Ontario Building Code: High Buildings: Integrating Architectural, Electrical and Mechanical Features

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Why?

• Architect as design coordinator
• Integrated design
  • Managing pros and cons
  • Ease of commissioning
  • Long term operations and maintenance

Outline

• Fire history in high buildings
• What is a high building?
• Code requirements
  • Limiting smoke movement
  • Elevator controls
  • Firefighter access
  • Smoke venting
  • Fire alarm features
  • Emergency power
  • Protection of conductors
  • Commissioning
• The future…
Outline

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25 storey Joelma Building
Sao Paulo, Brazil

• February 1, 1974, 8:50 AM
• Electrical on 12th floor
• 9:30 AM: flames nearly to roof
• Fire fed by large quantity of combustibles
• Building had no emergency exits, fire alarms or sprinkler
• Many escaped to the roof where a helicopter rescue was attempted but heat, smoke and inadequate landing space prevented helicopters from reaching the roof until well after the fire
• 10:30 AM: fire had burned out
• Death toll estimate 180 of 800 people
• Brazilian legislation updated following this fire

First Interstate Tower
Los Angeles, CA

• May 4, 1988
• Destroyed five floors $50 Million
• Injured 40 people
• One death, when the elevator the worker was riding in opened onto the burning 12th floor
• Cause: overloaded electrical circuits
• No sprinkler system installed originally
• Sprinkler system was 90% installed at the time of the fire, but was inoperative, awaiting the installation of water flow alarms.
• Los Angeles Building Codes were changed, requiring all high-rises to be equipped with fire sprinklers.
• This modified a 1974 ordinance that only required new buildings to contain fire sprinkler systems, grandfathering older buildings
One Meridian Plaza, Philadelphia, PA

- 150 m; Built in 1972, demolished 1999
- Fire: February 23, 1991
- Origin: 22nd floor in oil soaked rags
- Firefighting challenges: lack of power in the skyscraper and insufficient water pressure
- 3 firefighters died
- Fear of structural collapse
- Fire control once it reached the 30th floor which was one of the few floors that had sprinklers
- 10 sprinklers controlled the fire until it started burning itself out almost a day after it started
- Destroyed 8 floors and damaged neighboring buildings
- 8 years: vacant and damaged

28 Storey Apartment Building Shanghai, China

- November 15, 2010
- 58 dead, 70 to 120 injured
- Origin: sparks from welding work ignited scaffolding
- Construction practices contributed
- Government passed stricter regulations on the construction industry and increased frequency of fire safety inspections.

Windsor Tower, Madrid, Spain

- 20,000 m²
- One of the first modern towers in Madrid
- Designed in 1974 by a team of six prominent Spanish architects
- Constructed between 1975 and 1979
- Distinctive appearance
- Elemental geometry
- Facade completely covered by reflective glass-like panels that mirrored the sky of Madrid, diminishing its visual impact
- The structure was divided into two halves by a technical floor without windows
Windsor Tower, Madrid, Spain

- Midnight, Saturday, February 12, 2005
- Fire detected on the 21st floor
- Fire spread throughout the entire building
- Leading to the collapse of the outermost, steel parts of the upper floors
- Almost 24 hours to extinguish
- 7 seven firefighters were injured, nobody was killed in the fire
- City of Madrid paid for demolition (22 M Euros)

Forest Lane Apartments
Toronto, ON

- January 1995
- 30 storey, reinforced concrete construction
- Fire started in 6th floor suite
- Smoking materials on sofa
- Occupant attempted to throw the burning cushion out the window
- Opened patio door, but too much smoke, so dropped the cushion
- Left the apartment
- Left the door open
- Fire largely contained within suite of fire origin
- Extensive smoke damage
- Heat damage to exit door across the hall
- Allowed smoke to infiltrate the stairwell
- Fire crews used the other stair to bring hose from floor below
- 6 dead, found near top of stairwells
260 Queen’s Quay, Toronto, ON

Fire History

• High building challenges…
  • People movement
    • Evacuations take longer
    • Occupants have to pass by the fire floor
    • Reliant on stair evacuation
    • Persons with disabilities?
  • Smoke spread
    • Stack effect
    • Smoke movement through shafts
  • Firefighting challenges
    • Access to upper floors
    • Water supply

Fire History

• Code history
  • 1941 NBC:
    • No provisions for high buildings
    • Limited the height of buildings only for certain occupancies (e.g., high hazard occupancies)
  • 1960’s:
    • Increase in the number of high buildings in Canada
    • Extensive research
    • National Research Council of Canada recognized internationally
• 1970 NBC: Subsection 3.2.6., “Additional Requirements for High Buildings”
  • Similar to current approach
    • related to the number of storeys,
    • building occupancy and
    • cumulative occupant load

• 1970 NBC key features:
  • Voice communication system
  • CACF
  • Requirement for elevator door auto closers
  • Venting to aid firefighters by natural ventilation or smoke shaft
  • Sprinklers in specific areas (e.g., basements, restaurants, storeys with Group E occupancies)
  • Emergency power (2 hr) for life safety systems
  • Limits of flame spread and smoke developed classifications

• 1975 OBC: more developed high building requirements
  • Additional Key features included the following:
    • Smoke control for above grade storeys (exemptions for Group C buildings with areas of refuge, sprinklered buildings, etc.)
    • Separation of exit stairs serving above grade and below grade
    • Firefighters elevator
    • Protection of electrical conductors
Fire History

- 1995 NBC:
  - Inherently required all high buildings to be sprinklered
- OBC:
  - Did not require Group C residential high buildings to be sprinklered until 2010 (O.Reg. 205/08)
  - Imposed sprinklers on all Group C more than 3 storeys (one limited exception)

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  - Protection of conductors
  - Commissioning
- The future...

What are High Buildings?
3.2.6. Additional Requirements for High Buildings
3.2.6.1. Application
(1) This Subsection applies to a building,
   (a) of Group A, D, E or F major occupancy
       classification that is more than,
       (i) 36 m high, measured between grade and the floor level of
           the top storey,
What are High Buildings?

- Measuring grade on level surface

- Measuring grade (sloped)

- Determining first storey
What are High Buildings?

- Determining first storey

High building:
If > 18 metres and

\[
\text{Total occupant load above first storey} > 300
\]

1.8 \times \text{total stair width (metres)}
**What are High Buildings?**

1. **Ontario 2008 Building Code**
   - (b) containing a Group B major occupancy in which the floor level of the highest storey of that major occupancy is more than 18 m above grade,
     - Usually only applicable to Group B, Division 1 major occupancy

2. **Ontario 2008 Building Code**
   - (c) containing a floor area or part of a floor area located above the third storey designed or intended as a Group B, Division 2 or 3 occupancy, and
     - Any B2 or B3 occupancy above 3rd floor
     - Note: not specific to “major” occupancy

3. **Ontario 2008 Building Code**
   - (d) containing a Group C major occupancy whose floor level is more than 18 m above grade.
What are High Buildings?

- Common elements?
  - People movement
  - Any of...
    - Longer travel time in tall buildings
    - Slower travel time with large crowds
    - Longer pre-movement time (B occupancies)
    - Slower travel time (B2 and B3 occupancies)
    - Longer pre-movement time (C occupancies)

- Firefighting challenges
  - Access is difficult in tall buildings
  - Dealing with crowds
  - Assisting persons in B occupancies
  - Search and rescue hindered by occupants
  - Water supply limitations in tall buildings
What are High Buildings?

- Common elements?
  - Smoke spread
    - Stack effect in high buildings
    - Greater impact on occupants who are slower to react or take longer to travel

Which are high buildings?

- Stack Effect
  - When the outdoor temperature is lower than the indoor temperature
  - Creates pressure differential: directly proportional to building height and temperature difference

Which are high buildings?

- Air entering the lower floors and exiting from the upper floors
- Building acts as a chimney
- Especially in shafts
- Revolves around neutral plane
What are High Buildings?

- Reverse stack effect
- Summer
- Air entering the higher floors and exiting the lower
- Less significant because of the lower magnitude of the temperature differences

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What are High Buildings?

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What are High Buildings?
What are High Buildings?

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### Code Requirements

- Reading the Code
  - “or” and “and”
  - Most specific provision takes precedence over more general provision
- Exceptions
  - “…Except as required by …”
    - Exception takes precedence for areas covered by exception
  - “…Except as provided in ….”
    - Either general rule or exception can be applied
  - “…Except as permitted by…”
    - Either general rule or exception can be applied

### Code Requirements

- OBC 3.2.6.
- Addresses unique challenges of high buildings
- Linked to objectives for:
  - Occupant safety related to fire spread beyond area of fire origin (OS 1.2)
  - Occupant safety related to movement to safe place in a fire emergency (OS 1.5)
  - Property protection related to fire spread beyond area of fire origin (OP 1.2)

### Outline

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3.2.6.2. Limits to Smoke Movement
(1) A sprinklered building shall be designed in accordance with Sentences (2) to (5) and Supplementary Standard SB-4 to limit the danger to occupants and fire fighters from exposure to smoke in a building fire.

- General statement only
- No prescriptive or performance criteria
- Signpost to refer to Sentences 3.2.6.2.(2) to (5) and SB-4
- Applies only to sprinklered buildings
- Unsprinklered buildings?
  - Refer to 3.2.6.2.(6) for unsprinklered buildings
(6) A building that is not sprinklered shall be designed in accordance with Supplementary Standard SB-4 to limit the danger to occupants and fire fighters from exposure to smoke in a building fire.

- Does not refer to 3.2.6.2.(2) to (5)
- Provisions of 3.2.6.2.(2) to (5) are not suitable for nonsprinklered buildings

Limiting Smoke Movement

- What is SB-4?
  - Supplementary Standard SB-4
  - Part of the Code
  - Caution
    - Based on 1990 Supplement to NBC as well as Appendix to 2005 NBC
    - Watch out for out of date Code cross references
    - Series of examples of how to meet 3.2.6. smoke movement requirements

Limiting Smoke Movement

- Sprinklered buildings:
  - Measure A
  - No height limit
  - Few requirements
  - Represents “Canadian” stairwell pressurization concepts
  - Protection for elevator and vertical service shafts extending below grade
Limiting Smoke Movement

• Other measures for non-sprinklered buildings
• Measures B to M
• May be:
  • Height limits
  • Limits on occupant load
  • Depend on building configuration
    • Vestibules
    • Pressurized corridors
    • Vertically divided buildings
• When do these apply?

Limiting Smoke Movement

• Unsprinklered high buildings?
• Required to be sprinklered?
  • A3, D, and F3 if a high building (from 3.2.2.)
  • A2 (if more than 2 storeys)
  • B (all)
  • C (if more than 3 storeys combustible or 4 storeys noncombustible)
  • E (if more than 3 storeys)
  • F3 (if more than 6 storeys)
• Unsprinklered high building?
• Conclusion
• High building most likely will be sprinklered!
• Benefits:
  • Longer travel distances
  • Reduced fire resistance ratings in some cases
  • Less water supply required
  • Fire likely contained to room of origin
  • Reduced fire and water damage in event of fire
  • Decreased risk of injury or death to occupants or firefighters

Limiting Smoke Movement

• Coordination with M/E
  • Sprinkler in accordance with NFPA 13
• Challenges to sprinkler design:
  • Ceiling configuration
  • Obstructions more than 1200 mm wide
  • Water supply
  • Protection around openings (interconnected floors)

Limiting Smoke Movement

• Coordination with M/E
• Challenges to sprinkler design:
  • Fire alarm interface
  • Sprinkler zoning
  • Fire alarm zoning coordination
• Issues
  • Sprinkler zoning for stairwells and shafts
    • Habit of taking from closest floor area sprinklers
  • Concealed spaces
  • Fire hose cabinet locations
A building referred to in Sentence (1), shall be designed so that, during a period of 2 h after the start of a fire, each exit stair serving storeys below the lowest exit level will not contain more than 1% by volume of contaminated air from the fire floor, assuming an outdoor temperature equal to the January design temperature on a 2.5% basis determined in conformance with Supplementary Standard SB-1.

- Stairwell protection
- Define storeys below lowest exit level
- Lowest exit level

• Each exit stair serving storeys below the lowest exit level ...

Limiting Smoke Movement

Ontario 2006 Building Code
(2) A building referred to in Sentence (1), (sprinklered building) shall be designed so that...
Limiting Smoke Movement

- Sloped Site
- Average grade

Exit Level

Storey below lowest exit level
Limiting Smoke Movement

• National Building Code of Canada
• Definition of grade

Limiting Smoke Movement

(2) …each exit stair serving storeys below the lowest exit level will not contain more than 1% by volume of contaminated air from the fire floor, assuming an outdoor temperature equal to the January design temperature on a 2.5% basis determined in conformance with Supplementary Standard SB-1.

Limiting Smoke Movement

• Performance standard
  • Maximum smoke concentration
  • Establishes criteria
    • 1% by volume
    • January design temperature (2.5% basis) (SB-1)
      – Toronto -18 °C
      – Ottawa -25 °C
      – Thunder Bay -31 °C
      – Windsor -16 °C
• Solution SB-4 (Measure A for sprinklered buildings)
  • Stair shaft does not pass through the floor above the lowest exit level, or
  • If stair shaft continues above, is fire separated from above grade stair

• Vent or door to the outdoors near the top of the stair shaft
• Sized: >0.1 m² per storey opening to the stairwell
  • minus 0.01 m² if weather-stripped,
  • 0.02 m² if non-weather-stripped
Limiting Smoke Movement

- Vent size:
  - 2 storeys at 0.1 m²/storey = 0.2 m²
  - Minus
  - 2 doors at 0.02 m²/door (0.04 m²)
  - 0.2 – 0.04 = 0.16 m²
  - 400 mm by 400 mm

- Solution! SB-4 (Measure A for sprinklered buildings)
  - Stair shaft does not pass through the floor above the lowest exit level, or
  - If stair shaft continues above, is fire separated from above grade stair
  - Vent or door to the outdoors near the top of the stair shaft
  - Sized: >0.1 m² per storey opening to the stairwell
    - minus 0.01 m² if weather-stripped,
    - 0.02 m² if non-weather-stripped
  - and
  - Mechanical pressurization at or near bottom of shaft
  - Rate of 0.47 m³/s per storey served
Limiting Smoke Movement

- Fan size:
  - 0.47 m³/s per storey
  - 2 storeys at 0.47 m³/s = 0.94 m³/s

Limiting Smoke Movement

- Challenges?
  - Interior stairwells
  - Vent to the outdoors
  - Supply air
  - Fan location
  - 6.2.3.10.(1) Duct penetration of fire separations separating exits from the remainder of the building shall be in accordance with Article 3.4.4.4.
  - Integrity of exits: duct not a permitted opening
  - Duct is an extension of the exit
  - Heating of supply air
Limiting Smoke Movement

- Ducts extending from the stairwell to exterior:
  - Protected to same fire rating as stairwell
    - Shaft wall construction
    - Rated ducts
    - Fire wrap products

Limiting Smoke Movement

- Fan location:
  - Inside stairwell
  - Fire separated enclosure
  - Duct, fan location coordination required
(3) Each stairway that serves storeys above the lowest exit level shall have a vent to the outdoors, at or near the bottom of the stair shaft, that,
(a) has an openable area of 0.05 m$^2$ for every door between the stair shaft and a floor area, but not less than 1.8 m$^2$,
(b) opens directly to the outdoors or into a vestibule that has a similar opening to the outdoors, and
(c) has a door or closure that,
(i) is openable manually, and
(ii) can remain in the open position during a fire emergency.
(3) Each stairway that serves storeys above the lowest exit level...
(3) Each stairway that serves storeys above the lowest exit level shall have a vent to the outdoors, at or near the bottom of the stair shaft.

- has an openable area of 0.05 m$^2$ for every door between the stair shaft and a floor area, but not less than 1.8 m$^2$.
- opens directly to the outdoors or into a vestibule that has a similar opening to the outdoors, and
- has a door or closure that,
  - is openable manually, and
  - can remain in the open position during a fire emergency.
Limiting Smoke Movement

- Bottom vent
  - 0.05 m² per door from floor area
  - If 20 storey building
    - 0.05 m² x 20 = 1 m²
  - But not less than 1.8 m²
  - 900 mm by 2000 mm
  - Size of a single door!

- Manually openable
  - i.e. automatic power door opener not required
  - If louver or vent, manual control required
  - Can remain open
    - Mechanical holder/closer

Limiting Smoke Movement

(3) Each stairway that serves storeys above the lowest exit level ...shall have a vent to the outdoors, at or near the bottom of the stair shaft, that,
(a) has an openable area of 0.05 m² for every door between the stair shaft and a floor area, but not less than 1.8 m²;
(b) opens directly to the outdoors or into a vestibule that has a similar opening to the outdoors, and
(c) has a door or closure that,
  (i) is openable manually, and
  (ii) can remain in the open position during a fire emergency.
Limiting Smoke Movement

Vestibule configurations
C versus D

Limiting Smoke Movement

(3) Each stairway that serves storeys above the lowest exit level shall have a vent to the outdoors, at or near the bottom of the stair shaft, that,

(a) has an openable area of 0.05 m² for every door between the stair shaft and a floor area, but not less than 1.8 m²,

(b) opens directly to the outdoors or into a vestibule that has a similar opening to the outdoors, and

(c) has a door or closure that,

(i) is openable manually, and

(ii) can remain in the open position during a fire emergency.
Limiting Smoke Movement

- Challenges
  - Coordination of location of exits to exterior
  - Interior stairwells?
  - Mechanical pressurization for above grade stairwells

Limiting Smoke Movement

(4) Measures shall be taken to limit movement of smoke from a fire in a floor area below the lowest exit storey into upper storeys.
Limiting Smoke Movement

- ...SB-4...
- Measure A provisions for:
  - Elevator shafts
  - Vertical service spaces
  - but,...
    - there are conditions and different requirements

Limiting Smoke Movement

- Elevator shafts passing through the floor above the lowest exit storey...
Limiting Smoke Movement

- Elevator shafts passing through the floor above the lowest exit storey...
- Does not penetrate the floor of the storey immediately below the lowest exit storey
  - Except...
  - where there is a vestibule between the shaft and each floor area below grade
Limiting Smoke Movement

- Elevator shafts passing through the floor above the lowest exit storey...
  - Does not penetrate the floor of the storey immediately below the lowest exit storey
  - Except...
  - where there is a vestibule between the shaft and each floor area below grade
  - Vestibule per Measure D (3)
**Limiting Smoke Movement**

- Vestibule at below grade levels
  - 45 minute fire separation from public corridor to vestibule
  - Fire separation from floor area to vestibule equal to exit if not a public corridor
  - Fire separation from vestibule to elevator equal to stair rating (but difference between NBC and OBC)
  - Doors (other than elevator door) equipped with self-closing device and opens in direction of travel to vestibule.

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**Limiting Smoke Movement**

- Measure A references Measure D, Sentence (3) for vestibule design
- Measure D, Sentence (3) defines fire separation requirements
- Measure D also requires these vestibules to be pressurized...
- However, pressurization is not linked directly to Sentence (3) but rather to Measure D, Sentence (2).
- So, Measure A does not require pressurization of these vestibules

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**Limiting Smoke Movement**

- Vertical service spaces...
Limiting Smoke Movement

- Vertical service spaces...
- ...passing through floor above the lowest exit storey
Limiting Smoke Movement

- Vertical service spaces...
- ...passing through floor above the lowest exit storey
  - Tight-fitting noncombustible seal or firestop at floor level of the storey immediately above that storey

Limiting Smoke Movement

- Vertical service spaces...
- ...passing through floor above the lowest exit storey
  - Tight-fitting noncombustible seal or firestop at floor level of the storey immediately above that storey
  - Except
  - where the vertical service shaft is vented to the outdoors at the top of described in Measure F (10)
Limiting Smoke Movement

- Vertical service spaces...
- ...passing through floor above the lowest exit storey
  - Tight-fitting noncombustible seal or firestop at floor level of the storey immediately above that storey
  - Excerpt
    - where the vertical service shaft is vented to the outdoors at the top of described in Measure F (10)
    - Measure F, Sentence (10) describe
      - Area of vent opening
      - Location
      - Vent opens manually AND on smoke detector at top of shaft AND by manual control at CACF
(5) Except for exhaust fans in kitchens, washrooms and bathrooms in dwelling units, and except for fans used for smoke venting as required by Article 3.2.6.6., air moving fans in a system that serves more than 2 storeys shall be designed and installed so that in the event of a fire these fans can be stopped by means of a manually operated switch at the central alarm and control facility.

• Summary of smoke movement limitations
  • Mechanical pressurization of below-grade stairwells
  • Natural pressurization of above-grade stairwells
  • Protection of elevators that extend both below and above lowest exit storey
  • Protection of vertical service spaces that extend above lowest exit storey
  • And?
  • Sprinklered
3.2.6.3. Connected Buildings
(1) If a building described in Article 3.2.6.1. is connected to any other building, measures shall be taken to limit movement of contaminated air from one building into another during a fire.

• SB-4 for guidance
Questions

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Elevator Controls

3.2.6.4. Emergency Operation of Elevators

(1) Manual emergency recall shall be provided for all elevators serving storeys above the first storey.

- Manual recall only
- Only applicable to elevators serving above-grade storeys
Elevator Controls

- Beware...
- Conflict between OBC and TSSA regulations for elevators
- TSSA
  - Automatic recall for all elevators
  - Alternate floor recall
  - Smoke detectors in each elevator lobby

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3.2.6.4. Emergency Operation of Elevators

(1) Manual emergency recall ...

(2) Key-operated switches for emergency recall described by Sentence (1) shall be provided in a conspicuous location at,
   (a) each elevator lobby on the recall level, and
   (b) the central alarm and control facility required in Article 3.2.6.7.

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(3) In-car emergency service switches shall be provided in all elevator cars.

(4) Keys to operate the switches required by Sentences (2) and (3) shall be,
   (a) provided in a suitably identified box conspicuously located on the outside of an elevator hoistway near the central alarm and control facility required by Article 3.2.6.7., and
   (b) kept at the central alarm and control facility.
(5) In a building that is not sprinklered, automatic emergency recall operation shall be provided for all elevators serving storeys above the first storey.

(6) The automatic emergency recall feature in Sentence (5) shall be actuated by,

(a) smoke detectors installed in each elevator lobby on each storey, or
(b) the building fire alarm system.
Elevator Controls

- Minor challenges...
  - Programming functions of lobby smoke detectors
  - Coordination with elevator controller

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Firefighter Access

3.2.6.5. Elevator for Use by Fire Fighters
(1) At least one elevator shall be provided for use by fire fighters in conformance with Sentences (2) to (6).
(2) The elevator referred to in Sentence (1) shall have a useable platform area not less than 2.2 m$^2$ and shall be capable of carrying a load of 900 kg to the top floor that it serves from a landing on the storey containing the entrance for fire fighter access referred to in Articles 3.2.5.4. and 3.2.5.5. within 1 min.

• Does not need to serve below grade levels

(4) Except as permitted in Sentence (5), an elevator referred to in Sentence (1) shall be capable of providing transportation from the storey containing the entrance for fire fighter access referred to in Articles 3.2.5.4. and 3.2.5.5. to every floor that is above grade in the building and that is normally served by the elevator system.
(5) If it is necessary to change elevators to reach any floor referred to in Sentence (4), the system shall be designed so that not more than one change of elevator is required when travelling to any floor in the building from the storey containing the entrance for fire fighter access referred to in Articles 3.2.5.4. and 3.2.5.5.

(3) Except where Measure K of Supplementary Standard SB-4 is used, each elevator for use by fire fighters shall,…

- Measure K: Vertically divided buildings

  …3 options for protection of fire-fighters elevator

(a) be provided with a closure at each shaft opening so that the interlock mechanism remains mechanically engaged and electrical continuity is maintained in the interlock circuits and associated wiring for a period of not less than 1 h when the assembly is subjected to the standard fire exposure described in CAN4-S104-M, "Fire Tests of Door Assemblies",
(a) be provided with a closure at each shaft opening so that the interlock mechanism remains mechanically engaged and electrical continuity is maintained in the interlock circuits and associated wiring for a period of not less than 1 h when the assembly is subjected to the standard fire exposure described in CAN4-S104-M, "Fire Tests of Door Assemblies".

(b) be protected with a vestibule containing no occupancy and separated from the remainder of the floor area by a fire separation having a fire-resistance rating not less than 45 min, or
(c) be protected with a corridor containing no occupancy and separated from the remainder of the building by a fire separation having a fire-resistance rating not less than 1 h.

- Naturally suited to multi-tenant residential buildings

(6) Electrical conductors for the operation of the elevator referred to in Sentence (1) shall be,
(a) installed in service spaces conforming to Section 3.6. that do not contain other combustible material, or
(b) protected against exposure to fire from the service entrance of the emergency power supply, or the normal service entrance of the normal power supply, to the equipment served, to ensure operation for a period of 1 h when subjected to the standard fire exposure described in CAN/ULC-S101-M, “Fire Endurance Tests of Building Construction and Materials”.
(6) Electrical conductors for the operation of the elevator referred to in Sentence (1) shall be, 
(a) installed in service spaces conforming to Section 3.6. 
that do not contain other combustible material, or 
(b) protected against exposure to fire from the service 
entrance of the emergency power supply, or the normal 
service entrance of the normal power supply, to the 
equipment served, to ensure operation for a period of 1 h 
when subjected to the standard fire exposure described 
in CAN/ULC-S101-M, "Fire Endurance Tests of Building 
Construction and Materials".

• Architectural option versus fire rated conductors  
• Architectural option  
  • Often cheaper  
  • Complex when conductors are not continuously in 
    vertical shaft  
  • Not suited to retrofits and renovations  
• Fire rated conductors  
  • Expensive  
  • Routing not important  
  • Installation by qualified person

Questions
Outline

- Fire history in high buildings
- What is a high building?
- Code requirements
  - Limiting smoke movement
  - Elevator controls
  - Firefighter access
  - Smoke venting
  - Fire alarm features
  - Emergency power
  - Protection of conductors
  - Commissioning
- The future...

Smoke Venting

- Smoke venting
- Smoke management
- Smoke control

Smoke Venting

3.2.6.6. Venting to Aid Fire Fighting
(1) Means of venting each floor area to the outdoors shall be provided by windows, wall panels, smoke shafts or, except as provided by Sentence (5), the building exhaust system.
3.2.6.6. Venting to Aid Fire Fighting

(1) Means of venting each floor area to the outdoors shall be provided by windows, wall panels, smoke shafts or, except as provided by Sentence (5), the building exhaust system.

(2) Fixed glass windows shall not be used for the venting required by Sentence (1) if the breaking of the windows could endanger pedestrians below.
Smoke Venting

- Window venting
  - Uniformly distributed along exterior wall of each storey
  - > 1% of exterior wall area of that storey
  - Readily openable from interior (without wrenches or keys)
  - Readily identifiable from interior and exterior
  - When open, do not endanger persons outside the building

Smoke Venting

(3) Openable windows used for the venting required by Sentence (1) shall be permanently marked so that they are easily identifiable.
Smoke Venting

- Windows do not need to be located in each compartment
- Distribution should be at least one per side

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Smoke Venting

3.2.6.6. Venting to Aid Fire Fighting

(1) Means of venting each floor area to the outdoors shall be provided by windows, wall panels, smoke shafts or, except as provided by Sentence (5), the building exhaust system.

- Same requirements as for windows
Smoke Venting

- Smoke shafts
  - Rarely used
  - Openings from each storey (sized per SB-4)
  - Closures able to be opened remotely
  - Cross sectional area not less than maximum opening size to the shaft
  - Fire separation equal to floor fire rating
  - Opening to outdoors at top
  - Terminate not less than 900 mm above roof
  - No combustible materials, fuel lines or services required in an emergency

Smoke Venting

3.2.6.6. Venting to Aid Fire Fighting
(1) Means of venting each floor area to the outdoors shall be provided by windows, wall panels, smoke shafts or, except as provided by Sentence (5), the building exhaust system.

(5) In a building that is not sprinklered, venting of floor areas required in Sentence (1) shall not be provided by the building exhaust system.
Smoke Venting

- Building air handling system
  - 6 Air changes per hour per floor
  - Not more than one floor at a time
  - Emergency power required for fans

Smoke Venting

- Applicable to all storeys
  - Including below grade storeys
- Venting fan capacity per storey
  - 6 ACH
- Make up air?
  - 6.2.3.11.(1) make up air required when ventilating to outdoors
- Heating?
  - 6.2.3.11.(3) air direct from outdoors in winter to occupied areas to be tempered to maintain indoor air temperature

Smoke Venting

(4) Elevator hoistway shall not be designed for the venting required by Sentence (1).

- If were used for smoke venting...
- …not usable by firefighters or for emergency evacuation of persons with disabilities
Outline

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Fire Alarm Features

3.2.6.7. Central Alarm and Control Facility

- What is a CACF?
- Separate room accessible to firefighters
- Contains all control functions for fire and life safety systems
- Contains indicators for many fire and life safety systems
- Usable as a safe staging area for firefighter response

3.2.6.7. Central Alarm and Control Facility

(1) A central alarm and control facility shall be provided on the storey containing the entrance for firefighter access referred to in Articles 3.2.5.4. and 3.2.5.5. in a location that,

(a) is readily accessible to fire fighters entering the building, and

(b) takes into account the effect of background noise likely to occur under fire emergency conditions, so that the facility can properly perform its required function under such conditions.
3.2.6.7. Central Alarm and Control Facility
(1) A central alarm and control facility shall be provided on the storey containing the entrance for fire fighter access referred to in Articles 3.2.5.4. and 3.2.5.5. in a location that,
(a) is readily accessible to fire fighters entering the building, and
(b) takes into account the effect of background noise likely to occur under fire emergency conditions, so that the facility can properly perform its required function under such conditions.

- What’s not required?
- Fire rating not specified, but…
- Independent air supply not specified, but…
- Size to be coordinated with electrical engineer
- Need room for numerous panels and controls
- Need room for firefighters in bulky gear

(2) The central alarm and control facility required in Sentence (1) shall include,
(a) means to control the voice communication system … so that messages can be sent to,
(i) all loudspeakers simultaneously,
(ii) individual floor areas, and
(iii) exit stairwells,
Fire Alarm Features

(b) means to indicate audibly and visually alert signals and alarm signals and a switch to,
(i) silence the audible portion of these signals, and
(ii) indicate visually that the audible portion has been silenced,
(c) means to indicate visually that elevators are on emergency recall,
(d) an annunciator conforming to Article 3.2.4.8.,

(e) means to transmit alert signals and alarm signals to the fire department ..., 
(f) means to release hold-open devices on doors to vestibules,
(g) means to manually actuate alarm signals in the building selectively to any zone or zones,
(h) means to silence the alarm signals referred to in Clause (g)

(i) means, as appropriate to the Measure for fire safety provided in the building, to,
(i) actuate auxiliary equipment, or
(ii) communicate with a continually staffed control centre,
(j) means to communicate with every elevator car,
(k) means to indicate visually, individual sprinkler system water flow signals,
(l) means to indicate audibly and visually, sprinkler system supervisory signals and trouble signals,
Fire Alarm Features

(m) a switch to silence the audible portion of a supervisory signal or a trouble signal, and
(n) visual indication that the audible portion of a supervisory signal or a trouble signal has been silenced.

- Electromagnetic lock release

Fire Alarm Features

3.2.6.8. Voice Communication System

(1) A voice communication system or systems conforming to Article 3.2.4.22. shall be provided in a building if,
   (a) the floor of the top storey is more than 36 m above grade, or
   (b) a floor area or part of a floor area located above the third storey is designed or intended for use as a Group B, Division 2 or 3 occupancy.
Fire Alarm Features

- Does not apply to high buildings less than 36 metres (unless Group B2 or B3 occupancies)
- Voice communication benefits (based on extensive research):
  - Recognition of fire alarm signal
  - “Information” is key to engaging occupants
  - Less likely to “panic”
  - Can direct information to those in need
  - Trained staff will have cues to initiate their response

Fire Alarm Features

- Design complications
  - Speakers throughout the floor area for audibility
  - Impact of interior finishes and acoustic treatments
  - Capacity to allow for future modifications
  - Intelligibility
    - Mandatory in 2012 OBC
    - Difficult in large open spaces (atriums)

Outline

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    - Protection of conductors
    - Commissioning
- The future...
• Separate provisions for:
  • Lighting
  • Fire alarm
  • Building systems

Emergency Power

3.2.7.4. Emergency Power for Lighting
(1) An emergency power supply shall be,
(a) provided to maintain the emergency lighting required by this Subsection from a power source such as batteries or generators that will continue to supply power in the event that the regular power supply to the building is interrupted, and

(b) so designed and installed that upon failure of the regular power it will assume the electrical load automatically for a period of,
(i) 2 h for a building within the scope of Subsection 3.2.6.,
(ii) 1 h for a building of Group B major occupancy classification that is not within the scope of Subsection 3.2.6., and
(iii) 30 min for a building of any other occupancy.
3.2.7.8. Emergency Power for Fire Alarm Systems

(1) Fire alarm systems, including those incorporating a voice communication system, shall be provided with an emergency power supply conforming to Sentences (2) to (4).

(2) The emergency power supply required by Sentence (1) shall be supplied from,
(a) a generator,
(b) batteries,
(c) a combination of the items described in Clauses (a) and (b).

(3) The emergency power supply required by Sentence (1) shall be capable of providing,
(a) supervisory power for not less than 24 h, and
(b) immediately following, emergency power under full load for not less than,
(i) 2 h for a building within the scope of Subsection 3.2.6.,
(ii) 1 h for a building classified as Group B major occupancy that is not within the scope of Subsection 3.2.6.,
(iii) 5 min for a building not required to be equipped with an annunciator, and
(iv) 30 min for any other building.
3.2.7.9. Emergency Power for Building Services

(1) An emergency power supply capable of operating under a full load for not less than 2 h shall be provided by an emergency generator for,

(a) every elevator serving storeys above the first storey in a building that is more than 36 m high measured between grade and the floor level of the top storey and every elevator for fire fighters in conformance with Sentence (2),

(b) water supply for fire fighting in conformance with Article 3.2.5.7., if the supply is dependent on electrical power supplied to the building, and the building is within the scope of Subsection 3.2.6.,

(c) fans and other electrical equipment that are installed to maintain the air quality specified in Article 3.2.6.2., and

(d) fans required for venting by Article 3.2.6.6.
(2) Except as permitted by Sentence (3), the emergency power supply for elevators required by Clause (1)(a) shall be capable of operating all elevators for fire fighters plus one additional elevator simultaneously.

(3) Sentence (2) does not apply if the time to recall all elevators under emergency power supply is not more than 5 min, each from its most remote storey to,
(a) the storey containing the entrance for fire fighter access referred to in Articles 3.2.5.4 and 3.2.5.5., or
(b) to a transfer lobby.

3.6.2.8. Emergency Power Installations

(1) A generator to supply emergency power for lighting, fire safety and life safety systems shall be located in a room that,
(a) is separated from the remainder of the building by a fire separation with a fire-resistance rating not less than
(i) 2 h for buildings within the scope of Subsection 3.2.6., and
(ii) 1 h for other buildings, and
(b) contains only the generating set and equipment that is related to the emergency power supply system.
Protection of Conductors

3.2.7.10. Protection of Electrical Conductors

(1) Electrical conductors that are used in conjunction with fire alarm systems and with emergency equipment described in Articles 3.2.6.2. to 3.2.6.8. and 3.2.7.3. and Sentences 3.3.3.6.(1) and 3.3.3.7.(4) shall conform to Sentences (2) to (8).

(2) Except as permitted by Sentences (6) to (8), electrical conductors referred to in Sentence (1) shall conform to ULC-S139, “Fire Test for Evaluation of Integrity of Electrical Cables”, including hose stream application, to provide a circuit integrity rating of not less than 1 h.

• 1 hour circuit integrity versus 2 hour functionality on emergency power?
• Conflict?
Protection of Conductors

(6) Electrical conductors located in a service space that contains no other combustible material and is separated from the remainder of the building by a fire separation that has a fire-resistance rating not less than 1 h need not conform to Sentence (2).

Protection of Conductors

- 2 options
  - Fire rated conductors
  - Service spaces
  - Coordination

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- The future...
### 3.2.6.9. Testing

(1) The systems for control of smoke movement and mechanical venting required by Articles 3.2.6.2. and 3.2.6.6. shall be tested to ensure satisfactory operation in accordance with the procedures described in Supplementary Standard SB-4.

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**Commissioning**

- Additional commissioning of life safety and fire protection systems
  - Already required by NBC 2010
  - Will be required by OBC 2012
  - Applicable to all buildings (not just high buildings)
  - Requires performance of proper operation
  - Requires performance of inter-relationship between systems
  - Already good practice, but…
  - No test standard mandated by NBC or OBC

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**Commissioning**

- Standards in development
  - NFPA 3
  - CAN/ULC-S1001
Questions

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The Future

• Trends:
  • No significant changes in 2012 OBC
  • No significant changes in proposed changes to NBC
  • Higher buildings of combustible construction
    • BC Building Code (6 storeys)
    • National and Ontario (proposals for 6 storeys)
    • Special cases – higher than 6 storeys
    • Upper limit?
  • Elevators for unescorted evacuation
A few more points…

- Other Code implications for high buildings
  - Limits on interior finishes/flame spread ratings
  - Cannot use window sprinkler protection glazing on exits in high buildings
  - Accessible floors or “cross-over” floors required
  - Increased requirements for protection of foamed plastic insulation (unsprinklered)
  - Complex integration with interconnected floor space features

A few more points…

- Evacuation of persons with mobility disabilities
  - Sprinkler protection
  - Stay in place
  - Refuge areas
  - Firefighter assisted elevator evacuation
  - Unassisted elevator evacuation
  - Stairwell evacuation

A few more points…

- Change of use (existing buildings)
  - Part 11
  - “shall conform to the requirements of Subsection 3.2.6.”
  - In particular, implications for change of use to Group A, B or C occupancies