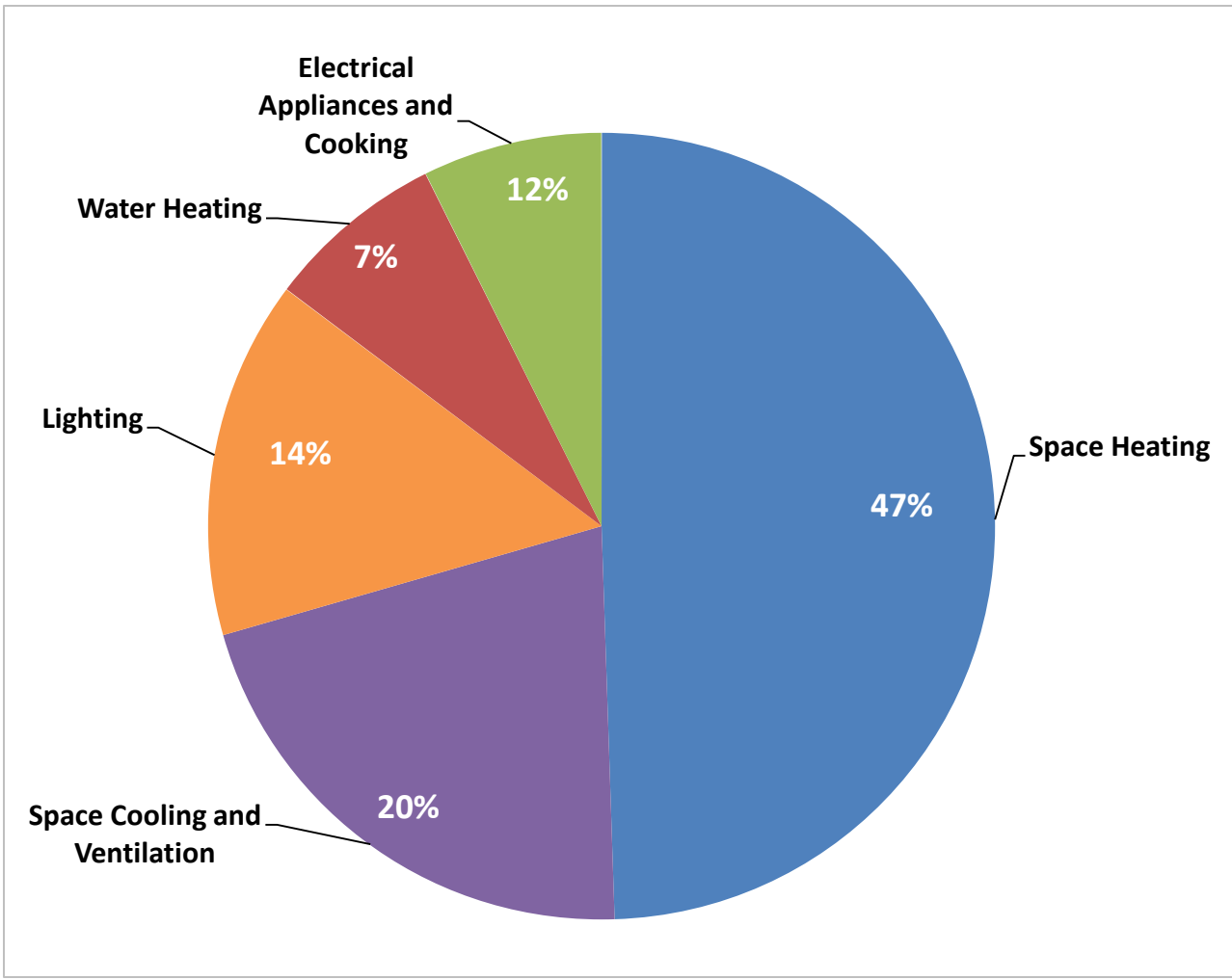


# School Building Energy Efficiency Education



# Overall Energy Use in Education Buildings



**Total - 2003:**  
240 billion kWh

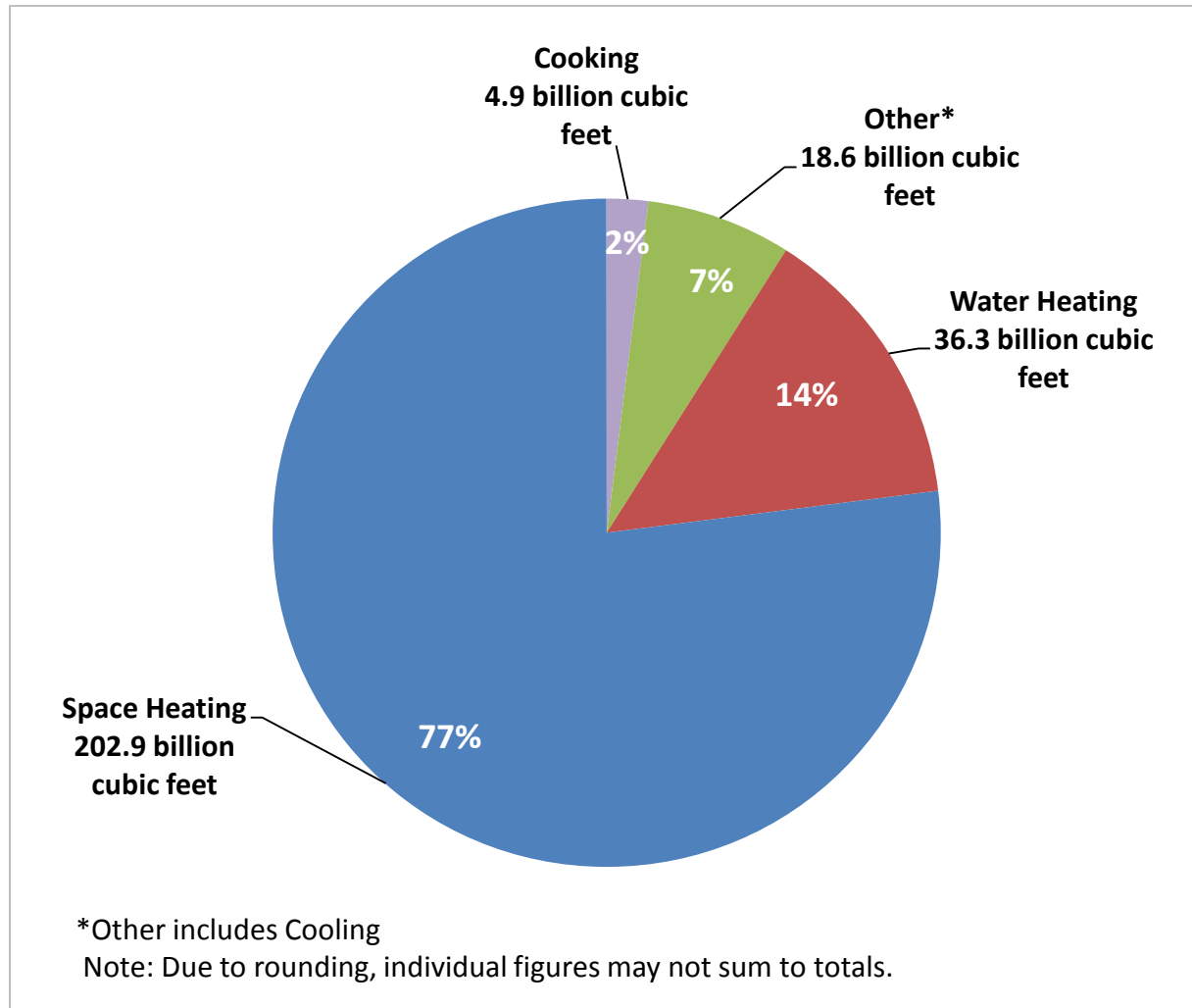
**1995:**  
180 billion kWh

**Source:**  
U.S. Energy Information  
Administration,  
2003 Commercial  
Buildings Energy  
Consumption Survey

2012 CBECS data release:  
November 2015



# Natural Gas Use In Education Buildings



**Total - 2003:**  
263 billion cubic feet

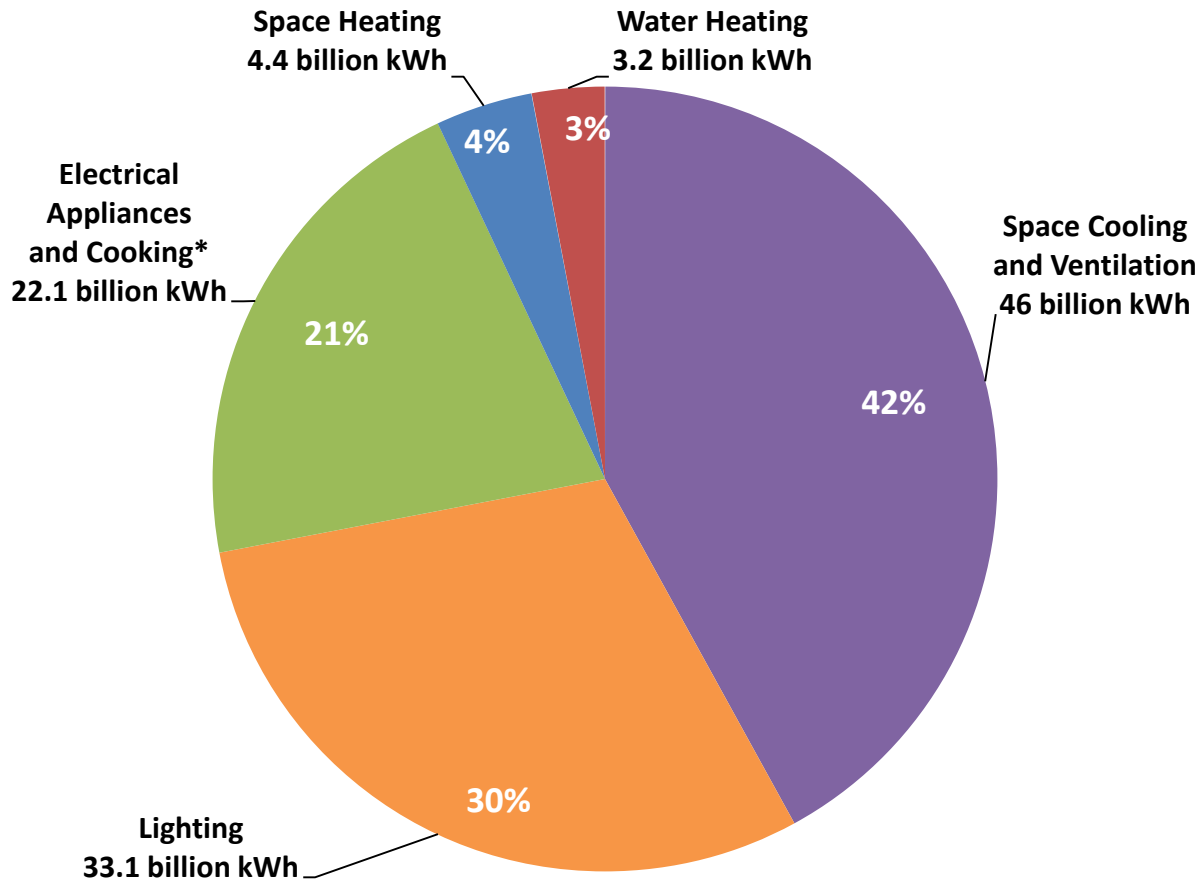
**1995:**  
239 billion cubic feet

**Source:**  
U.S. Energy Information  
Administration,  
2003 Commercial  
Buildings Energy  
Consumption Survey

2012 CBECS data release:  
November 2015



# Electricity Use in Education Buildings



\*Electrical Appliances and Cooking includes Computers (9.4 billion kWh), Miscellaneous uses (6.2 billion kWh), Refrigeration (4.7 billion kWh), Office equipment (1.2 billion kWh), and Cooking (0.6 billion kWh). Note: Due to rounding, individual figures may not sum to totals.

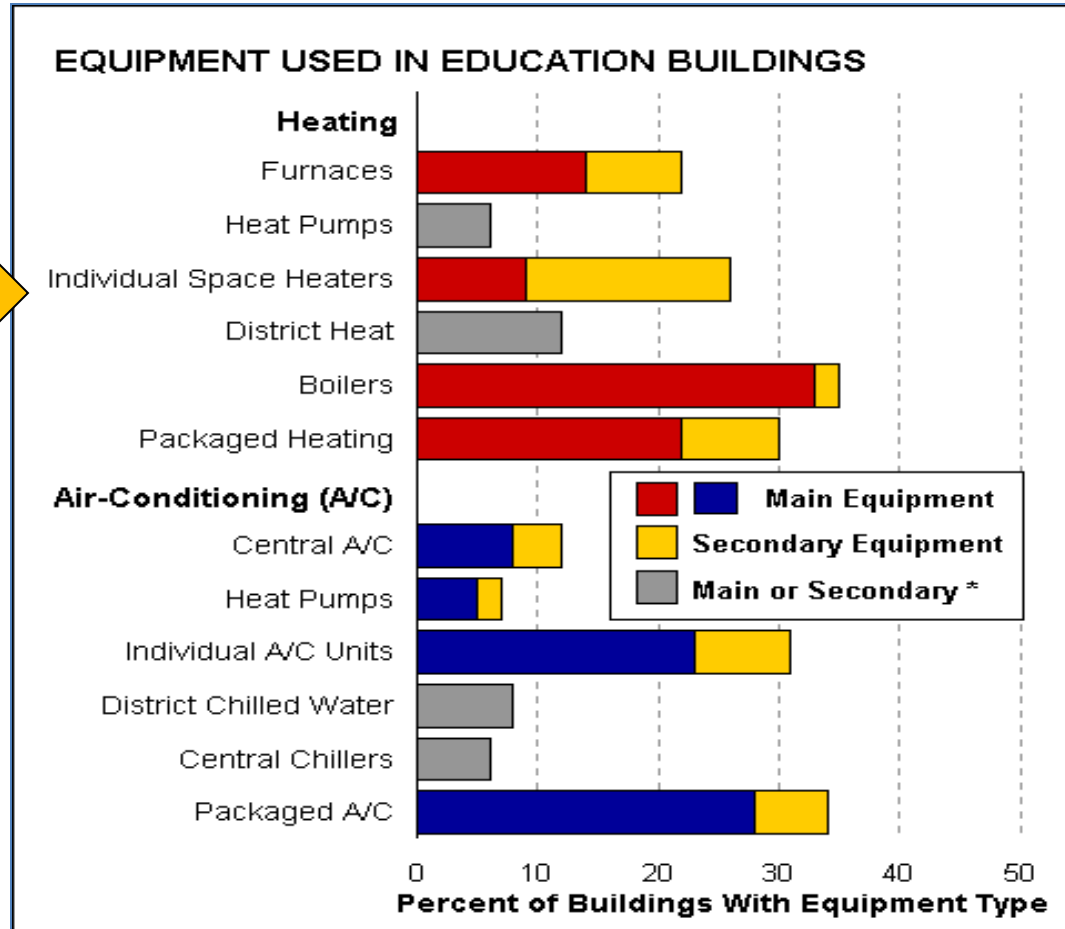
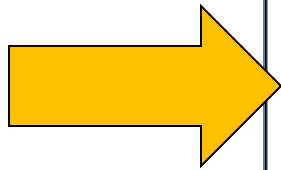
**Total - 2003:**  
109 billion kWh

**1995:**  
65 billion kWh

**Source:**  
U.S. Energy Information  
Administration,  
2003 Commercial  
Buildings Energy  
Consumption Survey

2012 CBECS data release:  
November 2015

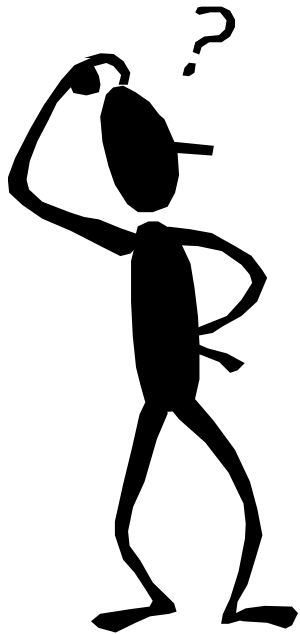
# Equipment Used in Education Buildings



**Source:**  
 Department of  
 Energy - 1995  
 Commercial  
 Buildings Energy  
 Consumption  
 Survey

# Energy-Saving Opportunities

*What to  
Look For*



- Lighting Opportunities
- Small Appliances/Plug Load
- HVAC Opportunities
- Preventative Maintenance

# What is a Foot Candle?

foot-can·dle (f t k n dl) *n.* *Abbr.* fc or ft-c

A unit of measure of the intensity of light falling on a surface, equal to one lumen per square foot and originally defined with reference to a standardized candle burning at one foot from a given surface.

# Recommended Light Levels for Schools

Area	Task	Foot Candle Range
Classrooms	Reading printed material	30 - 75 fc
	Writing	50 - 70 fc
	Drafting/accounting/sewing	50 - 150 fc
Gymnasiums	Assemblies	10 fc
	General exercising	30 fc
	Games/matches	30 - 50 fc
Cafeteria	Dining	15 - 50 fc
	Cooking	50 -100 fc
Bathroom	Grooming	20 - 50 fc
	Lavatories	10 - 20 fc
Miscellaneous	Stairways	10 - 30 fc
	Hallways	10 - 20 fc





# Energy-Efficient Lamps

## Compact Fluorescent & Fluorescent Lamps



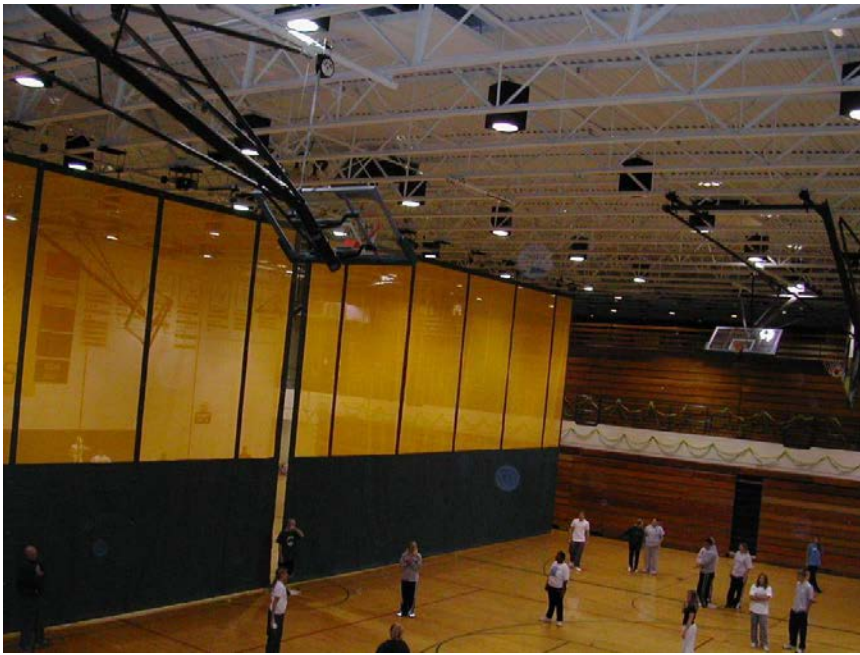
# Less Efficient Lamps

## Incandescent and Metal Halide Lamps



# 400MH to T8 Fluorescents

- 400watt Metal Halide to 6-Lamp F32 T8 (50% watt reduction)
- Increased light level from 30 to 50 fc, one for one replacement
- From 450 watts to 224 watts; changed from delayed start to instant on
- CRI from 65 to 85, increasing color rendering dramatically



# School Gym – HID to HIF

**Existing System:** 64 fixtures = **29,858 W**

54 400-W HPS – 465W each; six 400W MH – 458W each; four 500W Incandescent night lights

**New System:** 48-1x8 fixtures = **11,934 W** (60% reduction)

42 4-Lamp T5HO wire grille at 234W; 6 6-Lamp T5HO wire grille at 351W over ball court



# Occupancy Sensors

- Controls lighting use in classrooms, offices, halls, storage rooms, and restrooms
- Measures movement of people within a space
- Sensor Costs:
  - About \$30 to replace a light switch
  - Up to \$200 for ceiling/mounted units
- Payback period: 3-6 years



# Vending Miser System



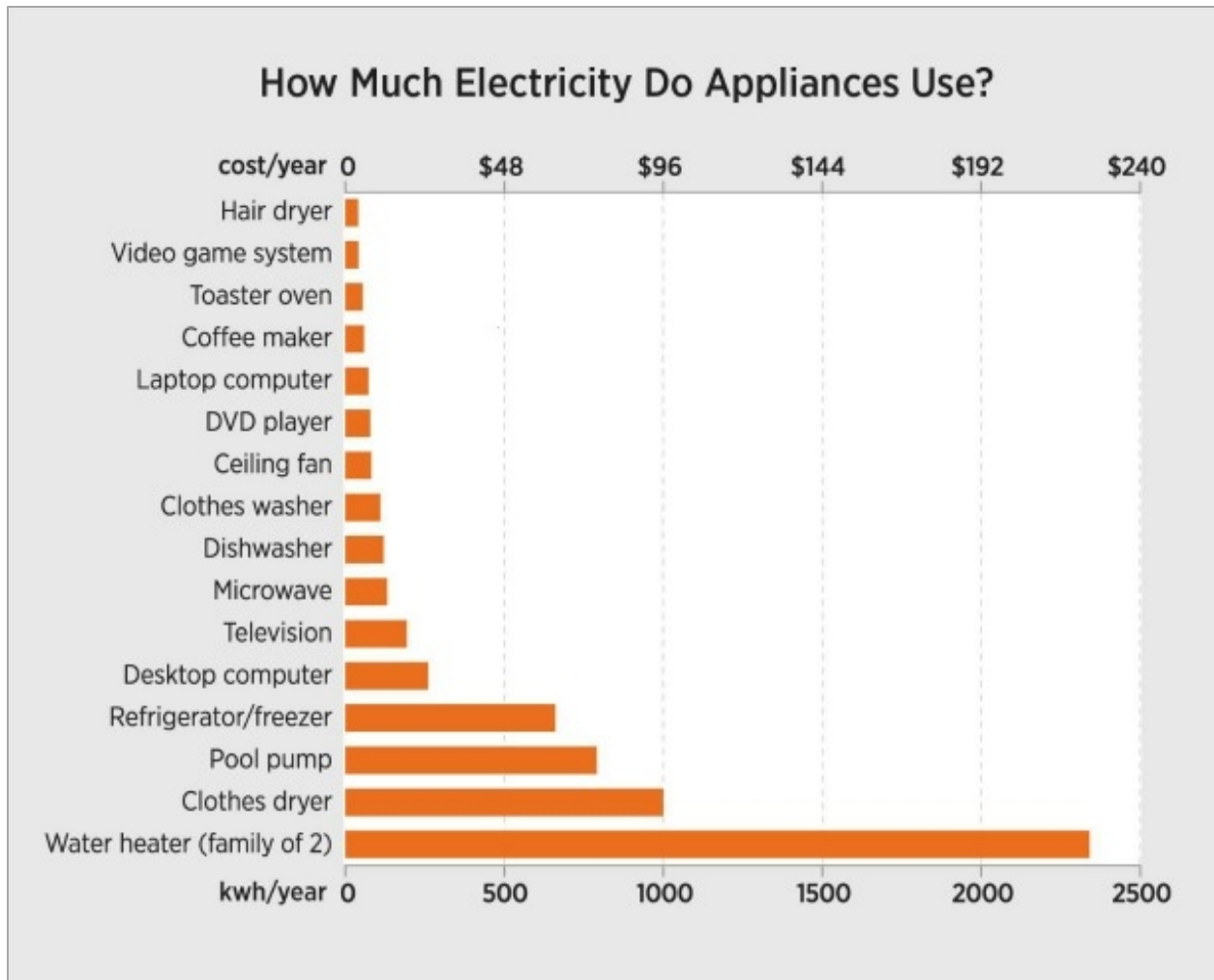
- Vending machines use about \$380 of electricity annually
- Vending Misers can cut energy consumption in half
- Cost is about \$165; payback is less than 2 years
- Tested by Coca-Cola and Pepsi: The system had no adverse impacts on product quality or the vending machine.

# Small Appliances / Plug Load

Appliance	Time in use	Kilowatt/hours used per year	Cost per Year
Aquarium	24 hours/day	700	\$70.00
Clock	24 hours/day	36	\$3.60
Clock radio	24 hours/day	44	\$40
Coffee maker	30 minute/day	128	\$12.80
Computer	4 hours/day	520	\$52.00
Dehumidifier	12 hours/day	700	\$70.00
Box Fan	4 hrs/day, 180 days/yr	144	\$14.40
Heater (portable)	3 hours/day, 120 days/yr	540	\$54.00
Microwave over	2 hours/week	89	\$8.90
Radio (stereo)	2 hours/day	73	\$7.30
Refrigerator (small, dorm size)	24 hours/day	340	\$34.00
Refrigerator (frost-free 16 cubic feet)	24 hours/day	642	\$64.20
Refrigerator (frost-free 18 cubic feet)	24 hours/day	683	\$68.30
Television (color)	3 hours/day	264	\$26.40
Toaster oven	1 hour/day	73	\$7.30
VCR	4 hours/day	30	\$3.00



# How Much Electricity Do Appliances Use?



This chart shows how much energy a typical appliance uses per year and its cost based on national averages.

For example, a refrigerator/freezer uses almost five times the electricity the average television uses.

**Source:**  
U.S. Department of Energy, 2014



# Energy Use of Computers

- Average computer uses 165 watts or .165 kilowatts/hr
  - On Peak Rate: 4.232¢/hr; Off Peak Rate: 2.942¢/hr
- Computers left on most school days and weekends
- 80% turned off during vacations

178 School Days =\$25

76 Vacation Days (20%  
of Fleet on) =\$2

52 Weekends (75%  
of Fleet On) =\$9

7 Holidays (20% of  
Fleet on) =20¢

1 computer costs \$36.20

2900 Computers Cost \$104,980



# Efficient Computer Operation

- 99% of fleet turned off from 8:30 pm to 7 am
- 90% of fleet turned off during vacation days
- 99% of fleet turned off during weekends and holidays
- Estimated annual savings = **\$55,303**

178 School Days =\$16

76 Vacation Days (10%  
of Fleet on) =\$1

52 Weekends (1%  
of Fleet On) =12¢

7 Holidays (1% of  
Fleet on) =1¢

1 computer costs  
\$17.13

**2900 Computers Cost \$49,677**

# HVAC Opportunities

(Heating, Ventilation, and Air Conditioning)

Boiler Type

Air Handling Units

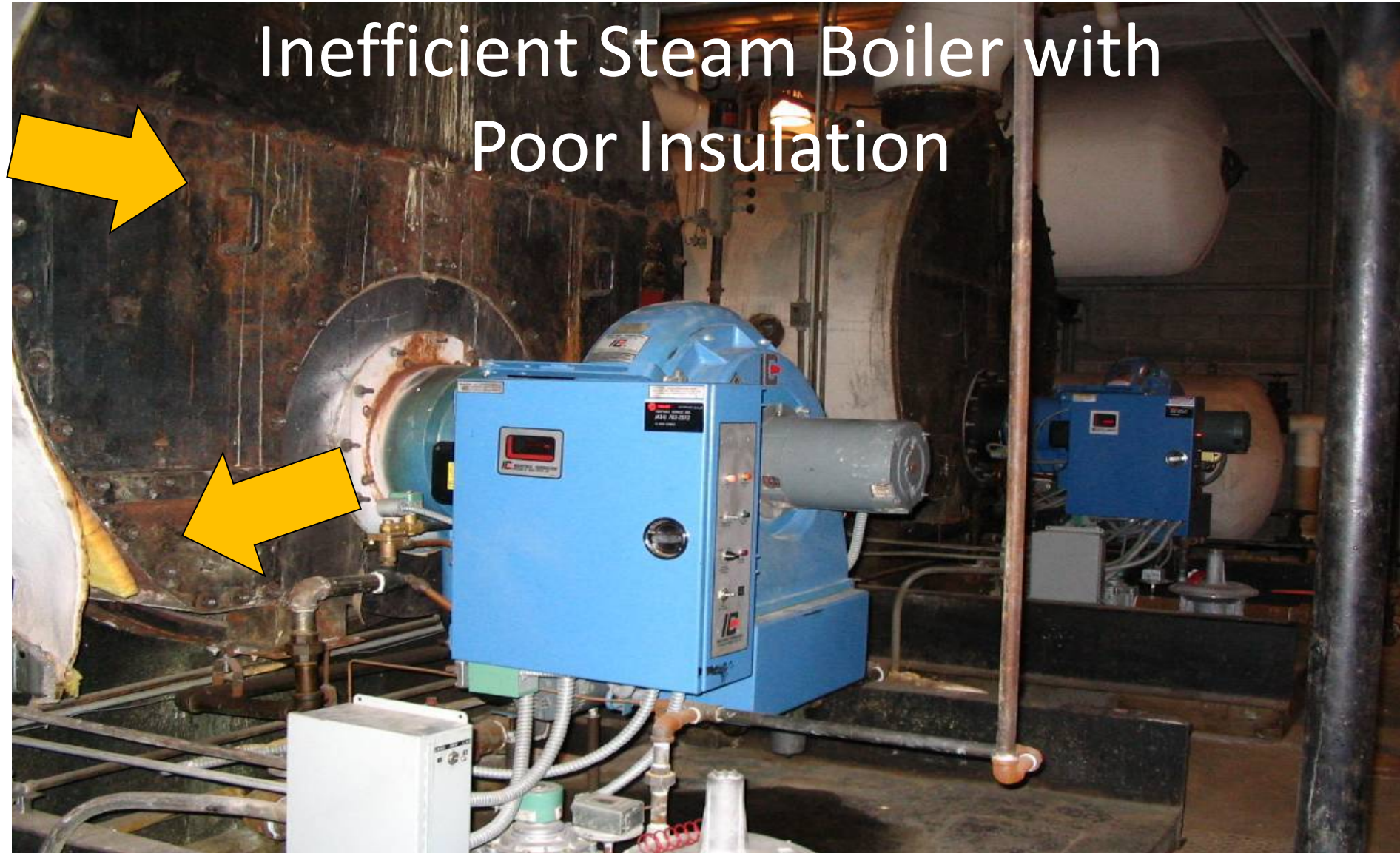


# Heat Generation

- Typically steam or hot water is moved throughout the building
- **Hot water boilers are more efficient than steam systems**
- Hot water systems offer greater control:
  - In hot water systems, water temperature is adjusted based on outdoor air temperature
  - In steam systems, heat output is constant whether outdoor air temperature is 40 degrees or 10 below zero



# Inefficient Steam Boiler with Poor Insulation

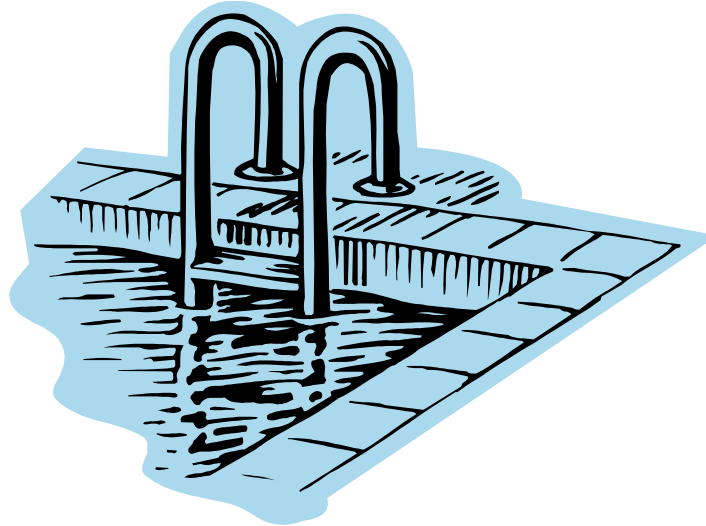


# Air Handling Units and Filters



# Swimming Pool Opportunities

- Pool Cover
- Water Supply



# Pool Covers

- Provides insulation and a barrier to reduce heat loss and evaporation, thereby saving energy and chemicals
- Rarely used in school buildings even when available (time, staff, bulky, etc.)





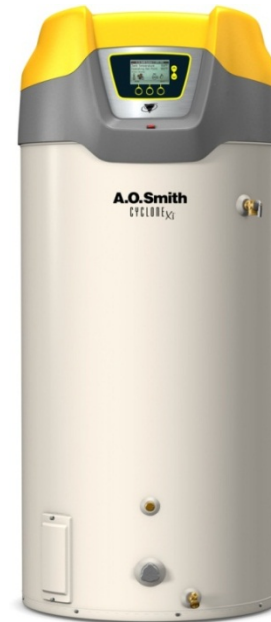
# Pool Water Supply



- Apply variable frequency drive (VFD) to pool filtration system
  - Reducing pump speed saves energy
  - An evaluation is recommended prior to installation
- “Throttle” pool circulation pump system
  - Partially closing a shutoff valve on the pump discharge side

# Domestic Hot Water

- Check temperature settings
- Large storage tanks are no longer needed



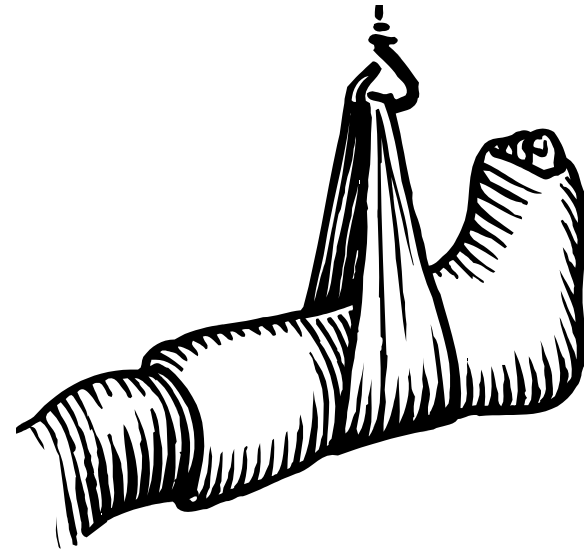
An example  
of a 96%  
efficient hot  
water heater

# Maintenance Opportunities

## Clean What's Dirty



## Fix What's Broken



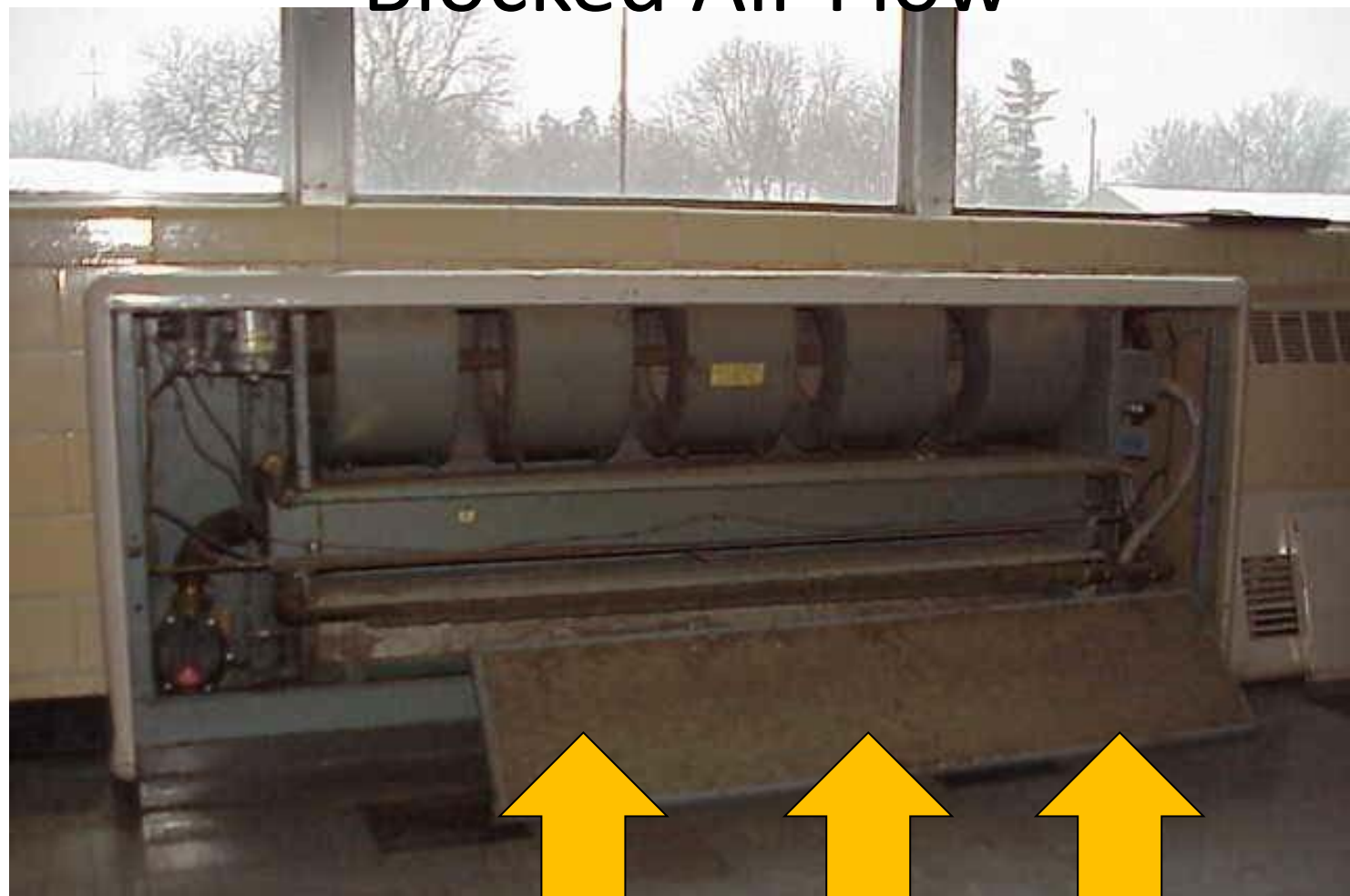
# Dirty Circulating Pump - Shortens Equipment Life



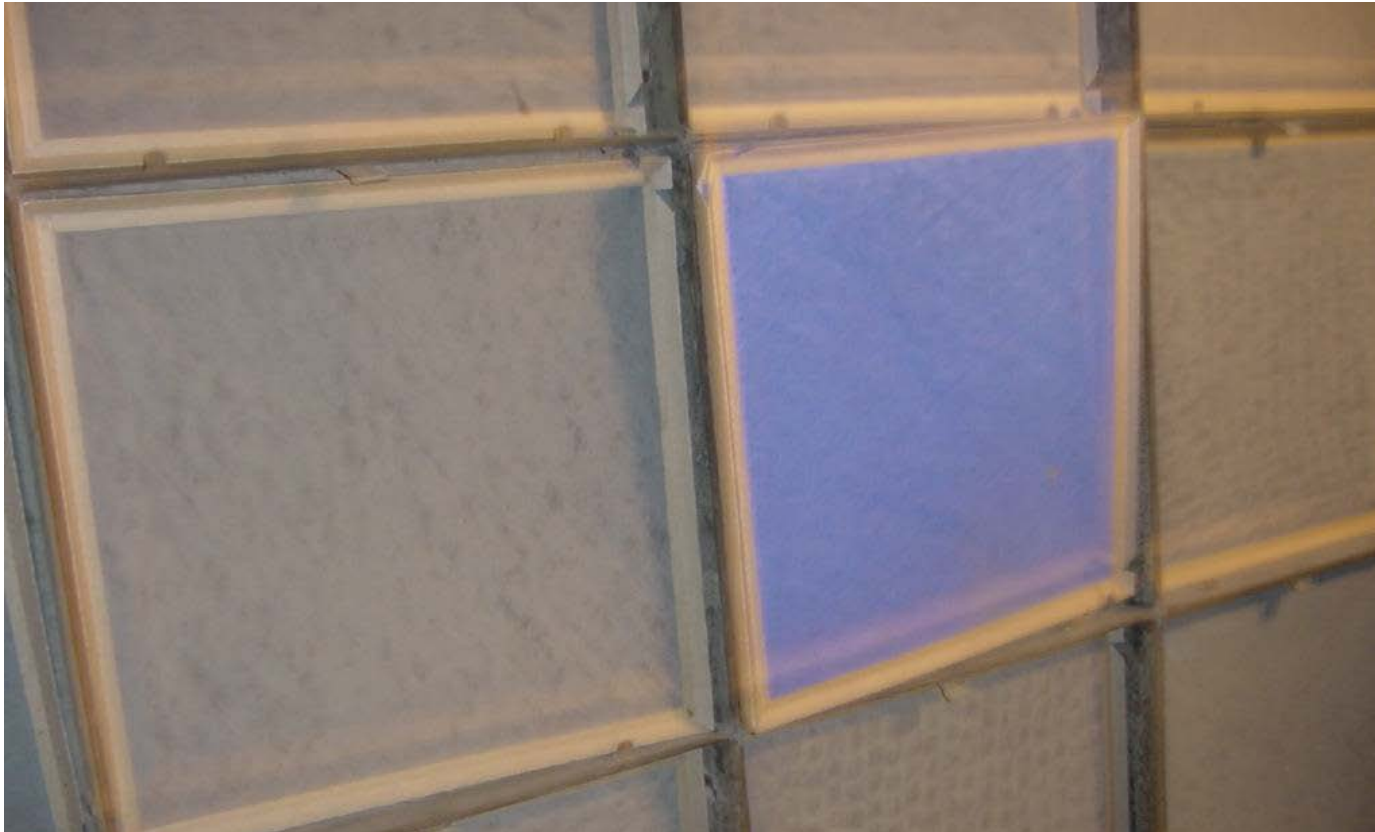
# Damaged Ceiling Tiles from Leaking Roof - Affects Air Quality



# Unit Ventilator with Dirty Filter – Blocked Air Flow



# Old Dirty Filters vs. New Filter



# Bird nests in outside air intake – potential for Indoor Air Quality problems

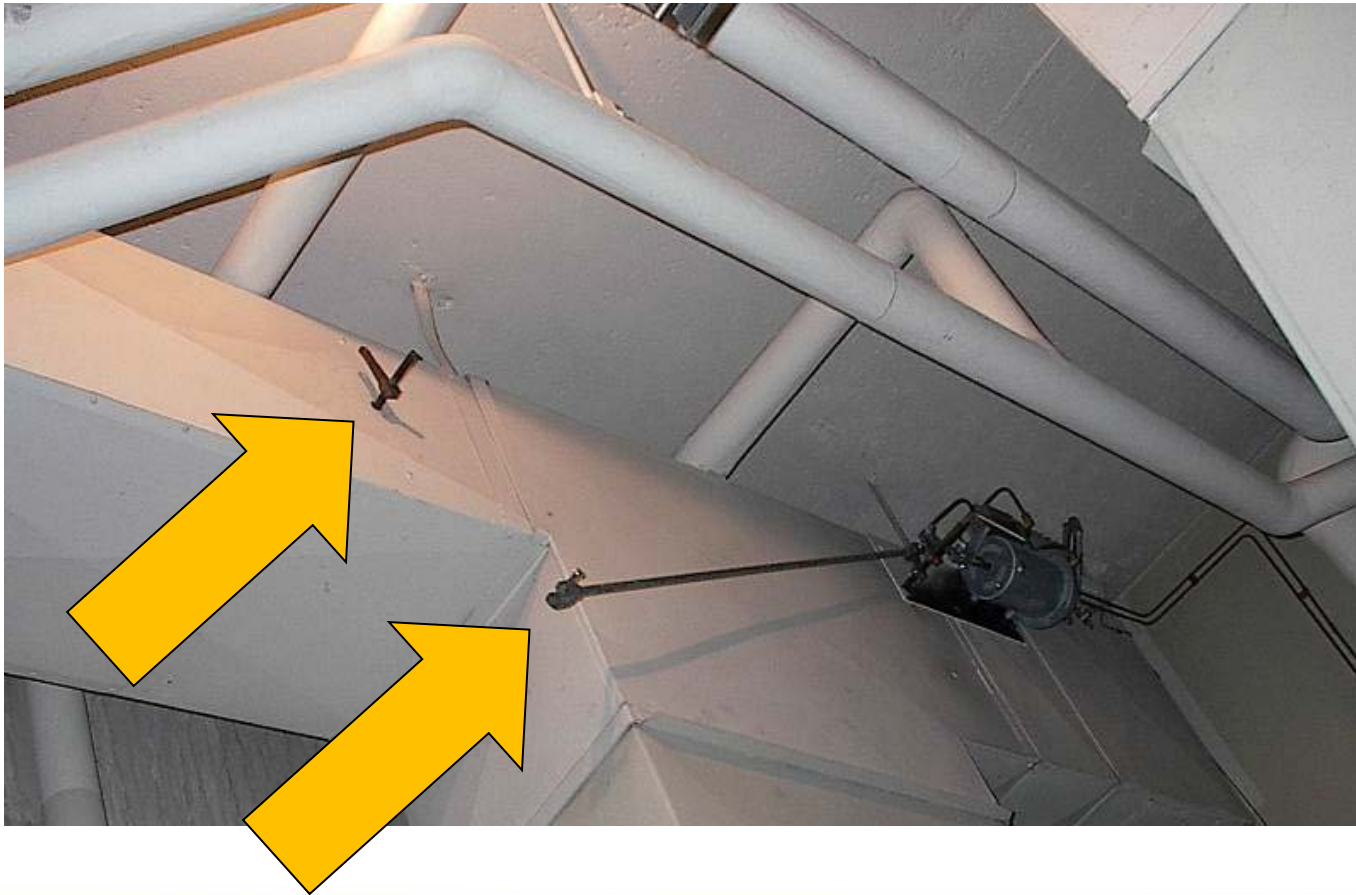




# Damaged Weather Stripping



# Actuator Disconnected from Damper



# Condensate Tank with Leaky Steam Traps



# Dampers Propped Open



# Valve Leak and Damaged Insulation



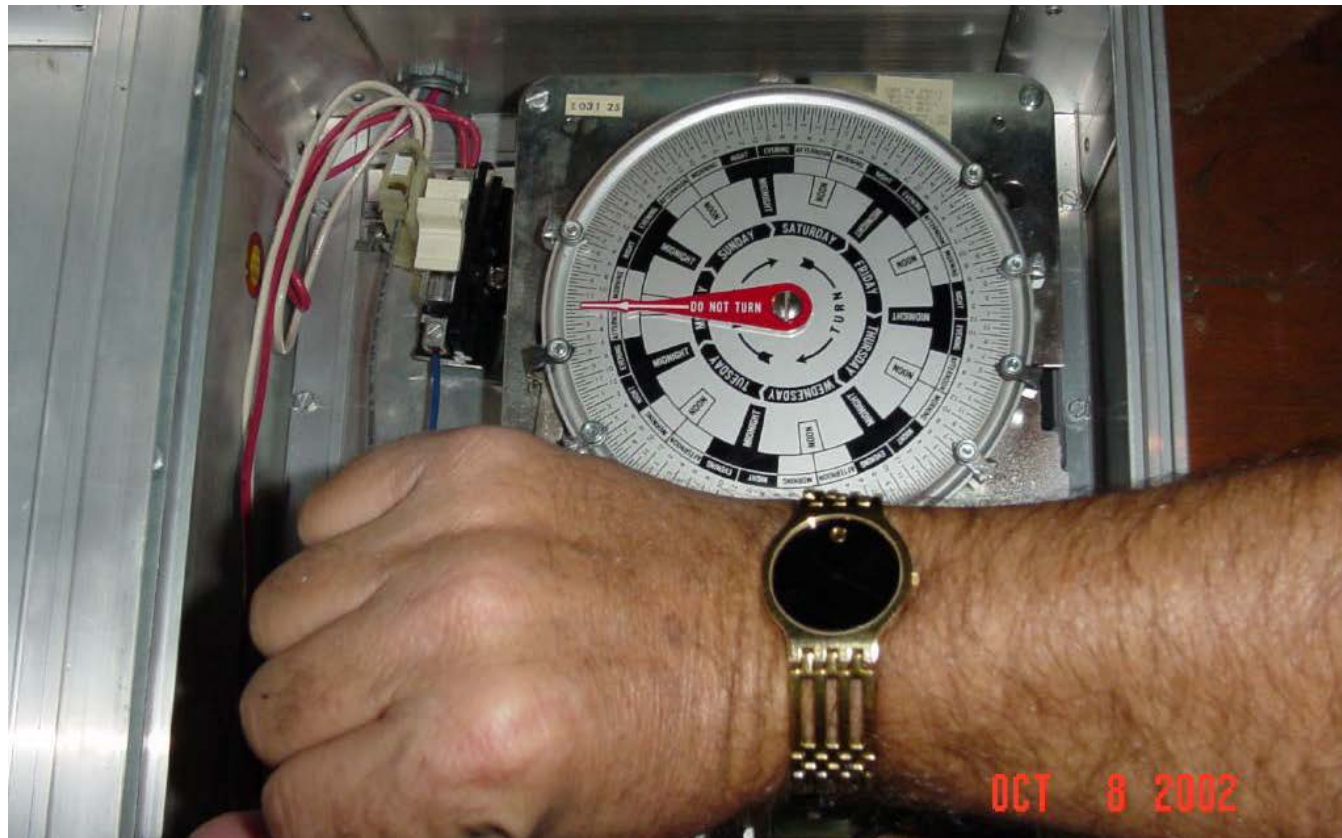
# Boarded up Outside Air Intakes



# Preventative Maintenance is Important



# Set Correct Time on Control Units





# KEEP's Partners

- Wisconsin Center for Environmental Education
- University of Wisconsin-Stevens Point
- Wisconsin State Energy Office
- Green & Healthy Schools Wisconsin
- College of Natural Resources
- Wisconsin Utilities
- Cool Choices

