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SOME CONTROL AND COMMUNICATION CONSIDERATIONS IN DESIGNING AN EMERGENCY ELEVATOR EVACUATION SYSTEM

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ABSTRACT

The possible use of elevators in tall buildings for evacuation of building occupants in fire emergencies is likely to require a greater level of control of the evacuation by the fire emergency team. If only occupants with disabilities were permitted to use the elevators, the potential problems would be less and the evacuation procedures would be simpler. Items related to human behavior that should be addressed include: giving elevator users as large a feeling of control as feasible; providing communication links between the control center and the occupants, especially those in elevators and elevator lobbies; and, organizing and controlling evacuations, including phased evacuations.

INTRODUCTION

Klote et al. (1992) studied the problems in designing and operating elevators that can be used to evacuate building occupants during fire emergencies. They concluded that "Elevator evacuation is feasible..." This paper discusses some of the control and communication systems that need to be addressed before designing an emergency elevator evacuation system (EEES)

The EEES considered in this paper would be designed to protect the elevator lobbies and shafts from the products of combustion from fires not in the elevator lobbies, elevator shafts or associated machine rooms. That is, fires outside the area used for elevator evacuation should not endanger occupants while they are using the elevators for evacuation. (Obviously, fires in an elevator shaft or lobby would preclude using any affected elevators.) Therefore, when the fire safety features of the building are operating as anticipated, the elevator should not go into "Phase I Emergency Recall Operation" or "Phase II Emergency In-Car Operation." The building could be evacuated using the normal elevator controls.

It should be noted that some minor amounts of smoke might enter the elevator lobby without endangering those using the elevator. The smoke/ heat detection system that activates Phase I should not respond to minor amounts of smoke in the EEES.

FEELING OF CONTROL

An EEES is based on the use of elevators which are mechanical systems that could fail or malfunction for a variety of reasons. When building occupants use stairs to evacuate a building, they have more of a feeling of personal control than when they use elevators. We believe this statement is true despite the fact that the stairway could have severe congestion or severe smoke conditions.

When use of the elevators is restricted to those with relevant disabilities, we would not recommend a major redesign of the controls inside the elevator to give building occupants additional control over the elevators in a fire emergency. However, there may be a few special control features that could be added to give the elevator users a feeling of additional control. For example, when firefighters operate the elevator in Phase II, continuous pressure must be applied to a button to open the elevator door. In Phase II operations this feature might provide an increase in safety to elevator users. After a fire has been detected but prior to initiation of Phases I and II, this feature could be operational when the elevator is responding to instructions from occupants inside the elevator cab.

It would provide elevator users an added sense of control that might encourage elevator use during a fire emergency even though we would not anticipate any effect on safety. It should not be operational when discharging elevator users at the floor of building egress or when responding to the calls from elevator lobbies.

COMMAND CENTER

Large buildings often have a command center or control room that is a focal point for directing an emergency evacuation. The elevator evacuation can be completed without involvement of the command center if the use of elevators is successfully restricted to those with disabilities, if there are few occupants with mobility limitations in relation to the elevator capacity, and if the egress path from the elevator to the exit is safe to use. However, there would still a need for a communication system that permits communication between those using the EEES and the command center. A system based on the building's telephone system with a hardened wiring system should be adequate.

Emergency phones are generally required in elevators. (Emergency phones often lack handsets, using speakers and microphones to allow handsfree operation, to permit communications with more than one person in the elevator, and to discourage pilferage.) If the use of elevators is part of the fire emergency plan, emergency phones are also needed in the protected elevator lobbies, since occupants may become stuck in the lobbies without access to the elevators cars. A direct dialing feature for these emergency phones will help ensure that persons in elevators and elevator lobbies can easily summon assistance. These emergency phones should directly dial a remote location that is always manned, such as the command center.

In a tall building with a high occupant load per stairway the need for control of the evacuation to avoid excessive congestion is the same whether or not elevators are used to evacuate occupants. However, the tolerance of stair users for delays will be much greater than the tolerance of elevator users–unexplained elevator delays will lead to concern that the EEES is not functioning properly and may not be providing the promised safety.

Persons in the command center who are responsible for managing the evacuation are labelled "coordinators," regardless of whether they are fire fighters or building employees.

While varying degrees of automation are possible, we will examine only two feasible anchor-points along the continuum: evacuations that are coordinated entirely by coordinators; and evacuations that are directed by a computer program with oversight by coordinators. In both cases three sources of input used together would provide much of the information used in routing of elevators to floors: (1) the alarm system identifies the fire floor or zone, (2) the call buttons that occupants customarily use to request elevator service identify which floors have building occupants still waiting to be evacuated; and (3) floor monitors could report to the command center (e.g., how many people are waiting in particular elevator lobbies). Television or security cameras in each elevator lobby would be a valuable additional source of information.

Manual control. The first approach is to have coordinators in the command center direct elevators to where they are most immediately needed and to alert stairway monitors when their floor should be evacuated. (As stated above, if evacuation by elevator is restricted to only a few occupants with disabilities, there may be no need for central control of elevators.) Operators would be stationed in the elevators. The coordinators would communicate with and direct these operators. The coordinators should use a decision protocol or evacuation model when prioritizing floors.

Automated control with human oversight. The second approach is to use a computer program to set priorities and determine which floors should evacuate using the elevators, which into the stairwells, and which should wait their turn to evacuate. The computer would send elevators to the appropriate floor. We also assume that monitors would <u>not</u> be assigned to operate elevators. (Staff assigned to operate elevators only in emergencies would have difficulty gaining access to their assigned elevator.) However, to assure an acceptably high level of reliability, we assume that some sort of human oversight over the operation of the computer program will be needed. Coordinators would monitor the activities of the computer as well as the fire conditions in the building. If necessary, they could override the computer and either: (1) monitors would commandeer the elevators and operate them or (2) the coordinators would directly control the elevators from the command center.

USE BY THE GENERAL POPULATION

The use of elevators for emergency evacuation need not be limited to occupants with disabilities. In tall buildings, total evacuation using stairs is a time consuming activity. The length of time would be extended if the fire department uses a significant portion of the stair capacity for firefighting activities. Permitting and encouraging a portion of the general population to use the elevators would decrease the total evacuation time.

The use of elevators to evacuate a tall building during a fire emergency is much more complicated than using them for evacuating only occupants with disabilities. Some occupants would be assigned to elevators and others to stairs. There would be a need for a phased evacuation for each group. If it was desired to maximize the number of occupants using elevators rather than stairs, it would be necessary for all elevators to operate in the fire evacuation mode. To increase the probability that the first installations operate successfully, it is anticipated that the first installations would be limited to evacuating only occupants with disabilities and their escorts.

PHASED EVACUATION

It should not be assumed that the fire protection features of the building would protect the EEES indefinitely. The building occupants near the fire should not be subjected to the congestion and lengthy delays of an unphased evacuation of a tall building using only elevators. (Similarly, occupants near the fire should not be subjected to the congestion and lengthy delays of an unphased evacuation of a tall building using only stairs.)

One approach is to limit the use of the elevators to occupants (and their escorts) who have qualifying mobility limitations. It is hypothesized that these persons will constitute a relatively small percentage of the occupants in many buildings. See Pauls and Juillet (1990). When the capacity of the elevators is sufficient to evacuate all such occupants in a short period of time, there would be no need for special routing of the elevators to give priority to those on or near the fire floor and there would be no need for a special phased evacuation for occupants with disabilities. (Our experience in a small sample of office buildings confirms the hypothesis that persons with mobility limitations are a small percentage of occupants in many buildings but a wider range of buildings should be studied.)

To permit an orderly evacuation and the rapid evacuation of the most endangered occupants in a tall building, a phased evacuation would be needed, whether or not the elevators are used to evacuate a portion of the general population. (See Groner and Levin (1992) and Groner (1995).) A phased evacuation requires a higher level of preparation by the building management, a more complex fire emergency plan, more training, a higher level of control by the occupant emergency organization and a good emergency communication system.

A phased evacuation means that the elevators will be controlled by the occupant emergency system rather than by the call buttons. The actual control can be by a computer, by staff in the command center, or a combination of the two. The presence (and number) of occupants in lobbies needing evacuation can be determined by some combination of: information from fire wardens; television cameras; and signals from the call buttons.

The above discussion illustrates the complexity of an emergency elevator evacuation system used by a portion of the general population of the building. There is also a need for a significant training/ education program to convince fully mobile occupants to use the assigned elevators. (See Groner and Levin, 1995.) One would anticipate that early emergency elevator evacuation systems would restrict elevator use to occupants with mobility limitations.

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