Fire Considerations

Combustible Cladding and Components Of Exterior Walls and Curtain Walls

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- BASc, Queen's University at Kingston – Civil Engineering
- M Eng, UBC's short lived Fire Science program
- 25 year's experience in Equivalencies and Alternative Solutions

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- BASc, University of Waterloo – Mechanical Engineering
- CFD and risk analysis

GHL CONSULTANTS LTD

- Founded in 1992
- Building Code consultants
- Code reviews – assisting clients and authorities
- Fire engineering services
  - Performance-based fire engineering design
  - Risk analysis
  - Legal / expert opinion

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Fire Engineering

- Prefer “Fire Engineering”
  - Focus on Part 3
  - Fire hazard analysis
  - Fire risk analysis
  - Structural fire resistance
  - Heat transfer
  - Egress/evacuation
  - Smoke control design
  - Persons with disabilities / ADA work
  - No system design

9 Principals + Staff (Total 24)

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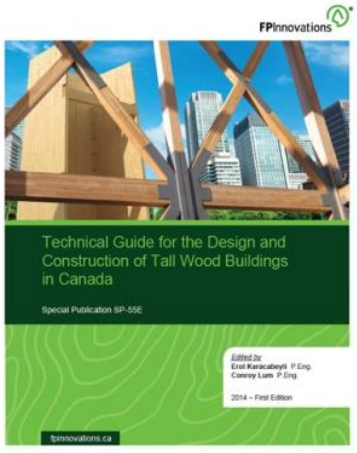
Research Work

- BC Wood First Advisory Committee to Forestry Investment Innovations
- CAN 086 Task Group on Fire (Andrew Harmsworth)
- NEWBuildS Research Network (Andrew Harmsworth, Board of Directors) – 70 Master's and PhD Students
- Effectiveness of Sprinkler Systems after an Earthquake
- Fire Chapter –Tall Wood Guide, Lead Author



LET US BEGIN

Fire Spread

Following ignition, the objective is to limit fire to:

- Object of origin
- Room of origin
- Floor of origin
- Building of origin
- … “during the time required to achieve occupant safety and for emergency responders to perform their duties”

Fire Spread

Following ignition, limiting fire to:

- Object of origin – regulations on building contents (carpets, mattresses, etc)
- Room of origin – compartment fire separations
- Floor of origin – floor-to-floor fire separations
- Building of origin – spatial separation

Fire Spread

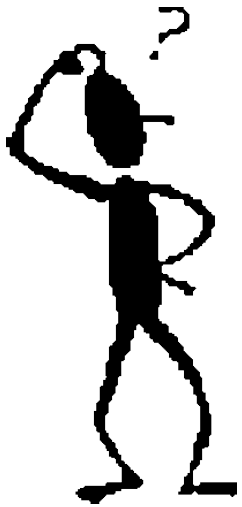
- Fire burns upwards and outwards
- The goal is to keep the fire within the limited area of origin
- F03, OS1.2, OP1.2: Limiting effect of fire beyond point of origin

Fire Spread

The question:

Will the exterior wall contribute to fire spread to outside of its compartment or building of origin?

nbcnews.com



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Fire Spread

The Building Code solution:

Limit exposed combustible components, and fire-block void spaces of the exterior wall

Combustible vs Noncombustible

- ***Noncombustible***: a material meets the acceptance criteria of CAN/ULC-S114
- ***Combustible***: a material fails to meet the acceptance criteria of CAN/ULC-S114
- ***Noncombustible construction***: type of construction using noncombustible materials for structural members and other building assemblies
- ***Combustible construction***: type of construction that does not meet the requirements for *noncombustible construction*

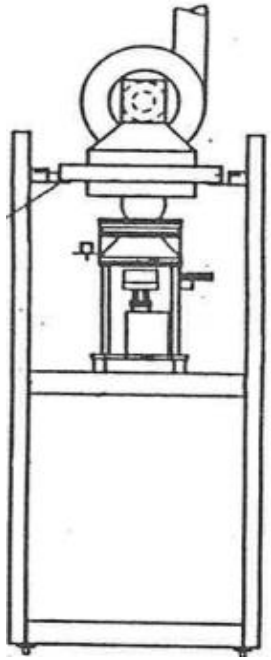
Why Noncombustible?

- Additional fuel may increase:
  - Fire growth and spread
  - Increase fire intensity
  - Prolong fire duration

- Noncombustible construction = “simple”

Noncombustible Materials

- Article 3.1.5.1 Noncombustible Materials
  - **Sentence 3.1.5.1.(2):** Materials can be used in noncombustible construction provided specific conditions are met when tested in accordance with CAN/ULC-S135, at a heat flux of 50kW/m^2

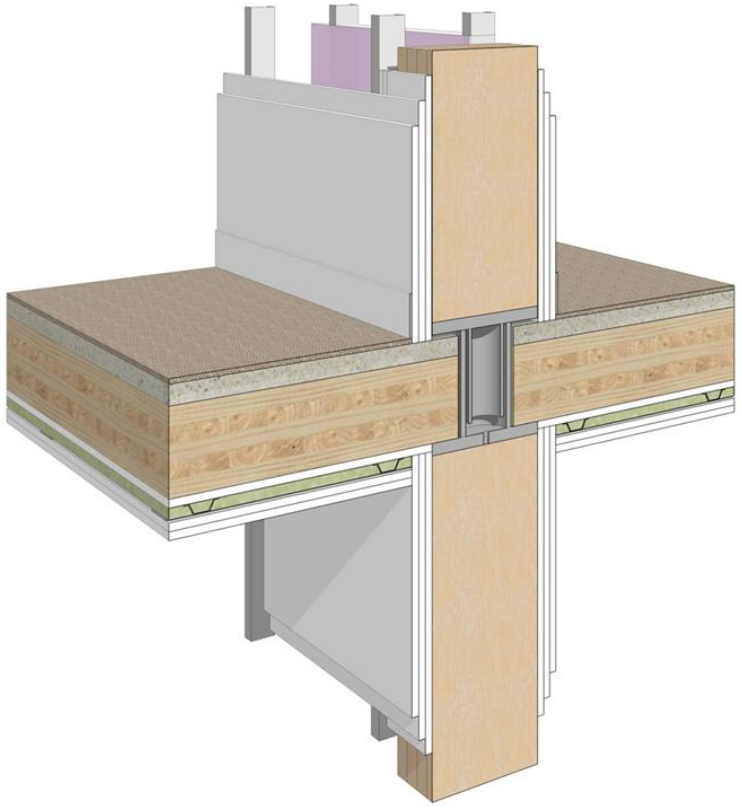


Noncombustible Materials

- For complex materials of discrete layers in CAN/ULC-S135 test:
  - Test layers separately until all layers are exposed or burn (Sentence 3.1.5.1.(3)).
  - Results based on cumulative emission

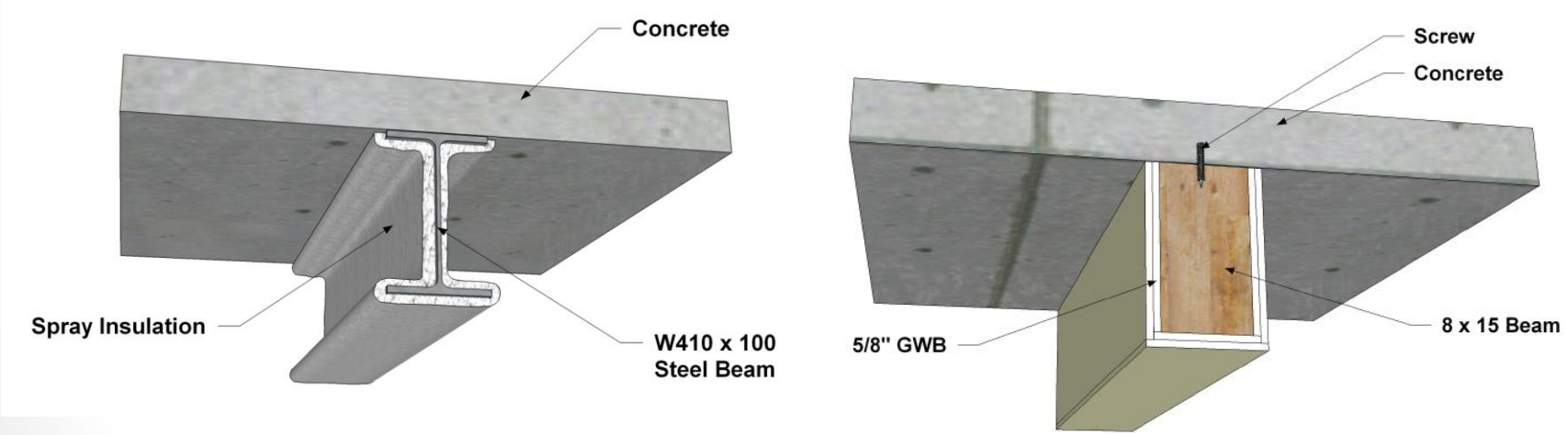
Developing the Solution

- Separate the wood structure from the fire
- “Encapsulation”



What is the Difference?

- Steel cannot be exposed (critical temp. approx. 500C)
- Wood begins charring at 270C



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Spatial Separation

- Subsection 3.2.3 - Defines base requirements for exterior wall.
- Developed from the St. Lawrence Burns tests in 1959.
- Requirements based on:
  - Occupancy
  - Sprinklered/unsprinklered
  - Limiting distance
  - Area of exposing building face

Spatial Separation Requirements

- Article 3.2.3.5 Limiting Distance Less Than 1.2m
  - **Sentence 3.2.3.5.(1):** Any openings shall be protected by closures whose fire-protection rating is in conformance with the fire-resistance rating required for the wall
  - **Sentence 3.2.3.5.(2):** Wired glass or glass block shall not be used

- Can provide an alternative solution using special sprinklers

Spatial Separation Requirements

- Article 3.2.3.6 Combustible Projections
  - Projections: min. 1.2m to PL, or 2.4m apart (Sentence 3.2.3.6.(1))
  - Soffits : min. 0.45m to PL required (Sentence 3.2.3.6.(2),(3))
  - Soffits < 1.2m to CL or IL: special protection (Sentence 3.2.3.6.(4))
    - No openings
    - Sheet steel
    - Aluminum
    - GWB
    - Wood

Spatial Separation Requirements

- Article 3.2.3.7 Construction of Exposing Building Face

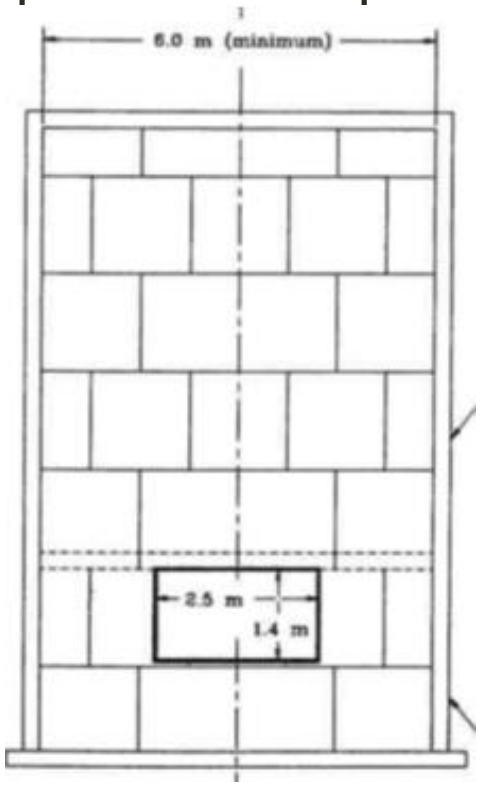
Occupancy	Area of Openings Permitted (%)	Required Fire-resistance Rating	Required Type of Construction	Required Type of Cladding
Group A, B, C, D, or F-3	0 to 10	1h	NC	NC
	> 10 to 25	1h	CC	NC
	> 25 to 50	45min	CC	NC
	> 50 to < 100	45min	CC	CC
Group E, F-1 or F-2	0 to 10	2h	NC	NC
	> 10 to 25	2h	CC	NC
	> 25 to 50	1h	CC	NC
	> 50 to < 100	1h	CC	CC

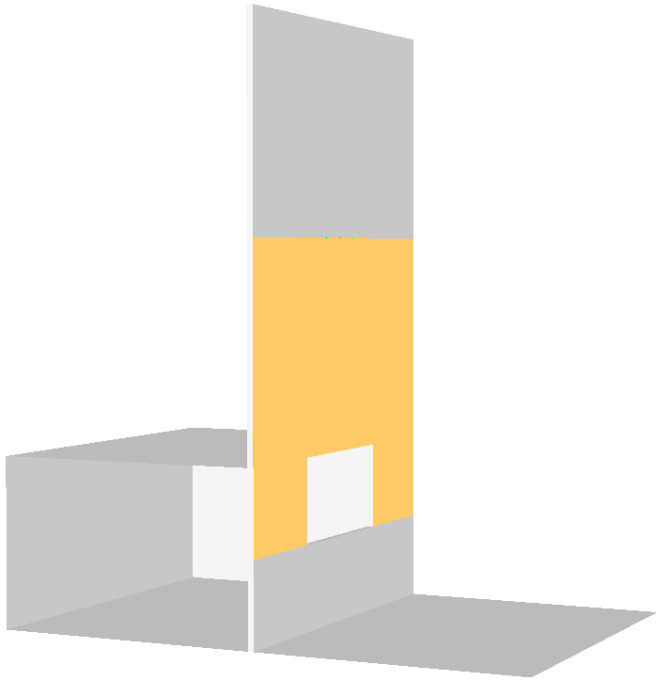
Spatial – Cladding Exemptions

- Article 3.2.3.7 Construction of Exposing Building Face
  - **Sentence 3.2.3.7.(3):** Where permitted openings is >10%, combustible cladding permitted if wall assembly complies with the requirements of Sentences 3.1.5.5.(1), (3), and (4)
  - **CAN/ULC-S134**
    - < 5m above opening
    - < 35kW/m^2 measured 3.5m above opening

CAN/ULC-S134 Test

- You can do anything as long as the wall passes the test, and permitted unprotected opening is more than 10%





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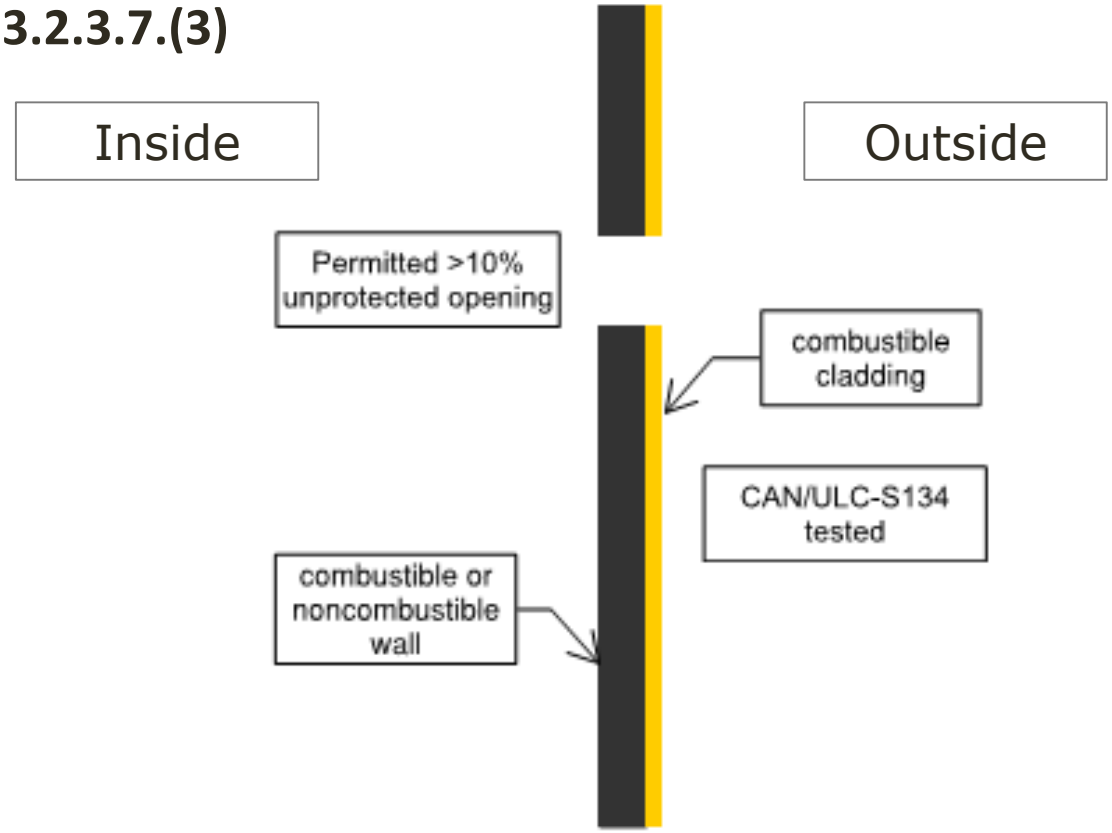
Spatial – Cladding Exemptions

- Article 3.2.3.7 Construction of Exposing Building Face
  - **Sentence 3.2.3.7.(3)**

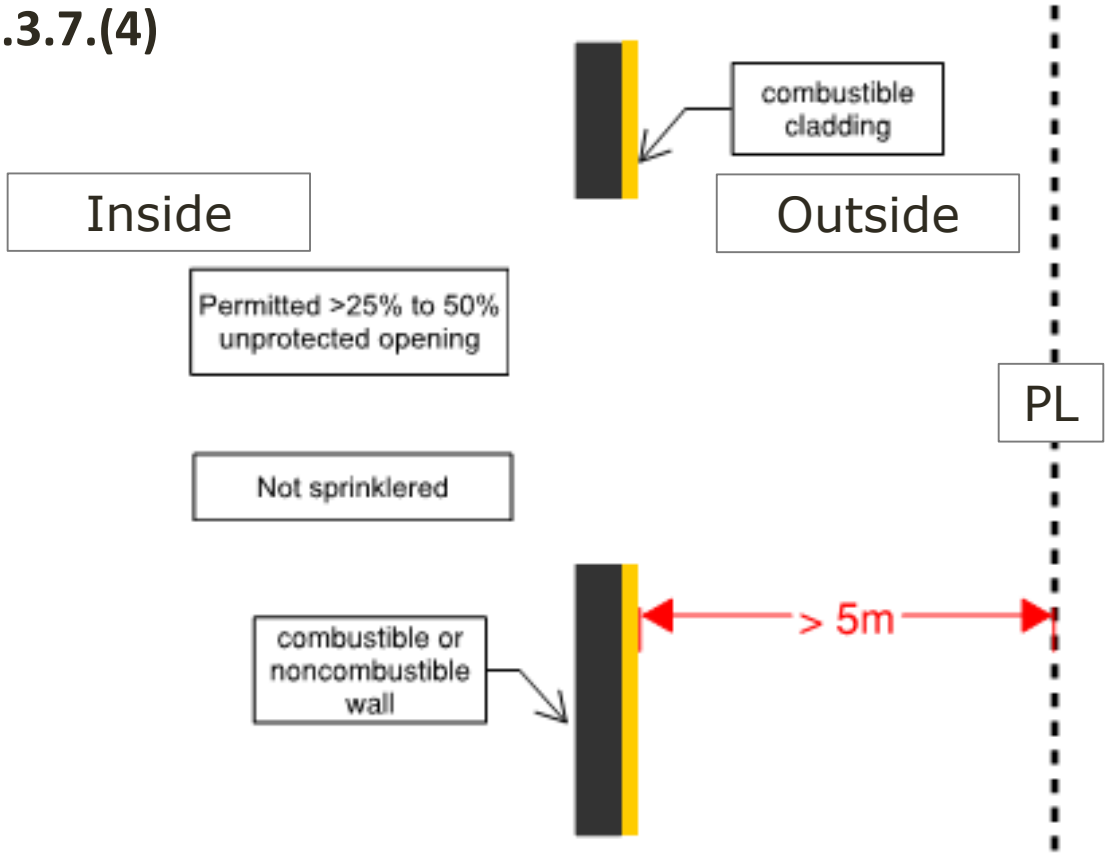


Spatial – Cladding Exemptions

- Article 3.2.3.7 Construction of Exposing Building Face
  - **Sentence 3.2.3.7.(4):** Where permitted openings is >25% to 50%, combustible cladding permitted if:
    - LD > 5m,
    - Sprinklered, or
    - Specific cladding requirements per Clause 3.2.3.7.(4)(c) or Clause 3.2.3.7.(4)(d)

Spatial – Cladding Exemptions

- Article 3.2.3.7 Construction of Exposing Building Face
  - **Sentence 3.2.3.7.(4)**



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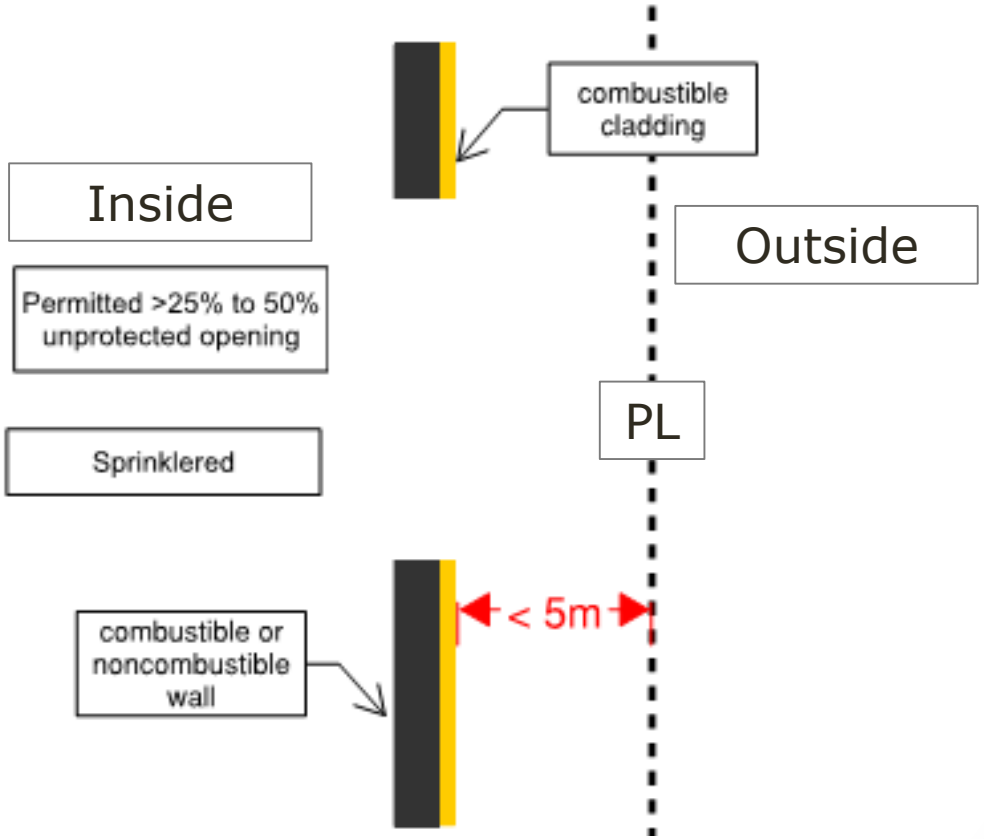
Spatial – Cladding Exemptions

- Article 3.2.3.7 Construction of Exposing Building Face
  - **Sentence 3.2.3.7.(5)**



Spatial – Cladding Exemptions

- Article 3.2.3.7 Construction of Exposing Building Face
  - **Sentence 3.2.3.7.(5):** Where openings is >10% to 25%, combustible cladding permitted if walls comply Article 3.1.5.5
  - **CAN/ULC-S134**
    - < 5m above opening
    - < 35kW/m^2 measured 3.5m above opening

Exemption: Decorative FRT Wood

- Article 3.1.5.21 Decorative Wood Cladding
  - **Sentence 3.1.5.21.(1):** Decorative FRT wood cladding is permitted at 1st storey.
  - **FRT:** ASTM D 2898 and CAN/ULC-S102

Spatial – Foamed Plastic Insulation

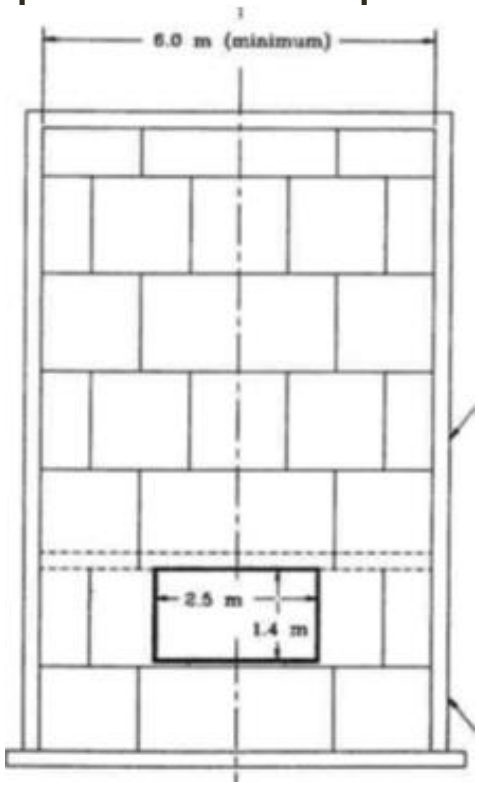
- Article 3.2.3.8 Protection of Exterior Building Face
  - Foamed plastics are permitted if permitted openings >10%, but require protection from exterior:
    - If more than 3 storeys by
    - Concrete or masonry, or
    - Noncombustible material meeting special criteria when tested per CAN/ULC-S101
  - Protection is waived for walls that comply with Article 3.1.5.5

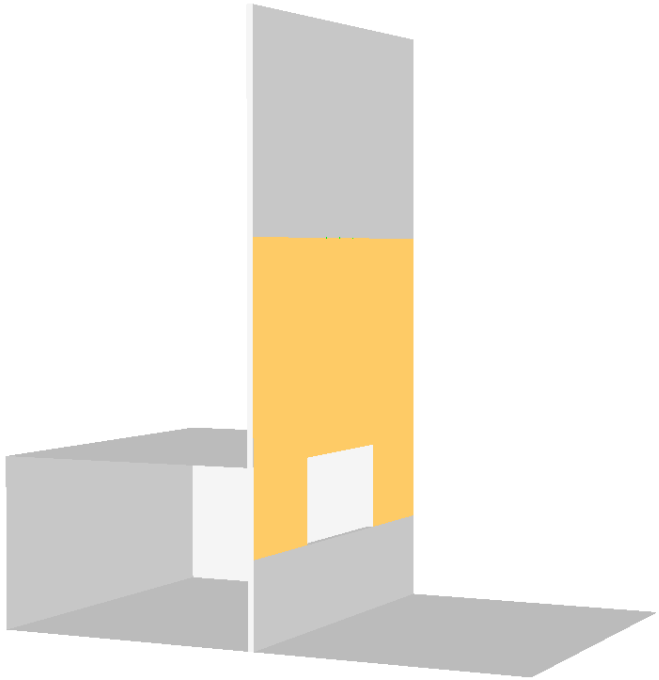
Combustible Cladding

- Article 3.1.5.5 Combustible Cladding Systems
  - **Sentence 3.1.5.5.(1):** Combustible cladding on exterior non-loadbearing wall assembly is permitted provided:
    - Not >3 storeys, or is sprinklered
    - The interior surfaces protected by thermal barrier, and
    - Meets Sentences (3) and (4) when tested per CAN/ULC-S134
  - **Sentence 3.1.5.5.(2):** The permission in Sentence (1) does not apply if spatial separation limits permitted unprotected openings to not more than 10% of the exposing building face

CAN/ULC-S134 Test

- You can do anything as long as the wall passes the test, and permitted unprotected opening is more than 10%





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CAN/ULC-S134 Test

3 storey exterior wall apparatus at NRC

CAN/ULC-S134 Test

Exterior cladding fire test at NRC

Combustible Cladding (Performance Criteria)

- Article 3.1.5.5 Combustible Cladding Systems
  - **Sentence 3.1.5.5.(3)**
    - < 5m above opening
  - **Sentence 3.1.5.5.(4)**
    - < 35kW/m^2 measured 3.5m above opening
  - **Sentence 3.1.5.5.(5)**
    - If FRT, test per ASTM D 2898

CLT With FRT Plywood Sheathing

NRC·CNRC

NRC CNRC

Exterior Walls and CAN/ULC S134 Test

LWF/spray polyurethane		CLT/outboard polystyrene	
gypsum	FRT plywood	gypsum	FRT plywood
			
Passed	Passed	Passed	Failed

Permitted Combustibles

- Article 3.1.5.2 Minor Combustible Components
  - **Sentence 3.1.5.2.(1):** The following minor combustible components are permitted in a NC building:
    - Paint
    - Mastics, caulking materials, foamed plastic air sealants
    - Fire stops and fire blocks
    - Adhesives, vapour barriers and sheathing papers
    - Wood blocking for attachment of fixtures
    - Similar minor components
    - (Province ruled fiberglass clips acceptable)

Permitted Combustibles

- Article 3.1.5.4 Combustible Glazing
  - Limits to Combustible Glazing and Skylights:
    - Installed no higher than 2nd storey (Sentence 3.1.5.4.(2))
    - FSR <75 (Sentence 3.1.5.4.(3))
    - Other limitations if FSR >75 (Sentence 3.1.5.4.(4))

Permitted Combustibles

- Article 3.1.5.4 Combustible Glazing
  - Sentence 3.1.5.4.(5)
  - Limits to combustible window sashes and frames :
    - “Individual unit” separated by noncombustible wall construction from other openings,
    - Windows separated by 1m of noncombustible construction, and
    - The area of openings <40% of the wall.

Permitted Combustibles

- Article 3.1.5.6 Nailing Elements
  - <50mm thick
- Article 3.1.5.7 Millwork
- Article 3.1.5.10 Combustible Interior Finishes
  - <1mm thick
  - <25mm thick and FSR <150
  - No foamed plastics
- Article 3.1.5.11 Gypsum Board

Insulation and Protection

- Article 3.1.5.12 Combustible Insulation and Protection
  - **Sentence 3.1.5.12.(1):** Combustible insulation
  - FSR <25
  - No foamed plastics

Insulation and Protection

- Article 3.1.5.12 Combustible Insulation and Protection
  - **Sentence 3.1.5.12.(2):** Foamed plastics
  - FSR <25
  - Protected by a thermal barrier:
    - Min 12.7mm thick GWB,
    - Lath and plaster,
    - Masonry / concrete, or
    - Any thermal barrier meeting Class B when tested per CAN/ULC-S124

Insulation and Protection

- Article 3.1.5.12 Combustible Insulation and Protection
  - **Sentence 3.1.5.12.(3):** Combustible insulation FSR > 25 to 500
  - Protected by a thermal barrier:
    - Min 12.7mm thick GWB,
    - Lath and plaster,
    - Min 25mm masonry / concrete, or
    - Any thermal barrier tested per CAN/ULC-S101, avg T rise <140C, and max. T rise <180C on its unexposed face within 10min

Insulation and Protection

- Article 3.1.5.12 Combustible Insulation and Protection
  - **Sentence 3.1.5.12.(4):** If Combustible insulation FSR > 25 to 500 + unsprinklered building and >18m high:
  - Protected by a thermal barrier:
    - Min 15.9mm thick Type X GWB,
    - Min 50mm (or 75mm) masonry / concrete, or
    - Any thermal barrier tested per CAN/ULC-S101, avg T rise <140C, and max. T rise <180C on its unexposed face within 20min; remain in place for 40min

Prefab Panels

- Article 3.1.5.12 Combustible Insulation and Protection
  - **Sentence 3.1.5.12.(6):** Thermosetting foamed plastic insulation with FSR <500, factory-assembled exterior wall panel with no air space is permitted provided:
    - Foamed plastic protected on both sides by sheet steel >0.38mm thick that will remain in place for >10min when the wall is tested per CAN/ULC-S101,
    - FSR of the wall panel = FSR permitted for the room it abounds
    - Building does not contain Group B or Group C major occupancy, and
    - Building is not more than 18m high, measured between grade and the floor level of the top storey

Freezer Panels

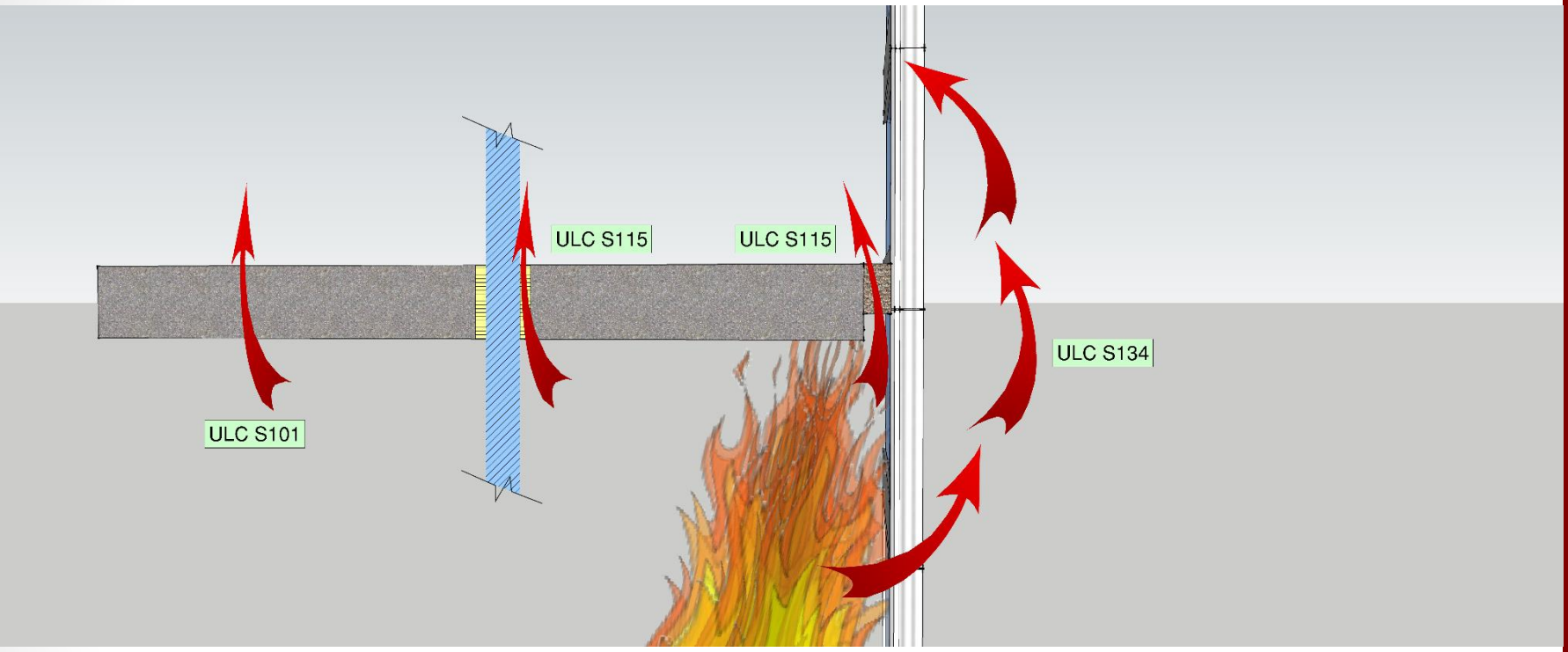
- Article 3.1.5.12 Combustible Insulation and Protection
  - **Sentence 3.1.5.12.(7):** Freezer panels FSR <500 requires special provisions:
    - Building is sprinklered
    - Building is not more than 18m high, measured between grade and the floor level of the top storey
    - Building does not contain Group A, B or C major occupancy

Rating of Exterior Walls

- Article 3.1.7.3 Exposure Conditions for Rating
  - **Sentence 3.1.7.3.(3):** Exterior walls shall be rated for exposure to fire from inside the building
  - Concept is to protect adjacent building from fire within our building; not the other way around

Curtainwall Firestop

Curtainwall Firestopping



Curtain wall Firestopping addressed by Engineering Judgement

Engineering Judgments

Two types

- By listing agency
- By external engineer

apeg.bc.ca

Engineering Judgments

Listing Agency

- Test standards give listing agency authority to make judgements
- Inherent in many listings

Engineering Judgments

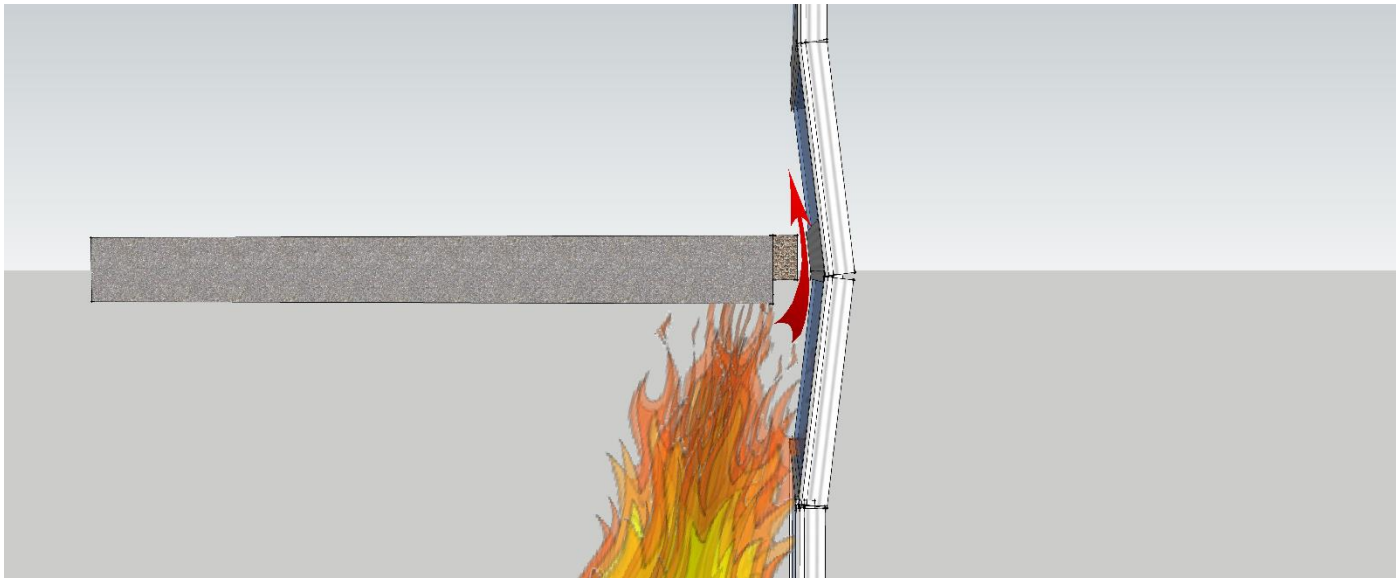
External Engineer

- Must be knowledgeable in:
  - test criteria
  - standard, and
  - material properties

- In BC, engineering judgment must be sealed by BC registered or licensed engineer – APEG Bulletin

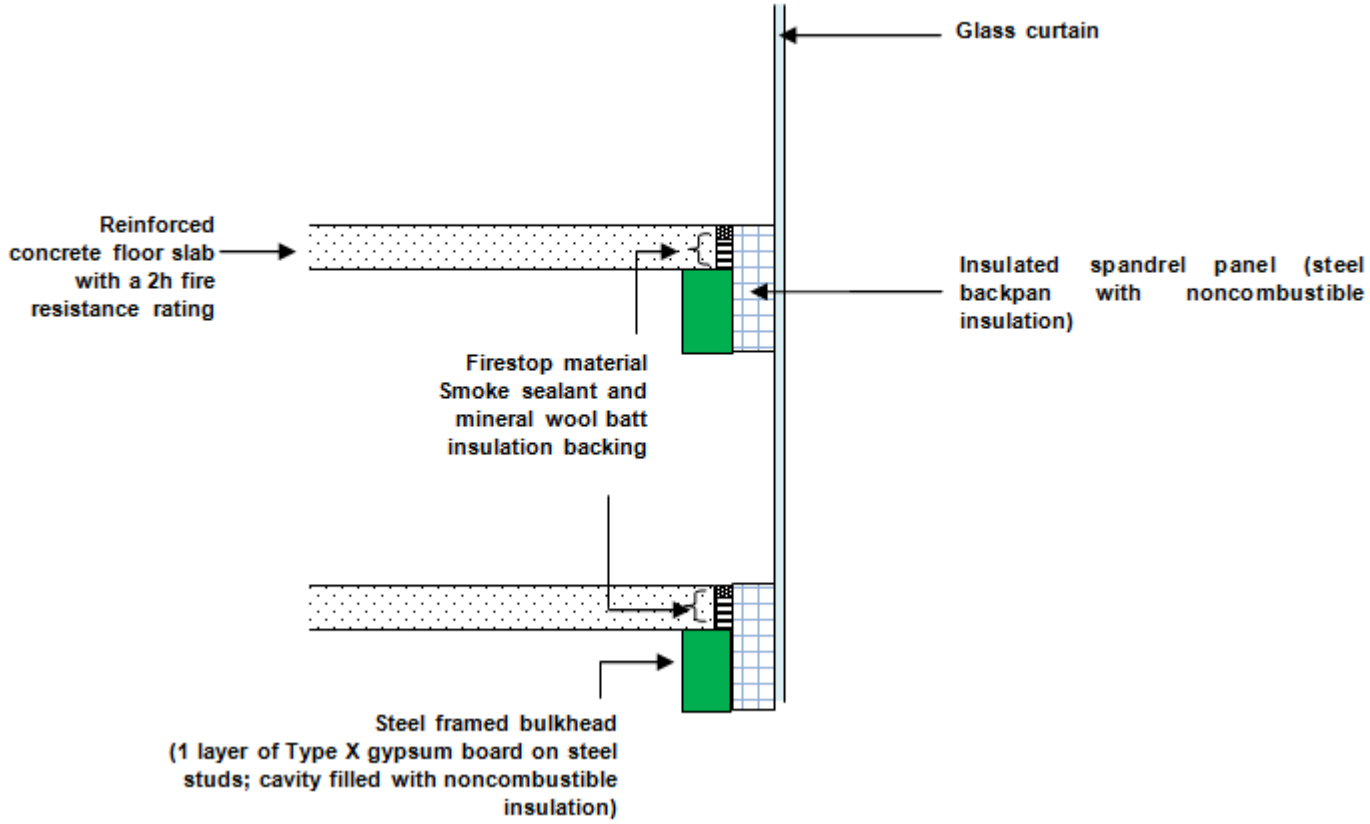
Firestop Systems

- Curtain wall fire stopping
- Aluminum curtain walls
- Expansion in a fire can create a gap between rated floor and unrated curtain wall



Firestop Systems

Curtain wall firestopping example



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Questions?

Thank you

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