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VERTICAL TRANSPORTATION

- Design Guidelines
- Technology

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Elevator Design Guidelines

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Learning Objectives

- Understand what impacts the core design and rules of thumb to apply in schematic/ concept design phases.
- Become conversant with and know which applications to use for their particular building type.
- Understand the nuances of elevator technology and how it impacts their design.
- Gain a basic understanding of the new codes as they affect elevator design and consequently building design.

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Presentation Outline

- Elevator Technology
  - Elevator Design Guidelines
  - Elevator Application
  - New Developments / Trends
  - Recent Code Developments & Implications

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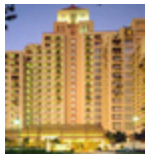
Elevator Design Guidelines

- System Performance Criteria –
  - Specific Criteria varies based on building type:
    - Office Building, Hotel, Residential, Parking Structure, Commercial Office Buildings
    - Hotels
    - Residential



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Elevator Design Guidelines

- Basic Criteria
  - Average Interval (AI)
    - The frequency (in seconds) of elevator dispatches from the primary elevator landing during a peak 5-minute traffic period. This is the Quality of Elevator Service
  - Handling Capacity (HC)
    - The %-age of the population moved *during the same period*. This is the Quantity of Elevator Service

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Elevator Design Guidelines

- Commercial Office Buildings
  - Average Interval: Less than 30 Seconds
  - Handling Capacity %
    - 12% for Diversified Tenants
    - 13% for Mixed Tenants
    - 14% for Single Tenant
  - Rules of Thumb:
    - One Elevator per 50,000 GSF
    - One Elevator per 2.5 – 3 floors served
    - One Elevator for 250 – 300 persons

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Elevator Design Guidelines

- Hotels
  - Average Interval: 40 - 50 Seconds
  - Handling Capacity
    - 10% -12% for Commercial/Resort
    - 12% -15% for Convention/Theme Park
  - Based on Density Per Unit
  - Rules of Thumb:
    - One Passenger Elevator per 100 Rooms
    - Minimum of 2 Passenger Elevators
    - 2 Service Elevators up to 300 Rooms
    - 3 Service Elevators up to 500 Rooms

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Elevator Design Guidelines

- Residential
  - Average Interval: 35 - 60 Seconds
  - Handling Capacity
    - 8% - 12%
  - Based on Density Per Unit
  - Standards Vary Based on Property/Market
  - Rules of Thumb:
    - One Passenger Elevator per 150 Units
    - One Service Elevator per 300 Units

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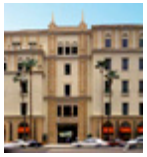
Elevator Design Guidelines

- Service Elevators
  - 4,000 Pound Capacity Minimum– Deeper than Wide
  - Rules of Thumb:
    - Office Building : >300,000 GSF = Dedicated Service Elevator; Add Additional Elevator for each incremental 400,000 GSF
    - Hotels: Minimum of one service car all building; One per Two passenger cars; One per 200 keys
    - Residential: Varies based on user groups and rise.



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Layout Considerations: Lobby and Core Design

- Lobby Design:
  - Four car group: have 2 facing 2
  - Maximum 3 cars in line
  - Four in line depreciates service due to longer door hold open times—ADA requirement

- Lobby size and configuration:
  - Avoid walk thru lobbies
  - Passenger elevators—lobby width
    - Between 10 to 14 feet
  - Service Elevators: Depth of car x 2

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Common Layout Issues:

- Layout Information:
  - Otis' smaller hoistway size that do not apply to other manufacturers
  - Use of center opening doors with car interior widths that are too small (5'-8")
  - Use of capacities that are not oriented towards industry standard configurations (4500 pound cars)
  - Providing intermediate supports or rail supports when rail size could be adjusted.
  - Using hoistway dimensions which do not allow sufficient space for seismic equipment
  - Not providing for out of plumb conditions—increasing hoistway sizes
  - Proper rough opening sizes
  - Providing only one elevator

- Machine Room Information:
  - Safe and convenient path to the machine room
  - Access across the rooftop requires lighting, no tripping hazards, minimum headroom, etc.
  - Conduit to remote control panels & lobby panels.
  - Remote machine rooms and exposed piping (not in ground and In PVC)

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Common Layout Issues:

- Parking Garages:
  - Exposed entrances
  - Overhead and side protection or gasketed entrances,
  - Water traveling down the hoistway instead of sloping away.
  - No provisions for Car AC on glass back cars
  - Entrance block outs & back fill to cover the cold joint in a garage.

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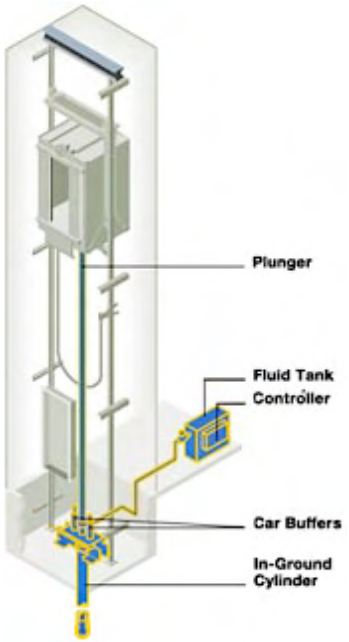
Elevator Applications:

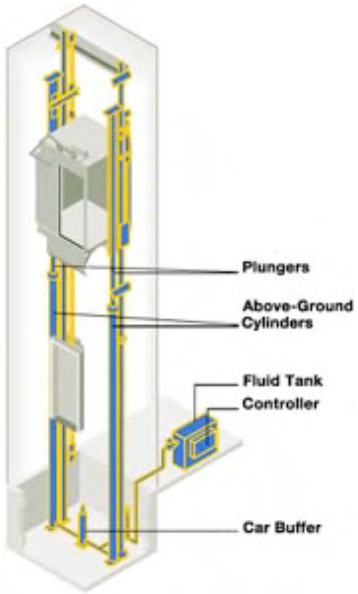
Hydraulic Types—Common to all: 2 to 5 floors; max rise 40 to 45 feet

- Direct Plunger
  - Environmental concerns



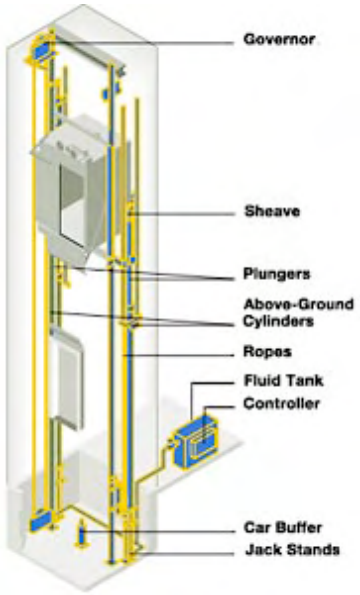
Holeless

Limited to 15’-0”



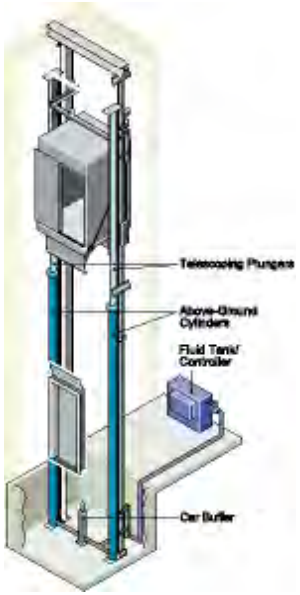
Roped Hydro

Expensive to Install
Problematic



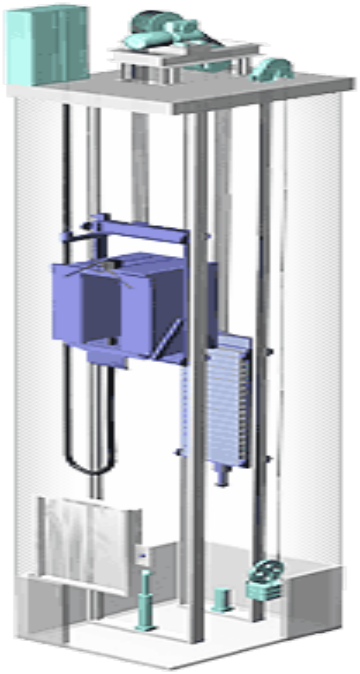
Telescoping Holeless

Limited to 40’-0”;



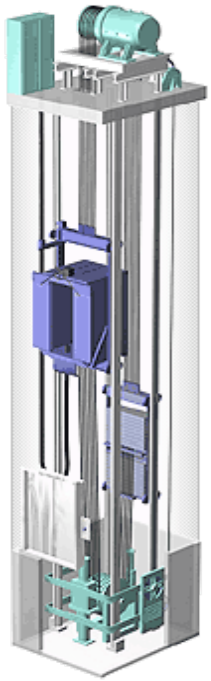
Elevator Applications: Traction

Geared



Stops: 5-15
Rise up to 150’
Max. Speed: 500 FPM

Gearless



Stops: 15-60 +
Rise 2000’
Max. Speed: 2400 FPM

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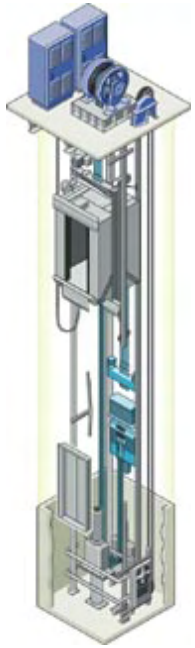
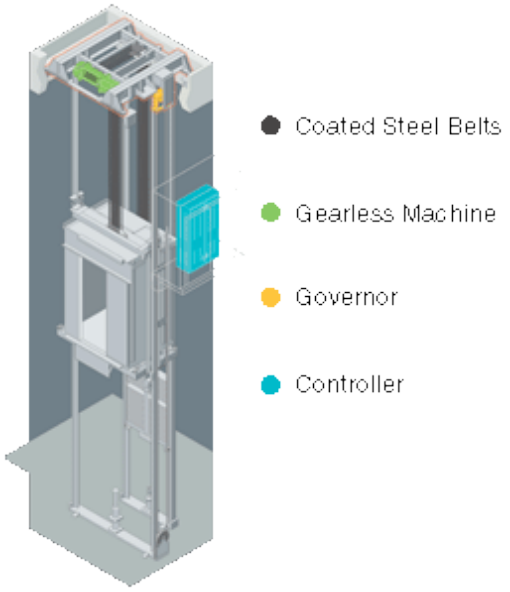
Elevator Applications: Machine Room Less

Traditional



Machine Room Less



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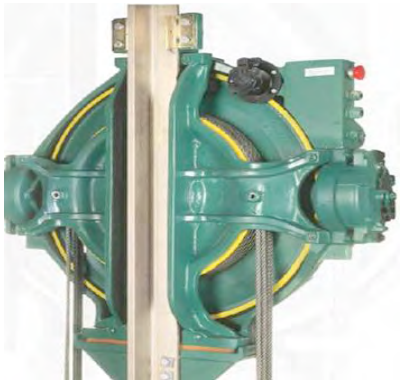
Elevator Applications: Machine Room Less

- Variety of Machine Locations Available
  - Overhead Rail Mount
  - Overhead
  - Pit
- Manufacturer and Machine Location Affects Critical Dimensions Overhead, Pit, Hoistway Plan
- Can Plan for “Worst Case”, but Final Dimensions must suit Manufacturer
- Be Cautious on use of Web Sites; look at two minimum
- MRL Is Expected to Replace Most Hydraulic New Applications within 20 Years

KONE



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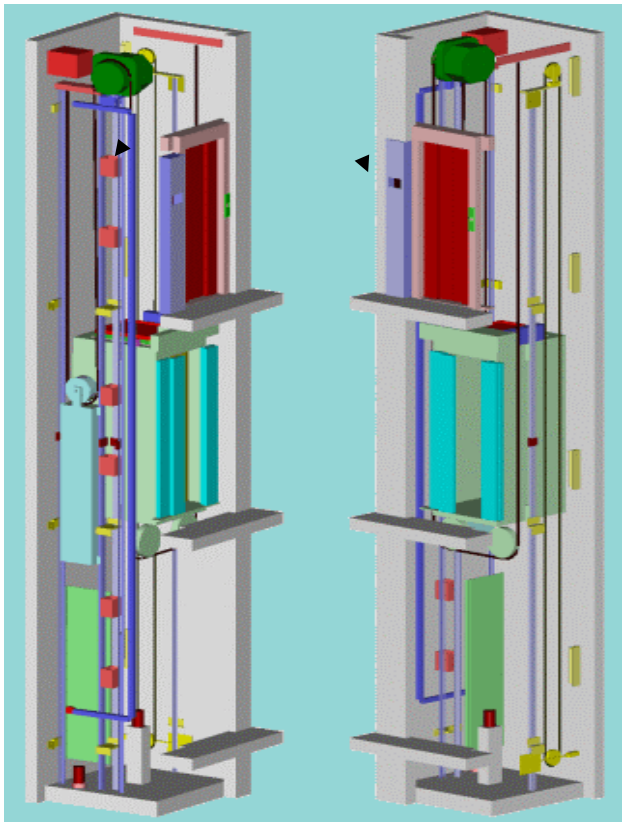
Elevator Applications: Machine Room Less:



- Controls
  - Typically Mounted at top landing
  - Accessed from Hallway
  - Local Code Acceptance Issues

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Elevator Applications: Machine Room Less:

- MRLS Application by Company

MRL	PASSENGER					SERVICE		
CAPACITY	2000	3000	3500	4000		4000	4500	5000
TKEC	Y	Y	Y	Y		Y	Y	Y
SPEED	Up to 500 fpm					Up to 500 fpm		
Problem with acceptance in state of CA; units installed in LV and approved by LB; 4000 pound passenger available in front openings only								
OTIS	Y	Y	Y	Y		Y	Y	Y
SPEED	Up to 500 fpm			350		Up to 350 fpm		350
MEUS	Y	Y	Y	N		Y	Y	Y
SPEED	200 and 350 fpm					200 and 350		
4000 pound passenger to be "released soon"; service in front openings only								
SECO	Y	Y	Y	N		N	Y	N
SPEED	Up to 500 fpm					Up to 500 fpm		
KONE	Y	Y	Y	Y		Y	Y	N
SPEED	Up to 500 fpm					Up to 350 fpm		

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Elevator Applications: Machine Room Less:

- MRLS Dimensional Comparative—Passenger Elevators

MRL Comparison					
3500# @ 350 FPM	Hstwy Width	Hstwy Depth	Pit Depth*	Hstwy Overhead	Note: no cwt safeties, 100' travel +/-, front openings only, seismic, 10' cab ht.
Otis rear cwt	8'-6"	7'-10"	5'-5 1/4"	17'-5"	
Otis side cwt	9'-6"	6'-11"	5'-5 1/4"	17'-5"	
Kone	9'-9"	7'-8"	8'-6"	17'-0"	
Schindler	9'-4"	7'-1"	5'-7"	17'-0"	
Thyssen	9'-2"	6'-11"	5'-0"	18'-0"	
4000# @ 350 FPM					
Otis rear cwt	9'-6"	7'-10"	5'-5 1/4"	17'-5"	
Otis side cwt	10'-6"	6'-11"	5'-5 1/4"	17'-5"	
Kone	10'-9"	7'-8"	8'-6"	17'-0"	
Schindler	n/a	n/a	n/a	n/a	
Thyssen	10'-6"	7'-10"	5'-5 1/4"	18'-0"	
3500# @ 450 FPM	not available				
4000# @ 450 FPM	not available				

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Common Application Issues:

- MRLS Equipment:
  - Differences in applications; KONE, Otis, Schindler, TKEC
  - Minimal operational features
  - Car finish weight restrictions
  - Distance to control rooms
  - Control room sizes and locations
  - Some jurisdictions required A/C in the hoistway for an MRL
- Hydraulics:
  - Suppliers indicate up to 70 feet of travel with direct plunger type. In fact , most companies will not sell this.
  - Incorrect application of this product; too slow; borehole too deep would require drilling a hole at least 75’-0”
  - Standard hydros are cost engineered
  - Maximum number of upstarts is 40 upstarts/hr
  - Use of thin gauge materials,
  - Minimal options
  - Made for the residential market, not the commercial market

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Common Application Issues:

- Car Interior Finishes:
  - Car finish weight restrictions
  - Car finish material restrictions (smoke generation/flame spread).
  - Coordination between car shell emergency exits for drop ceiling
  - Coordination of wall panels and vent slots
- Glass Elevators:
  - Hoistway glass issues
  - Cleaning plan
  - Ledges from mullions
  - Direct sun
  - Shrouding
  - Ledges not beveled on glass backs
  - Provisions for Car AC on glass back cars

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New Developments:

- Control Systems
- Volumetric By Pass
- Battery Lowering for Elevators

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New Developments: Control Systems

- Call Destination Encoding
  - Users Input Floor Destination
    Elevator System Determines Which Elevator to Take
  - No more UP and DOWN Buttons in Hall Ways
- Car Stations Contain only Pushbuttons for Special Operations
  - Communication
  - Code Functions
- Door Jambs Contain LEDs showing which Floors will Be served.
- Elevator Hall Lanterns with Alpha Designations Keypad Display Directs User to Elevator

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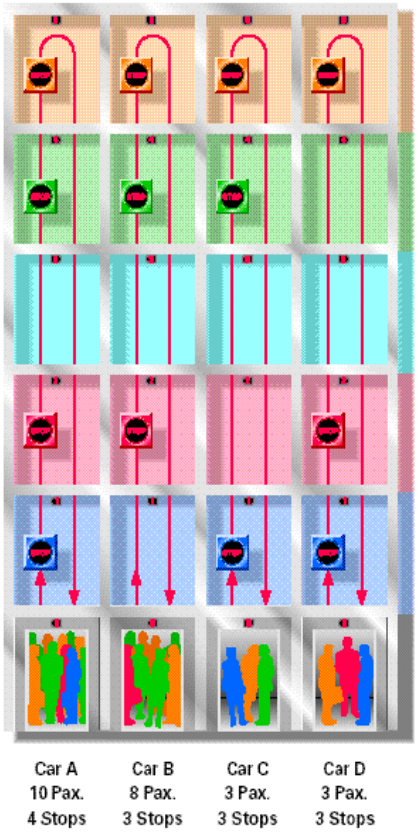
New Developments: Control Systems



Traditional 2-Button Method

- Random Distribution

Destination Dispatching

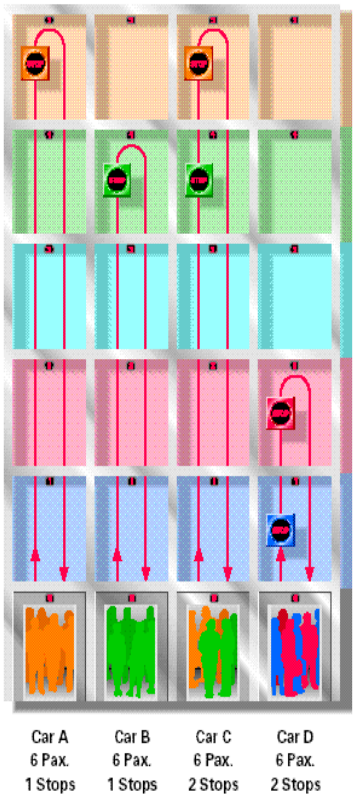
Call Destination Method

– Passengers Grouped to Same or Nearby Destination

– Round-trip Time Reduced in Up-peak Travel

Efficient System Requires Education of Passengers

Doesn't Reduce Number of Elevators Required



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New Developments: Operational Options

- Volumetric By-Pass:
  - Now able to determine amount of space being used inside the elevator
  - By Passes other calls and dispatches another elevator
  - Avoids additional stops when elevator is at capacity

- Battery Lowering Upon Power Loss:
  - Lowers car to bottom floor and opens doors
  - Avoids entrapments
  - Has been available on Hydraulics
  - Now available for Traction
  - Does not relieve obligation for Standby Power Code requirements

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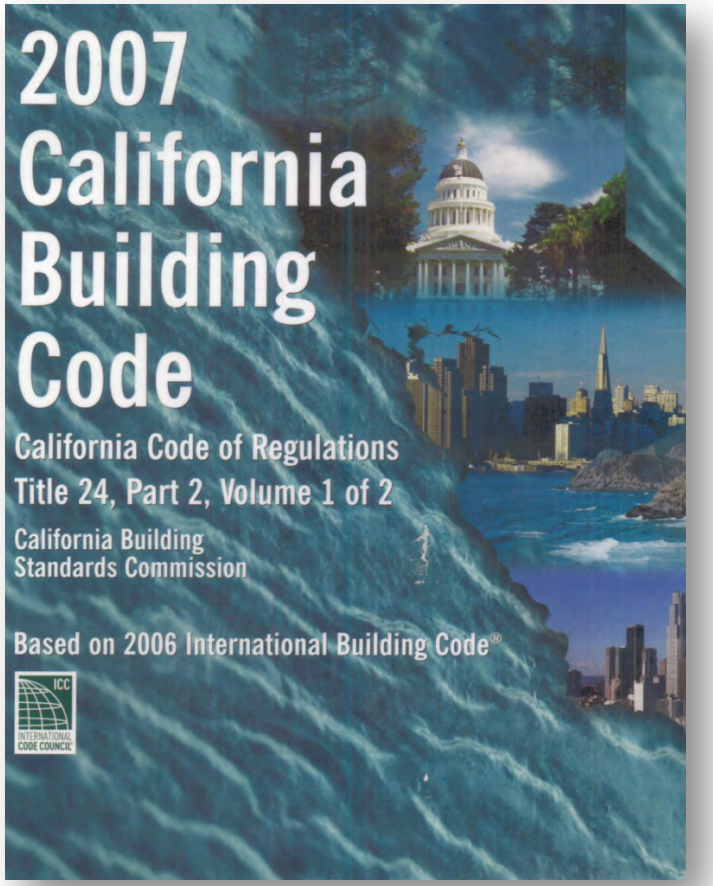
Code Changes:



- Means of Egress
- Emergency Signs
- Stretcher Compliance
- Venting of Hoistways
- Machine Rooms
- IBC Codes

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Common Code Issues:

- Code :
  - Other codes that affect the elevator design
  - California Code nuances
  - 10 footcandles illumination at landings
  - Stretcher car for every multistory building (not 4 stories or more per IBC)
  - More stringent disabled access requirements
  - Sump Pumps and drains are not required for internal applications

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Code Changes:

Chapter 10 Means of Egress (CBC 2007)

- Section 1007 Accessible Means of Egress
  - 1007.2.1 Elevators required
    - In buildings where a required accessible floor is four or more stories above or below a level of exit discharge, at least one required accessible means of egress shall be an elevator complying with Section 1007.4.

Effect: Elevator becomes a required means of egress requiring emergency power.

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Code Changes:

Chapter 10 Means of Egress (CBC 2007)

- Section 1007 Accessible Means of Egress
  - 1007.2.1 Elevators required
    - Exceptions for Building equipped throughout :
      - with an automatic sprinkler system – elevator not required on floors with a horizontal exit and located at or above the level of exit discharge.
      - with an automatic sprinkler system installed, elevator shall not be required on floors provided with a ramp.

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Code Changes:

Chapter 10 Means of Egress (CBC 2007)

- Section 1007 Accessible Means of Egress
  - 1007.4 Elevators
    - In order to be considered part of an accessible means of egress, an elevator shall comply with the emergency operation and signaling device requirements of Section 2.27 of ASME A17.1. Standby power shall be provided in accordance with Sections 2702 and 3003.
    - Exception:
      - Elevators are not required to be accessed from an area of refuge or horizontal exit in open parking garages.

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Code Changes:

Chapter 10 Means of Egress (CBC 2007)

- Section 1007 Accessible Means of Egress

Previous Requirement:

- Elevators not required as a Means of Egress.

- Elevators required to be equipped with standby power only in buildings with occupied floors 75-ft. above access floor.

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Code Changes:

Chapter 30 – Elevators and Conveying Systems (CBC 2007)

- 3002.3 Emergency signs
  - An approved pictorial sign of a standardized design shall be posted adjacent to each elevator call station on all floors instructing occupants to use the exit stairways and not to use the elevators in case of fire. The sign shall read: IN FIRE EMERGENCY, DO NOT USE ELEVATOR. USE EXIT STAIRS. The emergency sign shall not be required for elevators that are part of an accessible means of egress complying with Section 1007.4.

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Code Changes:

Chapter 30 – Elevators and Conveying Systems (CBC 2007)

- 3002.3 Emergency signs

Previous Requirement:

-CBC 2001 included different signage requirements for different building types.

Effect: Provides a single clarified requirement for signage.

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Code Changes:

Stretcher Compliance-CBC 2007

- New IBC & CBC requirements for larger stretcher
- Gurney size has increased—3002.4a
  - 3500 pound cars with center opening doors do not comply
  - 3500 pound cars with side opening doors comply
  - Unlike IBC, CBC requires elevator be capable of transporting a gurney in two-story buildings
  - Requires 4000 pound passenger shaped cars, which are not standard for many companies MRL product

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Code Changes:

Chapter 30 – Elevators and Conveying Systems (CBC 2007)

- 3002.4a General stretcher requirements
  - All buildings and structures with one or more passenger elevators shall be provided with not less than one medical emergency service to all landings meeting the provisions of Section 3002.4a.

Previous Requirement: CBC 2001 required stretcher accessibility in buildings with four or more stories.

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Code Changes:

Chapter 30 – Elevators and Conveying Systems (CBC 2007)

- 3002.4a General stretcher requirements
  - Exceptions:
    - Elevators in structures used only by maintenance and operating personnel.
    - Elevators in jails and penal institutions.
    - Elevators in buildings where each landing is at ground level or is accessible at grade level or by a ramp.
    - Elevators in two-story buildings equipped with stairs of a configuration that will accommodate the carrying of the gurney or stretcher as permitted by the local jurisdictional authority.
    - Elevators in buildings less than four stories in height for which the local jurisdictional authority has granted an exception in the form of a written document

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Code Changes:

Chapter 30 – Elevators and Conveying Systems (CBC 2007)

- 3002.4a.3 Elevator entrance openings and car size
  - The elevator car shall accommodate a 24" by 84" ambulance gurney or stretcher in the horizontal open position, shall be provided with a minimum clear distance between walls and door excluding return panels not less than 80" by 54", and a minimum distance from wall to return panel not less than 51" with a 42" side slide door.

Note: Describes elevator industry standard 3500 lb. capacity passenger elevator.

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Code Changes:

Chapter 30 – Elevators and Conveying Systems (CBC 2007)

- 3002.4a.3 Elevator entrance openings and car size
  - Exception:
    - The elevator car dimensions and/or the clear entrance opening dimensions may be altered where it can be demonstrated to the local jurisdictional authority's satisfaction that the proposed configuration will handle the designated gurney or stretcher with equivalent ease. Documentation from the local authority shall be provided to the Occupational Safety and Health Standards Board.
  - *Previous Requirement: CBC 2001 required at least one elevator to accommodate a 24" x 76" stretcher.*

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Code Changes:

Elevator Industry Concern

- 2006 IBC: minimum one elevator serving all floors to accommodate a 24″ by 84″ stretcher in buildings 4 or more floors.
- 3,500 lb. car cannot accommodate a rectangle of this size if the corners are square, but can with rounded edges.
- 2009 IBC will include language incorporating a 5″ minimum radius on stretcher corners (thus allowing a 3,500 lb car), the 2006 IBC is silent on this issue.

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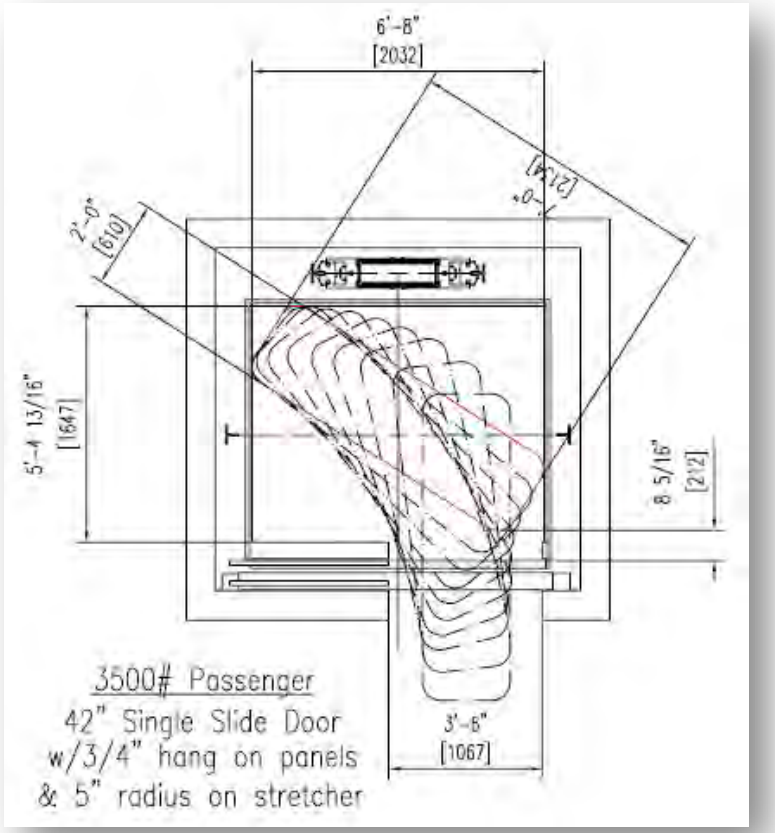

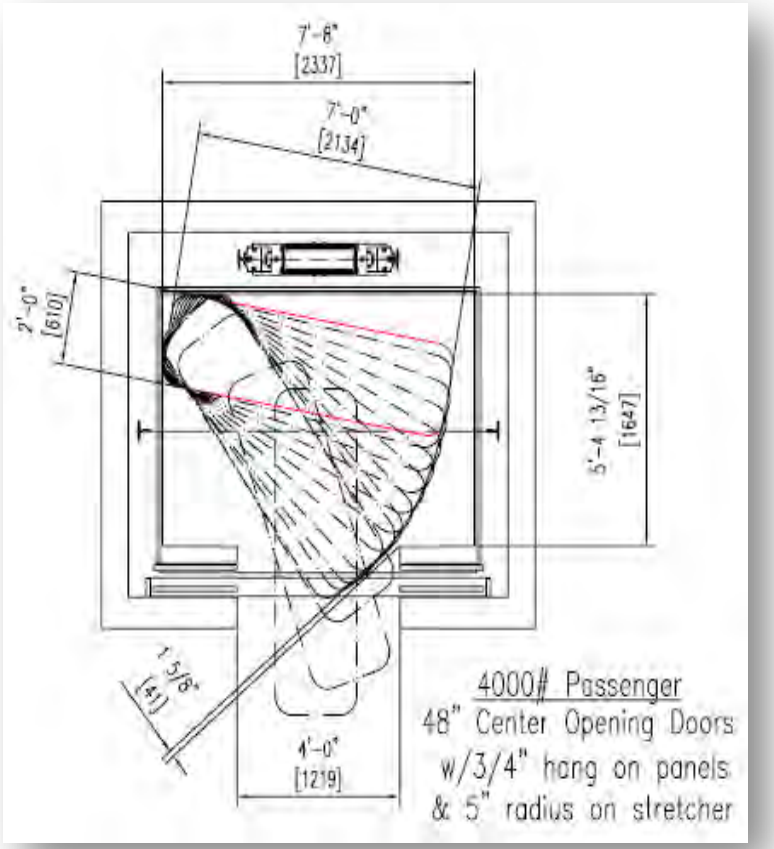

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Code Changes:

ICC Response

- On July 28, 2008, ICC staff issued an advisory letter stating that the addition of the language regarding the rounded corners was essentially a clarification of the existing code requirement. Because all stretchers have rounded corners, it was implicit in the 2006 IBC that this design feature could be considered when specifying a car size to meet this code requirement.

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Code Changes:

Chapter 30 – Elevators and Conveying Systems (CBC 2007)

- 3004.1 Vents required
  - Hoistways of elevators and dumbwaiters penetrating more than three stories shall be provided with a means for venting smoke and hot gases to the outer air in case of fire.

Previous Requirement

-Required venting for elevator shafts only, not dumbwaiters

-Required for hoistways penetrating more than two floors

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Code Changes:

Chapter 30 – Elevators and Conveying Systems (CBC 2007)

- 3004.1 Vents required
  - Exception:
    - In occupancies of other than Groups R-1, R-2, I-1, I-2 and similar occupancies with overnight sleeping quarters, venting of hoistways is not required where the building is equipped throughout with an approved automatic sprinkler system installed in accordance with Section 903.3.1.1 or 903.3.1.2.

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Code Changes:

Chapter 30 – Elevators and Conveying Systems (CBC 2007)

- 3004.3 Area of vents
  - Except as provided for in Section 3004.3.1, the area of the vents shall not be less than 3½ percent of the area of the hoistway nor less than 3 feet^2 (0.28 m^2) for each elevator car, and not less than 3½ percent nor less than 0.5 feet^2 (0.047 m^2) for each dumbwaiter car in the hoistway, whichever is greater. Of the total required vent area, not less than one-third shall be permanently open. Closed portions of the required vent area shall consist of openings glazed with annealed glass not greater than 0.125 (3.2 mm) in thickness.

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Code Changes:

Chapter 30 – Elevators and Conveying Systems (CBC 2007)

- 3004.3 Area of vents
  - Exception
    - The total required vent area shall not be required to be permanently open where all the vent openings automatically open upon detection of smoke in the elevator lobbies or hoistway, upon power failure and upon activation of a manual override control.

Previous Requirement: Allowed manually operated vents only

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Code Changes:

Chapter 30 – Elevators and Conveying Systems (CBC 2007)

- Section 3006 Machine Rooms
  - 3006.5.2 Elevator power shunt-trip capability shall be disabled during Phase II emergency in-car operation.
  - 3006.5.3 Audible and visual annunciation shall be provided at the fire alarm control unit indicating the disabling of elevator power shunt-trip capability under Phase II operation.
  - 3006.5.4 Audible and visual annunciation shall be provided at the fire alarm control unit indicating that the automatic sprinklers, smoke detectors, or heat detectors in the elevator hoistway or elevator machine room have activated.

Note: Amendment to CBC dated 1/1/2009 effective 8/1/2009

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- Thank you for your time!

- **QUESTIONS??**

- This concludes the American Institute of Architects
- Continuing Education Systems Program

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Lerch Bates Consulting Groups

- **New Construction:**
  - Conceptual/schematic vertical transportation analysis.
  - Design development CAD drawings.
  - Opinion of probable costs and timetables.
  - Construction documents and maintenance contract.
  - Bidding assistance.
  - Construction administration.

- **Modernization:**
  - Survey of existing equipment.
  - Opinion of probable costs and timetables.
  - Construction documents and maintenance contract.
  - Bidding assistance.
  - Construction administration.

- **Maintenance Audit:**
  - Survey of equipment to determine if the level of maintenance is in compliance with provisions of the existing maintenance contract.
  - Reporting mechanism designed to monitor and validate the completion of maintenance deficiencies.

- **Maintenance Contract:**
  - Preparation of a “client-oriented”, performance based, document.
  - Bidding assistance for individual property or national contract.
  - Contract negotiation assistance.

- **Acquisition/Due Diligence:**
  - Survey of equipment to determine condition, quality of maintenance and remaining life expectancy.
  - Reporting mechanism with opinion of probable costs to rectify deficiencies.
  - Supplemental photographs.

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Materials Management and Materials Handling Group

- **Materials Management:**
  - Master planning for space requirements, functional programming and adjacency studies.
  - Operational and organizational surveys and analysis of existing facilities.
  - Labor analysis and equipment planning for new facilities.
  - Complete construction ready drawings and bid specifications.
  - Operational programming and training.

- **Materials Handling:**
  - Master transport planning for people, equipment and materials.
  - Operational / labor analysis and programming.
  - System audits, modernization studies, material flow analysis and efficiency evaluations.
  - Life cycle cost analysis of alternate, manual and / or automatic materials handling systems.
  - Systems planning and engineering. Complete construction ready drawings and bid specifications.
  - Construction review, equipment testing / turnover and operational training.

- **Shipping and Receiving Docks:**
  - Master planning for space, equipment and truck aprons.
  - Operational surveys and analysis for existing facilities.
  - Truck maneuvering, dock accessibility, studies for new facilities.
  - Complete dock planning and engineering including drawings and equipment and bid specifications.
  - Construction review, equipment testing / turnover and operational training.

- **Waste Management:**
  - Master planning for space, circulation and disposal of solid waste.
  - Operational and organizational surveys and analysis of existing facilities.
  - Analysis of alternate waste processing equipment for new facilities.
  - Construction ready drawings and bid specifications. Operational programming and training.

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Façade Consulting Group (Window Washing Equipment)

- **New Installation:**
  - Conceptual design for external or internal equipment.
  - Rigging method planning.
  - Construction documents.
  - Bidding assistance.
  - Installation administration.
  - Maintenance contract and procedures

- **Existing Installations:**
  - Maintenance evaluation.
  - Repair needs assessment.
  - Recommendations for modernization or modifications.
  - Required OSHA certification testing.
  - Maintenance contract and procedures.

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Thank you for your time!

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