Sustainability Training

Corcoran Management Company

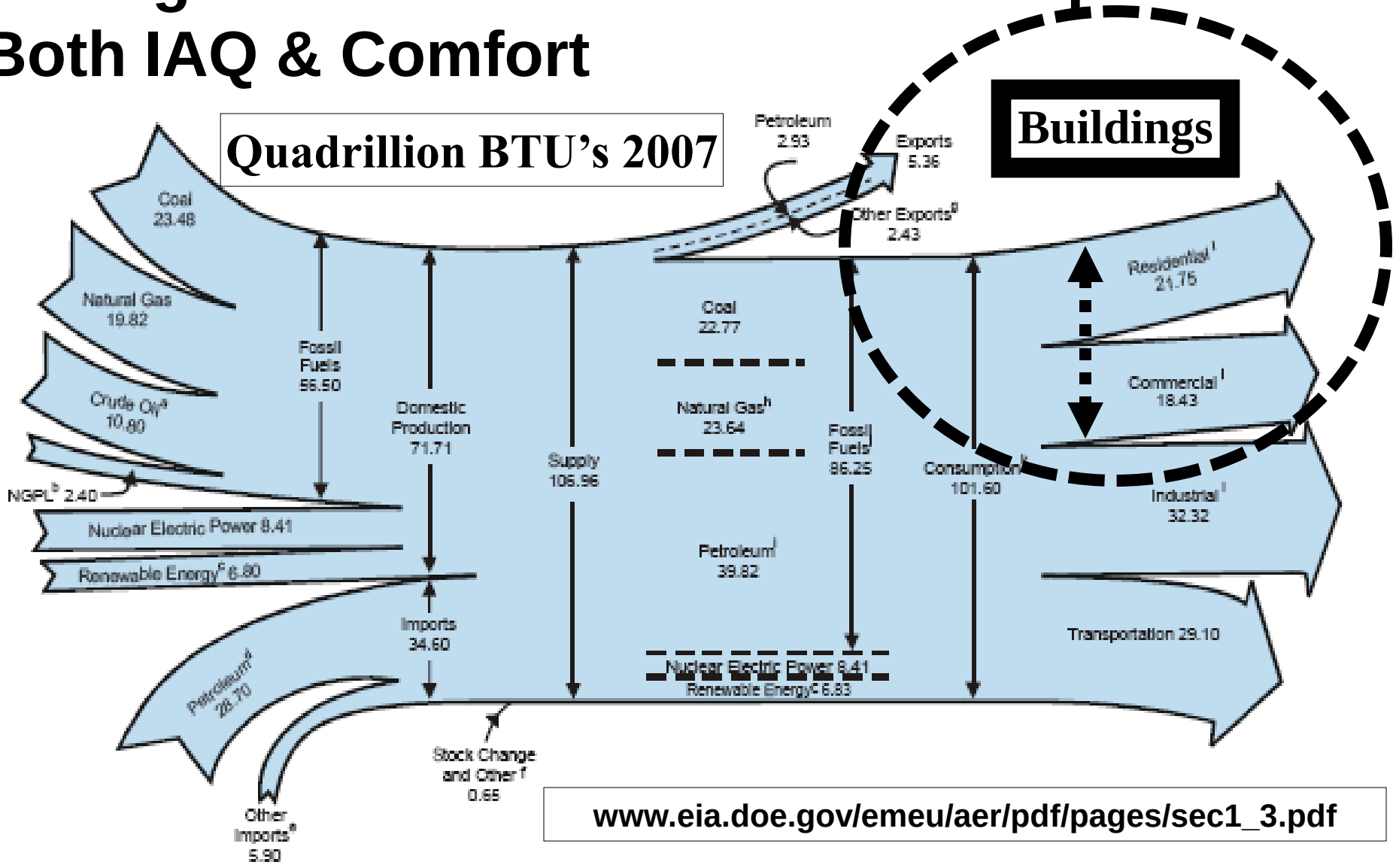
Sustainability Measures
Why Its Important: Now & Future

Regionally

Nationally

Planning, Costs & Benefits

Building Retrofits Offer Signifcant Energy Savings Within The USA & Often Improve Both IAQ & Comfort



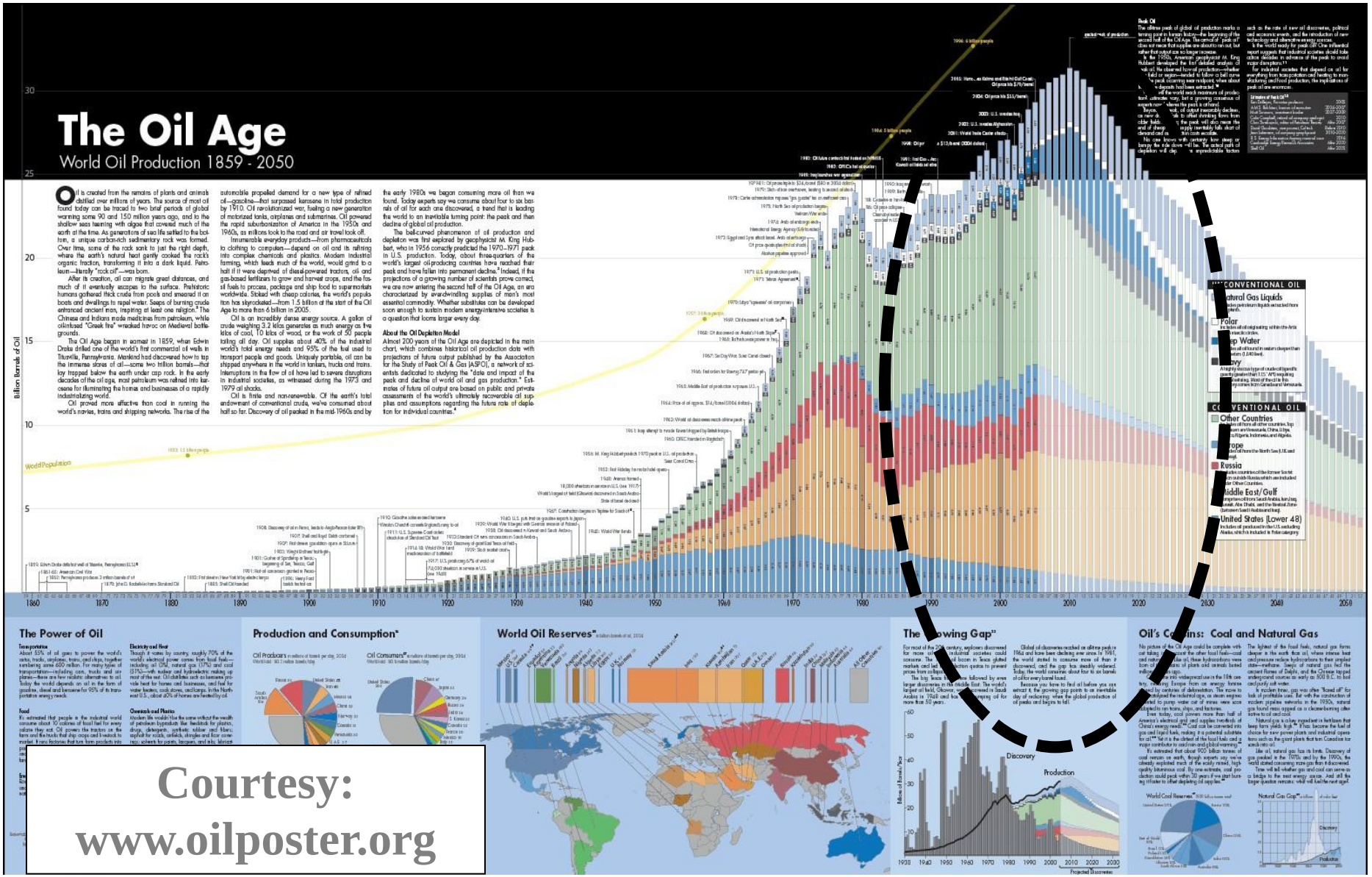
www.eia.doe.gov/emeu/aer/pdf/pages/sec1_3.pdf

Why Is This Relevant?

- **Reduced <u>Energy Consumption</u>**
- **Often Improved <u>Comfort & IAQ</u>**
- **<u>Long-Term Energy Cost Control</u>**
- **Existing Buildings Not That Hard To Do**
- **Good Internal Return on Investment $, & Good Incentives**

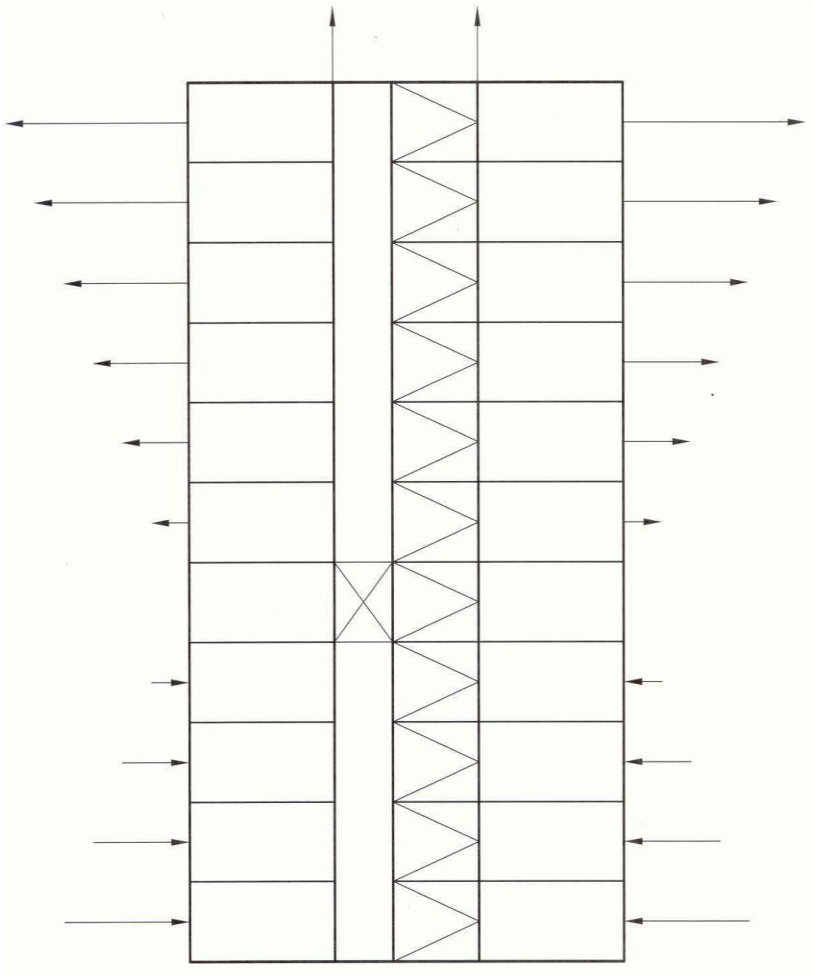
Also: There is lots of Coal & Gas in USA, & many “costs” associated with its use.

Use Reduction = Long-Term Cost Control



Typical Sustainability Items:

- Low Cost, No Cost : Water & Lighting, & Operational
- Heating & Cooling Efficiency, DHW
- Windows / Doors & Attic (Uncontrolled Air Leakage)
- Ventilation & Humidity Control
- Roof & Attic Insulation
- Basement / Crawlspace
- Renewable Energy



Typical Steps To Significant Energy Reduction

1. **Assess Needs / Opportunities, Site & Goals**
2. **Optimize Lighting**
3. **Optimize Water Use**
4. **Minimize Internal Loads** (lights, appliances, electronics)
5. **Optimize Domestic Hot Water**
6. **Optimize Heating**
7. **Optimize Cooling**
8. **Optimize Enclosures (Roof, Windows, Doors, Walls, Basements/Crawlspaces** (reduce heat & cooling load)
9. **Integrate Renewables to Address Remaining Loads**
10. **Incorporate: *Verification, Feedback, Evaluation***

Org. Courtesy THC

TODAYS AGENDA

1 - Review Low Cost, No Cost
(water use, lighting, operational changes)

2 - HVAC (Boilers, Ventilation, AC)

3 - Addressing Common Complaints
(Discussion Encouraged)

Photos: (Weymouth Commons East,
Proper, Faxon Commons, & Southfield)

Todays Learning Objective

Assist participants with identifying

<u>"Opportunities"</u> for Sustainability by:

- **Review of Low Cost / No Cost** **1 hr**
- **Present HVAC Information** **2 hr**
- **Small Group Activity** **1 hr**
- **Team Reports, Feedback** **1 hr**

Before & After Quiz

General Principle:

Some operational items are low cost. However, many changes to reduce energy use can be costly:

We Always Look For “Value Added” Opportunities & Rebates

Marginal or Incremental Cost of doing it better

1. Low- Cost, No- Cost Review

Water Use

Typical Opportunities

- Toilets
- Shower Heads
- Aerators
- Tub Diverters
- Leak Repairs

- Irrigation Sensors
- Irrigation Metering
- Cooling Tower Metering

Does Replacing Toilet Fixtures SAVE WATER?

YES!!

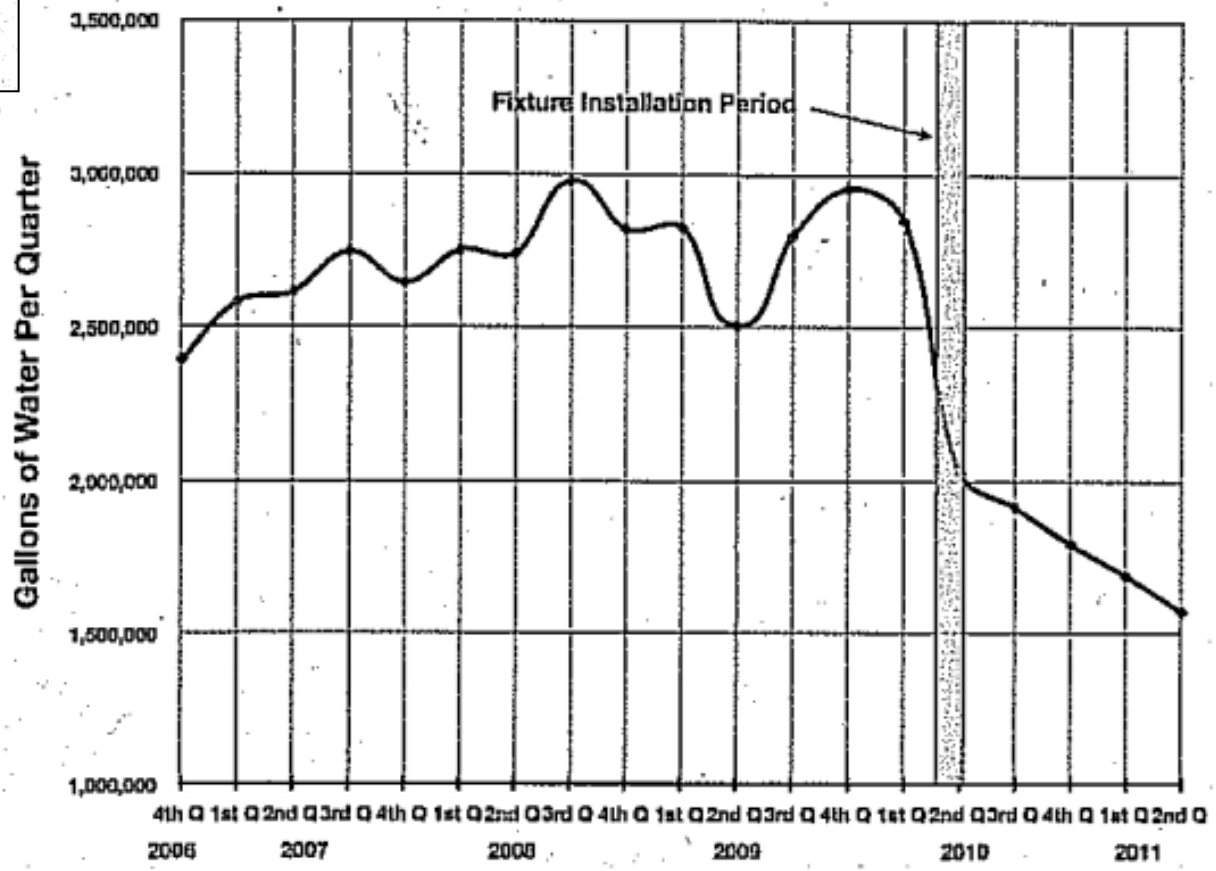
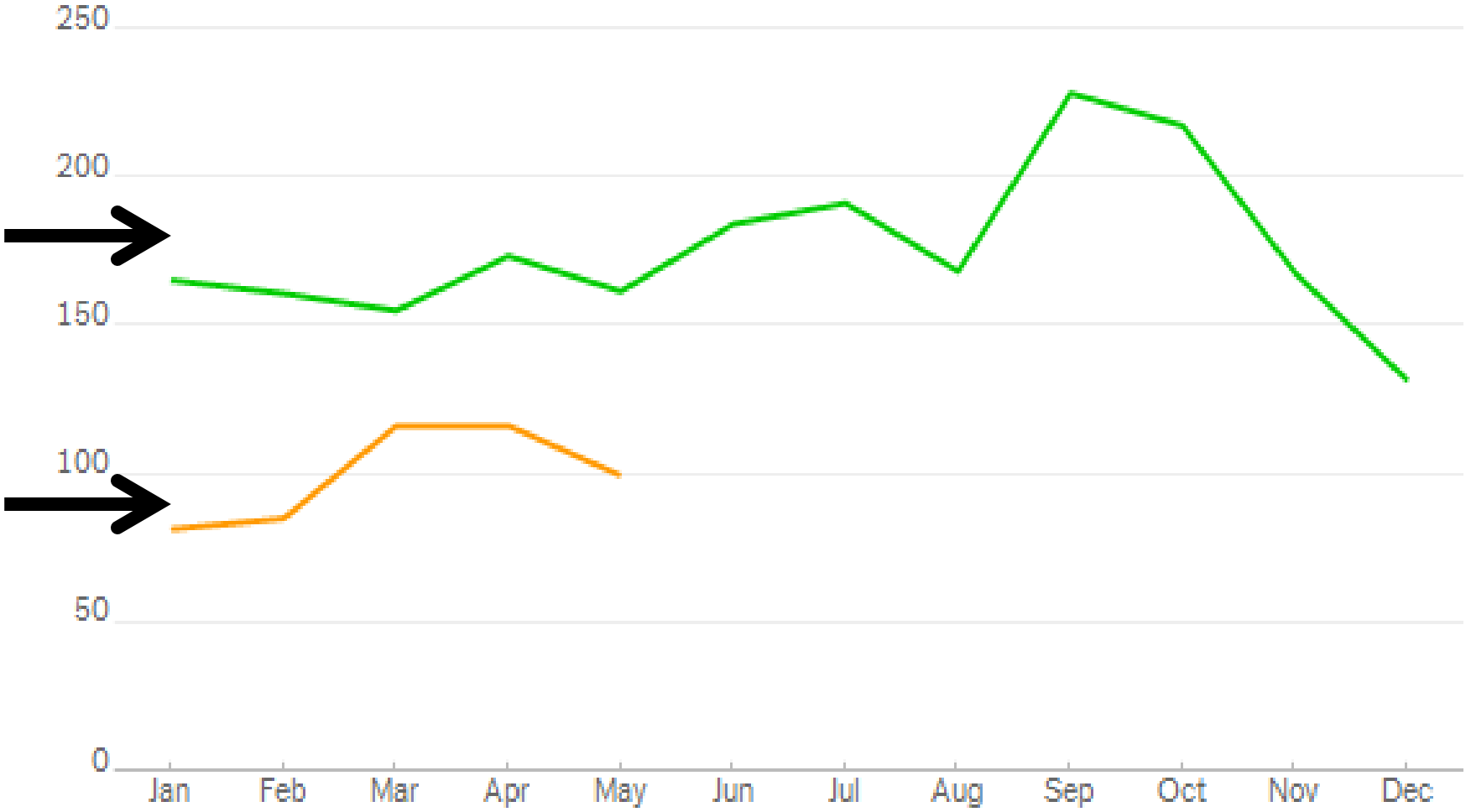


Figure 1. Mendelsohn water use declined dramatically after toilet replacement.

Courtesy Home Energy Jan/2012

YES!!

McNamara House, 3.0 GPF to 1.8 GPF
(gallons per bedroom)



Feedback?

- **Toilets**

Note: a silent leak of 7,000 gal a month ?

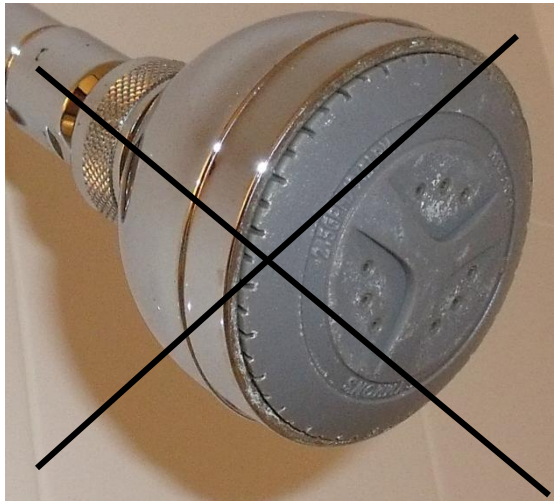
@ $0.01/gallon

= $840.00/yr

Feedback?

- **Shower Heads**

Flow Rate: 1.75 GPM



Feedback? Aerators

one drip = 3,000 gal a year

Flow Rate: .5 GPM

Feedback? Kitchen Aerators

Flow Rate:
1.5 GPM

one drip = 3,000 gal a year = $30.00

Feedback? Irrigation

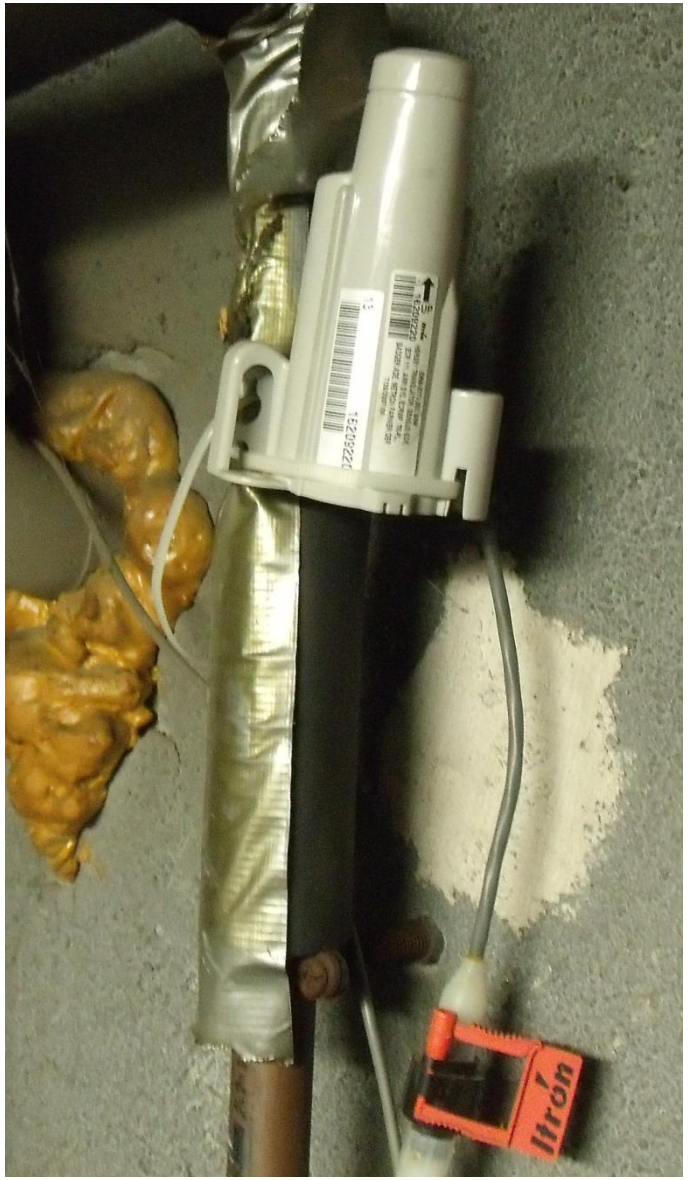
Small Leak = 7,000gal/month

Check for:

- **Soft areas**
- **Floods**
- **Keep off buildings**
- **Grass green enough**
- **Appropriate coverage**

Feedback? Newest Irrigation

Small Leak = 7,000 gal/month



Water Efficiency Protocol

Identify Additional Leaks:

1. **Building Exterior**
   - **Sillcocks**
   - **Irrigation**

2. **Common Areas**
   - **Boiler Room,**
   - **Hallways**
   - **Laundry**

3. **Cooling Tower Overflow?**

Water Efficiency Protocol (cont'd)

Identify Additional Leaks:

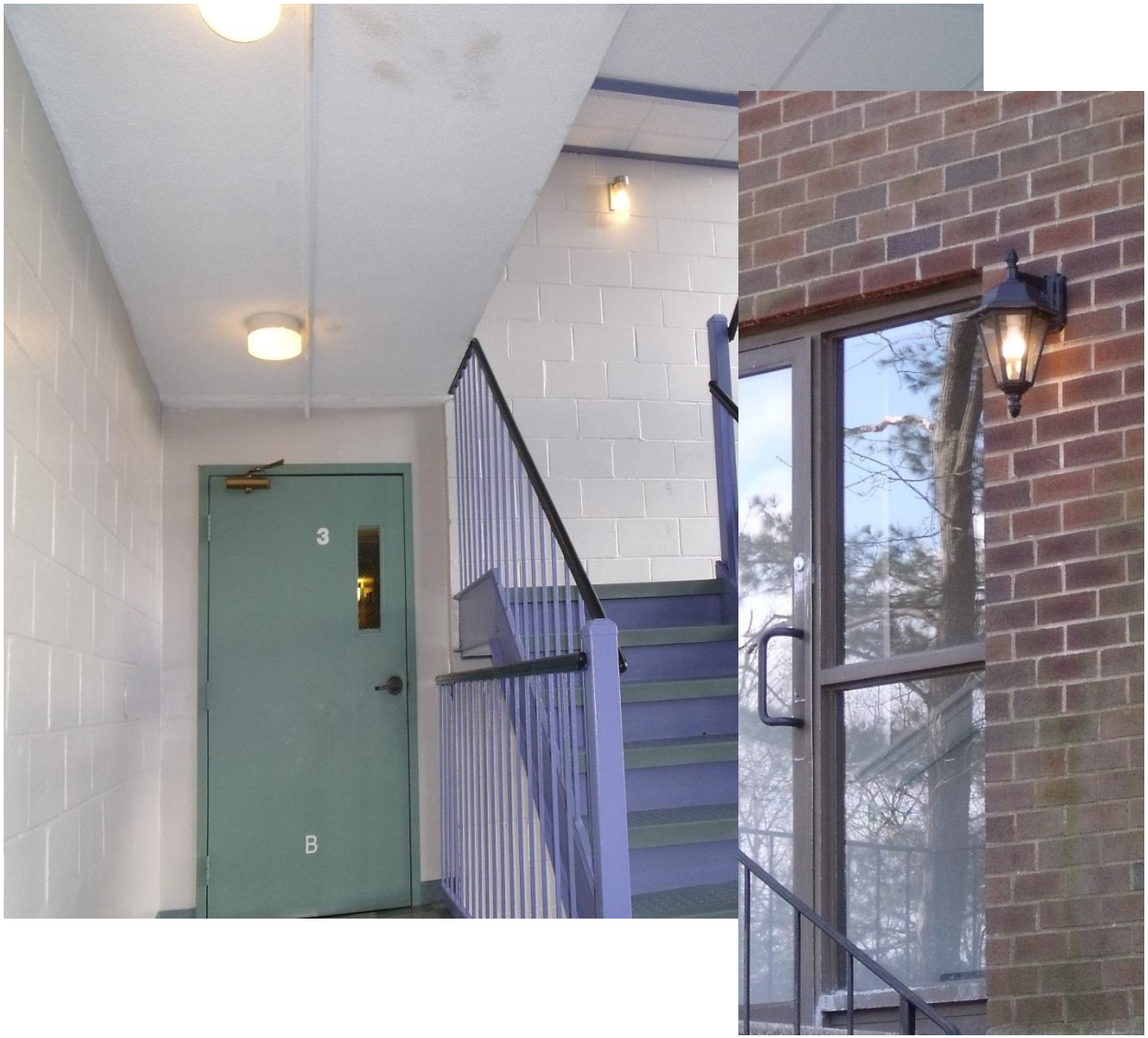
4. Apartments
   - Faucets
   - Shower
   - Diverter
   - Flappers
   - Portable washers?
   - Heating system leaks

Lighting

Opportunities

- **Audit?**

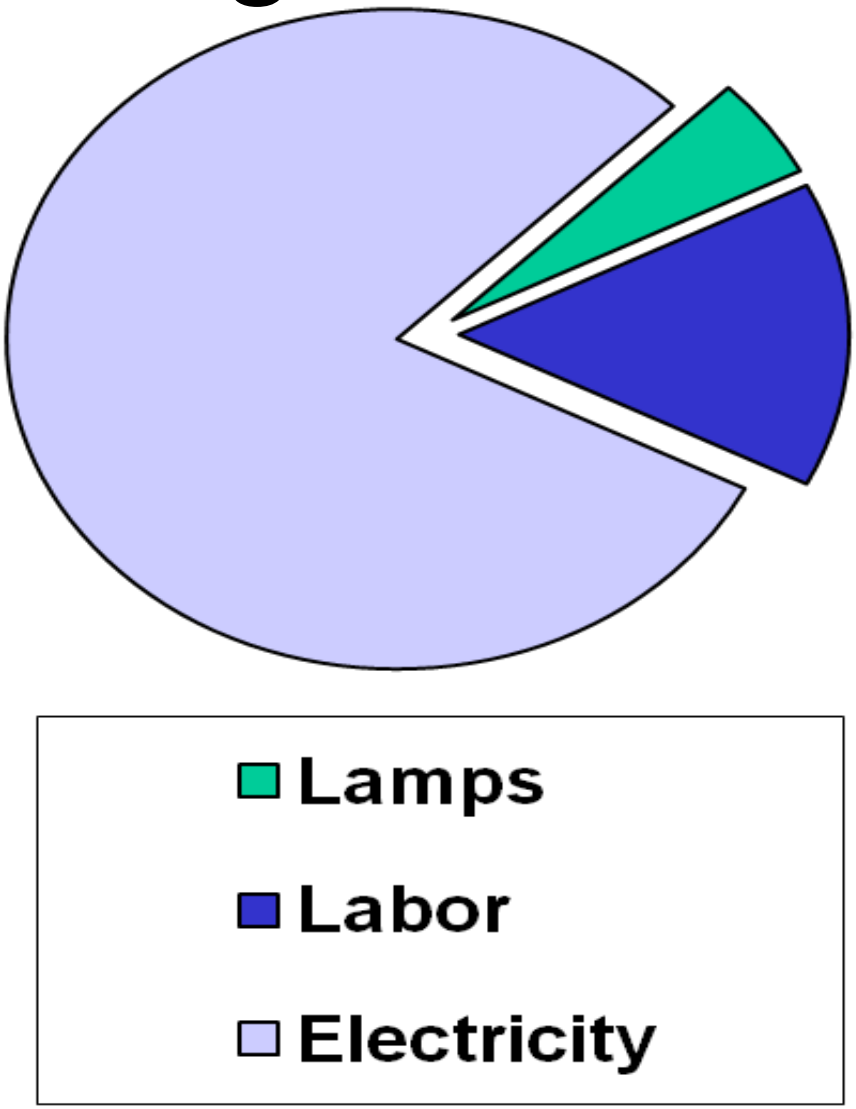
- **Controls**
- **Compact Fluorescent**
- **T-8’s, LED**
- **Outdoor**
- **Disposal**



Lighting Operating Costs

- Cost of lamps very low compared to Electricity to operate lighting

- Lighting is 30-50%? of Building's Electric Cost



Light Source Color Summary

uniform appearance in an area often matters

	CRI	CCT (°K)
Natural daylight	100	5000º – 8500º
Mercury vapor	20 - 50	4000º – 6000º
Metal halide	65 - 93	2900º – 6500º
Fluorescent	50 - 96	3000º – 8000º
Incandescent	100	2500º – 3000º
Induction	80	2700º – 5000º
Standard HPS	22	2200º
LED	Varies	Varies
Low pressure sodium	-44	1700º

Courtesy John Rice

Lighting Technology

Lamps

Ballasts

Fixtures

Controls

Lighting Practices:

- Meet designed light levels & quality goals:
  - *know what you need & how it will be used*
- Efficiently produce & deliver that light:
  - *use the most efficient equipment*
- Automatically control the operation of that light:
  - *use light only When & Where needed*
- Always Collect & Dispose / Recycle Properly

Lighting Controls

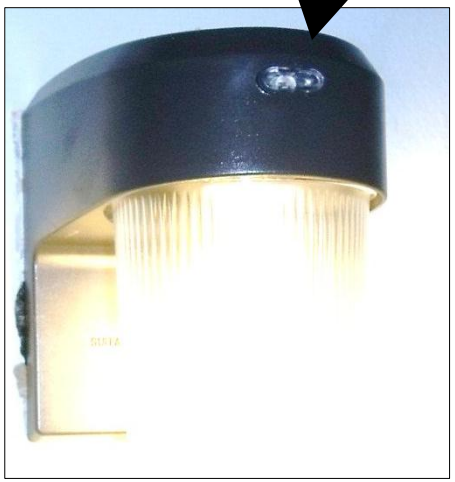
help take the human element out of the picture ("forgot to turn off the lights…")

- Occupancy (motion) sensors
- Photo sensors, **Timers**
- Combination switches
- Bi-Level Ballast T-8's
- Daylight harvesting?
- Daylight dimming?

Use Only Proven Very Reliable Controls

?

?



CFL Compact Fluorescent Lamps

LED **Light Emitting Diodes**

Cost? True Life ?
Success &
Failures?

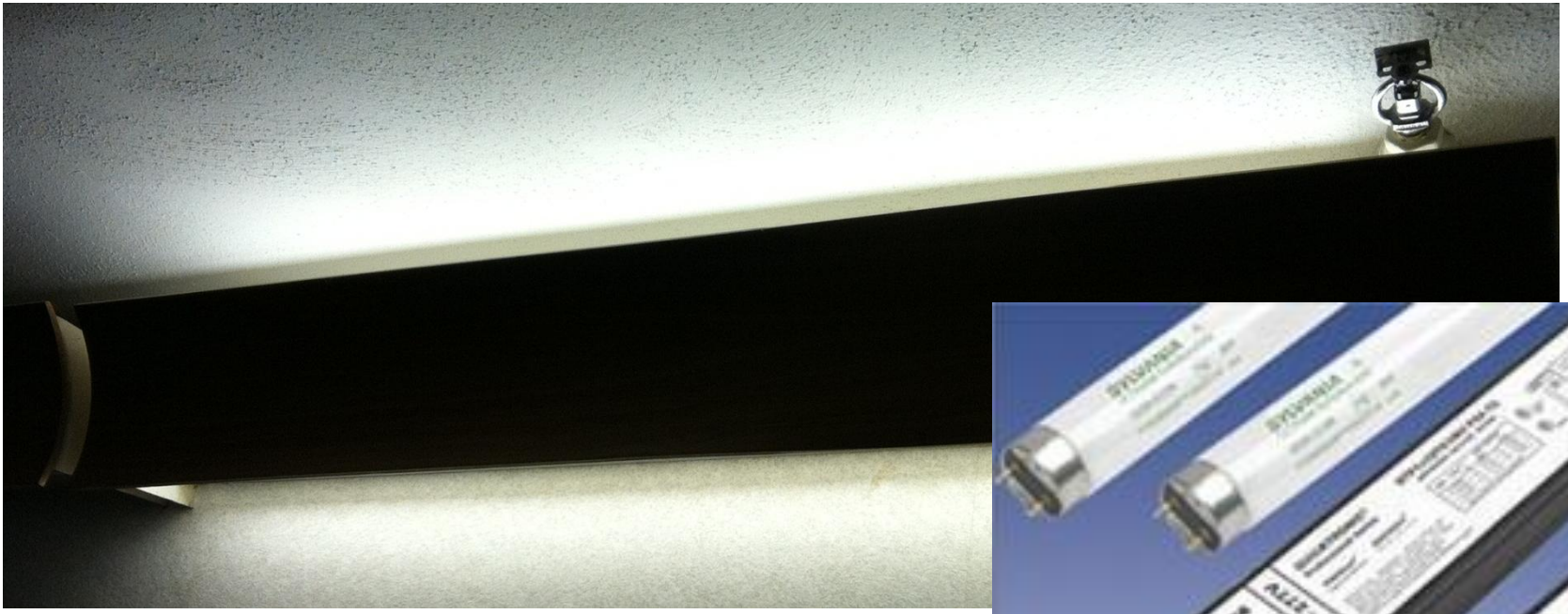
Unvented

Vented at top

Vented

Note: A CFL's life is shortened inside a closed up indoor fixture

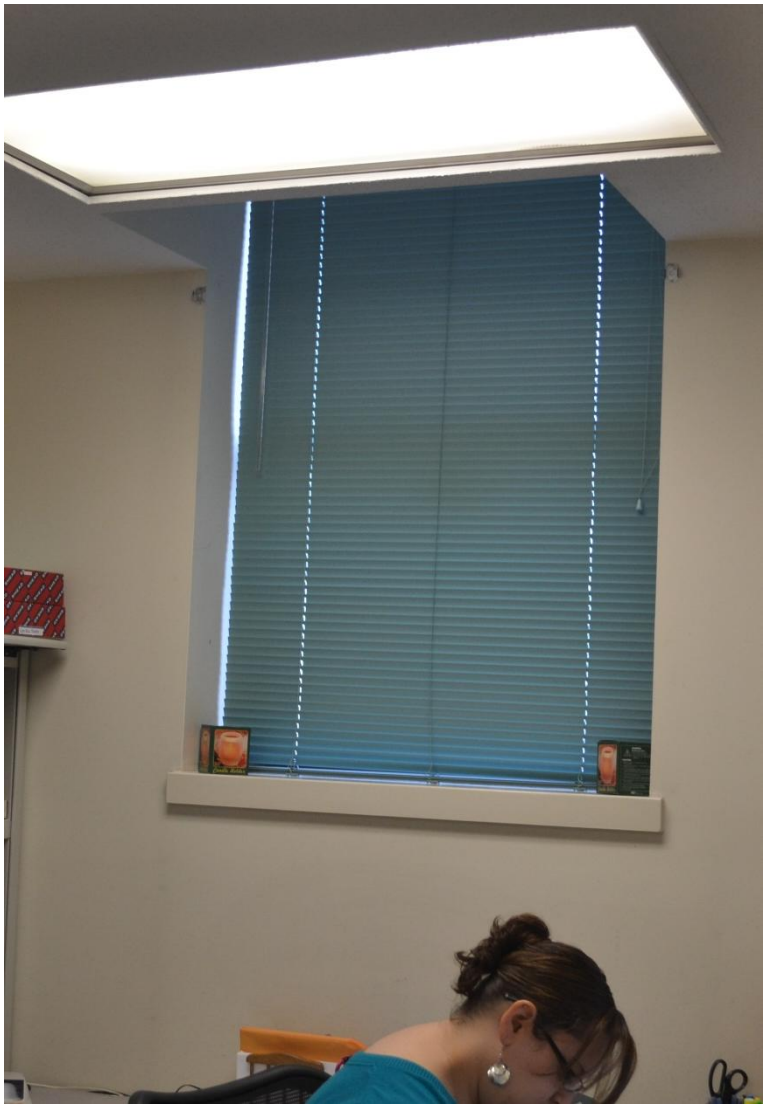
High Performance T8 Systems:
"Super T8" lamp, ballast, & control



T-12? = Opportunity

Retrofit

Updated



T- 8 = Savings

Hallway Appearance is Important

Is every other fixture OK?

T-12 to T-8,
1 fixture off
70% savings

T- 8 = Savings

High Performance T8 Systems:

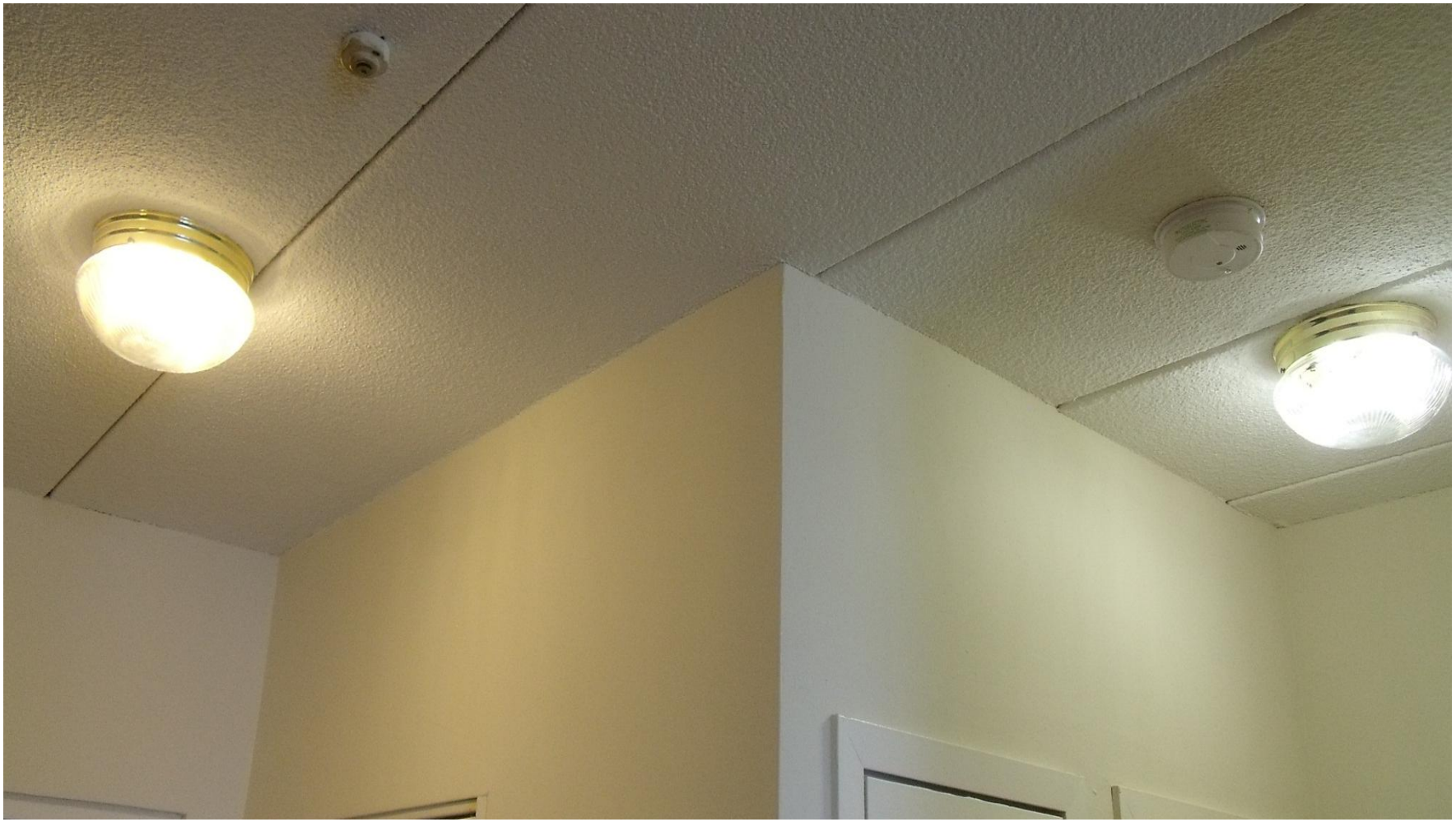
Combination:

- high-lumen, extended life lamps
- reduced wattage electronic ballast

15-20% more efficient than standard T8 systems

Savings 40% replacing 34-w T12's

It is important to use the same lamps within each apartment.



What is inside the fixture?

How much light is needed?

Leaving out bulbs = savings

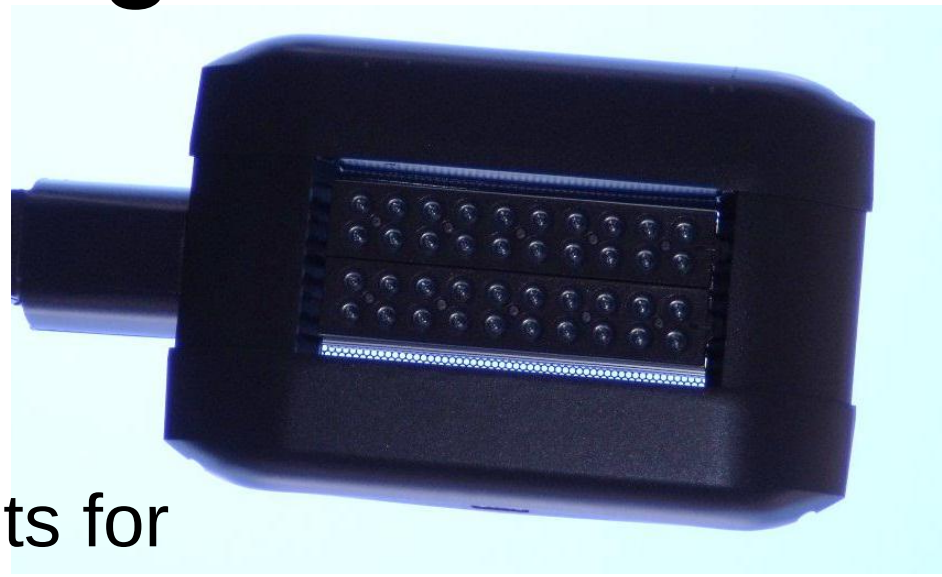
Consider safety & aesthetics when reducing light levels.

Discuss use of incandescent lamps

Outdoor Lighting

- Use appropriate light sources.
- Avoid glare – use cutoff fixtures.
- Put light only where needed.
- Use automatic controls.
- Avoid exterior conduit for aesthetic reasons.

Outdoor Lighting cont'd



- Use automatic controls.
- Consider LED Units.
- Carefully select LED units for proper spread.

- **Mission:** lights off during daylight.

Operational

- **Clean Drier Hoses for safety &performance**
- **(Frequency?)**

Other Operational Items:

- **Seasonal Schedule Updates for all timers**
- **Purchase with energy saving features:**

  Computers & Copiers
- **Purchase Only Energy Star Appliances**

Questions?

Other non-HVAC topics?

Break

2. HVAC

“No energy efficiency measures, equipment changes or upgrades should be made without Consulting the Director of Maintenance Operations & the Energy Efficiency Manager”.

“Hot” Water Heating

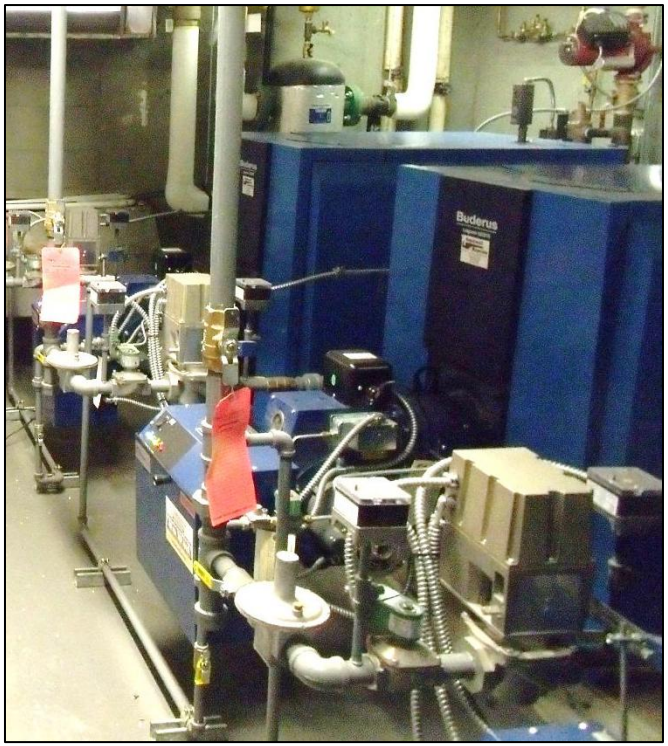
Range 140 - 190 F

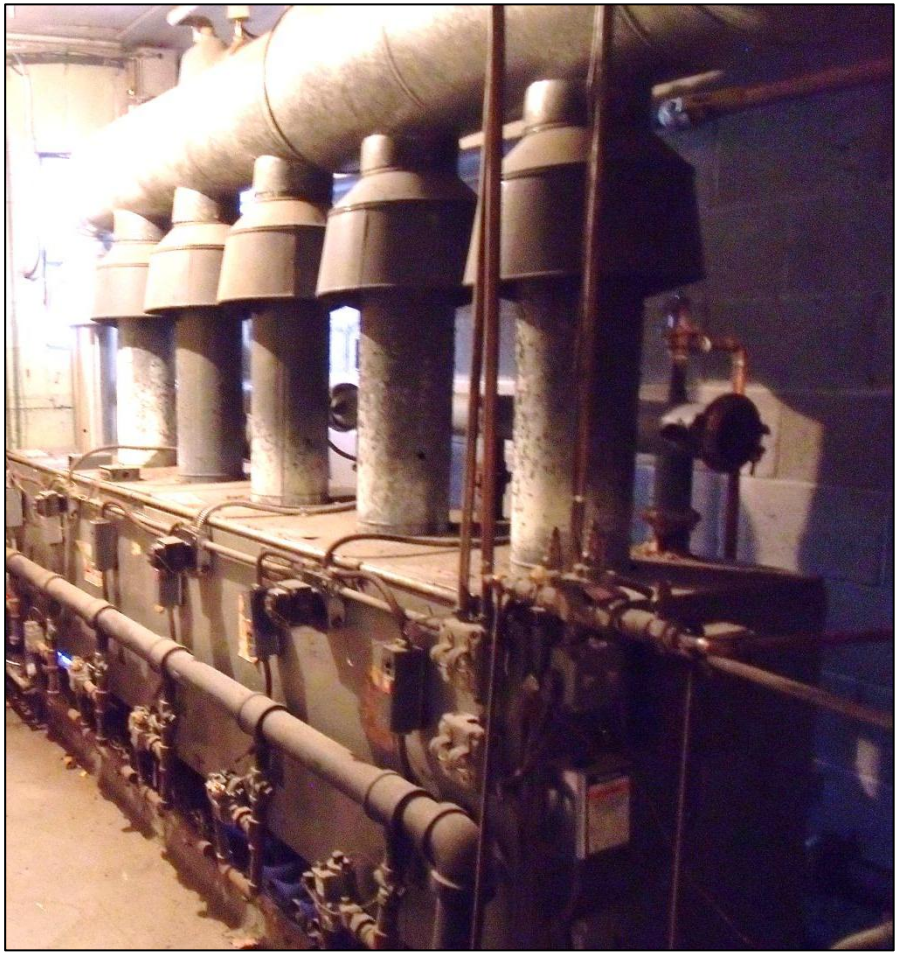
Hot Water **Boilers**

Higher Mass , Non-Condensing

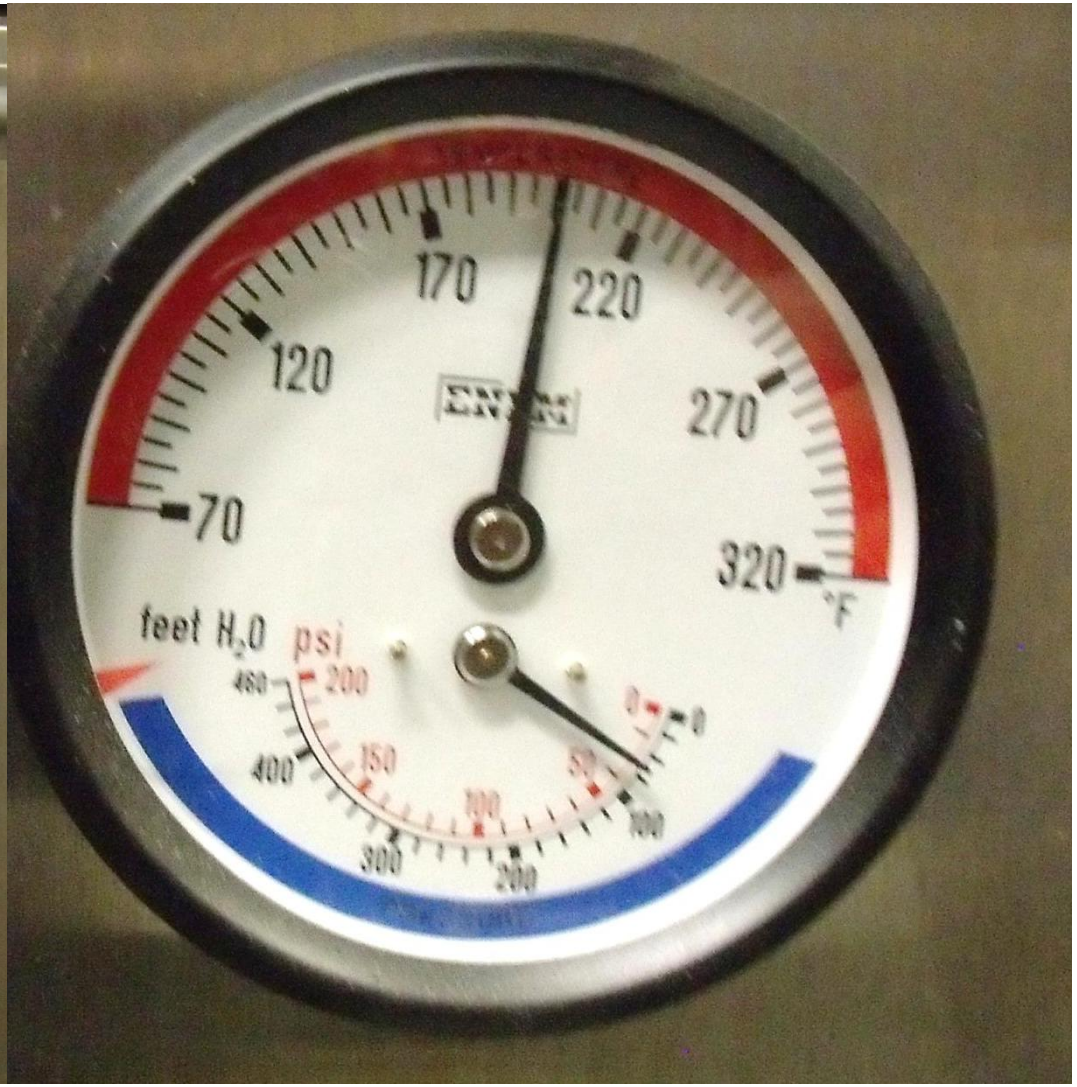
Maintain it,

keep it efficient!



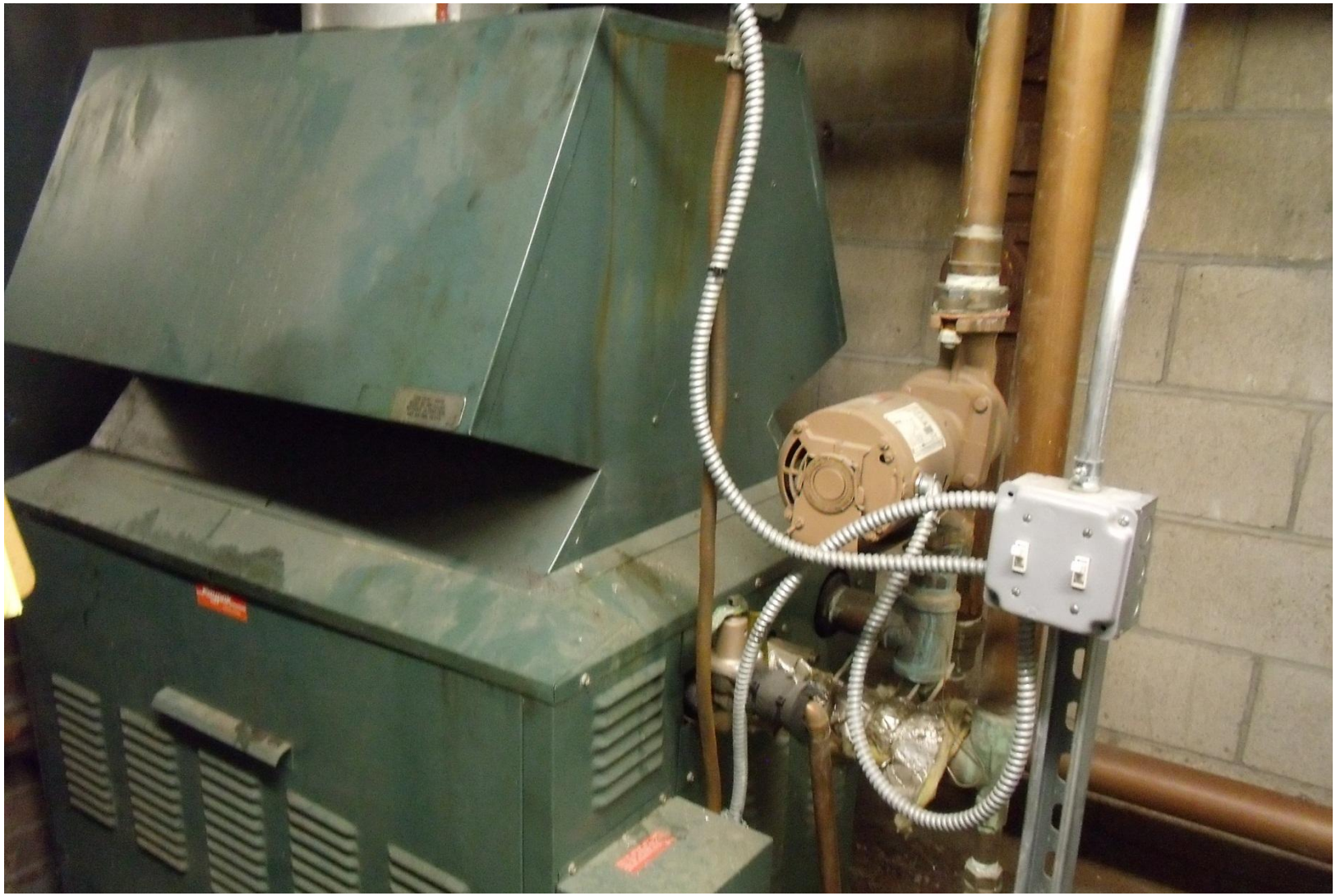


“Hot” Water Heating Range 140?-190? F



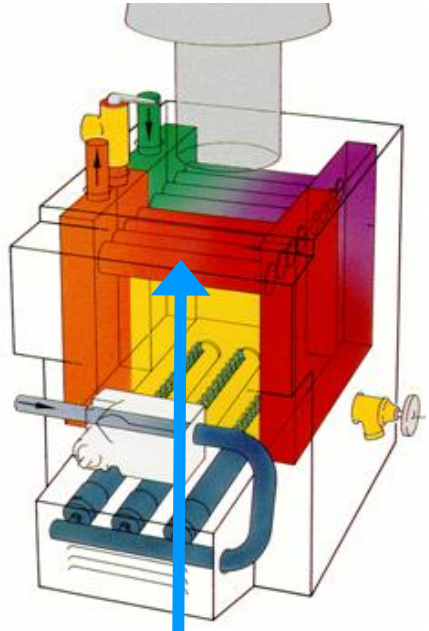
Domestic/Potable Water From Boilers

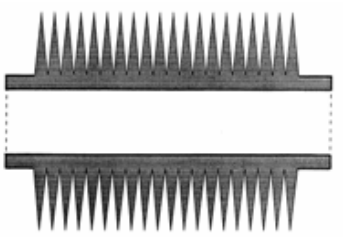
Dedicated Unit for Domestic/Potable Water



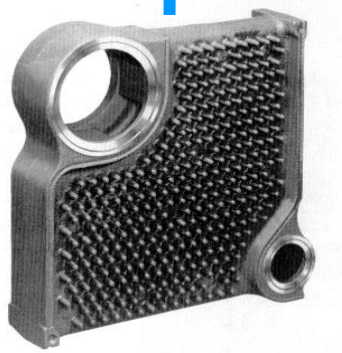
CONVENTIONAL BOILER TECHNOLOGY

Non-condensing construction





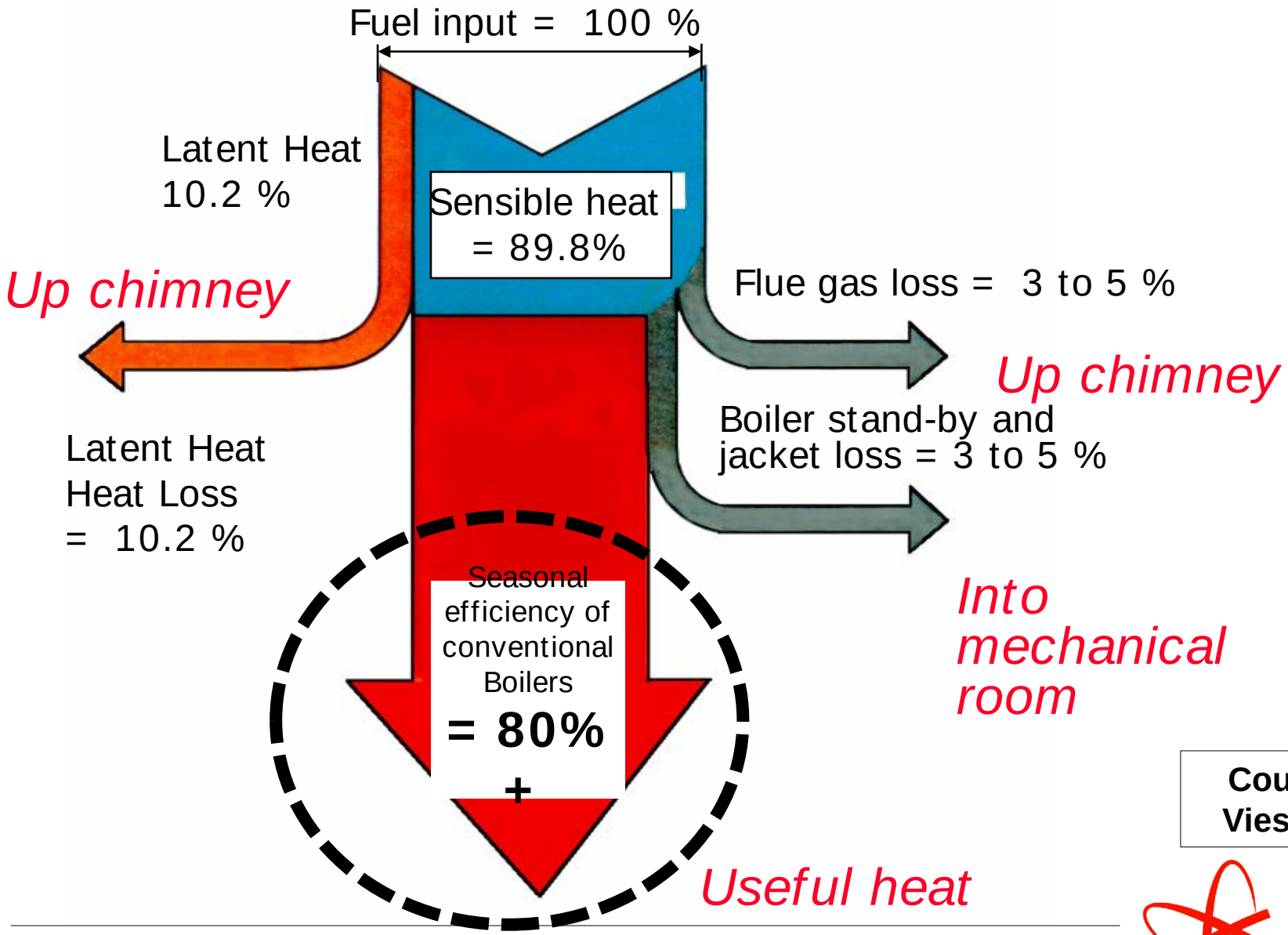
Fin tube boiler



Cast-iron sectional boiler

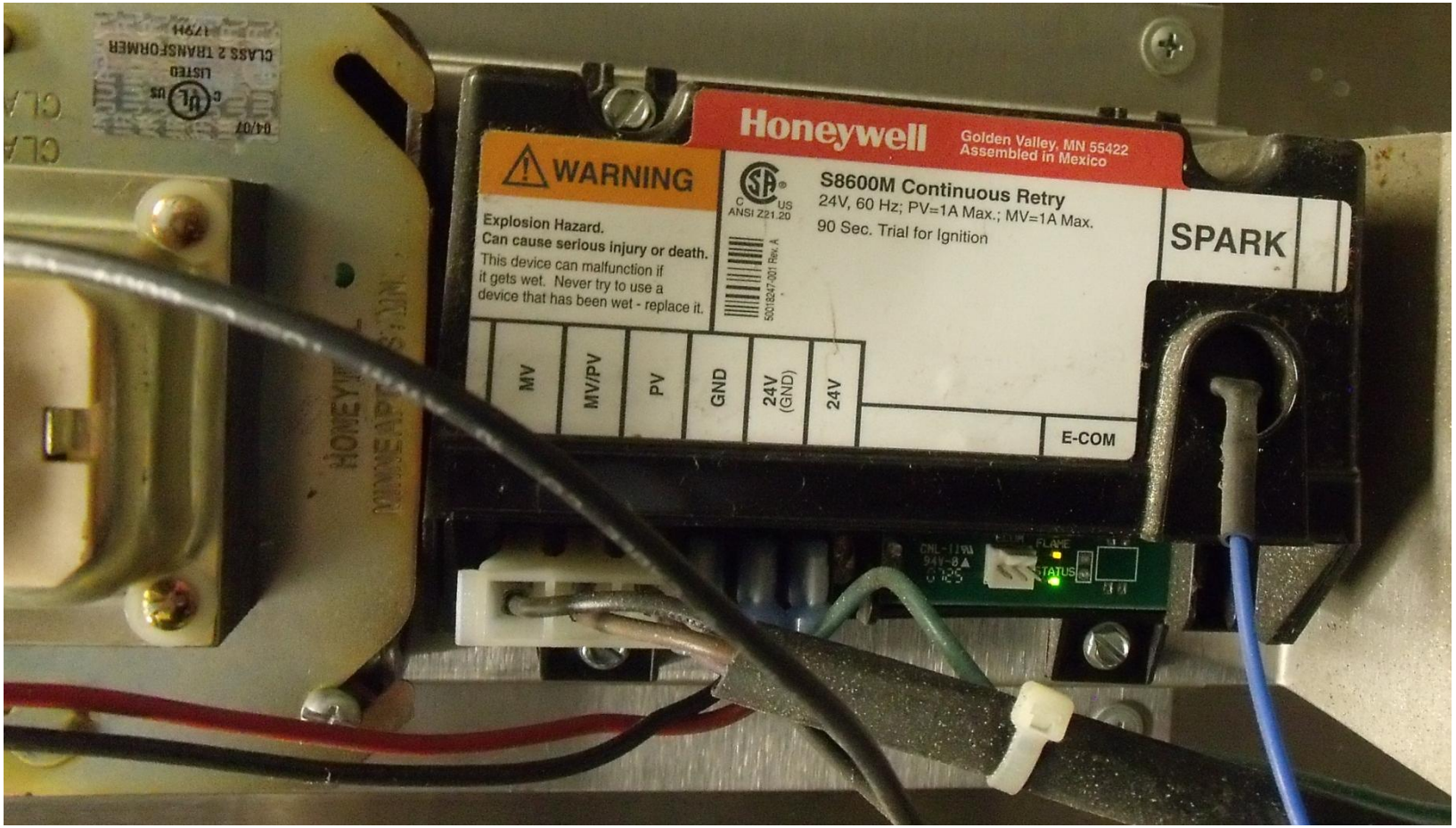
Courtesy Viessman

CONVENTIONAL BOILER HEAT FLOW

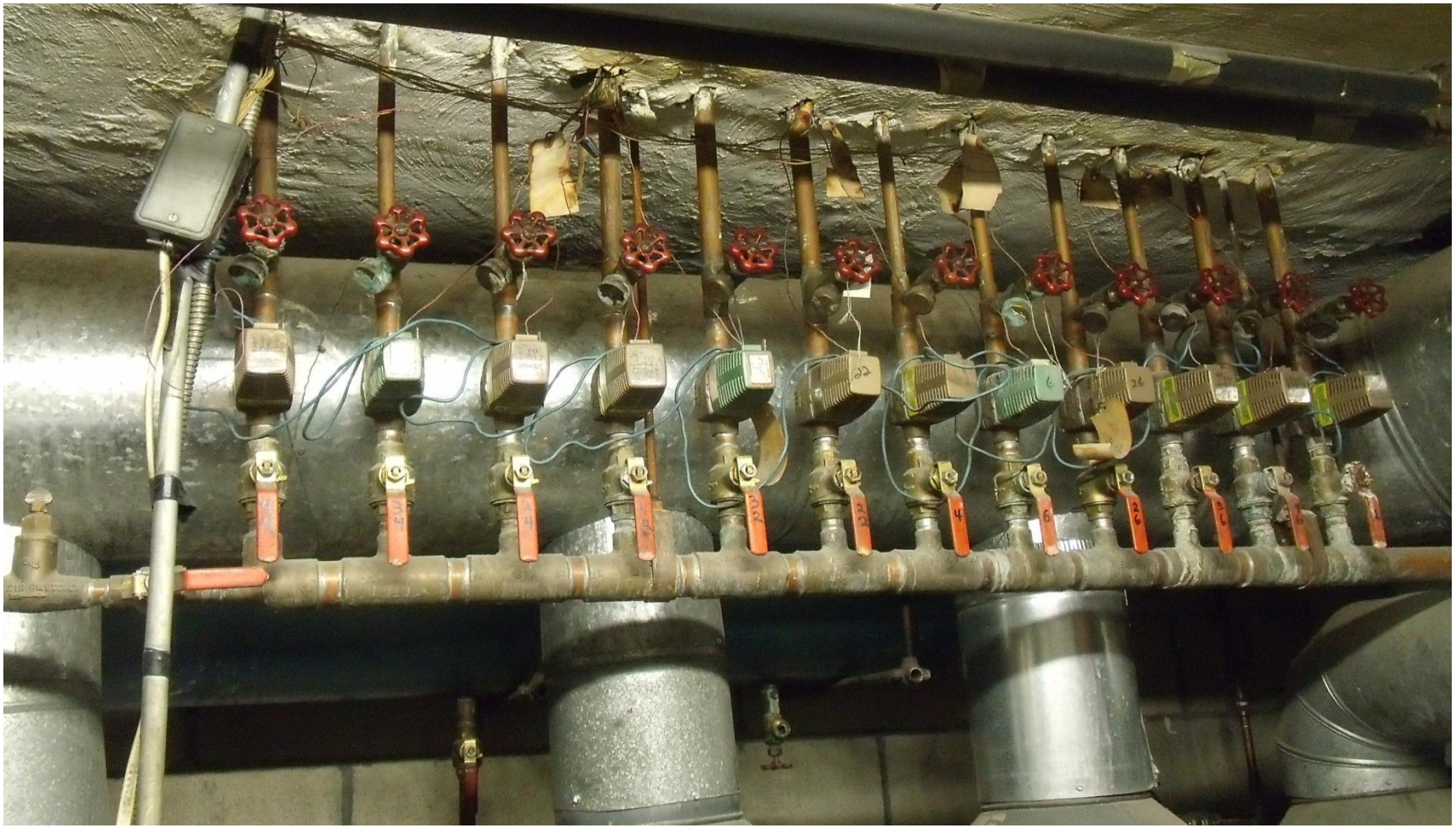


Courtesy Viessman

Readily Available Conventional Controls



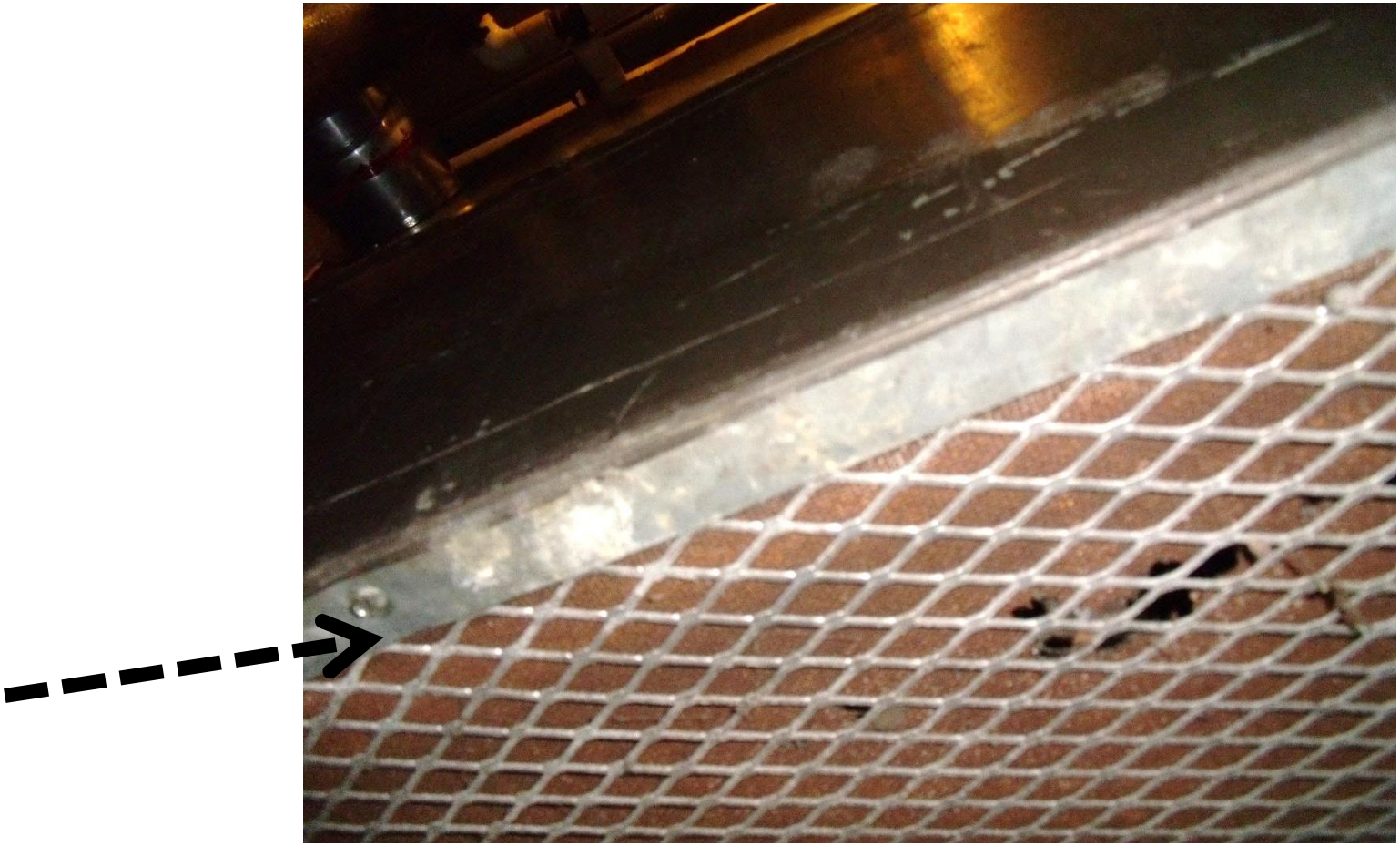
Zone Valves Are Serviceable
Do not leave on “manual”



Atmospherically Vented Non-Condensing

Boiler room needs make-up air supply for the boiler combustion & the chimney for safe operation.

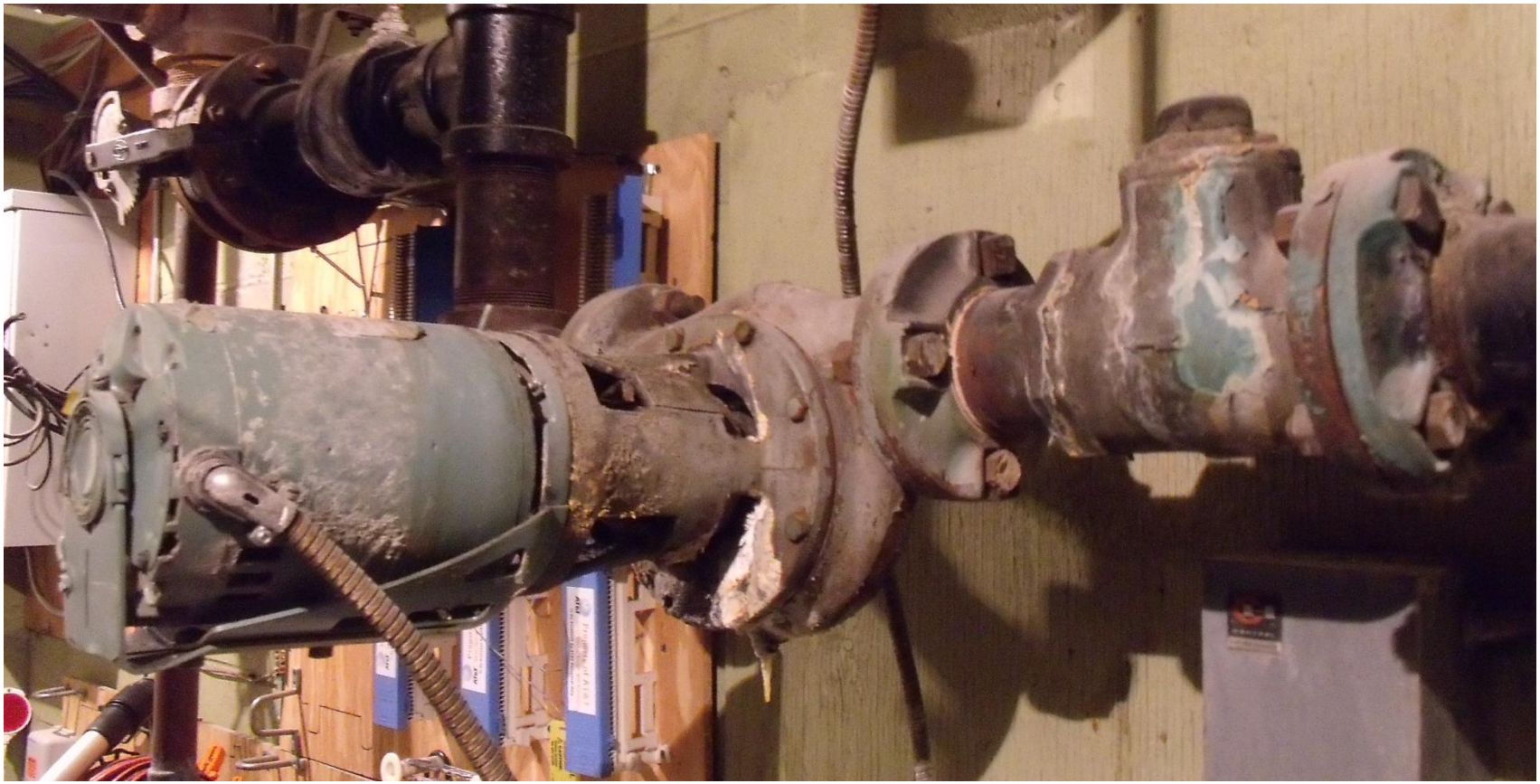
It is important to make sure that the boiler room venting is not blocked.



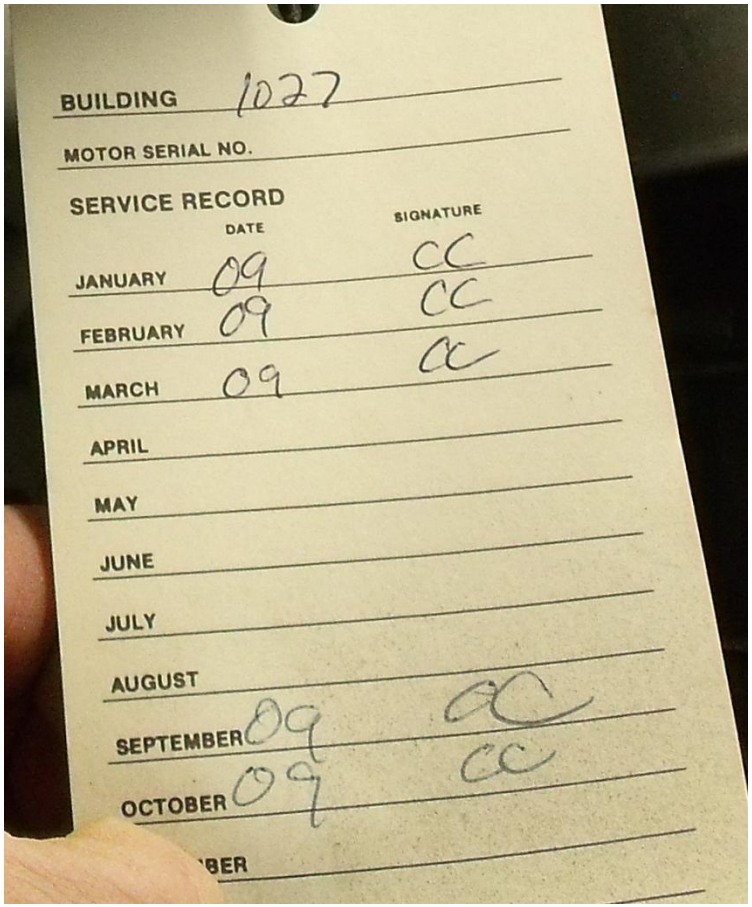
Keep vegetation away from air intakes.

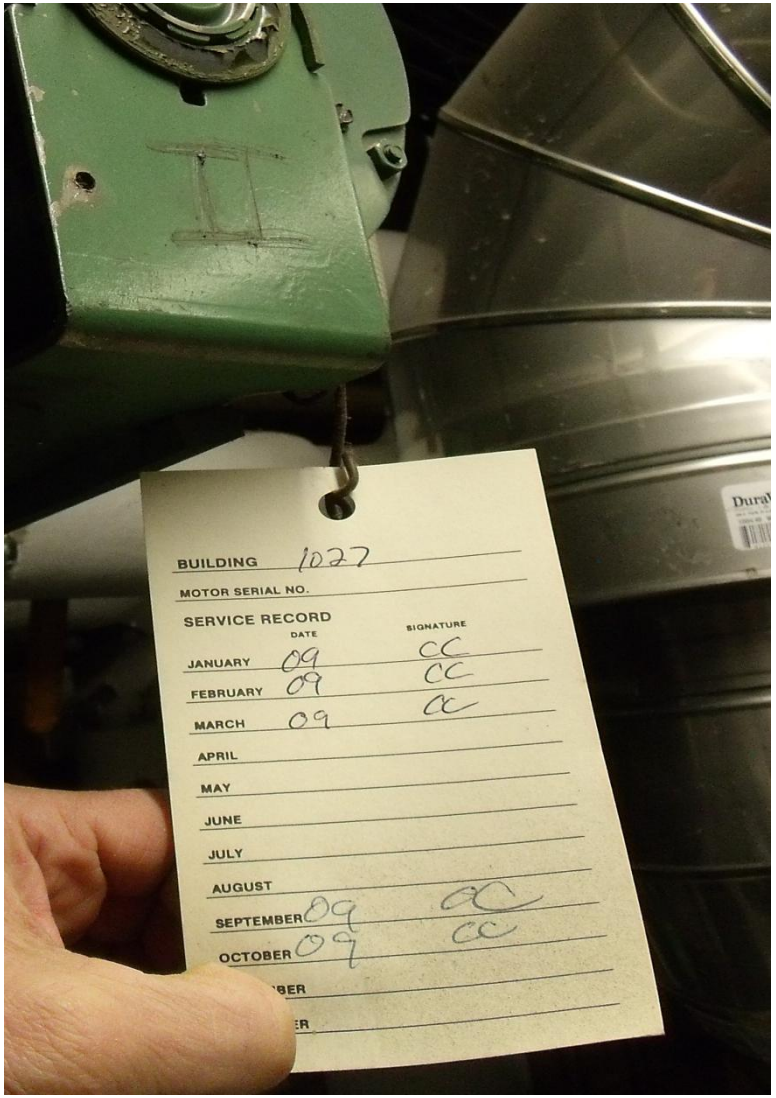
Locate sensor on NE side of building

Atmospheric systems typically have fixed single speed pumps; consider VFD Pump when replacing.



Maintenance procedures should be followed.





Atmospherically Vented Non-Condensing

being phased out

For Some of the Newer Boiler Installations

Atmospherically Vented Non-Condensing

Is being used

Combustion Tune-up

- "Tune-up" requires gas sampling
  - gases sampled: CO_2, O_2, CO

  & Stack Temperature Evaluation

- Stack temperatures as an indicator
  - high stack temperature?
  - low stack temperatures?

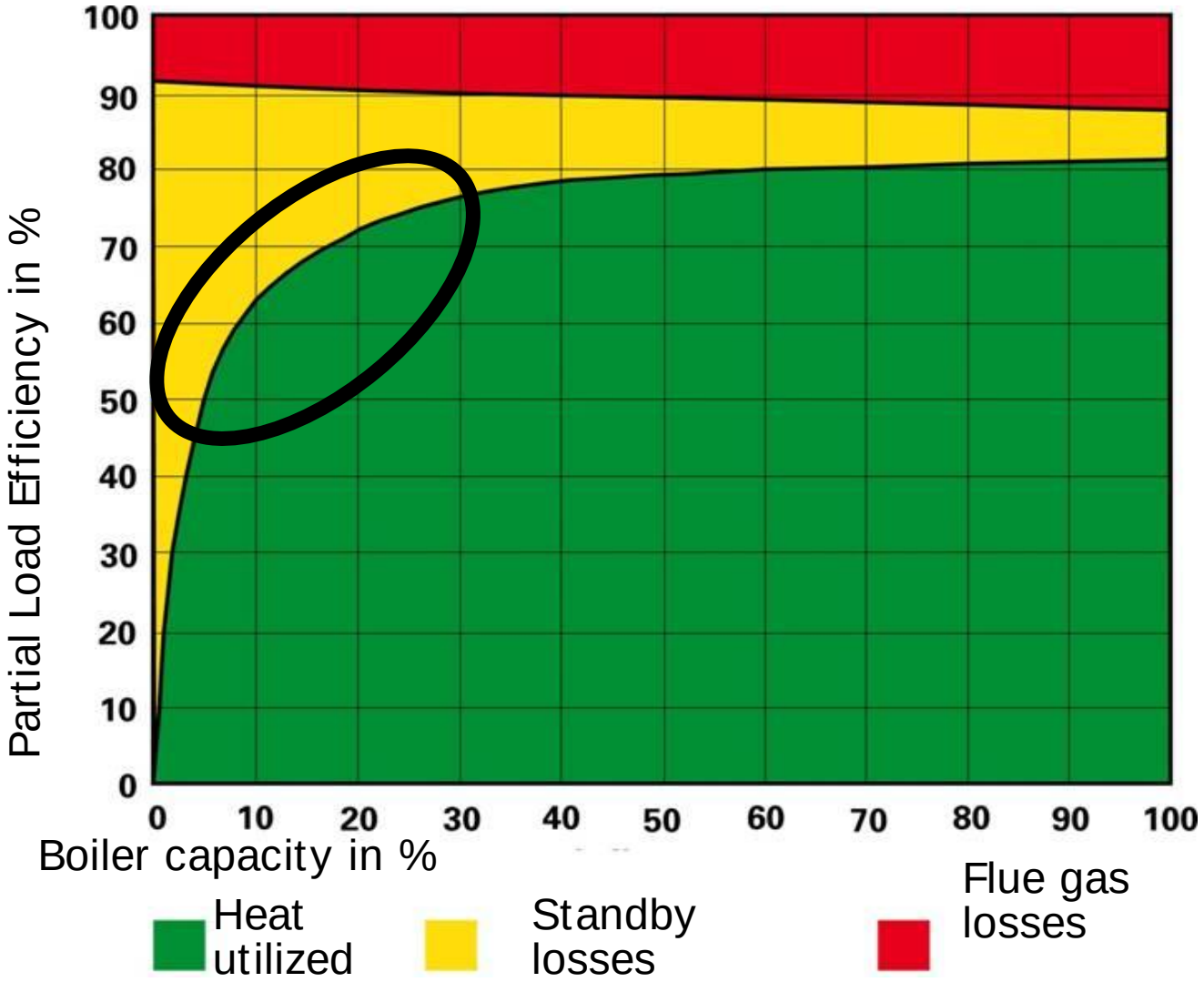
Combustion Efficiency

Table 2
Combustion Efficiency Table for Natural Gas

Courtesy BOC

Excess Air	% O_2	% CO_2	Combustion Efficiency — Flue Gas Temperature Less Combustion Air Temperature, Deg. F													
			170	180	190	200	210	220	230	240	250	260	270	280	290	300
0.0	0.0	11.8	86.3	86.1	85.9	85.7	85.5	85.3	85.1	84.9	84.7	84.5	84.2	84.0	83.8	83.6
2.2	0.5	11.5	86.3	86.1	85.9	85.6	85.4	85.2	85.0	84.8	84.6	84.4	84.1	83.9	83.7	83.5
4.5	1.0	11.2	86.2	86.0	85.8	85.6	85.3	85.1	84.9	84.7	84.5	84.2	84.0	83.8	83.6	83.4
6.9	1.5	11.0	86.1	85.9	85.7	85.5	85.2	85.0	84.8	84.6	84.4	84.1	83.9	83.7	83.5	83.2
9.5	2.0	10.7	86.1	85.8	85.6	85.4	85.2	84.9	84.7	84.5	84.2	84.0	83.8	83.6	83.3	83.1
12.1	2.5	10.4	86.0	85.7	85.5	85.3	85.1	84.8	84.6	84.4	84.1	83.9	83.7	83.4	83.2	83.0
15.0	3.0	10.1	85.9	85.7	85.4	85.2	85.0	84.7	84.5	84.2	84.0	83.8	83.5	83.3	83.0	82.8
18.0	3.5	9.8	85.8	85.6	85.3	85.1	84.8	84.6	84.4	84.1	83.9	83.6	83.4	83.1	82.9	82.6
21.1	4.0	9.6	85.7	85.5	85.2	85.0	84.7	84.5	84.2	84.0	83.8	83.5	83.2	83.0	82.7	82.5
24.5	4.5	9.3	85.6	85.4	85.1	84.8	84.6	84.3	84.1	83.8	83.6	83.3	83.1	82.8	82.6	82.3
28.1	5.0	9.0	85.5	85.2	85.0	84.7	84.5	84.2	83.9	83.7	83.4	83.2	82.9	82.6	82.4	82.1

COMPARING OLD & NEW BOILER TECHNOLOGY



Constant temperature boiler

Up to 85% ? efficient?

Courtesy Viessman

Use Outdoor Temperature Boiler Water Reset

Water temperature at <u>lowest</u> temperature that meets <u>both</u>

a) the manufacturers requirements &

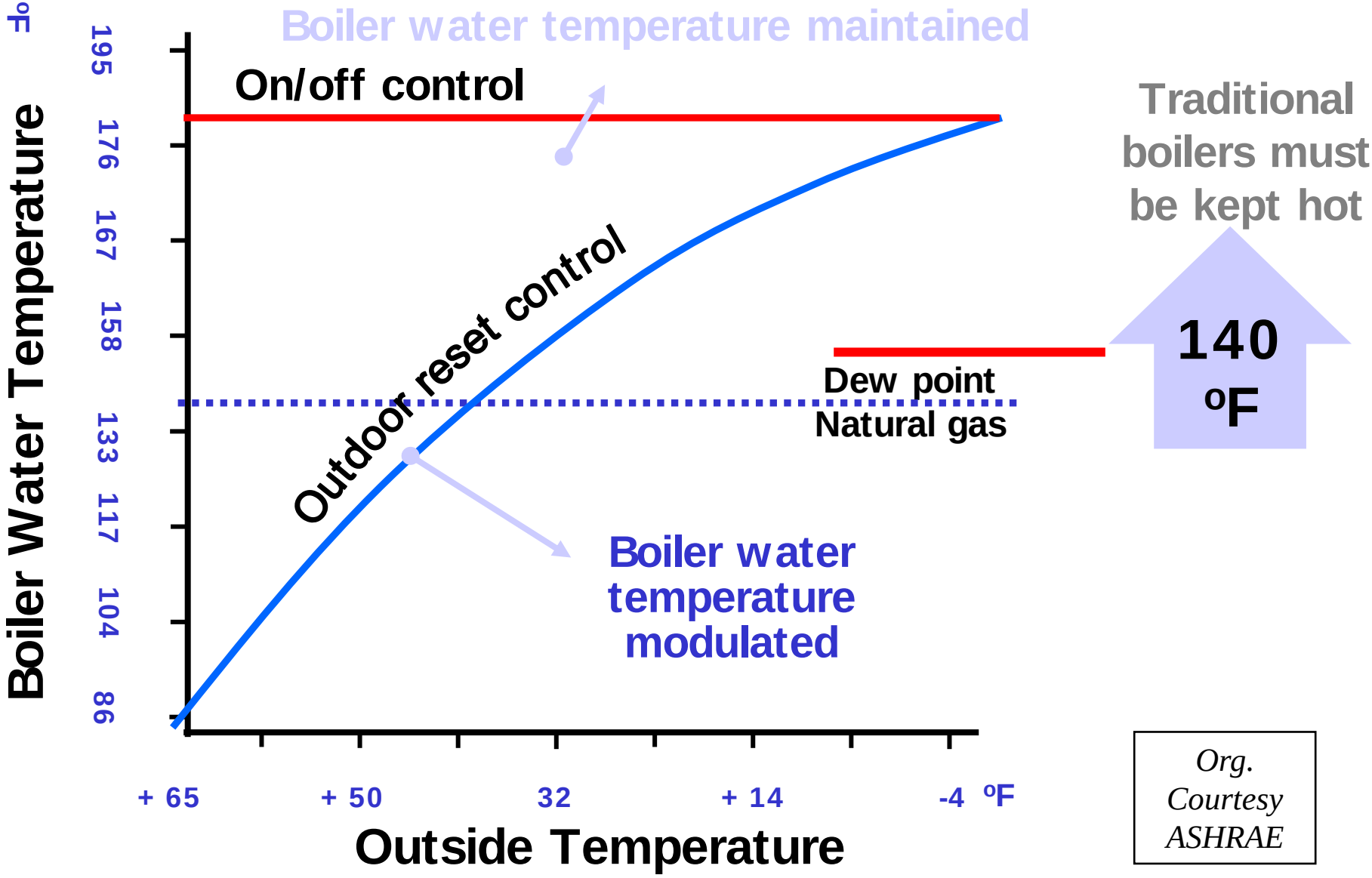
b) the heating requirements of the building

Properly locate sensor

140 ? return Non-Condensing USA boilers

104 ? return Non-Condensing German boilers

HYDRONIC WATER TEMPERATURE CONTROL



Org. Courtesy ASHRAE

Insulate pipes runs as much as possible

Chemical Treatment of Boiler Water is Desirable

Normal Boiler Maintenance

Soot & scale reduce heat transfer rates

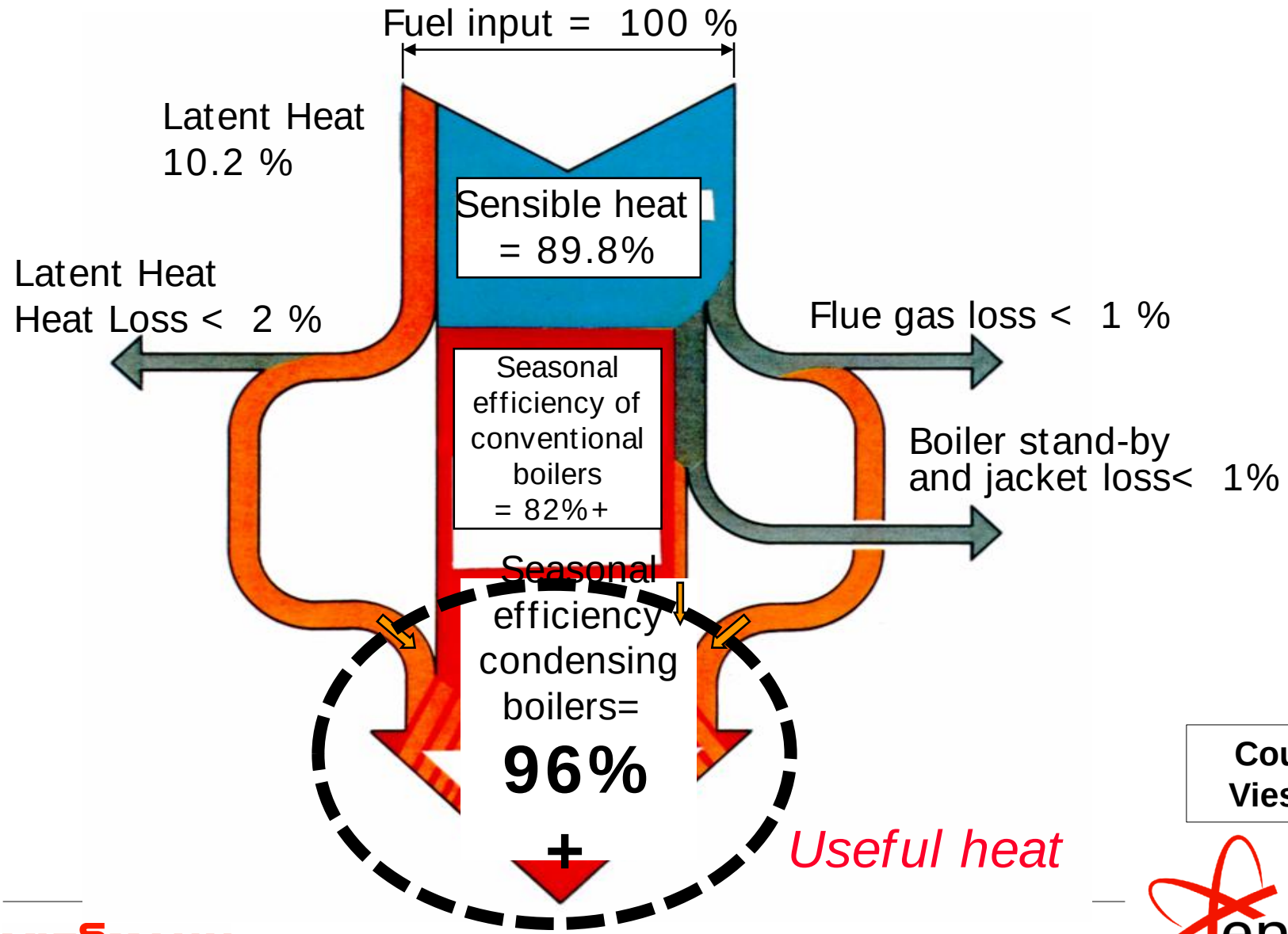
Includes:

- regular inspections
- record keeping (insurance inspections)
- accurate water treatment
- clean heat exchanging surfaces
- preventive maintenance

- Water treatment

Medium Temperature Water Heating *(the gold mine)* Condensing Boilers Range 120?-160? F

CONDENSING BOILER HEAT FLOW



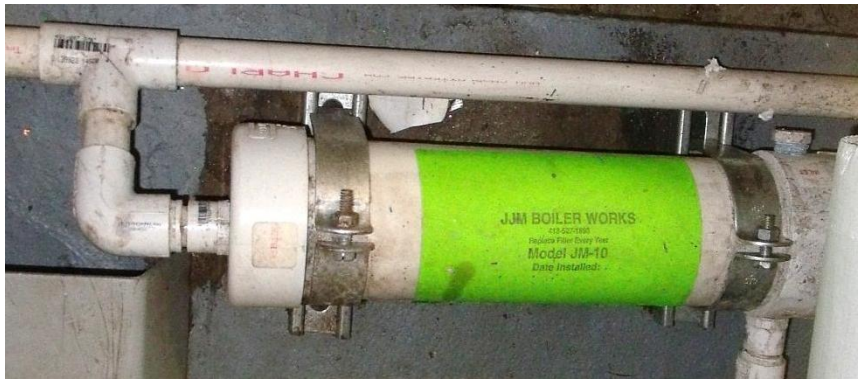
Courtesy
Viessman

Modern Boiler Rooms Retrofits:

- Condensing boilers
- Variable speed pumps
- Heat exchangers
- Buffer tank
- Blocked off outside air
- Service expertise needed & contracted for
- Critical maintenance needed

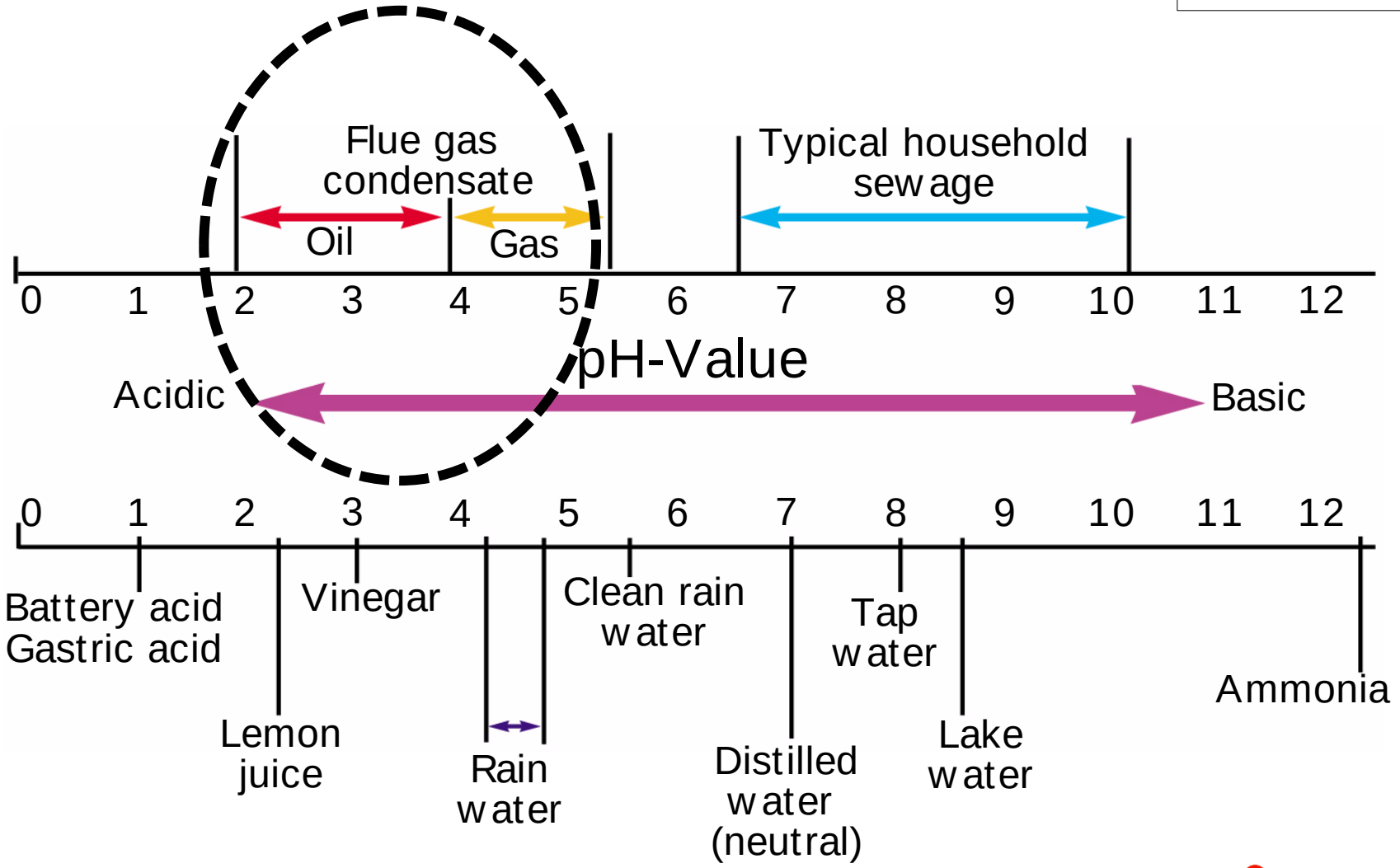
Modern Boiler Rooms Retrofits cont'd:

- **Computer controlled**
- **Natural gas & air goes in,**
- **Hot water is produced,**
- **Warm moist air & acidic condensate water leaves**

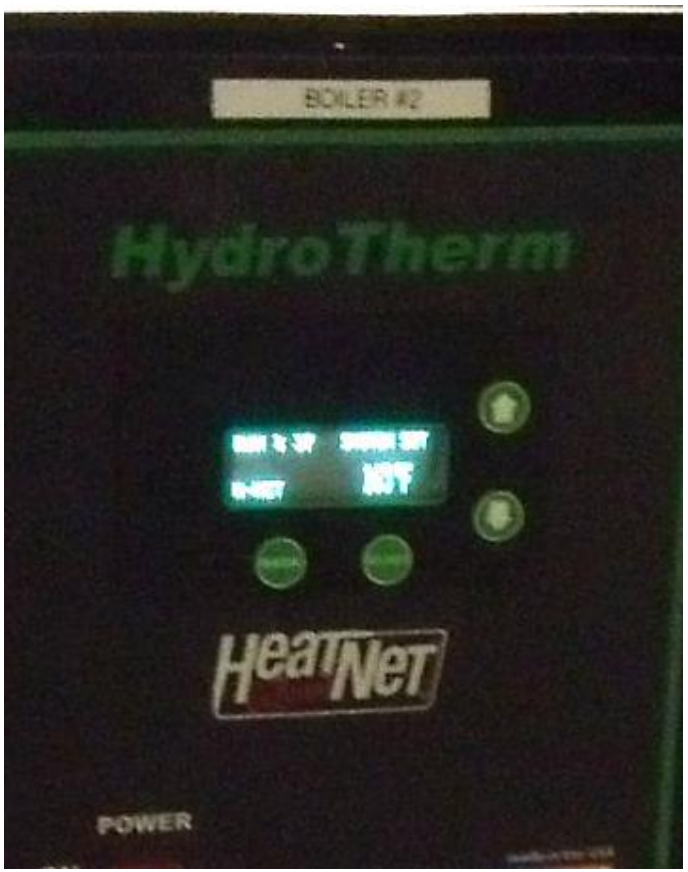


pH VALUES OF VARIOUS FLUIDS

Courtesy Viessman



Condensing Hot Water **Boilers**



Condensing Hot Water **Boilers**

Condensing Hot Water

Boilers

- **A company is under contract to service & maintain**
- **Unit is computer controlled, will tell you when it is not working well**

Aerco Condensing Hot Water "Modulating" **Boilers**

15 to 1 turn down ratio

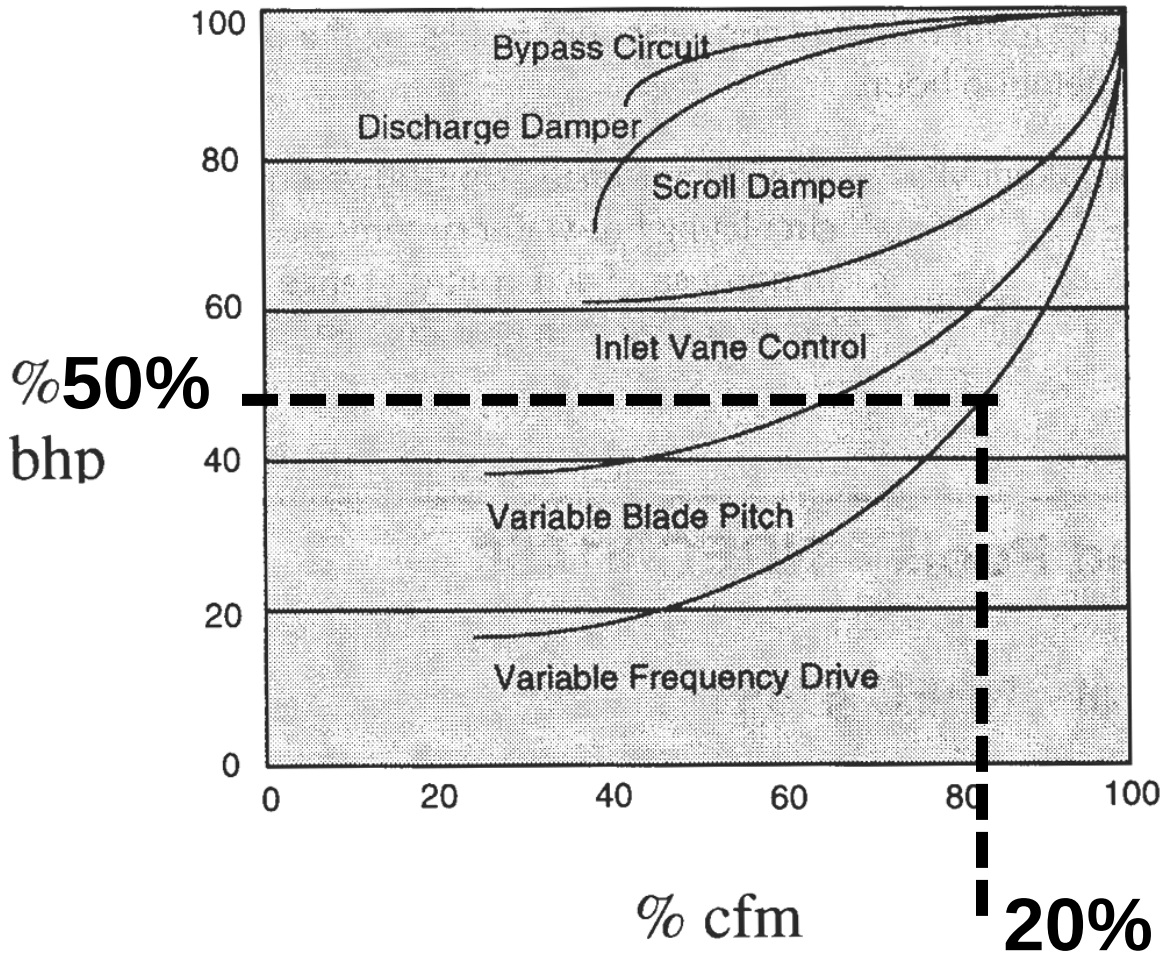
"efficiency *improves* at part load"

under the cover of a condensing boiler, “lots of redundancy”

Variable Speed Pump

Variable Speed Pumps “commissioned by contractor”

Variable Frequency Drives



Figure—Part Load Performance of Variable Flow Devices

Domestic Hot Water Heat Exchanger

Domestic Hot Water Heat Exchanger Controller

temperature controller

over temp

out

in

boiler water temp

Insulated pipes

un-insulated expansion tank &

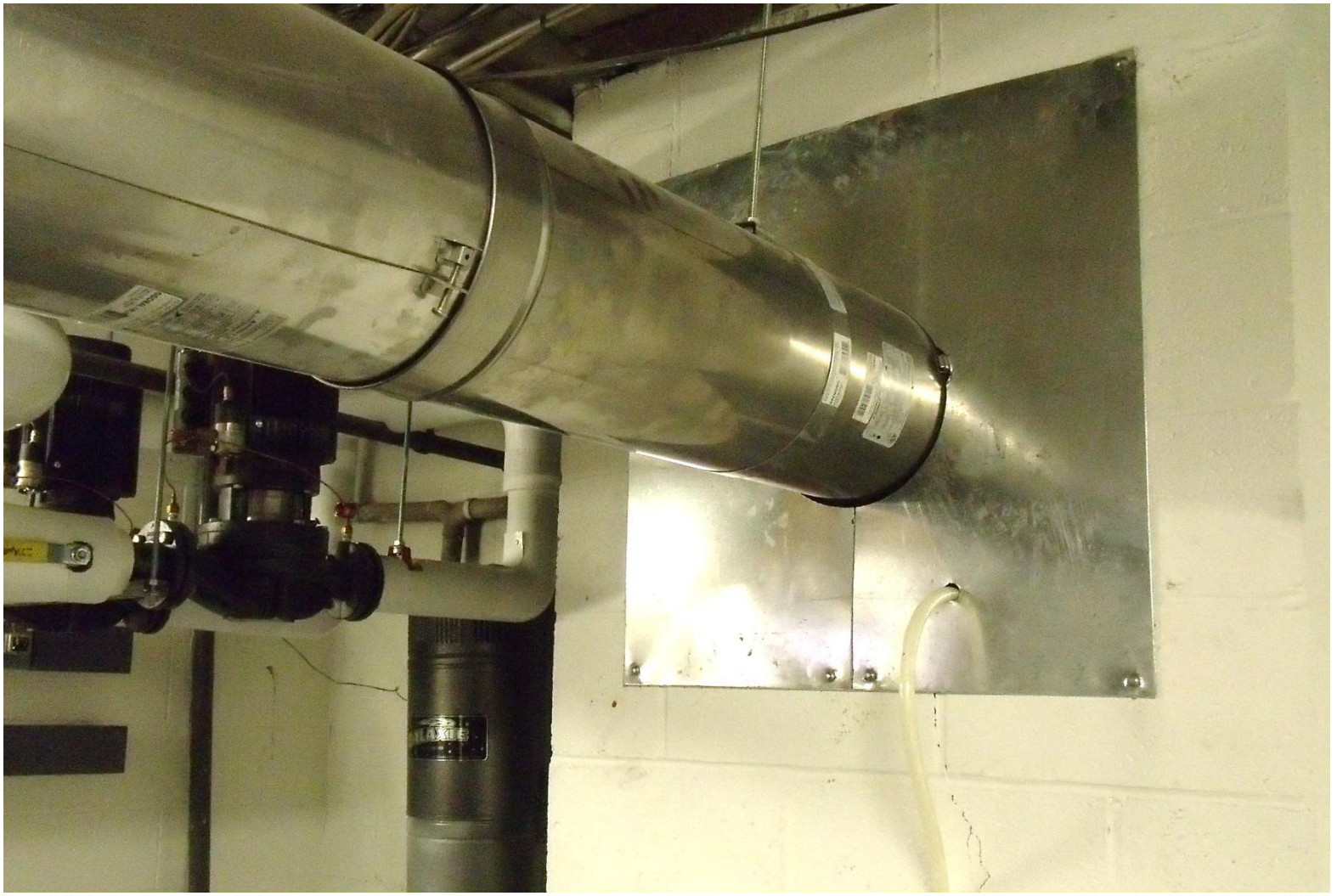
insulated storage/buffer tank

Air separators are still needed.

Large outside air openings for condensing boilers rooms are no longer needed.

Blocked off outside air louvers with dedicated outside air duct to boilers.

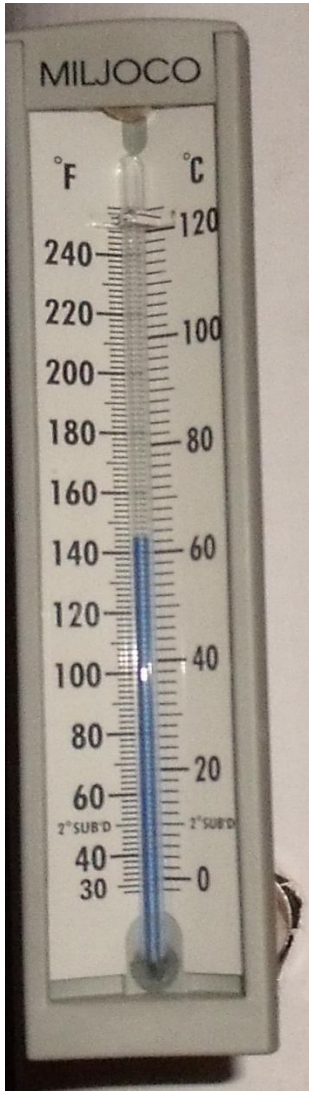
Stainless exhaust ducted through the old chimney, all the way to outdoors.



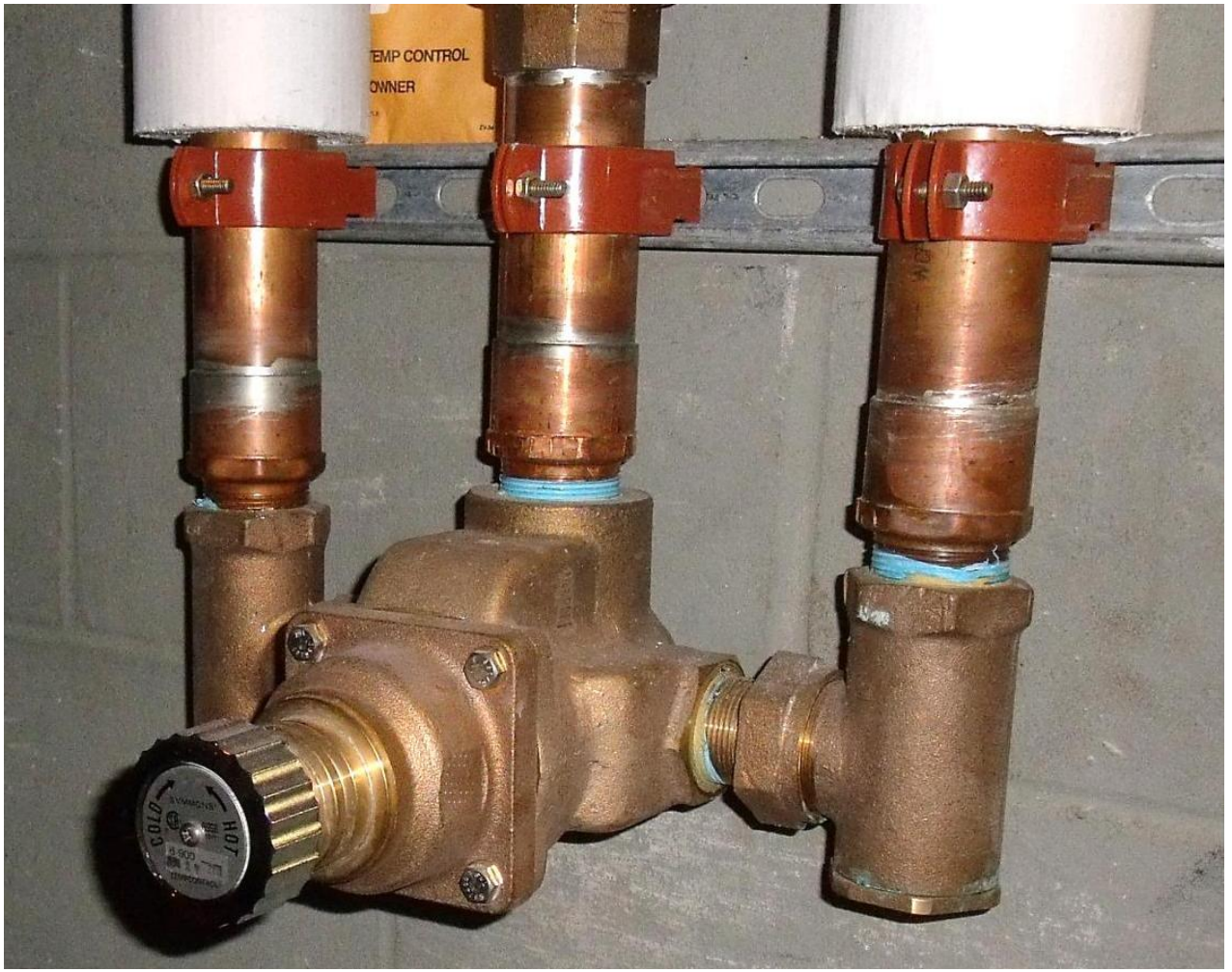
Buildings may still have zone valves.

Recent Upgrade, Not Condensing

Recent upgrade, not condensing, with boiler temperature reset control.



Hot Water Mixing Valve
(needs service every 6 months)



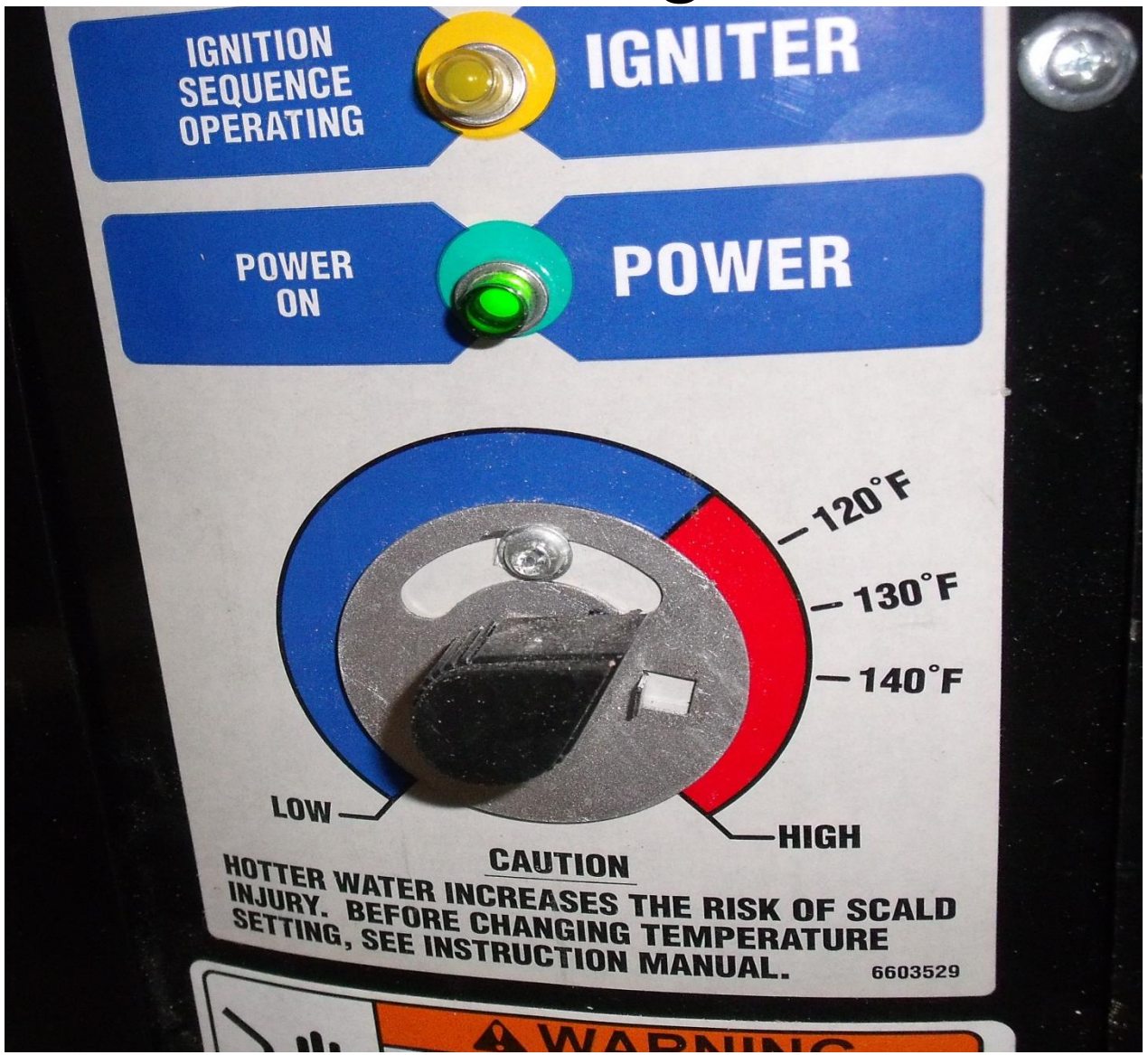
Distributed Heating & Cooling Systems

In this project each unit has:

- **Small self-contained condensing boiler & domestic water unit with expansion tank & mixing valve**
- **Acid neutralizer**
- **Condensate drain**
- **Split AC unit mounted in the outer wall**

Polaris Unit Condensing Boiler

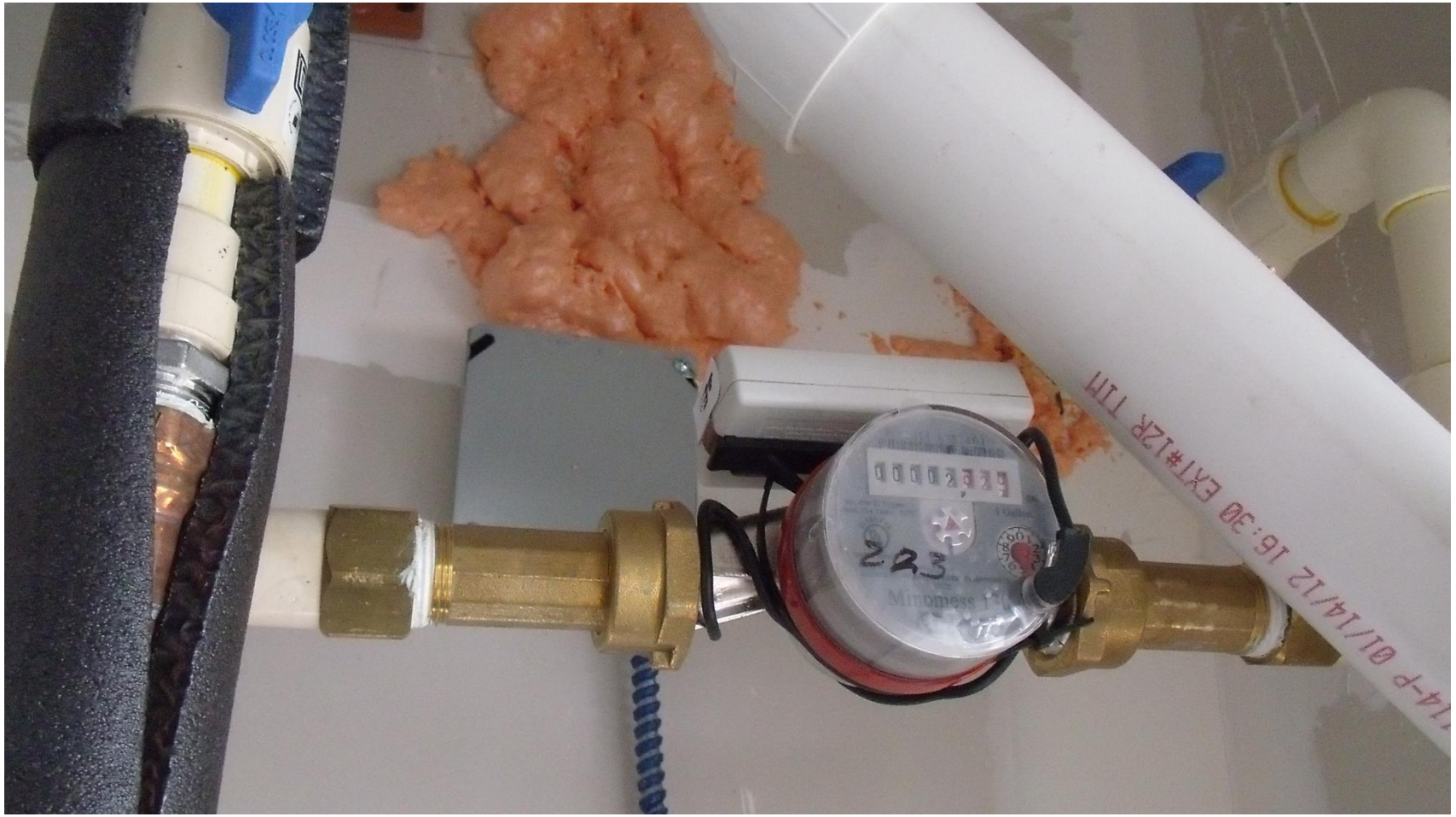
Set at 120 or higher minimum setting for occupant comfort, maximum of 140.



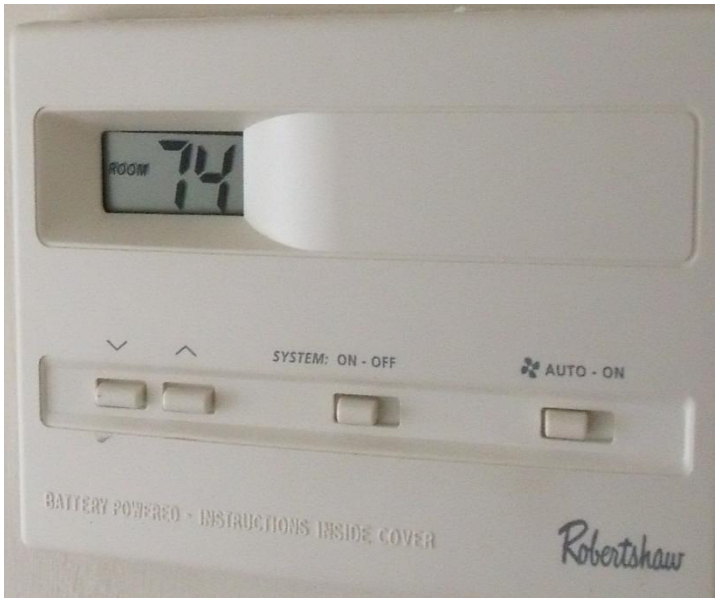
Inside 4 Pipe Unit:

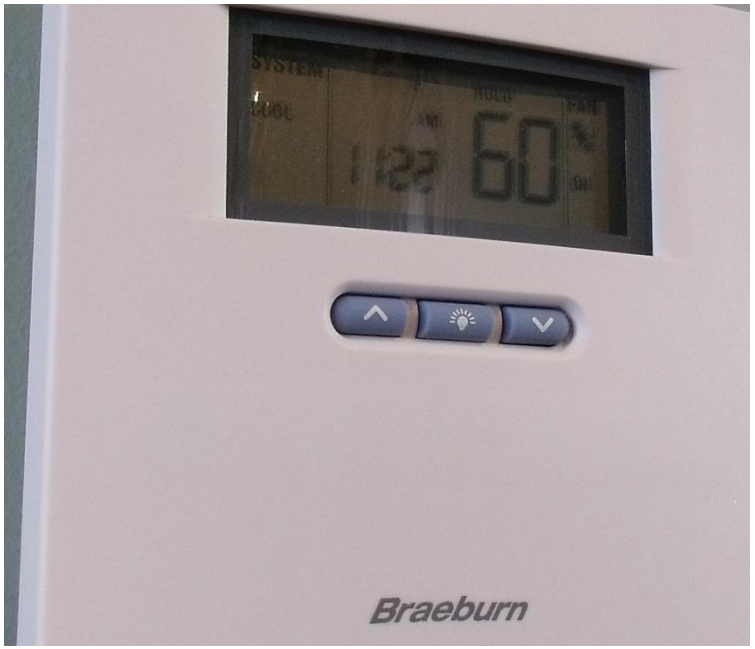
- Heating Coil
- Hot water pump
- Blower
- Controls
- DX coil
- Air filter
- Drain pan
- Overflow indicator
- Condensate pump?

Individual Water Metering



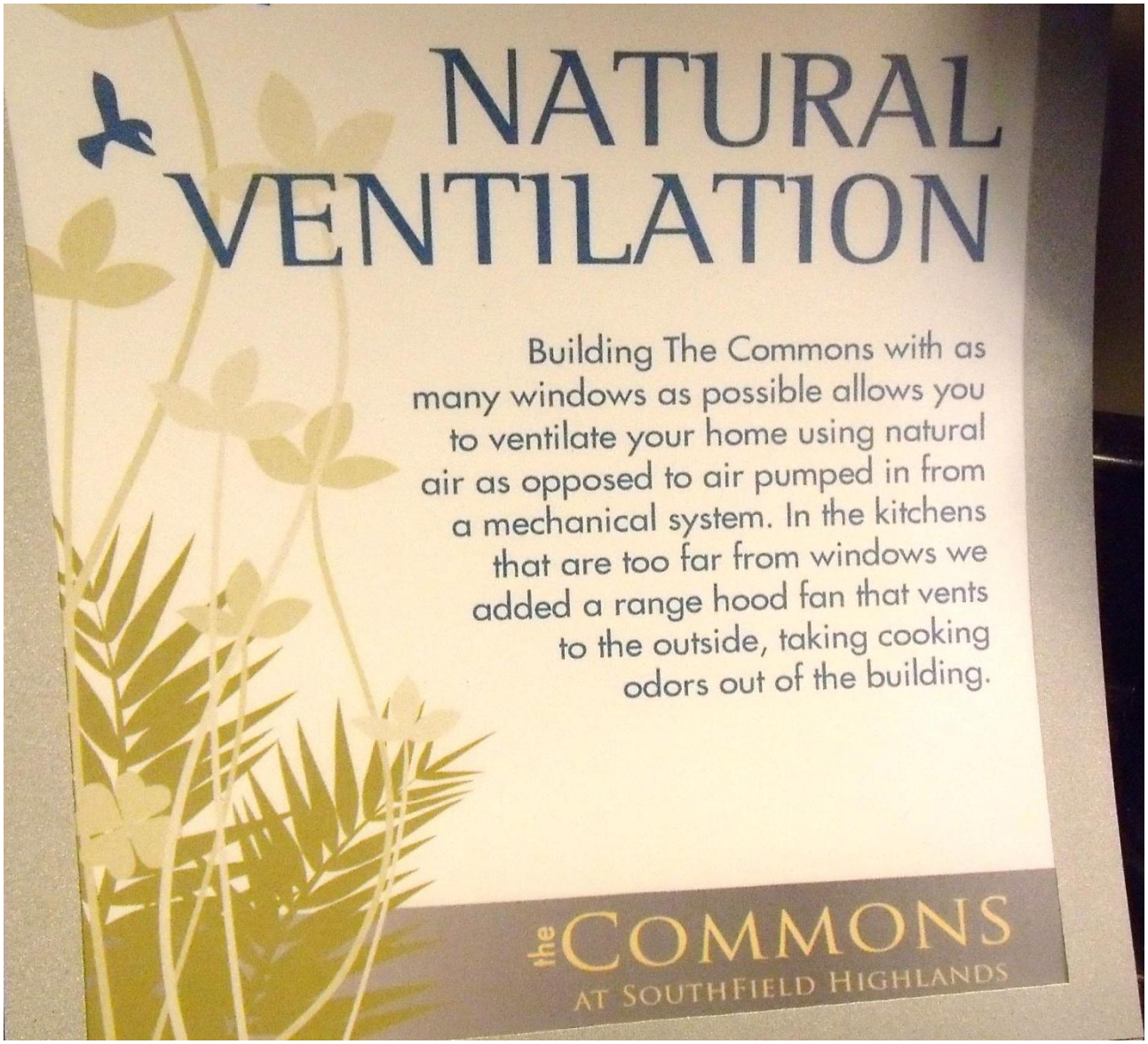
Occupant Controlled





Maintenance Will Be Important

Operable Windows



Occupancy Controlled Fan

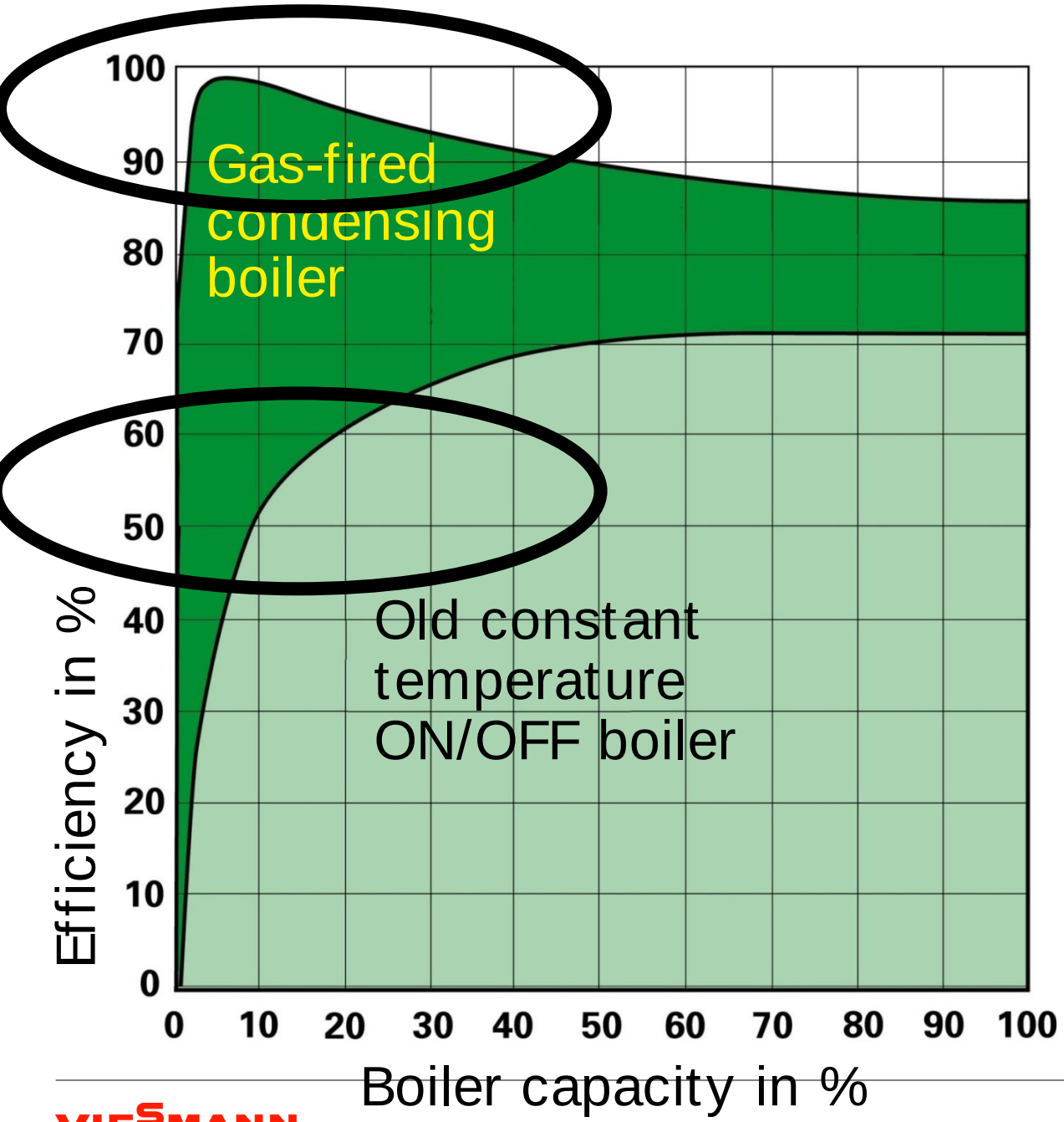
So why switch to far more complicated condensing boilers & furnaces?

EFFICIENCY INCREASES DUE TO FLUE GAS CONDENSATION

Combines the following:

1. Latent heat gain from condensate
2. Lower flue gas loss
3. Much lower radiant standby losses

Courtesy Viessman



TYPICAL BOILER EFFICIENCIES

96 %

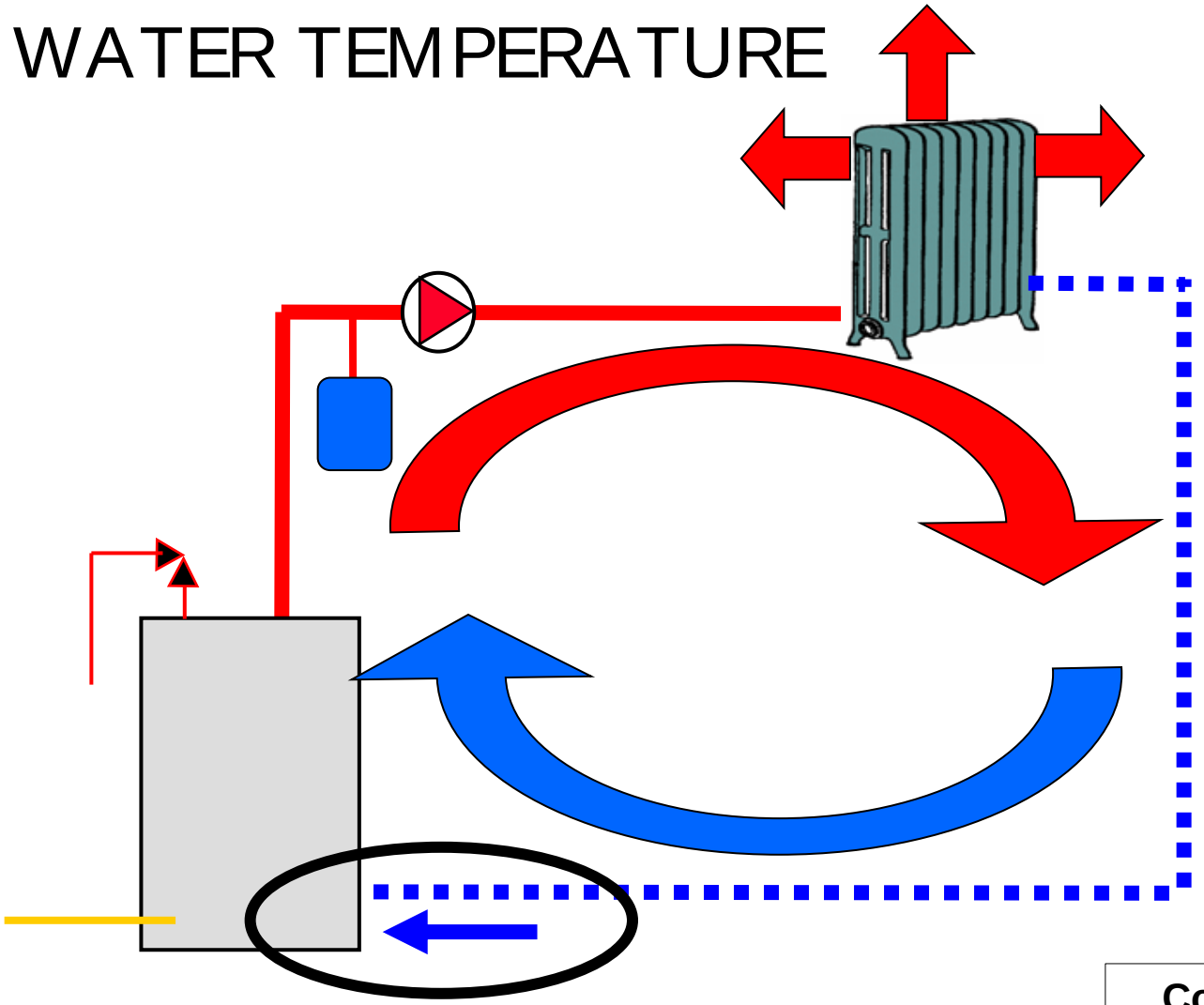
vs.

56%

Courtesy Viessman

When do condensing boilers actually condense?

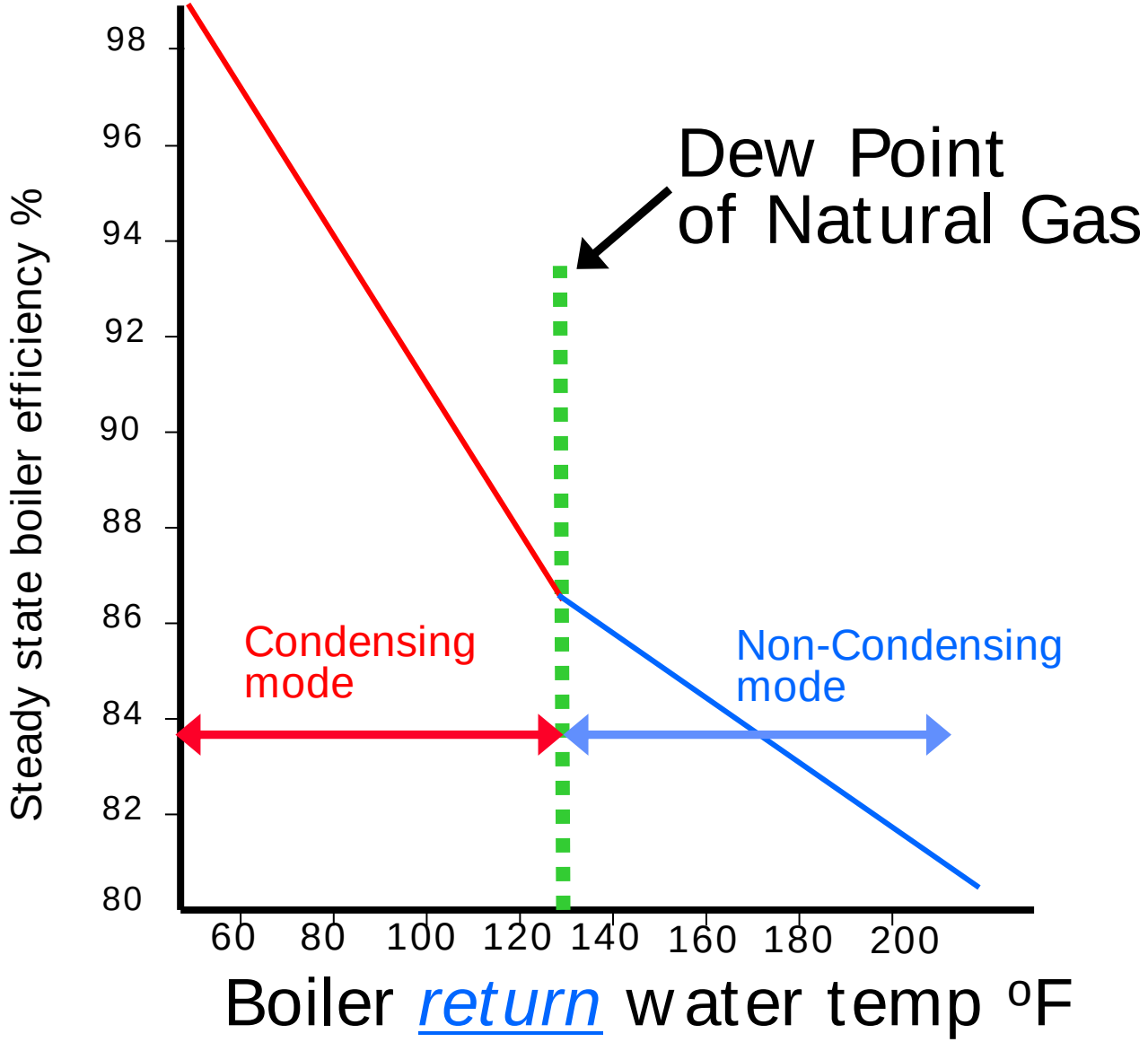
RETURN WATER TEMPERATURE



Boiler *return* water temperature determines condensing operation

Courtesy Viessman

SIMPLIFIED CONDENSING BOILER OPERATION

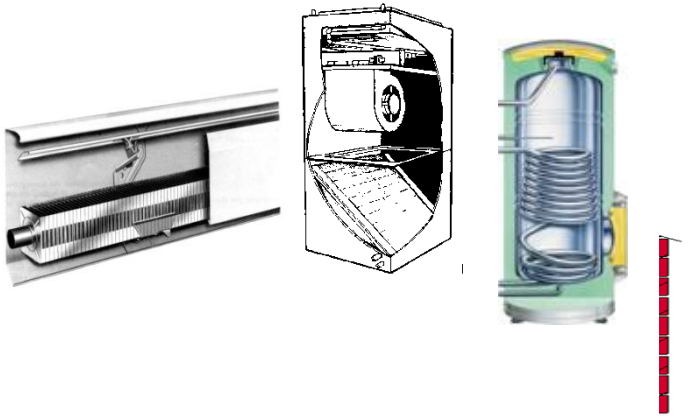


Courtesy Viessman

TYPICAL WATER TEMPERATURE REQUIREMENTS:

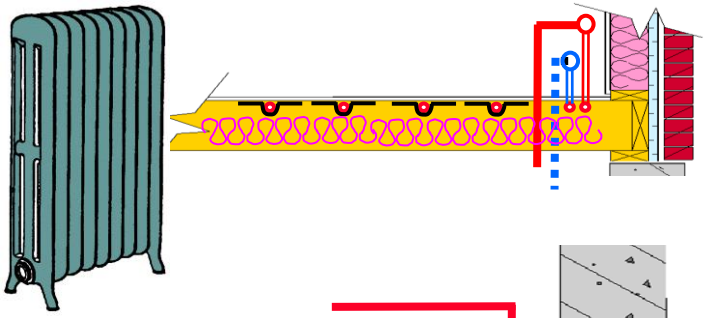
High temperature:

- Finned tube baseboard 140 - 190 °F
- Air heat fancoils 140 - 180 °F
- Pool/spa heat exchangers 160 - 180 °F
- DHW production 150 - 190 °F



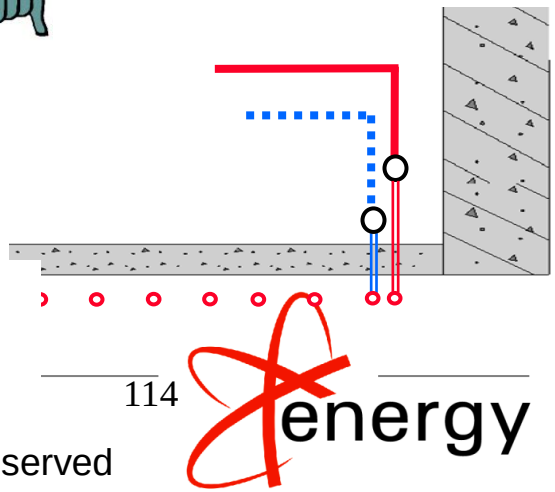
Medium temperature:

- Cast iron radiators 100 - 140 °F
- Low mass radiant floor
  ie: wood joist floors 100 -150 °F



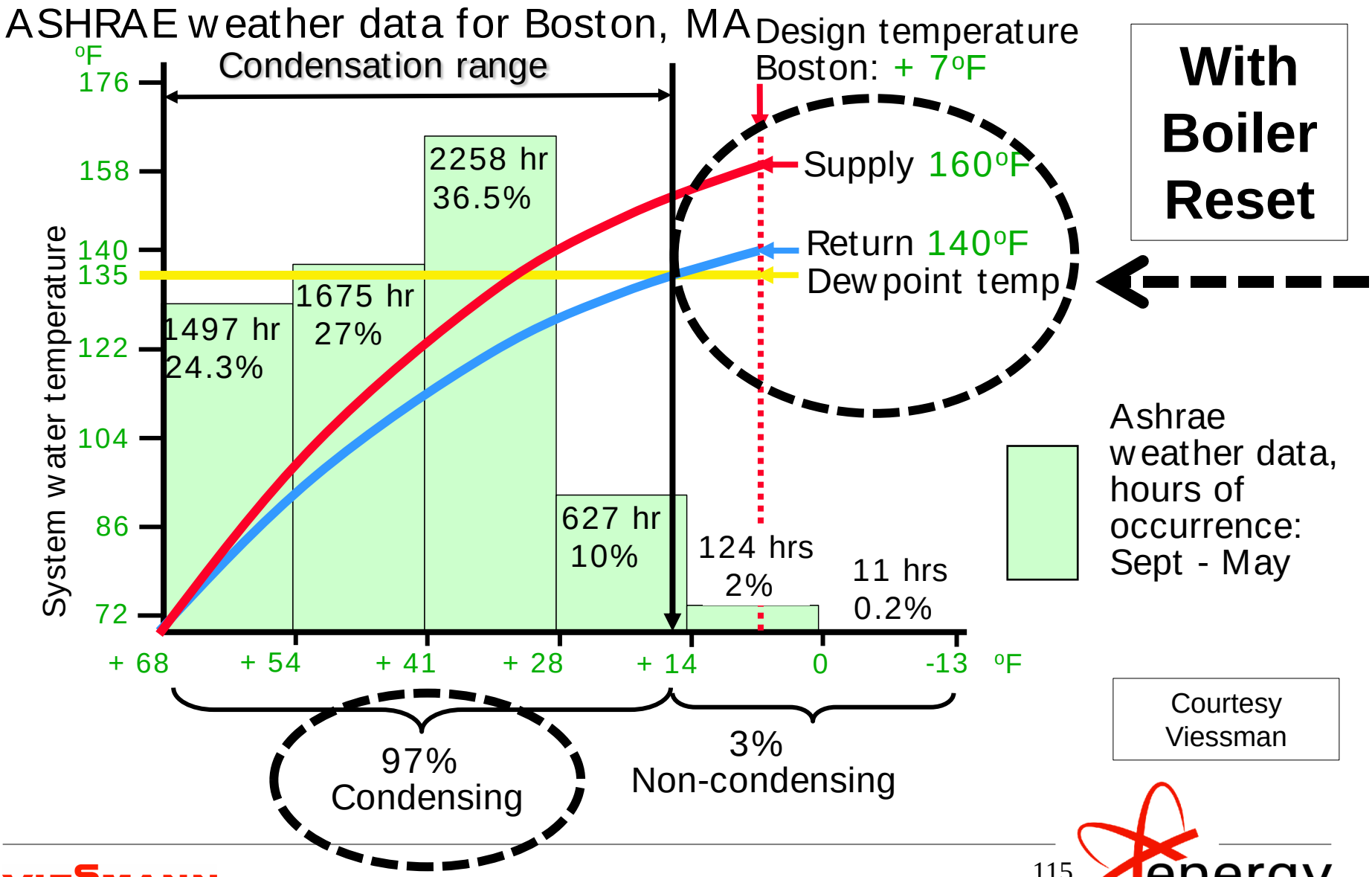
Low temperature:

- High mass radiant floor
  ie: concrete floors 80 - 120 °F
- Snowmelting systems 80 - 120 °F



Courtesy Viessman

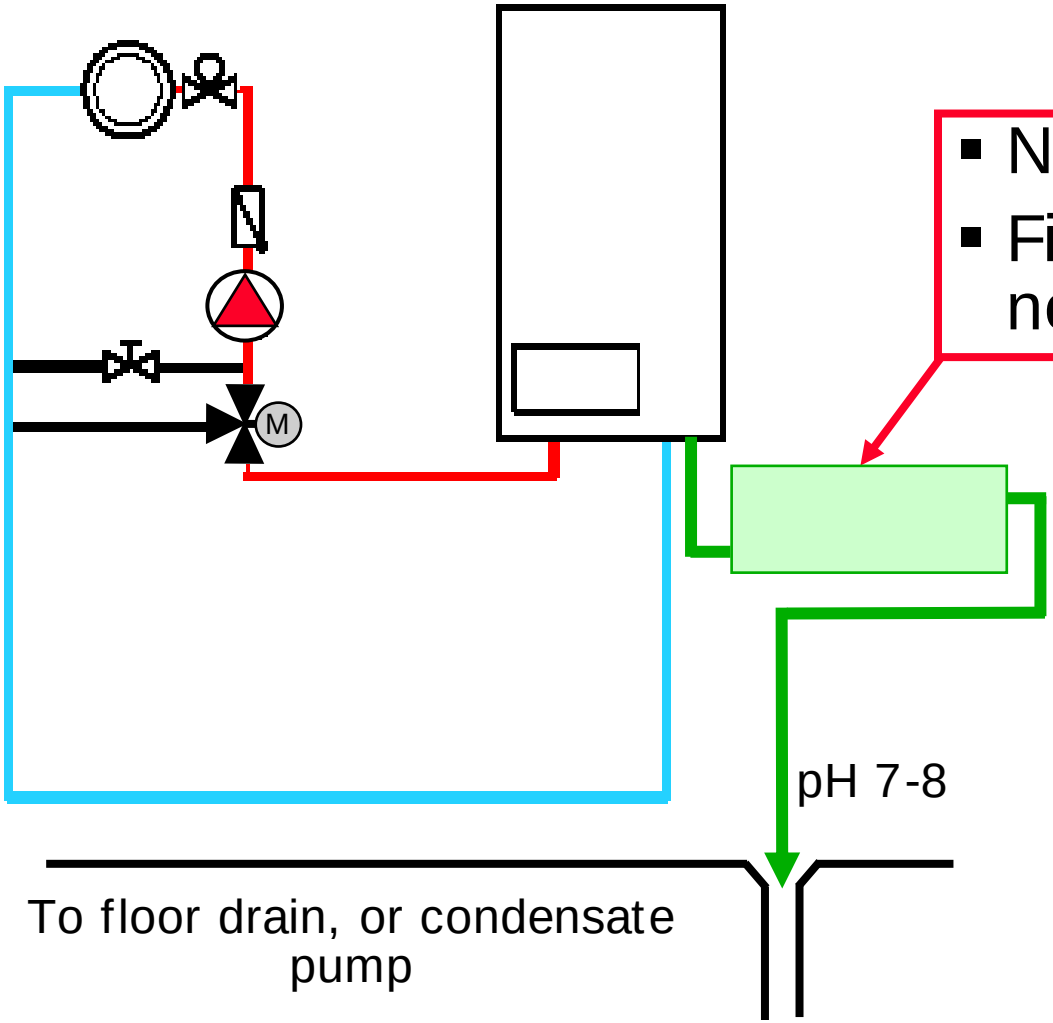
CONDENSING / NON CONDENSING RATIO



Construction requirements of condensing boiler technology

Courtesy Viessman

CONDENSATE NEUTRALIZATION



- Neutralization unit
- Filled with granular neutralizing material

Courtesy Viessman

Summary:
Condensing Hot Water Boilers

- Work best with Return Water of 140 F Max.
- Desirable to have Low Temperature Heat Distribution Components or oversize coils, radiators, or radiant floor
- Must be control by water temperature (boiler reset)
- Produce Nitric and or Sulfuric Acid liquids in combustion condensate
- Lowers Carbon Footprint

Hot Air Heating Range 90?-140? F

Furnace Types

- Fuels: Natural Gas or LP gas

- Annual Fuel Utilization Efficiency-AFUE
- Standing pilot efficiency Limits AFUE eff. To 70%

- **Newer furnaces standard AFUE 80%**

- **High efficiency** 92% or higher?

Distributed Common Area Systems: multiple condensing furnaces

Furnace Maintenance

- Air filters (Minimum MERV 8, pleated)
- Burner Inspections & Adjustments
- V-belts (Belt Tension)
- Clean furnace cabinet
- Inspect Heat Exchanger

Reminder:

Other Boiler Room Operational Items

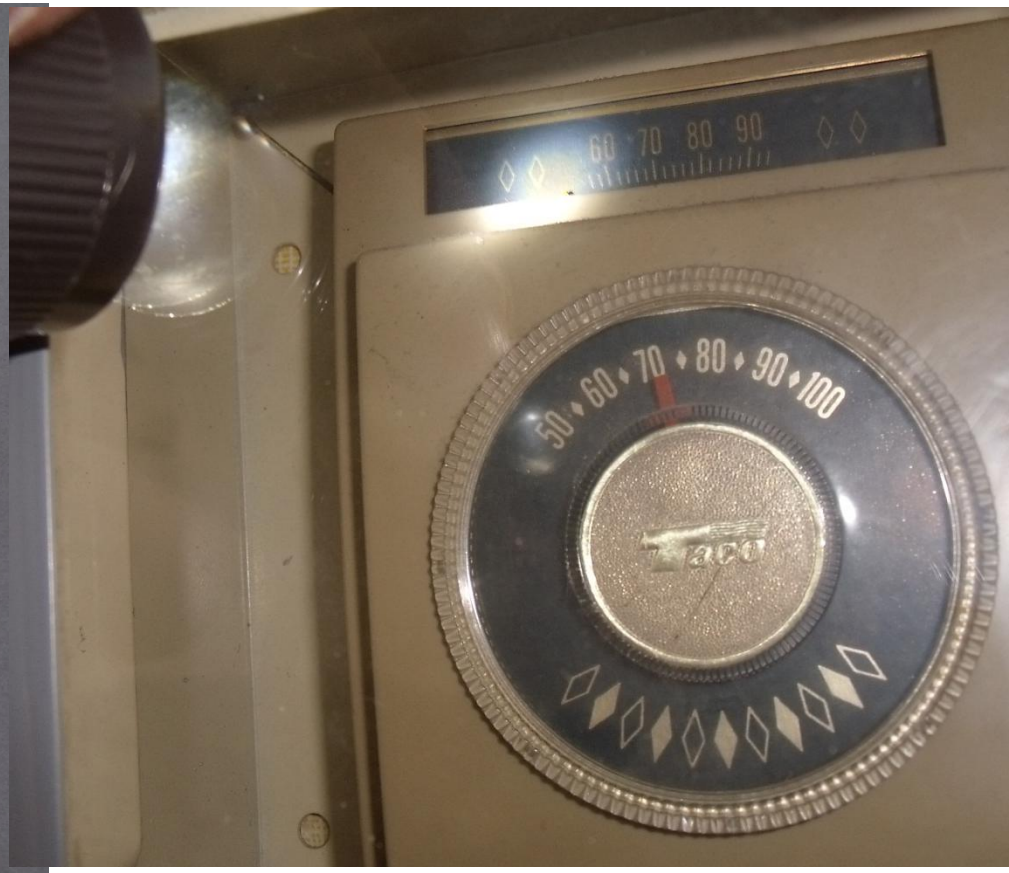
Safety Equipment May Need Periodic Testing & Maintenance During Annual Inspections

Boiler rooms are not storage areas .

Boiler rooms are not storage areas .

Know if you have asbestos.

Common Areas: Controls



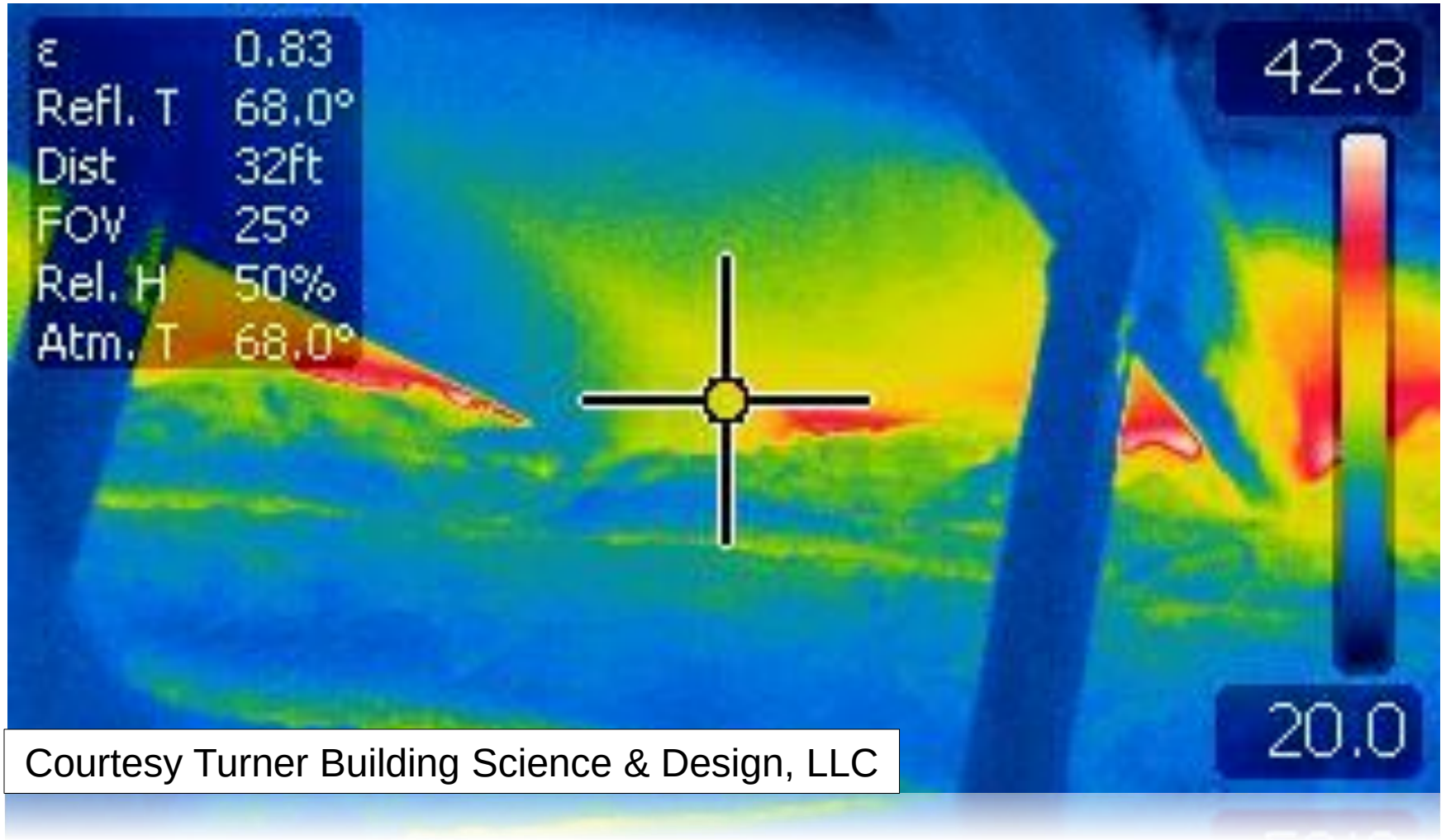
Other Common Area Contols

Season Covers Needed In Winter

Air Sealing & Insulation

Attic Insulation

Infrared Image of Air Leakage into Attic



Courtesy Turner Building Science & Design, LLC

Window Air Leakage

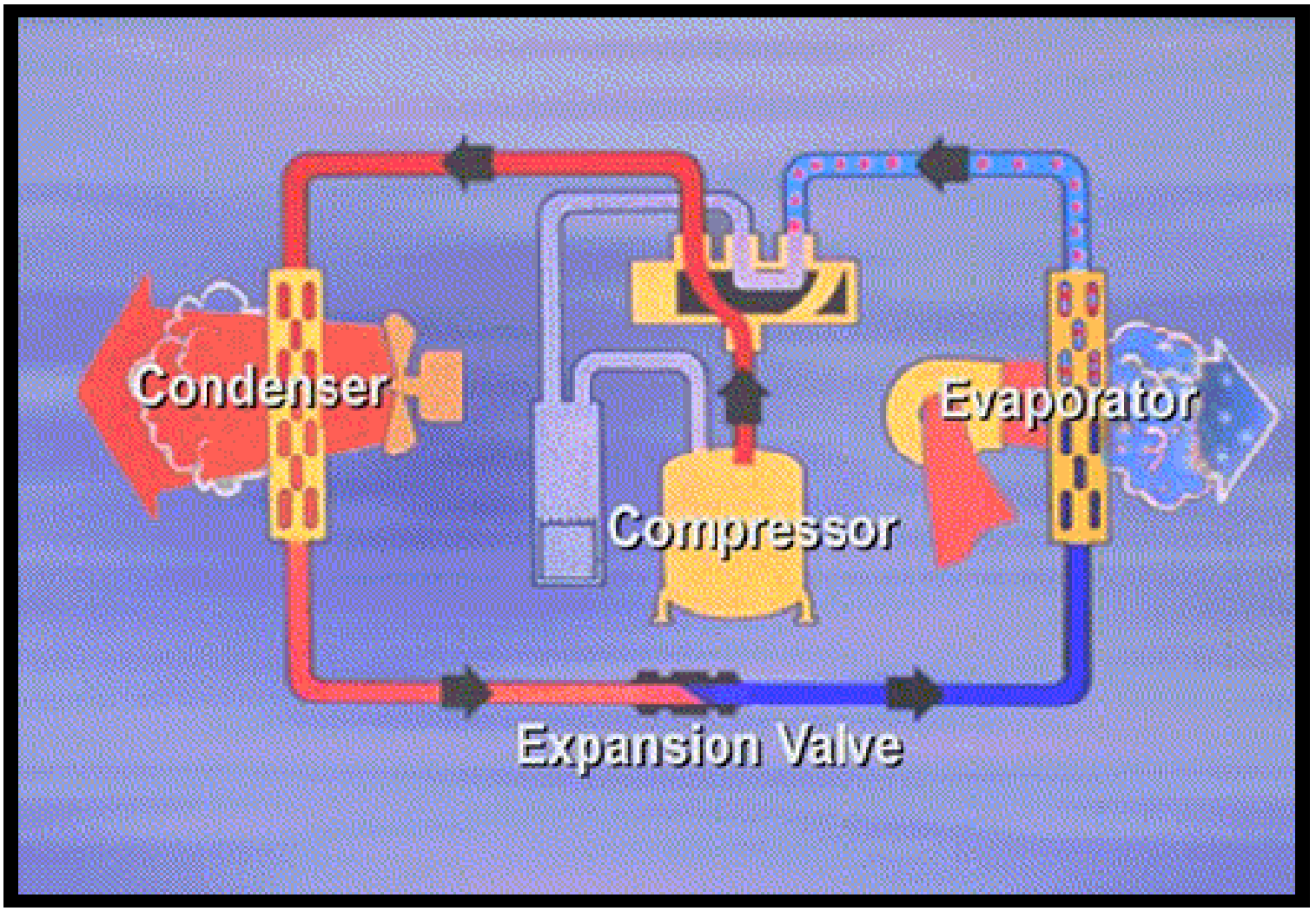
AC

High Efficiency Cooling & Drying

High Efficiency Cooling & Dehumidification

Summer Air = Condensation? = Mold, the cold earth makes concrete act like a big chilled plate

AC: Refrigerant Cycle illustration



Air Cooled Equipment Types

Machine Efficiency Variables

- **Compressor Design:** The lower the friction in the compressor, the higher the efficiency

- **Running The Machine as Designed:** Within the optimal temperature range for optimal efficiency.

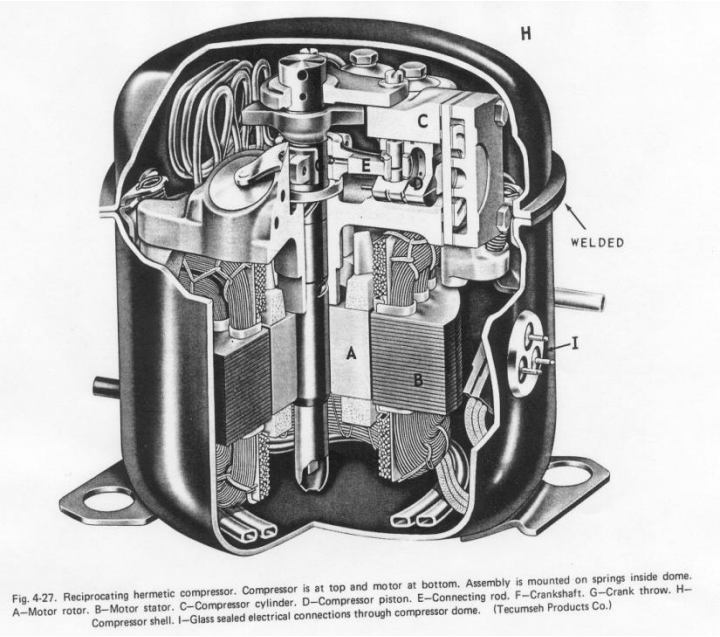


Fig. 4-27. Reciprocating hermetic compressor. Compressor is at top and motor at bottom. Assembly is mounted on springs inside dome. A—Motor rotor. B—Motor stator. C—Compressor cylinder. D—Compressor piston. E—Connecting rod. F—Crankshaft. G—Crank throw. H—Compressor shell. I—Glass sealed electrical connections through compressor dome. (Tecumseh Products Co.)

Hermetic Reciprocating Compressor

Photo courtesy of Modern Refrigeration and Air Conditioning, 1979

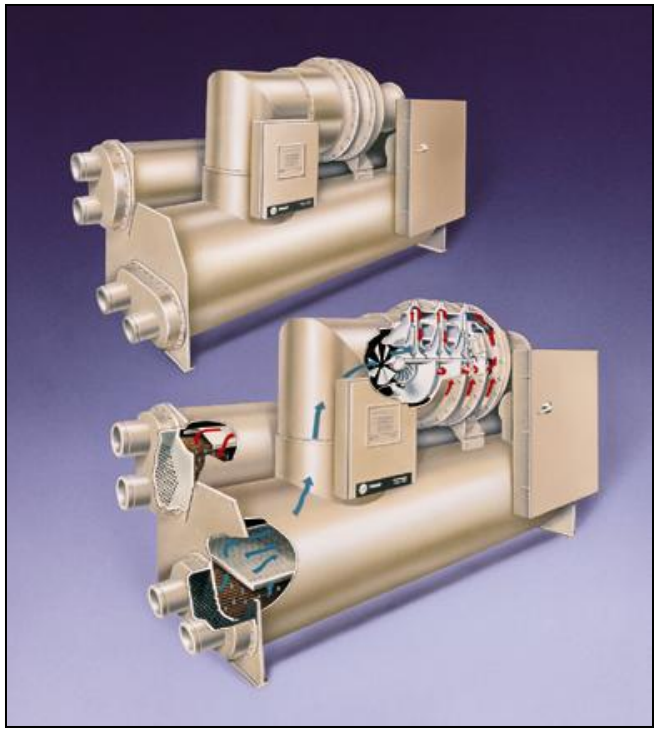
Cooling EER = 25+?

Frictionless Compressors = Ultra High Efficiency Chillers, Unloadable to 5-20% With Full Efficiency

www.turbocor.com

Chilled Water Systems

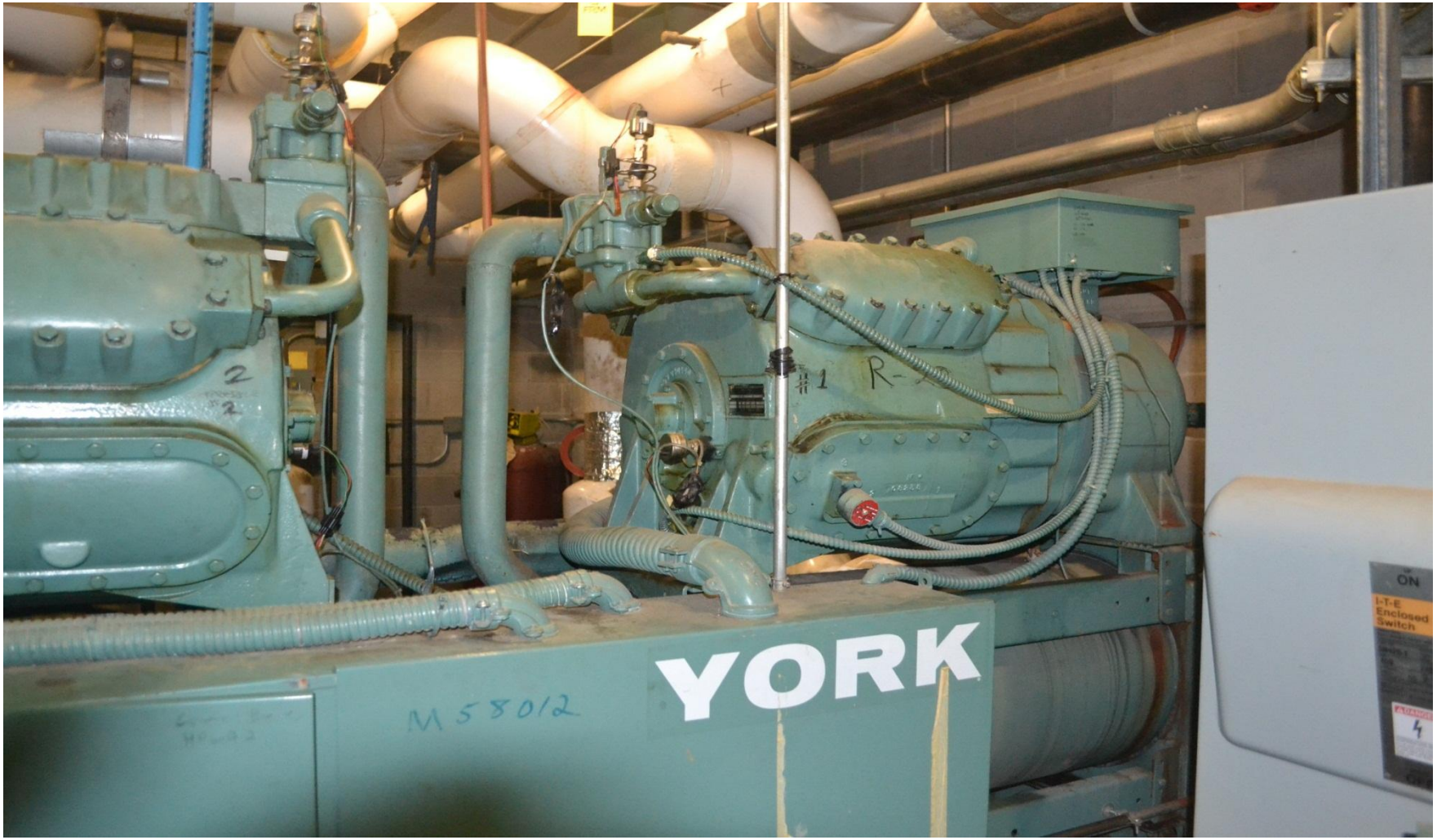
- Compressors
- Evaporator
- Temperature controls
- Chilled Water Distribution
- Terminal devices



Small Mini-Split Ductless Systems

- Uses electricity via a heat pump to move “heat” in or out of a building.
- No Ducts
- No Outside Air
- Very Efficient

All Chillers should be under contract for maintenance.



Building Cooling Optimizing:

- **Light Colored Roof**
- **Solar Shading Glass, Film or Blinds**
- **Maximize Internal Equipment Efficiency**
  - Lights, motors, power supplies, copies, printers, process heat exhaust
- **Tight Shell To Reduce Moisture Load**
- **VAV/Critical Zoning During Peak Loads**
- **Latent Energy Recovery of Exhaust Air**

Summary

Successfully implemented sustainability measures reduce demands on the planet's resources, provide for long term cost control, and often improve tenant comfort.

Thank you

Quiz & Evaluation

Thank you again

Questions?

Contact: John Corcoran