

Maine Indoor Air Quality Council

HOW TIGHT IS TOO TIGHT?

WAGDY ANIS AIA, LEED-AP
PRINCIPAL
Director of Technical Resources

SHEPLEY BULFINCH RICHARDSON AND ABBOTT
ARCHITECTS BOSTON, MA

How Tight is Too Tight?

- Quiz
- What Pollutants can be Indoors
 - Migration of Pollutants
- Ventilation Requirements in Buildings:
 - Commercial & Multiples – ASHRAE Standard 62.1
- Infiltration Control –Air Barriers
- Quiz

QUIZ : Yes! Or No!

- Building enclosures need to dry out.
- People need to breathe “fresh air” to stay healthy.
- Buildings need to breathe.
- Ventilation is essential
- Natural Ventilation is equal to Mechanical
- Tight building enclosure is essential to ventilation control.
- Tight buildings make you sick.

Why Ventilate When...

- Communicable Diseases Under Control With Good Hygiene
- Combustion Appliances Are Safe by Law
- Toxics Are Regulated
- Codes Require Operable Windows
- Ventilation Costs Energy & \$

Because:

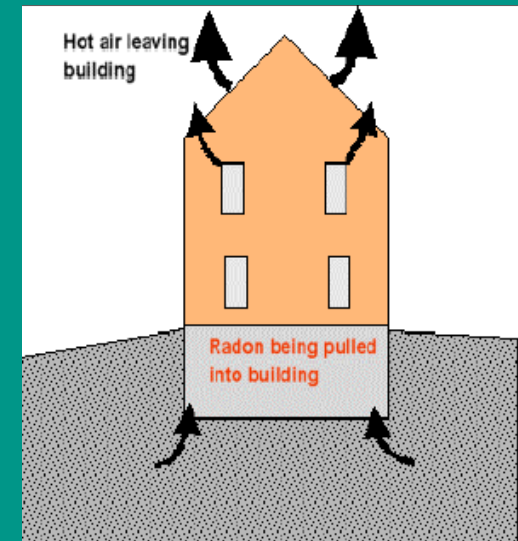
- People Emit “Human Bioeffluents”
 - CO₂ is only surrogate
- Daily Hygiene of Western World
 - 5 cfm/person adapted
 - 15 cfm/person unadapted
- Dominates In High-Density Spaces
 - But what about other spaces

Combustion:

- Lots of Pollutants
 - Water
 - NO_x, SO_x, CO_x
 - Soot & Unburned
- It Would Be OK If It Were All Vented

Building Emissions:

- Volatile Organic Compound (VOC)
 - Formaldehyde
 - Others
- Radon
 - Soil Gas
- Others
 - Particles



Toxics:

- Activities
 - Cleaning
 - Painting
 - Pesticides
 - Hobby
- Residues Linger
- Entrainment



Toxics:

- Mold, Fungi
- Dust Mite, Critters
 - Asthma



ASHRAE Standard 62.1

Ventilation for Acceptable Indoor Air Quality



Scope

- ◆ Commercial Buildings and Residential buildings 4 stories and higher

Rationale for New Rates

- ◆ Explicitly recognizes building as a source of indoor air pollutants
 - Followed lead of European standards
- ◆ Explicitly accounts for ventilation efficiency
- ◆ More studies to guide rate selection
 - Almost exclusively offices
- ◆ No smoking
- ◆ Rates still largely based on judgment of Project Committee

Ventilation Rate Procedure

People Component

Building Component

Outdoor Air
Ventilation
Rate for Space



$$V_o = R_p P_d + R_b A_b$$

Minimum cfm/Person X Number of People + Minimum cfm/sq ft X Building Area

Ventilation Rate
for System

$$V_{ot} = \Sigma V_o / E_v$$

System
Efficiency

Field and laboratory studies motivating people rates:

15 cfm person satisfies about 80 % of visitors to a space in terms of body odor perception

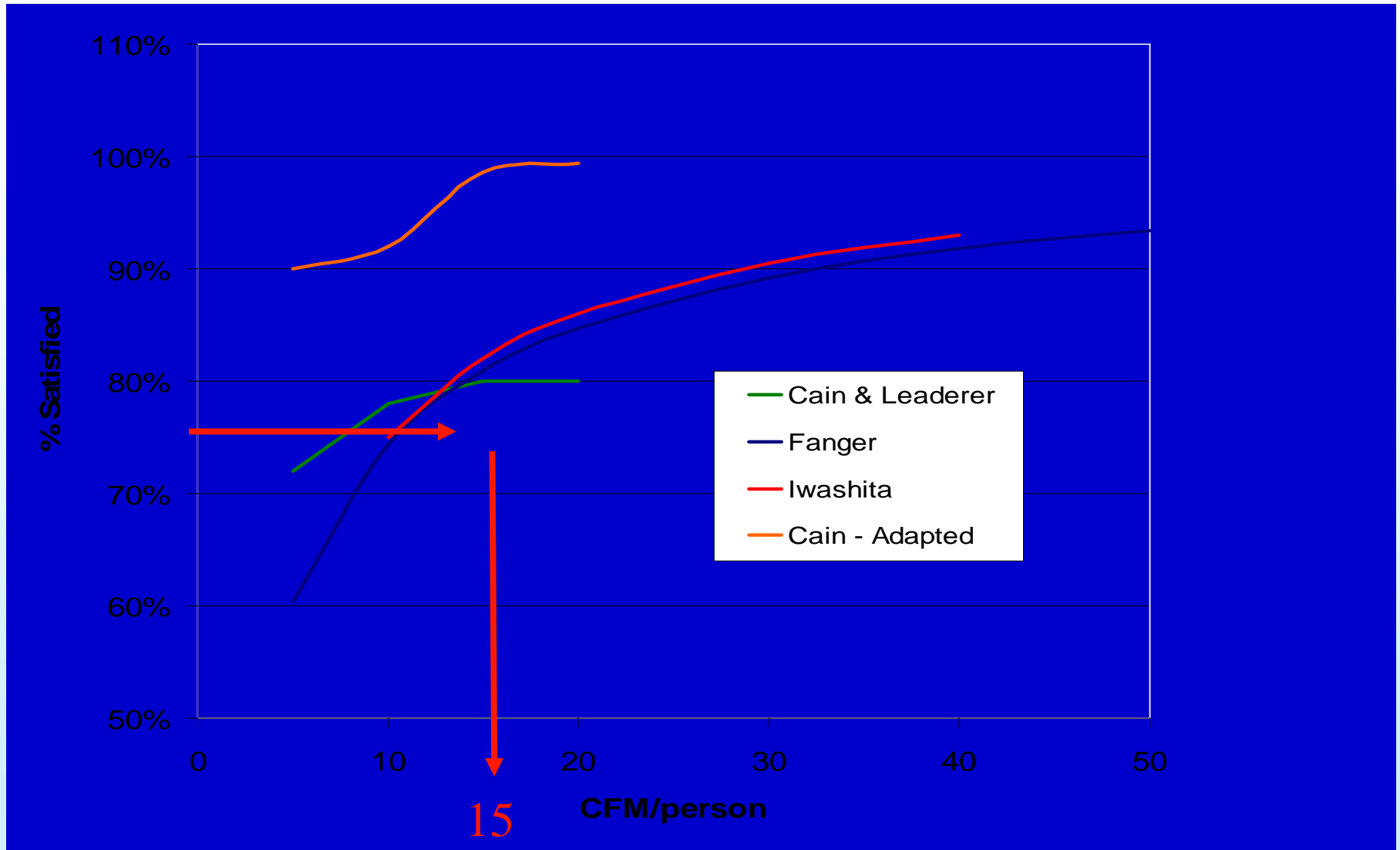
Significant adaptation to bioeffluents, but less so to materials

5 cfm person satisfies substantial majority of adapted occupants in offices.

Other spaces R_p : 5, 7.5, 10, 20, 0 (*building dominated*)
cfm/person

Chamber Body Odor Studies

Impact of ventilation rate on “visitors”



Used by permission of Andrew Persily, NIST.

Studies motivating building rates:

Satisfying about 80% of visitors due to “building” sources

Offices: 0.4 cfm/ft²; Kindergartens 0.5 cfm/ft²; Halls 0.7 cfm/ft²

Lowest value for office buildings, 0.03 cfm/ft²

Base rate for low-emitting buildings 0.06 cfm/ft²

Other spaces R_B : 0.06, 0.12, 0.18, 0.30, 0.48 cfm/ft²

Office building reference point

Total of 20 cfm per person correlates with fewer SBS symptoms in offices

Occupant density of 5/1000 ft² yields 17 cfm/person using new rates.

Other space types

Less information for definition of R_P and R_B

Use multiples of base values

Revised Ventilation Rate Procedure

Space	62-2001 (cfm/person)	62.1 rate at occupancy (people/1000 ft²)
Office	20	17 (5); 14 (7)
Conference room	20	6 (50)
Classroom	15	15 (25); 12 (50)
Lecture room	--	8 (65)
Auditorium	15	5 (150)

Zone Air Distribution Effectiveness

- ◆ Ventilation : Process of supplying or removing air (by natural or mechanical means) for the purpose of controlling contaminants, humidity or temperature
- ◆ Ventilation air needs to get to occupants
- ◆ 1989 to 2001: Systems shall be designed and installed so that ventilation air is supplied throughout the occupied zone
- ◆ 62.1 (7/3/03) contains table of default values and option to do your own test

Zone Air Distribution Effectiveness

Any point above the breathing zone is considered the ceiling!

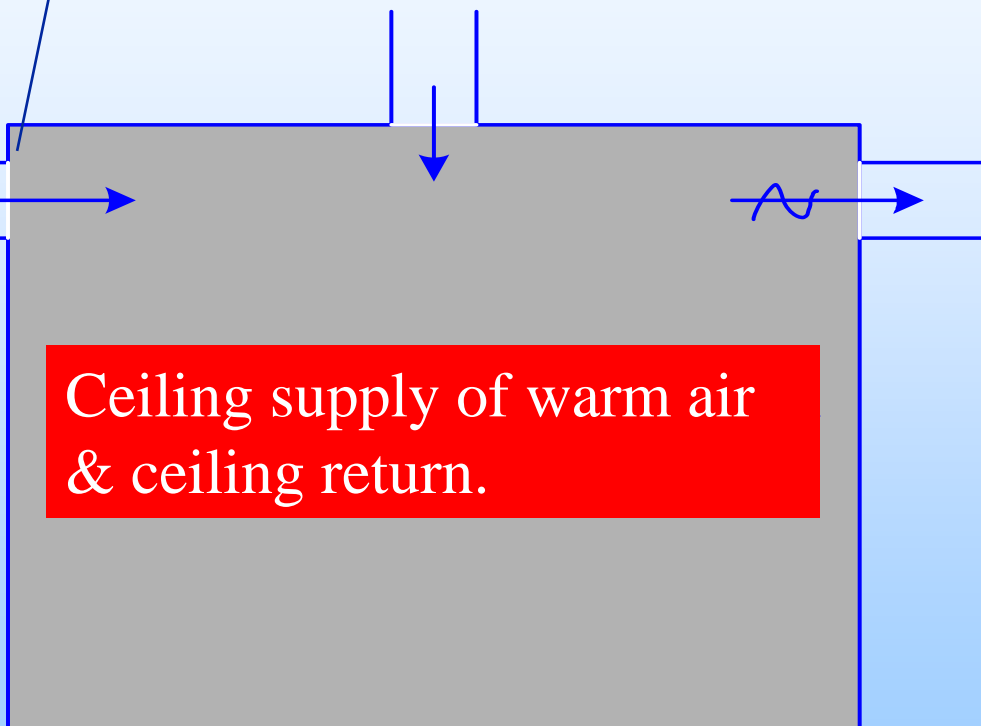
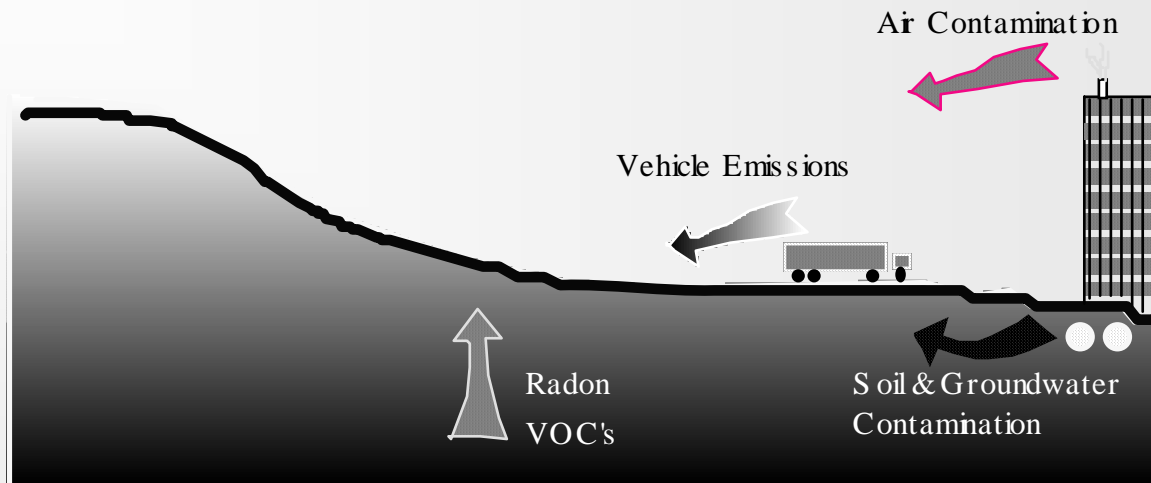


Table excerpt of one example.

Supply air minus room air temperature difference		Air change effectiveness
°F	°C	
<0	<0	1.0
0-15	0-8	1.0*
>15	>8	0.8

* 0.8 m/s (150 fpm) supply air jet reaches to within 1.4 m (4.5 ft) of floor level. Otherwise, use 0.8.

POLLUTANT SOURCES OUTDOORS

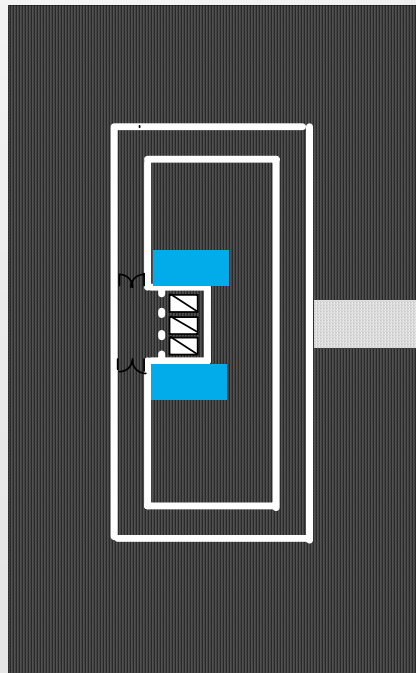


- Site History
- Adjacent Site Analysis
- Local Climate and Microclimate
- Soil and Groundwater Analysis

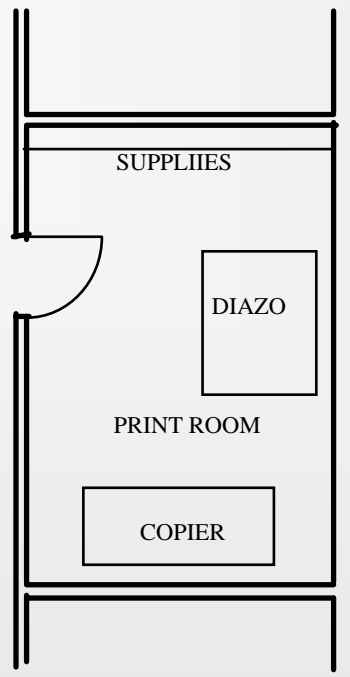
COMPARTMENTATION

Compartmentalize
To Control Design Pressures

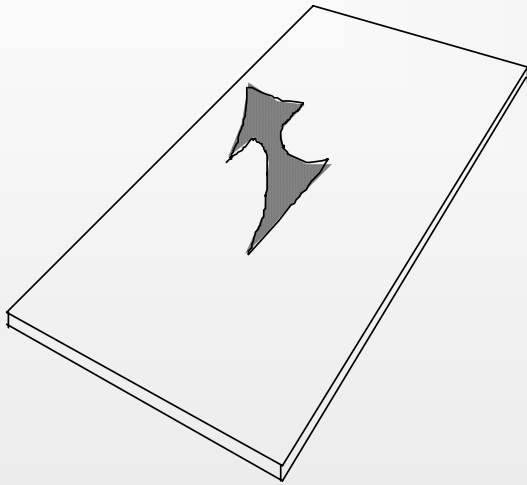
Elevator Lobbies
Storage Rooms
Toilets
Stairs
Utility Rooms
Copy Rooms



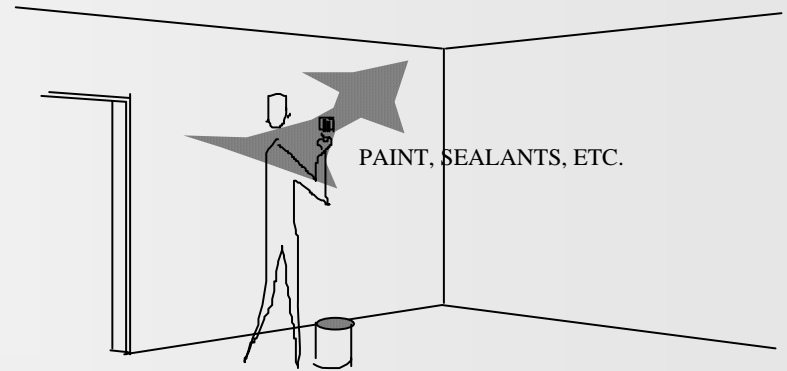
SOURCE CONTROL



SOURCE CONTROL

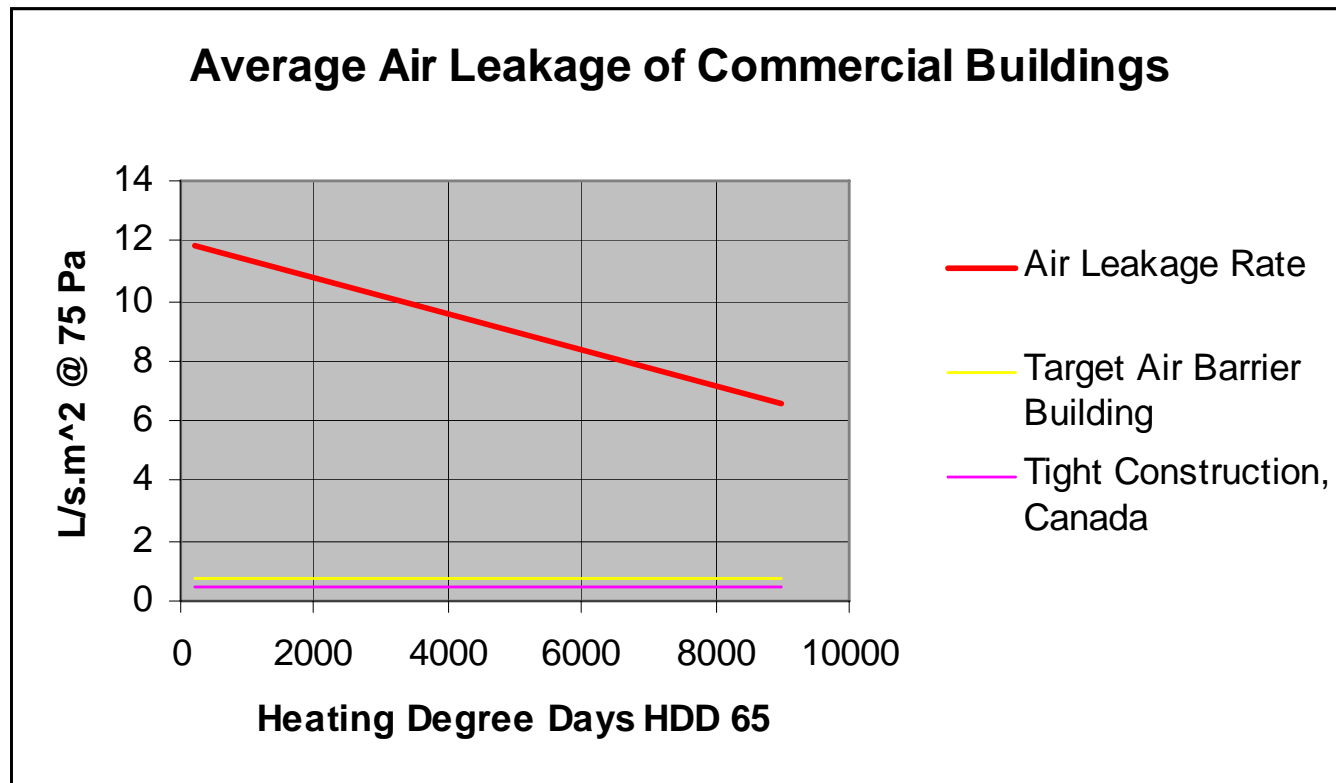


POLLUTANT DIFFUSION
(DRY PRODUCTS)

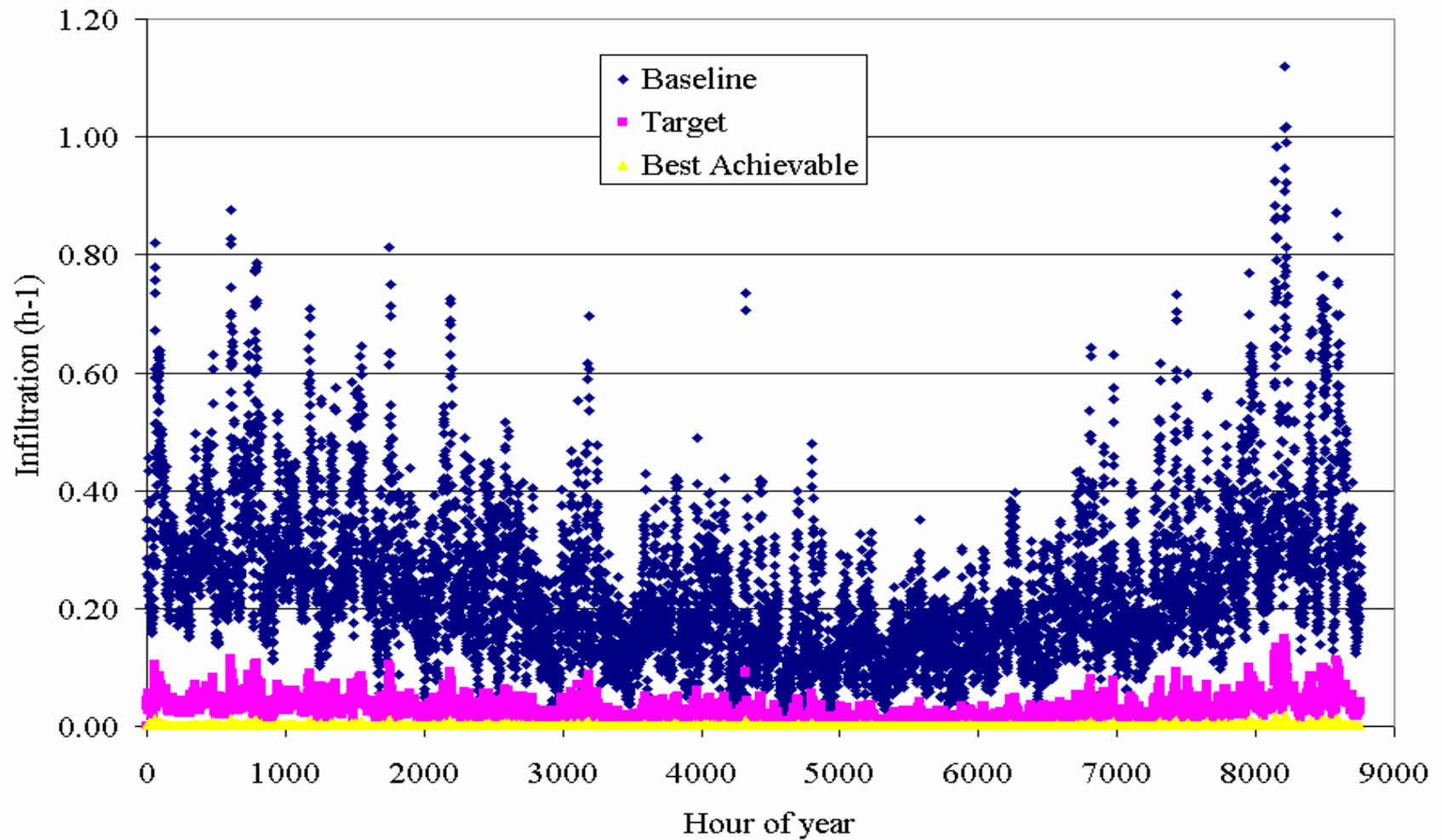


EVAPORATION
(WET PRODUCTS)

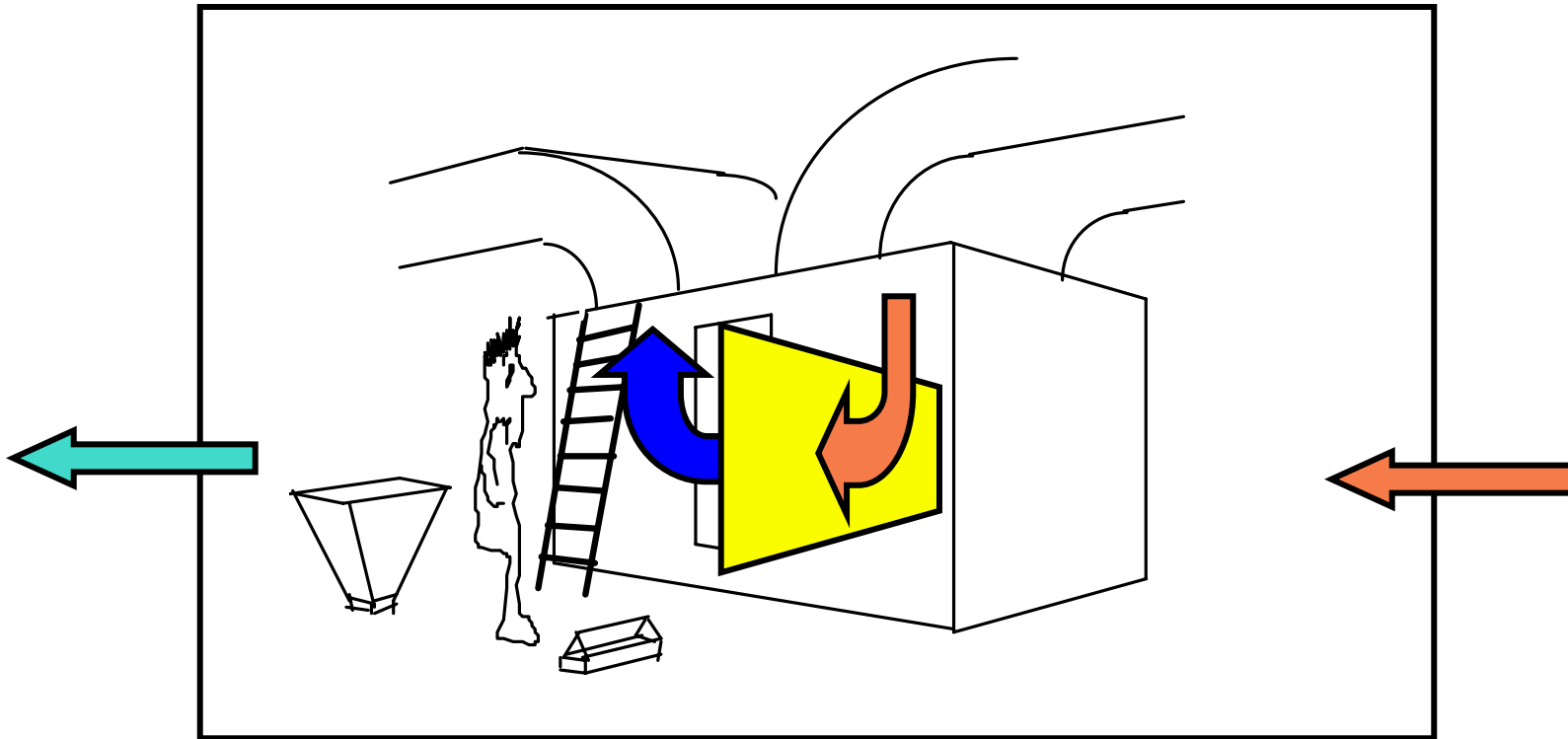
INFILTRATION RATES



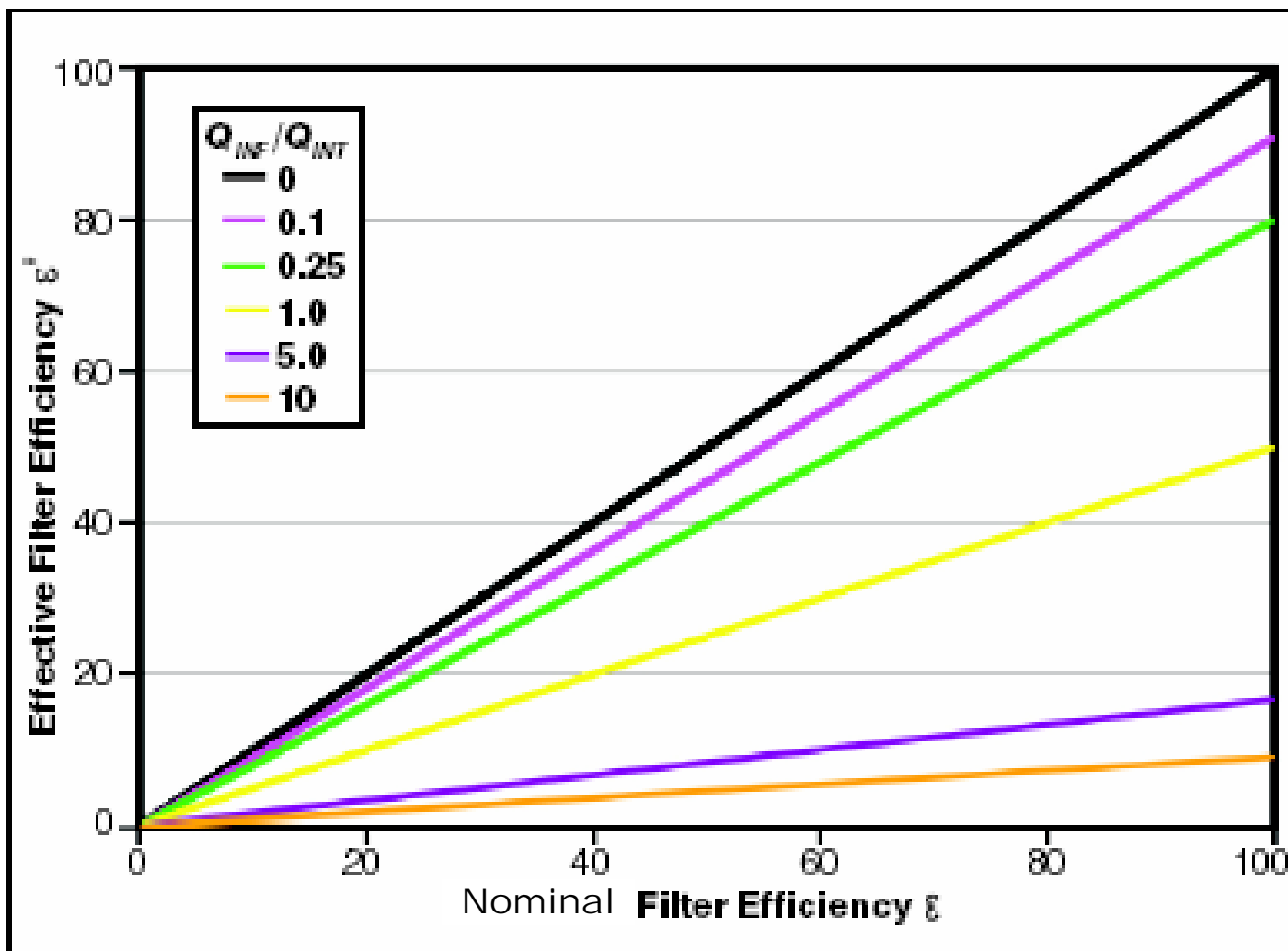
DRAFT Hourly Infiltration St. Louis



INFILTRATION AS FILTER BY-PASS



Nominal vs. Actual Filtration Efficiency



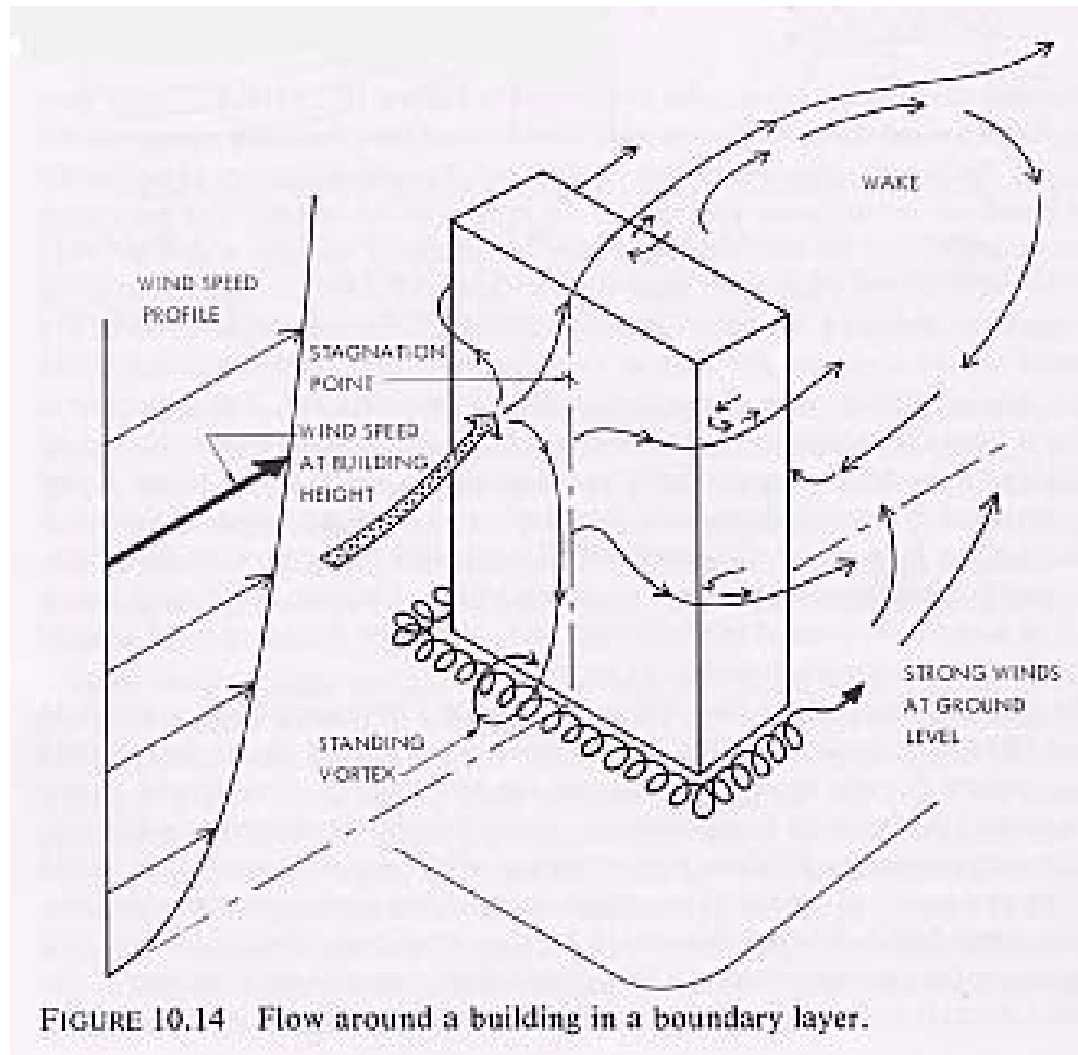
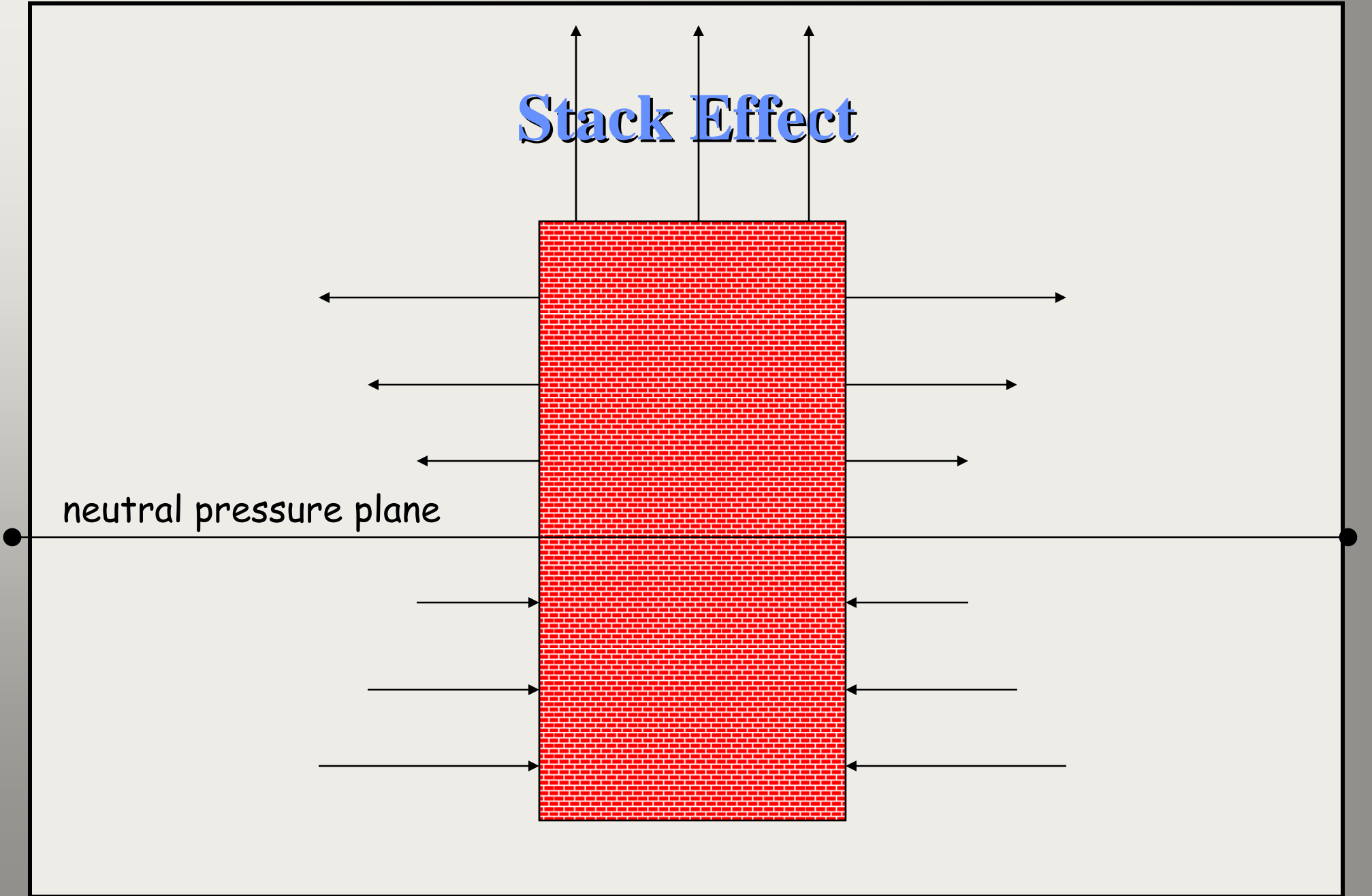
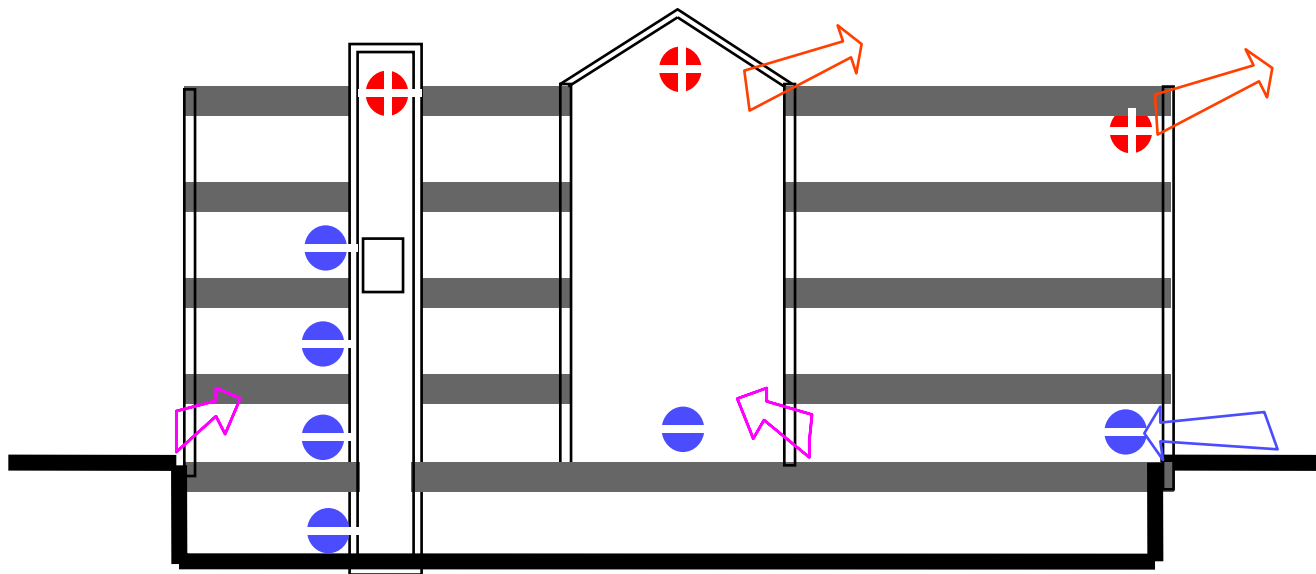


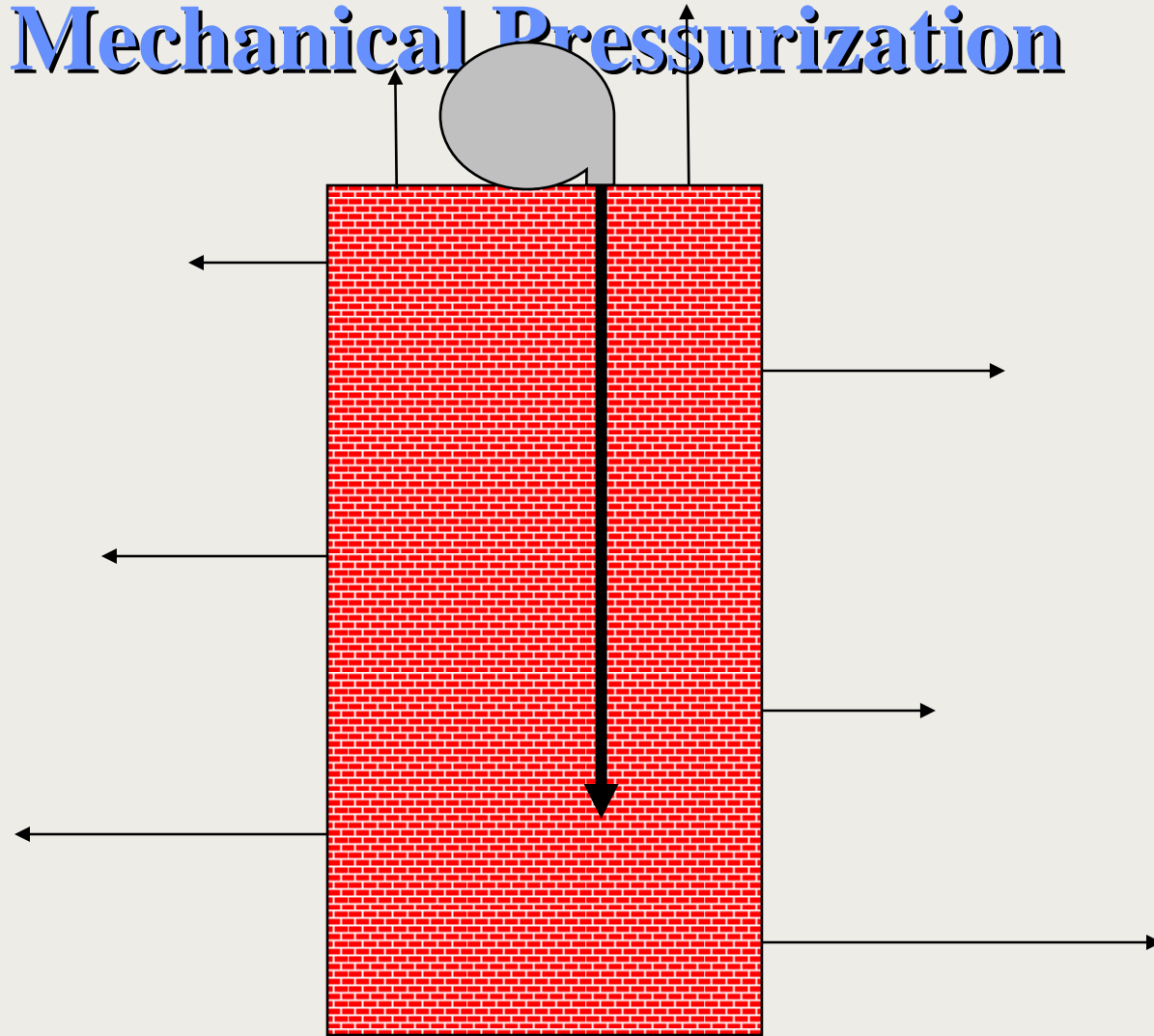
FIGURE 10.14 Flow around a building in a boundary layer.

Stack Effect

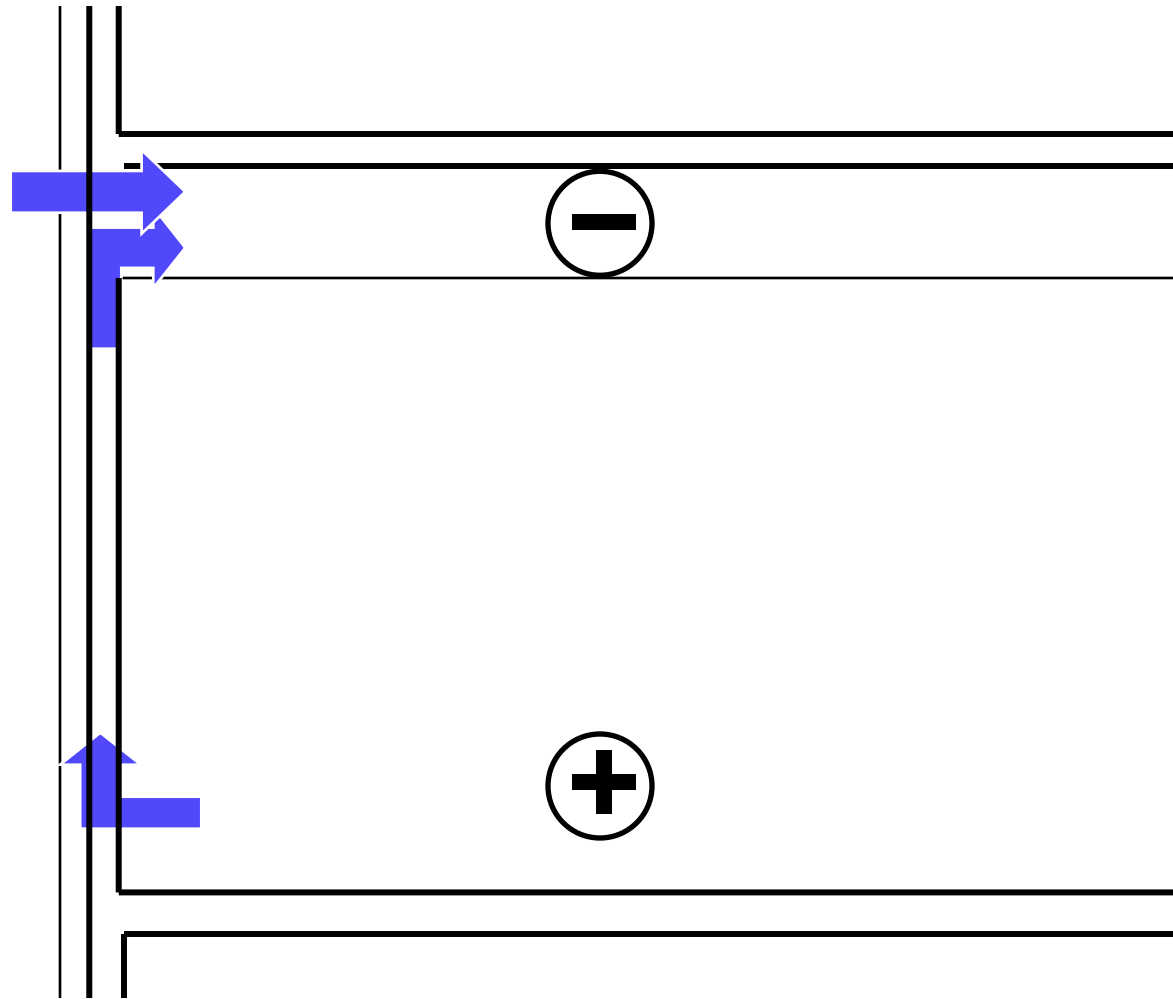




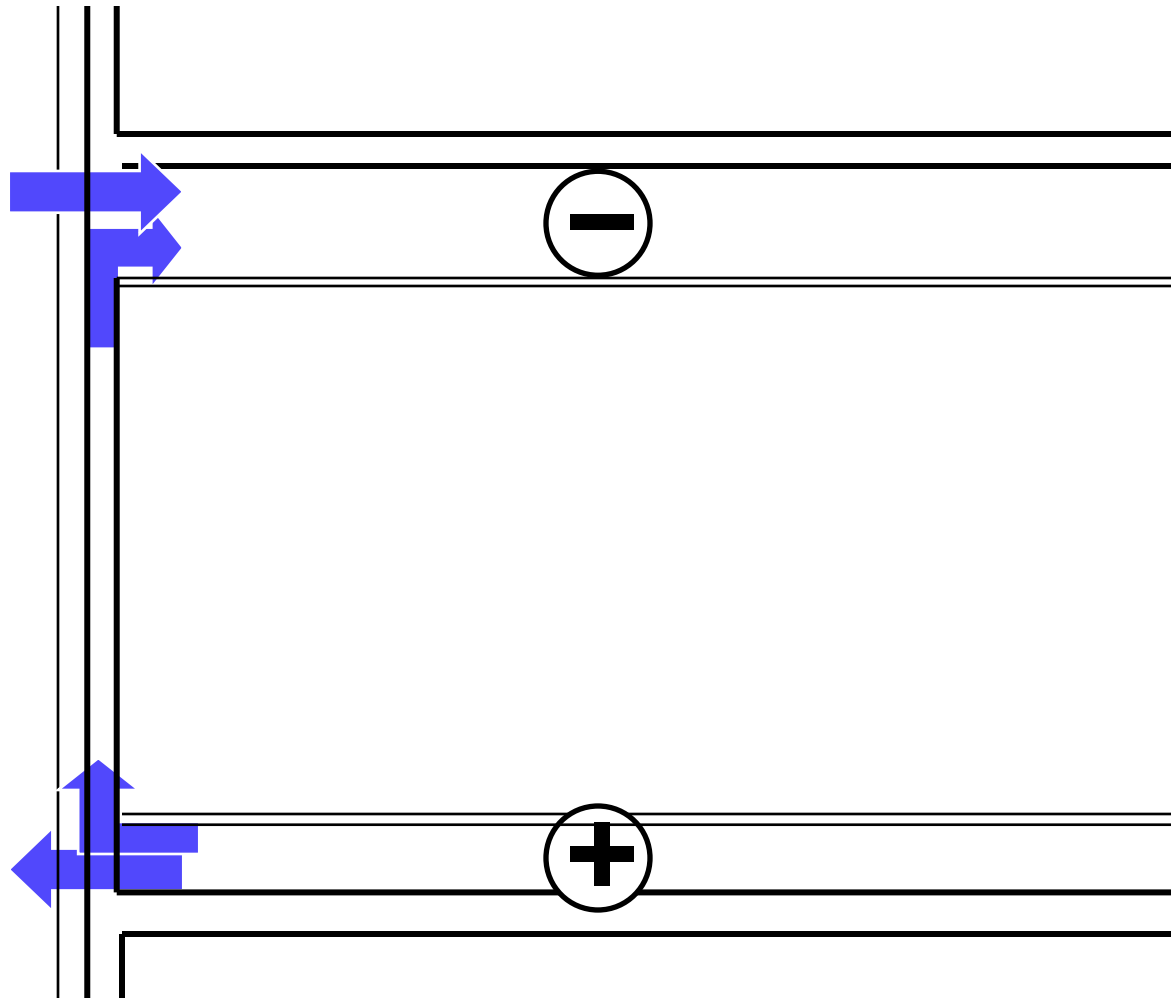
Mechanical Pressurization

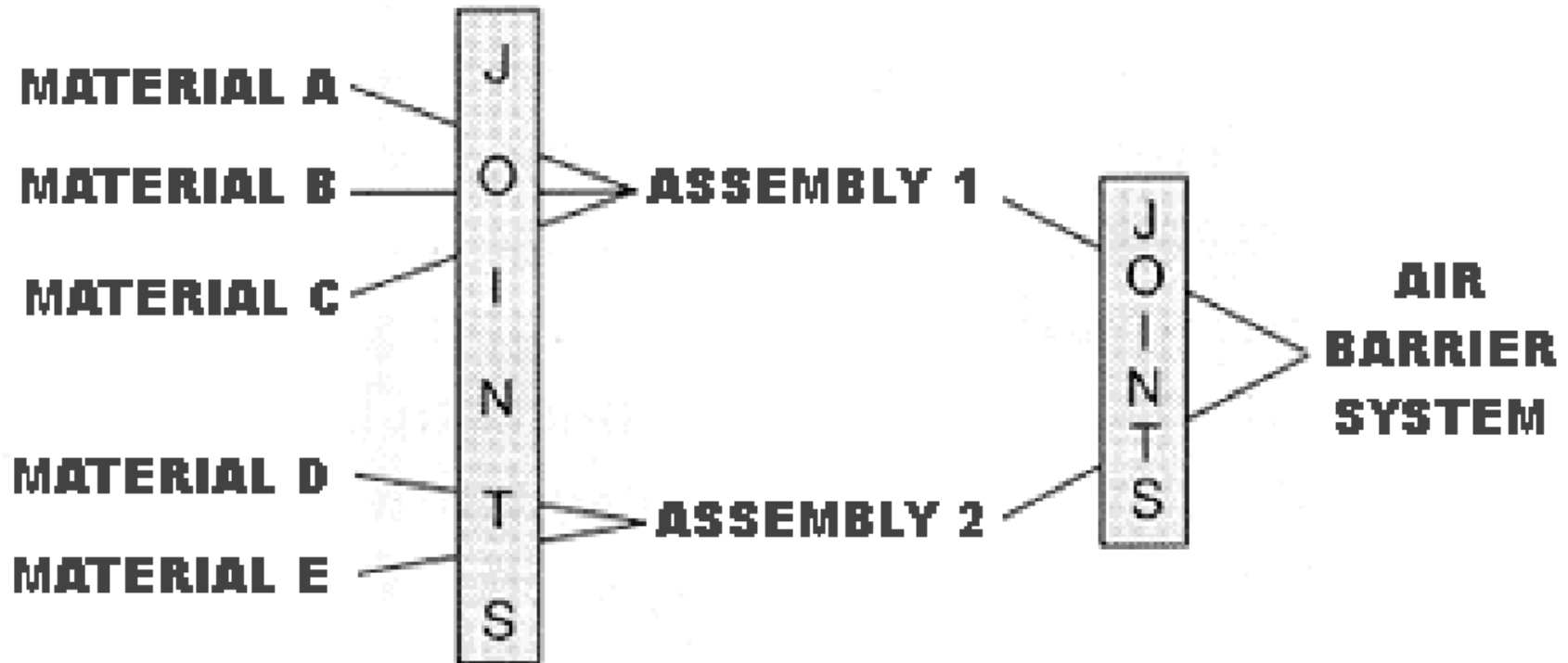


Decouple Exterior Walls From Plenums



Decouple Exterior Walls From Plenums





Conclusions:

- Build Tight – Ventilate right
- Compartmentalize to control pressure differentials
- Practice source control of pollutants