

J. Brooks Semple

VERTICAL EXITING: Are Elevators Another Way Out?

This author assesses the continuing efforts to make elevator systems safe for use during fire emergencies.



This report offers an overview of the ongoing efforts of the elevator industry, the NFPA, the National Institute for Standards and Technology (NIST), the American Society of Mechanical Engineers (ASME), and other involved parties to develop solutions to the problems involved in enhancing the security of elevator systems against various aspects of the fire environment. Their goal is the continued use of elevators during fire emergencies.

The Baltimore symposium

In February 1991, the NFPA, the ASME, and the Council of American Building Officials (CABO) sponsored a symposium on elevators and fire in Baltimore, Maryland. It was organized in anticipation of the forthcoming Americans with Disabilities Act and its associated Accessibility Guidelines (ADAAG).

The symposium emphasized a number of well-known questions regarding the need for elevator lobbies and their pres-

surization, as well as the appropriateness of sprinkler waterflow versus smoke detector initiation of elevator recall. It also provided an opportunity to publicize a number of elevator operation problems that were known only to the elevator industry, such as low heat tolerance of microprocessor controls and water sensitivity of door interlock and other elevator equipment in hoistways.

The 200 attendees, who were elevator and building officials and fire professionals, left the meeting determined that some immediate code revisions and further study of local fire service experience were steps to be taken as soon as possible. A few of these actions are outlined below.

NFPA panel session in New Orleans

To broaden the fire community's awareness of this major exit problem and to report on progress made since the Baltimore symposium, a special panel session

titled "The Use of Elevators in High-Rise Buildings During Fire Emergencies" was held at the NFPA Annual Meeting in New Orleans in May 1992.

Session panelists pointed out that the NFPA Life Safety Code Subcommittee on Means of Egress had recognized this basic problem nearly 15 years ago, culminating in the Section 5-12 proposal that was passed by the Safety to Life Committee, but was rejected on the floor at an annual meeting more than a decade ago. At the time, the prediction was made that if the NFPA membership failed to act favorably on the proposal, the federal government would force the issue.

Some European and Asian nations also have recognized the problem, and several are ahead of the United States in the process of solving it. Currently, we are enmeshed in a lack of building code coordination and a federal law to be enforced by individuals who are long on legal training, but may be unfamiliar with building construction. The Board for the

Coordination of Model Codes and the Department of Justice (DOJ) are rushing to establish codes and regulations, but there is no one authority to establish a humanistic approach to implementing them.

Technical problems

There are still both technical and operational problems to overcome. The technical problems are heat, smoke, water, and electric power reliability, most of which were addressed at the NFPA meeting in New Orleans.

Stairwell pressurization has been in use long enough to be a proven method of minimizing fire and smoke invasion of that component of means of egress. The same engineering principles apply to elevator hoistway pressurization, and similar success can be achieved if we recognize the differences in construction of stair and elevator shafts and their doors.

Because most building codes still require venting of elevator hoistways, provision must be made to negotiate away that requirement with the authority having jurisdiction, or to supply additional pressurization air to compensate for that which is lost. The number of stair doors open during a fire emergency has been the subject of debate and the cause of design limitations. Fortunately, in the case of elevators, the maximum design condition is one open door (or more, if there is more than one elevator in a shaft).

On the other hand, stairwells, unlike elevators, can be entered when you arrive at the door. Therefore, it is absolutely necessary to provide lobby smoke doors at every floor level to create smoke zones separated from the remainder of the floor areas. Conventional, loose-fitting elevator doors generally permit enough air leakage into the lobbies so that a separate, ducted lobby pressurization system is unnecessary.

Such a system effectively creates temporary areas of refuge and keeps fire, heat, and smoke at bay until and unless the entire floor area is overwhelmed by fire. This is an infrequent occurrence, particularly during the early stages of a fire when at least one elevator car could reach the fire floor to evacuate occupants waiting in the elevator lobby. In a building with a well-maintained sprinkler system, total floor involvement should never occur. However, until the time comes when all high-rise buildings are sprinklered and the sprinkler systems are tested semiannually, smoke will continue to be a major problem when fire occurs.

Water is a distinct problem requiring a separate solution. It was not discussed at the New Orleans session, but will be covered later in this report.

Heat and electrical reliability are

closely related. If a pressurization system can keep elevator hoistways substantially clear of heat and smoke, why not use hoistways as vertical risers to provide duplicate and remote electrical power supplies during emergencies? The failure of nonfire-resistive, single or clustered power supplies has resulted in catastrophic losses in several recent high-rise building fires. Hoistways can be better constructed to protect both a building's occupants and the electrical power that is needed to descend elevators for their safe egress.

For electrical power reliability during a fire, expensive large-capacity, space-consuming emergency generators are not the answer. The proper solution is duplicate, remotely run, fire-resistive power lines fed from two separate substations where available, as in all large cities.

However, emergency generators are still necessary in hospitals and critical service facilities and for utility outages. Smaller units capable of running one elevator car per elevator bank in addition to emergency lighting should be provided.

Another heat problem can occur in the elevator machine room. Most high-speed elevators used in high-rise buildings have microprocessor controls that are temperature-sensitive at degrees varying from 85°F to 104°F. ASME A17.1, the *Elevator Code*, does not mention air conditioning in elevator machine rooms because it is considered a building design function. Since no model code requires air conditioning in elevator machine rooms, the type and existence of air-conditioning equipment there is a local option.

The problem may be compounded by the fact that some fire department officers habitually switch off electrical and air-handling equipment power when they enter a fire building. Without cooling, the microprocessor controls rapidly overheat due to normal ambient heat released from elevator motors, resistors, and transformers. Loss of cooling is a more frequent cause of elevator control failure than is the direct effect of fire.

The elevator industry is aware of this control sensitivity. A common solution is to install internal thermostats to shut down the elevator car instantly when the critical temperature is approached; there is a separate control panel for each car. Stopping elevators is no help in evacuating people or in fire service operations, and it frequently adds the problem of elevators stalled between floors.

A patent is pending for liquid cooling of microprocessor elevator-control cabinets, not only to provide more efficient cooling during normal operations, but also to provide a minimum of 1 hour of heat absorption capacity if a cooling-power failure occurs. This will provide

control capability for the continued safe operation of elevators during a building fire for double the normal rush-hour evacuation time and loads carried. It also places the responsibility for cooling elevator controls with the most concerned parties—the elevator manufacturers or installers.

Few people have had as much operational experience in high-rise building fires as Elmer Chapman, retired chief of the New York City Fire Department, who was one of the panelists at the New Orleans session. His extensive field experience led him to develop 13 criteria for safe elevator design (see sidebar).

Members of the New Orleans panel discussed human factors involved in the problem, as well as the hardware requirements. In fire situations, mobility-impaired individuals have no choice but to use elevators or to wait in stairwell refuge areas either until the fire is controlled or until people can assist them down the stairs—by using a wheelchair carry, for example.

There has been a successful 20-year campaign to teach people not to use elevators in fires, but there is a downside to not using the elevators for those who have a choice of elevators or stairs. Longer evacuation time, physical effort required to descend stairs, the potential for long delays, and fear of stairway congestion all are important considerations. The need for phased evacuation of public buildings by floors in order to prevent congestion must be better publicized, especially to building occupants. Both occupant training and written emergency plans are vital to ensure safe evacuation.

The chairman of the New Orleans session concluded that all the speakers, despite the differences in their backgrounds and experience, agreed that when the revisions needed to meet the full intent of the ADAAG are completed, not much more will be required to provide safe evacuation for all building occupants under fire conditions.

ASME A17 efforts

The ASME A17 Elevator and Escalator Committee considered every suggestion made by the 16 speakers at the Baltimore symposium. Each suggestion was reviewed and assigned to one of 24 permanent A17 subcommittees or to several A17 ad hoc committees specifically created to review and analyze them.

Some of the technical work has been completed, and a few proposed changes to the *Elevator Code* have been submitted to the main A17 committee to be considered for inclusion in the 1993 edition of the *Code*.

After a careful review of fire and elevator industry experience, passage is

likely for the following pending sprinkler recommendations that are of particular interest to the fire community:

- Use sidewall sprinklers in the elevator hoistway pits. Nearly all hoistway fires result from trash accumulation in the pits. There will be installation stipulations to prevent water soaking of the elevator car and the lowest-level door-closing mechanism and to assure pit drainage.
- Sprinklers are not required at the tops of noncombustible hoistways of passenger elevators with car enclosure materials that meet the requirements of ASME A17.1. Sprinklers would rarely operate from that location, and if they did, would be ineffective and would raise havoc with the elevator controls in the hoistway.
- Sprinklers in elevator machine rooms are not considered detrimental to the safe operation of elevators. The underlying assumptions are that regular 212°F sprinklers—not quick response sprinklers—will be installed, and if the environment is hot enough to open such a sprinkler, the elevator machinery has exceeded its temperature limits and probably would be shut down before sprinkler activation occurred. Disconnecting the main power “upon or prior to” the application of water would then permit the use of a simple waterflow switch, in lieu of a preaction system.

These proposals have been coordinated with the NFPA sprinkler committee so that the NFPA 13, *Installation of Sprinkler Systems*, and ASME A17.1 standards will not conflict.

A pending recommendation by another A17 ad hoc committee is the establishment of “impending over-temperature” (IOT) at 5°C below that of the critical temperature (CT) of the microprocessor controls. If this recommendation is adopted, each control cabinet will have two safety thermostats, one to return the car to the designated level (normal Phase I elevator recall) when the IOT is reached. If the temperature then drops, the elevator automatically will go back into service. If the temperature rises to the CT, power will be cut immediately and will require manual reset, as it is at present. When the controls are in the range between the two temperatures, the car holding in Phase I will be available for Phase II fire fighters’ service, but it will have a new signal light to warn of the possibility of immediate shutdown, a feature not now available.

It has been accepted practice to connect smoke detectors required by A17.1 for elevator recall to the building fire protective signaling system, where one is in place. There is currently no provision for an annunciation panel for elevator-recall smoke detectors in buildings that lack fire signaling panels. Because the

13 Criteria for Safe Elevator Design

Elmer F. Chapman

The following is a list of 13 proposed requirements to ensure elevator safety during fire emergencies. It is not all-inclusive or in any order of priority, nor is it a pick-and-choose list of options.

Instead, it is intended as a compendium of safeguards that must be included in a total approach to the design of elevator systems that can be used safely for evacuation during fire emergencies, will enhance fire fighting operations, will reduce costly fire damage to elevators, and will diminish the time that businesses in the building must endure interruption to their normal routines. Additional studies are needed to ensure that all potential events have been considered.

1. The building shall be fully protected by a sprinkler system.
2. Elevator shafts should be pressurized.
3. Elevator lobbies on all floors should be enclosed.
4. Elevator lobbies should be pressurized.
5. Air intakes for the elevator shaft and lobby pressurization systems should be made from a smokefree location.
6. All elevator lobbies should be

protected by smoke detectors.

7. Elevator systems should be made water-resistive.

8. When a power failure occurs, all elevators should return to their designated level.

9. All elevators should be capable of being operated from a dedicated emergency power generator.

10. All elevator lobbies should have access to a pressurized stairway without [the occupants] passing through another fire area.

11. All elevator cars should have means for two-way voice communication between the elevator car and the fire command station.

12. All elevator lobbies should have means for two-way voice communication between the elevator lobby and the fire command station.

13. A program specifying the priority of elevator response during fire emergencies should be developed.

Technical problems to be solved include heat, smoke, water, and electrical power reliability in elevators during a fire.

Elmer F. Chapman is a retired chief of the New York City Fire Department.

A17 Elevator and Escalator Committee did not want to expand into panel specifying, it persuaded the NFPA 72 Protected Premises Committee to do so. This has been proposed by the NFPA 72 Technical Committee and approved by the NFPA Signaling Systems Correlating Committee for final association action at the NFPA Annual Meeting in Orlando in May 1993.

Local actions taken

In September 1992, NIST held a workshop on elevator use during fires. Dr. Jack Snell, deputy director of NIST’s Building and Fire Research Laboratory, opened the workshop, which was conducted by Dr. John H. Klote, head of NIST’s building fire physics group.

Klote’s summary of the meeting follows:

- The fire protection community should have the ability to use elevators for fire evacuation as one of many tools—such as sprinklers and compartmentation—to protect people in new and remodeled buildings. An elevator to be used for evacuation should be protected from heat, smoke, and water. Phase II opera-

tion can be used for fire evacuation.

- Further research concerning the extent of the water problem and development and evaluation of potential solutions are needed.

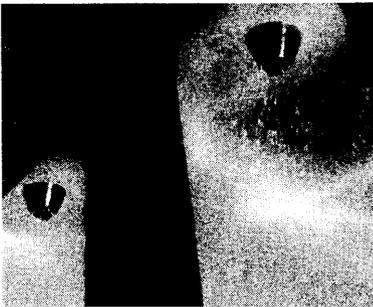
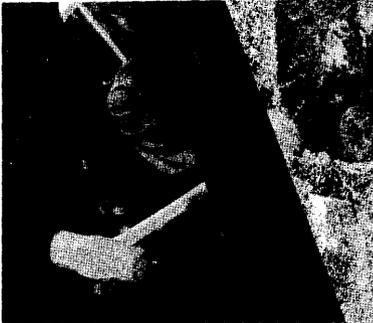
- While elevator evacuation technology may primarily be aimed at sprinklered buildings, information about elevator protection in unsprinklered buildings also is needed.

- The application of elevator evacuation for disabled people only is much simpler than for the general population and is the next logical step. Based on what is learned in this step, an application for the general population could follow.

In November 1992, a meeting hosted by an engineering firm was held in New York City for the city’s building and fire officials and members of the A17 Emergency Operations Committee. The following subjects were among those discussed:

- In the past, New York City permitted sprinkler waterflow switch control of elevator recall in fully sprinklered buildings, rather than smoke detector control, basically because of past experience with many unwanted alarms from sensitive

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detectors. Members of the A17 Emergency Operations Committee stressed the great improvements that had been made in detector selective sensitivity, cross-zoning, and alarm verification, as well as the inherent delay in ordinary sprinkler operation. It was noted that New York City now requires two cross-zoned detectors in each elevator lobby.

Most important, according to most members of the committee, was the need for the recall signal to come from the elevator lobby, not from somewhere else on the floor. No one at the meeting could recall any building with a sprinkler system zone that was restricted to elevator lobbies. Such a system, with fast response sprinklers, might be ideal but not cost-effective, particularly in light of recent improvements in smoke detector systems.

- Water, either from sprinkler actuation or from hose streams, is a major concern in regard to operational reliability of elevators. A broad-based committee with members from the A17 Emergency Operations Committee and New York City fire and building departments has an ongoing program to locate and prepare a site in which to test the water sensitivity of elevator elements in hoistways under controlled test conditions. There is a vital need to know more about this situation, which may be the weakest link in safe elevator operation under fire conditions. Elevator-door designs are being reviewed to restrict the flow of water into the hoistway, in place of expensive, water-proof elevator equipment in the hoistway.

- Control cooling is a subject that is not widely understood. Fire department officials sometimes turn off building power when they arrive at the fire scene, perhaps unaware that this action reduces both the reliability of the elevators and the time available to use them under emergency power. The need for some method of control cooling that is independent of all building power during an emergency is apparent.

- Current practice in New York City encourages immediate elevator recall, regardless of the point of water flow. This reserves the elevators exclusively for fire department use, and all evacuation by elevators is supervised by fire department personnel. This early recall signal from areas that may be remote from the elevator lobbies appears to be in conflict with the spirit, if not the letter, of the ADAAG.

- It was pointed out that the elevator industry is promoting elevator *accessibility*, not "egressibility." The industry prefers the status quo, rather than having the mobility-impaired wait in areas of rescue assistance on stair landings until fire department personnel arrive. Why should

they wait, if the automatic elevator system can be "fire-hardened" sufficiently to provide safe automatic service, at least until fire fighters arrive? What assurance is there that fire fighters know the location of people who need assistance?

Current status of the situation and future expectations

At the present time, the situation is in a state of flux. The problem will not go away. The question is: How long will solving it take?

At the moment, we have a new, extremely broad federal law—the ADA—with enforcement power vested in DOJ attorneys whose knowledge of existing building codes—and more important, the reasons for them—may be limited.

At the same time, there has been a lot of activity by the elevator industry, at least through the main committee and many subcommittees of A17. But elevator manufacturers are aware that the longer elevators are kept in service during building emergencies, the more likely is the possibility of real or perceived incidents involving equipment malfunction, which could lead to litigation.

There is encouraging closer cooperation between the ASME A17 committee and the NFPA 13 and 72 committees, but there are also many local codes and practices that are slow to change and continue to conflict with well-developed consensus standards.

Another advantage that has been attained is the generally nationwide requirement that all new high-rise buildings be sprinklered. But until a building, old or new, is fully sprinklered and its sprinkler equipment is frequently inspected and tested, there will continue to be a potential for substantial smoke emergencies.

Because the elevator industry was a major contributor to and beneficiary of the development of skyscrapers, it is being looked to for leadership in substantial enhancement of elevator reliability during building emergencies. But the elevator industry cannot do the job alone. All those who are affected by and interested in the solutions will have to help in order to meet this goal.

All in all, there is an interesting decade ahead of us. ♣

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