ENERGY EFFICIENCY AND EXISTING BUILDINGS

LandmarkWest!
The Community Preservation Corporation
CUNY Institute for Sustainable Cities
Steven Winter Associates, Inc.
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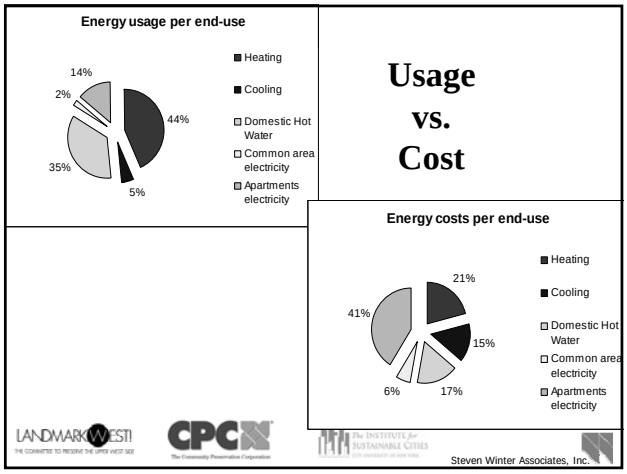
Part One
Fuel Analysis in Buildings

Who are we?

- Steven Winter Associates, Inc. (SWA) is a 36 year-old architecture and engineering consulting firm specializing in building performance.
- SWA has trained over 2000 managers, architects, engineers and maintenance staff on how to run and maintain multi-family buildings, and many other types of high performance buildings.

Introduction to Energy Usage Analysis

- What uses energy in my building?
- What energy use cost me the most my building?
- How energy efficient could my building be?



Introduction to energy cost analysis

- How much energy do we use ? Understanding energy bills.
- How can we compare energy usage between buildings?
- How do we make economic decisions on cost effective improvements?

Fuel units

Fuel Type	Unit
#2 oil	Gallon
#4 oil	Gallon
#6 oil	Gallon
Nat. Gas	Therm or CCF
Propane liq. gas	Gallon
Electricity	kWh

What is a BTU ?

- British Thermal Unit BTU
- 1 BTU = amount of heat to raise 1 pound of water to 1°F
- About the same amount of heat available when burning one kitchen match

Fuel comparison

Fuel Type	Unit	Equiv. BTU
#2 oil	1 Gallon	138,000
#4 oil	1 Gallon	145,000
#6 oil	1 Gallon	150,000
Nat. Gas	1 Therm	100,000
Propane liq. gas	1 Gallon	91,000
Electricity	1 kWh	3412

Parameters that can influence your energy bills:

- Weather conditions (if you are looking at heating fuel bills)
- Energy prices: seasonal and market variation
- Changes in building occupancy or occupants' behavior
- Equipment failure
- Down time
- Building improvements

BTU/sqft/HDD

- The energy usage per heated space per "weather severity" unit.
- Indicates how energy efficient your building is.

What is Base Energy Usage?

Base energy usage is the amount of energy you use on a non-heating or non-cooling day to run all non-heating or non-cooling loads.

Why do we care about base usage?

Once this can be determined on a daily basis, we can more easily estimate how efficiently our buildings heat, cool, and make hot water.

Calculating Base Energy Usage

1st, Get a printout of your fuel usage
(not bills, but consumption)

Select approximately a one year period of fuel **usage**

Get the annual consumption from this total = 60,355
(Because you ignore the first delivery)

010999	010999	2913	2913
012599	012599	3435	3435
020699	020699	2939	2939
041499	041499	1951	1951
050299	050299	2932	2932
060299	060299	2949	2949
070699	070699	3445	3445
081499	081499	2953	2953
102799	102799	2943	2943
111499	**111499**	2930	**2930**
112799	**112799**	2930	**2930**
121199	**121199**	2932	**2932**
121999	**121999**	3417	**3417**
122899	**122899**	2725	**2725**
011000	**011000**	2926	**2926**
011200	**011200**	2915	**2915**
012600	**012600**	2928	**2928**
020400	**020400**	2911	**2911**
021200	**021200**	2916	**2916**
021900	**021900**	2915	**2915**
030500	**030500**	3427	**3427**
032000	**032000**	2916	**2916**
040700	**040700**	2929	**2929**
050600	**050600**	2931	**2931**
060700	**060700**	2950	**2950**
071500	**071500**	2949	**2949**
082600	**082600**	2952	**2952**
100700	**100700**	3431	**3431**
110600	**110600**	3430	**3430**
112400	**112400**	2925	**2925**
120800	120800	2917	60,355
122300	122300	2465	2465
010301	010301	2906	2906

Highlight the summer (non-heating) months

Find the total usage between the summer periods on a daily basis

Average daily oil usage in summer = 2949 +2952 +3431 = 9332/122 days = 76.5 gallons/day x 365=

27,922.5 gallons oil for DHW use/60,355 = 46.3% oil usage for DHW

60,355 - 27,922.5 = 32,432.5 gallons of oil for heating

111499	2930
112799	2930
121199	2932
121999	3417
122899	2725
011000	2926
011200	2915
012600	2928
020400	2911
021200	2916
021900	2915
030500	3427
032000	2916
040700	2929
050600	2931
060700	***2950***
071500	***2949***
082600	***2952***
100700	***3431***
110600	**9332**
112400	2925
	60,355

Calculations Cont.

- 32,432.5 gallons of oil for heating
- 10,267 square feet per floor
- 6 floors
- total square feet= 10,267 x 6 = 61,602
- 32,432.5/ 61,602 = .53 gallons of # 4 oil per square foot for heat
- 145,000 Btu per gallon of #4 oil = 76340 Btu's/square foot per year for heat

What is a Heating Degree Day?

- To calculate the heating degree days for a particular day:
  - Find the day's average temperature by adding the day's high and low temperatures and dividing by two.
  - If the number is above 65, there are no heating degree days that day.
  - If the number is less than 65, subtract it from 65 to find the number of heating degree days.

Example of Heating Degree Day calculation

- For example, if the day's high temperature is 60 and the low is 40, the average temperature is 50 degrees
  - 65 minus 50 is 15 heating degree days
- Heating degree days can be found in the newspaper each day
- Cumulative HDD's can be found at www.weather.gov then by clicking on your city on the map

In an average winter, NYC has 4888 Heating Degree Days (HDD)

Site (Countywide Averages)	HDD
NYC	4888
Yonkers	5497
Albany	6750
Pennsylvania (Statewide)	5700-6100
Buffalo	6922
Montreal	9350

HDD notes the severity of weather in a particular location. The more HDD's, the colder the weather is.

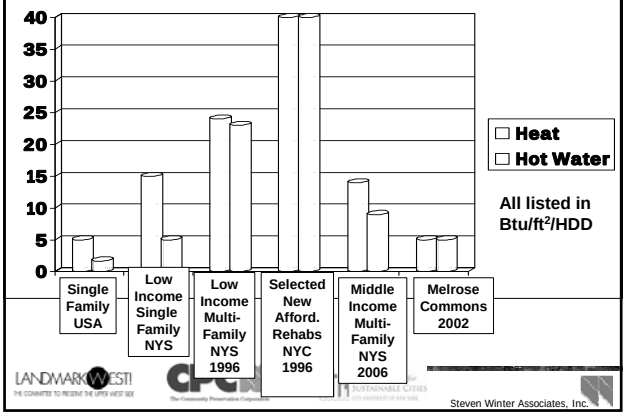
Now back to our Model Building

- 32,432.5/ 61,602 = .53 gallons of # 4 oil per square foot for heat
- 145,000 Btu per gallon of #4 oil = 76340 Btu's/square foot per year for heat
- Divided by 4888 HDD = **15.6 Btu/ft2/HDD**

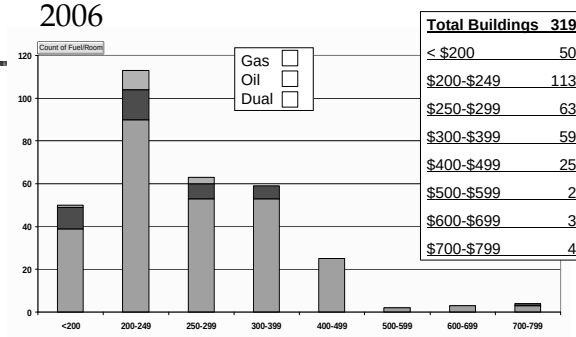
Comparing Building Heating Usage

- Compare by square foot
- Adjusted for weather
- We can compare buildings from Washington DC to Boston using the same measurement

Range of Energy Usage in Residential Buildings

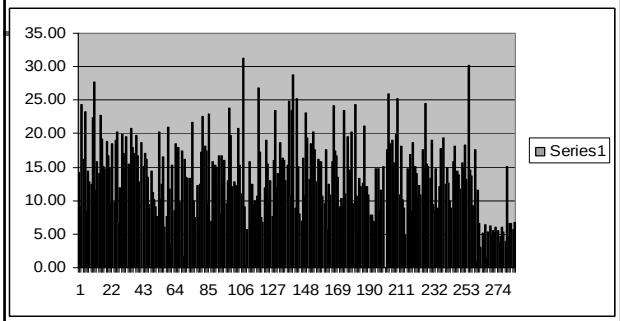


Bank Buildings- Fuel Costs per Room 2006

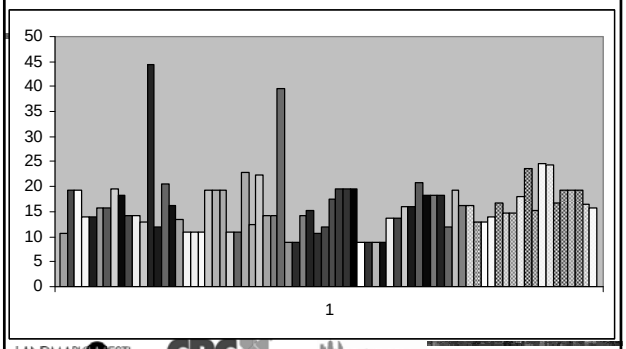


Total Buildings 319	
< $200	50
$200-$249	113
$250-$299	63
$300-$399	59
$400-$499	25
$500-$599	2
$600-$699	3
$700-$799	4

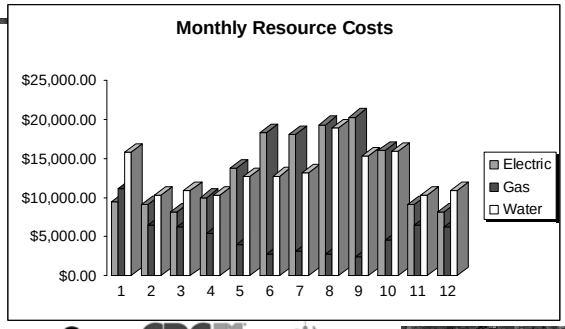
Almost 300 NYS Buildings requesting Energy Audits 2001-2005 (BTU/ft2/HDD)



A Top 10 Owner of NYC Properties: Multifamily Energy Usage



One Complex, 12 Months, Master Metered



Rent vs. fuel usage

For a **TWO BEDROOM** Apartment that is **660 SQ. FT.**, and rents for **$1,000/month**.

Annual Rent Dollars	Annual Fuel Use Therm/ft²	Annual Fuel Cost (at $1.85 per therm)	Annual Fuel Use as % of Annual Rent
12,000	.5	611	5.0%
12,000	1	1,221	10.0%
12,000	2	2,442	20.0%
12,000	4	4,884	40.0%

Recap:

- Get your fuel bills
- Tweak out your summer usage
- Separate heating and “base” usage
- Get your building square feet
- Heating vs. base usage percentages
- Btu/ft2/HDD

QUESTIONS?

Part 2
Whole Building Systems Approach

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Multi-Family Building Operator Training

Basics of Thermodynamics:

- **1st LAW of Thermodynamics: law of conservation**

  Energy cannot be created or destroyed. However, it can be exchanged between *the system* and its surroundings.

- **2nd LAW of Thermodynamics: entropy**

  Energy flows from states of greater order to states of lesser order

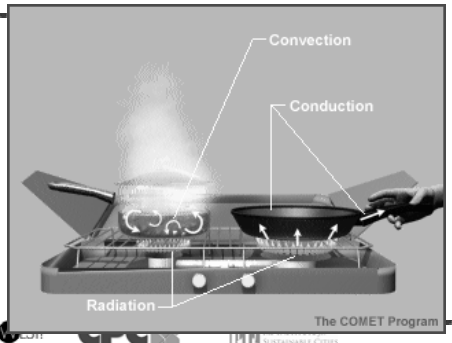
Basic principles derived from the 1st law and 2nd law

- Heat always flows from Hot to Cold.
- Steam travels from HIGH pressure to LOW pressure
- Moisture travels from MORE to LESS
- HOT AIR rises : and NOT heat

Heat transfers:

- Conduction
  - The movement of heat through the building materials
- Convection
  - Air currents circulation between warm and cool zones
- Radiation
  - Radiant heat = electromagnetic waves.
  - All objects transmit radiant energy.
  - The amount of heat transmitted depends on the intensity of temperature of the material

Conduction, Convection, Radiation.



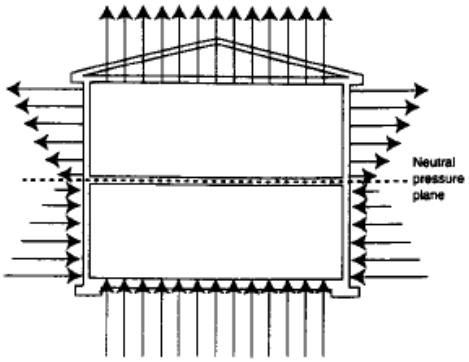
Building Heat Loss

- By Infiltration and Ventilation
  - By air movement into, through, and out of conditioned spaces
  - Wind, Stack Effect, Shafts & By-passes
  - Fans - exhaust and supply

Stack effect

- **Stack effect** is the pressure driven flow produced by convection (the tendency of warm air to rise).
- The stack effect exists whenever there is an indoor-outdoor temperature difference
- It becomes stronger as the temperature difference increases.
- As heated air escapes from upper levels of the building, indoor air moves from lower to upper floors,
- Replacement outdoor air is drawn into opening at the lower levels of buildings.

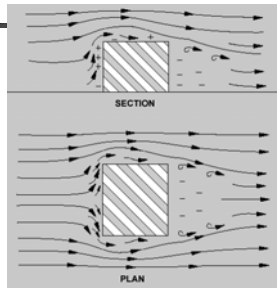
Graphic of Stack Effect



Wind effect

- **Wind effect:**
  - Creates local areas of high pressure on the windward side of a building
  - Creates low pressure on the leeward side of a building.
  - Depending on the leakage openings in the building exterior, wind can affect the pressure relationships within and between rooms.

Wind Effect:



- +'s indicate high pressure –'s indicate low pressure

One building component always interacts with the others

Here are some examples of how changing one system can affect the others:

- An occupied building will use less heating fuel than if it was vacant (at the same temperature setpoint).
- Replacing single pane windows with low-E argon-filled windows reduces heat losses in the building, yielding the boiler plant oversized for the building.
- Roof insulation considerably reduces heat losses and gains in the top floor apartments. As a result, tenants on the top floor reduce their cooling usage (electric bills) in the summer.

A building's envelope consists of:

- Exterior walls
- Roof
- Windows and doors
- Basement or crawl space
- Porches, overhangs, extensions
- Basically, the exterior shell of the building that meets the environment

Typical percentage of total envelope area for a 2 to 5 story multifamily building:

Walls	60%
Roof	20%
Windows	15%
Exposed basement	3%
Doors	2%

Can vary considerably with building type

Introduction to "R" and "U" values

- The thickness of a wall, ceiling or floor is not necessarily an indication of its ability to resist the flow of heat.

The R-value

- **The R-value** defines the ability of a material to resist the conduction of heat.
- **The higher the R-value is, the better**

Back to our "typical" building:

Walls	60%	R-11
Roof	20%	R-30
Windows	15%	R-1.5
Basement	3%	R-9
Doors	2%	R-1.5

So, how can replacement windows be cost effective?

Do the windows that you replace have:

- Continuous thermally broken frame
- Minimum double pane
- Frame that conducts less heat/cold
- Proper installation procedures
- Low emissivity (low-E) coatings particular to your region
- Overall R-Value determined by NFRC

What are NFRC ratings?

- National Fenestration Rating Council
- Industry-based standards
- Created by window manufacturers
- Takes into account the overall window
- Glass + frame + cracks
- Tested by independent labs
- Gives an overall R-Value of window
- www.NFRC.org for more information

Measuring Effectiveness of Low-E Coatings

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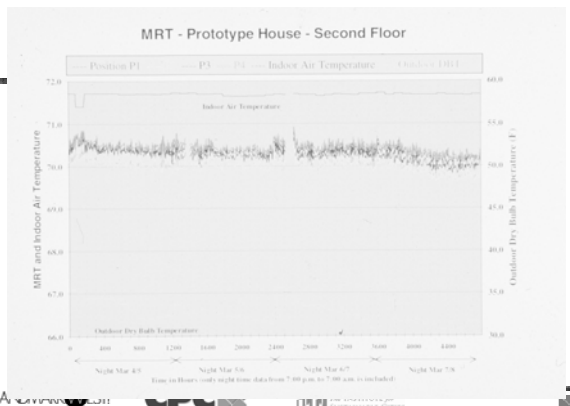

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Reality of improving envelope

- Contractors/salesmen will not make these calculations
- You can estimate these yourself
- Determine what would be most effective and would last longest
- Consider the envelope as a system

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Your building may have a good envelope, but it still has holes

The size and location of those holes will determine if air leakage is a major driving force for heat loss in your building

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If an apartment is a drafty 72ºF:

- Temperatures are colder at the floor
- If shoes are off, people feel cold
- Upper floor apartments will be warmer
- Lower floor apartments will be colder

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Typical holes in buildings:

- Piping and electrical penetrations
- Lights, phones, alarm systems, electric, plumbing added to the building after it was built
- Elevators, chimneys, and flues that go through the building to the roof
- Open windows, fire doors, roof doors, garage doors, and even entrance doors

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Things that increase stack effect:

- Very leaky buildings
- Cold outside temperatures and overheated buildings
- Large holes at the bottom and top of the building
- Lots of small holes at the top and bottom of the building
- Open doors and windows

Buildings with increased stack effect that have overheated top floor apartments tend to get worse as top floor tenants open windows to "reduce heat".

Lower floor tenants then complain of less heat, causing maintenance to turn heat up across the entire building.

Reduce stack effect by:

- Sealing all holes, no matter how small
- Stepping outside of your building, and thinking of the holes that someone else would see
- Covering soil in crawlspaces with plastic and sealing crawlspace vents
- Reducing the venting of elevators, skylights, and fire stairwells to code minimums

Reducing stack effect cont.

- Sealing all pipes and wires that penetrate the envelope
- Sealing all heat bypasses in attic or roof cavity and basement
- Remember that stuffing fiberglass in a hole does not seal it; caulk, spray foam, cement, plaster and other sealants seal holes
- Keeping exterior doors repaired and door checks working properly

Tightly sealed and insulated buildings are also:

- Less prone to the spread of fire
- Difficult for vermin to enter
- Less prone to exterior leaks
- Safer (with better doors and security)
- More durable

Envelope recap

- Find hole, seal hole
- Salespeople are not here to help
- New Windows don't save money
- Find hole, seal hole

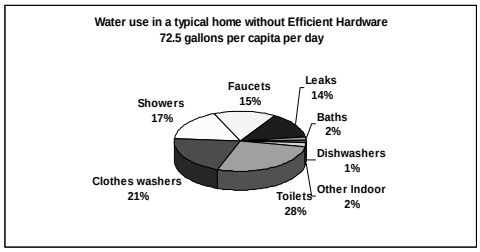
WATER

In many buildings, the water bill is larger than the heating, water heating, or electricity bill.

What are the major uses of water?

- Toilets
- Showers
- Sinks for washing dishes
- Leaks
- Washing sidewalks, cars, equipment
- Pools, gardens, lawns, and other outdoor uses

How much do we use?



Source D.E..P

Water Conservation effort

Water usage	Non-conserving home	Conserving home
Gallons per person per day	72.5	49.6
Savings		**32%**

Source D.E..P

Toilets

- Up to 6 to 8 gallons per flush (gpf)
- New models flush at 1.6 gpf
- Cheap models don't work at 1.6 gpf
- Consider replacement toilets
- Get the latest Maximum Performance (MaP) toilet tests at **www.cwwa.ca/**
- Try one out first in your house
- Install a few in the building and check reaction

Showers

- Some measured at over 12 gallons per min (gpm)
- Many low-flow models (2-2.5 gpm) are awful
- Many low flow models are not low flow
- No consistent standards except (2-2.5 gpm)
- Consult Consumer Reports
- Install a few and check reaction
- Don't install one that you haven't used at your own house

Sinks for washing dishes

- Sinks should have flows of under 1 gpm
- Water temperatures should be reduced to 120º F
- Consider dishwashers as water and hot water conservation items

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LEAKS

- Do we really have to remind you about leaks?
- 1 drip per second = 5 gallons per day
- Hot water leaks waste water and energy
- Severity of leaks can best be found by looking at your water meter at 2am
- Water running at that time is typically from leaks

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Pools, Gardens, Lawns

- Pools must have fresh water
- Consider a drainage lake or year-round filled with water if outdoor
- Consider greywater for gardens and lawns
- Consider roof run off into cisterns
- Reduce lawn water use with low-water ground coverings

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Washing Sidewalks, Cars, and Equipment

- Sidewalks are a real waste of water
- Dangerous to do in winter
- Cars should be done off-site
- Equipment should be done with buckets of water, not constant spray

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Saving hot water saves both water and energy!

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Is this how you make hot water?

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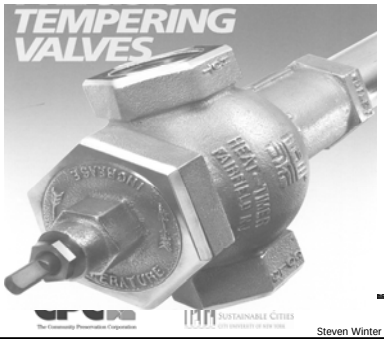
Typical hot water makers

- Inefficient
- Short life
- Can spill or backdraft products of combustion
- Notorious for carbon monoxide production

Alternatives:

- Small boilers with storage
- Sealed combustion units with furnace (one piece units)
- Larger buildings: running off boiler

Do you use a device like this?



What tempering valves can and cannot do:

- Can mix hot and cold water
- Can deliver that mix upstairs
- Can cause excessive water temperature
- Can therefore be very dangerous
- Can fail on full hot
- Cannot regulate temperature
- Cannot act as anti-scald device
- Cannot be set to a specific temperature
- Cannot be used as part of hot water management

Consider electronic mixing valves:

- Safer
- Accurate, lower temperatures
- Help reduce scald problems
- Good ones operate across various pressure settings
- Fail in closed (cold) position

137º F water burns human skin and is dangerously hot

Don't threaten the welfare of your occupants or the building. Keep water at safe temperatures.

Recap on Water

- Use real low-flow devices
- Change showerheads, aerators, toilets
- Stop washing sidewalks!
- Turn hot water temperature down!

Lighting, Appliance, and Electricity Usage

Electricity Definitions

- Watts are a unit of power or energy
- 1000 watts = 1 kilowatt
- Use 1000 watts of power for one hour, you have consumed a kilowatt hour (kWh)
- You have also peaked your instantaneous demand over that hour at one kilowatt (kW)
- Ten-100 watt bulbs burning for one hour use 1kWh

The real cost of lighting

- Electric Usage
  - 24/7 uses 6 times more electricity than for 4 hours a day
- Electric Demand
  - If your building is master metered for electricity, you will pay more if all the lights are ON at the same time
  - One kW of demand= $18 per month in NYC.
- Light bulb replacement
  - Equipment cost
  - Labor
  - Storage

Cost of apartment lighting for five years

Assumptions:
- 1 kWh costs $ 0.15
- Lighting on 4 h/day

	Incandescent	Compact Fluorescent
Type	75W	22W
Usage	0.075*7300 h = 547kWh	0.022*7300 h = 160 kWh
Operating cost	547*$0.15 = $82	160 *0.15 = $24
Investment	6*$0.50 = $3	$3
Total cost	**$85**	**$ 27**

Cost of common area lighting for one year

Assumptions:
- 1 kWh costs $ 0.15
- Lighting operates 24/7

	Incandescent	Compact Fluorescent
Type	75W	22W
Usage	0.075*8760 h = 657kWh	0.022*8760 h = 191 kWh
Operating cost	657*0.15 = $98	191 *0.15 = $29
Investment	8* $0.50 = $4	$3
Total cost	**$102**	**$ 32**

Cost effective all of the time!

Usage Patterns	100 Watt Bulb	75 Watt Bulb	25 W fluorescent	20 W fluorescent
24 hours per day annual cost of electricity + replacement bulbs	$131 + 6 x .50 = $134	$98.55 + $3 = $ 101.55	$32.85 + $4 = $36.85	$26.25 + $4 = $30.25
12 hours per day	$65.50 + 1.50 = $67.00	$49.25 + $1.50 = 50.75	$16.40 + $4 = $20.40	$13.10 + $4 = $17.10
6 hours per day	$32.25 + $1.00 = $33.25	24.50 + 1.00 = $25.50	$8.20 + $4 = $12.20	$6.50 + $4 = $10.50
3 hours per day	$16.00 + .50 = $16.50	$12.25 + .50 = $12.75	$4.00 + $4 = $8.00	$3.25 + $4 = $7.25
1 hour per day	$5.40 + 50 = $5.90	$4.10 + .50 = $4.60	$1. 40 + $4 = $5.40	$1.00 + $4 = $5.00

Assumes: 15 cent per kilowatt hour; Incandescent bulbs cost.50 cents and last 1200 hours; Compact fluorescent lights (CFL's) cost $4 and last 10,000 hours

Do not ignore lighting because:

- It is most probably your highest electricity usage and cost
- Fluorescents use 1/3 of the energy used by incandescent lighting and last 10 times longer
- Higher efficiency lighting is available for exterior and other special lighting
- Fluorescent lights are no longer ugly

If you say that fluorescent lights are yellow and give poor levels of lighting, you have not contacted a local professional lighting distributor who specializes in Energy Star lighting. Join the 21st Century of available lighting!

Screw-in base CFLs

Question:

What's more expensive than inefficient lighting?

Answer: Any lighting that is left on that needs to be off!

- Boiler rooms
- Storage rooms
- Garbage rooms
- Equipment rooms
- Elevator rooms
- Slop sink rooms
- Meter rooms
- Offices
- Laundry rooms
- Apartments?
- Exterior lighting during the day!!!!!
- Garage lighting
- Need we say more?

Two ways to control lighting:

- Motion sensors (we love these)
- Light sensors (we love these with reservations)

Motion Sensors

- Need to be installed in unobstructed area (typically ceiling mounted)
- Should be installed in all rooms that are frequently or infrequently vacant
- Dramatic energy savings; automation does no depend on humans to turn lights off
- NYSERDA pays you to install them (incentive)

Light sensors

- Sense when light is bright in rooms, hallways, outdoors
- Turns off lights when there is ample daylighting
- More effective than clock timers
- Need their light-sensing lens cleaned regularly

Light and motion sensors

- Good for public bathrooms
- Good to program heat setback in electrically heated buildings
- Good to program lights and HVAC shut-off in community rooms
- There may be hundreds of uses in your building that we haven't thought of

What uses half of all of the electricity in the US?

- MOTORS!

Motors:

- Elevator
- Fans
- Boiler pumps
- Hot Water pumps
- Many others specific to your buildings

Motors in your building should be all in an inventory, and their replacement should be with the most efficient comparable model on the market.

To find the most efficient replacement motors available, download the FREE MotorMaster software:

http://www1.eere.energy.gov/industry/bestpractices/software.html#mm

Elevators

- Establish and maintain regular inspections of controls, motors, suspension systems and all other elevator operations as required by manufacturers, maintenance company and all relevant codes.

Appliances

Appliances brought into your building:

- Refrigerators
- Freezers
- Dishwashers
- Washing machines
- Dryers
- Air conditioners
- Electric Heaters

Gas Appliances

- Install and maintain equipment in accordance with OSHA, AGA, and NFPA codes in relation to occupant and building safety. Provide carbon monoxide (CO) detector and local mechanical ventilation for safety as required by all codes and regulations and best building practice.

Refrigerators – 15 cubic feet

- Last 10 years (really 20 years)
- Most efficient 400 kWh/year
- Least efficient 800 kwh/year
- Over 10 years, $600 in savings
- Huge demand savings
- Increased cost $100
- Pays for itself in less than 2 years

Refrigerators, Freezers, and Dishwashers

- If you provide them, they should be Energy Star
- If people bring them in, they should be Energy Star

Washers and Dryers

- Many times you do not own them; you lease them
- Front load washers use less water, less hot water, and wring clothes out better
- Drying time is shorter, clothes are cleaner
- Dryers should NEVER be electric
- Your supplier carries Energy Star appliances and will install if you pester them

Gas Dryers

- Require that all dryers be vented to the exterior. Require CO detectors in all rooms with gas dryers.

Air Conditioners

- Need to be sized to the apartment load
- If they are too big, they will cool the room but not remove humidity
- Need to be Energy Star
- Cannot put a window unit in a sleeve
- Sleeve units are less efficient

Get the American Home Appliance Manufacturers (AHAM) guide to purchasing and sizing room A/C units:

http://www.cooloff.org/

Emergency Systems

- Test and maintain smoke, fire and CO detector systems, backup generator operation, emergency battery, backup functions, emergency lighting, special needs and blackout preparedness equipment.

Energy Conservation strategies for electric usage:

- Know the reduction in kWh
- Know the reduction in kW demand
- Know the lifetime of the product
- Know the incremental cost of the higher efficiency Energy Star item
- Make your selections wisely, you're living with them for a long time
- Will utilities give you $$$$

Electricity Recap:

- Energy Star fluorescent lights
- Get rid of all incandescent bulbs
- Energy Star appliances
- Energy Star washing mashines
- Motion and light sensors
- Motors

QUESTIONS……..

Then break for Lunch

HVAC: Heating Ventilation Air Conditioning

Session overview

- Heating systems
  - Central Heating Plant: boilers
  - Distribution system
- Ventilation systems
- Cooling Equipment

Heating system components

- Central heating plant: Boiler, hot water maker and furnace
  - Shell
  - Burner
  - Controls
- Distribution system: piping and apartment heaters

Heating Systems

Classified by type of Heat Distribution

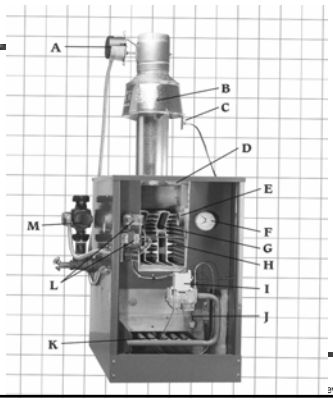
Hot air (furnaces)
- *Various duct arrangements*

Hot Water
- Gravity
- Forced (pumped)
  - *Various piping arrangements*
  - *Radiant heat*

Steam
- One-Pipe
- Two-Pipe

Electric
- Electric resistance Baseboard

Atmospheric Gas Appliance



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Modular Gas Boilers

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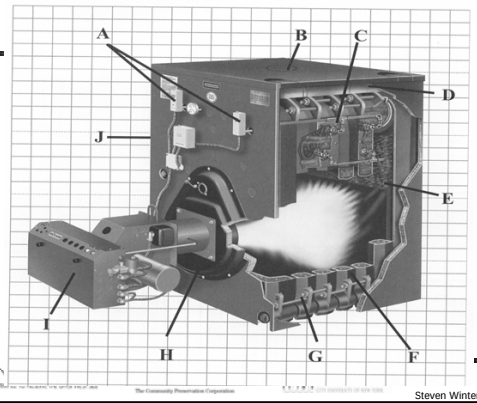
Sectional Power gas Boiler



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Scotch Marine Boiler

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Why not atmospheric gas?

- Inefficient
- Loses energy both on and off
- Cannot control draft
- Draft losses increase on cold days
- Very susceptible to backdrafting, spilling
- Typically poorly installed, maintained

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Why not modular?

- Most are one appliance, not modular
- Maintaining boiler water temperature probably largest system expense
- Most confusing control equipment
- Most do not have night setback
- First cost cheap, lifetime expensive

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How modular is this?

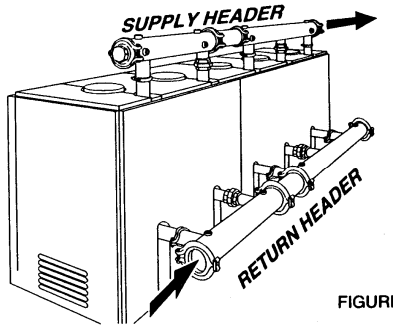


FIGURE 3.1

Why power vented or sealed combustion systems?

- Can adjust combustion efficiency
- Larger ones have multiple firing rates
- Overall better insulated equipment
- Reduced draft losses on off cycle
- More fuel converted to heat in equipment
- Longer life
- Fewer pieces of equipment

All heating and hot water appliances that burn fuel should be tested annually

- Boilers
- Hot water makers
- Furnaces

What should we test for?

- Accurate firing rates(s) in Btu/hour
- Accurate step or modulating firing
- Combustion efficiency
- Clean heat transfer surfaces
- Operation according to manufacturer
- Timing devices properly set and calibrated

Accurate firing rate in Btu/Hour

- Must be within 20% of rating but best efficiency when burner operates at rating
- Overfiring wastes energy while boiler is firing
- Overfiring causes on/off operation (cyclical firing)
- Find information on boiler rating plates
- Watch gas meter and/or oil nozzle

How to read gas meter to check firing rate

- Find the meter for the combustion appliance
- Look at it while the appliance is off and on
- Note the settings for cubic feet, tens of cubic feet, and hundreds of cubic feet
- While appliance is running, clock usage for one minute, or note time it takes to consume a set amount of cubic feet
- Check it a few times for accuracy

Firing rates for multiple gas boilers

- Manually shut of all boilers but one
- Run boiler on manual
- Check firing rate at meter
- Repeat steps with each boiler
- This is seldom done in factory or by service personnel; when questioned, it gets service people upset as most don't know how to do it

How to check firing rate(s) for oil fired appliances

- Procure, read, and follow the instructions
- Follow burner and boiler manufacturer's recommendations
- Call manufacturers if you have questions
- Note the exact firing rate and firing pattern of the flame (solid, semi-solid, hollow, etc.)
- Firing rate also depends upon oil pressure
- Ask service people what the firing rate is

Why do we care about overfiring?

- More heat goes up chimney
- Appliances cyclically firing (on/off/on/off)
- Wear and tear increases; efficiency decreases
- Equipment works best at design operation
- Very bad with atmospheric gas equipment

Why do we care about underfiring?

- Not enough energy to heat the building or/and to produce domestic hot water
- Causes system to run more often
- Sensors never satisfied
- Occupants never satisfied
- Energy use increases

Firing rates of equipment are virtually never set correctly by factory, installation, service, or maintenance personnel. The firing rate of your combustion appliances is the rate at which you use energy, and therefore, is extremely important to monitor if you are concerned with energy efficiency.

Testing for accurate step or modulation firing

- Procure, read and follow the instructions
- Ask maintenance personnel what makes equipment reduce firing rate
- Ask service personnel what makes equipment reduce firing rate
- Install equipment that makes firing rates operate with greater accuracy (vaporstat to replace pressuretrol)
- Have a meeting of all of the minds, then reset the equipment
- Monitor fuel usage daily after any change in settings

Testing for combustion efficiency:

Combustion efficiency in simple terms is the percentage of fuel that you purchase that is efficiently converted to heat in the combustion appliance.

How important is combustion efficiency?

- It tells you how efficiently your equipment is running
- If taken regularly, it can be a great diagnostic tool for performance
- It increases awareness of staff in combustion appliance efficiency
- It is a valuable safety tool to ensure that products of combustion are not entering living space

Combustion chemistry

- Air to fuel ratio is critical for proper efficiency
- If combustion is perfect, no oxygen is left
- If not enough oxygen, smoke or carbon monoxide can be produced
- If too much air, low efficiency and carbon monoxide can be produced (if any portion of the flame is reduced below 1128°F)

Tests for combustion efficiency:

- Net stack temperature
- Carbon Dioxide or oxygen
- Smoke
- Draft
- Carbon monoxide
- These should be given to you in writing by service personnel every time the equipment is tested. Most of you should have your own test equipment, and test your own equipment.

Combustion efficiency kit

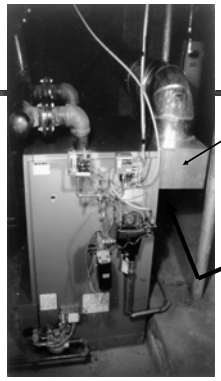
Where to test for combustion efficiency

- Typically, taken 6-12” from the beginning of the flue piping as gasses exit the appliance
- $^{5}/_{16}$” hole in a straight run of flue pipe
- All tests examine gasses as they leave the combustion appliance
- Below the diverter in atmospheric gas equipment

Gas-fired unit

Draft hood on a gas-fired boiler vent.

Drill test hole here



Gas-fired boiler with a draft diverter attached to the cabinet.

Don't drill a test hole in the vent connector.

Test should be done by placing test probe at least 6" into the breech, as with a furnace with a built-in draft diverter.

Combustion Efficiency (CE) Testing

- Tests should be done regularly
- Most buildings should have in-house capacity for testing
- At least, temperature, draft, and CO should be monitored by most buildings
- Most technicians do not have equipment on their truck

More on CE testing

- Kits can be purchased for $1100-$10,000
- Testing can be completed in 10 minutes
- Combustion efficiency=system efficiency
- System efficiency=building efficiency
- Building efficiency = money

CE and fuel cost savings?

SAVINGS FOR EVERY $100 FUEL COSTS BY INCREASE OF COMBUSTION EFFICIENCY

ASSUMING CONSTANT RADIATION AND OTHER UNACCOUNTED FOR LOSSES

From an Original Efficiency of:	To an Increased Combustion Efficiency of:								
	55%	60%	65%	70%	75%	80%	85%	90%	95%
50%	$9.10	$16.70	$23.10	$28.60	$33.30	$37.50	$41.20	$44.40	$47.40
55%	—	8.30	15.40	21.50	26.70	31.20	35.30	38.90	42.10
60%	—	—	7.70	14.30	20.00	25.00	29.40	33.30	37.80
65%	—	—	—	7.10	13.30	18.80	23.50	27.80	31.60
70%	—	—	—	—	6.70	12.50	17.60	22.20	26.30
75%	—	—	—	—	—	6.30	11.80	16.70	21.10
80%	—	—	—	—	—	—	5.90	11.10	15.80
85%	—	—	—	—	—	—	—	5.60	10.50
90%	—	—	—	—	—	—	—	—	5.30

Ventilation

Ventilation: a trade-off between health and energy conservation

- Ventilation is a necessity: your building needs to breath, its occupants too!
- There was no mechanical ventilation 40years ago, only cracks and holes in the walls to "supply" outside air.
- Envelop performance requirements have forced the installation of mechanical ventilation.

Different types of Ventilation equipment

- Mechanical Ventilation with roof fans (exhaust fans) is the most common type.
- Supply and exhaust system
- Natural ventilation: no mechanical ventilation system

What is an Air Change Per Hour rate?

- This is the volume of air that escapes the building in an hour.
- Typical ranges in existing buildings: 0.3 to 1.0 ac/hour
- ASHRAE requirements for NEW residential construction=0.35

Is your ventilation system properly sized?

- An oversized exhaust fan system will "pull" more air than necessary= energy waste
- With an undersized exhaust fan system contaminated air will remain in the building with risks of condensation, proliferation of germs and mold problems.

Is your ventilation system properly sized? Cont.

- Ventilation capacity of an exhaust fan is measured in CFM (Cubic Feet per Minute).
- In a Multi-family building, the average installed ventilation requirement is 100CFM per kitchen
- In a Multi-family building, the average installed ventilation requirement is 50CFM per bathroom

Is your ventilation system properly sized? Cont.

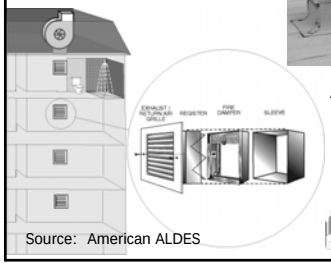
- Example:
  - For a 100-unit building that consists of 1 kitchen-1 bath apartments
  - The total ventilation requirement should be:

    (100 +50) * 100 = 15,000 CFM
- How does it compare to the sum of the roof fans airflow capacity?

How do we Ventilate: Central Exhaust Systems

Roof Fans

- Vertical shaft
- Horizontal take-offs
- Sidewall or ceiling grilles at each floor



All or Nothing

- Continuous Venting (preferable)
- Intermittent Venting

Source: American ALDES

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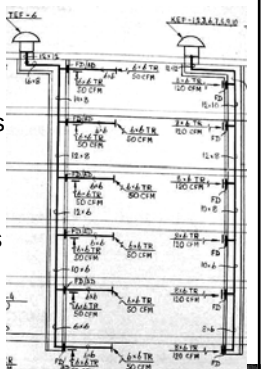
Balancing Challenges

- Central Systems are difficult to balance.
- Constantly changing wind and stack effect pressures
- Traveling multiple floors takes a lot of time.
- Building inspectors don't care, so no one else cares either.



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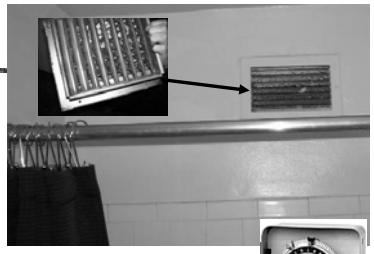
not to mention…

Covered

Clogged



Loose or Broken Belts

OFF (IAQ)

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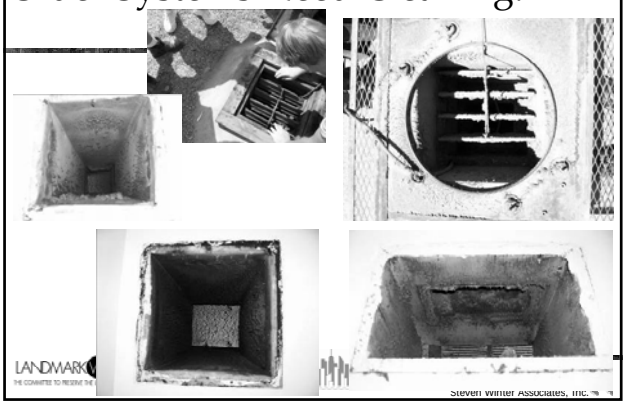
Older Systems Need Cleaning!



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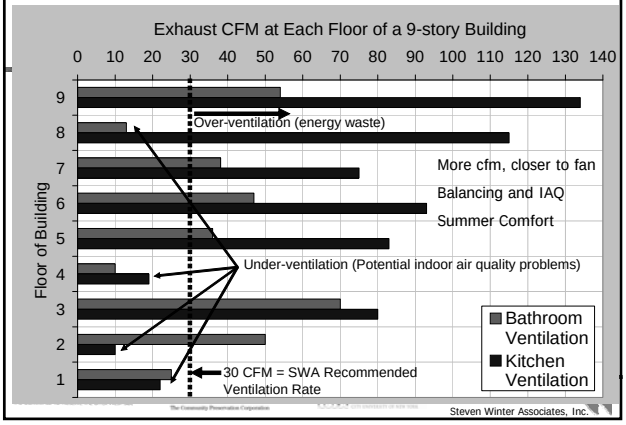
What actually happens…



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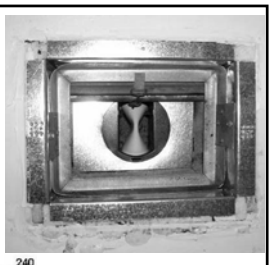
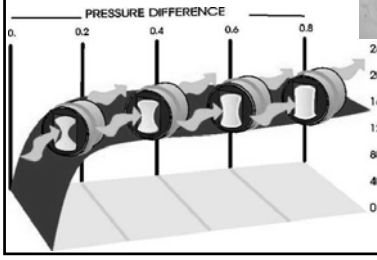
One Solution…

- American ALDES Constant Air Regulator (CAR) dampers
- Balancing from floor to floor and season to season
- Factory calibrated for dialing in to CFM (especially important at lower rates)





- No manual balancing required
- "Pays for itself…"

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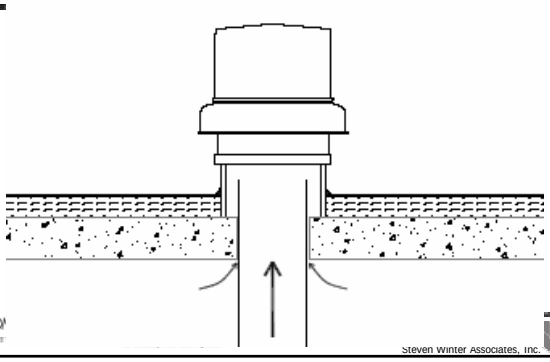
But we also have to pay attention to the ducts…..

Leakage at Roof Curb



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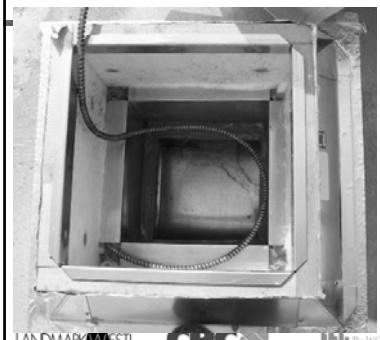
Leakage at Roof Curb



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Leakage at Shaft Transverse Joints

Depends on the Quality of the Installation

Good Sealing

Some Sealing

No Sealing

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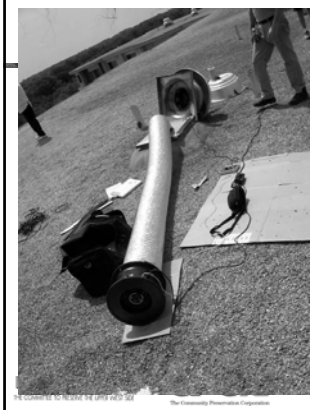
Duct Tightness Evaluation with Existing Buildings



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Summary of Exhaust Duct Tightness Results

based on 22 shafts in 4 new construction buildings

duct leakage due to sheet metal only

	Duct Leakage	
Quality of Duct Sealing	Range	Average
Best Practice	5 - 14 CFM50 per floor	10 CFM50 per floor
Some Mastic	11 - 18 CFM50 per floor	15 CFM50 per floor
No Mastic	20+ CFM50 per floor	

Leakage based on duct pressure of 50 Pa (0.2 inch water column)

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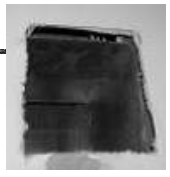
Leakage at Sheetrock Connection



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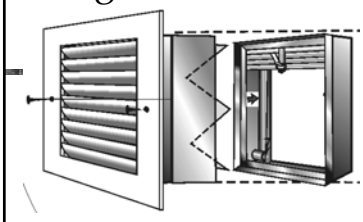
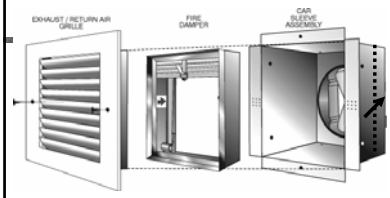
Leakage at Sheetrock Connection

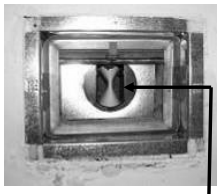


Assuming a 1/16″ gap along perimeter (red):

8 x 8 duct → 2.0 square inches of leakage area per exhaust grille
6 x 6 duct → 1.5 square inches of leakage area per exhaust grille

Leakage at Sheetrock Connection
with CAR dampers

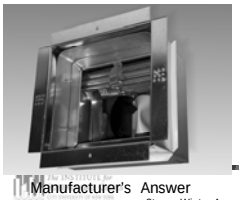




CAR damper sleeve spans gap between take-off duct and sheetrock
→ Reduces but does not eliminate leakage

Note: free area of CAR damper (35 CFM) compared to potential leakage area

Leakage at Sheetrock Connection
with gasketed CAR dampers

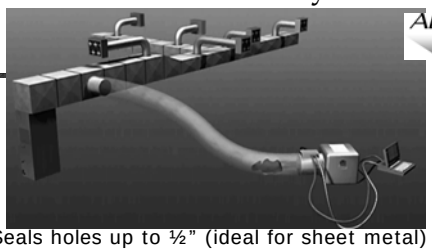


The good news…

- Roof curb and sheetrock connection leakage is relatively easy to address in ALL buildings.
- … and these details may represent up to 50% of total system leakage!!!

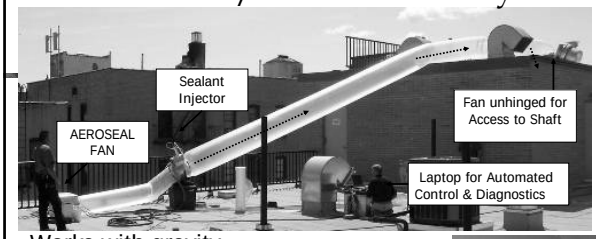
But what about the other 50% ???
(in both new and existing buildings)

Carrier AEROSEAL System

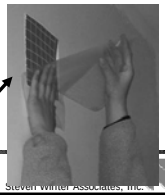


- Seals holes up to ½" (ideal for sheet metal)
- Sealant remains rubbery
- Vinyl polymer is safe
- No lingering odors or off-gassing
- Lasts 10+ years
- Over 25,000 homes and 400 commercial buildings

AEROSEAL w/ Roof Exhaust Systems

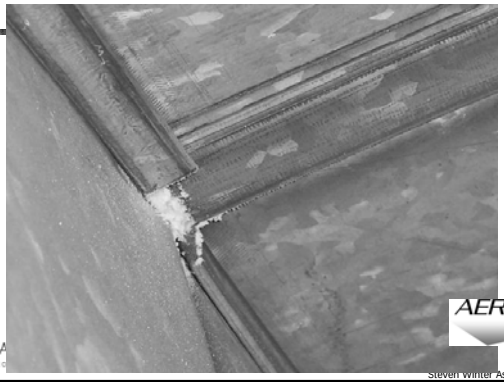


•Works with gravity.
•Exhaust systems are simple!
•Openings at each floor temporarily blocked with friction fit foam blocks (Apartment Access!).

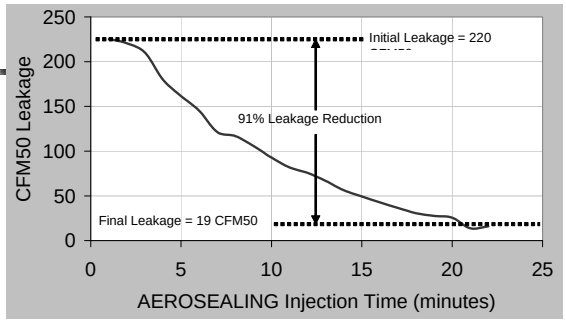


Carrier AEROSEAL System

- Does not coat ducts!!!



AEROSEAL Leakage Reduction Results

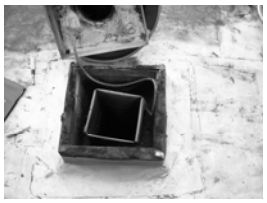


- Automatic real time feedback to laptop

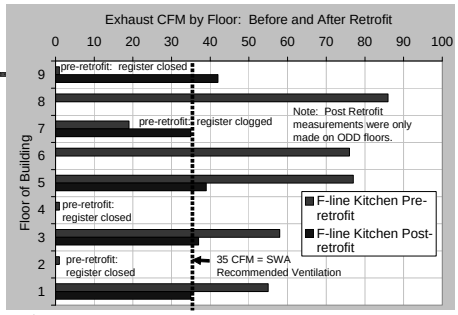
AEROSEAL w/ Roof Exhaust Systems

AEROSEAL in Existing Buildings

- Does not make sense in all cases
- Scouting is necessary
  - Disconnects
  - Spaces served
  - Management/Tenant relations



Existing Building Result: IAQ + Energy Benefits



$1 - $2 per CFM of Ventilation Load Reduction (NYC)
IF the heating system is smart enough…

Budget Costs

- CAR dampers = $53 per grille ($84 with FD)
- Duct Cleaning + AEROSEAL Prep. + CAR damper installation = $65 per grille
- AEROSEAL = ~$3000 (fixed price per day)
- Fan tuning = TBD
- Screening costs = TBD

Observation 1: Clean your ducts and get CAR installation and AEROSEAL prep. for free

Observation 2: AEROSEAL will not be the most expensive part of the job

Roof fan maintenance tips

- Insure that the rooftop fan units are inspected, at a minimum, annually.
- Check daily for proper operation. For belt-driven exhaust fans, keep belt tightened or replace any broken belt immediately.
- Ventilation ducts and apartment ventilation registers should be kept clean. Ducts and register cleaning typically average a $70 to $120 cost per apartment.

Room air conditioning

- The E.E.R (Energy Efficiency Rating) value of a Room Air Conditioning unit determines how efficient is the equipment:
  - 10-year old unit: EER = 6.0 to 7.0
  - Minimum ASHRAE requirement: 10.7 EER
  - 2007 projected requirements: 14.0 !

Selecting the right room air conditioning

- Select an Energy Star® equipment that can use 10% less than a new conventional model
- Shop for room AC with a minimum 14.0 EER.

What wastes the most energy in my building?

- Bad Windows?
- Building Penetrations?
- Old Boiler?
- Appliances?
- Lighting?
- Walls and Roof?
- Air Conditioning?
- None of the above……

CONTROL!

- When your systems go on
- When your systems go off
- The temperature in the building
- The temperature of the water
- The pressure and flow of the water
- Air movement systems
- ….and, who makes these decisions?

The heating of the building

When must we heat?
What controls the heat?
When do we not heat?
What are the local heating laws?

When must we provide heat? (NYC Example)

- From October 1 to May 31 (Heating season)
- During the day (6am-10pm)
- When outside temperature is less than 55ºF
- Temperature must be at least 68ºF in every apartment
- During the night (10pm-6am)
- When outside temperature is less than 40ºF
- Temperature must be at least 55ºF in every apartment

Are heating minimums acceptable to most residents?

Probably not

But overheating is expensive

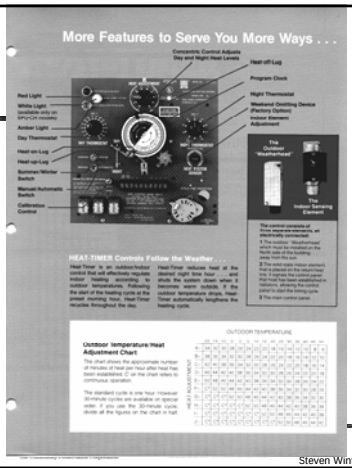
Not to mention unhealthy

What can we do to make lower temperatures acceptable?

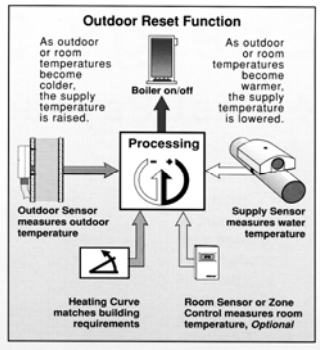
- Reduce drafts and stack effect
- Don't overheat early in the heating season
- Don't provide heat when not required
- Respond personally to heat complaints
- Give maintenance digital thermometers
- Educate residents
- Explain health problems with overheating

Non-typical heating controls that work well:

- Properly set year-round clock
- Steam sensors that measure condensate
- Outdoor reset (temperature sensor)
- Modulating Aquastat (hydronic systems)
- Burner modulation controls
- Light or motion sensitive thermostats
- Energy management systems
- Fuel usage monitoring logs



Outdoor Reset/Modulating Aquastat



Burner Modulation Controls

- Designed to reduce burner firing rate
- Should be used after steam pressure is reached—reduce firing rate
- Should be used when boiler is being used to make DHW only (non heating)
- Typically among worst building gaffes
- TYPICALLY CAN PROVIDE BIG SAVINGS

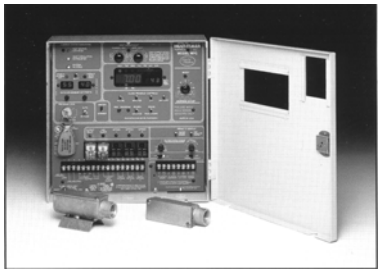
Humans that adjust firing rates:

- Fuel company service personnel
- Original installers of boilers
- Building maintenance personnel
- Other building maintenance personnel

Who should be adjusting modulating, step firing, and related controls?

A trained mechanic who reads all of the instructions that go with the burner, boiler, and controls.

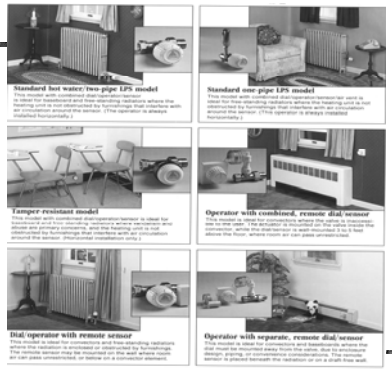
This control panel is worthless unless properly adjusted!



Light or motion sensitive thermostats

- Great for electrically heated buildings
- Should be performed as apartments become vacant
- Best if residents don't know
- Probably not cost effective by themselves
- Include sealing drafts/reducing stack effect
- Check a few manufacturers—freebies?

Other locally used thermostats:



Thermostatic radiator valves

- Expensive, but effective
- Not really tamper proof
- Good for solving selected overheating
- Good when designed into new systems
- Not a replacement for good system balancing
- Do not work in all applications

So maybe I just need one of those expensive Energy Management Systems!

What do these EMS things do, anyway?

What an EMS will NOT do:

- Solve maintenance problems
- Increase heating plant efficiency
- Teach people to use equipment properly
- Save energy if not employed properly
- Solve a distribution problem
- Work well in a building with drafts or excessive stack effect

What an EMS ***can*** do:

- Monitor boiler operation in relation to temperature
- Reduce rampant overheating
- Monitor fuel deliveries and usage
- Defend you in heat litigation
- Allow you to run many buildings from one remote location

What an EMS ***does*** do:

- Typically measures temperatures in 10% of apartments
- Ignores high and low temperature
- Works to bring all other apartments to pre-determined average temperature
- Prevents overheating of building and H_2O
- If monitored properly, makes you a better energy manager

Steps to understanding controls:

- Get the instructions for the boilers, burners, timers, and controls that run your heating/DHW plants
- Read all of the instructions
- ***Follow the instructions!***
- Get your systems tuned/adjusted in mid-summer, when mechanics have more time

QUESTIONS?

…..and break

Selected Topics in Health, Safety and Comfort

F.L. Andrew Padian
Steven Winter Associates, Inc.

Topics

- Minimizing Asthma and Allergy Triggers
- Controlling Mold
- Chemical Safety
- Carbon Monoxide
- Clean up and/or Remediation
  - Mold, Asbestos, Lead, Radon

Indoor Air Quality

- The average American spends 90% of their time INDOORS
- The quality of air indoors can be worse than that outdoors.
- Indoor pollutants include:
  - Chemicals used indoors (e.g. cleaners and paints)
  - Triggers for allergic and asthmatic reactions

Asthma and Allergies

- Asthma is very common among children, teens and adults.
- It is a disease that causes the airways of the lungs to tighten.
- Asthma is now the number one cause of hospitalization for children.

Prevalence of Asthma

- The number of children diagnosed with asthma doubled between 1983 and 1995
- In most cities, more than 1 in 5 families has a child with asthma.
- Asthma rates are particularly high among those living in poor conditions (urban centers and rural areas).
- Asthma is linked to allergies. Most, but not all, people with asthma have allergies.

Cause of Asthma

- It is not known what causes asthma, but dust is believed to be one cause. Outdoor air quality and obesity may also be causes.
- Its likely that building managers have a number of children with asthma living in their building.

Outdoor Air Quality

Asthma Attacks

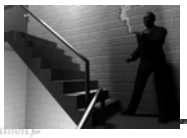
- An "asthma attack" is when your lungs aren't getting enough air to breathe. Common symptoms include:
  - Trouble breathing
  - Wheezing
  - Coughing
  - Chest pain
  - Chest tightness

What Causes an Asthma Attack

- Things that cause asthma attacks are called "triggers".
- "Triggers" include:
  1. **Secondhand smoke**
  2. **Cockroaches (and their remains)**
  3. **Dust mites (and their remains)**
  4. **Rodents (and their remains)**
  5. **Pets with fur**
  6. **Nitrogen dioxide**
  7. **Mold**

Building Triggers

- Second Hand Smoke
  - Permeates into non-smoking apartments through cracks and under doors
  - Should not be permitted in stairs and hallways
- What Building Managers Can Do
  - Discourage smoking in the hallways and stairs with signs and warnings
  - Fill cracks to stop odor migration between apartments
  - Confirm ventilation is working properly



Building Triggers

- Dust mites
  - small insects, found in almost every home, that live in mattresses and bedding materials, carpets, upholstered furniture, stuffed toys and curtains
- Rodents (and their remains)
- Pets with fur
- What Building Managers Can Do
  - Fill cracks to stop air migration between apartments, carrying skin filaments and pet hair between apartments.
  - Keep common areas clean
  - Post educational placards educating occupants on the connection between moisture and dust and pests.
  - Reduce carpeting

Walk-Off Mats and Vacuums

- Walk-off mats at entrances reduce the particulates in the indoor air, and time and energy in housekeeping.

Vacuums

- For carpets, look for vacuums that carry the CRI label for soil removal, dust containment, and appearance retention. (www.carpet-rug.org).
- HEPA Filters
  - High efficiency particulate air filters
  - Filters that remove 99.97% of airborne particles down to 0.3 microns in diameter

Building Triggers

- Cockroaches
- What Building Managers Can Do
  - Fill cracks to stop air migration between apartments; enclose with boric acid where roaches move
  - Control moisture to keep areas inhospitable to cockroaches and rodents.
  - Keep common areas clean
  - Post educational placards educating occupants on the connection between moisture and dust and pests.

Building Triggers

- Nitrogen Dioxide
  - odorless byproduct of indoor fuel-burning appliances, such as gas stoves, furnaces, and unvented gas space heaters)
- What Building Managers Can Do
  - Ensure adequate ventilation and proper exhausting in areas with combustion appliances

Building Triggers - Mold

- Most molds are unsightly, but basically harmless.
- People react differently to mold.
  - Some molds can cause mild to serious allergic reactions in some individuals.
  - Aspergillus fumigatus, a particular type of mold, can cause infection in an immunocompromised person
  - Molds can trigger asthma episodes
- No EPA regulations, e.g. Threshold Limit Values (TLV) for airborne mold spores.

Mold

- Molds produce tiny spores to reproduce.
- Mold spores waft through the indoor and outdoor air continually; there is no practical way to eliminate them from the indoor environment.
- Mold grows indoors when spores land on damp, “nutritious” materials.
- “Food for mold”: wood, paper, carpet, wallboard, ceiling tiles, upholstered furniture and foods.

Controlling Mold

- Mold spores will germinate and grow as long as the moisture is available.
- The way to prevent and mitigate mold is to control moisture.

After a Flood

- Dry water damaged areas and items within 24-48 hours to prevent mold growth.
- In areas of excessive moisture, consider using a high volume commercial dehumidifier.
- Remove items which cannot be dried rapidly.
- BIOCIDE TREATMENT is not necessary, and does NOT replace the above steps.
- Avoid ozone and chlorine dioxide treatments.

NYC Guideline - Remediation

"Remove or clean…in a way that prevents …(contamination) from leaving a work area and entering an occupied…area, while protecting the health of workers performing the abatement."

- NYC "Guidelines on Assessment and Remediation of Fungi in Indoor Environments" http://www.nyc.gov/html/doh/html/epi/moldrpt1.html

Exterior Sources of Moisture

- Roof leaks
- Flashing
- Missing downspouts and gutters
- Windows/facades
- Damaged building materials
- Failure of roof membranes, balconies, overhangs
- Deteriorating caulks/sealants
- Improper vapor barrier location/installation
- Inadequate interior moisture removal

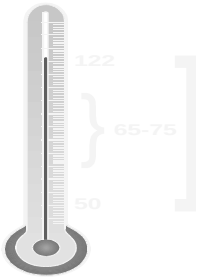
Interior Sources of Moisture

- Unvented bathrooms and kitchens
- Leaky plumbing
- Wall condensation
- Unvented dryers
- Wet basements
- People, pets
- Gas stoves

Mitigating Moisture

- Rain hoods protect intakes
- Traps prevent internal flooding
- Repaired leaks prevent flooding
- Insulate cold surfaces (e.g. windows, piping, exterior walls, roof, or floors) to prevent condensation.
- Do not install carpeting where there is a perpetual moisture problem, (e.g., by drinking fountains, by sinks, or on concrete floors with leaks or frequent condensation).

Suitable Temperatures for Mold



- Range from 50°-122°F
- Many prefer temperatures of 65°-75°F
- TYPICAL OF INDOORS

MOISTURE Recap

- Controlling indoor MOISTURE is a major step for controlling:
  - Mold
  - Cockroaches
  - Rodents
  - Rust
  - Bacteria
  - Building degradation

SEALING & CAULKING Recap

- Closing holes and sealing cracks is a major step for controlling:
  - Tobacco smoke & odor migration
  - Cockroaches and other pests
  - Heat loss and drafts
  - Comfort

Standing Water

- "Moisture" (and moist materials) favors MOLD
  - wood, cellulose, wallpaper, glues, paints, mortars, textiles
- Standing water favors BACTERIA
  - cooling coil drain pans, condensed water on slab floors, inner walls, ductwork

Chemical Safety

- Sources of toxic fumes in the building
  - Housekeeping chemicals
  - Renovation work (e.g. paint, adhesives)
  - Pesticides

Housekeeping Chemicals

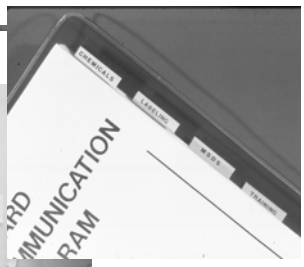
Know what you are working with

- Know chemicals in products you handle
- What might happen if overexposed?
- Precautions
- Physical hazards (fire, explosion)
- Spill cleanup
- Safe handling and storage

Hazardous Chemical Program

- Inventory
- Labels
- Material Safety Data Sheets (MSDS)
- Information and Training
- Contractor Work
- Non-Routine Tasks
- If using chemicals, need OSHA Hazard Communication (Right to Know) training and procedures

Material Safety Data Sheet (MSDS)



Labels To Look For

Wear Proper Protection

Even Brief Exposures are Serious

Using Cleaning Products Correctly

- Read instructions for use and portions; do not use more cleanser than you need
  - Off-gasses more odor and VOC's
  - Product is harder to rinse clean
  - Surfaces can become slippery or sticky
- Do not use harsh chemicals unless necessary
  - Powerful cleaning agents do not necessarily perform better than less toxic alternatives
  - Combined cleaners and disinfectants are often highly toxic and acidic, and do not actually disinfect.
  - Disinfection is rarely required or helpful

Using Cleaning Products Correctly

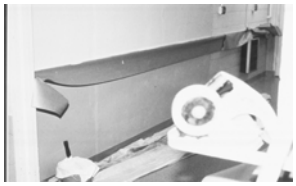
- Mild detergents with neutral pH are safest for use and often sufficient.
- Favor pump sprays over aerosol cans to reduce environmental impact.

Better Cleaning Products

- Non-toxic (or low-toxicity) products free of:
  - Chlorine
  - Petrochemical solvents
  - Glycol ethers
  - Phosphates
  - Acids
  - Caustics
  - Dyes
  - Perfumes
- Do not be fooled by names (e.g. "Green.."); read the label and ingredients.

IAQ Mgmt During Renovations

- Seal off or filter return vents through which odors could migrate to other areas of the building.
- Seal off doorways to other areas through which odors and dust could migrate.



IAQ Mgmt During Renovations

- Provide fan-aided, direct exhaust from renovation areas.
- Use "low-VOC" and low-odor products.

Recommended VOC-Limits

- Interior "low-VOC" Paints
  - Non-flat: 150 grams/Litre
  - Flat: 50 g/L
- Exterior "low-VOC" Coatings
  - Non-flat: 200 g/L
  - Flat: 100 g/L

Recommended VOC-Limits

- Coatings
  - Bond Breakers 350
  - Clear Wood Finishes
    - Varnish 350
    - Sanding Sealers 350
    - Lacquer 275
  - Clear Brushing Lacquer 275
  - Fire-Proofing Exterior Coatings 350
  - Fire-Retardant Coatings
    - Clear 650
    - Pigmented 350
  - Floor Coatings 100
  - Industrial Maintenance (IM) Coatings 250
    - High Temp. IM Coatings 420
    - Zinc-Rich IM Primers 340
  - Japans/Faux Finishing Coatings 350
  - Low-solids Coatings 120
  - Mastic Coatings 300
  - Metallic Pigmented Coatings 500
  - Multi-Color Coatings 250
  - Pigmented Lacquer 275
  - Pre-Treatment Wash Primers 420

Recommended VOC-Limits

- Coatings cont.
  - Primers, Sealers, and Undercoaters 200
  - Quick-Dry Enamels 250
  - Quick-Dry Primers, Sealers, and Undercoaters 200
  - Recycled Coatings 250
  - Roof Coatings 50
  - Roof Primers, Bituminous 350
  - Rust Preventative Coatings 400
  - Shellac
    - Clear 730
    - Pigmented 550
  - Specialty Primers 350
  - Stains 250
  - Stains, Interior 250
  - Traffic Coatings 150
  - Waterproofing Sealers 250
  - Waterproofing Concrete/Masonry Sealers 400
  - Other Coating Types (not included in above) 250

Recommended VOC-Limits

- Sealants
  - Architectural 250 g/l
  - Architectural – Nonporous 250 g/l
  - Architectural – Porous 775 g/l
  - Other 750 g/l

Recommended VOC-Limits

- Adhesives
  - Indoor carpet adhesive 50 g/l
  - Carpet pad adhesive 50 g/l
  - Wood flooring adhesive 100 g/l
  - Rubber floor adhesive 60 g/l
  - Sub-floor adhesive 50 g/l
  - Ceramic tile adhesive 65 g/l
  - VCT and asphalt tile adhesive 50 g/l
  - Drywall and panel adhesive 50 g/l
  - Cove base adhesive 50 g/l
  - Multipurpose construction adhesive 70 g/l

Avoiding Urea Formaldehyde

- Composite wood
  - Conventional composite wood contains urea formaldehyde – a known carcinogen
  - Look for composite wood and agrifiber products that are urea-formaldehyde free.

Integrated Pest Management

Integrated Pest Management (IPM)

- As long as there are suitable conditions for insects and pests, no insecticide or pesticide will work long term.
  - Remove moisture
  - Clean up “food source”
  - Close pathways to area (e.g. cracks and holes)
  - Lightly dust gaps between walls with boric acid before closing them up
- Pest control is a “whole building” issue, not simply one apartment.

Pesticides and Toxicity

- Pesticides are related to:
  - Cancers (particularly breast and prostate)
  - Reproductive problems
  - Respiratory system problems (e.g. coughs)
- Relatively safe and non-toxic pesticide:
  - Boric Acid

IPM Case Study

- Lehman Village Houses (LVH)
  - East Harlem Public Housing (600 apts)
- GOAL: Reduce amount and severity of asthma
  - Asthma worsened by roaches and rodents in building
  - Antigens (microscopic parts of roach bodies, rodent skin, urine or saliva) cause allergic disease, including some forms of asthma

LVH - IPM Elements

- Suspended pesticide application
- Hired, trained, paid team of residents
- Inspected structure and apartments
- HEPA vacuumed wall cavities, floors, cabinets
- Removed, cleaned roach droppings
- Cleaned kitchens well

LVH - Elements continued..

- Roach bait stations (pucks or Combat) and glue traps for mice
- Filled, caulked, sealed cracks, holes, gaps
- Applied boric acid along wall
- Roach counts with sticky traps

LVH - Elements continued..

- Educated tenants
- Reported water leaks, water damage, major structural repair needs
- Provided for free, sealing trash cans, tupperware, and “green” cleaning supplies

LVH – IPM in Action

- First phase - about 60% of 150 apartments in the one building enrolled
- Extensive use of “off the shelf” pesticides, including those banned for indoor use, foggers, and aerosol pesticides

LVH – IPM Results

- Roaches reduced in 73% apts
- Overall counts declined 76%
- 46% reported mice problems gone
- In control building, no change (Ficam Plus, carbamate with pyrethrin)

Carbon Monoxide

- Generated by combustion equipment
  - Appliances which burn hydrocarbons for warmth, cooking or decorative purposes
    - Space heaters
    - Ranges
    - Ovens
    - Stoves
    - Furnaces
    - Fireplaces, vented and unvented
    - Clothes dryers
    - Water heaters

Carbon Monoxide Poisoning

- Invisible and odorless gas
- Health effects include:
  - Headaches (150 ppm)
  - Dizziness
  - Sleepiness
  - Watery eyes
  - Breathing problems
  - Loss of Consciousness (400 ppm)
  - Death
- Often confused with the flu

Carbon Monoxide Sensors

- Power options
  - battery
  - plug in
  - hard wired
- Display options
  - Simple CO sensors sound a high decimal beep when CO levels remain at 70 parts per million (PPM) for a predefined period of time (typically an hour).
  - More advanced systems include a digital display that shows how high the level of CO actually is. The accuracy of these units is typically better.
  - Sensors are available that will record the highest level reached over a given period of time.

Asbestos

- Asbestos is a mineral fiber. It was used for strengthening, insulation and fire proofing.
- Breathing in high levels of asbestos fibers can lead to lung cancer.
- Breathing in asbestos over a long period of time can lead to asbestosis (lungs are scarred with fibrous tissue)
- Most people exposed to small amounts of asbestos do not develop health problems, but individual asbestos fibers inhaled can remain in the lungs for a long time, increasing the risk of disease.

Asbestos in the Home

- Few products are manufactured with asbestos today. All such products are clearly labeled.

Mitigating Asbestos

- If an asbestos material is clearly deteriorating, contact an asbestos inspector and/or contractor.
- The contractor will mitigate the problem one of two ways:
  - Sealing or encapsulation
  - Removal
- Do not handle asbestos materials yourself. You may make the situation worse.

Dealing with an Asbestos Issue

- Recommendations and guidelines for hiring Asbestos Inspectors and Contractors at:
  www.epa.gov/asbestos
- NY City Asbestos Regulations
  www.nyc.gov/html/dep/html/asbestos.html
- NY State Asbestos regulations
  www.labor.state.ny.us/business_ny/employer_responsibilities/safety/s56.htm

LEAD

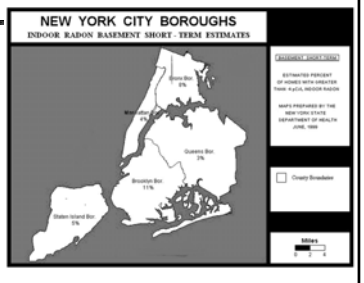
- Lead is a highly toxic metal that was used for many years in products found in and around our homes.
- Health effects, particularly in children under 6, include:
  - behavioral problems
  - learning disabilities
  - seizures
  - death

Sources of Lead

- Primary sources of lead exposure for children are:
  - deteriorating lead-based paint,
  - lead contaminated dust, and
  - lead contaminated residential soil.
- Other sources include:
  - Drinking water (plumbing with lead or lead solder)
    - You cannot see, smell, or taste lead, and boiling your water will not get rid of lead.
  - Old painted toys and furniture.
  - Lead smelters or other industries that release lead into the air.
  - Hobbies that use lead, such as making pottery or stained glass, or refinishing furniture.

Radon

- Radon is a gaseous radioactive element
- Found in earth and rock below homes, in well water and in building materials.
- Increased risk of lung cancer 5-25 years after exposure
  - Annually, about 12% of lung cancer cases in the US attributable to radon.



Bldg Mgmt: Responding to IAQ Complaints

- Respond promptly and with credibility
- Do not underestimate the problem
- Handle all complaints matter-of-factly
- Encourage bldg occupants to participate.
- Respect privacy
- Keep building occupants informed.

Role of Occupants in IAQ Mgmt

- Recognize activities that can cause IAQ problems.
- Communicate IAQ problems to building management.
- Work with building management to resolve IAQ problem.
- Follow up with building management to confirm problem was resolved.

Follow-Up on an IAQ Problem

- Were conditions and/or activities identified that could have contributed to the problem.
- Were these issues mitigated in such a way that the problem might have been removed?
- Did the symptoms go away?
- If not, what is the next step? --Do not assume all problems have been identified and mitigated.

Next Steps

- Repeat all prior steps, but expand the scope of interest.
- Seek outside assistance to:
  - Sample air
  - Add the credibility of a third party to the investigation
  - Invite special expertise

Where to Get More Information

- EPA's web resource for IAQ info Extensive links to other sites
  - www.epa.gov/iaq

For More Information on…

- Better Cleaning Products and Practices
  - Green Seal Household Cleaners (GS-08) and Industrial & Institutional Cleaners (GS-37) standards: www.greenseal.org/standards.htm#environmental. Green Seal preferred products: www.greenseal.org/recommendations.htm#product
- INTEGRATED PEST MANAGEMENT
  - http://www.ipm.ucdavis.edu/PMG/selectnewpest.home.html
  - Ted Outwater, Integrated Pest Management Program Coordinator, Hunter College School of Health Sciences, Center for Occupational and Environmental Health toutwate@hunter.cuny.edu

For More Information on…

- LEAD
  - The National Lead Information Center (NLIC): http://www.epa.gov/lead/nlic.htm and 1-800-424-LEAD (5323)
- ASTHMA
  - http://www.epa.gov/asthma
  - http://www.asthmaregionalcouncil.org/about/documents/AsthmaandHousingConnection_000.ppt
  - New York City Asthma Partnership: www.asthma-nyc.org/nycap/
- RADON
  - http://www.health.state.ny.us/nysdoh/radon/radonhom.htm

For More Information on…

- MOLD
  - NYC "Guidelines on Assessment and Remediation of Fungi in Indoor Environments" http://www.nyc.gov/html/doh/html/epi/moldrpt1.html
  - EPA Mold Guide http://www.epa.gov/mold/moldguide.html

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Things to do in next week:

- Talk to lighting supplier; change to all fluorescent
- Get the instructions for all of the HVAC ventilation, and control equipment
- Request a printout of all of your energy bills for 2 years from your suppliers
- Change your appliance purchasing to all Energy Star

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Things to do in the next month:

- Calculate your heating usage in Btu/ft²/HDD
- Check firing rate and combustion efficiency of all combustion appliances
- Test selected showers, sinks, and toilets for water usage
- Begin air-sealing protocols throughout your building

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Things to do in the next year:

- Have an energy audit done in your building
- Plan long-term capital intensive system replacements (HVAC, roof windows, elevators) for highest efficiency and greatest durability
- Reduce your energy usage by 20%

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Questions?

Please fill out evaluations…..

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