EVACUATION PROCEDURES FOR OCCUPANTS WITH DISABILITIES IN HIGHRISE BUILDINGS

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ABSTRACT

In the past decade, there has been a great deal of interest in North America in providing equal accessibility to buildings for all people. For example, a large number of residential, office, institutional and mercantile buildings are now accessible, or being retrofitted for accessibility, to people with different disabilities. While accessibility is being promoted, the question of "equal egressibility" is now becoming a subject of concern. Egressibility means that, in case of an emergency, the occupants have the ability to leave a building or to reach an area of safety unharmed. Egressibility does not mean that every occupant should evacuate in the same manner or through the same route; rather, it intends to provide an equal level of life safety for everyone.

Different options to provide life safety for people with disabilities are presented in the literature and various approaches are considered in Canada. Building mangers have to choose between two strategies: protect-in-place and *everybody-out*. Each strategy necessitates careful planning to establish an evacuation procedure that takes into account the building and occupant characteristics.

In assessing the effectiveness of these two strategies and their evacuation procedures for occupants with disabilities, the general opinion is that there is no ideal solution that will resolve ail problems. The present paper discusses the two evacuation strategies and their complementary procedures that can be implemented to provide an acceptable level of life safety to occupants with disabilities in highrise buildings during emergencies.

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INTRODUCTION

The issue of equal accessibility to buildings for occupants with physical disabilities has been resolved over the years, with, for example, the introduction of elevators and access ramps to most buildings (Traynor, 1994). The access of perceptually-impaired people has also been facilitated by new building components such as the use of raised or Braille characters for the blind on elevator buttons, and the introduction of simple wayfinding signs for the hearing-impaired. Too often, however, the problem of "equal egressibility" has not yet been taken into account. In Canada, in 1991, 15.5% of the population had a limitation of some type, and of those, 93.7% lived in standard types of buildings from single-family houses to highrise residential buildings (Statistics Canada, 1992). Among the people with disabilities of working age, more than half of them were working outside their homes, while 97% of disabled school age children were attending regular school. Thus, people with disabilities represent a significant percentage of potential users of multi-level buildings of all type of occupancies.

Providing "equal egressibility" in highrise buildings does not imply that the means of egress will be the same for everyone in all buildings, but that there should be an equal level of life safety for everyone. Furthermore, not all disabled people are the same, and there should not be an attempt to necessarily solve everyone's problems with one ideal solution (NIST, 1995). Occupants with mobility impairments do not have the same needs as occupants with visual impairments, auditory impairments or mental impairments. In looking for solutions, it is important to keep in mind that a solution that is acceptable for one group may impede another. Ideally, the chosen solution should benefit more than one group or at least not impede the safety of any other.

Standards have been set in the UK (Sime, 1987) and in the USA following the Americans with Disabilities Act (Cummings & Jaeger, 1993; BOCA, 1995). In Canada, the 1995 National Building Code and National Fire Code of Canada present the minimal fire safety requirements. All of these documents provide general guidance for designers, builders and fire safety engineers (Pauls, 1988, 1989). Building managers, however, are still hesitant about deciding how to provide acceptable life safety for occupants with disabilities in existing buildings. As the body of literature on the subject of fire safety and people with disabilities increases, managers are looking for plain information that would help them make the best decisions. This paper is an attempt to summarize the major options discussed in the Canadian context.

FIRE SAFETY PLANNING

A starting point in planning fire safety procedures for disabled occupants is to determine what the building provides in terms of fire safety features, as well as the needs and capabilities of the building users. Such information will help identify the areas needing improvement and the problems to be resolved.

The fire safety planning initially involves the definition of an evacuation strategy. The strategy should reflect the management's evacuation philosophy, taking into account fire safety requirements imposed by regulations and by occupants' needs as well as the building's characteristics and the cost-effectiveness of various options. Once the strategy is determined, a procedure can be defined. The procedure will describe the role and responsibilities of staff and occupants. It should include the precise sequence of actions to be taken in case of an emergency. Finally, a plan based on the procedure, is devised. It consists of clear and concise instructions intended for the occupants of the building. Copies of the plan are usually displayed in or near elevators, but should also be provided in employees' manuals or distributed when a person signs a lease.

Evacuation Strategy

Defining the evacuation strategy will involve a decision between two alternatives: ***protect-in-place*** or ***everybudy-out*** (PWC, 1981). The ***prutect-in-place*** strategy implies that some or all occupants will stay in the building during a fire. These occupants will need a fire- and smoke-safe compartment where they can wait until firefighters control the situation or rescue them.

compartments are referred to as areas of refuge, and include enclosed rooms and balconies. The *everybody-out* strategy refers to immediate evacuation of the full building or of the floors where the occupants could be affected by the fire. In this case, those with mobility impairments can either evacuate using safe elevators or be carried down the stairs.

For many highrise buildings, the *everybody-out* strategy which, in its pure definition, implies total evacuation, may not be a feasible alternative. Evacuating all occupants of a highrise building could require considerable time, and could delay the evacuation of those who are in real danger. A better solution is using the *everybody-out* strategy as a sequential evacuation It implies the evacuation of floors by priority, starting with the affected floor and those directly above and below. In many cases, occupants on floors remote from the fire floor may not need to evacuate at all. Occupants on the selected floors to be evacuated can move down to ground level or can go to a safe floor below. This strategy suggests that occupants with disabilities will be moved up or down a number of floors. Implementing a sequential evacuation procedure requires training for all occupants including the disabled occupants and the accompanying persons. A sequential evacuation will necessitate an efficient communication system that will give out precise instructions so that occupants can understand who should evacuate to which destination.

The ***protect-in-place*** strategy means that occupants will stay where they are or move horizontally to an area of refuge during a fire. It implies fire safety features that include: sprinkler and smoke control systems, fire and smoke resistant walls, ceilings and doors, and provision for occupants to communicate with people outside if they need help.

Decisions on the chosen strategy should be made based on the design of the building, the fire safety features, the possible architectural modifications and the costs involved. For all buildings, the strategy will have to be explained to occupants using the evacuation plan and should be assessed through drills. In most highrise buildings, a communication system to inform occupants of the situation and to provide instructions would be needed.

Evacuation Procedure

Once a strategy has been selected, an evacuation procedure should be developed. The procedure is only useful insofar as people are willing and ready to use it. Obtaining disabled occupants' opinions in the early stages of the process will ensure that the procedure is accepted by all occupants. Whatever the strategy being considered, disabled occupants must be comfortable with the planned procedure.

It is essential that the details of the procedure also be discussed with the local fire department to obtain their comments and suggestions, and to assess how their rescue activities relate to the evacuation procedure developed.

The procedure is then described in the evacuation plan. The plan details specific instructions to follow in case of an emergency. The instructions may vary among occupants depending on their characteristics and needs. The evacuation plan should be available to all occupants, presented in manuals and posted in strategic locations.

Occupant Training

For many building users, planning for an emergency is not a high priority. Many occupants are not willing to spend the time necessary to familiarize themselves with complicated procedures. Keeping the procedures clear and simple is the best way to ensure that occupants will know and remember how to react during an emergency. Training is an important factor in improving occupants' knowledge of fire safety procedures. To be effective, three stages of training should be planned. During the first stage, talk-throughs or short seminars are used to describe the procedure to the occupants who can ask for explanations and discuss their specific needs and concerns. The second stage is to proceed with announced drills which put into practice the information received during the talk-throughs. Finally, surprise drills, as a third stage, should be

used to assess the procedure and to improve the occupants' training. This three-step training procedure should be carried out every year in residential and office buildings. Drills are essential because they are the best way to assess the procedure and they offer an opportunity for actively training occupants (Proulx et al, 1995).

Many managers are reluctant to carry out unannounced evacuation drills because they fear occupants will panic. The concern about people panicking during a drill is just as unjustified as the fear of people panicking during a fire (Sime, 1980). Panic has never been shown to have an important influence on the behaviour of occupants during a fire. In fact, panic rarely occurs, even during a very serious blaze (Keating, 1982). The primary concern should be to motivate all occupants to participate in the fire safety education and training programs being provided. Training should not be seen as a burden or a waste of time, but should be seen as essential for a person's own safety and that of others. Drills, announced or unannounced, should never last much more than 10 min, which would be the time available in most buildings for occupants to reach safety during an actual fire.

BUILDING CHARACTERISTICS

The building characteristics include all components that can have an impact on the evacuation of occupants in case of an emergency. The design and architectural properties of the building, such as the size and location of staircases and exits, will affect occupants' evacuation possibilities. Those characteristics should be taken into account when developing the fire safety strategy and procedure. Certain features can be designed specifically for emergency situations. These include areas of refbge, safe elevators, sprinkler protection and smoke control systems. Other features used at all times will also be most valuable during an emergency, such as communication systems and wayfinding signage. All of these features can, in most cases, improve fire safety not only for disabled occupants, but for all building users.

Areas of Refuge

If the evacuation strategy selected is to ***protect-in-place,*** areas will be needed where occupants can wait safely until the situation is controlled or until they are rescued. Areas of refuge, also known as safe areas, staging areas, areas of rescue assistance or areas of evacuation assistance, consist of an accessible space, equipped with fire doors and fire-resisting materials that limit the passage of fire and smoke. They are required by the Americans with Disabilities Act (ADA) in buildings where there are no sprinklers and no accessible exits. The area of refbge should offer the same protection and fire-rating as an exit staircase. Some buildings use staircase landings as their areas of refbge. In these cases, the landing area must be large enough so that the staircase is not obstructed by disabled occupants waiting there, including wheelchair users. Most researchers believe that an area of refuge should be directly connected to an escape route, such as a staircase or elevator. Such areas are called areas of rescue assistance. In situations where firefighters plan to use elevators to evacuate occupants, the elevator lobby can be designed to serve as an area of refbge, protecting occupants while they wait to use the elevators if leaving the floor is necessary. If an area does not open directly onto a stairway or elevator, it should at least be situated close to one so that people seeking refbge are easily accessible to rescuers, should the need arise to evacuate them (Klote et al, 1992).

Other areas of refbge include same-level connections between two buildings, where two separate buildings are linked by a passageway, through which occupants can move to the next building and use its elevators for egress. Another option is the horizontal separation of floors, where floors are divided into two or more sections, with fire and smoke resistant doors between each compartment. In the event of a fire in one of the zones, occupants move to the other zone and wait there until the fire is extinguished or until they are rescued. Power-operated fire doors with a specified fire endurance could be used to protect areas of refbge. Door holders and closers can be wired into the alarm, which would result in the closing of all such doors when the alarm is activated (Gudgel, 1992).

In apartment buildings, balconies are often defined as areas of refuge. The balcony as a refuge area may not be appropriate during Canadian winters since the door to the balcony could be blocked by snow or ice and since people could be forced to wait outside for a long time in very cold temperatures. In many apartments, occupants must move up or down one step to get from their apartment to the balcony, such a step would be difficult to negotiate for wheelchair users (Aikman, 1993).

If it is planned that occupants will move up or down to reach an area of refuge, it will be necessary to develop a specific procedure. As will be discussed later, the occupants with disabilities can be moved to another floor by a "safe elevator" or the procedure may identify buddies that will carry disabled occupants by hand or with an evacuation chair to the floor of the area of refuge.

The safety of a refuge area depends on the details of the design, the type of fire exposure, the outside wind, the temperature conditions and the capability and reliability of the smoke control system. Without pressurization, areas of refbge can become dangerous. There is also serious concerns about using enclosed rooms which do not have two means of escape as areas of refuge.

A crucial aspect of the success of the area of refbge concept is the occupants' willingness to accept and use these areas during a fire. The organizational and human behaviour aspects of the use of areas of refbge are more complex than those of the traditional total evacuation. The acceptance of areas of refbge by occupants, as a safe place to wait during an emergency, is also dependent on design details. For example, two-way communication should be provided in each area of refuge to allow occupants to signal their presence to rescue officers and to obtain information on the situation. Windows looking to the outside and inside of the building could prove to be a source of reassurance for occupants having to stay in refbge areas for a prolonged period of time. Also chairs should be installed in areas of refbge since potential users may not be in a wheelchairs but may not be able to stand up for a long time, such as people suffering from heart problems or rheumatism (Shields, **1993).**

When using refuge areas, coordination of the evacuation procedure with the fire department and other rescuers is essential, as the people in the area of refbge may need to be evacuated. Depending on their size and location, the areas of refuge can be used either only for disabled occupants, or for all occupants. For example, a staircase landing cannot hold more than a few occupants, while a horizontal separation may allow all occupants to remain in the building to wait for further instructions. From an owner's point of view, areas of refbge should not represent non-leasable space. Owners can therefore use existing areas, such as elevator lobbies needed in everyday operations but modified to serve this purpose in an emergency.

Safe Elevators

In the context of the ***everybody-out*** strategy, safe elevators would be very useful *to* bring occupants with disabilities down to the ground level or to a floor with an area of refuge. The term 'safe elevator' refers to an elevator that can be safely used by occupants during a fire. The technology to ensure that elevators are safe to use in a fire is available, but it still must be accepted by the codes before building owners will be willing to install them in their facilities. Safe elevators should be protected fiom fire, heat, smoke, water damage and power loss. Fire-resistant doors are needed; pressurization against piston and stack effect throughout the shaft is essential to control the smoke; dual power systems must be installed for reliability; and components that can function in a wet environment are also needed (Klote & Fowell, **1993).** Finally, each floor should have an enclosed elevator lobby, similar to an area of refuge, where occupants can wait for the elevator.

The organizational aspects of using safe elevators can be quite complex. First it must be determined if the use of the elevators during a fire will be restricted to disabled occupants only or available to all occupants. The limited capacity of the elevators will require the careful management **of** people, and some prioritizing will be essential, such as evacuating only specific floors unless the situation is threatening to all.

In many buildings, safe elevators for firefighters are available but, currently, their use is limited to the rescue team during a fire. Fire safety procedures can be changed to accommodate disabled occupants, but it might be problematic if firefighters need the elevators to deal with fire suppression, while occupants are waiting to evacuate using the same elevators. If the elevator lobby can serve as an area of refbge, the disabled occupants can safely wait until the elevator is free, or until the firefighters choose the best time to evacuate them. The evacuation procedures should indicate clearly whether the occupants, the firefighters or the building managers, have priority and who has the responsibility for operating the elevators. Regardless of who is in charge of managing and directing the elevators, disabled occupants should be able to contact a person in charge, or directly contact the elevator operator to identify themselves and communicate their status and location (Pauls et al, 1991).

Finally, the signs installed should always provide clear and correct information about elevator use during a fire. For example, if safe elevators are provided, old signs indicating that occupants should not use elevators during fires should be replaced by signs indicating that these elevators can be safely used during an emergency and how and by whom they can be used. The use of elevators during a fire emergency will necessitate a complete re-education of occupants. Through the years, people have learned that, in case of fire, they should not use the elevators. Reversing these instructions implies that people must be re-educated and must understand where and when elevators can be safely used in fires.

Fire Protection Systems

It has been said that "the operation of a properly designed sprinkler system eliminates the life threat to all occupants" (Klote et al, 1992). This might be true theoretically, but sprinklers are not a perfect solution, for instance, they may not be triggered during a smouldering or a shielded fire.

Similarly, other fire protection systems such as fire separations and smoke control systems may not work under certain circumstances. **A** properly designed and maintained fire protection system, however, will minimize the development of a fire, the spread of fire and smoke to other parts of the buildings and will allow time for occupants with disabilities to move to an area of safety. In large buildings, the cost of installing fire protection systems and of providing refuge areas could be cost-effective if the building is allowed to be built higher or to have larger floor areas than normally permitted, thus providing additional use of space.

Communications

The evacuation plan provided to occupants should specify the type of alarm that is used during a fire emergency, whether it will be a slow-whoop, a continuous bell, or the new Temporal **3** signal. Until all buildings upgrade their alarm sounders to the Temporal **3** standard, it is essential to specify in the emergency plan which fire alarm sound is used in the building, to help occupants recognize the fire alarm. If information will come through a **P.A.** system, it should also be mentioned in the plan.

It has been said that, during an emergency, what occupants need most is useful information. It **is** important to provide occupants with information on the fact that there is a fire, where the fire is located, and what is the best course of action (Proulx & Sime, 1991). For example, the location of the fire could influence the choice of egress route, and a P.A. system could be an effective way of keeping occupants informed about the unfolding situation. Occupants with disabilities would be most in need of information since they might have to wait to be rescued or they might have to follow different evacuation instructions than other occupants.

As well, communication among occupants or between the occupants and the rescue team during an evacuation should not be overlooked. Occupants with disabilities have distinct needs in terms of communication, which vary from one person to the other, depending on the nature of their

limitations and on the fire safety procedure intended for them. Communication needs should be determined on a case-by-case basis.

Throughout an evacuation, the alarm can seriously inhibit communication if the sound level is very high. It is suggested that alarm sounders be installed in living and working areas rather than in circulation areas such as corridors or staircases, where the sound of the alarm may prevent essential communication between occupants during an emergency. It is also important to interrupt the alarm while messages are given though the **P.A.** system to ensure their audibility. When firefighters arrive at a building, they sometimes turn off the alarm, even if the situation is not entirely under control. This procedure can lead occupants to believe that the emergency is over and they may decide to return to their initial locations. **A** continuing signal would keep occupants aware that the situation is still under investigation and that they should remain in a safe location. The sound level of the alarm should not be too loud in order to allow communication between occupants. Disabled occupants unfamiliar with evacuation procedures are very likely to need more information than most occupants; a loud alarm may increase their anxiety over a long period of time, while preventing them fiom communicating with each other.

Wayfinding Signage

Pictograms, signs and building plans are available in most buildings to help occupants find their way around the building during every use of the premises. These wayfinding signs should incorporate information on location of refbge areas and safe elevators. **A** building with efficient wayfinding signage will be most valuable during an emergency to help occupants find their way to safety. If the space is complex and occupants are not familiar with the evacuation route, signs will be relied upon to reach safety. The wayfinding signage should be straightforward to help in the occupants' decision-making process during an emergency (Arthur & Passini, 1992).

Identification signs are needed for refbge areas. There is not yet a convention on a standard sign to indicate an area of refbge. **A** standardized sign would increase the familiarity and the acceptance of the concept. The same point can be raised for the safe elevator; a standard sign should be developed to identify the specific elevators that can be used during a fire emergency.

COMPLEMENTARY PROCEDURES

Three systems can be implemented to complement and support the evacuation procedure. The first one, a fire warden system, can benefit all occupants. The other two, a list of occupants in need of assistance and a buddy system, can be especially useful for disabled occupants. The effective implementation of these systems constitute key elements in ensuring the success of the evacuation procedure.

Fire Wardens

Many office buildings have a system of fire wardens. Generally, one employee, working in each section of the building on every floor, is designated as a fire warden. Fire wardens should receive training and thus be well aware of the evacuation procedure. They are also expected to inform new occupants of the evacuation procedure and to make sure that everyone reaches an area of safety during an emergency. This kind of system seems to work well because it ensures that one person will take a leadership role during an emergency. It may create problems if the person chosen as the fire warden is not a person with a position of authority in everyday operations since, during an emergency, others might not be willing to listen to the instructions provided by a warden who is usually in a subordinate position. Also, the warden should not be a person who frequently has to work outside the premises, because that person may well be absent during an emergency. Alternate wardens have to be identified to replace fire wardens who may be away for holidays, sick leaves or other reasons.

It is more complicated to implement a fire warden system in apartment buildings. In an apartment building, it is not reasonable to expect a resident to ensure that everyone has evacuated a section of the building; this person would need to have access to all the private

apartments under his or her responsibility to make sure that all occupants leave. The person chosen must be willing to take on the duty, should be physically able to help or to find help, and should not be someone who is often away fiom the building. It is felt, however, that the role of fire warden could be modified to accommodate the needs of apartment buildings. The responsibilities could be limited to providing fire safety information to other occupants, to knock on all doors in the event of a fire, to be aware of the occupants who may need assistance and to report the location of occupants in need of assistance to the firefighters or rescue officers. Since the fire warden cannot be expected to be in his or her apartment at all times, there is no assurance that the warden will be there to help during a fire. Identifying more than one fire warden could resolve that problem, increasing the chances that at least one of them would be present during an emergency.

List of Occupants in Need of Assistance

Many highrise buildings have what is sometimes called a "fire list", which contains an up-to-date account of disabled people, a description of their limitations and their respective locations in the building. The list system, if kept up-to-date, is useful in quickly identifying the people needing assistance, and can be consulted by rescue officers when they arrive on the scene. It should be stored where it can easily be accessed by arriving firefighters.

The fire list, unfortunately, is not always a complete listing of all the occupants with disabilities. Some occupants may refuse to be on the list or may not come forward and ask to be listed. Others may have a disability that they refuse to acknowledge or which they feel does not impact their capacity to react during an emergency. Furthermore, visitors with disabilities would not be on the list.

The main problem with fire lists is that often they are not kept updated. If the list is not accurate, firefighters may waste valuable time attempting to rescue occupants that have moved out of the building. For a fire list to be a useful tool, someone has to be given the responsibility for updating it every **3** to ***6*** months, ensuring that the latest version is available to firefighters and rescuers. Usually the list is placed in the fire alarm control panel, which is one of the first locations firefighters will investigate upon arrival.

Buddy System

Many office buildings, where disabled occupants are present, have implemented the buddy system. Each person with a limitation is paired with one or more people with no limitations. It is suggested that a person with a visibility or hearing impairment be assigned one buddy, and that a person with a mobility impairment be assigned two buddies. This system cannot be used if the person with a limitation does not want to be identified as such or does not want to receive special treatment.

The buddies should be selected carefully. The buddy and the person with the disability have to be able to quickly make contact with each other in case of an emergency. If a buddy is untrained or inappropriate (e.g., not strong enough if the person must be carried), the system becomes ineffective. If the buddy appears untrained, it is unlikely that he or she will inspire the confidence necessary to motivate the disabled person to evacuate. In most cases, the disabled person should be able to determine if help is really needed and, if ***so,*** what form of help is required. It is sometimes planned that the buddies will carry the disabled person a few floors up or down, either by hand or with an evacuation chair. Such a procedure will necessitate considerable training from all parties to be safely executed during an emergency.

The buddy is expected to remain with the person throughout the evacuation. If moving to another floor is necessary, some suggest that the buddy and the person with the limitation should wait until others have evacuated and the stairwells are free. This should depend on the person's type of disability and the evacuation technique used. For example, a deaf person can easily evacuate with the occupants' flow, at the same speed as other occupants, while carrying a person in a wheelchair down the stairs could block the entire staircase and, therefore, should be

performed after most occupants have evacuated. Whatever the procedure agreed upon, it should be practiced ahead of time so that both the buddy and the person with the disability are familiar and comfortable with this procedure.

The buddy system could also be implemented in apartment buildings, but is not as convenient when neighbours do not know each other very well. Some people with disabilities could feel that having a stranger designated to help them and having to practice the procedure goes against their need for privacy. It should be reassuring, however, for the person with the disability to have someone who knows how to help in case of an emergency. The buddy system should not be seen as a burden by either party if the buddies are carefully paired off A person who is constantly away from the apartment or office building would not be a good choice for a buddy.

Assigning a buddy ensures that a least one person is willing to take the responsibility for helping the disabled person. If no one is designated as a buddy, there is a risk that all occupants will assume that someone else is going to help the disabled person and, meanwhile, this person could be left without help. The buddy system is especially useful for disabled occupants living alone.

CONCLUSIONS

The risk of fire cannot be completely removed fiom modem buildings. Many alternatives, however, are available at reasonable cost to ensure an acceptable risk-to-life for all occupants, including occupants with disabilities. The first step should be to decide on an evacuation strategy in relation to the building characteristics: either all occupants exit the building, or safe areas are designed so that some or all occupants can find refuge during an emergency. Once the strategy is selected, a procedure must be established, clearly defining evacuation actions to be performed by all occupants. The life safety measures implemented in buildings involve all occupants, whether disabled or not. At one point, anyone may be affected by an impairment, or be called upon to assist someone who is disabled, so it is imperative that everyone be aware of the procedure. To convey the information to the occupants, the emergency plan should be posted in the building and distributed to occupants. Regular training and practice for all occupants is an essential part of any successful fire safety procedure.

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