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DOOR CLOSE

It is important that all parties, from rescue personnel to building designers understand the intent of the fire service operation provisions of ASME A17.1, *Safety Code for Elevators and Escalators*.

Elevator controls

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 before the advent of the high-rise, these were considered too dangerous to move people.

In 1854, however, 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.

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But, while elevators proved to be 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 in modern day elevators to detect people in the doorway) and water in the shaft sometimes shorted out electrical safety devices or may have caused failure of braking systems. Thus, the use of elevators for occupant egress or fire department access was discouraged.

In 1973, the elevator industry developed a system that recalls elevators and takes them out of service if smoke is detected in the lobbies, machine room, or hoistway.

In 1973, the elevator industry developed a system that recalls elevators and takes them out of service if smoke is detected in the lobbies, machine room, or hoistway. Mandated in the American Society of Mechanical Engineers (ASME) A17.1, *Safety Code for Elevators and Escalators,*[1] for all automatic passenger elevators, this system involves two distinct phases of emergency operation.

In Phase I, the detection of smoke or heat causes the elevators to be recalled to the ground floor, unless this is where smoke was detected. The doors open, and the elevators are locked out of service. Responding fire fighters may use the elevators under manual control of a fire fighter in the car using a special fire fighter key in what is called Phase-II operation.

While Phase II operation is used to evacuate people with mobility impairments, some fire department standard operating procedures for high-rise fire fighting rely on stairs for access, staging, and operations. ASME A17.4, *Guide for Emergency Personnel,*[2] contains detailed instructions for fire fighters' service operation.

In the 1980s, the United Kingdom developed BS5588 part 5[3], a standard for fire fighter lifts. It describes a fire-fighting shaft consisting of an elevator, protected lobbies on each floor with direct access to one of the required stairs, and standpipes, all enclosed in fire resistant construction. According to a survey[4] by the International Organization for Standardization (ISO) committee responsible for ISO/TC178 elevator standards, this system is used in a few countries, generally former British colonies, for buildings greater than 18 meters (60 feet). Recently, BS5588 part 5 has been adopted as CEN Standard EN 81-73 for use throughout the European Union.

Also in the 1980s, the Federal Aviation Administration (FAA) was interested in providing a secondary means of egress from air traffic control towers. Because a control tower's footprint is so small, it is not possible to provide two remote stairs, but any tower of significant height has an elevator and stairs. The FAA contacted the National Institute of Standards and Technology (NIST), and a cooperative project launched with the elevator industry, coordinated through the National Elevator Industry Institute, resulted in changes in the 1997 edition of NFPA 101®, *Life Safety Code*®[5], that were subsequently incorporated into NFPA 5000®, *Building and Construction Safety Code*®. In addition to the technical requirements for the equipment and components, NFPA criteria also limits the number of occupants in the tower and requires periodic drills.

While requirements exist for elevators for emergency use by fire fighters and people with mobility impairments, there are currently no codes or standards for egress elevators for use by building occupants. There are, however, egress elevators accepted under performance-based design provisions based on engineering analysis. An example of where such elevators can be found is the Stratosphere Tower in Las Vegas, Nevada.

Atop the 800-foot (250-meter) Stratosphere Tower is an 11-story building, known as the Pod. The Pod has an emergency staircase that is considered impractical for use in emergency conditions. Thus the four double-deck elevators designed for emergency use. One is reserved for the fire department, and the others are used under manual control to evacuate all occupants from the two lower floors of the Pod, which were 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.[6]

New demands for protected elevators

The attacks on the World Trade Center on September 11, 2001, showed that access by fire fighters to incidents on upper floors of tall buildings was problematic. Fire fighters in their protective clothing and carrying the normal gear for high-rise firefighting that includes hose packs and forced entry tools require about 2 minutes per floor to ascend stairs. Once they arrive at the fire scene, they are likely to require rest before they can begin suppression operations. Logistics is also an issue, especially re-supplying oxygen tanks that have a practical capacity of 15 minutes to 20 minutes, depending on the level of exertion.

Clearly, using elevators to move people and equipment to a staging area, which is normally two floors below the fire floor, is the only reasonable approach. Although many in the fire service did not trust the safety of elevators during a fire incident, some departments began to cautiously incorporate elevator access into their high-rise firefighting procedures after 9/11, requiring inspection of the hoistway for signs of smoke and sometimes stationing a fire fighter in the machine room.

In the summer of 2003, NIST approached the ASME A17 committee with a proposal to explore the development of protected elevators for fire service access and for occupant egress in collaboration with the A17 code committee, elevator industry, and fire service. These groups agreed and organized a workshop to explore issues and barriers. A call for papers resulted in a range of speakers, most of whom supported the concept. Breakout groups identified many issues and some ideas on features that should be incorporated into any such system.

Based on these results, the ASME A17 committee established two task groups under the Emergency Operations Committee to develop recommendations for fire-service access elevators and for occupant egress elevators.

A key finding from the workshop was that the incorporation of fire fighters emergency service operation in the 1980s resulted in systems that could continue to operate safely during a fire and would safely take the elevators out of service before there was any risk of entrapment from an effect of the fire. However, many fire departments would manually initiate recall of the elevators on their arrival to control access and to ensure that there were no trapped occupants. While this practice would not materially affect fire service access, it would affect the use of the elevators for occupant egress.

The ASME A17 task groups followed a formal hazard analysis using an ISO standard for risk assessment without the step of assigning probabilities. While tedious, this process is thorough and results in a detailed record of the conditions the committee considered and the mitigation of all hazards identified.

Protecting elevators

The ASME A17 task groups largely addressed the safety issues associated with fire service access elevators by adding real-time monitoring of critical systems from the fire command station that the building codes already required as the incident command location for high-rise buildings. This allows the fire service to monitor the safety and functionality of the systems and to warn fire fighters by radio if the safety of the elevator is in doubt. The task groups also identified other improvements that would make it less likely that the fire or firefighting operations might cause the systems to fail, including better protecting the power to the system, monitoring the internal temperature of the controller, and protecting some critical components in the hoistway from water damage. Finally, the groups provided arrangements to facilitate self-rescue in case of entrapment.

Far more complicated are the arrangements and protocols needed to evacuate occupants by elevator. Unlike the fire service, elevator occupants are not trained or equipped to deal with emergencies. The only thing that can be assumed is familiarity with the normal use of the elevators, as these are the primary means of daily ingress and egress. Thus, while some degree of proactive management of the evacuation by the fire service is provided, the use of elevators for evacuation must be as close to "normal" as possible, with some allowance for guidance by informational messages.

The current ASME A.17 requirements for fire fighter emergency operation are considered effective in maintaining safe operation, even during a fire.

The task groups' concept of occupant egress elevators included protecting the entire bank of cars to take advantage of the system's full handling capacity. This is an elevator industry term describing the design of the system for normal operation where the number, size, and speed of the cars, number of floors served, and occupant load are all considered to achieve a specific service objective.

The elevators in an office building are designed with a handling capacity of 8 percent to 10 percent (downpeak 5), meaning that 8 percent to 10 percent of the entire population of the building can be collected from various floors and transported to the ground floor in five minutes. Apartment buildings are typically designed for a handling capacity of 4 percent to 5 percent (downpeak 5), and some high-end offices, such as the new WTC 7 owned by Silverstein Properties in New York City, are being designed for 12.5 percent, meaning shorter waits for an elevator at 5 p.m. The handling capacity calculation is standardized throughout the elevator industry and is discussed in design manuals such as the Vertical Transportation Handbook.[7]

The current ASME A17 requirements for fire fighter emergency operation are considered effective in maintaining safe operation, even during a fire. If the elevators are to be used for occupant egress, it is important to keep them in service for as long as possible. This led the task groups to observe that enclosed and protected lobbies are needed on every floor, not only to provide a protected space for occupants to wait, but also to protect the elevator lobby from smoke or fire exposure that will initiate elevator recall. Previous work by NIST showed that elevator-landing doors are particularly susceptible to jamming with relatively small pressure differences across them. However, a system in which the hoistway is pressurized and the lobby has a positive pressure with respect to the rest of the building by leakage can provide smoke protection for the hoistway and lobby without causing problems with the landing doors.

Provision of real-time environmental monitoring of the lobbies and two-way communication with the fire command station would also be specified. Dynamic signs, which the fire alarm industry calls textural notification appliances, would be provided in each lobby to give information to waiting occupants. In most modern systems, the elevator controller's dispatch software can provide real-time estimates of the time before an elevator car arrives at that floor, and this will be specified as part of the system.

Evacuation protocol

To provide the needed efficiencies in quickly moving occupants, a new operational protocol is being developed and recommended. Since elevators are most efficient when the number of starts and stops is minimized, the elevators would operate in a shuttle mode in the evacuation protocol. The cars would not respond to car calls–that is, floor buttons in the car–and hall calls, or call buttons in the lobby, would only register that there are occupants waiting there. First priority would be given to collecting occupants on the fire floor, one floor above, and two floors below, and taking them to the main lobby. Note that the initial evacuation zone extends two floors below the fire so that the lobby normally used by the fire fighters for staging would be unoccupied by the time they arrive.

Once the fire zone was empty, the elevator evacuation would proceed from the highest floors downward. People on lower floors would be told the length of wait for an elevator and they might choose to start down the exit stair that would be accessible from the lobby. If any of these occupants needed to rest, they could enter a lobby and do so, or wait for an elevator.

By taking advantage of all the handling capacity of the system, it is unnecessary to restrict access to the evacuation elevators to just people with limited mobility. Since the lower floors would be the last to be served, there is incentive for most occupants on those floors to egress by the stairs. By starting with the upper floors, the occupants who require the longest egress times by stairs would be evacuated first, dramatically lowering the total egress time for even the tallest buildings.

Many of the features described here are already being implemented in tall buildings outside the United States. For example, the Petronas Towers in Kuala Lumpur reports that incorporating elevators into the egress plan has resulted in total evacuation times in both towers of about 20 minutes. Taipei 101, which is currently the tallest building in the world at 101 occupied stories, reports a total evacuation time for the tower and the very large podium area at the base of just under one hour.

Addressing user needs

The fire service must be confident that an elevator is safe and reliable and that they can escape or be rescued quickly by their colleagues if they become entrapped. The fire service has the opportunity to train with the elevator systems and, when the practice becomes more common, they will have an opportunity to use them during real fires. Monitoring critical systems at the fire command station in real time makes them confident that incident command can relay warnings by radio if needed and will know quickly if an entrapment occurs.

Occupant egress elevators provide a different set of challenges. Using them for emergency egress should be as close to using them for normal egress as possible, and a steady stream of information is needed. This can be addressed primarily by incorporating dynamic signage, operated from the fire alarm system, in each elevator lobby to provide a high level of reliability. Again, monitoring critical systems in real-time and having two-way communication capabilities would supplement information transfer and increase reliability.

The occupant egress elevator further addresses the needs of people with various disabilities by providing a means of egress they can use with all other building occupants without outside assistance. By protecting all the elevators, the normal design capacity of the system would be sufficient for use by everyone, with the backup of the fire service access elevators to help those who need it after suppression operations have begun. If additional capacity were needed, the fire service could press any occupant egress elevators into service under manual control.

Recognizing the potential benefits of protected elevators in federal buildings and elsewhere, the U.S. General Services Administration (GSA) is providing funding that supplements NIST's investment in these activities and has agreed to incorporate such systems in a future federal building as a demonstration of the technology. NIST welcomes the opportunity to work with GSA to advance technologies beneficial to government workers and to the public.

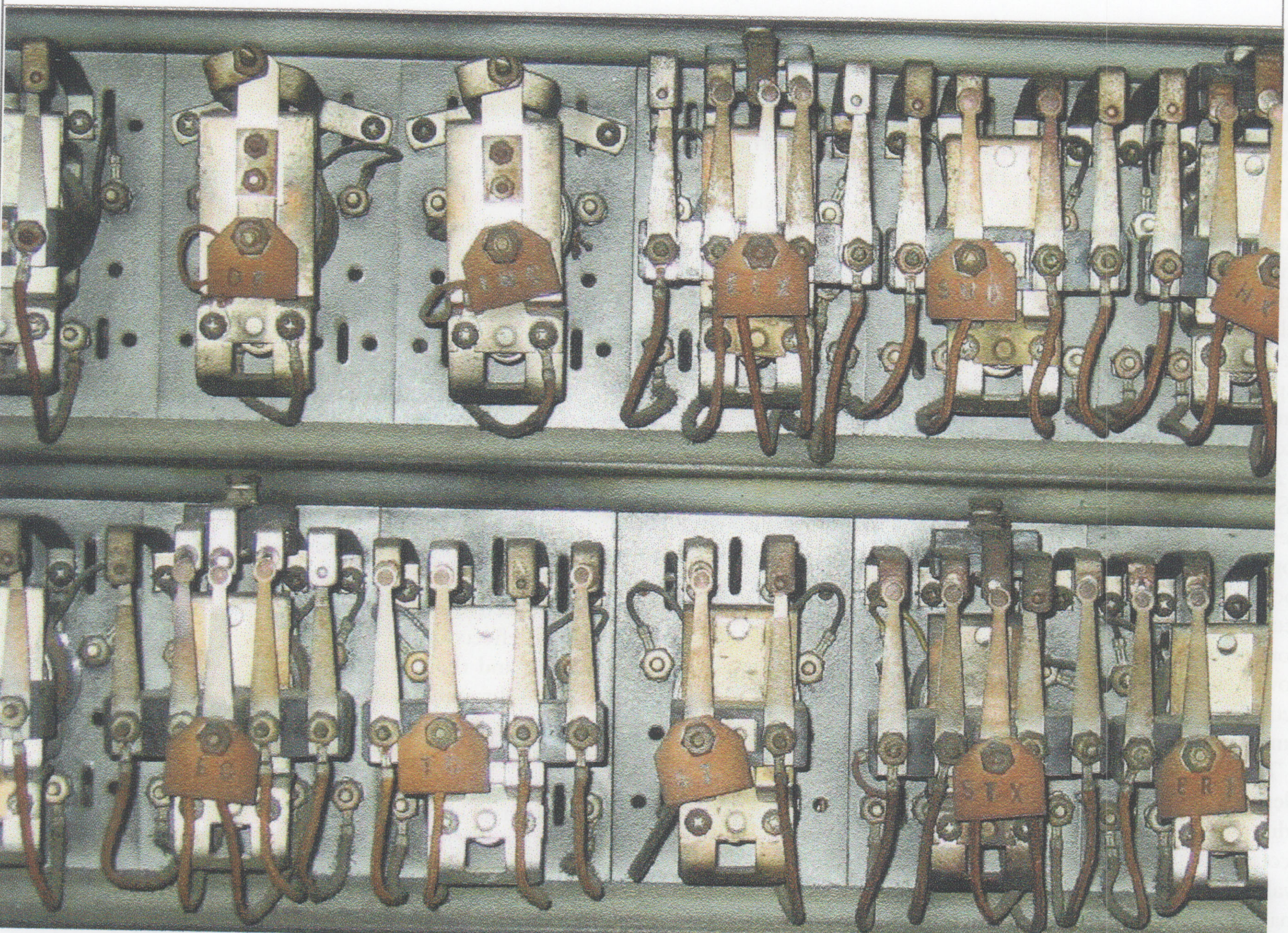
Fire sprinklers and elevators

Rules relating to sprinkler installation in elevator shafts and machinery rooms have long been a source of conflict, but there have been significant efforts to coordinate the requirements of NFPA 13, *Installation of Sprinkler Systems*, with those of ASME A17, *Safety Code for Elevators and Escalators*.

The most notable took place following the February 1991 Symposium on Elevators and Fire, jointly sponsored by ASME, NFPA, and the Council of American Building Officials. The organizations established a code coordination committee that met in late 1991 and 1992 and reached several key points of agreement:

Summary of requirements

1. Sprinklers in Elevator Pits: It was agreed that sprinklers in elevator pits are a good idea because this is a likely location of fire due to the accumulation of debris. Although the accumula-



tion of water in the pit is a potential concern, this concern can take place regardless of whether sprinkler protection is provided.

2. Sprinklers in Hoistways: It was agreed that sprinklers are not necessary at the tops of hoistways if the hoistway is noncombustible and the elevator car is constructed in accordance with the flame spread and smoke development requirements of ASME A17.1.

3. Sprinklers in Machine Rooms: It was agreed that sprinklers may not be necessary in an elevator machine room if it is located at the top of a building and contains nothing other than elevator equipment. It was further agreed that concern over water discharge and power-disconnect requirements can be addressed by requiring means to automatically disconnect the main line power supply to the affected elevator upon or prior to the application of water.

These points of agreement were largely adopted into the 1994 edition of NFPA 13 through a major rewrite of Section 4.5.5. The NFPA 13 requirements have changed very little since that time. Now contained in Section 8.14.5 of the 2002 edition of NFPA 13, the rules make specific accommodations for elevators.

Pit sprinklers: Sidewall sprinklers are to be placed within 2 feet (61 centimeters) of the floor of an elevator pit, without regard to the normal distances required below a ceiling. The NFPA 13 Annex suggests placing the sidewall sprinklers near the side of the pit below the elevator doors and taking care to avoid interference with the elevator toe guard. The pit sprinklers can be omitted for enclosed, noncombustible shafts that do not contain combustible hydraulic fluids. Since sprinklers at the base of the shaft are not expected to discharge onto operating components of the elevator, they can be connected directly to the building sprinkler system with no special valving or delay mechanism.

Hoistway sprinklers: Upright or pendent sprinklers are required at the tops of elevator hoistways, except noncombustible hoistways for passenger elevators with car enclosure materials meeting ASME A17.1.

Machine room sprinklers: The standard has no special rules for elevator machine rooms, except to require that machine room, sprinklers and sprinklers at the tops of hoistways be of ordinary or intermediate temperature rating. In other words, high temperature rated sprinklers that would be delayed in operation are not permitted. Sprinkler protection of elevator machine rooms is expected as part of a complete sprinkler system since these spaces are not specifically excluded from the need for sprinklers.

An Annex section in NFPA 13 discusses the ASME A17.1 requirement that power to the elevators be shut down upon or before the application of water in elevator machine rooms or hoistways, and suggests this can be accomplished by a sufficiently sensitive detection system or by using devices that effect power shutdown immediately upon sprinkler activation, such as a waterflow switch with no time delay.

The NFPA Committee on Automatic Sprinklers is now completing work on the next, 2007, edition of NFPA 13. One of the proposals accepted in this cycle allows the option of sidewall sprinklers at the top of hoistways rather than upright or pendent sprinklers. A proposal that would have required the hoistway sprinklers to be part of a preaction system was rejected on the basis that there are other ways to meet the ASME A17.1 requirements. Another proposal would have eliminated sprinklers from the elevator machine room under certain conditions of smoke detection, signage prohibiting storage, and control of combustible contents, as now permitted in the Commonwealth of Massachusetts. The Technical Committee rejected this proposal on the basis that "buildings are to be fully sprinklered which includes these types of spaces. Storage can occur in these types of spaces regardless of signage." The Committee is aware that reliance on housekeeping practices has historically been an inadequate substitute for complete sprinkler protection.

In the view of the fire sprinkler community, the current rules represent a reasonable approach to elevator protection. Unfortunately, continued lack of consistency in the application and enforcement of these rules can create problems that go beyond the lack of protection. Disagreements among multiple authorities having jurisdiction for an elevator installation have led in some instances to last-minute changes in protection, with consequences of improper valving, inadequate protection against freezing, or other problems.

At the least, it is necessary that elevator protection issues be discussed at the project planning stage. Ideally, those discussions will lead to recognition that sprinkler protection in accordance with NFPA 13 is reasonable and proper.

Elevator smoke control

Deadly fires, such as the 1980 MGM Grand Hotel and Casino fire[8] and the 1988 First Interstate Building fire,[9] have shown that unprotected elevators can provide a significant path for vertical smoke movement from fires through building.

Several factors, including the lack of sprinkler protection on the fire floor, elevator doors that did not provide an effective smoke barrier, as well as the combined effects of the natural buoyancy of hot smoke and the stack effect, resulted in smoke spread through the elevator hoistways to upper levels. A properly designed smoke management system could have helped to mitigate smoke movement through the elevator shafts in these high-rise buildings.

Designers have several alternatives when designing smoke management systems for elevator shafts[10], including pressurize the elevator hoistway; pressurize the elevator lobby; and exhausting the fire floor, which creates a positive pressure in the elevator hoistway relative to the fire floor.

Passive systems

These methods can be used individually or in combination.

Pressurize Hoistway: Some jurisdictions require hoistway pressurization when elevator lobbies are not provided. In general, dedicated supply fans are used to pressurize hoistways to a minimum pressure 0.05 inches (0.13 centimeters) of water column. Since the elevator machine room in cable elevators is open to the hoistway through the cable sleeves, these rooms can be pressurized along with the shaft.

Elevator doors are typically not tight-fitting and tend to be a major source of leakage in the shaft, as do vents. Doors and vents, as well as other sources of leakage, must be accounted for in the design.

In addition, the piston effect may need to be considered if elevators are expected to be used by responders or others during as fire event.

Pressurize Elevator Lobby: If an elevator lobby is provided, this lobby can be pressurized along with the elevator shaft. A second design goal for these types of system is that the opening force for the elevator lobby doors cannot exceed 30 pounds (13.6 kilograms) at the latch side when it is operating and the pressure should not interfere with the opening or closing of the elevator doors. This approach typically allows smaller fans, since the leakage air is lower, but a duct system is necessary to distribute air to the various floors.

Exhaust Fire Floor: Exhausting the fire floor has a similar effect as pressurizing the hoistway or lobby; however, these systems tend to be larger, more costly and more complicated than elevator pressurization systems. The goal of this approach is to limit smoke to the fire floor.

Passive Systems: Smoke tight elevator hoistways and/or lobbies can be an effective means of limiting smoke movement. If protected lobbies are not provided, doors on hold-open devices or deployable smoke barriers can be installed across the elevator doors to maintain an effective smoke barrier. Given the effectiveness of quick-response sprinklers, the requirement for smoke-tight separations is a constant topic of debate.

Design considerations

When designing smoke management systems for elevators, as well as other areas, it is helpful to understand the stack effect, a phenomenon that occurs when there are temperature differences between the air outside the elevator shaft and the air in the rest of the building. Where the air outside the shaft is cooler than the air inside it, buoyancy causes the hot interior air to flow toward the top of an elevator shaft, while air from the lower areas of the building or outside the building enters the shaft towards the bottom to replace the hot air. This causes a general upward flow that can help push smoke into the shaft. When the temperature difference is reversed, the opposite flow results.

Other design considerations include the piston effects, wind effects, and normal HVAC effects that need to be taken into consideration. As elevators travel up within the shaft, air from within the top of the shaft is pressurized and air in the bottom of the shaft is de-pressurized. Pressures are reversed when elevators are moving down. Wind velocity may also influence the design, as the wind will increase pressure on the side being impacted by the wind and decrease pressure on the downstream side of the building. Normal HVAC is typically shutdown during emergency operation. Klote[11] describes methods for accounting for the piston effect and wind velocity.

Consideration should be also be given to providing automatic sprinklers when designing these systems, as the 0.05 inches of water column assumes that a large fire would not occur within the space. Additionally, emergency power is necessary for required life safety systems.

Although the design of smoke management systems presents challenges, smoke management techniques can increase the level of elevator safety in high-rise buildings. With the recent discussions about the use of elevators for evacuation, it is perhaps even more critical to consider smoke management solutions for elevators now than ever before.

Elevator sump pumps

Elevator sump pits are intended to keep water away from the equipment at the bottom of an elevator shaft if the hoistway fire suppression system is activated. Just allow the water to drain into the elevator sump pit, and the equipment stays dry and functional. It's as simple as that. Or is it?

Anyone designing an elevator sump pump system must consider not only removing discharged sprinkler water, but also preventing any oil that has leaked from the elevator's hydraulic lift from entering the sewer system. If the hydraulic system works properly, it generally releases only a small amount of oil. If the system fails, however, a sizable volume could be lost. This oil, combined with the volume of water discharged by one sprinkler, provides a design challenge for the engineer.

In an effort to keep oil from leaking into their sewer systems, some states are trying require the design and installation of large sum pits below elevator shaft floors from which water may be pumped out and disposed of later. Unfortunately, a blanket requirement mandating that a sump pit contain a pump is not necessarily the right way to design the system.

Section 2.2.2.5 of the 2000 edition of ASME A17.1 requires all elevator pits with Firefighters' Emergency Operations (FEO) to have a drain or sump pump. ASME A17.1 also requires a connection to the emergency power supply and protection of circuits to ensure that accidental grounding or short-circuiting does not occur after an emergency has begun.

Instead of a sump pump, an oil separator or some other device can be used to remove oil from the elevator shaft, thus preventing discharge into the sanitary sewer. However, an oversized oil separator is a maintenance issue, and an undersized oil separator will not remove oil effectively.

Replacing the oil separator with a system called an "oil minder" could help resolve the issue. The oil minder concept relies on the fact that oil floats on water. As water is pumped from the bottom of the pit and the water level falls, the oil minder's sensing device detects the oil and shuts off the pump, thus allowing the water out and keeping the oil in.

This controversy has been a long time in the making, but a blanket requirement to provide an elevator sump pump creates more design issues than it solves.

Pros and cons of elevator door restrictors

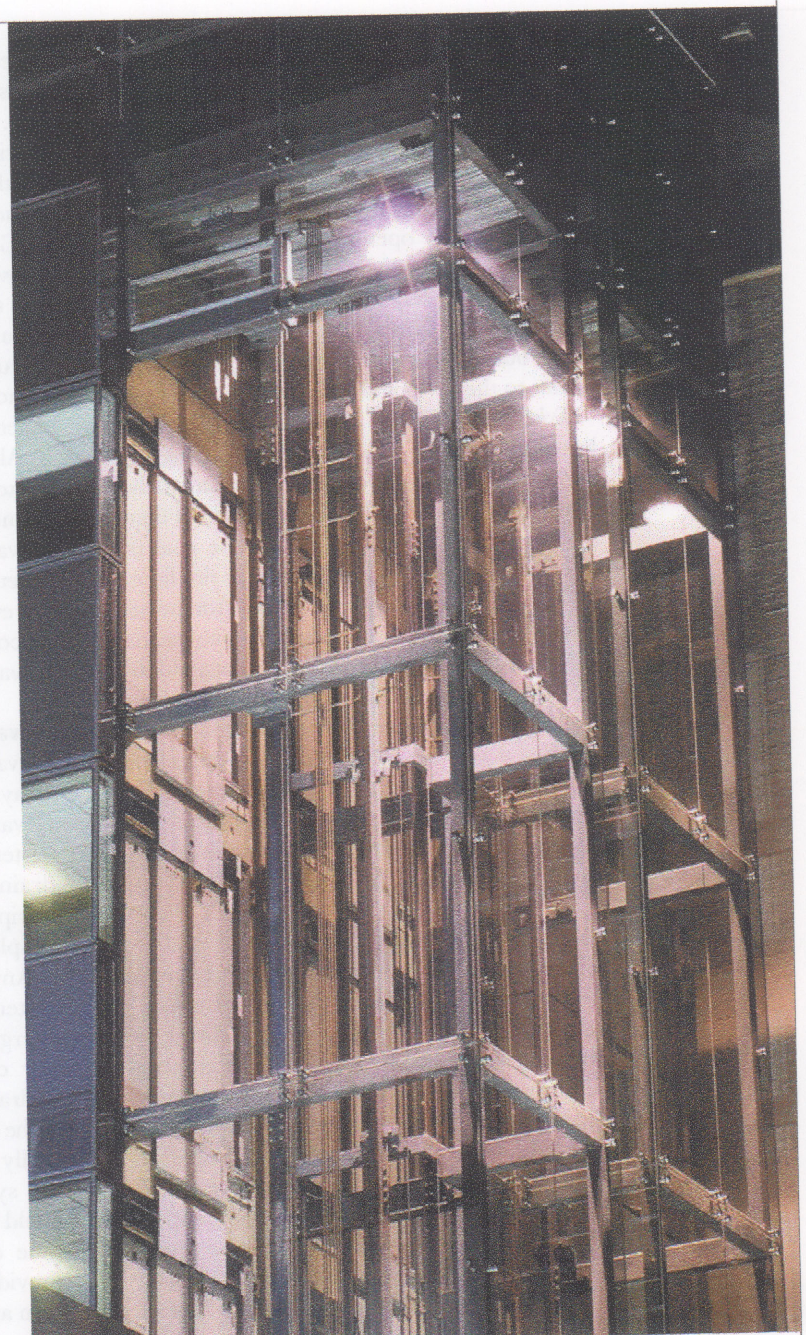
When entering an elevator, most passengers do not realize they have agreed to be securely locked in that elevator cab until the car reaches its destination. Should the elevator lose power before reaching its destination, all methods of self-evacuation are mechanically prohibited. This applies equally to emergency personnel and the public.

Door restrictors, which ASME A17.1 requires on passenger elevators, are mechanical devices designed to prevent a passenger from opening the elevator car or hoistway doors more than 4 inches (10.2 centimeters) when the elevator car is outside the "unlocking zone." ASME defines the unlocking zone as "a zone extending from the landing floor level to a point not less than 75 millimeters (3 inches) or more than 450 millimeters (18 inches) above and below the landing."

The requirement for door restrictors was implemented to prevent passengers from falling into an open hoistway underneath the elevator platform while trying to evacuate from an elevator that is stuck between floors.

Is this a real concern? Unfortunately, it is.

Picture yourself in an elevator that has stopped 5 feet (1.5 meters) above the landing. If you could open the elevator car door, you would have access to the hoistway door interlock, which is typically easy to open from this position. Once you opened the standard hoistway door, you would discover that you now had access to an opening 2 feet (0.6 meters) high from which you could try to exit the elevator. What you wouldn't be able to see is the unprotected space underneath the platform and platform guard. If you were to lower yourself backward from the elevator, your feet would tend to push into the hoistway. If you were to jump forward, you would risk falling backward into the hoistway.



So why not lock passengers in the elevator? Imagine being trapped inside an elevator that

lost power only 19 inches (0.5 centimeters) above a landing in the World Trade Center on September 11, 2001. Or imagaine being an emergency responder who found himself trapped and unable to override the door restrictor. This is not exactly farfetched.

In the attacks on the World Trade Center in 1993 and 2001, many people found themselves trapped inside elevators. In 1993, there were no door restrictors on the elevators. By September 11, 2001, however, about half of the elevators had been retrofitted with these devices. On that day, the few successful escapes that are known to have taken place were from those elevators that had not yet been equipped with the door restrictor devices.

On May 18, 2004, Alan Reiss, Deputy Director of Aviation at The Port Authority of New York and New Jersey testified before the 9/11 Commission, saying "Another item that should be looked at is the elevator code requirement that door restrictors must lock the elevator doors closed when the elevator is not level with a landing. This is a requirement of the current codes, and such devices were being installed as elevators were modernized at the World Trade Center. These devices are meant to improve safety and prevent accidental falls into the shaft, but they have the potential consequence of trapping individuals in an elevator when it is stuck between floors, preventing escapes such as took place in both 1993 and 2001."

Recently, Northwest Territories in Canada modified the CSA B44-04, Elevator Safety Code, to allow extended platform guards as an alternative to door restrictors in some cases. Platform guards are sheet metal extensions mounted directly from the car sill and supported to restrict hoistway access below the car platform. The code modification to Requirement 2.15.9.5 states that "A platform guard may be used as an alternative to the requirement set out in 2.12.5.1 if the platform guard...is installed so that the hoistway opening space below the platform guard is limited to not more than 250 milimeters (9.8 inches) between the floor and the bottom of the platform guard, regardless of the location of the elevator car when it is stopped."

While this alternative certainly prevents falling into the hoistway and allows for self-evacuation if necessary, the pit depth on many existing elevators is insufficient to accommodate this extended guard length. In addition, the platform guard does not prevent injuries during the unassisted evacuation of an elevator that has stopped significantly above or below the landing, other than the falling scenario described above.

So if power is lost while traveling in an elevator, how likely is it that you will be prevented from getting out of the elevator? In a building with the typical 10-foot (3-meter) floor-to-floor height and a maximum unlocking zone of 18 inches (45.7 centimeters) above and below the floor, the elevator car doors will be mechanically restricted during 70 percent of the hoistway travel. The probability increases to 95 percent where the minimum unlocking zone of 3 inches (7.6 centimeters) above and below the floor is employed.

In any case, there is a significant potential of being locked in the elevator should there be a loss of power. This is a fact of which most passengers, including the public and emergency responders, are probably unaware.

Emergency operation overview

ASME A17.1, *Safety Code for Elevators and Escalators*, includes special provisions for elevator operation during fire emergencies. These are identified as Phase I Emergency Recall Operation and Phase II Emergency In-Car Operation.

Phase I Emergency Recall Operation is used to take elevators out of normal service. This prevents building occupants from going to the fire floor and also makes the elevators available for use by firefighters. Recall operation can be activated manually by firefighters from the key-operated "FIRE RECALL" switch located at the designated level. Manual activation causes the elevator(s) to return nonstop to the designated level.

Recall operation can also be activated automatically by the fire alarm system in response to the actuation of specific fire alarm initiating devices. These initiating devices are those required at each elevator lobby, elevator machine room, and elevator hoistway when sprinklers are installed in those hoistways. The use of smoke detectors is required unless environmental conditions require the use of another type of automatic initiating device such as a heat detector. Automatic activation of recall operation causes the elevator to return nonstop to either the "designated level" or the "alternate level" as determined by the building configuration and the location of the first of these initiating devices to actuate. The designated level is typically the level where firefighters would normally arrive. The alternate level is used when the first initiating device to actuate is located at the designated level, either in the lobby or in the machine room if it is located at the designated level. Note that only these specific fire alarm initiating devices can activate recall operation. Fire alarm signals from devices in other building locations do not result in elevator recall.

Each elevator car is equipped with a special visual signal (fire hat) that will illuminate when Phase I Emergency Recall Operation is activated manually or automatically. This visual signal remains activated until elevator operation is restored to automatic operation.

Once Phase I Emergency Recall Operation has been activated and elevator cars have returned to the appropriate level, Phase II Emergency In-Car Operation can be activated. Phase II operation is activated manually by firefighters from the key-operated "FIRE OPERATION" switch located in each elevator car. Once activated fire fighters have control of the elevator.

There is a potential that operation of the elevator could be adversely affected during a fire event. To help warn firefighters of this potential, the special visual signal (fire hat) used to indicate that activation of Phase I Emergency Recall Operation is caused to illuminate intermittently (flashing instead of steady illumination). The trigger for this intermittent illumination is when Phase I Emergency Recall Operation is activated automatically by a fire alarm initiating device located in elevator machine room or hoistway, since a fire in these locations could impact the operation of the elevator. It should be noted that when the visual signal is flashing, Phase II Emergency In-Car Operation is still permitted and fire fighters are allowed to continue using the elevator at there own discretion based on their knowledge of the fire conditions.

ASME A17.1 also includes special provisions for automatic elevator shutdown when elevator equipment is located where the application of water from automatic fire sprinklers could cause unsafe elevator operation. The use of heat detectors located in proximity to the sprinkler heads is one means used to achieve elevator shutdown. Heat detector operation causes the main line power to the elevator to be automatically disconnected. This is typically referred to as "shunt trip" due to the name of the mechanism used to operate the main line power circuit breaker. When elevator shutdown occurs the elevator will stop in place due to the failsafe operation of the elevator braking mechanism.

Because of the potential of entrapment associated with shunt trip operation, revisions processed for the 2006 edition of ASME A17.1 will require the heat detectors used for shunt trip to initiate Phase I Emergency Recall Operation and delay the removal of power and the release of water to allow the completion of recall. Note that if the elevators are already operating on Phase II Emergency In-Car Operation, the recall operation will not occur, but shutdown and water release will still be delayed. If the elevator is on Phase II operation, the delay will allow the car to go to the next selected floor. Once the car has stopped at the floor all registered calls are canceled and shunt trip will activate. As a warning to fire fighters of the impending elevator shutdown, the heat detectors used for this operation will also cause the special visual signal (fire hat) to illuminate intermittently. Note that in the case of impending elevator shutdown, once the elevator car has stopped at a landing, it will remain at the landing and car calls will not register. While the new shunt trip provisions should greatly minimize the risk of entrapment, it should be recognized that complete elimination of this risk may not be possible.

Elevators and the fire service

Although elevators normally operate flawlessly, they can fail. Their safe operation should not be taken for granted.

In many jurisdictions, building owners test Firefighters' Emergency Operation (FEO) monthly in accordance with Section 8.6.10.1 of the 2004 edition of ASME A17.1. And authorities having jurisdiction over elevator licensing requirements should also test FEO regularly. In addition, those jurisdictions that have adopted NFPA 1, *Uniform Fire Code*™, should also be testing and assuring at each elevator has an FEO. Since fire fighters cannot be certain when FEO was last tested or the quality of the inspection, however, they should confirm that the elevator is operating properly before using it during a fire.

An elevator's FEO consists of a Phase I and a Phase II.

Phase I is activated by the Phase I key switch or by a fire alarm initiating device (FAID). The FAIDs that initiate Phase I recall are located at each floor the elevator serves, typically in the elevator lobby; in the elevator machine room; and in the elevator hoistway, when required. When Phase I is activated, the elevator ceases normal operation, illuminates the fire fighter helmet pictograph, and returns the elevator non-stop to the designated level or, if the FAID initiating Phase I is on the designated level, to an alternate landing. This keeps the public from taking an elevator to the fire floor and renders the car call buttons, corridor call buttons, and automatic door reopening devices inoperative.

Once recalled, the elevator will not operate until it is reset or the Phase II switch located in the elevator is placed in the "on" position.

Upon arrival at a fire, fire fighters should confirm that all elevators have recalled to the designated or alternate recall floor. This can normally be done from the fire control room. If the elevators have not been recalled, they should be recalled manually using the Phase I key switch in the fire control room. If an elevator does not manually recall, fire fighters must search for it to confirm that no one is trapped inside or above the fire floor.

When a fire occurs at the elevator's designated recall landing, the elevators may automatically recall to an alternate floor. Once at the alternate floor, the elevator can still be recalled manually to the designated landing by activating the Phase I key switch in the elevator lobby or, when applicable, by activating both the Phase I key switch in the elevator lobby and the key switch in the fire control room. The Phase I key switch in the elevator lobby should only be activated when fire fighters know that the designated level is safe.

Before using the elevator, fire crews should check the hoistway for fire, water, or smoke and make sure the helmet pictograph is not flashing. In newer elevators, the flashing pictograph indicates that the elevator may malfunction and possibly trap the fire fighters in the elevator. After checking the hoistway and pictograph, the Phase II key switch must be placed in the "on" position.

Before traveling to an upper floor, fire fighters must test the "door open" and "door close" buttons to confirm that they operate properly. Both buttons require constant pressure in Phase II operation and must be depressed until the door is completely closed or opened. If the button is released before the doors are fully closed or open, they will automatically reverse direction.

Once the doors have been tested, a floor can be registered. While traveling to the selected floor, fire fighters should depress the "call cancel" button to ensure that all car calls cancel and the elevator stops at or before the next available landing. Before leaving the elevator, fire fighters should test the "hold" position of the Phase II key switch to confirm it is operating properly.

ASME A17.1 requires all equipment necessary for the operation of Phase II to be located in the main car-operating panel behind a locked cover, labeled "Firefighters' Operation," that can be opened with the fire service key. ASME A17.1 also requires a "run/stop" switch behind the cover that will cancel all registered calls and cut power to the elevator when placed in the "stop" position.

Training

To prevent injuries and deaths, every fire department should develop, implement, and strictly enforce of standard operating procedures that specifically address elevator use during fires. Every fire fighter and fire inspector should be trained to operate FEO, including Phase I and Phase II, emergency power activation, and fire fighter self-rescue.

Fire fighters, fire inspectors, and building owners must become familiar with the codes specific to elevator FEO. They must be diligent about testing and inspecting its operation and take time to research and implement an elevator-training program. Not only will this increase the reliability of the elevators, but it might save the life of a fire fighter.

Emergency operation on an elevator

In the event of a fire, the Firefighters' Emergency Operation (FEO) on an elevator may prove invaluable in controlling the fire and safely evacuating the building.

Since 1973, ASME A17.1 *Safety Code for Elevators and Escalators*,[12,13] has required that elevators travelling 25 feet (7.2 meters) or more be equipped with a feature that, when initiated, will return the elevator to the main floor or another designated floor of the building. This feature is commonly referred to as Phase I Emergency Recall Operation and can be started with a key-switch or by a fire alarm initiating device.

Beginning in 1981, ASME A17.1 further required all automatic elevators with Phase I Emergency Recall Operation to be equipped with a feature that allows fire fighters or other authorized personnel to operate the elevator during an emergency from within the car. This feature is commonly referred to as Phase II Emergency In-Car Operation.

One of the most reliable methods of ensuring that elevator equipment will function correctly is to verify that it has been properly maintained and inspected

One of the most reliable methods of ensuring that elevator equipment will function correctly is to verify that it has been properly maintained and inspected. ASME A17.1 requires that the Phase I Recall of all elevators with FEO be tested monthly using the lobby key switch and that the Phase II Emergency Operation be tested a minimum of a one-floor run. Deficiencies found during the monthly testing procedure must be corrected.

A record of the test results, usually in the form of a test log located in the elevator machine room, must be made available to elevator personnel and the authority having jurisdiction. A sample monthly fire service test log may be downloaded without charge at www.naesai.org.

Many elevator inspection agencies train fire service personnel how to use the Phase I and Phase II Emergency Recall Operation. If such training is not available, however, fire fighters can follow some basic instructions to ensure that the Phase I and Phase II features are operating properly:

To recall the elevators, fire fighters should insert the key into the designated level key-operated switch, turn the switch to the "on" position, and remove the key. All elevators should return to the designated level and park with the doors open. Then the fire fighters should enter the elevator and push a car button to ensure that the elevator will not leave the floor.

Once this has been verified, the emergency responders can initiate Phase II by inserting the key in the key-switch, turning the switch to the "on" position, and verifying that the key can be removed when the switch is in that position. The responder can then press the desired floor button. If more than one floor button is pressed, the elevator will travel to the first available floor and all other floor calls will be cancelled.

To cancel the floor selection, the responder can press the "Call Cancel" button. The elevator will go to the next available floor, and the doors will stay closed until the next step has been initiated.

Once the car has arrived at the floor, the fire fighter should press and hold the "door open" button to open the car door. If the button is released before the doors fully open, the doors will close. This allows the doors to close immediately if there is a fire or smoke at that floor.

To hold the car at the floor once the doors have opened, fire fighters can turn the key in the car to the "hold" position and remove the key. This will ensure that the car will stay at the landing until Phase II is initiated again or the in-car switch has been turned to the "off" position.

To close the elevator door, fire fighters can press and hold the "door close" button. If the button is released before the doors are fully closed, the doors will reopen.

Finally, to return the car to the recall floor-turn the Phase II key to the "off" position. The car doors will close automatically, and the elevator will return to the recall floor.

Endnotes

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2. *Guide for Emergency Personnel*, ASME A17.4-1999, ibid

3. *Fire Precautions in the Design, Construction, and Use of Buildings*, BS 5588 Part 5 1991, *Code of Practice for Firefighting Lifts and Stairs*, British Standards Institution, London.

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5. NFPA 101®, *Life Safety Code*®, 2000, National Fire Protection Association, Quincy, MA.

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11. Klote, J., Principles of Smoke Management (NFPA 92B), American Society of Heating, Refrigeration, and Air-Conditioning Engineers, Atlanta, GA, 2002.

12. ASME A17.1-2004 *Safety Code for Elevators and Escalators*: Section 2.27–Emergency Operation and Signaling Devices

13. ASME A17.2-2004 *Guide for Inspection of Elevators, Escalators, and Moving Walks.*

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