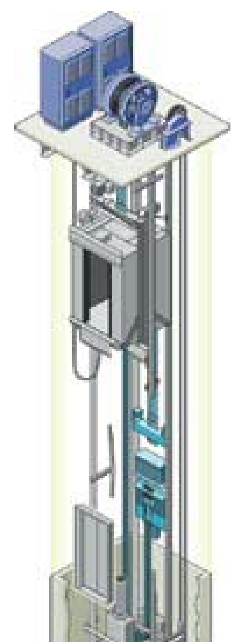
PROTECTED ELEVATORS FOR EGRESS AND ACCESS DURING FIRES IN TALL BUILDINGS

Richard W. Bukowski, P.E., FSFPE
NIST Building and Fire Research Laboratory
100 Bureau Drive MS8664
Gaithersburg, Maryland 20899 USA

The events of September 11 have generated renewed interest in the use of protected elevators for egress and access. U.S. building codes contain requirements for accessible elevators for assisted evacuation of people with disabilities. Firefighter lifts, required in tall buildings in some countries, are being discussed to improve both the safety and efficiency of firefighting operations. The desire for increased egress capacity of tall buildings to facilitate simultaneous evacuation has rekindled interest in elevators as a secondary means of egress for all occupants. Elevators used for each of these purposes share many of the same design characteristics and the need for an extraordinary level of safety and reliability.

HISTORY

The development of the passenger elevator is tied directly to the emergence of tall buildings. While various types of freight lifts were found in warehouses and factories these were considered too dangerous to move people. In 1854 Elisha Graves Otis demonstrated an automatic safety brake that changed the landscape. Within a few years his steam elevators had eliminated one of the major limits to building height. But while elevators proved to provide one of the safest forms of transportation there were instances where people were killed while using elevators during building fires. Heat sometimes activated call buttons bringing cars to the fire floor where smoke prevented the doors from closing (light beams are used to detect people in the doorway) and water in the shaft sometimes shorted out safety devices. Thus the use of elevators for occupant egress or fire department access was discouraged.



In the 1973 the elevator industry developed a system that recalls the elevators and takes them out of service if smoke is detected in the lobbies, machine room, or hoistway. Mandated in the *Safety Code for Elevators and Escalators*[1] (ASME A17.1) for all (automatic) passenger elevators this system involves two, distinct phases of emergency operation. In Phase 1, the detection of smoke or heat in specific locations results in the elevators being immediately recalled to the ground floor (unless this is where smoke was detected), the doors open, and the elevators are locked out of service. The responding fire department can then choose to use the elevators under manual control of a firefighter in the car by use of a special firefighter key, in what is called Phase 2 operation. While Phase 2 is sometimes used to evacuate people with disabilities, most fire department "standard operating procedures" for high-rise firefighting depend on the stairs for access, staging, and operations. ASME publishes a *Guide for Emergency Personnel*[2] (A17.4) that includes detailed instructions for firefighters' Service operation.

CURRENT REQUIREMENTS FOR EMERGENCY USE ELEVAOTRS

All U.S. building codes contain a requirement for accessible elevators in any building with an accessible floor above the third floor as a part of the accessible means of egress. These requirements are all identical, being extracted from the ADA Accessibility Guidelines (ADAAG) and mandated under the Americans with Disabilities Act (ADA).

Some countries require firefighter lifts in tall buildings to provide for fire department access and to support operations as well as to evacuate people with disabilities. England has such a requirement supported by a British Standard (BS 5588 Part 5)[3] requiring firefighter lifts in buildings exceeding 18 m (60 ft) in height. Firefighter lifts are also provided in the Petronas Towers, the world's tallest buildings in Kuala Lumpur, Malaysia.

The NFPA's Life Safety Code (NFPA 101)[4] includes provisions for egress elevators to be provided as a secondary means of egress for air traffic control towers where the small footprint prohibits two, "remote" stairs. These are secure facilities not open to the public and with limited numbers of occupants.

While the above requirements exist for elevators for emergency use by firefighters and people with disabilities, there are currently no codes or standards for egress elevators for use by building occupants. There is, however, an example of a structure that uses elevators as the primary means of egress and fire service access. This is the Stratosphere Tower in Las Vegas, Nevada. Essentially an eleven-story building sited atop an 800-foot tower, it has a single emergency stair that is considered impractical. Thus the four, double deck elevators are designed for emergency use. One is reserved for use by the fire department with the remaining three used under manual control to evacuate all occupants from the two lower floors that are designed as areas of refuge. Occupancy of the tower is limited to the number of people that can be evacuated by the elevators in one hour[5].

Figure 1 - Stratosphere Tower in Las Vegas

COMMON CHARACTERISTICS

Whether for access by the fire service or for egress, elevators provided for use in fire emergencies share several characteristics intended to assure safety and reliability. They are required to be installed in a smokeproof hoistway constructed to a 2-hr fire resistance and pressurized against smoke infiltration. Enclosed lobbies are required on every floor, which are also 2-hr (1-hr in fully sprinklered buildings) and pressurized. In fact, the lobby is crucial to the operation since elevator doors are particularly susceptible to jamming under even mild pressure differences. Thus, the smoke control system should pressurize the shaft and lobby together so that there is a minimal pressure difference across the door.

The lobbies are provided with a 2-way communication system to the building fire command center so that people in the lobby can be informed of the status of any impending rescue.

Emergency power to operate the elevator in the case of main power failure is also specified. Water intrusion into the hoistway can short out safety components such as switches that prevent the doors from opening unless there is a car present, and even the safety brake; so water protection or waterproof components are needed.

Within the U.S., any use of the elevator for fire service access or for rescue of people with disabilities is done under manual control of a firefighter in each car under Phase 2 recall. The elevator industry will not guarantee that its automatic controls can react appropriately to all hazards that might occur and cannot assure safe operation. Thus, the trained operator must be able to recognize hazardous conditions and cease operations. This represents a resource allocation problem for most fire departments that simply cannot assign a firefighter to every car. Further, the susceptibility of safety controls to failure from water results in a requirement for an automatic shutdown of elevator power before activation of fire sprinklers in the machine room or hoistway. This would result in any operating elevator cars to suddenly come to a halt.

SOLUTIONS FOR REILABLE ELERGENCY ELEVATORS

The first solution is to eliminate the susceptibility to water by using waterproof components and eliminating the requirement to shut down power. Next is to eliminate the need for firefighters to operate each car.

Figure 2 - NIST prototype fire service interface

Here we propose operating the elevators under ***remote manual control***. The elevator industry would identify every parameter critical to the safe operation of the elevator and these would by monitored and displayed in real time on the ***standard fire service interface***[6] recently implemented in the National Fire Alarm Code (NFPA 72). This interface was developed as a tool for incident management that can collect information from its own sensors and other building systems (through a common communication protocol such as BACnet) and display the information in a format common to all manufacturers systems. The interface further supports specific control functions so that the operator could manually initiate recall if any monitored parameters exceed the allowable operating envelope.

Because continuous monitoring of the system is crucial to safe and reliable operation we propose incorporating a triple redundant communication pathway. The fire alarm system is currently required to incorporate two, redundant communication trunks usually run up the two stairways. Either trunk is sufficient for the full system operation and two-way communication to the entire building. While these trunks are "remote" it is possible that a single event could sever both trunks, rendering the portion of the system above the breaks inoperable. We propose providing a wireless link between the bottom (generally the fire command center) and the top of the system as a third, independent pathway. This would maintain full operation of the system should both trunks fail. This would add little cost, high reliability, and can be done with current technology.

DELEVOPMENT OF OPERATING PROCEDURES

Prior research and recent advances can address all of the technology issues identified as critical to the safe and reliable operation of elevators during fires. The remaining piece is the development of operating procedures for access, egress, and rescue of the disabled that are sensitive to the human factors issues and to the need for these activities to occur simultaneously in tall buildings. Thus the systems must be designed and used such that they do not interfere.

One example is whether firefighter lifts and egress elevators can share common lobbies. Occupants awaiting egress may interfere with staging of suppression operations. Another is access to stairs and the use of the stairs for mounting the fire attack. Third is the sequence of egress operations. First priority would be given to egress of occupants from a few floors around the fire floor. Next a group of floors above the first group should be evacuated but if a disabled person enters a lobby on another floor at what point should that person be extracted? These sequencing delays would likely cause people on other floors to use the stairs rather than awaiting the elevators. Should people above the fire take the stairs to a point and then transfer to the elevators while people below the fire should take the stairs all the way?

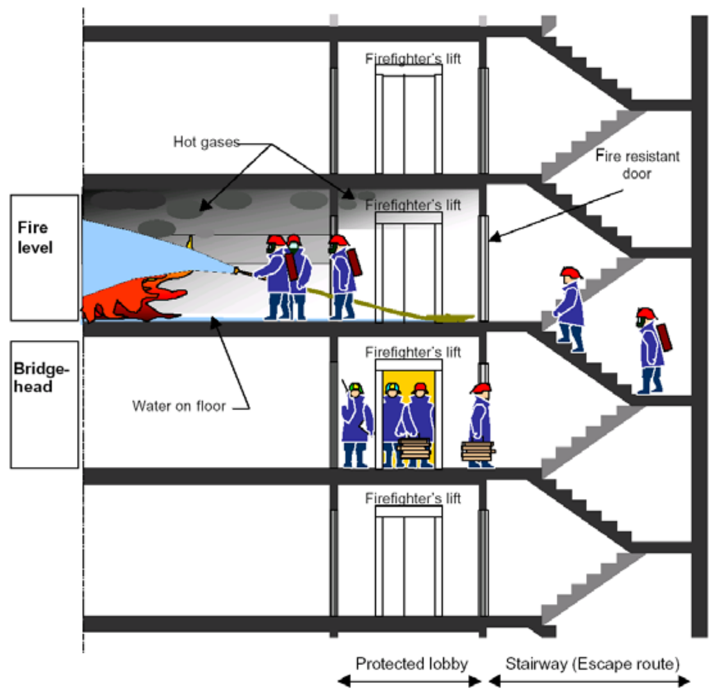


Figure 3 - firefighter lifts carry people and equipment to the floor below the fire with attack staged from the stairs

The operational procedures and sequencing will have an effect on the design and arrangement of the entire egress system and needs careful thought. A proposal for such procedures is being developed for presentation at an international conference on tall buildings in Spring 2003.

REFERENCES

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[4] Life Safety Code (NFPA 101 2000, Nat Fire Prot Assn, Quincy, MA 02269

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