Building Science
Adventures In Building Science

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Definition of a Problem

People
Pollutant (hot, wet, UV, ozone)
Path
Pressure
Supply air into occupied zone returns to AHU by passing through deliberately porous dropped ceiling or through return grilles installed in dropped ceiling.

Air handling unit extracts air from dropped ceiling, conditions it and injects it into the occupied zones via supply ductwork.

Dropped ceiling depressurized by air handling units extracting air from dropped ceiling.
Air barrier system not present to prevent air from being extracted from roof assembly

Corrugated metal roof deck

Membrane roof

Rigid insulation

Brick veneer

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Interior gypsum should extend to underside of roof deck and be sealed

Exterior sheathing

Metal stud wall

Cavity insulation

Suspended ceiling

Top chord bearing roof truss

Interior gypsum

Return plenum operates under negative pressure relative to occupied space and exterior
Brick veneer

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Interior gypsum extends to underside of floor deck and is sealed

Exterior sheathing

Metal stud wall

Cavity insulation

“Air seal” between floor assembly and perimeter gypsum board

Grate to equalize pressure

Suspended ceiling

Fully ducted supply

Interior gypsum

Air Handler Unit

“Hard” ducted return
Air Flow

- Air flow depends on size of hole
- Air flow depends on pressure difference
  \[ \text{Flow} = \text{Area} \times \sqrt{\Delta P} \times \text{Coefficient} \]
- Air flows from higher pressure to lower pressure
Figure 2.11
Three Dimensional Multi-Layer
Multi-Cell Analogue

Figure 2.12
Three Dimensional Multi-Layer
Multi-Cell Non-Contiguous
Analogue
Figure 3.1
**Exterior Air Pressure Field**
(from Hutcheon & Handegord, 1983)

Distribution of pressures (+) and suctions (-) on a house with a low-sloped roof with wind perpendicular to eave.

Figure 3.2
**Exterior Air Pressure Field**
Extending Below Grade
Pressure coefficients on walls and roof of rectangular buildings without parapets.
Figure 3.5
Air Conveyance System Air Pressure Field
(from Sauer & Howell, 1990)
Figure 3.8
**Hotel HVAC System**
- Air exhausted from bathrooms via central rooftop exhaust fans
- Air supplied from corridors via undercut doors
Brick veneer

Air space

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Gypsum sheathing

Fiberglass cavity insulation

Interior gypsum board

Metal studs are perforated permitting air to be drawn through wall cavity

Interconnected hollow wall cavity constructed from metal studs with punched openings acting as an air duct

Interior spaces are at a positive pressure relative to the exterior
Figure 3.10

**Pressure Field Due to Fan-Coil Unit**

**Plan View**
- Room is at positive air pressure relative to exterior-driven air from corridor and air supplied to room from fan-coil unit pulling air from exterior through the demising wall
- Fan-coil unit depressurizes dropped ceiling assembly due to return plenum design
- Demising wall cavity pulled negative due to connection to dropped ceiling return plenum

Figure 3.11

**Pressure Field Due to Central Exhaust**

**Plan View**
- Leakage of central exhaust duct pulls air out of service shaft depressurizing shaft and demising walls
Leaky air handling unit and supply ducts

Note: Colored shading depicts the building’s thermal barrier and pressure boundary. The thermal barrier and pressure boundary enclose the conditioned space.
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Grille located high in wall on bedroom side to avoid blockage by furniture.

Cavity is sealed tight, drywall glued to studs and plates on both sides.

Grille located low in wall on hallway side.
Back-to-back grilles on both sides of partition wall with interior baffles
Sound and light baffles (sheet metal)
Back-to-back grilles

Sound and light baffles (sheet metal)