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Seminar 37: Space Pressurization for Infection Control and Hospital Accreditation

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Controlling Contaminants with Space Pressurization

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Learning Objectives

- Select and specify control strategies for various pressurized spaces by applying the physics of air infiltration to infection control objectives
- Explain the standard requirements for various pressurized spaces from the viewpoint of a facilities engineer
- Specify systems and equipment that support a monitoring plan for pressurized spaces
- Train the facilities staff about monitoring of pressurized spaces and the requirements as specified in the standards

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Acknowledgements

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Potential source of bias: the speaker is employed by a BAS provider

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Agenda

- Introduction, Infiltration, Containment
- Pressurization Methods
- Lessons for Design
- Summary

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Room Pressurization

A ventilation technology that controls migration of air contaminants by inducing drafts between spaces.

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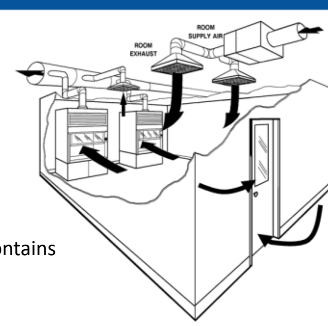
Room Pressurization

- Exhaust system removes air
- Supply system delivers less
- Room pressure is negative
- Infiltration makes up the difference
- Inward air flow contains pollutants



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How is success defined?

Success is control of contaminants, not flows and pressure values

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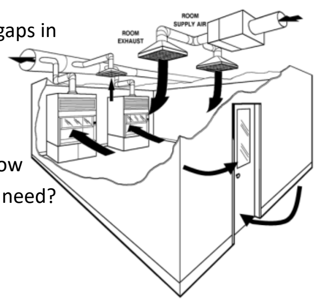
Infiltration Model for Pressurization

- Air velocity through gaps in envelope controls contaminants
- Velocity related to pressure by orifice flow
- What velocity do we need?



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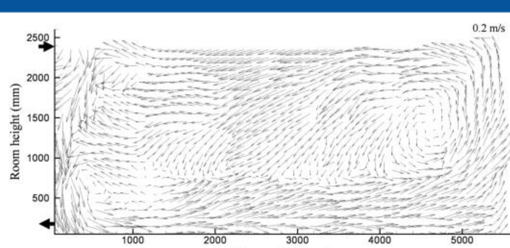
Reality of Room Air Motion



Photograph of flow field (2D) in cross section of a room

"Particle Image Velocimetry"

Zhao L., ASHRAE Transactions, DA-07-044

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Velocity and Leakage Area

- Flow is velocity times area
- 2011 ASHRAE Handbook HVAC Applications, puts it together: 53-9

$$Q = fA\sqrt{\Delta P}$$

  - Q = infiltration flow
  - f = discharge coefficient and factor for units
  - A = leakage area
  - ΔP = pressure across envelope

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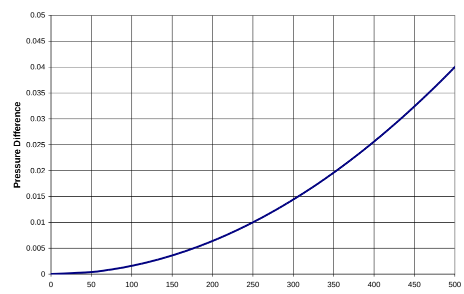
Infiltration Curve – Pressure Difference vs. Flow



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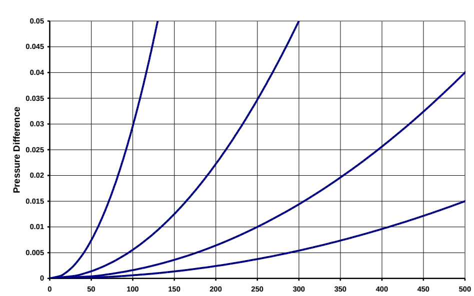
Infiltration Curves for Several Values of Leakage Area



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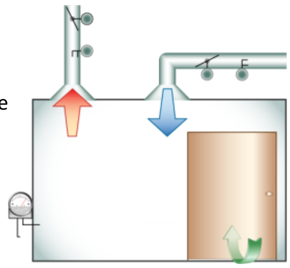
Pressurization and Migration

- Positive room pressure drives air and contaminants out
- Negative room pressure draws air and contaminants in
- Neutral room pressure exchanges air and contaminants both directions



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Control Methods Compared

Three widely published methods [1,2]

- Space pressure feedback
- Differential flow control
- Cascade control

1. 2015 ASHRAE Handbook, HVAC Applications. Chapter 16 Laboratory Systems
2. Siemens Building Technologies: Doc #125-2412. Room Pressurization Control

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Control Methods Compared

Some other ways

- Adaptive leakage model[1]
- Trim valve[2]

1. W Sun, ASHRAE Transactions, NA-04-7-2. Quantitative Multistage Pressurizations in Controlled and Critical Environments
2. L. Gartner and C. Kiley, Anthology of Biosafety 2005. Animal Room Design Issues in High Containment

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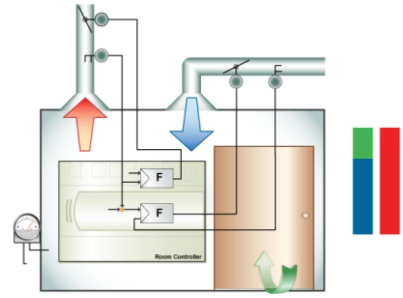
Differential Flow Control



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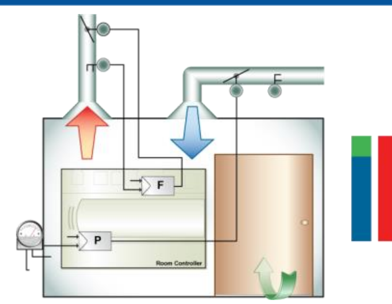
Pressure Feedback



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Selecting a Control Method

Factors affecting selection[1]

- Tightness of envelope
- Number of pressure levels needed
- Speed of disturbances and response
- Duct conditions for flow measurement

1. 2015 ASHRAE Handbook – HVAC Applications, Chapter 16 - Laboratory Systems, page 16.12

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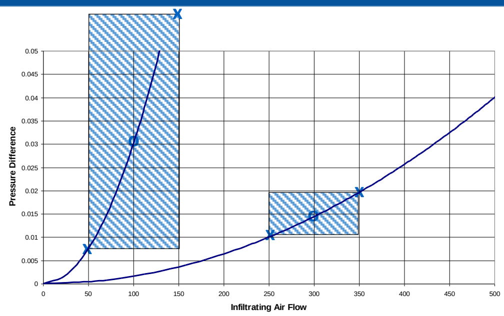
Tightness of Envelope



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Lessons for Design

- Solid wall is the most important component to control contaminants
- Leakage in envelope is the primary mechanical parameter
- Most applicable control strategy depends on leakage area
- Operators need monitors. Design them in.

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Questions?

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