Water Efficiency 101

August 4, 2008

Presenters:
Francis Wheeler
Bill Hoffman, PE

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GSA

Phoenix, AZ
August 3-6, 2008

What Substance Is?

Always in motion.
Runs but never walks.
Is used but never destroyed.
Found in the air.
On the Surface.
And underground.
We can't live without it.
AND WE TAKE IT FOR GRANTED!

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Outline

- Water Reduction Requirements
- Identifying Current Water Usage Through Mass Balance
- Ways to Save & Payback Ranges
- Resources Available

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Executive Order 13423:

"Strengthening Federal Environmental, Energy, and Transportation Management"

- **"Beginning in FY 2008, reduce water consumption intensity, relative to the baseline of FY2007 through life cycle cost-effective measure by 2 percent annually through the end of fiscal year 2015 or by 16 percent by the end of fiscal year 2015…"**
- DOE Supplemental Guidance – Jan 08

Executive Order 13423:

"Strengthening Federal Environmental, Energy, and Transportation Management"

- **Three Components of Compliance**
  - **Baseline Development**
  - **Efficiency Opportunity Identification / Implementation**
  - **Reporting**

Executive Order 13423:

"Strengthening Federal Environmental, Energy, and Transportation Management"

- **Agencies to conduct water audits of at least 10 percent of facility square footage annually and conduct audits at least every 10 years thereafter**
- **NOTE: EO 13123 was superseded by EO13423**

Executive Order 13423:

"Strengthening Federal Environmental, Energy, and Transportation Management"

- **Baseline, FY 2007 gallons per gross square foot per year**
- **DOE will amend its energy data report to include guidance on accurate reporting of water consumption and savings beginning with 2008 report**

Executive Order 13423:

"Strengthening Federal Environmental, Energy, and Transportation Management"

- **Water Use – defined as ALL water used at Federal facilities…where the water is classified for human consumption.**

i.e. potable water, laundry, cleaning, landscape irrigation, cooling towers, boilers, fire suppression

- **Gross square footage will rely on the value reported for energy use of that facility. Water use intensity will not be usable to make comparisons with other agencies. BASELINE**

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Executive Order 13423:

"Strengthening Federal Environmental, Energy, and Transportation Management"

- Facility – Any buildings, installation, structure, land and other property owned or operated by, or constructed or manufactured and leased to, the Federal Government, as well as any fixture.
- Water use data will include all uses of potable water to create a WUI (Water Use Index) number, which is water use divided by gross square footage. Potable water used for irrigation is to be reported in total water use but the amount of turn of landscape area is not included in gross square footage.

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- NOTE: Where meters are unavailable, assumptions will be used and detailed in reports

How Much Can YOU Save?

- Based on a PNNL 2005 study, 35 to 50 billion gallons per year savings potential

	People	Homes
Day	769,230,769	187,500,000
Month	25,641,026	6,250,000
Year	2,136,752	520,833

Note: 65 GPCPD or 8,000 per home/month

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Off the Shelf Ways to Save

Common "Off-the-Shelf" Water Efficiency Technologies

Technology Category	Type Detail	Federal Application (building type)	Water Use			Savings Potential	Comments
			Traditional	Existing Standard	High Efficiency		
Faucets	Lavatory: Private Use	Residential housing, barracks, and other dwelling units, including hotel guest rooms and hospital rooms	3 gpm	2.2 gpm at 60 psi	1.5 gpm at 60 psi – Look for WaterSense label	1.5 gpm	Simple and very cost-effective retrofit. Note that hospitals should not use aerating faucets; use laminar flow devices instead. Entrained air can trap bacteria and germs.
	Lavatory: Public Use	Public buildings, transportation facilities, schools and other educational facilities, office buildings, food service facilities, mercantile facilities, and other facilities that are not intended for private use.	3 gpm	2.2 gpm at 60 psi	0.5 gpm at 60 psi per ASME A112.18.1	2.5 gpm	Current ASME standard is highly efficient and incorporated currently in most plumbing codes, but not regularly enforced. Faucet may be controlled manually or by sensor
	Lavatory: Metering Faucet may be actuated manually or by sensor	High use applications		0.25 gallons per cycle			A faucet that after actuation dispenses water of a predetermined volume for a predetermined period of time. The volume or cycle duration can be fixed or adjustable. Faucet may be controlled manually or by sensor
	Kitchen and other applications	Kitchens, pantries, food service facilities, other non-lavatory applications	3-5 gpm	2.2 gpm	none	2.8-1.5 gpm	Simple and very cost-effective retrofit.

Faucets

KEY POINTS

- Units must have existing threads Or be replaced
- Consider basins when replacing
- faucets
- Sensors don't save water
- Focus on flow rates, customer satisfaction, O&M for leak prevention

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Off the Shelf Ways to Save

Technology Category	Type Detail	Federal Application (building type)	Water Use			Savings Potential	Comments
			Traditional	Existing Standard	High Efficiency		
Showerhead	Wall mount, Handheld	Barracks, offices	3.5-5 gpm	2.5gpm at 80 psi	2.0 gpm at 80 psi. WaterSense specification under development	~12 gal/shower[5]	Showerhead flow rate decreases over time due to scale build-up. Flow rate at replacement may be 75% of manufacturer rated flow.
Toilets	Gravity Flush Tank	Residential housing	Pre1980: 5 gal/flush 1980-94: 3.5 gal/flush	1.6 gal/flush	1.28 gal/flush with at least 350 gram waste removal. Look for WaterSense label	2.2 - 3.7 gal/flush	New models are engineered for effective flushing.
	Pressure Assist Tank	Residential housing, Commercial facilities and barracks	Pre1980: 5 gal/flush 1980-94: 3.5 gal/flush	1.6 gal/flush	1.28 gal/flush with at least 350 gram waste removal. Look for WaterSense label	2.2 - 3.7 gal/flush	Supplemental supply-line pressure used to assist in flushing.
	Flush Valve	Commercial facilities and barracks	Pre1980: 5 gal/flush 1980-94: 3.5 gal/flush	1.6 gal/flush	1.28 gal/flush (Currently under review by WaterSense)	2.2 - 3.7 gal/flush	Flush valve and bowl should be matched for effective flush action.
Urinals	Standard Flush	Commercial facilities and barracks	1.5 – 3 gal/flush	1.0 gal/flush	0.5 gal/flush (Currently under review by WaterSense)	2.5-1 gal/flush	Proven technology in widespread use. Highly efficient (<0.25 gal/flush) products are emerging in market.
	No water	Commercial facilities; remote application with limited water and high use	1.5 – 3 gal/flush	1.0 gal/flush	0.0 gal/flush (Currently under review by WaterSense)	3-1.5 gal/flush	Some maintenance and user acceptability issues but increasing in use in Federal sector.

Domestic Plumbing

- You can't use low flow components on high flow china
- Leakage is extensive, both commercial & residential
- Change specifications
- Leverage available rebates
- Sensors don't save water
- Focus on flow rates, customer satisfaction, O&M for leak prevention

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Off the Shelf Ways to Save

Technology Category	Type Detail	Federal Application (building type)	Water Use			Savings Potential	Comments
			Traditional	Existing Standard	High Efficiency		
Clothes Washers	Standard Vertical Axis or Front Loading	Barracks, lodging, recreation facilities	35-55 gal/load	9.5 gal/ft3 Approx. 33 gallons per load or less[6]	8.0gal/ft3 Approx. 28 gal/load or less	7-27 gal/load	Big water & energy savings from high number of loads/day offsets increased first cost. Front and top loaders available.
Commercial Dishwashers	Under Counter	Designed to be installed under food preparation workspaces.	1-1.8 gal/rack	No Standard	1.0 gal/rack	Up to 0.8 gal/rack	Machines with an overall height of less than 36-inches; rack of dishes remains stationary within the machine during sequential wash and rinse sprays. High temp machines are most water efficient.
	Stationary Single Tank Door	Commercial kitchen or cafeteria operations	1.1-2.2 gal/rack	No Standard	0.95 gal/rack	Up to 1.2 gal/rack	Includes machines commonly referred to as pot, pan and utensil washers. Also applies to machines in which the rack revolves on an axis during the wash and rinse cycles. High temp machines are most water efficient.
	Single Tank Conveyor	Commercial kitchen or cafeteria operations	0.7-1.4 gal/rack	No Standard	0.7 gal/rack	Up to 0.7 gal/rack	A single tank conveyor machine has a tank for wash water followed by a final sanitizing rinse and does not have a pumped rinse tank.
	Multiple Tank Conveyor	Commercial kitchen or cafeteria operations	0.54-1.12 gal/rack	No Standard	0.54 gal/rack	Up to 0.58 gal/rack	Machines with one or more tanks for wash water and one or more tanks for pumped rinse water, followed by a final sanitizing rinse.

Laundry Washers

- Options include recycling, rebuilding or total replacement
- Leakage is extensive, both commercial & residential
- Change specifications
- Leverage available rebates
- Savings from energy & chemical/detergents
- Focus on production

Off the Shelf Ways to Save

Technology Category	Type Detail	Federal Application (building type)	Water Use			Savings Potential	Comments
			Traditional	Existing Standard	High Efficiency		
Commercial Ice Makers	Ice-making head and remote condensing units	Operations requiring larger volume of ice.	Water cooled units can use 150 gal/100 lbs. of ice	No Standard	Air cooled, 25 gal/100 lbs. of ice	125 gal/100 lbs. of ice	Typically larger volume applications where ice-making head and storage bin are separate or ice-making head and condenser units are separate.
	Self-Contained	Most common configuration for low volume applications.	Water cooled units can use 150 gal/100 lbs. of ice	No Standard	Air cooled, 30 gal/100 lbs. of ice	120 gal/100 lbs. of ice	Free standing units where ice-making unit and storage compartment are housed together in a single cabinet.
Pre-rinse Spray Valves	Handheld hose-mounted dish sprayers	Commercial kitchen or cafeteria operations	2-5 gpm	1.6 gpm at 60psi		3.4-0.4 gpm	
Commercial Steam Cookers	Compartment Steamers	Commercial kitchen or cafeteria operations	25-35 gal/hr	No Standard	ENERGYSTAR: Qualified cookers average 2 gal/hr[7]	Up to 33 gal/hr	

Kitchens

- Leakage is extensive, so is staff training
- Change specifications
- Savings from energy & chemical/detergents
- Focus on production for steamer retrofits
- Include key staff (dietary)

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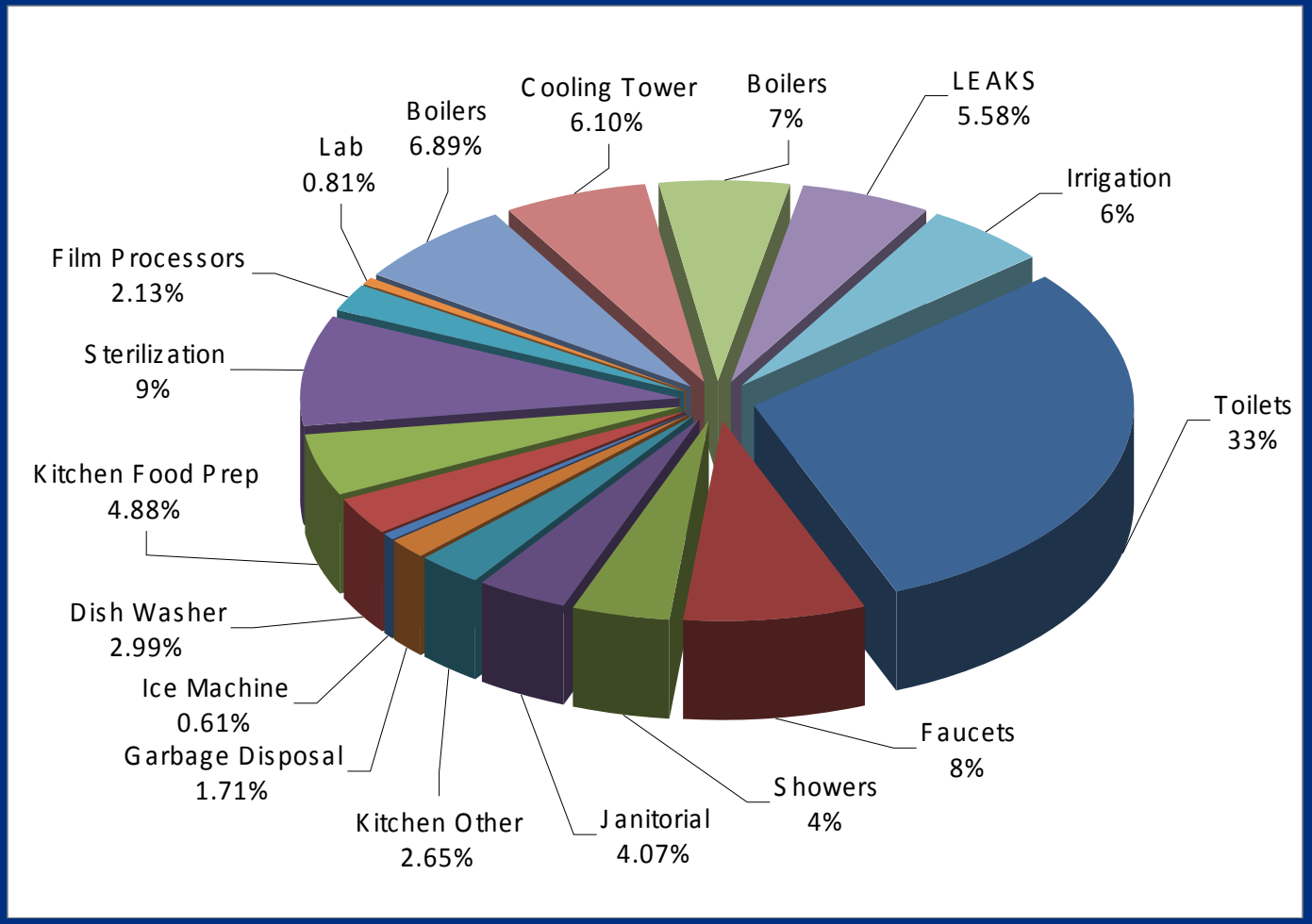
Water Balance



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Areas Covered

- **Water Treatment**
- **Cooling Tower and Boiler Operations including energy considerations**
- **Alternate On-Site Sources of Water**
- **Examples**

Water Treatment?

- **Basic water chemistry**
- **Types and purpose of treatment**
- **A look at treatment equipment**

Basic Water Chemistry

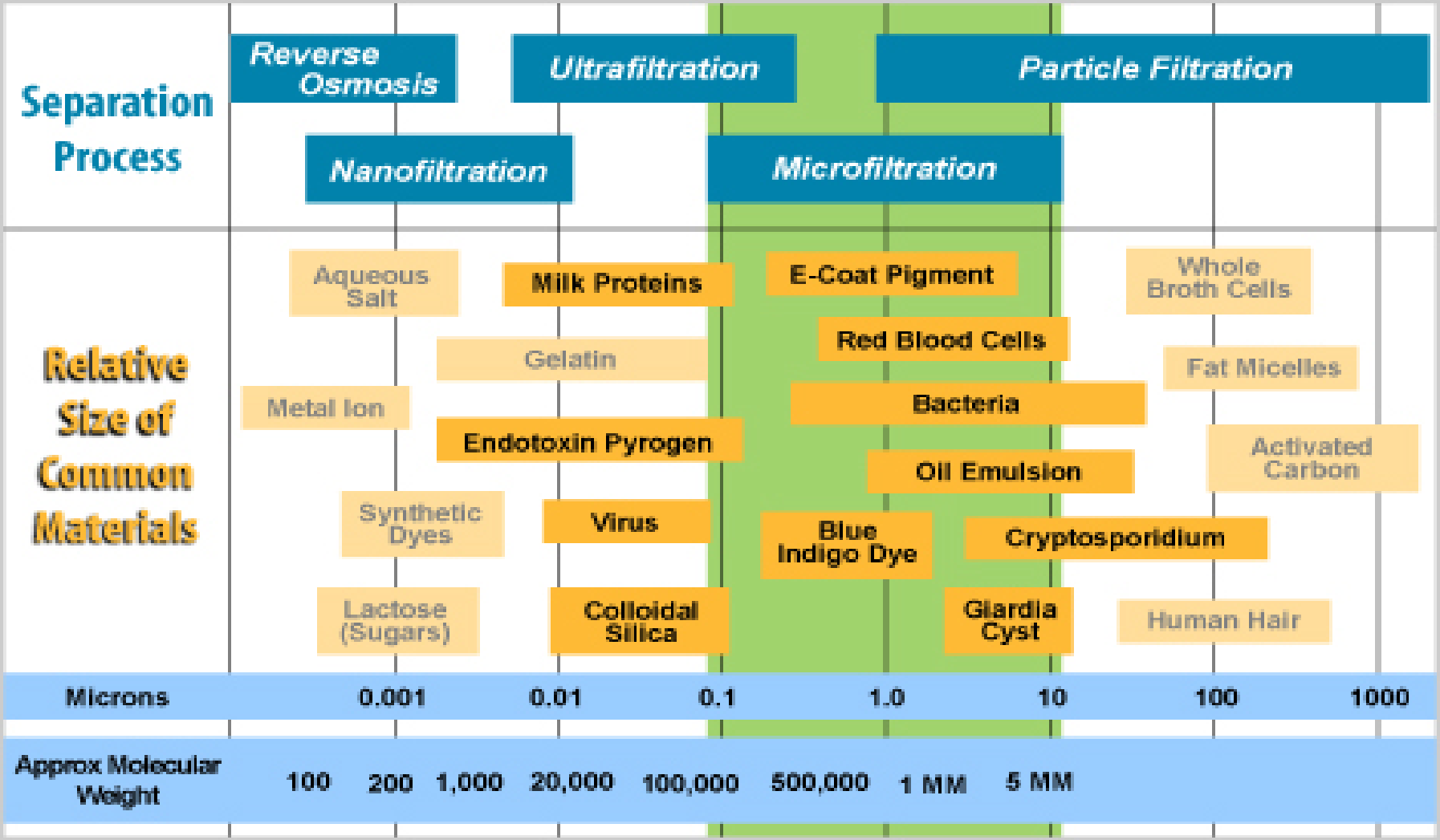
- **Dissolved Salts**
- **Alkalinity, pH, Bicarbonate, etc.**
- **Hardness**
- **Iron and Manganese**
- **Organics**
- **Particulates**
- **Silica**
- **Biological Specie**

Types of Treatment

- Filtration of particulates and smaller particles
- Removal of cations and anions
- Removal of organic matter
- Softening
- Disinfection
- Special treatment

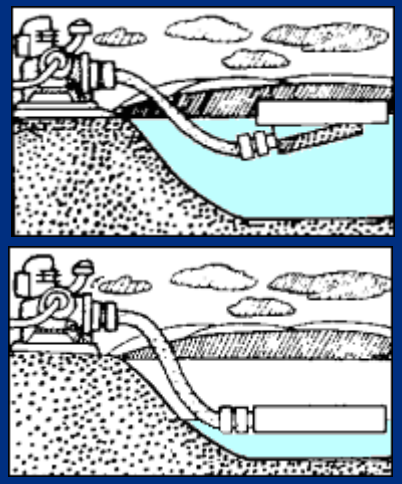
Filtration of particulates and smaller particles

- Strainers
- Particulate Filtration
- Micro and Ultra Filtration



Note: 1 micron (micrometer) = 4 x 10-5 inches = 1 x 104 Angstrom units

Strainers of all Kinds



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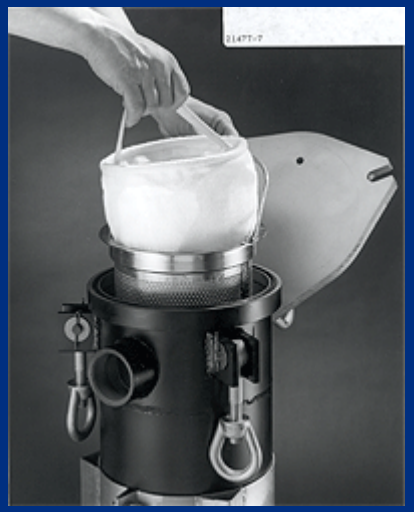
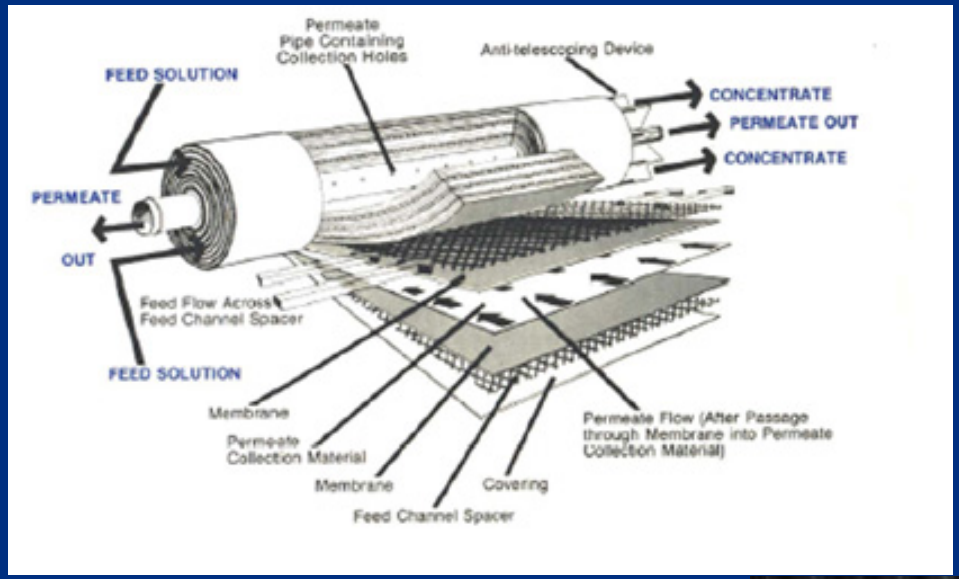
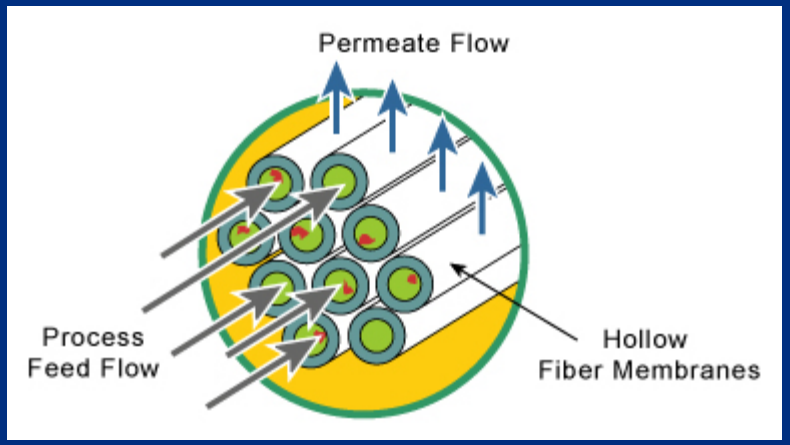
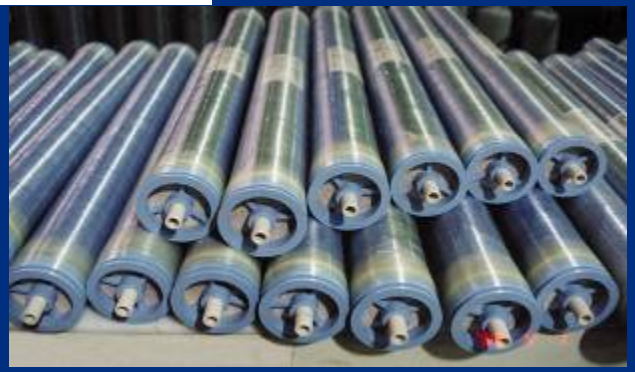
More Filters



Spiral Wound and Hollow Fiber Membrane Filters and RO Units







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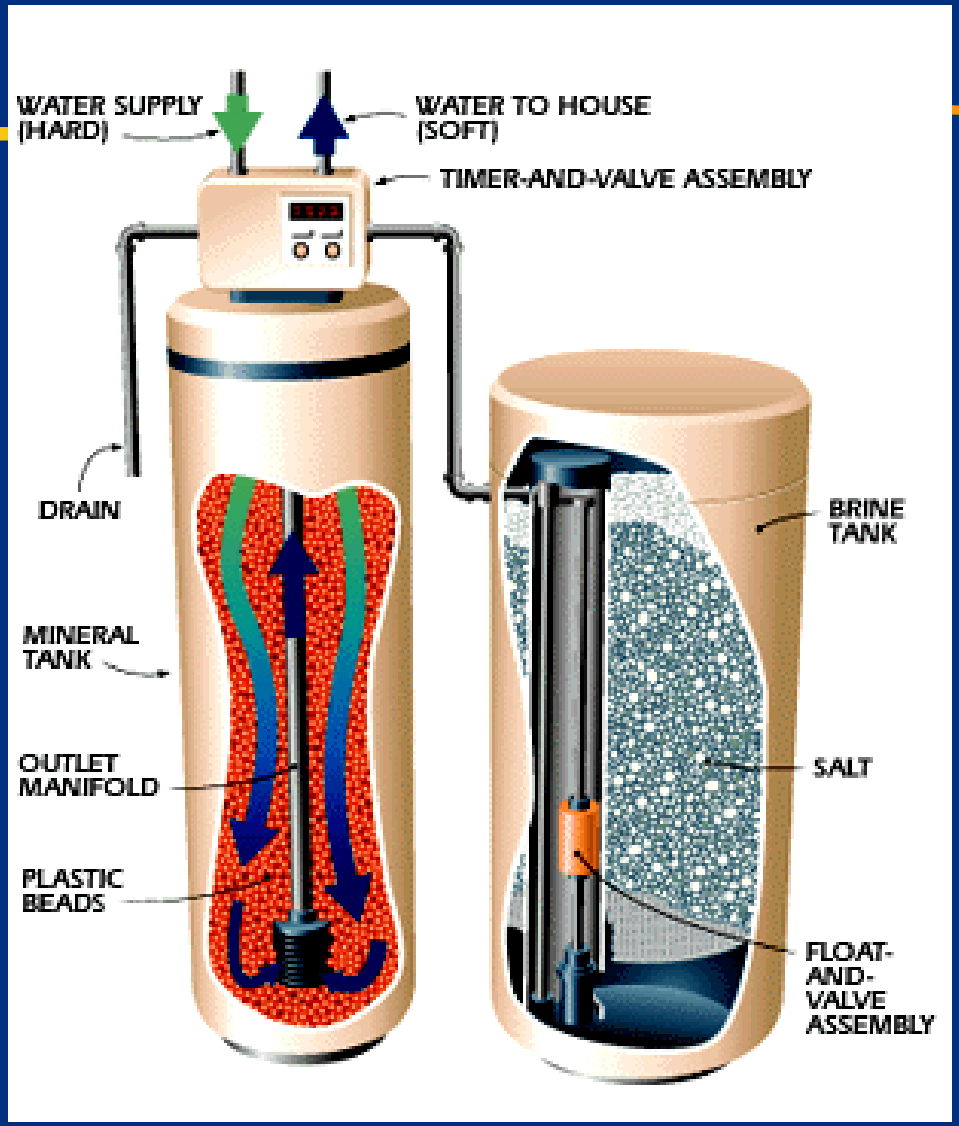
“Benchtop” Ultra Pure Systems

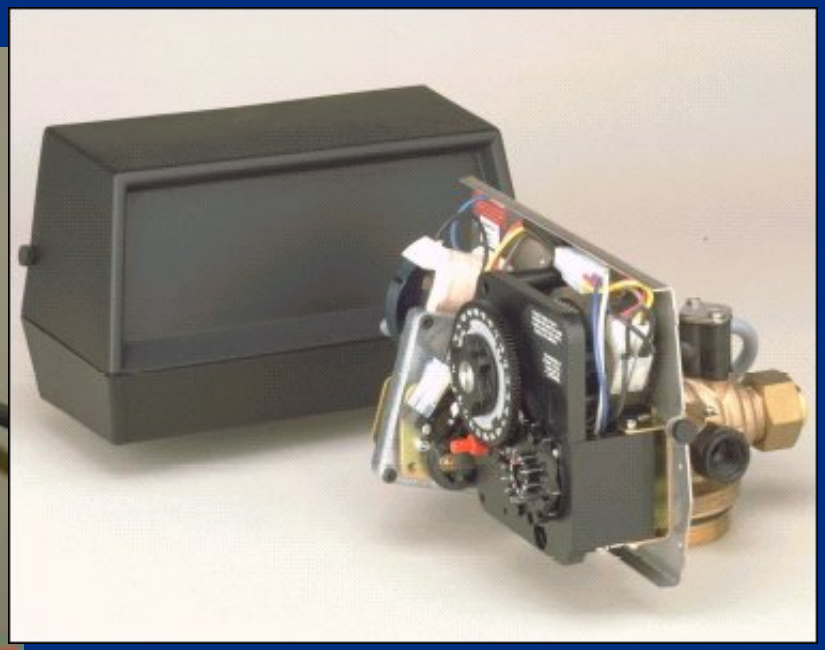
Softening, Deionization, & Other Ion Removal Processes

- Softening either with ion exchange resin or lime precipitation
- Special ion removal such as iron, arsenic, etc.
- Deionization (strong acid/base resins)

How Softeners Work



Old Timer vs. Flow Based



Softening, RO, & UV

800 Gallon per Day UPW Lab System

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Lab Water Stills

UPW System

It is Better to have One Large RO System

Percent of Water Down the Drain!

- **1-30 liters per hour – 90%**
- **30-100 liters per hour 80%**
- **100 liters per hour up 50%**

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Cooling Towers & Other Energy Relationships

Save Water – Save Energy

Save Energy – Save Water

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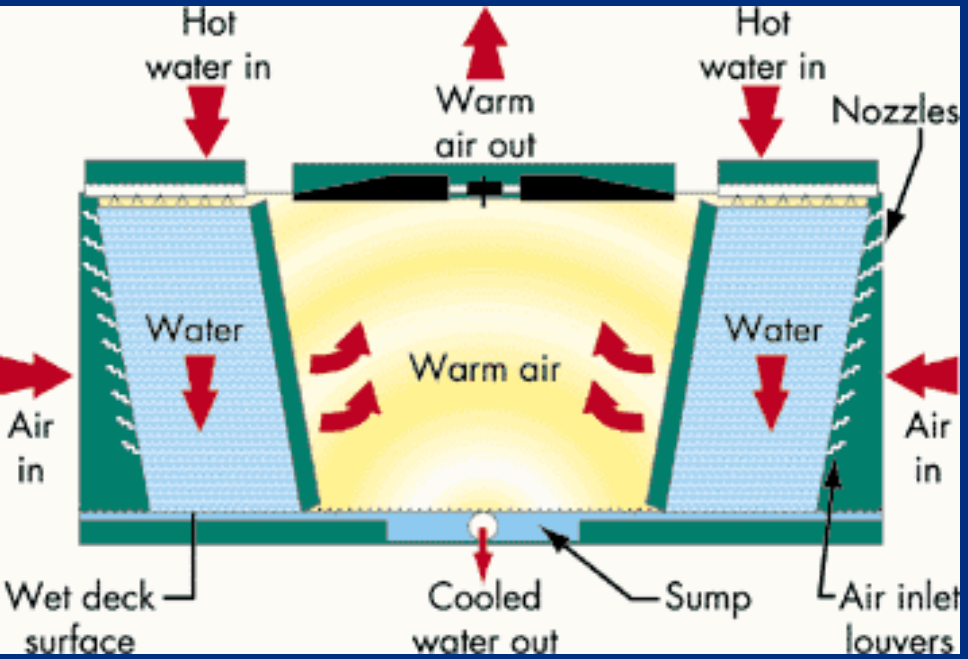
Cooling Towers

The purpose of a cooling tower is to get rid of

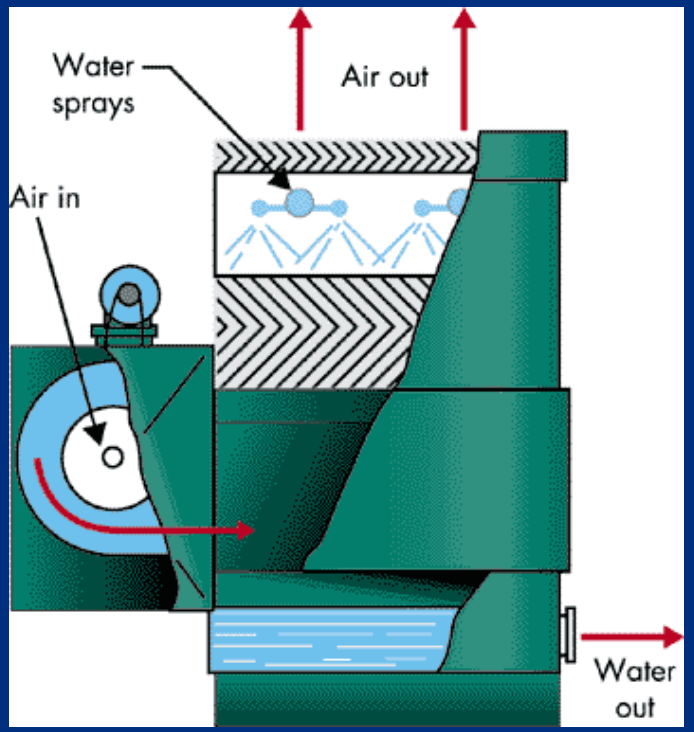
unwanted energy!

Cooling towers come in all sizes

Types of Cooling Towers



Cross-flow Induced Draft



Up-flow Forced Draft

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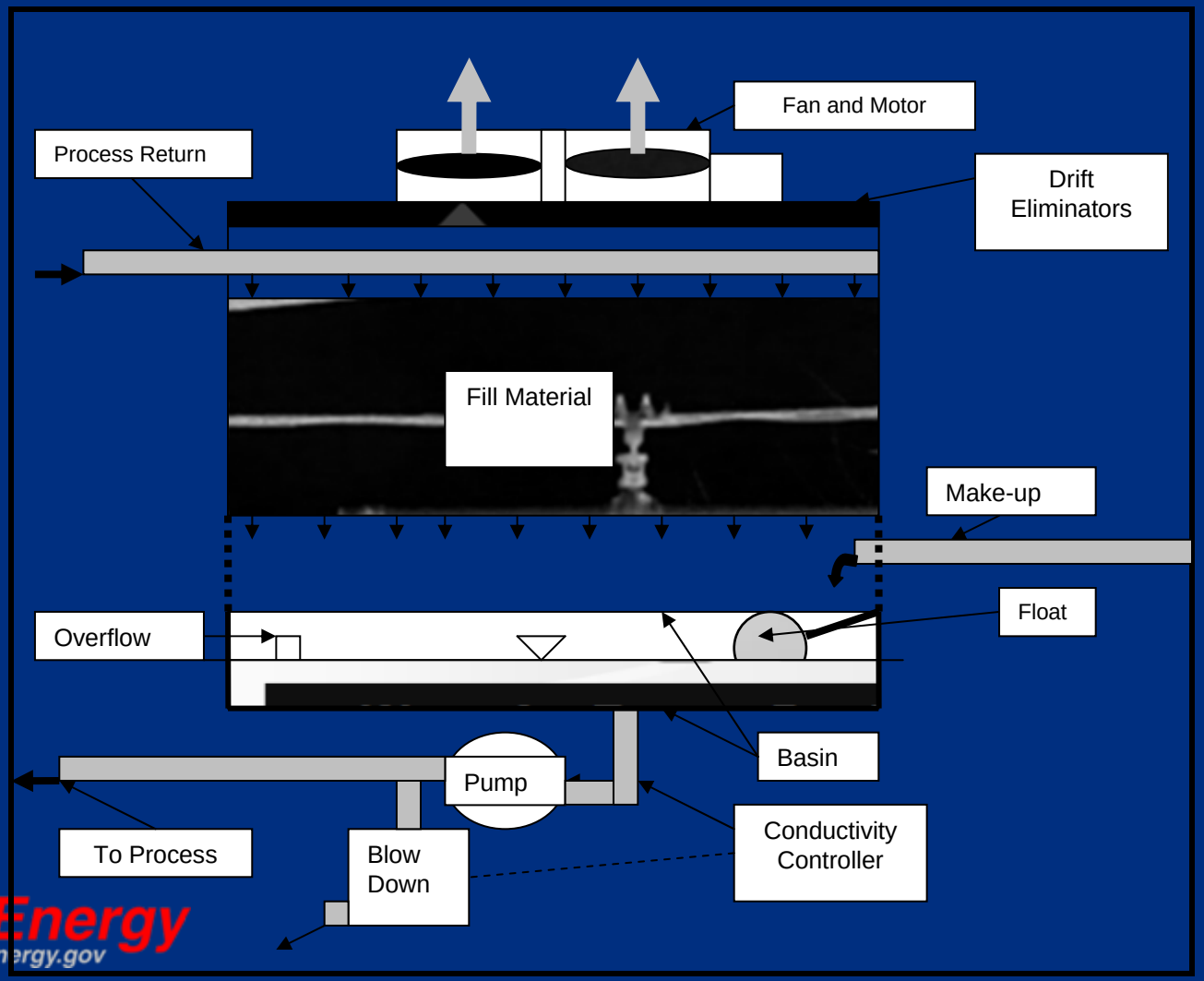
Typical Counterflow Tower



Cooling Tower Water Use

$$M = E + B + D + L$$

Where

M = Makeup

E = Evaporation

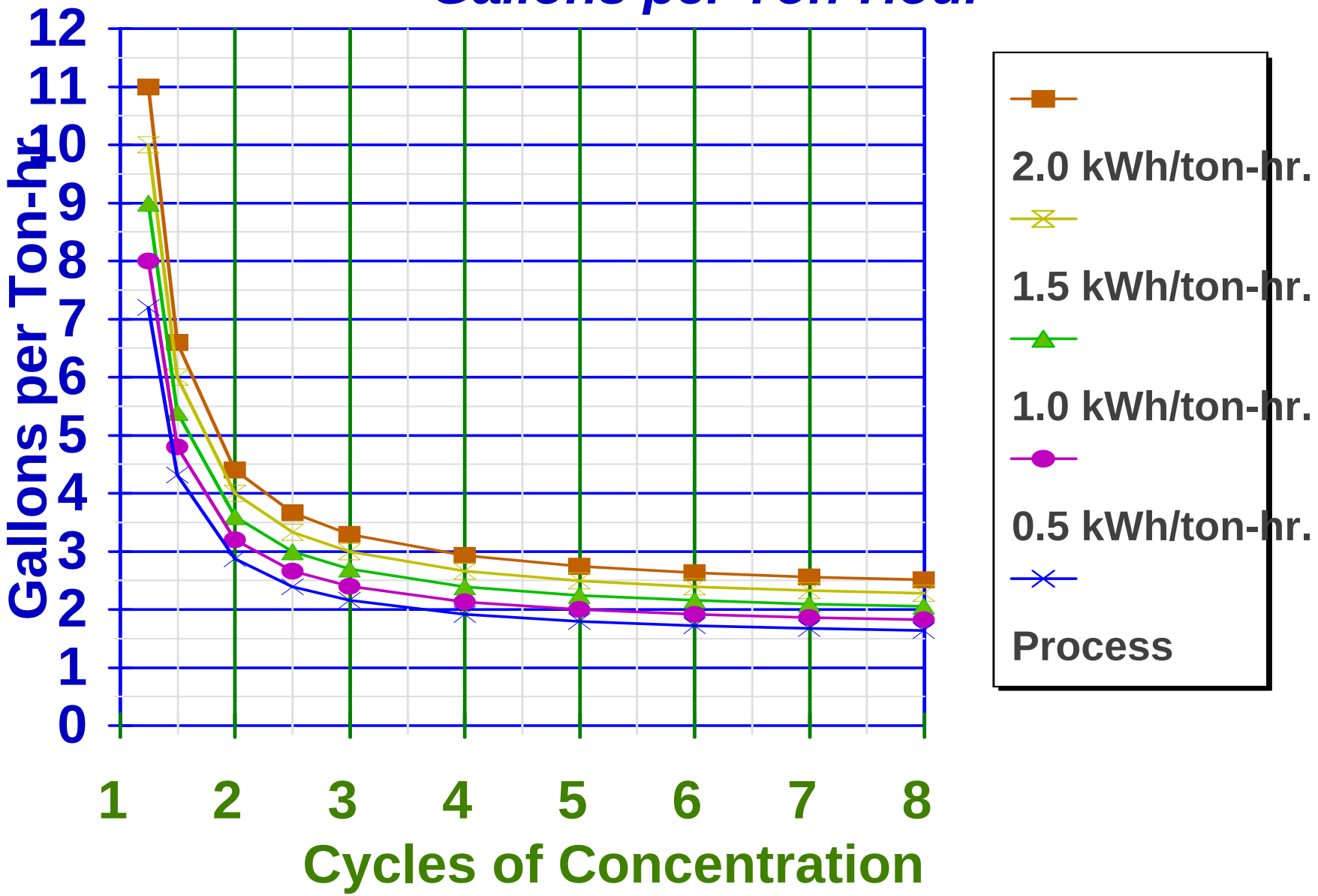
B = Blowdown

D= Drift and wind loss

L = Leaks, overflows, and other losses

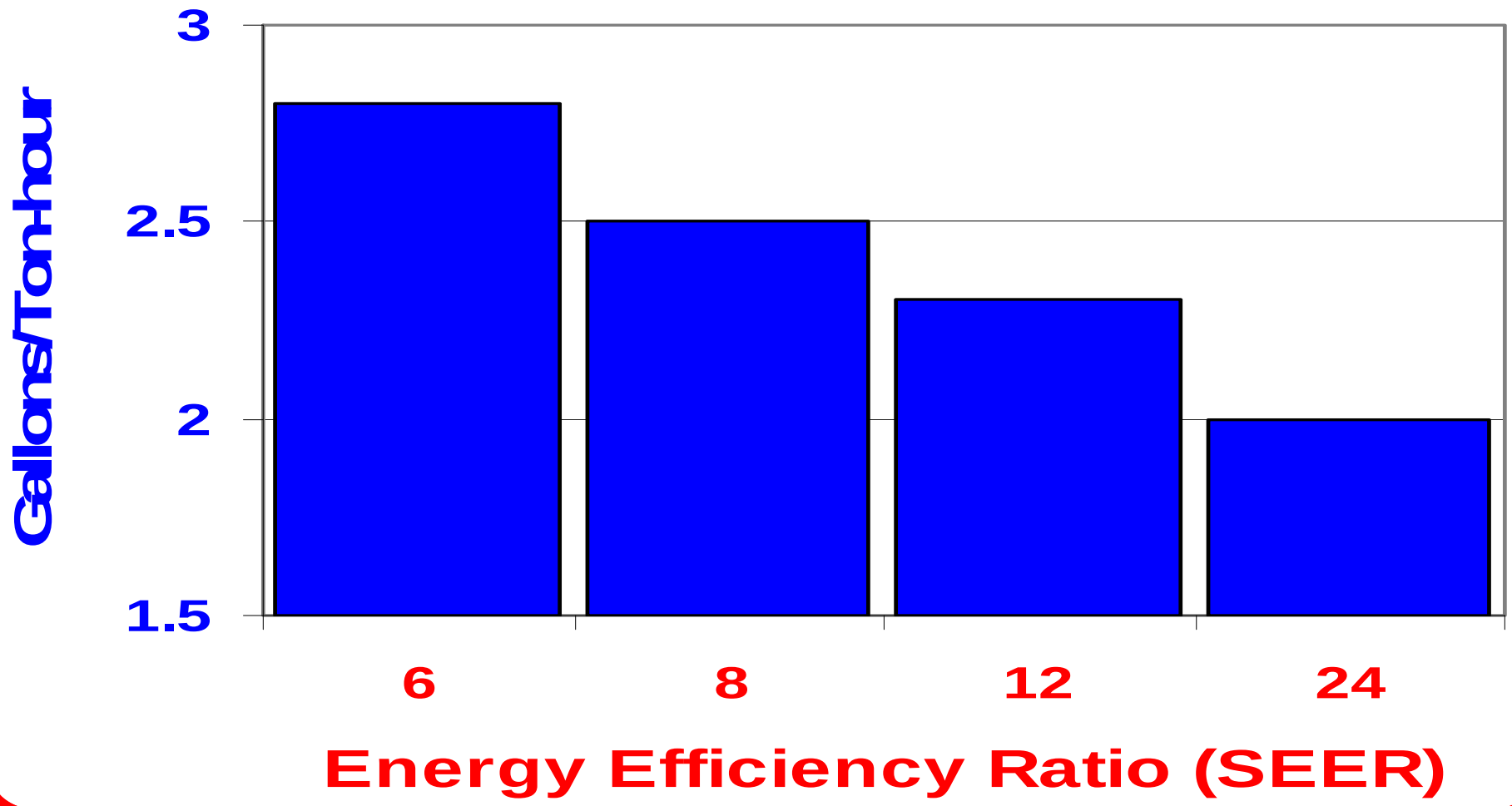
Cooling Tower Water Use

Gallons per Ton-Hour



Impact of Air Conditioning Efficiency on Water Use in Cooling Towers

Assumes Five Cycles of Concentration



Savings With Cooling Tower

Energy savings

0.3 to 0.6 kWh/Ton-Hr

Equal to about

2.5 to 5.0 cents

in most markets

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Cost of Tower Operations

Cost Factor *2.0 to 2.5 gal./Ton-hr*	Cents per Ton-Hr Range
Water/wastewater	**1.0 to 2.4**
Chemical	**0.1 to 0.4**
Capital	**0.2 to 0.4**
Energy	**0.1 to 0.3**
Other O&M	**0.1**
TOTAL	**1.5 to 3.6**

Ways other than a cooling tower

- Direct Exchange (DX)
- Variable Frequency Drive Air Cooled
- Absorption – Evaporation Systems

What You Want to See

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What You Don't Want to See

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Cooling Tower Controls and Alarms

- ✓ Makeup & blowdown meters,
- ✓ Conductivity controllers,
- ✓ Overflow alarms,
- ✓ Drift eliminators, and
- ✓ Electronic monitoring

The Cooling Tower Contract

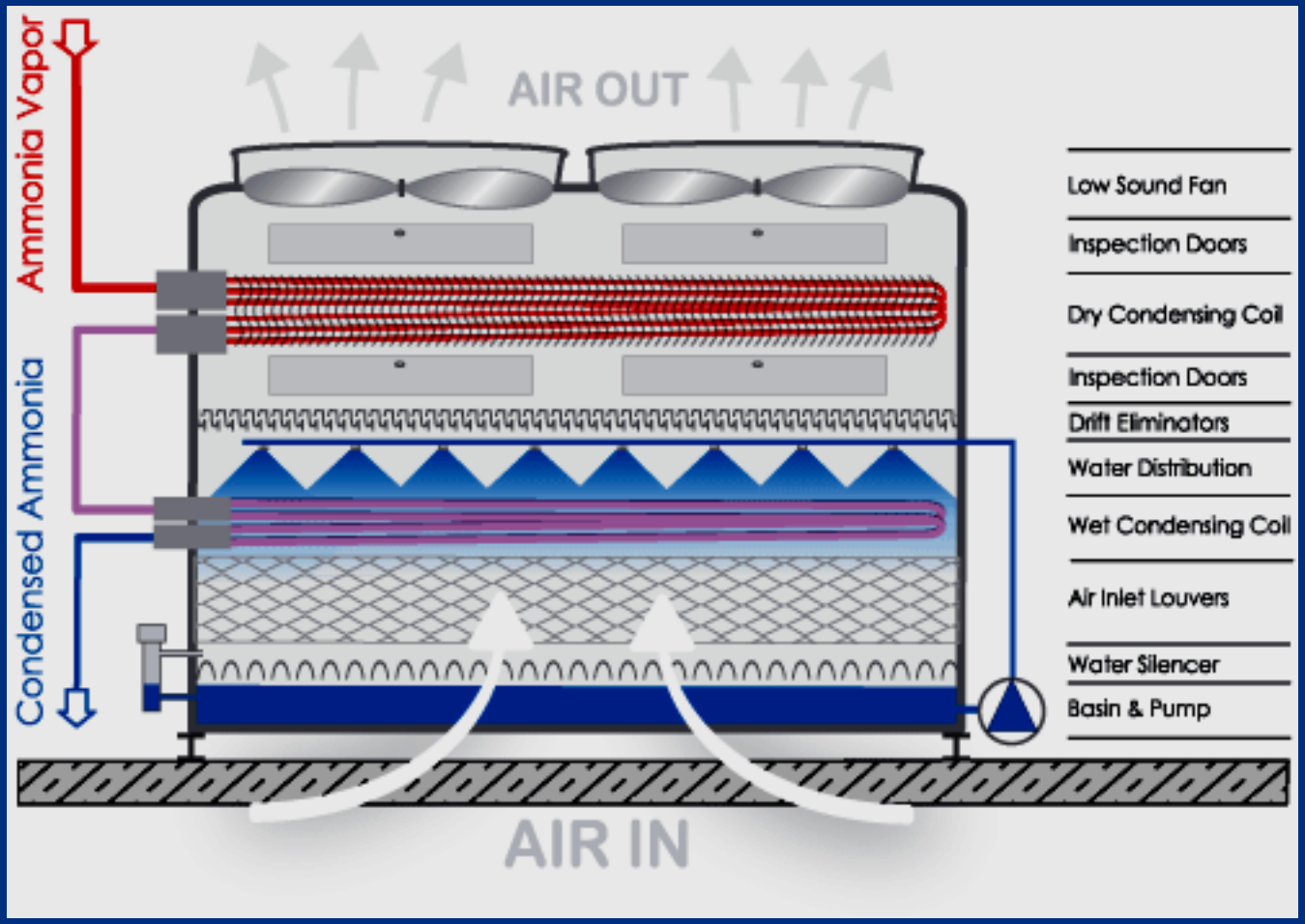
- Require a minimum number of cycles of Concentration
- Have all meter reading reports part of responsibility
- Keep record on ton-hours of cooling vs. water use.

Other Ways to Reduce Use

- Energy Conservation
- Air-side Economizers
- Water-side Economizers
- Reuse of Waste Heat
- Drift Eliminators
- Pre-cooling
- Variable Frequency Drives
- Thermal Storage

Water-Side Economizer

Hybrid Cooling Tower



Other Examples

- Ice Machines
- Lab Chillers
- Boilers & Hot Water
- Vacuum Systems

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Jump to first page

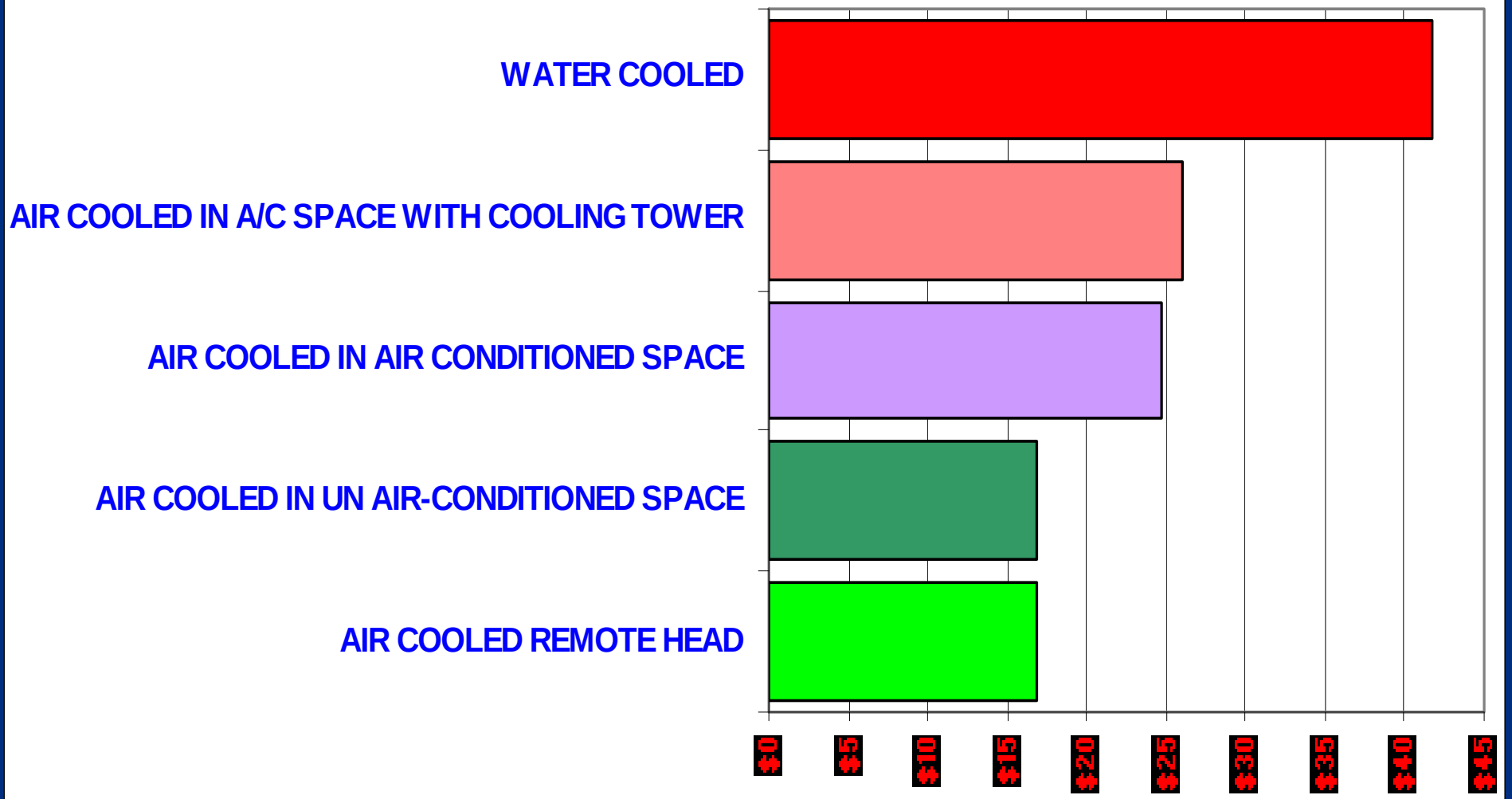
Air cooled ice machine

Water cooled ice machine
(no louvers)

Ice Machine Inputs

Hundreds of pounds made per day	*8.0*
kWh per 100 pounds of ice *air cooled*	*5.13*
kWh per 100 pounds of ice *air cooled remote head*	*5.23*
kWh per 100 pounds of ice *water cooled*	*4.70*
Gal. Per 100# *for cooling*	*150.0*
Gal. Per 100# of ice - *air cooled unit*	*20.0*
Gal. Per 100# of ice - *air cooled unit remote head*	*20.0*
Gal. Per 100# of ice- *water cooled unit*	*20.0*
Cost of Electricity (cents/kWh)	*10.5*
$ per 1000 gal for water	*$3.00*
$ per 1000 gal for wastewater	*$4.00*
Air Conditioner efficiency	*1.0*

Life Cycle Cost for 800 Pounds of Ice a Day Over 8.5 Year Life of Unit



Steam Boilers

- **Conductivity Controllers**
- **Condensate Return**
- ***METERING***
- **Energy Conservation**

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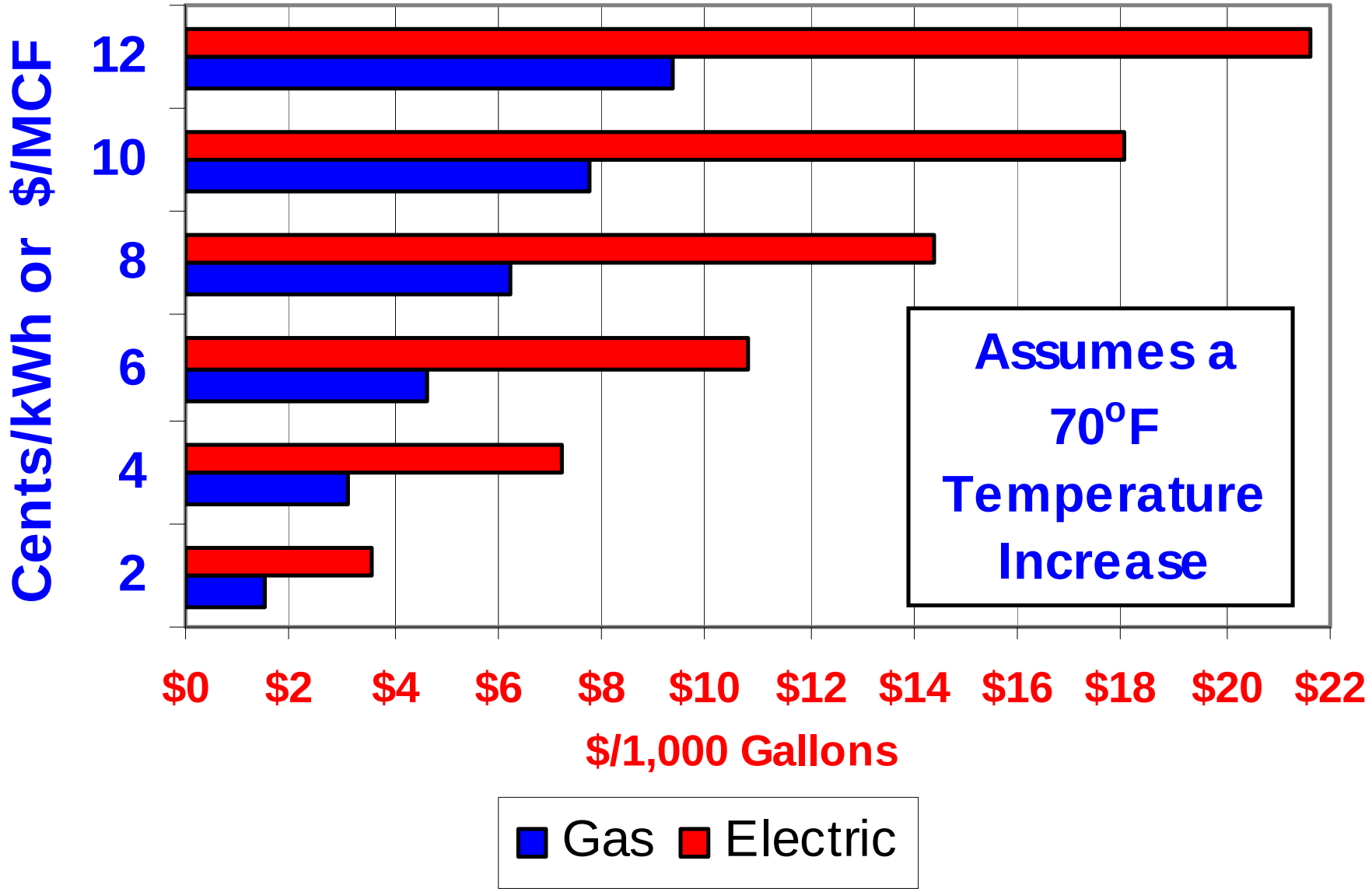
Energy Costs for Heating Water



Vacuum Systems

Old Liquid Ring and New Dry Vacuum Pump at Dental Office

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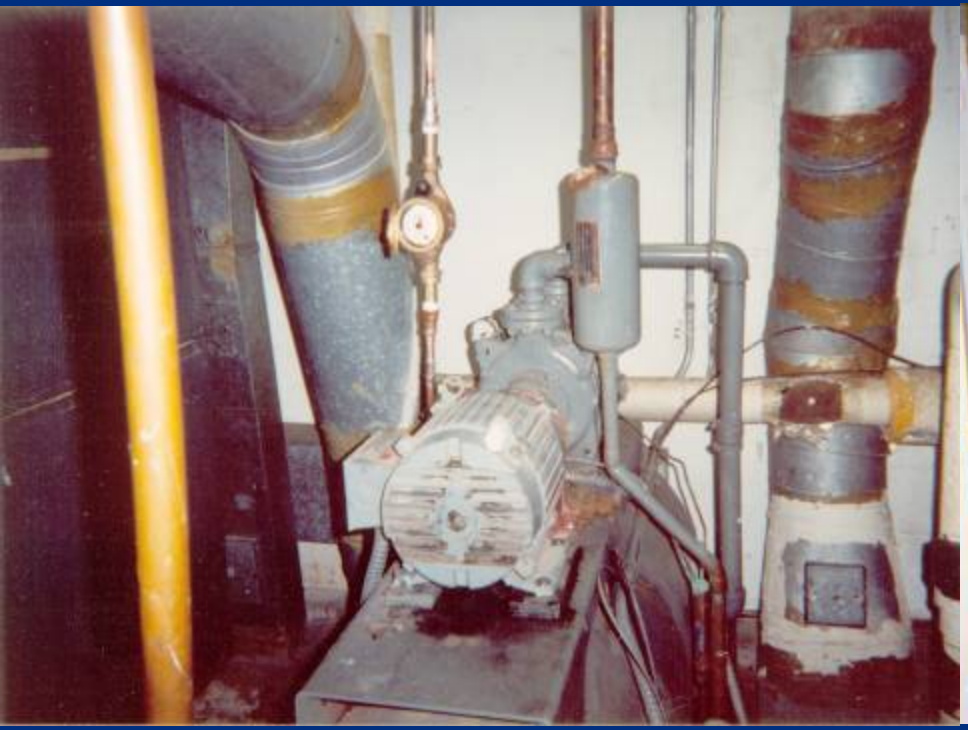

Old Liquid Ring Vacuum Pump on Surgical Unit

New Dry Vacuum Pump Cut Out 3,600 gallons per day

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Alternatives to Once-Through Cooling

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Alternate On-Site Sources of Water

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Alternate On-Site Sources of Water

- Rainwater harvesting
- Stormwater harvesting
- Air conditioner condensate
- Swimming pool filter backwash water
- Cooling tower blowdown
- Reverse osmosis (RO) and nanofiltration (NF) reject water
- Gray water
- On-site treated wastewater systems
- Foundation drain water
- Others??????

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Where it can be used

- irrigation,
- green roofs,
- cooling tower makeup water,
- toilet and urinal flushing,
- makeup for an ornamental pond/fountain
- swimming pools,
- laundry,
- process use, and
- aquifer recharge and wetlands maintenance.

Cost Considerations

- The volume produced
- The timing of when the source is produced in relationship to the demand;
- The potential to combine multiple sources;
- Water quality;
- Type of treatment required;
- System cost and payback.

Matching Source to Use

- **The Quality of the source must be acceptable for use.**
- **Treatment may be required**
- **The quantity of the source must be quantified.**

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Quantifying Volume Available

- Engineering Estimates
- Metering and Bucket and Stopwatch
- Sizing Storage vs. Use

Using Landscape as a Rain Harvesting System

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Shape land to hold water

EXAMPLES

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Pumps & Storage Tanks for Groundwater Recovery at AMD

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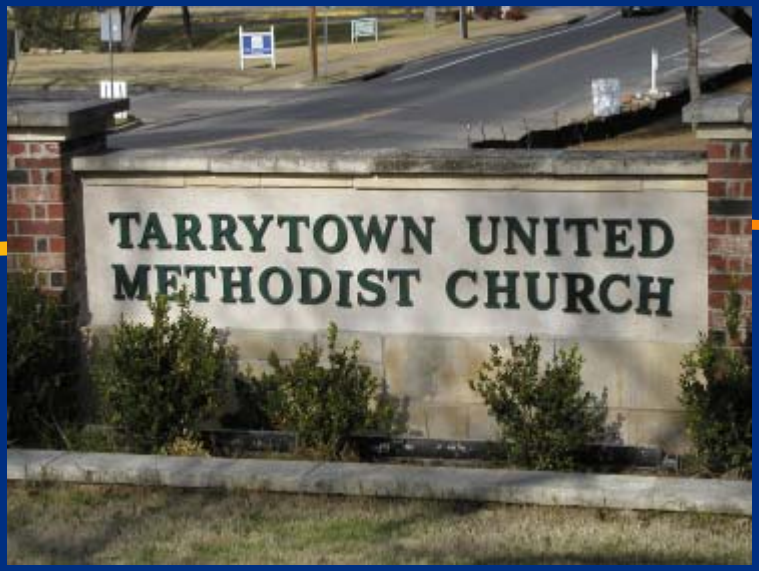
TARRYTOWN UNITED
METHODIST CHURCH

Old water cooled laser hooked up to water recovery system

Part of rainwater harvesting system at Austin's new Homeless Shelter.

Rainwater & AC condensate will be used for toilet and urinal flushing and landscape (planter box) irrigation.


ONLY IN TEXAS!

City Hall – Austin, Texas

Large Laundry Recycle System

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New Bank of America Tower in Manhattan

This LEED Platinum project collects rainwater, gray-water foundation drain water and A/C condensate water for reuse in toilet flushing and cooling tower makeup.

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AMD Lantana Site

- Largest known rainwater/AC condensate harvesting project
- Used for irrigation and cooling tower makeup
- 1.3 Million Gallons

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Would you like to know more about this session?

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Don’t forget to fill out and drop off your session evaluations.