ELEVATOR OPERATION DURING FIRE EMERGENCIES IN HIGH BUILDINGS

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ABSTRACT

Since 1973 the National Building Code of Canada has included special requirements to assure the availability and usability of elevators for fire fighting operations in high buildings under emergency conditions. The requirements have been harmonized with the Safety Code for Elevators published by the Canadian Standards Association. To ensure safety for the fire fighter, limits are placed upon smoke contamination of the hoistway, controls are provided to permit the recall of elevators, emergency power is mandated, and other complementary measures are included.

INTRODUCTION

The presence of smoke is a major problem encountered by occupants attempting to evacuate a building in which there is a fire. Smoke particles can obscure visibility in an egress route and make it difficult to recognize familiar landmarks. Carbon monoxide and other gaseous products of combustion can disorient and eventually, through asphyxiation, kill a person exposed directly to smoke.

In a small building it is usually possible for occupants to evacuate before smoke and products of combustion overwhelm them. As buildings increase in area and height a point is reached when it is not reasonable to expect that all occupants can escape from and avoid the effects of smoke.

It is assumed that fire fighters will respond to a call to a building on fire and in addition to their fire fighting operations will provide assistance to occupants during evacuation. It is not reasonable to expect a fire fighter to gain access to upper storeys in a high building by means of stairways. Special attention is given to the protection and operation of elevators to ensure their availability to fire fighters in an emergency.

Special provisions for fire safety in high buildings were first incorporated into the National Building Code of Canada 1970 edition through revisions issued in 1973. The requirements were developed in terms of performance criteria. A companion document "Measures for Fire Safety in High Buildings" was issued to assist designers in complying with the intent of the Code. Succeeding editions of the National Building Code of Canada have revised and improved the requirements.

The National Building Code of Canada identifies a high building by means of several criteria that take into account the use of the building and its height. Special requirements for high buildings apply to buildings of different height depending on the number and mobility of occupants involved. Although not a specified criterion, there is concern for the safety of persons in buildings in which the time to evacuate the occupants exceeds the time during which significant quantities of smoke can migrate from the fire area into stair shafts, elevator hoistways and their machine rooms, service shafts and principal egress routes.

HIGH BUILDING DEFINITION

A high building, under the requirements of the National Building Code of Canada, is one which is identified by a number of interrelated criteria. It includes any building:

- that is more than 36 metres high measured between grade and the floor level of the uppermost storey;
- that is between 18 and 36 metres high measured between grade and the floor level of

the uppermost storey and in which the exit stair system has insufficient capacity to hold all the occupants of the building;

- of residential occupancy that has its uppermost floor level more than 18 metres above grade;
- containing an institutional occupancy whose highest floor level is more than 18 metres above grade;
- in which a health care occupancy is located above the third storey.

The most stringent of the criteria applies to a given building.

LIMITS ON SMOKE CONTAMINATION

The National Building Code of Canada requires that every high building be designed to limit the danger to occupants and fire fighters from exposure to smoke from a building fire.
The tolerable limit on smoke contamination in a space, other than the fire floor, is deemed to be reached when the gaseous products of combustion reaching that space from the fire floor can no longer be diluted by at least 100 times their volume of fresh air. It is assumed that this condition can occur within ten to twenty minutes after the start of a fire. During a fire incident, this limit on contamination must be maintained for a period of two hours in any hoistway containing elevators used for fire fighting and rescue operations. The limit on smoke contamination in these elevator hoistways does not apply in buildings that are sprinklered or that contain residential suites with each suite having direct access to an exterior balcony.

The wide range of designs encountered in the types and uses
of buildings does not allow for one simple solution to the problems created by the movement of smoke through high buildings. Various solutions were developed that satisfy the performance expectations and these are included in Chapter 3 of the Supplement to the National Building Code of Canada 1990.

CENTRAL ALARM AND CONTROL FACILITY

A key element in addressing the needs of occupants and fire fighters in an emergency is the provision of a central alarm and control facility. This facility is usually a room or space located on the main entrance floor in a location that will be readily available to fire fighters and other supervisory personnel responding to an emergency. All building services that are necessary to ensure safety in an emergency are channelled to this facility. These include:

- means to control the voice communication system which is required in buildings more than 36 metres high at the floor level of the top storey and in buildings with an institutional occupancy above the third storey;
- means to indicate visually that elevators are on emergency recall;
- an annunciator to indicate the location of any manual pull station or fire detector that has been actuated;
- means to release hold open devices on doors to vestibules;
- means to actuate and silence alarm signals;
- means to transmit alert signals and alarm signals to the fire department;
- means to actuate auxiliary equipment required by the fire fighters or means to communicate with a continually staffed auxiliary equipment control centre.

The central alarm and control facility is intended to be the command post for operations by the fire department. It provides them with a means to continually monitor the progress of efforts to contain and suppress the fire. In some cases the occupants of the building are expected to remain in areas of the building for a substantial period of time after the start of a fire. The central control facility allows communication with the occupants and reduces the possibility of panic or of individuals making uninformed decisions that could result in injury or death.

VOICE AND OTHER COMMUNICATION FACILITIES

To provide communication during an emergency the National Building Code of Canada requires a voice communication system to be installed in buildings more than 36 metres high and in buildings with an institutional occupancy above the third storey. The voice communication system provides two-way communication between each floor area and the central alarm and control facility. Instruction of the building supervisory personnel in the use of the voice communication system in the building is required by the National Fire Code of Canada.

The Safety Code for Elevators requires means to enable two way conversation between elevator cars and the central alarm and control facility in all high buildings. It stipulates that these means of communication are operable for a period of at least 4 hours in the event that the electrical power supply to the building fails.

For low buildings the Safety Code for Elevators requires the installation of an audio signalling device in each elevator car. It is intended that a signal from this device be sent to a location where there is a person on duty who can respond to the emergency or to an alarm bell outside the building near the main entrance.

These means of communication are intended to permit a person who is trapped in an elevator car to alert persons at other locations that there is a need for action to free them from the elevator car. The two way conversation facilities enable fire fighters to communicate with one another during a fire emergency and optimize the deployment of their forces to control and extinguish a fire and to evacuate persons who require assistance.

PROTECTION AND CONTROL OF ELEVATORS

In a high building elevators are the usual means by which occupants reach an upper floor and by which they move between floors. Elevator hoistways and elevator control wiring exposed to the effects of fire may be rendered inoperable for further service. The National Building Code of Canada requires that an elevator hoistway used by fire fighters have a higher fire-resistance rating than is required for other hoistways and the value is that required for shafts containing exit stairs. Elevator hoistways for fire fighting service are required to be essentially free of smoke contamination for at least two hours after the start of a fire. The electrical conductors for the operation of elevators for fire fighters have to be protected so that service can be maintained for not less than one hour.

To minimize the possibility that persons could be trapped in elevators above the floor on which a fire is located provisions are made for the recall of elevators to the street floor. The return of elevators to a recall level also assists fire fighters by enabling them to verify that there are no persons trapped in the elevators and that the elevators are available for their use. In recognition that in an unsprinklered building there will be little control of fire spread until the fire fighters have moved into position to suppress a fire, the elevators are recalled automatically as a result of actuation of smoke detectors in elevator lobbies or on the actuation of the fire alarm system. To minimize the recall of elevators as a result of false alarms it is permissible to install two smoke detectors in each elevator lobby and design the system so that both smoke detectors have to be actuated in order to recall the elevator cars.

In a sprinklered building it is considered that the sprinklers will control the spread of a fire and thereby minimize the quantity of smoke that can be generated. In view of this concept the recall of elevators can be initiated by a manual key operated switch located in a conspicuous place in each elevator lobby at the recall level or by an alternative switch at the central alarm and control facility. Keys for the operation of these manual switches are required to be placed in a box on the outside of the elevator hoistway with duplicate keys at the central alarm and control facility. It is intended that the fire fighters who respond to the call to the building will supervise the recall of elevators by manual means.

In-car emergency operation switches are required. Although all elevator cars have these operating switches, only those elevators provided for fire fighter use operate in hoistways that are designed to be free of substantial smoke contamination. It is considered that the in-car emergency switches in other elevators provides a backup option that would be available during an emergency that occurs while an elevator for fire fighters is out of service for maintenance. Under these circumstances the fire fighters would be expected to use self-contained breathing apparatus to protect them from the effects of smoke.

To improve the reliability of elevators used by fire fighters these specific elevators are required to be protected from the effects of fire by at least one of three methods:

- by having the hoistway entrance provided with a tested closure or door system at each opening whereby the interlock mechanism will remain functional for not less than 1 hour;
- by protecting the hoistway entrance with an unoccupied vestibule separated from the remainder of the floor area by a fire separation with a minimum fire resistance rating of 45 minutes;
- by protecting the hoistway entrance with an unoccupied corridor separated from the remainder of the floor area by a fire separation with a minimum fire resistance rating of 45 minutes.

It is necessary to ensure that there will be no prolonged delay in reaching the fire floor in a high building as a result of frequent changes of elevator and the need to transfer fire fighting equipment. The National Building Code of Canada requires that, subject to permission to have a single change of elevators in special cases, the elevator for fire fighters is capable of serving every storey in the building above grade.

The National Building Code of Canada requires that the majority of buildings, including every high building, have barrier free accessibility. Many persons with physical disabilities will be unable to evacuate by means of stairs and it is expected that in high buildings they will be evacuated by fire fighters using protected elevators. In any building over 3 storeys high it is required that elevators intended for the evacuation of persons with physical disabilities be protected from smoke contamination in the same manner as the elevator for fire fighters in a high building. To address the need to provide safety for persons with physical disabilities in buildings where elevators are not protected from the infiltration of smoke the National Building Code of Canada requires the incorporation of features in the building design that will provide refuge areas for these persons.

EMERGENCY POWER SUPPLY

It is assumed that primary electrical power will be maintained to the building for as long as possible and that the emergency power system will be required to operate only when the main power has been deliberately disconnected or has failed.

Voice communication systems, fire alarm and detection systems, normal and emergency lighting, water supply for fire fighting, operation of fans required to maintain the air quality and fans required for venting, and the operation of elevators in the building all depend upon the supply of electrical power. Without the continued supply of power the building would be unsafe for occupants and for fire fighters. In the absence of electrical power there would be no practicable means of ensuring water supply for fire fighting, unless the fire department had sufficient equipment to boost water supply and pressure to standpipe systems for the duration of the fire. The National Building Code of Canada requires that there be an emergency source of electrical power for the building to operate the equipment referred to previously. This emergency source is required to supply power under full load for the equipment for a period of not less than 2 hours.

Even when there is no fire situation in a building emergency power for elevators is required so that elevators trapped between floors during power failure can be returned to the street floor or an alternative floor. The emergency power has to be sufficient in quantity to simultaneously operate all elevators for fire fighters plus one additional elevator
but with the flexibility to provide any elevator in the building with power so that it can be moved.

In relatively small buildings with few elevators, the National Building Code of Canada permits the emergency power for elevators to be reduced to a value that can operate just one elevator at a time if all of the elevators in the building can be returned from their most remote location to their transfer lobby or to the street floor in not more than 5 minutes under emergency power.

PROTECTION OF ELECTRICAL CONDUCTORS

Electrical conductors used to supply electricity to the elevators designated for fire fighter use are required to be located in protected service spaces that contain no other combustible materials or to be protected against fire from the supply entrance to the building or the emergency supply location to the elevators for fire fighter use. The minimum time for which the conductors must carry power is 1 hour. Proprietary wires and cables that have been directly exposed to a fire with the time temperature curve used for the testing of structural assemblies and have demonstrated the ability to function throughout the time are also accepted for the power supply to elevators.

VENTING

Provision to vent the building by the fire fighters during and after the fire is a requirement of the National Building Code of Canada. One method of venting that is used is to convert a vertical service space into a smoke shaft by opening it at the top and directing the smoke from the fire floor into the smoke shaft. It is recognized that any top vented shaft can become a smoke shaft and act like a chimney to draw smoke into it. For this reason the National Building Code of Canada stipulates that no elevator shaft in a high

building be designed for venting. This means that machine rooms at the top of an elevator hoistway would have no direct openings to the outside that could be deliberately or accidentally left open. This absence of venting of elevator hoistways will assist the fire fighters in fighting the fire through utilization of elevators for transporting personnel and equipment by reducing the hazard from smoke.

SPRINKLERS

An automatic sprinkler system in a high building assists in limiting the problems associated with the spread of smoke by controlling and suppressing a fire during its early stages. A certain amount of smoke will be generated until the sprinkler system and the fire fighters have extinguished the fire completely. The National Building Code envisages that in a high sprinklered building the smoke from the fire floor will be vented by means of the air handling system. To adequately remove the smoke the system is required to exhaust air and smoke from any floor area to the outdoors at a rate of six air changes per hour and have the fans connected to the emergency power supply. On the premise that the sprinkler system and air handling system will adequately control the spread of smoke, the National Building Code of Canada does not require any further measures to control the spread of smoke into the elevator hoistways.

TESTING

Assurance of the performance of the emergency systems in the building is accomplished by requirements for testing of elevators and smoke control systems and emergency power supply by the National Building Code of Canada and by referenced standards issued by other organizations.

National Fire Code of Canada

The National Fire Code of Canada, a companion document to the National Building Code of Canada, requires that a fire safety plan be prepared for every high building. The plan is prepared by the owner of the building in consultation with the fire department and other applicable regulatory authorities and must include:

- instruction of supervising staff on use of the voice communication system;
- procedures for use of elevators and for evacuation of persons with physical disabilities;
- action to be taken by supervisory staff to initiate smoke control and other emergency procedures in the period before the arrival of the fire department;
- procedures to facilitate fire department access to the building and to the fire location within the building.

Extensive requirements are contained in the National Fire Code of Canada for the inspection, testing, maintenance and testing of emergency power and lighting systems, automatic sprinkler systems, fire alarm and voice communication systems and special fire suppression systems. Similar requirements for the elevator systems are contained in the Safety Code for Elevators. The intent of all these requirements is to ensure that the fire fighter can use the elevators and other emergency equipment in the building with confidence that it will provide the support that is needed to control and extinguish a fire and evacuate all occupants of the building safely.

SUMMARY

Since 1973 the National Building Code of Canada has provided a regulatory framework that is intended to provide the means to reduce the probability of a severe fire in a building and the means for fire fighters to operate in confidence and with safety. Before that time elevators were given little credit in their ability to aid the fire fighter and provide for the evacuation of persons from fire affected areas of the building. The need to protect the fire fighter and improve accessibility to the fire area has been recognized. The need to consider the evacuation of persons with physical disabilities has been a more recent concern that has arisen out of a recognition that barrier free access to buildings is a right for these individuals and once they are in the building there is a responsibility for code writing authorities to consider the need to provide for their evacuation in an emergency.

The writer expects that with the ability to ensure reliability of elevators for use during a fire emergency there will be a trend to accept the use elevators for general evacuation within a building by moving persons above the fire floor to lower

floors where they can remain or move through exit stairs to the exterior. This would require that the majority of elevators would be located in smoke free protected hoistways and that there would be sufficient power to move several elevators simultaneously. This would constitute a major reversal of a long standing policy that all persons should use the exit stairs in an emergency.

REFERENCES

National Building Code of Canada 1990, National Research Council Canada, Ottawa, Ontario, Canada K1A 0R6

National Fire Code of Canada 1990, National Research Council Canada, Ottawa, Ontario, Canada K1A 0R6

Chapter 3, Supplement to the National Building Code of Canada 1990, National Research Council Canada, Ottawa, Ontario, Canada K1A 0R6

CAN3-B44-M1985, Safety Code for Elevators, Escalators, Dumbwaiters, Moving Walks and Freight Platform Lifts, Canadian Standards Association, Rexdale, Ontario, Canada M9W 1R3

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