#3910

PRESENTLY, ELEVATORS ARE NOT SAFE IN FIRE EMERGENCIES

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ABSTRACT

A comprehensive study by elevator experts led to recommendations for code rules to be incorporated into the ANSI/ASME A17.1 Elevator Safety Code. Recommendations were approved by the A17.1 code-making body, and operation of elevators in fire emergencies became part of the elevator code that has almost universal acceptance and has become the basis for local, state, and even foreign codes.

Background information that supports the emergency use of elevators is provided. This information details elevator operation for purposes of providing insight to the uninitiated. Sprinklers, power supply, smoke, pressurization, entrances, and stack effect are among the topics that are covered.

Interface of the A17.1 Elevator Safety Code with the three major Model Building Codes and National Fire Protection Association (NFPA) code committees provides for safe operation of elevators during fire emergencies.

INTRODUCTION

Prior to 1970, the NFPA did not report a single loss of life in a high-rise office building. Unfortunately, since 1970, there have been high-rise fires where loss of life did occur. Although the overwhelming number of fire deaths occur in small buildings, headlines are given to high-rise fires because of the potential for multiple deaths and injuries.

A firefighter's nightmare is a fire out of control in a high-rise during office hours, and the potential for a real catastrophe, rather than a nightmare, exists.

High-rises of 40 or 50 years ago were predominantly of steel construction. In addition, there were steel desks, steel files, and steel or masonry partitions. In contrast, many present-day offices are aesthetic masterpieces, and the population density ratio is greater. Add to this the unbelievable amount of paper that is generated and stored, and one has a tremendous fire load that is increasing yearly.

As a result of the building construction boom, it is safe to say that in the past decade approximately 4000 to 5000 buildings greater than 100 ft in height were built (100 ft is about as high as fire ladders can reach). Furthermore, these buildings qualify as high-rise, since the three major Model Building Codes consider installations of 75 ft or more to be high-rise. Requirements for elevators in these buildings would be mandatory.

High-rise buildings present new and different problems to fire suppression forces, yet the causes of fires, as well as types of materials used, are not different from conventional low-rise buildings. If a fire breaks out in the top floors of a megastructure, firefighters have to lug their equipment up the stairs or risk riding the elevators. As an example of high-rise occupancy, it is possible for about 65,000 people to be in one of the towers of New York's World Trade Center. Thus, the potential for a major catastrophe becomes readily apparent.

If there is cause for alarm, it isn't shared by many people who own and manage high-rise office buildings. They believe that the solutions fire specialists seek are prohibitively expensive when considering the risk of being caught in a high-rise fire. They state that the odds of being killed in a high-rise fire are one in several million—about the same as being killed by lightning (Rustin 1981) (Figure 1).

Firefighters, on the other hand, say that thus far, there has been an element of luck, since many of the fires have occurred after working hours. Even the MGM fire in Las Vegas could have been a worse disaster. It occurred at 7 a.m., when none of the theater activity was going on, and the casino was not very busy. Despite this, it was the third worst high-rise fire in U.S. history, killing 84 people.

On a smaller scale, but relevant to the devastation possible in an office building fire, on February 1, 1974, the

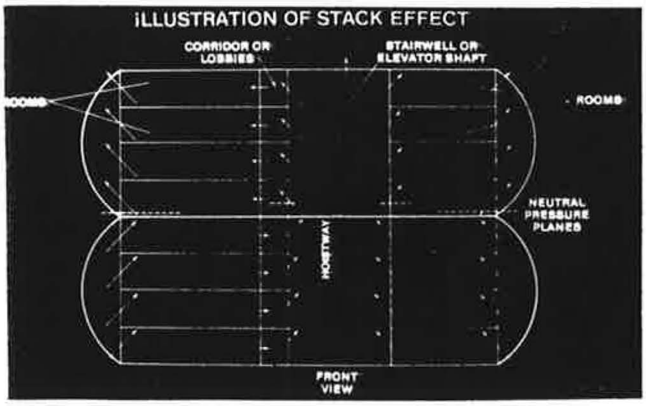

Figure 1 *Illustration of stack effect*

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Joelma Building in Sao Paulo, Brazil, experienced a midmorning fire that started in a window air conditioner on the 12th floor of the 25-story structure (NFPA 1974). The 11th through 25th floors contained offices; below that were parking levels. At the time of the fire, 601 employees were in the office structure—179 of the 601, or 30% of the workers who were present, died in the fire.

Another 300 were injured. Of the 422 occupants who survived the fire, about 300 made their escape by elevators. While they are not recommended for this purpose because of the possibility that occupants could be trapped, the elevators did an excellent job until they were taken out of service because of severe smoke and heat conditions in the hoistways. The success of the elevators in this case could be attributed to two conditions:

1. The use of elevator operators allowed the elevators to be run in express fashion, stopping only at wanted floors.
2. The power supply to the elevators was luckily not affected early in the fire.

The majority of deaths in fires are usually a result of smoke asphyxiation. In the MGM fire, for example, 70 of the 84 deaths occurred on the upper floors where smoke concentration was the greatest (ASME 1983). This could be attributed to building stack effect, where smoke enters the elevator hoistway and vertical shafts on the lower floors and exits above the neutral plane.

Stack effect may also have an adverse effect on elevator door closing. An incident that illustrates how serious this can be occurred in a high-rise building during high wind conditions. The wind blew out a revolving door on the first floor of the building. The ensuing rush of air into the hoistway was so severe that the elevator doors at the first floor of an eight-car bank could not close, thus rendering the entire bank of cars out of service. This could have been even more serious in the event of a fire.

The ANSI/ASME A17.1 Elevator Safety Code (hereinafter referred to as A17.1) did not exclude elevator operation by firefighters. In 1969, supplement "c" to the 1965 A17.1 Code covered fire operation of elevators in Appendix E. Still not content, A17.1 formed an ad hoc fire committee in 1971 to promulgate rules for inclusion in the code proper and eliminate Appendix E. Supplement "b" to the 1971 Code was issued in 1973 and contained an expanded Section 211, which covered firefighters' operation. The need to keep abreast with changing technology, methods, and emergency use of elevators resulted in the ad hoc committee becoming a permanent standing committee.

Before outlining how a firefighter's service functions, it might be advantageous to review why elevators are unsafe in fire emergencies and what the A17.1 committee considered in its deliberations. Elevators are unsafe in fire emergencies because:

TABLE 1
Why Elevators Are Unsafe in Emergencies

1. Persons may have to wait.
2. Elevators respond to calls.
3. Elevators cannot start until doors are closed.
4. Power failure may occur.

TABLE 2
Fatal Delivery

1. Car button pressed.
2. Floor buttons pressed.
3. Heat may melt or deform button or wiring at fire floor.
4. Normal functioning of elevator may by chance stop elevator at fire floor.

1. People may push a corridor button and wait for elevators that may never respond. Valuable time in which to escape may be lost forever.
2. Elevators respond to car and corridor calls. One of these calls may be to the fire floor.
3. Elevators cannot start until the car and hoistway doors are closed. A panic could lead to overcrowding of an elevator and blockage of the doors, thus preventing closing.
4. During a fire, power failure can happen at any moment and lead to entrapment.

Fatal delivery of the elevator to the fire floor can be caused by:

1. An elevator passenger pressing the car button for the fire floor.
2. One or both of the corridor call buttons being pushed on the fire floor.
3. Heat melting or deforming the corridor pushbutton or pushbutton wiring at the fire floor, resulting in a demand for service.
4. Normal functioning of today's efficient elevators, such as high- or low-call reversal, may occur at the fire floor.

As stated, all of the above and more were taken into consideration when writing the code requirements for elevator firefighter operation.

FIREFIGHTERS' OPERATION

Briefly, elevator firefighter operation functions as follows:

Phase I—A three-position switch ("on," "off," and "bypass") is provided at the designated or recall level for each elevator or for each group of elevators. When the switch is in the "on" position, all cars controlled by the switch that are on automatic service are returned to the designated level and park with the doors open. The reason for the elevators parking with the doors open is that it provides the first firefighters on the scene with an instant snapshot of the elevators that have returned. The closed doors would initiate an immediate search for that elevator or elevators in order to check them for possible entrapment. All car and corridor calls are rendered ineffective, as is the in-car stop switch. Phase I is also initiated by activation of smoke detectors that are required in each elevator lobby at each floor and in the associated machine room. Activation of the designated level's detector will send the cars to an alternate level.

No device other than the Phase I switch or the lobby and machine room detectors shall initiate Phase I. The reason for this is that the activation of a sensor remote from the elevator lobby may not warrant elevator recall. For example, a smoldering wastebasket some distance from the elevators could trigger a detector in the immediate area. This by itself would not warrant elevator recall.

The "bypass" position on the three-position lobby switch permits normal elevator service independent of the smoke detectors. Each elevator is provided with a visual and audible signal to alert the passengers when the car is placed on Phase I and the car is returning to the designated level.

Elevator programming is arranged to return automatic cars being operated by designated attendants (except hospital service) after a delay not exceeding 60 seconds. This ensures that no car will be left somewhere in the building with its doors open.

Phase II—A three-position switch ("off," "hold," and "on") is provided in each car for use of emergency personnel at the designated or alternate levels. Placing the switch to the "on" position places the car on Phase II operation and control is from within the car only. Corridor buttons remain inactive. Door opening and closing is activated by constant pressure of the appropriate button. The control of the doors provides the operator with maximum security. If the door "open" button is released before the doors are fully open, the doors will reclose.

When the switch is in the "hold" position, the car remains at the floor with its doors open, and door "close" buttons are inoperative. This permits a firefighter to leave the car without fear of someone walking in and taking the elevator.

When the switch is in the "off" position, with the system on Phase I, and the car away from designated or alternate levels, the elevator will revert to Phase I and return to the designated or alternate level. This provides the firefighters with the capability to send the car back for supplies or for others to use the car without losing a firefighter at the fire scene.

For a complete description of firefighting operation, refer to rules 211.3 through 211.8 in the ANSI/ASME A17.1 Code for Elevators and Escalators.

These rules provide comprehensive guidelines for elevator use during fires and the rules are constantly being reviewed to serve the firefighters' needs. Firefighters participate in the formulation of these rules. The committee is striving to achieve its goal of standardized firemen's operation in the not-too-distant future. This will permit firefighters to enter any manufacturer's elevator and have an identical means of operating the elevators in emergencies. Firefighters are fully aware of the inherent risks involved in using elevators under fire conditions, but they insist that they want the ability to use elevators if they so choose. The A17.1 code is written to make the elevators as safe as possible.

It would be ideal if it could be stated that all elevators function as per A17.1, but they do not. There are approximately 14,000 codes in the United States, and although the majority follow A17.1, there are deviations that require modifications.

ELEVATOR OPERATION

To further complicate the situation, we are always being confronted with demands that elevators should be capable of running during a fire. This is not possible today—someday it might be. Elevators, unlike a simple seesaw, are complex systems. These systems must be designed to meet the rigid requirements of A17.1, but this alone is not sufficient. Elevator operation is directly affected by building conditions that can be detrimental if not properly addressed. For example, would you run an automobile through a flooded underpass? In all probability you would not, knowing that the car could stall out and the brakes could fail. Just as water is not compatible with automobiles, it is not compatible with elevators. Yet, elevators are expected to run with sprinklers in the machine rooms and hoistway. Water can short across safety circuitry and permit elevators to run with their doors open. More than likely, there will be an elevator shutdown, and people will be trapped inside stalled elevators. Just as with automobiles, elevator machine brakes can get wet and not function. To make it worse, an unbalanced situation between the elevator car and its counterweight will cause the car to slip through the wet brake in either the up or down direction, depending on the weight imbalance. This freewheeling effect can have dangerous consequences.

For elevators to continue running during a fire, power must be maintained. Even standby power is of no value if the distribution panel explodes, as it did at the MGM. To achieve the goal of having running elevators, it may be necessary for the building to provide a dedicated, protected power supply for the elevators.

The Veteran's Administration conducted a study on pressurized elevator hoistways and received assistance from the elevator industry in locating suitable buildings. Unfortunately, the supposedly pressurized hoistways that were found proved to be inadequate. In one instance, the fan for pressurizing was found to be reversed. Also, the volume of air required to pressurize a high-rise may be too great to achieve. It is beyond the province of this paper to present a case for or against hoistway pressurization. Suffice it to say that there is not unanimity one way or the other. The major thrust, however, seems to be with air-handling and smoke control zones. Since elevator hoistways are part of the building and, as such, are taken into consideration in air handling, the A17.1 committee did not feel that air handling was within its prime area of expertise and deferred the matter to the three major Model Building Codes. By the same token, hoistway venting requirements were removed from A17.1 and reference was made to the building codes.

Smoke control in buildings is a major consideration and Donoghue (1983) stated the industry position as follows:

> The enclosed elevator lobby presents us with a practical solution, though it may not be as aesthetic as the architect and building owners would like. But there may be other benefits that should be studied when an enclosed elevator lobby is provided. With some modifications in the building code requirements, they possibly could be used as areas of refuge for the handicapped and as safe staging areas for firefighting personnel utilizing elevators operating in Phase II.

Handicapped persons are always a concern, but "handicapped" in the moral context is no longer applicable. Under fire conditions, even a firefighter can be considered handicapped, especially when he is near exhaustion or if his oxygen supply is gone. Further, able-bodied occupants can become handicapped from smoke or from walking up or down steps or from hysteria. Therefore, when engineers hear that provisions must be made for the handicapped during a fire, they should expand the overall picture, because even normally ambulatory persons can suddenly become nonambulatory.

There is no one solution or magic remedy for the use of elevators during fires. It is a complex problem that the A17.1 code committee is committed to resolving. A major step toward resolving this and other issues was the formulation of the Code Coordination Committee. The committee is comprised of representatives from A17.1, the three major building codes (BOCA, SBCC, and ICBO), the NFPA, building owners, inspection authorities, and interested parties. The Code Coordination Committee presents the perfect vehicle for addressing issues that are of the utmost importance. It directs solutions of problems to those with the greatest expertise. This assures coverage that heretofore was not as encompassing as possible. A case in point: requirements for the venting of hoistways were removed from A17.1 and reference was made to the Model Building Codes. It was felt that air-handling expertise was not in the province of elevator suppliers and more rightfully belonged in building code requirements.

CONCLUSION

Presently, elevators are not safe in fire emergencies.

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