially blocked for use by evacuees.

"In the event of a single stairwell, these fundamental fire attack strategies are not possible and set back firefighter strategy development by 40 years. Further, by removing the ability to engage the fire attack from a lower floor, the ability for firefighters to fight the fire has been significantly impacted and their safety further threatened," the OAFC notes.

Removal of this important second staircase will cause delay in evacuation while also hindering firefighting and rescue operations, endangering both residents and first responders.

Human Behaviour

Human behaviour is another concern. As noted in the study on means of escape for the UK government [6], it is likely that residents will learn of a fire in the building from neighbours or online or from neighbours. If they are not immediately provided with information about the nature of the incident or building status and advised to stay put, they may attempt to evacuate themselves, increasing the changes of creating congestion on the stairs and exposure to the fire or smoke, and to emergency responders.

More research is required on understanding human behaviour during fire evacuations.

Fire Safety Equipment is Not Perfect

Proponents of single-stair construction have pointed to advances in fire protection—such as fire alarms, smoke detectors, and particularly sprinklers—as justification for removing the second required stairs in new construction. There is no question these systems have significantly improved the fire safety of new buildings and saved countless lives.

However, like all devices, they may not function as expected. They may break down, or they may be offline due to repair or replacement. In the case of sprinklers, the water supply may be temporarily unavailable or insufficient due to high usage, watermain maintenance, drought or other issues.

Winters Hotel Case Study

The fatal 2022 Winters Hotel fire in downtown Vancouver, British Columbia, illustrates the vulnerabilities of fire protection systems. The single-room occupancy hotel (rooming house) was run by a non-profit organization with government funding, and was equipped with both a sprinkler and fire alarm system.

As related at a January, 2024 inquest, a small fire broke out at the hotel on April 8, 2022 and was extinguished by sprinklers. The sprinklers caused flooding in seven units and were turned off to prevent further flooding.

Although Vancouver Fire and Rescue Service ordered the non-profit to have the systems serviced and reset, the non-profit did not schedule this work until three days later, April 11 at 3 p.m., for a

variety of reasons, including avoiding weekend rates, its policy for hiring tradespeople and past practice.

On the morning of April 11, another fire broke out at the Winters Hotel, sparked by unattended candles. This time, the sprinklers and fire alarm systems did not activate, and the hotel was completely destroyed. More than 70 people lost their homes and possessions, numerous people were injured and two people lost their lives: a 53-year-old man with severe hearing loss, and a 68-year-old woman believed to have been wearing a brace on her foot at the time of the fire. Those who survived were woken or alerted by staff or neighbours, and described smoke-filled hallways and stairwells as they tried to escape.

Redundancy is the Foundation of Fire Protection

Redundancy of fire protection systems is critical because individual systems may fail, and do fail.

As noted in the official position of the National Association of State Fire Marshals [10], fire safety equipment is just one of the many layered elements of fire protection in a building. "Proper exiting, much like smoke alarms and carbon monoxide alarms, is known to have saved thousands of lives and have been and remain the fundamental building blocks to life safety. Layered fire prevention measures encompassing exiting, fire sprinkler systems, fire rated construction, automatic fire alarm systems, compartmentalization and the many other codes afford a reasonable level of protection."

The UFV report on single egress stairs [3] pointed to failures in smoke alarms and sprinkler systems in a significant percentage of residential apartment fires. For example, problems with smoke alarms were noted in almost 9% of the fires, while in 7.3% of fires, automatic extinguishing equipment did not operate because the fire was too small to trigger it or some other reason.

Further, fewer than 40% of residential apartment fires were reported to be detected by smoke alarms or detectors, heat alarms or automatic sprinkler or other systems. In about 10% of the fires, residents did not evacuate because they didn't hear an alarm, had physical and mental challenges, were under the influence of drugs or alcohol, or another reason.

The UFV report by Garis, Singh and Plecas on fire protection systems in residential buildings [8] illustrates the greater risk of fire spread when these systems fail. The report noted that if a smoke alarm failed in a building that was partially or fully sprinklered, the percentage of fires that extended beyond the room of origin was twice that of fires in buildings with functioning alarms and sprinklers.

The report also showed that while sprinklers help contain fires, they are not foolproof. Fires in sprinklered buildings were contained to the room of origin 93.5% of the time, meaning that 6.5% of the fires spread beyond the room of origin, potentially hindering evacuations for a total of 2,500 fires, or about 227 per year studied.

The article *Smoke, Stacks and Second Stairs* by the UK's Fire Protection Association [4] notes the increased protection offered by pressurization systems to remove smoke from hallways and stairwells. However, it also says these systems should not be seen as an alternative to a second staircase, but rather a complement to fixed measures, such as compartmentation or an additional escape route.

Cognitive Factors

Human behaviour may also reduce the reliability of smoke alarms and resident fire safety training. As Clare, J. and Robinson, R. revealed in their study for the National Indigenous Fire Safety Council [9], people are susceptible to cognitive factors such as the "knowing-doing gap" – the disconnect between knowledge and performance – and the "wear-off effect" – in which the benefits of training wear off over time.

These phenomena may reduce fire safety in multi-family residential buildings if managers do not provide regular, scheduled fire safety training including evacuation plans and the need to check and maintain smoke alarms.

The wear-off effect may also play a growing role in smoke alarm reliability as jurisdictions move toward permanent Daylight Savings Time. Thanks to public education by fire departments, these semi-annual time changes have become a trigger for residents to check, maintain and clean their smoke alarms, and change batteries if applicable. The loss of these semi-annual reminders may affect smoke alarm function over time.

Challenges with Building Inspection Compliance

Proposed safety measures for single-stair buildings include limits of 60 people per storey and a maximum of four units per storey. However, any such occupant load cap in a residential dwelling is essentially unenforceable given that residential dwellings cannot be inspected for the enforcement of occupant load without reasonable cause. Two households on the same floor having holiday activity on the same evening could easily exceed the occupant cap, but the authorities would not be aware unless they are reported by a neighbour.

Age and Mobility Must be Considered

The average age of the population is rising everywhere, and with that, the growing number of potential accessibility issues, from mobility to hearing or sight impairments. As we age or become less mobile, research shows that fire becomes a growing risk to our life and safety.

The UFV report on single egress stairs [3] notes that in over half of unintentional residential fire deaths studied, the individual was age 70 and up. As well, in 14% of unintentional residential fire deaths, there were mobility-related issues (e.g. use of crutches or wheelchair) or cognitive impairments (e.g. dementia).

This is supported by Runefors, M.'s report for Lund University [7] that notes that prevention of fire fatalities needs to differentiate between different groups, including older adults with reduced mobility. The risk of dying from fires increases with age, the report says, with smoking playing a significant role in risk. Older non-smokers were two to three times more like to die in a fire; older smokers were 45 times more likely. Additionally, the benefit of smoke alarms was quite low for those 85-plus, and the effectiveness of sprinkler systems decreased with age and the presence of smoking.

The report for the UK Government on evacuation strategies from high-rise buildings [5] noted that evacuees moving at a slower pace caused congestion in staircases, but this was less of a factor when two staircases were used.

The report by Spearpoint, M. et al. on means of escape for the UK government [6] noted that consideration should be given to changing demographics and the growing proportion of residents with movement impairments. As this proportion increases, the benefit of alternative means of egress might increase, but would require management in some form, such as prioritized access.

Conclusion

Changes in building practice and codes in Canada have traditionally followed an in-depth consensus-based process that considers all perspectives, extensive research and evidence. Due to the important and wide-ranging implications, it is not a process to be rushed, considered incremental or driven by single-issue agendas.

Both the proponents and opponents of single egress stairs in residential buildings of three to eight storeys raise a variety of points that require further investigation and due consideration. This report reveals a range of vulnerabilities in the arguments being made in favour of the change, based on existing fire research and statistical data from Canada and elsewhere.

It is imperative that any changes to the building code be made in close collaboration with the fire service.

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