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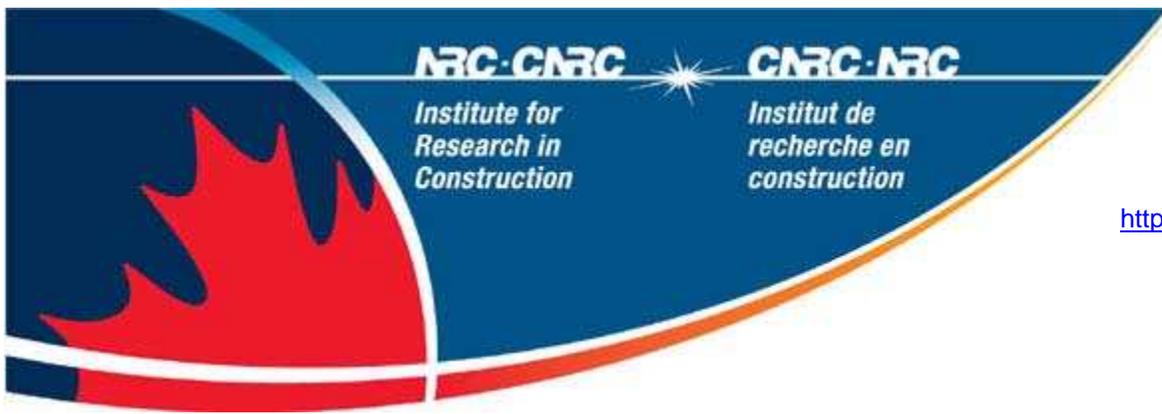
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## High-rise office egress: the human factors

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## **High-rise Office Egress: The Human Factors**

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The behaviour of high-rise office building occupants faced with an emergency can be studied through evacuation drills and the interview of evacuees following an incident. The response of occupants is divided in sequences, which relates to the chronology of the unfolding event. In the initial moment, an absence of response due to ignorance or disbelief is often observed. This period is characterized by ambiguous cues being perceived in the environment. This could be the smell of burning, the sight of smoke, flickering of lights or a tremor in the building that essentially may not initiate any response in the first few moments. If occupants are committed to a specific activity they might very well complete this task before turning their attention to an unusual ongoing event. Forget about panic, it happens too rarely even in the most severe incidents to really consider it as a likely response. In fact, the initial moments of an emergency are often characterized by inertia or a perplexed slow response of the building occupants.

As these initial cues persist and accumulate with additional cues, occupants are likely to start investigating these ambiguous cues. This investigation response can take several forms; some will try to find the source of the problem by moving around the floor, visiting rooms, opening doors; others will call the superintendent or a person responsible for the building to try to obtain information. This attempt at obtaining more information is necessary in order for the occupants to appraise the situation and make a decision on the best course of action. If the information is not readily available they will look for it. As part of this sequence, occupants will engage into the milling process. They will start talking and milling with others around in an effort to get a better understanding of the situation at hand by discussing what is happening with others. This period of time from the initial

perception of an unusual cue until the person makes the decision to start an evacuation is called “pre-movement” time. This pre-movement time may involve considerable movement that is not yet related to evacuation movement.

Depending on the information and cues available, this pre-movement time can last for short or extended times [1].

Part of the pre-movement time also involves actions such as fighting the fire. Although it is fairly rare that occupants will attempt to fight the fire in an office building, it is possible that some individuals will perceive their role as requiring that they try to fight the fire. Such an action takes time. Some occupants will be inclined to warn others of the emergency. The affiliation concept may come into play, as occupants will tend to gather with family members, if there are any in the building, or close friends to evacuate together. It has also been observed, in major emergencies, that occupants will contact family members by phone or e-mail to let them know that they are “all right” and are starting their evacuation. These types of actions as well as retrieving belongings, personal and work-related, are all part of getting prepared to leave and are part of the pre-movement time.

The pre-movement time has been assessed during evacuation drills and through interviews with high-rise office fire victims. During drills, occupants tended to invest 35 seconds to 1 minute in pre-movement time [2,3]. In real emergency evacuations, a wide variety of times have been reported: from 5 minutes to over 25 minutes [4, 5, 6]. Certainly pre-movement time is a critical time to consider and better means to reduce this time need to be devised. For instance, training prior to the event and information delivered to occupants during the event can contribute to shorten pre-movement time. Debriefing after an event can also contribute to shorten subsequent pre-movement time.

Once occupants have made the decision that an evacuation is necessary, they will have to select an egress route. Familiarity with the building will kick in, as people will tend to move in a familiar direction rather than experiment with new routes during an emergency. Training and the presence of floor fire wardens may help the decision on the selection of the closest route to egress. What others are doing and their direction of movement will also influence where individuals will head to.

Behaviour inside the stairwells is unlike what many may imagine; in a high-rise office building there will be no running or pandemonium. The movement is likely to be slow and hot if the building is fully occupied. Demonstration of altruistic behaviours are prevalent with people helping the injured and the disabled and encouraging highly-aroused others with small talk and soothing phrases such as “we will make it”, “we are almost there”, etc. The speed of movement will be relatively slow in the stairs as people are trying to enter into the stairwell from different floors. Usually evacuees already on the stairs will tend to feel a priority and will allow only one or a few persons at a time to enter into the crowded stairwell. Recent evacuation studies have demonstrated that occupants will not squeeze over  $2.3 \text{ p/m}^2$  (persons per square meter) and even this density for only a limited time [7]: at such density, the speed of movement is considerably reduced. If a slow person enters the stairwell, it is likely to have a major impact on the movement speeds of the evacuees behind. Counterflow can also create a slowdown of movement. Absence of lighting, signage or the presence of smoke, water or debris will also have an impact on the evacuees’ speed of movement.

There are a few specific factors that have a major impact on the evacuation movement down the stairs; stairwell size, crowd density, simultaneous evacuation of several floors, merging of evacuees, talking to others, use of cellphones and blackberries, evacuees out of shape or overweight and inappropriate footwear. Among the means to improve evacuation movement in

stairwells the appropriate stairwell width for the occupancy is essential and possibly additional stairwells for the lower floors. Allowing the use of elevators for egress is also a must to ensure the safe evacuation of all occupants. Smoke control, a wayguidance system and lighting will also improve movement in stairwells. Occupants can be educated and trained to be more efficient in the stairwell regarding merging, footwear, slow evacuees and the use of communication devices.

There are some tools available to predict evacuation time from high-rise office buildings. Usually these tools are fairly good at predicting evacuation time for a fire drill. They are much less efficient, however, at predicting the evacuation time for different emergency scenarios. Most of these models are too simplistic when considering the pre-movement time, which is a crucial input. Further, some of these models need to review their movement equations in light of the current demographics and the new anthropometrics of the North American population. They should also consider more closely the reality of human interactions regarding merging in stairwells and crowding.

Overall, people in a fire are rational and are making decisions based on the information available at the time of the event. They will attempt to make the best decision to preserve themselves and loved ones. Evacuees are often helpful, courageous and cooperative. They will follow instructions for a person in authority, if it matches their own judgment of the situation. High-rise building occupants are not emergency experts, they lack experience with such events; this is why education and training are so important. During an emergency most people are relatively cool and composed; the trauma comes after the event when the person has re-assessed all that could have gone wrong and all they could have done differently.

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