

# BUILDING CENTES:

## “DESIGN WITH SAFETY IN MIND”

Presented on Behalf of The:

Barbados Association of Professional  
Engineers by:


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# Intent:


- This presentation will highlight:
  - The value of incorporating SAFETY from the design stage of building projects:
    - Potential risk can be assessed and managed at that early stage.
    - Reduce any negative impact on occupants later.

# Content:

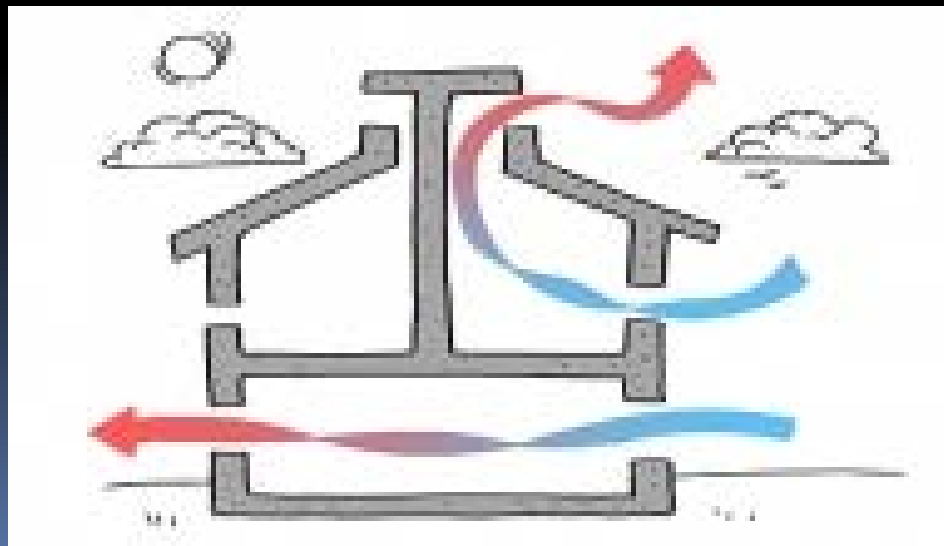
- HVAC Systems, (Active vs. Passive)
- Emergency Routes & Exits
- Surface Finishes ( Such as paints. VOCs emission)
- Considerations for Plant and Utility Rooms (Location, Uses, Etc.)



# HVAC Systems: Active & Passive

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- Active AC Systems – Mechanical system requiring an Electrical Power source.
    - Usually Compressor driven.
    - Accounts for High percentage of building energy consumption ( 30% +).

- Passive AC Systems – Natural HVAC/Architectural Processes and Strategy aimed at improving the Indoor (or Outdoor) environment with low or no energy consumption.
  - Natural Ventilation.



- Evaporative cooling.



photo: Jeremy Faludi

ceiling



90°

# Stratification

When hot air rises to the ceiling and cold air settles at floor level.



floor

69°

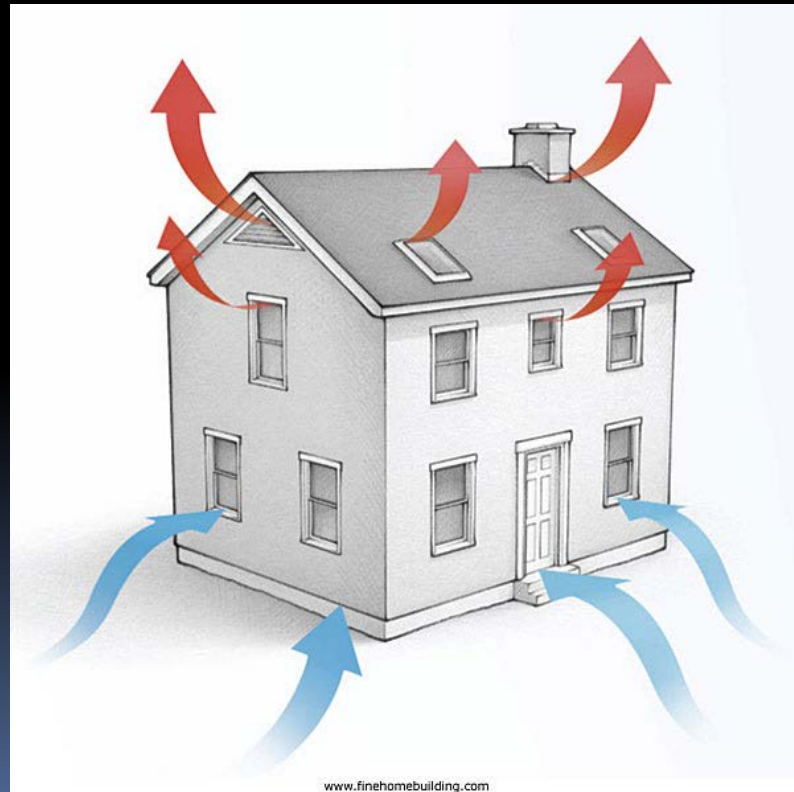


- Stratification:

- Bouyancy:


- Hot Air rises – Less Dense than cold air.

- Stack Effect.








□ Stack Effect.....


- Hot air rises and escapes at top of Stack.
  - Low pressure created within stack drawing in outside air.
  - .....Chimney.
  - Layers/pockets/Plumes of air at unique core temperatures.
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- Smoke (CO & the products of combustion) presents the greatest threat to life in the case of building fires.
- Fire, while it may be localized, eg. The Atrium of a multistorey Hotel, SMOKE will travel wherever the building airflow, natural bouyancy and Stack Effect will take it.
- Case of MGM Grand Hotel (21 storey Hotel) fire – Las Vegas 1980.....85 Fatalities, 600 affected....'only' 18 fatalities at the actual level (ground) were the fire started and contained. 61 fatalities in the High Rise Tower where smoke travelled thru the stairs, Air Handling Equipment, Shafts, floor joints.....

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- The IBC addresses issue of smoke migration, identifying where protection is required:
    - Vertical Shafts.
    - Smoke Barriers/Partitions.
    - Floor openings.
    - Stairwells
    - Emergency Exits...

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- The Design Engineer will decide on the type of system required:
    - Passive systems:
      - Advantage – Low or No energy cost, Natural Bouyancy/Stack effect.
      - Limitations – Variable outside temperatures, variances in wind speed, air entrainment, air pressure differentials induced by the HVAC system.

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- Active systems:
    - Mechanical Exhaust.
    - Considerations to achieve a tenable environment:
      - Space Geometry
      - Fuel Load
      - Make up air introduction/effect on exit routes.
      - IBC objective to keep smoke layer at min 6' above highest walkway surface in an atrium.
      - NFPA 92 – Standard for smoke control system.
      - Handbook of smoke control Engineers.....

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- Techniques:
    - Modeling & Simulation – Computational Fluid Dynamics (CFD)
    - NFPA 92 Equations.
    - Space pressurization.
    - Fire Rated Walls.
    - Fire Dampers where AC Ducts traverse Fire Rated Walls.
    - Control systems w/smoke detectors signaling AHUs shut down.



# Emergency Routes & Exits



## ■ OSHA Reg. Std. 29CFR

- Part Number: 1910
- Part Title: Occupational Safety and Health Standards
- Subpart: E
- Subpart Title: Means of Egress
- Standard #: [1910.36](#)
- Title: Design and construction requirements for exit routes.


- GPO Source: [e-CFR](#)


- Must be permanent.
- Must be adequate to serve the occupant load.
- Surrounded by Fire resistant building materials w/Fire rating:
  - 1 hr when connecting 3 or fewer floors.
  - 2 hr when connecting 4 or more floors.

- Opening must be limited:
  - Access into E/exit only as necessary from occupied areas.
  - Exit to exterior.
  - Exits protected by approved self closing doors w/'Panic' Bar, swinging out in the direction of travel.
- Adequate Number:
  - To ensure safe exit in an emergency ref. NFPA 101-2009, Life Safety Code, or IFC- 2009, International Fire Code (incorporated by reference, see § 1910.6).
  - Separated as far as possible.



- Exit Discharge:

- Lead directly outside or to a street, walkway, refuge area, public way, or open space with access to the outside.
  - The street, walkway, refuge area, public way, or open space to which an exit discharge leads must be large enough to accommodate the building occupants likely to use the exit route.
  - Exit stairs that continue beyond the level on which the exit discharge is located must be interrupted at that level by doors, partitions, or other effective means that clearly indicate the direction of travel leading to the exit discharge.
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- Height & Width Requirements:
    - Ceilings to be min 7'-6" AFFL with any projections leading to min 6'-8" AFFL.
    - An exit access must be at least 28 inches wide at all points. Where there is only one exit access leading to an exit or exit discharge, the width of the exit and exit discharge must be at least equal to the width of the exit access.



# Surface Finishes





- VOC Emission:

- Most scents are VOCs.
  - VOCs (formaldehyde) are emitted into the atmosphere as some paints dry.
  - VOCs can cause headaches & dizziness.
  - VOCs are suspected Carcinogens.
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- VOC Emission:

- US Federal government caps VOCs in paints at 250 – 380 g/l.
  - VOC free paints are now very popular.
  - Dyes, when added to VOC free paint can introduce high levels of VOCs.
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# Considerations for Plant & Utility Rooms (Location, Uses etc.)



- Location:
  - Not immediately off Emergency Exit corridors:
    - Low pressure zone -> smoke hazard.
  - Not to be used as Archive/Cleaning Solutions Storage, Mops Closet.
    - Must be clear fro Emergency ease of access.
    - Most scents are VOCs.



# Importance of Incorporating Safety at Project Design

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- At Project initiation, whether we are considering an Atrium type design (Hotels, Prisons...), Fire Escapes, location of Plant Rooms.....Safety considerations CANNOT be an after thought.
  - The only opportunity to *GET IT RIGHT THE 1<sup>ST</sup> TIME* is at **Design!!**
  - Engineers try to be as proactive as practical. We employ past experiences to update their LLKB and improve our designs to make our environment safe & better for all.



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