OCCUPANT EVACUATION OPERATION OF ELEVATORS

An Outline of Benefits, Requirements and Suggested Implementation Strategies

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OVERVIEW

TOPICS COVERED

- Public perception of elevator use
- Benefits of using elevators for evacuation
- Industry research & events
- Current OEO requirements
- Implementation & coordination strategies
Public is instructed to:
• Not use elevators in the event of a fire!
• Use exit stairs only.
This is portrayed by:
• Signage
• Fire alarm voice messages
• People’s upbringing
INTRODUCTION

EGRESS BY STAIRS

- Stairs may be challenging for some.
  - Mobility impaired occupants
  - Elderly occupants
  - Small children

- The taller the building, the longer the evacuation time and higher probability of fatigue and other delays etc.
  - Different movement speeds of occupants
    - Age
    - Mobility impairments
    - Health
    - Fatigue during longer evacuation times
WHY NOT USE ELEVATORS FOR EVACUATION?

Evacuation Goals:

- Improve evacuation times
- Improve environment & experience for occupants
  - Lead to less panic and confusion
  - Easier for occupants with mobility impairments
  - Less strenuous for elderly occupants and people with other health limitations

Needs to be done with the proper safeguards in place to ensure:

- Effectiveness in a fire event
- Safety in a fire event
NIST RESEARCH (EARLY 1990’s)

- Evacuation of four GSA Buildings was simulated using the stairs, elevators and combination of both.

- Study included various scenarios:
  - Different building sizes
  - Different numbers of elevators
  - Different building occupant loads
NIST RESEARCH (EARLY 1990’s)

Conclusions:

- Combination of stairs and elevators = quickest evacuation times.
- Elevators have a greater impact on evacuation in taller buildings.
  - Combination of both was faster than any single means
  - Evacuation by only the elevators was faster than evacuation by only stairs
  - More evident in the taller of the buildings
SEPTEMBER 11, 2001

- Many occupants (approx. 3,000) safely exited WTC2 using the elevators.
- Faster evacuation rate than WTC1 where elevators were damaged & inoperable
- Emphasized benefits of using elevators for evacuation.
- Caused the industry to prioritize evaluation of elevators as a means for evacuation.
  - If done with proper safeguards
OVERALL OCCUPANT EVACUATION ELEVATOR REQUIREMENTS

CURRENT CODE PROVISIONS

  - Section 3008
  - Section 7.14
  - Section 2.27.11
  - Section 21.6
OVERALL OCCUPANT EVACUATION ELEVATOR REQUIREMENTS

BUILDING REQUIREMENTS

- Occupant evacuation elevators are **not** mandated to be provided in any of the current codes.

- May be provided **in lieu** of additional exit stairway required for buildings more than 420 feet in height required by IBC.
BUILDING REQUIREMENTS

- Sprinkler system required throughout building
  - Specifically prohibited in:
    - Machine Rooms & Spaces
    - Control Rooms & Spaces
    - Hoistways
      - NFPA 101 allows sprinklers within 24” of the elevator pit floor.
  - Shunt trip is prohibited
    - A17.1 does not require shunt trip for elevator pit sprinklers
  - Means for preventing sprinkler water infiltration to elevator shafts from elevator lobbies.
    - Sloped floors
    - Floor drains etc.
OVERALL OCCUPANT EVACUATION ELEVATOR REQUIREMENTS

BUILDING REQUIREMENTS

- Emergency voice/alarm communication fire alarm system required throughout the building.
  - Min. 1 audible notification appliance in Occupant Evacuation Elevator (OEE) lobby
  - Min. 1 visible notification appliance in Occupant Evacuation Elevator (OEE) lobby
- Two-Way communication system required in OEE lobbies to building fire command center.
OVERALL OCCUPANT EVACUATION
ELEVATOR REQUIREMENTS

BUILDING REQUIREMENTS

ジー OEE lobby
  • Enclosed
    – 1 hr Smoke barrier
  • Minimum size
    – 25% of floor occupancy at
      3 ft² per occupant
ジー 2 hour fire resistance rated shafts
ジー Exit stair access from OEE Lobbies
  • Directly adjacent to lobby or,
  • Via separated protected path of travel with same protection level as lobby enclosure.
ジー Permanent signage at all elevators
  • Elevators are suitable for use by building occupants evacuating during fires.
ELEVATOR REQUIREMENTS

Power Wiring
- Protected by 2 hour fire resistance rating
  - 2-hour rated circuit integrity cable systems or,
  - Within 2 hour rated construction or,
  - Listed circuit protective system with a 2-hour fire resistance rating

Standby Power
- Type 60/Class 2/Level 1
- For equipment including:
  - Elevator equipment
  - Ventilation and cooling equipment for machine and control rooms and spaces
  - Elevator car lighting
OEO REQUIREMENTS

- Occupant Evacuation Operation to comply with:
  - ASME A17.1/CSA B44
    - OEO sequencing
    - elevator system notifications
  - NFPA 72
    - OEO activation
    - Voice message coordination
    - Signals from fire alarm system to elevator system
OVERALL OCCUPANT EVACUATION
ELEVATOR REQUIREMENTS

NFPA 72 REQUIREMENTS

☞ OEO Activation
- Automatic detection throughout the building
  - Fire alarm system
  - Sprinkler system activation
  - NOT activated on manual fire alarm boxes throughout the building
    - Only manually initiated from within fire command center
  - NOT activated on alarm from elevator discharge level (ASME A17.1 requirement)

- Determination of Evacuation floor group
  - First alarm:
    - Floor of incident
    - Two floors above
    - Two floors below
  - Subsequent alarms: (ASME A17.1 requirement)
    - All floors between alarm floors
    - Two floors above group
    - Two floor below group
  - Total building Evacuation
    - All floors
OVERALL OCCUPANT EVACUATION ELEVATOR REQUIREMENTS

**OEO EVACUATION FLOOR GROUPS**

<table>
<thead>
<tr>
<th>One Alarm:</th>
<th>15</th>
<th>14</th>
<th>13</th>
<th>12</th>
<th>11</th>
<th>10</th>
<th>Alarm</th>
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<tbody>
<tr>
<td>Evacuation Group:</td>
<td>Floors 8 - 12</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Multiple Alarms:</th>
<th>15</th>
<th>14</th>
<th>13</th>
<th>12</th>
<th>11</th>
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</thead>
<tbody>
<tr>
<td>2nd Alarm</td>
<td>10</td>
<td></td>
<td></td>
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<td></td>
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<tr>
<td>Evacuation Group:</td>
<td>Floors 5 - 14</td>
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</table>

<table>
<thead>
<tr>
<th>Total Building Evacuation:</th>
<th>15</th>
<th>14</th>
<th>13</th>
<th>12</th>
<th>11</th>
<th>10</th>
</tr>
</thead>
<tbody>
<tr>
<td>3rd Alarm</td>
<td>9</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Evacuation Group:</td>
<td>All Floors</td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

- Fire Floor Evacuating
- Floor Evacuating
- Floor Not Evacuating
NFPA 72 REQUIREMENTS

- Fire alarm system voice message
  - Alert message to all floors **not** evacuating
    - Evacuation status of building
    - Elevators are unavailable for use during this time
  - Evacuation to all evacuating floors
    - Evacuation message and tone
    - “Elevators are available for evacuation”

- OEO Termination
  - When fire alarm event is cleared and system is reset
  - When Phase I recall is activated
    - Fire alarm initiating device in elevator machine room, shaft, control space, lobby etc.
OVERALL OCCUPANT EVACUATION
ELEVATOR REQUIREMENTS

NFPA 72 REQUIREMENTS

- Transmit information to elevator systems to allow for accurate OEO sequencing.
  - Relays between control equipment
  - Serial communications between control equipment
    - Required to be UL listed

- Functions at the fire command center:
  - Annunciate evacuation status of each floor
  - Provide manual controls for OEO manipulation by authorities
  - Provide manual means for initiating Total Building Evacuation
ASME A17.1/B44 REQUIREMENTS

◆ OEO Sequencing
  • OEO Evacuation priorities
    – Assign priority to fire floors based on sequence alarms are received
      » 1st alarm floor = first evacuation priority
      » 2nd alarm floor = second evacuation priority
      » Etc.
  • Total building evacuation priorities
    – Assign priorities based on distance from elevator discharge level
      » Highest floor = first priority
      » One floor below highest floor = second priority
      » Etc.
  • ASME A17.1/B44 Evacuation priority provisions require two signals per floor from fire alarm system.
    – Floor with active fire alarm
    – Floor being evacuated
OEO Sequencing

- Cars automatically travel to a floor within evacuation group and park with doors closed
- Cars serve car calls from evacuation group floors based on priority assignments.
- Once cars are occupied, they travel downward toward the discharge level
  - May stop at other floors in the evacuation group before the discharge floor
- All but one car return to discharge level after 60 seconds of no car calls from evacuation group
  - One car remains at lowest level of group to serve additional car calls
OVERALL OCCUPANT EVACUATION ELEVATOR REQUIREMENTS

ASME A17.1/B44 REQUIREMENTS

🔹 Elevator system notification
  • Variable message signage in each lobby
    – Normal Operation
      » “Elevators operating normally”
    – During OEO
      » On evacuation floors
        • “Elevators & stairs available for evacuation. Next car in x minutes”
      » On Evacuation floors if elevators are unavailable (recall, out of service etc.)
        • “Elevators are unavailable for evacuation. Use stairs for evacuation.”
    » On other Floors
      • Elevators temporarily dedicated to other floors
    » On elevator discharge level
      • “Elevators dedicated to evacuation. Do not enter the elevators.”
OVERALL OCCUPANT EVACUATION ELEVATOR REQUIREMENTS

ASME A17.1/B44 REQUIREMENTS

○ In-Car Notification
  • Elevator is being used to evacuate the building
    – Voice message
    – Visual signal or variable message sign
  • Weight overload
    – Voice message and visual signal
      » When load exceeds 100%
      » Car to remain stopped with doors open until load is reduced.

⚠️ WARNING
Do Not Exceed Lift Capacity
OVERALL OCCUPANT EVACUATION
ELEVATOR REQUIREMENTS

ASME A17.1/B44 REQUIREMENTS

- Fire command center requirements
  - Elevator status annunciation (each elevator)
    - Occupied?
    - Floor
    - Direction
    - Status power to elevator equipment
      » Normal power
      » Emergency power
OVERALL OCCUPANT EVACUATION ELEVATOR REQUIREMENTS

OEO SEQUENCING OVERVIEW

Elevator Occupant Evacuation Operation Sequence Flowchart

- Elevator Taken Out of Service (Service, Maintenance, Dedicated Operation, Emergency Power Transition etc.)
- Manual Initiation of Phase I Elevator Recall
- Activation of Automatic Fire Alarm Initiating Device
- Manual Initiation of Floor Evacuation Via Emergency Command Center Controls

Is At Least One Elevator Available For OEO?

Yes

Recall Elevator(s)

Is Device Associated With Phase I Recall?

Yes

Is Device Associated With Phase I Recall?

Yes

Has Total Building Evacuation Been Initiated?

Yes

Set Evacuation Group of Floors As:
- Floors 1
- Floors 1
- Floors 2

Set Evacuation Group of Floors As:
- All Floors

Broadcast Automatic Voice Message to Evacuate Via Stairs Only on All Floors In Evacuation Group.

No

Set Evacuation Group of Floors As:
- All Floors

Broadcast Automatic Voice Message to Evacuate Via Stairs and Elevators on All Floors In Evacuation Group.

Broadcast Automatic Voice Message to Evacuate Via Stairs and OEO Elevators.

Communication to Fire Alarm System That Elevator(s) Are Available For OEO

Communicate to Fire Alarm System That All Elevators Are Unavailable For OEO

Occupy Evacuate Via Stairs

Occupy Evacuate Via Stairs

Assign Higher Evacuation Priority to Floors With Active Fire Alarms & Manually Selected Floors

Initiate OEO Sequence on All Floors Within Evacuation Group

Send Evacuation Status To Elevator Controller For Each Floor In Evacuation Group.

Send Fire/Manual Evacuation Status To Elevator Controller

Initiate Phase I Elevator Recall Via Fire Alarm Relay Closure To Elevator Controller

Logic Decision

Initiating Event

End Result

Flowchart Legend

- Fire Alarm System Action Event
- Elevator System Action Event

* The “Floor of Event” is defined as a floor with an active fire alarm or a floor manually selected for evacuation.
EDUCATION

- OEO is a new concept to the codes
  - Requires time to ensure all involved parties are educated and fully understand requirements
    - Architects
    - Elevator manufacturers & installers
    - Fire alarm system manufacturers & Installers
    - Authorities Having Jurisdiction
      » Make sure they understand the overall goals of OEE’s and the benefits they provide.
    - Building occupants at time of occupancy

- This education should be completed for project team in the very early stages of any project installing OEEs.
COORDINATION

- Substantial coordination required between:
  - Architects
  - Fire protection engineers
  - Elevator provider and installer
  - Fire alarm system provider and installer

- Sequencing can get very complex and all parties need to collaborate closely throughout design, installation and commissioning.
COMMISSIONING

- Commissioning will be very time intensive to ensure all functions are provided and working correctly
  - This will require more coordination between trades
  - Commissioning should be fully complete prior to scheduling AHJ due to the complexity and time required to verify system operations.
SUGGESTED COURSE OF ACTION

- Educational meetings early in project
  - Address any and all questions and bring all parties up to speed on requirements
  - Meet with AHJ to provide same level of education and answer any and all questions
    - Participate in follow up meetings/presentations

- Planning and project review
  - Coordinate planning and design of:
    - Elevator systems
    - Fire alarm systems
    - Sprinkler systems
    - Architecture of OEE lobbies and building stairways
  - Conduct multiple design review meetings with all involved parties
SUGGESTED COURSE OF ACTION

○ Commissioning
  • Coordinate commissioning activities with all involved parties
    – Ensure enough time is allotted to complete commissioning of entire building.

○ Inform AHJ of completion of commissioning
  • AHJ may require that they witness operation of the system.
    – Repeat limited or full commissioning activities
SUGGESTED COURSE OF ACTION

- Building personnel education
  - Provide educational materials and demonstrations
    - Owner
    - Building management
    - Building tenants / day-to-day occupants
  - Outline/demonstrate buildings’ OEE capabilities
    - Stress safety of OEEs
    - Overview OEO
    - State evacuation may be via stairs or elevators
    - Outline OEE availability notification means
      » Variable message signs
      » Fire alarm system voice message
      » In car notification
        - Voice messages
        - Visual indications
NEW OEE CONCEPT WARRANTS FUTURE CASE STUDIES & RESEARCH

Goal is to ensure reliability and effectiveness of real life arrangements
• Egress simulations of prescriptive OEO requirements
• Live evacuation drills of tall buildings
• Collect feedback from:
  – Occupants
  – AHJs
  – Building managers/owners
• Determine effectiveness and identify any modifications that may improve elevator evacuation
  » Evacuation time
  » Occupant experience
  » Information displayed
  » OEO sequence
  » OEO manual controls
QUESTIONS?

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