

# MULTI-PURPOSE ELEVATORS FOR ACCESSIBILITY AND EMERGENCY-USE\*

by Frederick H. Barker

This article's primary focus is elevator egressibility for persons with disabilities, along with elevator accessibility for firefighters in new high-rise office buildings in the U.S. in the event of a fire condition. The concepts presented in this article can be adapted or expanded for other buildings and locations.

A multi-purpose elevator(s) is proposed for normal, productive uses; people unable to use stairs during a fire; and firefighters after they have arrived and taken command. This safety improvement has precedence in the U.K. and is believed to be more practical than providing all elevators for fire evacuation. Partly to compensate for the costs of this improvement, the secondary focus is promoting curtailment of the Americans with Disabilities Act Accessibility Guidelines (ADAAG)<sup>1</sup> as they relate to providing all elevators in a group for full accessibility. This proposal would be consistent with the proportions of other building provisions providing accessibility under the ADAAG.

## Introduction and Summary

Building management, fire prevention and emergency communications are as important as the building's architectural compartments and electro-mechanical systems. Considering the risks, it is basic to any evacuation elevator concept that the building be appropriately fully sprinklered.

In a building with sprinklers, a dedicated evacuation elevator would likely never be used for its intended purpose, suggesting the elevator be put to other uses and operated and maintained to detect malfunctions before the elevator is ever needed during a fire.

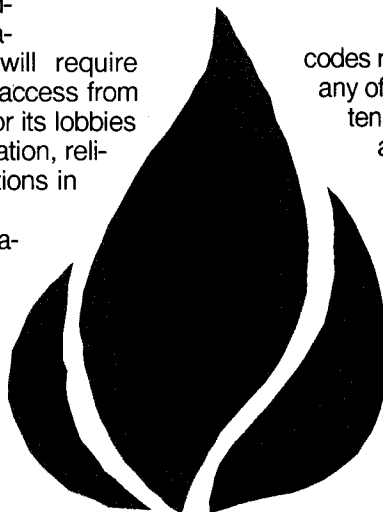
This article supports present model codes for high-rise buildings that embrace the present "defend-in-place" concept of partial building evacuation, plus the multi-purpose elevator(s) outlined herein. This elevator(s) will require compartmentation for its lobbies, protected access from its lobbies to a stairway, air pressurization for its lobbies and hoistway, means to prevent water infiltration, reliable emergency power and some modifications in elevator and related equipment.

It is suggested that this multi-purpose elevator(s) be one elevator in each group of passenger elevators (see Figure 1), one or more dual-entry elevators in the highest-rise

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group of passenger elevators and/or, subject to the approval of the local code authorities, well-managed service elevators as necessary to serve all floor areas except top floor mechanical levels. More than one such elevator would be required for buildings with large floorplates and multiple cores; buildings with sky lobbies, which would also require a protected crossover floor area; and office buildings with large populations of aged persons or persons with disabilities.

A multi-purpose elevator(s) is believed to be more cost-effective than a dedicated firefighting/evacuation elevator required by the British Standards, without compromising inside car size (16.6 ft.<sup>2</sup>/1.54 m<sup>2</sup>, minimum allowed)<sup>2</sup>. It would also be much more cost-effective than proposals for providing all elevators for general evacuation, without compromising our present overall approaches to high-rise buildings.

The ADAAG were apparently enacted without having been established in our model codes, adequately tested design criteria for the accessible means of egress referenced in the ADAAG. These means are: "areas of rescue assistance" or "evacuation elevators." Sample refuge areas were subsequently evaluated by the National Institute of Standards and Technology (NIST) and found to be either "a haven or a hazard" due to design variations, and in many cases, people with mobility limitations could not reach the areas in time. NIST also indicated that a properly designed sprinkler system would provide superior protection to such areas.<sup>3</sup> Regarding the alternative in the ADAAG, the concept of an evacuation elevator presently competes with the Building Officials and Code Administrators International (BOCA) National Building Code and the American Society of Mechanical Engineers (ASME) A17.1 Elevator Code.<sup>4</sup> These model

codes require an elevator be recalled if smoke is present in any of its lobbies. These codes also lack design criteria for tenability in evacuation elevator lobbies and hoistways, and requirements to avert elevator failures due to water infiltration, a loss of power, equipment overtemperature and airborne soot.

Even when our model codes support an evacuation elevator – and despite our best efforts – stairs will still, by their nature, be more reliable than elevators during a fire and should be used as and when directed by everybody who can use them. In the final analysis, appropriate codes, designs, installations and maintenance for a building's compartments and systems, based on the individual nature of the building, will significantly alleviate the potential or

perceived magnitude of the fundamental concern, which is protecting life. By now, we all recognize the role of sprinklers in protecting life, followed by their roles in protecting property and continued operations.

The proposals for general evacuation using all elevators represent a very expensive or problematic departure from our present codes and designs for high-rise buildings. If all the related issues – including descending water and power losses – could be addressed safely and economically, using the elevators well below the fire floors would, someday, help when it is necessary to completely evacuate a tall building. However, based on the issues identified later herein and our progress with accepted concepts for even smaller scale buildings, tall buildings – like existing buildings – should be treated separately.

While a multi-purpose elevator(s) compares favorably in terms of cost and core space to providing a dedicated elevator

or to providing all elevators for general evacuation, the elevator(s) will still increase the cost of new buildings and eventually the cost of substantially rehabilitating an existing building. To help compensate, it is suggested the ADAAG be curtailed for commercial office buildings, from providing all elevators to providing at least one elevator in a group for full-accessibility.

Cost-effectiveness may eventually become the prime requisite to ultimately achieve acceptance among owners, municipalities, manufacturers, design professionals, as well as advocacy groups interested in persons with disabilities, and be the catalyst for amending the ADAAG. There are also other more detailed reasons to revisit the ADAAG for elevators. These reasons are outlined in the next section.

If all elevators are to be both fully accessible and “evacuation elevators,” the elevator cost potential for the ADAAG could be a serious economic mistake. At some juncture, we may need to consider the extent to which our present model codes, which require sprinklers, have been effective; and the degree to which our present elevating for high-rise office buildings already provides a reasonable level of accessibility for persons with disabilities. We should also recognize that our real estate industry is already cost-burdened with other issues.

The concepts herein will provide a workable and reasonable solution to the total elevator access + egress equation for persons with disabilities, and provide the aggregate life-safety and property protection advantages of a better-protected elevator for firefighters.

#### **Detailed Reasons for Revisiting the ADAAG for Elevators (Accessibility)**

It would be helpful if a wide-interest and multi-disciplined interpretive body were established to review and approve suggested changes to the ADAAG, such as the following. This would reduce the present climate of narrow-interest interpretations, debates over goal versus requirement, fears or risks of legal action and hasten improvements without reliance on our legal process.

#### **Accessible Elevators Comply with ASME A17.1-1990**

ADAAG Article 4.10.1 suggests all pre-1990 elevators be upgraded, as necessary, to the 1990 edition of the model elevator code. This code has nothing to do with accessibility for persons with disabilities, and such upgrading would still not provide a single evacuation elevator during a fire. This article also competes with local versions and adaptations of the ASME A17.1 Code.

#### **Door Dwell-Open Timing, Accessibility for Every Elevator in a Group**

ADAAG Articles 4.10.7 and 4.10.8 suggest the doors be delayed from closing for every elevator in every group for most landing calls and every car call, regardless of who is placing the call. Such delays increase waiting times for everybody or can increase elevator equipment or quantity to compensate. This can affect the net/gross efficiency and related costs of new office buildings and their alterations. Moreover, Article 4.10.7 and the word “elevators” throughout the ADAAG support the common elevator industry interpretation that every elevator in a group be made as fully accessible as described.

The ADAAG appear oriented toward single elevators rather than groups of elevators.

#### **Accessible Elevator Sizes**

For new buildings, ADAAG Article 4.10.9, et al. suggest standard floor plans be provided for all passenger elevators. The wider-than-deep configuration is not the only solution to wheelchair mobility, as evidenced by the criteria for a 60" wheelchair turning circle and 36" opening outlined under the ADAAG for an accessible route and for elevators in trans-

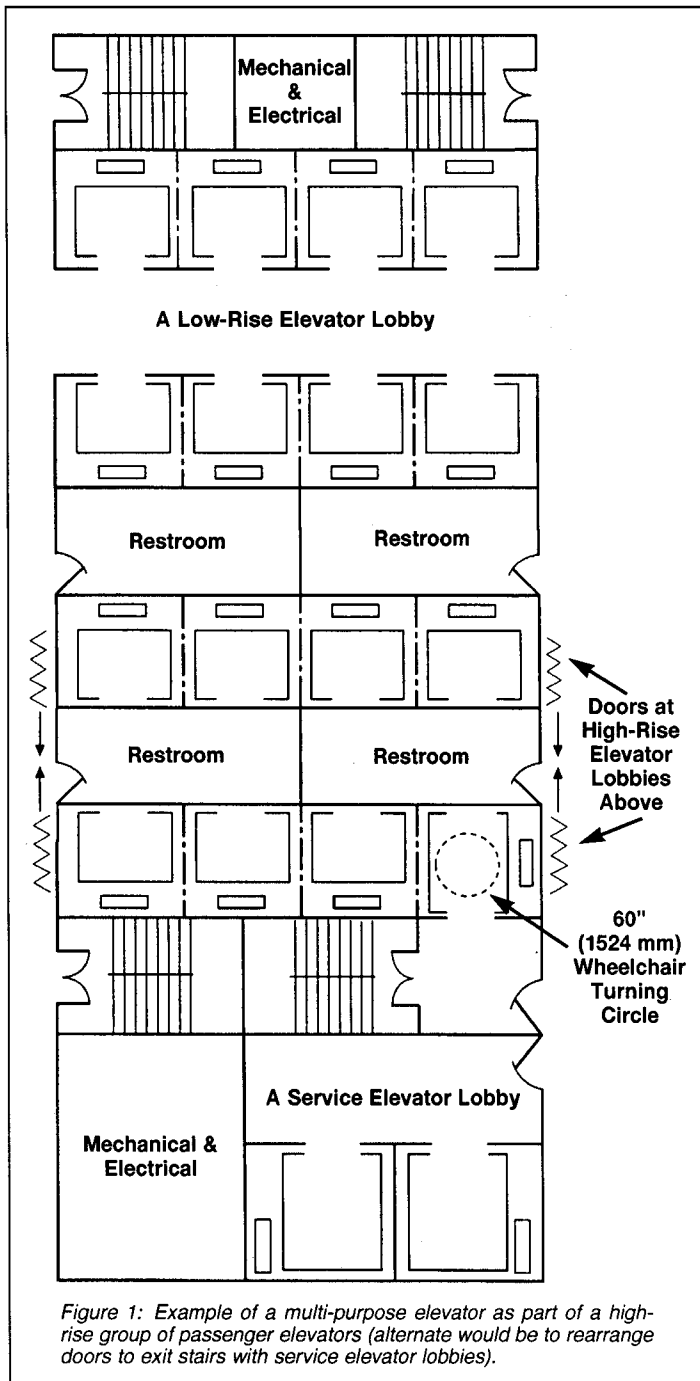


Figure 1: Example of a multi-purpose elevator as part of a high-rise group of passenger elevators (alternate would be to rearrange doors to exit stairs with service elevator lobbies).

## MULTI-PURPOSE ELEVATORS FOR ACCESSIBILITY AND EMERGENCY-USE

Continued

portation facilities. This affects space planning. This also competes with the option of a dual-entry, multi-purpose elevator with a side-located counterweight – the U.K.'s approach to multi-purpose elevator(s) to supplement their dedicated fire-fighting elevator. The ADAAG floor plan with offset door openings to reduce platform width, while sometimes necessary, will increase waiting times further (beyond the door dwell-open timing in the preceding paragraph), and asymmetrical openings in an elevator lobby will pose aesthetic challenges.

ADAAG Article 4.1.6(3)(c) seems to recognize existing hoistway constraints, technical infeasibility, floor plans as small as 48" x 48" inside and equivalent facilitation. However, it would be helpful for interpretive understanding if the detailed criteria for existing elevator floor plans contained in the suggestions made by the National Elevator Industry Association, Inc. (NEII) in 1985<sup>5</sup> were added to this article as a goal.

For major alterations, debates often ensue over whether floor plans for new buildings or alterations should apply. The minimum elevator sizes for alterations do not allow for turning a wheelchair, and there are configurations other than those in Article 4.10.9 for elevators in new buildings which would. All accessible sizes should be clearly recognized due to possible space constraints in new, as well as existing buildings.

### **Non-contact with Elevator Doors**

ADAAG Article 4.10.6 no longer recognizes that passenger contact with the doors may occur, as did ANSI A117.1-1986.<sup>6</sup> Typical passenger-protective devices for reopening elevator doors are mounted on the car doors and protect generally in that plane only. They do not protect directly against the connected landing doors. The range or responsiveness of the electronic or retracting edge used, the thickness and mass of the landing doors, particularly at the main floor, and differences in hoistway air movements on cold versus warm days can all affect the degree of protection afforded. An additional sensor not unlike those over automatic building doors could be productively incorporated in the car door track area and aimed at a point or range in the landing opening. Additional research is recommended in this area.

Door-"nudging" operation also appears contrary to ADAAG Article 4.10.6.

### **Heights of Car Controls, Call Buttons and Entrance Floor Designations**

Apparent inconsistencies in heights appear among various articles in Section 4.10: Landing buttons at 42", floor designations on entrance frames at 60", top floor buttons in car control panels ≤54/48" (for side/front wheelchair approach) and car emergency controls at 35", are all considered accessible. Call buttons are being lowered in many elevator lobbies, where it is usually easier to turn a wheelchair than inside the cab or entrance opening, where much higher buttons and designations are suggested by the ADAAG. It has also been difficult to lower the top floor buttons in elevators that serve many floors without creating a confusing arrangement of controls. Additionally, the designations for the lowest floor buttons and emergency controls become difficult for many people to read, especially by taller, visually impaired people.<sup>7</sup>

Widespread modifications for existing elevators may not be necessary. Also, alternative technologies may help alleviate the height/visibility issue for elevators to be made fully accessible.

### **Door-Open and Door-Close Buttons**

Door-close (or >|<) buttons are typically inoperative in ele-

vators in the U.S. during automatic operation. Moreover, placing the door-close button next to the door-open or (<|>) button at 35" can delay reaction time for a passenger attempting to stop the doors from closing on a person with disabilities or for a firefighter attempting to close the doors. For an elevator with front and rear doors (dual-entry), there may simply be insufficient reaction time as one searches for the right button among an array of buttons at 35" labeled, "<|>F, >|<F, <|>R, >|<R." At a minimum, door-close buttons should be located elsewhere in car control panels where quickly accessible to firefighters and building staff.

### **Alternative and New Technologies**

One of the benefits the ADAAG interpreting body suggested earlier would be the possibility to review changes in technology and equivalent facilitation. For example, numerical keypads, considered accessible for public telephones and with a common order of buttons, could solve some height and visibility concerns if used in lieu of conventional floor buttons in car control panels. Actually, keypads may soon be found at elevator call stations in more lobbies in the U.S., at least at floors above the main floor in suburban office buildings for entering interfloor destinations in advance. New technologies are also arising as a result of the thought the ADAAG have encouraged.

### **The Quantity of Elevators in a Group Providing Accessibility**

Most existing elevators in high-rise office buildings still provide a reasonable degree of accessibility for some persons with disabilities. Having accepted this, we should focus more closely on the quantity of elevators in a group to be made (or assigned as being) fully accessible.

Considering the quantities or proportions of a building's parking spaces, wheelchair spaces in assembly areas, toilets, entrance doors, drinking fountains, telephones and nonelevator accessible routes to be made accessible under the ADAAG, specially equipping and sizing every elevator in a group for full accessibility appears uniquely disproportionate for commercial office buildings, and it is also unnecessary from a technological standpoint.

A concept for equipping less than all elevators in a group for accessibility (see Figure 2) was suggested to the American National Standards Institute (ANSI) in mid-1988. This included a separate call station at every floor next to the specially equipped elevator. These stations were to be used by persons with disabilities to temporarily call the specially equipped elevator away from the group, in semi-express fashion, so as not to delay passengers who may be aboard. Once a special call was placed, the elevator would not take any new calls until the special call(s) was answered. The elevator would stop en route or reverse direction after its highest or lowest car call and answer the special call. To reduce accidental or intentional misuse, signaling was included to announce arrival and direction separately at the landings and to immediately alert passengers in the elevator that a special call had been placed. The concept avoided delaying every elevator in a group for every call and should be revisited proactively under the ADAAG review body suggested.<sup>8</sup>

Another professional has suggested using these separate call stations to actuate (on-demand) the extended door-open times for elevator car calls and the in-car audible floor-passing signal or voice announcement suggested by the ADAAG. Still others have suggested a building directory of accessible provisions or a nationwide key/card system for persons with disabilities. *The latter may have special merit to minimize misuse of a multi-purpose elevator during a fire.*

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## MULTI-PURPOSE ELEVATORS FOR ACCESSIBILITY AND EMERGENCY-USE Continued

Further studies should be made to determine the appropriate quantity or proportion of elevators in a group to be made fully accessible in commercial office buildings. If we accepted the elevator traffic performance considered acceptable for multi-family housing by the U.S. Department of Housing and Urban Development<sup>9</sup> – a single-elevator interval of 144 seconds – and based our calculations on standard estimating methods<sup>10</sup> and the semi-express operation described above and perhaps adjusted the elevator to maintain medium size car loads, we might accept one or two elevators per group. We might even accept one elevator per group based on the characteristics and availability of the other elevators in an office building and the hope that our viewpoint might help pave the way for at least one evacuation elevator per building.

### The "Defend-In-Place" Concept

Our present model codes and designs for high-rise buildings generally embrace the concept of partial evacuation, sometimes referred to as "defend-in-place."<sup>11</sup> The components of this concept may include systemized smoke and heat detection, automatic sprinklers, pressurized egress stairways, air pressure sandwiching of and smoke venting for the fire floor(s), shaft venting, fire-resistive compartments and materials, smoke barriers, firestopping, doors, emergency power, signaling, communications, a fire command station and a host of other considerations beyond the scope of this paper.<sup>12</sup>

Perhaps the strongest argument for partial building evacuation is found in an argument for nonevacuation in compartmented fire-resistive buildings. It is argued that most deaths occur when people attempt to evacuate under conditions of smoke and open doors, and concluded it is safer for disabled and nondisabled persons alike generally to stay in place and be protected by the building's fire-resistive compartments.<sup>13</sup> Certainly, the inhalation of smoke and gases is commonly recognized as causing most deaths in building fires, or approximately 75% as compared to 25% by thermal causes.<sup>14</sup> However, total nonevacuation concepts can fall apart during multiple city-wide emergencies or the widespread failure of a building's compartments or systems (i.e., terrorist attack). Pure-compartmentation theories also attempt to debate the need for sprinklers.

Our pertinent concerns with the defend-in-place concept seem to be: that some people with disabilities may be unable to reach a stairway landing or other refuge area in time, that the refuge area may not be reliable and that some people with disabilities may not be able to use an egress stairway. The multi-purpose elevator will provide an accessible means of vertical egress for people who cannot use stairs. It will not improve the potential of reaching its lobby, particularly if the elevator's emergency entrance is away from a regular access path. There is also potential that the elevator will not respond; in which case, the elevator's lobby or the stairway landing area connected to its lobby by way of a door must be relied upon for refuge or rescue.

All things considered, including the performance of the model codes or insurance criteria that require sprinklers, and the case studies of people helping their fellow man during a fire<sup>15</sup>, the multi-purpose elevator will still be a safety improvement to what we now have, and a workable alternative to redesigning buildings to provide all elevators for general evacuation. In the final analysis, we could help alleviate our residual concerns by stressing fire prevention, training, drills, communications and even "buddy" assignments for persons with disabilities.

After all is said and done regarding the period of time a person with disabilities may require an evacuation elevator, a *better-protected elevator will still help firefighters help us "defend-in-place."* The New York City Fire Department has for several years sought just one water-resistant elevator.<sup>16</sup> They postponed their quest pending the final outcome of an evacuation elevator(s) under the ADAAG and/or their efforts as part of a task group initiated by the ASME A17.1 Emergency Operations Committee to study the issue of elevator reliability with water entering hoistways.<sup>17</sup>

### All Elevators for Evacuation, Tall Buildings, Smokespread

Arguments against using all elevators for general evacuation can also be derived from the

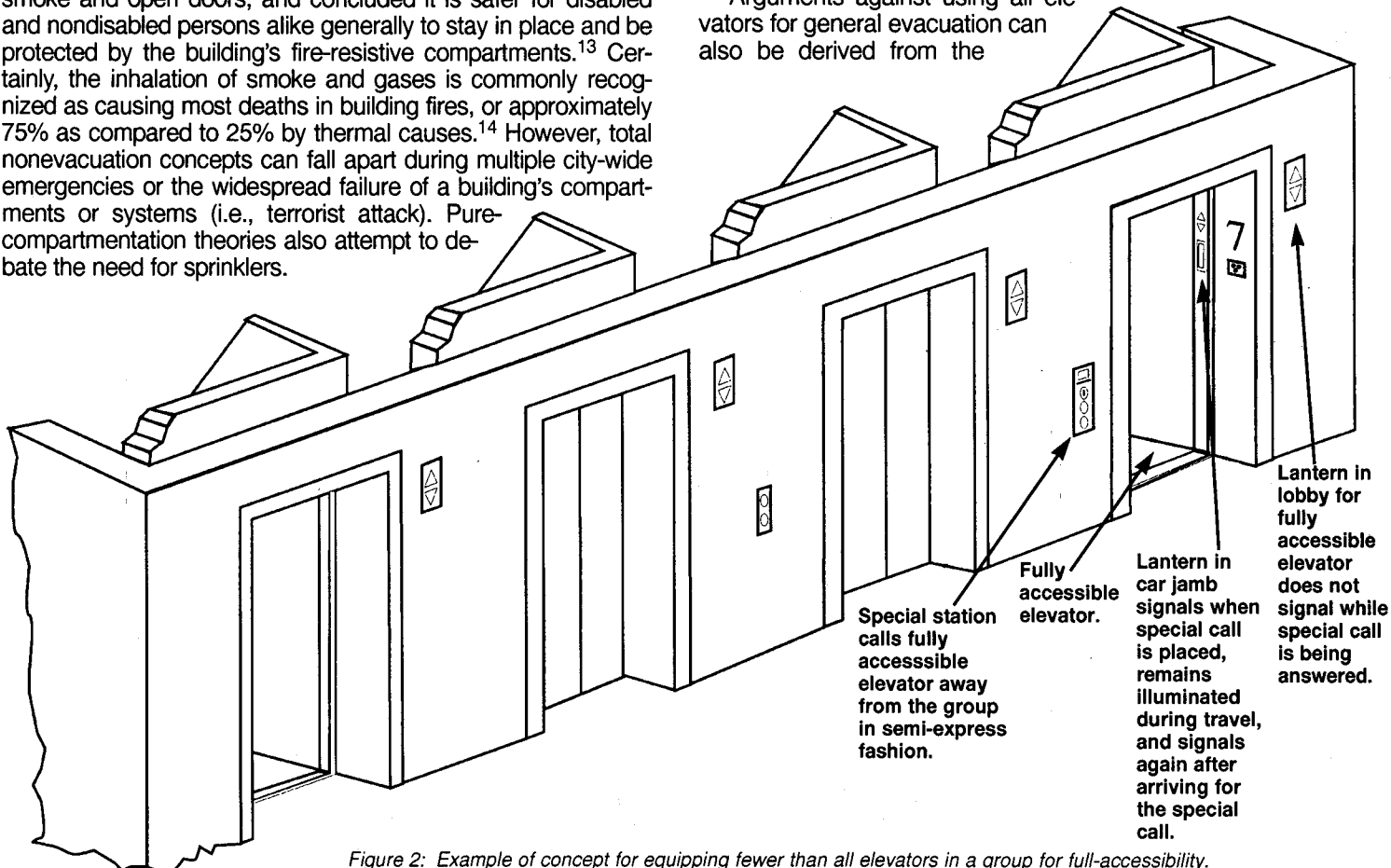


Figure 2: Example of concept for equipping fewer than all elevators in a group for full-accessibility.

somewhat radical argument for nonevacuation referenced earlier.<sup>18</sup> Adding to these arguments would be issues regarding human behavior, elevator lobby sizes to accommodate the crowd, holding elevator lobby doors open, car overloading and holding elevator doors open, heightened concerns of elevator reliability, increased elevator dependency on building emergency systems, protected access from elevator lobbies to a backup stairway(s), the amount of pressurized fresh air required, the amount of emergency power required (even for elevators with the advantage over the counterweight of full car loads going down) and firefighters' issues — such as counterflow traffic and conflicting demands for elevators. There are also detailed issues, some of which are found in a later section herein on designs providing just one multi-purpose elevator.

Full evacuation elevating would change high-rise buildings radically. Elevator lobbies would have to be oversized, increasing core space and normal elevator boarding and waiting times. Open-ended elevator lobbies which facilitate normal peak pedestrian flows would have to be provided with special automatic folding doors. Protected access to a backup stairway(s) would have to be found, along with alternate locations in or out of the core for restrooms. These are in addition to the increases in supportive building mechanical and electrical systems.

A proposal to shuttle elevators to help evacuate one floor at a time to increase elevator group handling capacity and free up the stairways may someday facilitate the challenge of completely evacuating a tall building.<sup>19</sup> The margins for safe exiting have been noted as more limited in tall buildings.<sup>20</sup> However, this suggestion should only be considered for elevators located entirely, and well below, the fire floors. These elevators can still be affected by descending water, power loss and cool smoke. While the complexities of smoke movement are better understood today, thanks to earlier research efforts<sup>21</sup>, similar research efforts will be required on the movement of water used during a fire as it relates to all building emergency systems.

Emergency exiting worked well during the fire following the explosion at the World Trade Center (see ELEVATOR WORLD, June 1993). What we should recall from that event is that smoke can quickly migrate up elevator hoistways and on to upper floors, due partially to the gaps around conventional elevator doors, open elevator lobbies and natural stack effect.<sup>22</sup> Smoke migration by way of elevator hoistways could be substantially reduced in the future with flexible smoke seals/brushes around the gaps of all elevator landing doors in the building. Brushes suitable to 400°F (204°C) and representative wind velocities have been tested in the U.S., installed on fire-fighting elevators in the U.K. and will reduce the size of the hoistway pressurization fan(s) required for an evacuation elevator. (Such brushes/seals may also have some impact on reducing normal HVAC energy costs.)

#### ADAAG in Context

Faced with a fire on a high-rise floor, those who do not have a mobility limitation could safely reach and use an egress stairway, particularly if they had participated in the building's fire prevention program and received a fire warning. This evacuation could commence without waiting for firefighters to make their way through busy city traffic, identify the floor of incidence, take a conventionally protected elevator to no higher than two floors below the fire floor<sup>23</sup> and then walk to find and reach the area of rescue assistance.

#### Developing Codes and Designs for Multi-Purpose Elevators

In the final analysis, improvements in building compartments and systems will be needed for multi-purpose elevator(s). Ele-

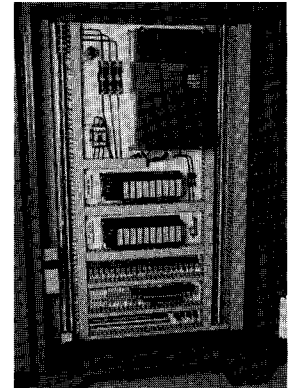
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vator manufacturers cannot provide an elevator for evacuation purposes all by themselves.

Significant code thought on such elevators can be found in the British Standards (BS) 5588: Parts 5 and 8.<sup>24</sup> Included are dual-entry elevator(s), consistent with the option of providing the multi-purpose elevator(s) as part of the high-rise group of elevators. Following are some detailed issues for any evacuation elevator:

### **Water from Sprinklers and Attack Lines, Water-Flow Switch Signals**

Water from sprinklers and firefighters' attack lines can affect the reliability of elevators, related electrical systems and certain hoistway wall construction. Elevator operation can quickly cease after water infiltrates hoistways, machine rooms or related electrical distribution or supply areas. Means to prevent water from entering these areas initially will reduce the elevator and electrical designs necessary to hedge against failures and hazards. Criteria for floor drains and/or slopes at elevator landings can be found in BS 5588: Part 5. Full-width guide gibs or guide gib brackets at the bottom of elevator landing door panels, noncontact closure angles at the trailing edges of panels and smoke brushes/seals for all remaining door gaps may help impede or strategically divert some water as it heads for the hoistway. To the extent all such preventive measures test ineffective, the location, arrangement, covering and/or enclosing of certain elevator equipment will need to be (and is being) revisited.<sup>25</sup>

"Appropriately fully sprinklered" in the Introduction and Summary referred to appropriateness of sprinklers in elevator machine rooms and top-of-hoistways, as examples, consistent with the latest requirements of the National Fire Protection Association (NFPA).<sup>26</sup> Fires in newer elevator machine rooms are infrequent, not known to have caused any major fires outside the room and less likely to occur with adoption of the Canadian Standards Association B44.1/ASME A17.5 Code for Elevator and Escalator Electrical Equipment for new elevators and elevator components upgraded. When elevator machine room sprinklers discharge, property may be damaged; the elevators will likely be out of service for firefighters; and unless the appropriate systems are installed, passengers or firefighters will be potentially stalled somewhere in-travel for the long-term. Where machine room sprinklers are mandated or appropriate, it is appropriate to provide coordinated systems of smoke detectors to recall the elevators, a preaction sprinkler system with compatible high-temperature on-off heads, an indication the elevators operating have safely arrived at the main floor, heat sensors to arm the preaction system, circuit breakers in lieu of fused disconnect switches as the normal means to disconnect the power and an automatic power-disconnecting means.

In lieu of such systems for sprinklers in a machine room, it may be appropriate to focus more closely on sprinklering the non-hoistway areas surrounding the room, means to keep the water from infiltrating the room, and elevator controller overtemperature signals in the car and at the elevator fire command station to inform building staff and firefighters of the condition at the machine room. In the final analysis, local debates over sprinklers in machine rooms may someday disappear, considering we are at the advent of enclosed AC motors, and machine brakes which can be covered, for high-speed elevator machines in the U.S.

Sprinklers in hoistways are considered ineffective, problematic in terms of safe elevator operation and unnecessary under

the latest edition of NFPA 13, where elevator car enclosures have limited combustibility in accordance with the 1985 or later edition of ASME A17.1. The most useful place for such sprinklers is the pit, particularly for service and freight elevators. The related elevator operation, equipment and drainage issues for sprinklers in pits are beyond the scope of this paper.

We all recognize the application of water as an effective fire-fighting, life-saving means and, therefore, are beginning to recognize a primary design criterion for its use. From a combined perspective, signals from the sprinkler system water-flow switch at every floor can be useful in pinpointing the location of the fire floor(s). Due to the dynamics of building air movements, smoke detector signals, while necessary, may be relatively less accurate. Sprinkler flow signals could provide valuable information for firefighters operating an elevator manually or enable more dynamic automatic recall operation beyond today's alternate floor recall<sup>27</sup> for the other elevators. In developing more dynamic elevator recall operations, it will still be important to firefighters to have elevator service at the main floor, which supports the concept of a protected elevator.

### **Protecting Related Electrical Work from Water and Heat**

The importance of maintaining necessary electrical power cannot be overstated for essential life-safety systems, including those elevators to be used during a fire. Power supplies and distribution can be affected by water or heat. It would be prudent to dedicate the electrical feeder and emergency power transfer switch for the evacuation elevator(s) and protect these services by placing them in the hoistway and machine room, respectively. The protection and location of the emergency power source, usually a diesel engine generator, sometimes located near the top of the building, is beyond the scope of this paper.<sup>28</sup>

Placing an elevator main electrical feeder in an elevator hoistway is an area where trade and code jurisdictions may need to compromise and coordinate for the common good. Similarly, wiring for intercommunication with the evacuation elevator's lobbies, as well as wiring for addressable smoke detectors and sprinkler water-flow switches related to this elevator, could also be protectively and productively placed in the hoistway.

### **Smoke and Air Movements, Elevator Door Operation**

Pressurized fresh air is necessary for tenability for the elevator's evacuation purpose. Only firefighters presently have self-contained breathing apparatus. Pressurization should be provided for the elevator's compartmented lobbies to help keep smoke from infiltrating into these lobbies and indirectly into the car enclosure. The hoistway should also be pressurized in the event the elevator is stalled in-travel. The capability of venting the hoistway to outside air, which could be by way of rated duct through the elevator machine room, should be provided in the event power to the fan(s) ceases as a means to smoke-purge the hoistway. The capability of venting the machine room separately may also be necessary.

As introduced earlier, flexible smoke brushes/seals should be provided around the perimeter gaps of all elevator landing door panels involved to help reduce smoke infiltration, reduce the size of the air handling equipment (particularly since the elevator's hoistway may be shared with other elevators) and reduce leakage for the overall smoke control effort. As described earlier, such brushes/seals should actually be installed on every elevator landing door in the building to reduce smoke migration onto the floors by way of elevator hoistways.

The multi-purpose elevator could share its now airtight hoistway with up to three other elevators consistent with standard practices. As a design option to reduce the air handling equip-

ment and connected emergency power load and to add compartmentation, a hoistway divider wall could be provided. The wall should leave at least two high-speed elevators in a common hoistway with adequate space to allow for normal air piston effect, compounded by normal or reverse stack effect. As further necessary to maintain normal high-speed elevator ride quality, piston-effect relief vents to inside air could be considered in the hoistway, coordinated with smoke control dampers for each vent and smoke venting at the top.

The elevator's doors must be able to close during induced air pressures and natural stack effect conditions, including times when firefighters would fold revolving building-entry doors open on a cold, wintery day. Weighted-type auxiliary landing door closers and closed-loop elevator door operator controls would help provide positive closing assistance through the entire travel of the door and maintain safe closing power in response to varying air resistances.

To minimize the amount of soot and heat that can enter the machine room, the deflector or secondary sheaves for all elevators in the room should be arranged to reduce floor penetrations to the minimum amount necessary for ropes. Optimally, these sheaves would be located above the machine room floor for servicing and acoustics. Machines located below could be similarly arranged with a protective wall utilizing two deflector sheaves on the hoistway side of the "basement" machine room wall.

All code and design professionals involved with elevators and fire will become keenly interested in a building's neutral pressure plane at the hoistway. Temperature and pressure differentials outside the building and normal and reverse stack effects move buoyant hot smoke upwards and cool smoke downwards throughout the building. The effects of wind, leakage and induced changes in pressure<sup>29</sup> will also become of interest.

#### **Equipment Temperature Tolerance**

Machine room air conditioning prolongs reliable controller operation and component life, provides a comfort level for personnel providing needed maintenance and repairs, and if properly coordinated, could work to extend emergency elevator operation during a fire. While air conditioning may be a dedicated unit inside the machine room that recirculates the air, such units may or may not be shut down during a fire, depending upon the locations of connected smoke detectors and local code requirements. A cross-disciplinary effort should be undertaken to review the issues involved with maintaining machine room air conditioning during a fire. Reliable sprinkler protection for all nonhoistway areas surrounding the machine room will also work to reduce temperature.

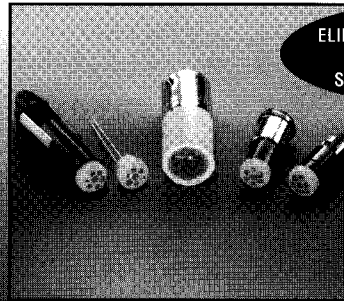
Operating temperature tolerances should be established for the evacuation elevator's equipment. These could be maintained by a dedicated air conditioner mounted on and powered with the elevator controller, single-car emergency operation, capability for the passage of regenerative power – including for variable frequency AC drives, and/or practical improvements in elevator controller components, including electronic insulators, boards and wiring connections.<sup>30</sup> Firefighters may also desire a selectable option for reduced-speed operation particularly during the advanced stages of a fire. This option will also work to reduce heat generated by the elevator machine room equipment.

#### **Elevator Fire Command Station**

For high-rise office buildings where there are several groups and/or scattered locations of elevators, a centralized elevator fire command station should be provided for the emergency management of the vertical transportation system amongst other complex building systems. The station should clearly dis-

*Continued* ▶

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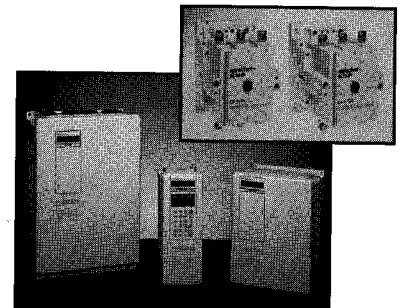
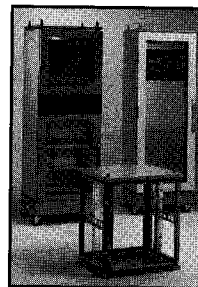
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## MULTI-PURPOSE ELEVATORS FOR ACCESSIBILITY AND EMERGENCY-USE

Continued

play the location, position, direction, doors open/closed and operation mode of every elevator simultaneously. The station should be located near the building's fire command station in an area staffed at all times, and should be equipped with elevator emergency power controls, an auxiliary firefighters' recall switch for each group of elevators, a controller overtemperature signal for each elevator, and an intercommunication master station encompassing all elevators, machine rooms and evacuation elevator lobbies. Computer keyboard-actuated controls should be avoided for elevator emergency controls requiring timely actuation. Elevator fire command stations can be productively combined with normal elevator management and security controls in building security rooms.

### Service Elevator(s) Option for the Multi-Purpose Elevator

The term "service elevator" is an accessible passenger elevator used primarily or secondarily to transport materials with the required combination freight ratings. It would be helpful if service elevators were defined as such under the ASME A17.1 Code. What are traditionally known as "freight elevators" may have vertical bi-parting doors and operation or control of leveling not conducive to use by persons with disabilities. Such ele-

vators are provided in few office buildings today and are also not considered accessible under ADAAG Article 4.10.1.

Service elevators usually share the important advantages with freight elevators of being larger, serving most floors with minimal transfers and having a core location with a separate vestibule. On the other hand, service elevators may similarly be operated by an attendant who can walk away, requiring emergency signals following a delayed response. Additionally, their lobbies may be cluttered with debris and extend to basement areas. If the service elevator option is exercised for the multi-purpose elevator(s), these fire prevention issues will need to be addressed proactively by owners, managers and local code-enforcing authorities.

Considering the advantages of service elevators and that based on some old "rules of thumb," a service elevator may be provided for every 300,000 to 500,000 square feet of commercial office building space, it may be practical to equip all primary service elevators as multi-purpose elevators.

*The code option providing service elevators as multi-purpose elevator(s) should not be discounted. We should consider the anticipated magnitude of the problem for new sprinklered buildings and the challenge establishing consistent code concepts when we begin to examine the requirements for substantially rehabilitating an existing high-rise office building.*

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