



# Elevators, Fire, and Accessibility

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**MULTI-PURPOSE ELEVATORS FOR PERSONS WITH DISABILITIES AND  
FIREFIGHTERS IN NEW HIGH-RISE OFFICE BUILDINGS IN THE U.S.  
(WITH CONCEPTS FOR ACCESSIBILITY AND  
OTHER BUILDINGS AND LOCATIONS)**

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### ABSTRACT

The primary focus is elevator egressibility for persons with disabilities and elevator accessibility for firefighters in new highrise office buildings in the U.S., in the event of a fire condition. The concepts 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 UK and is believed by the author to be more practical than providing all elevators for fire evacuation. In part to compensate for the costs of this improvement, the secondary focus is to promote curtailment of the Americans with Disabilities Act Accessibility Guidelines (ADAAG) as they relate to providing all elevators in a group for full accessibility, which 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 will be 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, it is likely a dedicated evacuation elevator would never be used for its intended purpose. This suggests the elevator be put to other uses, and operated and maintained to detect malfunctions before the elevator is ever needed during a fire.

This paper supports our present model codes for

highrise 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, one or more dual-entry elevators in the highest-rise 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 skylobbies, 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 by the author to be more cost-effective than the British Standards for a dedicated firefighting/evacuation elevator, without compromising inside car size (16.6 sq.ft./1.54 sq.m., minimum allowed)? and 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, adequate and 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 **BOCA** National Building Code and the **ASME-A17.1 elevator** code! These model codes simply require that **an** elevator be recalled if smoke is present in any of its lobbies. These codes also lack, for example, 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 could be **addressed** safely and economically, including descending water and power **losses**, using the elevators well below the fire floors would 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 to providing **at** least one elevator in a group for full-accessibility (from providing **all elevators**).

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

If all elevators **are** to be both fully-accessible and be "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, to which our present **elevatoring** for high-rise office buildings already provides a reasonable **level** of **accessibility** for some **persons** with **disabilities**, and to which 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 lifesafety and property protection advantages of a better-protected elevator for firefighters.

#### **DETAILED REASONS FOR REVISITING THE ADAAG FOR ELEVATORS (RE: ACCESSIBILITY)**

It would be helpful if a wide-interest and multi-disciplined interpretive body were established to review comments such as the following, and approve changes to the **ADAAG**. 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-A 17.1-1990**

**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 every landing and 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 in. wheelchair turning circle and 36 in. opening outlined under the **ADAAG** for an accessible route and for elevators in transportation facilities. This affects space planning. This also competes with the option of a dual-entry, multipurpose elevator with a side-located counterweight, which is the U.K.'s approach to multipurpose elevator(s) to supplement their dedicated fire fighting elevator(s). 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 pose aesthetic challenges with asymmetrical openings in an elevator lobby.

**ADAAG** Article **4.1.6(3)(c)** does recognize existing hoistway constraints, technical infeasibility, floor plans as small as 48 in. x 48 in. 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 aerations, debates often ensue over whether floor plans for new buildings or alterations should apply. The minimum elevator sizes for aerations 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 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 @ 42 in., floor designations on entrance frames @ 60 in., top floor buttons in car control panels ≤ 54/ 48 in. (for side/ front wheelchair approach), and car emergency controls @ 35 in., 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 a confusing arrangement of controls, and the designations for the lowest floor buttons and emergency controls are also difficult for

many people to read, including 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 the elevators to be made fully-accessible.

- **Door Open and Door Close Buttons**

**Door-close** or ">|<" buttons are typically inoperative in elevators in the U.S. during automatic operation. Moreover, placing the ">|<" button next to the door open or "<|>" button @ 35 in. 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 @ 35 in. 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 of the ADAAG interpreting body suggested earlier would be to review changes in technology and equivalent facilitation. For example, numerical keypads, which are considered accessible for public telephones and have 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 as 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 has encouraged.

### THE QUANTITY OF ELEVATORS IN A GROUP PROVIDING ACCESSIBILITY

It is believed by the author that 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 be able to 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 non-elevator 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. It is also not necessary from a technology standpoint.

A concept for equipping less than all elevators in a group for accessibility 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.*

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 (HUD),<sup>9</sup> which is a single elevator interval of 144 seconds, and we based our calculations on standard estimating methods<sup>10</sup> and the semi-express operation described above, and perhaps we even 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 to generally 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 non-evacuation concepts can **fall apart** during multiple citywide emergencies or the widespread failure of a building's compartments or systems (e.g., terrorist attack), as examples. Pure compartmentation theories also attempt to debate the need for sprinklers.

Our pertinent concerns with the defend-in-place concept appear 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 be a safety improvement to what we now have, and a workable **alternative** to redesigning our 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** all, "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, SMOKE SPREAD

Arguments against using all **elevators** for general evacuation can also be derived from the 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 back-up stairway(s), the amount of pressurized fresh air required, the amount of emergency power required (even with the advantage over the counterweight of **full** car loads going down), and firefighters' issues such as **counterflow** traffic and conflicting demands for

vertical transportation. There are also detailed issues, some of which can be found in a later section herein on designs to provide just one multi-purpose elevator.

Full evacuation elevating would change high-rise buildings radically. Elevator lobbies would have to be oversized, which would increase 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 back-up **stairway(s)** would have to be found, along with alternate locations in or out of the core for restrooms, for example. 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 help **free-up** the stairways, may someday help facilitate the volumetric challenge of completely evacuating a tall building? **The** margins for safe **exit** in have been noted **as** more limited in tall buildings! 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, a power **loss**, and cool smoke. While the complexities of smoke movements are better understood today, thanks to earlier research efforts? similar research efforts will be required on the movements of water **as** they relate to all building emergency systems.

Emergency exiting worked during the fire following the explosion at the World Trade **Center**. What we should recall from that event is that smoke can quickly migrate up elevator hoistways and onto 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., have been installed on firefighting elevators in the U.K., and will reduce the **size** of the pressurization **fan(s)** 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, most of us who do not have a mobility limitation could safely reach and use an egress stairway, particularly if we had participated in the building's fire prevention program **and** received a fire warning. We would not have to rely on help from our fellow man (although we all do to some degree). We would not have to wait for firefighters to make their way through busy **city** traffic, **learn** our location, take a conventionally-protected elevator to no higher than two floors below us,<sup>23</sup> and then walk to find and reach our area of rescue assistance.

## DEVELOPING CODES AND DESIGNS FOR THE MULTI-PURPOSE ELEVATORS

In the final analysis, improvements in building compartments and systems will be needed for the multi-purpose elevator(s). Elevator 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), which are consistent with the option of providing the multi-purpose elevator(s) **as** part of the high-rise group of elevators. The following upon some of the 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 or 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 slope at the elevator's 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, **non-contact** closure angles **at** the trailing edges of the 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?

"Appropriately fully-sprinklered" in the Introduction and Summary referred to the 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 will be even less likely to occur with the adoption of the **CSA-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, there is the potential that passengers or firefighters will be 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 sprinkling 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 disappear someday, considering we are at the advent of enclosed a.c. motors, and 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 in 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. (Some code criteria for sprinklers in pits can be found in **BS-5588**: Part 5.)

We all recognize water as life-saving and we are beginning to recognize water as a primary design criterion. 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.

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

The importance of maintaining the necessary electrical power cannot be overstated for essential lifesafety systems, including 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, which is usually diesel engine generators that are sometimes located near the top of the building, are 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 for the evacuation elevator's lobbies and wiring for addressable smoke detectors and sprinkler water-flow switches related to this elevator could also be protectively, and productively, placed in the elevator's hoistway.

#### o **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 for 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 for 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, help reduce the size of the air handling equipment (particularly since the elevator's hoistway may be shared with other elevators), and help reduce leakage for the overall smoke control effort. (As described earlier, such brushed 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-air-tighter hoistway with up to three other elevators, consistent with standard practices. As a design option to reduce the air handling equipment 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, and smoke venting at the top.

The elevator's doors must be able to close based on the induced air pressures and natural stack effect conditions, including times when firefighters would fold revolving building entry doors open on a cold wintry day in Chicago or New York, for example. 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 motive closing power based on the

varying air resistances, respectively.

To help 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 penetrations between the floor and hoistway to the minimum manageable amount 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 as it relates to temperature and pressure differentials outside the building, and normal and reverse stack effects moving buoyant hot smoke upwards and cool smoke downwards, as well as the effects of wind, leakage, and induced changes in pressure.<sup>29</sup>

- **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 non-hoistway 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 based on a dedicated air conditioner mounted on and powered with the elevator controller, simplified single-car emergency operation, the passage of regenerative power including for variable frequency a.c. 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, particularly during the advanced stages of a fire, which will work to reduce heat generated by the elevator.

- **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 display the location, position, direction, doors open/closed, and operation mode of every elevator simultaneously. The station 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, an intercommunication master station encompassing all elevators, machine rooms, and evacuation elevator lobbies, and should be located near the building's fire command station in an area staffed at all times. 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.)

#### **SERVICE ELEVATOR(S) OPTION FOR THE MULTI-PURPOSE ELEVATOR**

The term "service elevator," as used herein, 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, operation, or control of leveling not conducive to use by persons with disabilities; are provided in few office buildings today, and are 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, where emergency signals followed by a delayed response would be required, and their lobbies may be cluttered with debris and materials 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 a service elevator may be provided for every 300,000 to 500,000 gross square feet of space in a commercial office building, based on some old "rules of thumb," it may be practical to equip all primary service elevators as multipurpose elevators.

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

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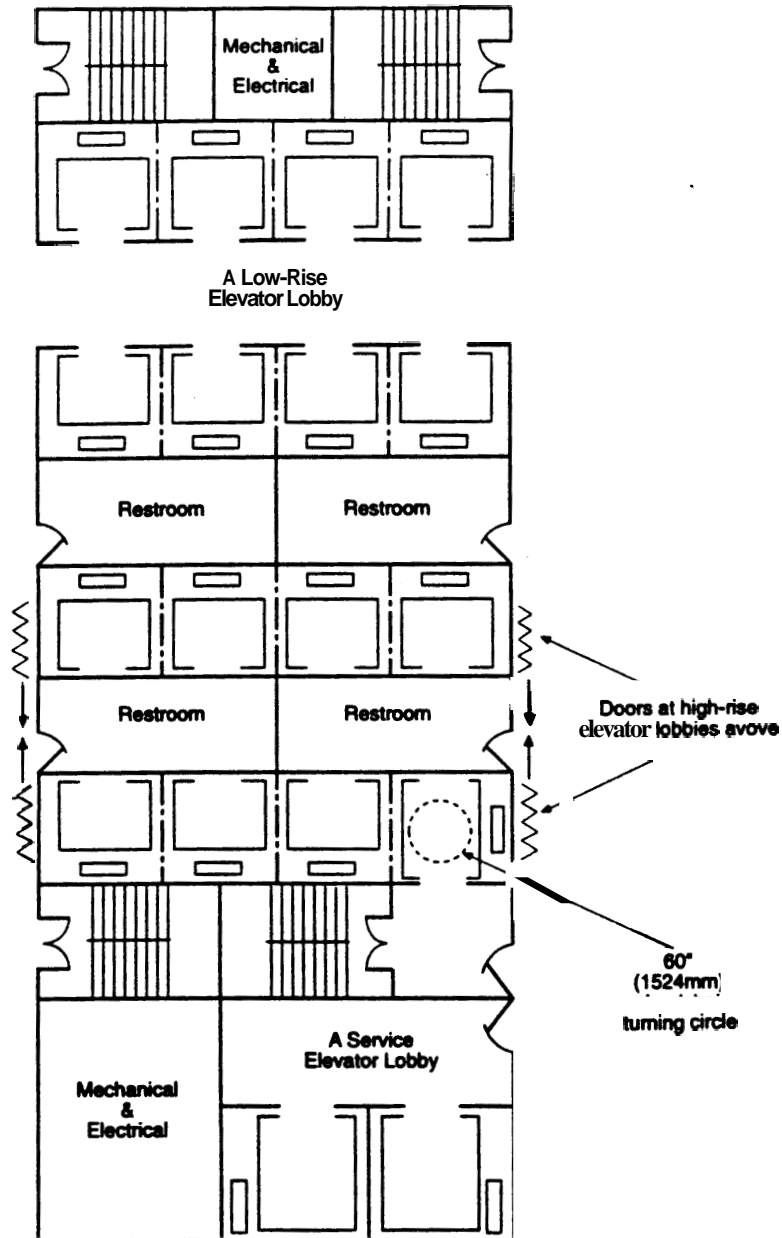


Figure 1: Example of a multi-purpose elevator as part of a high-rise group of passenger elevators (alternate would be to rearrange doors to exit stairs with service elevator lobbies)

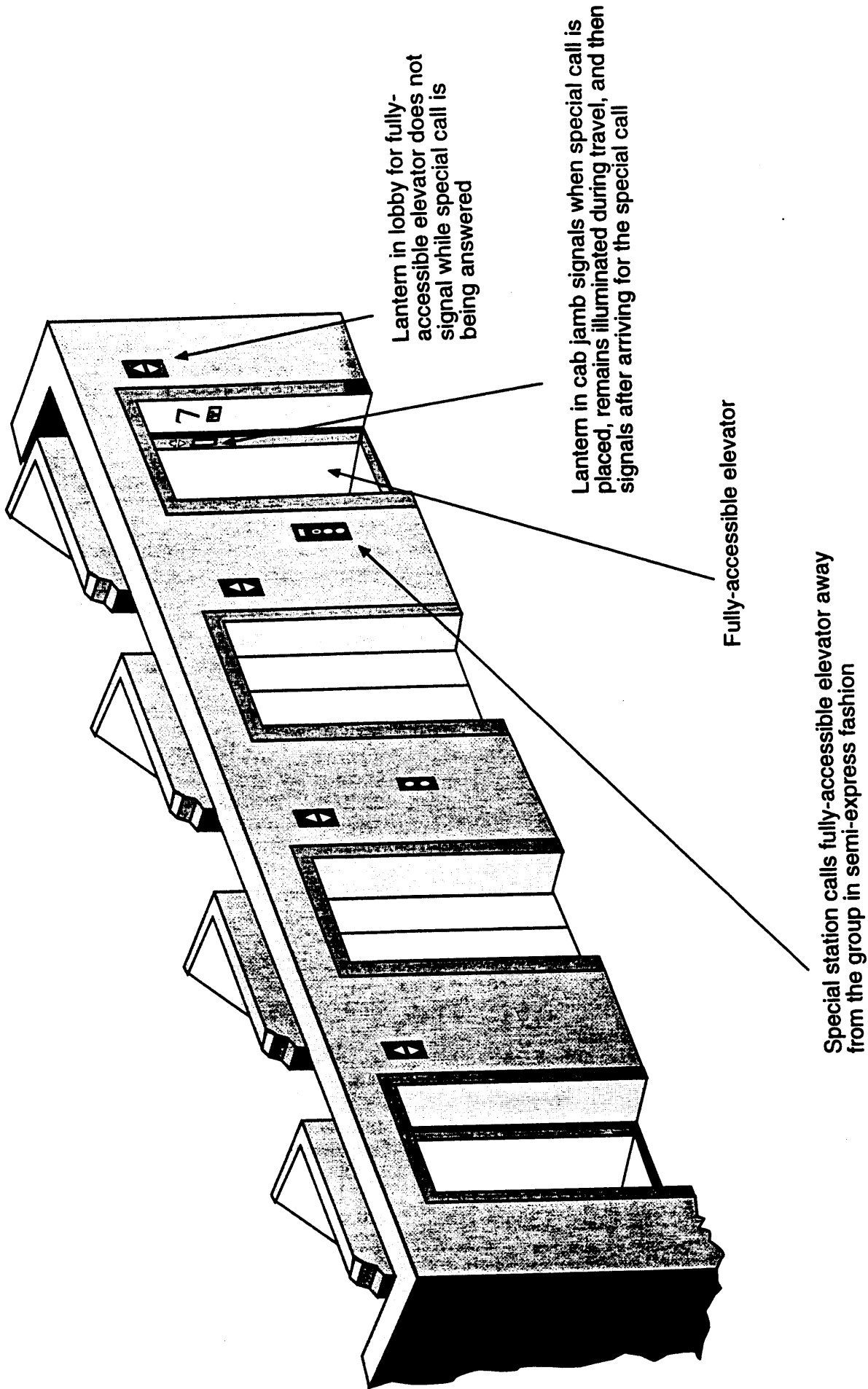


Figure 2: Example of concept for equipping less than all elevators in a group for full-accessibility

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