Collaborative Bachelor's Degree Program of Fire Protection and Safety Engineering Technology between Southwest Jiaotong University and Oklahoma State University, U.S.A.

FPST 1213 Fire and Safety Hazard Recognition

Means of Egress

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Objectives

- Understand the components of a means of egress
- Know the codes and standards applicable to means of egress
- Understand and calculate occupant loads

2

Loss of Life in Buildings

- Inadequate building and life safety codes
- Failure to comply with codes and standards

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Examples

- Iroquois Theatre Fire:1903, 602 Fatalities
- Triangle Shirtwaist Fire:1911, 146 Fatalities
- Cocoanut Grove Fire:1942, 492 Fatalities
- Our Lady of the Angels, 1958, 95 Fatalities
- Happy Land Social Club, 1990, 87 Fatalities
- Imperial Food Products, 1991, 25 Fatalities
- Station Nightclub Fire: 2003, 100 Fatalities

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Human Behavior in Fire

- Panic
- Lack of experience
- Perception of Risk
  - Seriousness of Threat
  - Convergence Clusters
  - Reentry Behavior
- Individual characteristics
- Physical characteristics
- "Fight, Freeze or Flee"

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Occupancy Classifications

- Assembly
- Business
- Educational
- Day Care
- Factory/Industrial
- Institutional
- Mercantile
- Residential
- Residential Board and Care
- Storage
- Utility/Miscellaneous
- Multiple

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Occupant Load

- Total number of people for which the means of egress of a building or portions thereof is designed.
  - Occupant load = net floor area / area per person
- Used to determine
  - Capacity of individual and total means of egress
  - Number of exits required
  - Maximum travel distances to exits

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Example

- Calculate the occupant load of a building that was formerly a warehouse and has recently been turned into a nightclub. The area of this facility measures 100 feet by 150 feet. As a nightclub, it will contain un-concentrated tables and chairs around a large dance floor.

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Example

- Step 1:
  - Determine total square footage of the nightclub by multiplying length times width.
    - 100 feet x 150 feet = 15,000 ft^2.
- Step 2:
  - Consult code to determine maximum allowable floor area per person in an assembly location without un-concentrated tables and chairs.

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2018 International Fire Code

CHAPTER 10 MEANS OF EGRESS
Third Printing: Apr 2019

[BE] 1004.5 Areas without fixed seating.

The number of occupants shall be computed at the rate of one occupant per unit of area as prescribed in Table 1004.5. For areas without *fixed seating*, the occupant load shall be not less than that number determined by dividing the floor area under consideration by the *occupant load* factor assigned to the function of the space as set forth in Table 1004.5. Where an intended function is not listed in Table 1004.5, the *fire code official* shall establish a function based on a listed function that most nearly resembles the intended function.

Exception: Where *approved* by the *fire code official*, the actual number of occupants for whom each occupied space, floor or building is designed, although less than those determined by calculation, shall be permitted to be used in the determination of the design *occupant load*.

[BE] TABLE 1004.5
MAXIMUM FLOOR AREA ALLOWANCES PER OCCUPANT

FUNCTION OF SPACE	OCCUPANT LOAD FACTOR[a]
Accessory storage areas, mechanical equipment room	300 gross
Agricultural building	300 gross
Aircraft hangars	500 gross
Airport terminal	
Baggage claim	20 gross
Baggage handling	300 gross
Concourse	100 gross
Waiting areas	15 gross
Assembly	
Gaming floors (keno, slots, etc.)	11 gross
Exhibit gallery and museum	30 net
Assembly with fixed seats	See Section 1004.4
Assembly without fixed seats	
Concentrated (chairs only – not fixed)	7 net
Standing space	5 net
Unconcentrated (tables and chairs)	15 net

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NFPA 101 Table 7.3.1.2

Δ Table 7.3.1.2 Occupant Load Factor

Use	(ft²/person)[a]	(m²/person)[a]
Assembly Use		
Concentrated use, without fixed seating	7 net	0.65 net
Less concentrated use, without fixed seating	15 net	1.4 net
Bench-type seating	1 person/18 linear in.	1 person/455 linear mm
Fixed seating	Use number of fixed seats	Use number of fixed seats
Waiting spaces	See 12.1.7.2 and 13.1.7.2.	See 12.1.7.2 and 13.1.7.2.
Kitchens	100	9.3
Library stack areas	100	9.3
Library reading rooms	50 net	4.6 net
Swimming pools	50 (water surface)	4.6 (water surface)
Swimming pool decks	30	2.8
Exercise rooms with equipment	50	4.6
Exercise rooms without equipment	15	1.4

Δ Table 7.3.1.2 *Continued*

Use	(ft²/person)[a]	(m²/person)[a]
Sales area on floor below street floor[c]	30	2.8
Sales area on floors above street floor[c]	60	5.6
Floors or portions of floors used only for offices	See business use.	See business use.
Floors or portions of floors used only for storage, receiving, and shipping, and not open to general public	300	27.9
Mall structures[d]	Per factors applicable to use of space[c]	
Residential Use		
Hotels and dormitories	200	18.6
Apartment buildings	200	18.6
Board and care, large	200	18.6

Shaded text = Revisions. Δ = Text deletions and figure/table revisions. • = Section deletions. *N* = New material. 2018 Edition

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NFPA 5000 Chapter 11

MEANS OF EGRESS 5000-161

Δ Table 11.3.1.2 Occupant Load Factor

Use	ft² (per person)[a]	m² (per person)[a]
Assembly Use		
Concentrated use, without fixed seating	7 net	0.65 net
Less concentrated use, without fixed seating	15 net	1.4 net
Bench-type seating	1 person/18 linear in.	1 person/45.7 linear cm
Fixed seating	Number of fixed seats	Number of fixed seats
Waiting spaces	See 16.1.6.1.	See 16.1.6.1.
Kitchens	100	9.3
Library stack areas	100	9.3
Library reading rooms	50 net	4.6 net
Swimming pools	50 (of water surface)	4.6 (of water surface)
Swimming pool decks	30	2.8
Exercise rooms with equipment	50	4.6
Exercise rooms without equipment	15	1.4
Stages	15 net	1.4 net
Lighting and access catwalks, galleries, gridirons	100 net	9.3 net
Casinos and similar gaming areas	11	1
Skating rinks	50	4.6
Business Use (other than below)	100 ft²	9.3m²
Concentrated business use[f]	50	4.6
Airport traffic control tower observation levels	40	3.7
Day-Care Use	35 net	3.3 net
Detention and Correctional Use	120	11.1
Educational Use		
Classrooms	20 net	1.9 net
Shops, laboratories, vocational rooms	50 net	4.6 net
Health Care Use		
Inpatient treatment departments	240	22.3
Sleeping departments	120	11.1
Ambulatory health care	150	13
Industrial Use		

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Collaborative Bachelor's Degree Program of Fire Protection and Safety Engineering Technology between Southwest Jiaotong University and Oklahoma State University, U.S.A.

So which code do you use?

Whichever is dictated by local ordinances

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NFPA 101 or NFPA 5000?

- Scope and Purpose
  - 101 1.2 - Purpose
    - The purpose of this Code is to provide minimum requirements, with due regard to function, for the **design, operation, and maintenance** of buildings and structures for safety to life from fire. Its provisions will also aid life safety in similar emergencies.
  - 5000 1.2 – Purpose
    - The purpose of the Code is to provide minimum **design regulations** to safeguard life, health, property, and public welfare and to minimize injuries by **regulating and controlling the permitting, design, construction, quality of materials, use and occupancy, location, and maintenance** of all buildings and structures within the jurisdiction and certain equipment specifically regulated herein

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NFPA 5000 Chapter 11

Table 11.3.1.2 Occupant Load Factor

Use	ft² (per person)[a]	m² (per person)[a]
Assembly Use		
Concentrated use, without fixed seating	7 net	0.65 net
Less concentrated use, without fixed seating	15 net	1.4 net
Bench-type seating	1 person/18 linear in.	1 person/45.7 linear cm
Fixed seating	Number of fixed seats	Number of fixed seats
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Ambulatory health care	150	13
Industrial Use		

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Occupant Load

- OL = Net Floor Area / Area per Person
- Gross = Refers to the entire square footage of space measured wall to wall with no deductions for desks, files, movable partitions, or other items.
- Net = Refers to the square footage minus any space taken up by equipment furniture, corridors, or other space that is not used for the occupancy.

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Example

- Step 3:
  - Allow 15 square feet per person based on the requirements of the code.
    - Occupant Load = 15,000 ft^2 /15 ft^2
    - Occupant Load = 1,000 persons

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Means of Egress

- E2 Nightclub Stampede
  - Chicago, 2003
  - 21 Fatalities; 50 Injuries
  - Triggered by 15-person fight being broken up with pepper spray
  - The only known exit was the steep front stairwell leading to the main entrance on the ground floor, but its narrow doors opened inward
  - People piled 6' high
  - Owners were convicted of criminal contempt for failure to keep facility up to code and sentenced to two years in prison.

https://tribwgntv.files.wordpress.com/2013/04/24715160-sf.jpg?w=432

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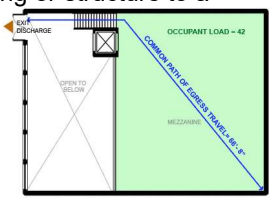
Means of Egress

- A continuous and unobstructed path of vertical and horizontal egress or exit travel from any occupied point in a building or structure to a public way.
- Public Way
  - 10 feet high
  - 10 feet wide
  - Common Path of Travel
    - The route of travel used to determine measured egress distances in code enforcement



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Typical Issues

- Improperly designed or marked exits
- Overcrowded occupancies
  - Station Nightclub
- Floor Loading
  - "Floor Collapse" video
- Inaccessible exits
- Locked or blocked exits
  - P. 243
- Inadequate fire protection systems

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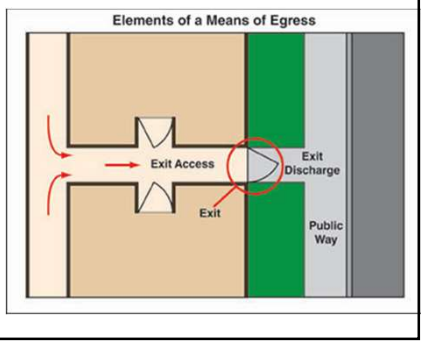
Means of Egress

- Exit Access
- Exit
- Exit Discharge
- Public Way



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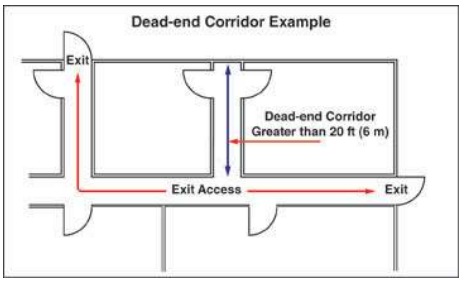
Exit Access

- Portion of a means of egress that leads to an exit



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Exit

- The exit is separated from the area of the building from which escape is to be made. It is a protected path consisting of exit components constructed of approved fire-resistant rated materials

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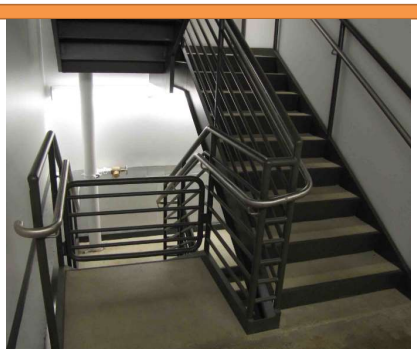
Exit?



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Exit?

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Exit Discharge

- The exit discharge exists between the termination of the exit and the public way.
  - Exterior walkway along the side of the structure
  - Privately owned drive or alley that connects the exit to the public way
    - e.g. parking lot

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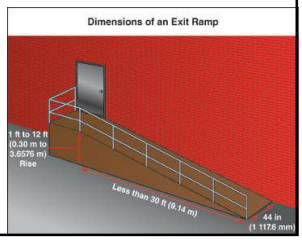
Components

- Doors
- Walls
- Ceilings
- Floors
- Stairs
- Ramps
- Fire escape ladders



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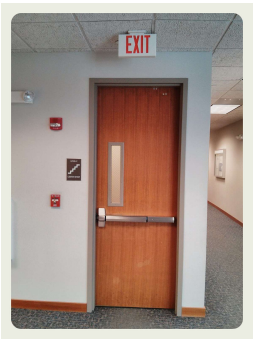
Exit Illumination and Markings



- Illumination
- Markings
- Auxiliary Power

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Emergency Action Plans

- NFPA 101 and OSHA 1910 Subpart E
  - Reporting a Fire
  - Emergency Evacuation
  - Continuity of Operations
  - Accountability
  - Rescue or Medical Responsibilities
  - Roster and Contact Information

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