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- **Questions**

- There will be a discussion/Q&A session at the end of the presentation.
- Submit questions to the organizer and panelists via the chat window

- **Presentation Slides & Recording**

- Presentation slides will be sent to all participants.
- This session will be recorded.

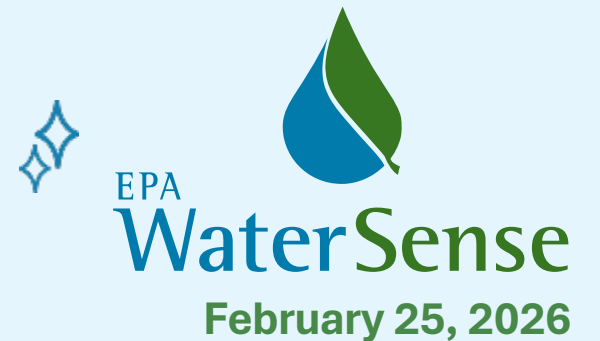
- **Notes**

- To improve audio quality, all attendees are muted upon entry.

All About Cooling Towers

Kersey Manliclic, EPA WaterSense

Mark Gentili, Los Angeles Department of Water and Power



COOLING TOWERS

Huge Water Savings for little effort!

Mark Gentili

xmgenti@gmail.com

AGENDA

The Basics: Moving Heat

Cooling Towers – where they are, types, tonnage

Why is Cooling Tower water treated?

Cycles of Concentration – the key to water savings

Types of Water Treatment programs

Disclaimer

The information provided in this presentation is from my experience and any opinions presented are my own, not the opinions of my employer. The materials in this presentation are meant to examine cooling tower systems and water treatment, to clarify and illustrate typical situations based on personal experience. The materials are not intended to provide legal advice, or to establish legal standards of reasonable behavior or to discredit any companies involved in the cooling tower industry.

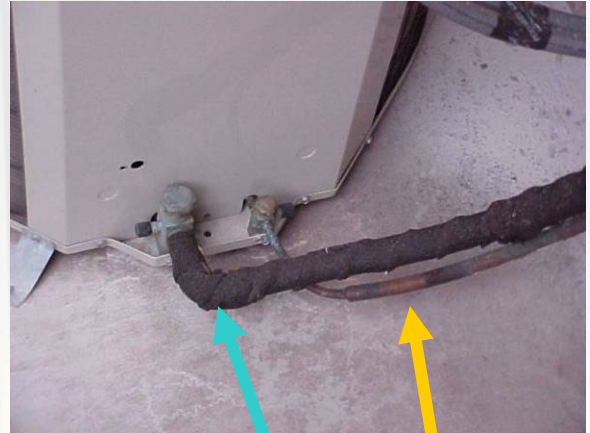
Your home Air Conditioner

- Air Conditioner at home
- This air conditioner is 5-tons
- Usually one ton per 450-500 residential sq. ft.
- It moves the heat from inside of your home to the outside by blowing air over the coils which contain refrigerant (transfer medium).



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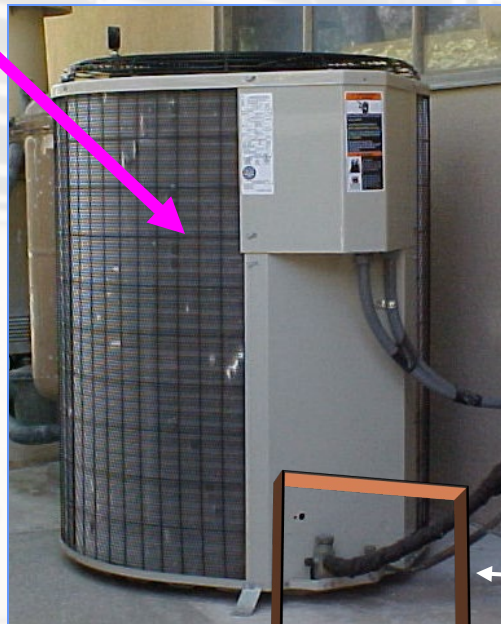
Condenser



Cooler

COOLER AIR

COOLER AIR



See label on unit

A Cooling Tower works in the same way as your home air conditioner

- It moves the heat from inside of a building to the outside
- It uses water to move the heat instead of refrigerant, like your home air conditioner

What types of buildings have cooling towers/ECs?

- Supermarkets
- Office Buildings
- Schools
- Industrial – cold storage, dye houses, factories, food processors, restaurants
- Some dry cleaners

All cooling towers have
something in common.
What is it?

EVAPORATION



Types of Cooling Towers

- Induced draft
- Forced draft
- Natural draft

Induced Draft Cooling Towers

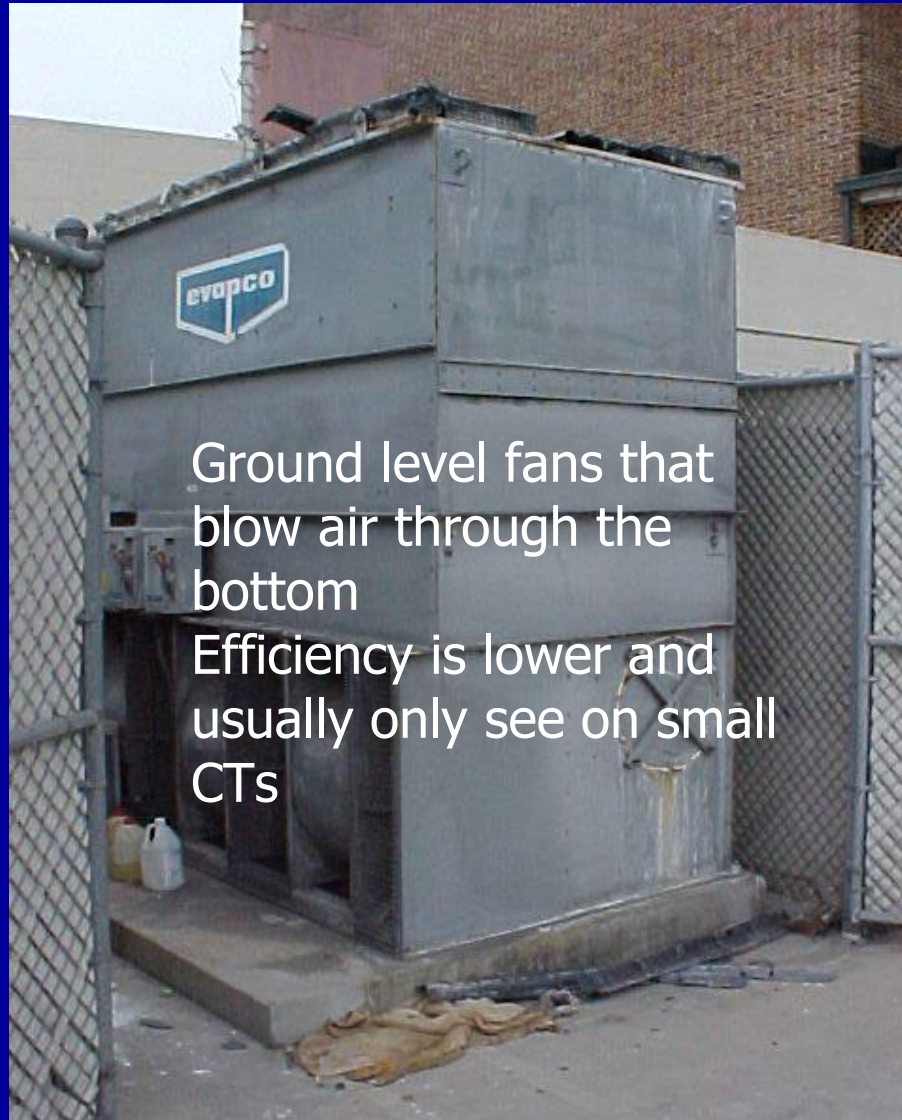




Central Heating and Refrigeration Plant

20,000-Ton **Induced** Draft Cooling Towers serving 13 buildings

Cooling Towers



Ground level fans that blow air through the bottom

Efficiency is lower and usually only see on small CTs

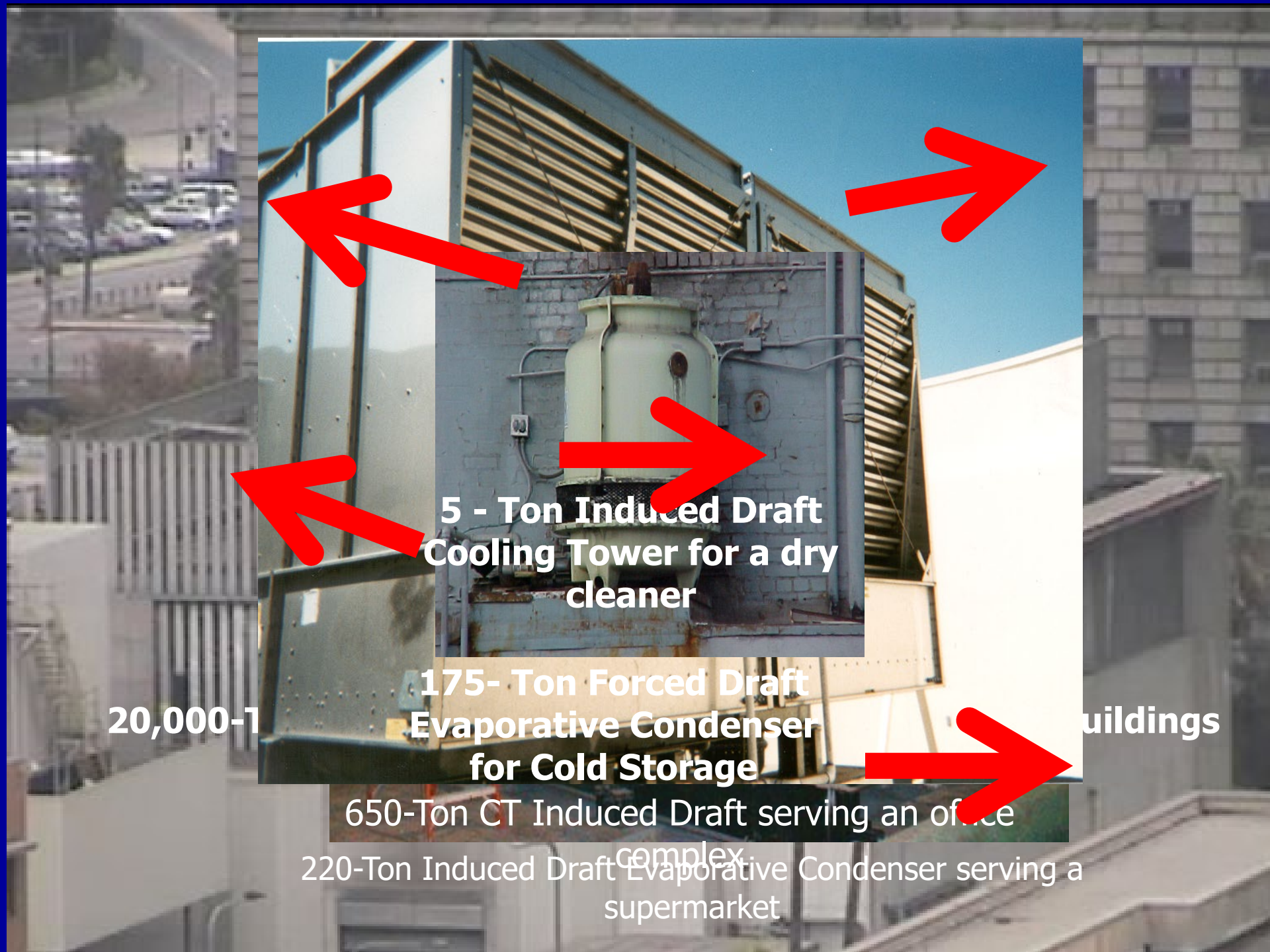
180-Ton FORCED DRAFT CT serving 250 hotel rooms

Natural Draft Cooling Towers



- No Fans - Air Flow caused by Chimney effect
- Very tall ($\geq 75'$) otherwise air flow would be very inefficient.
- This one one is 660' tall





5 - Ton Induced Draft Cooling Tower for a dry cleaner

175- Ton Forced Draft Evaporative Condenser for Cold Storage

20,000-1

Buildings

650-Ton CT Induced Draft serving an office

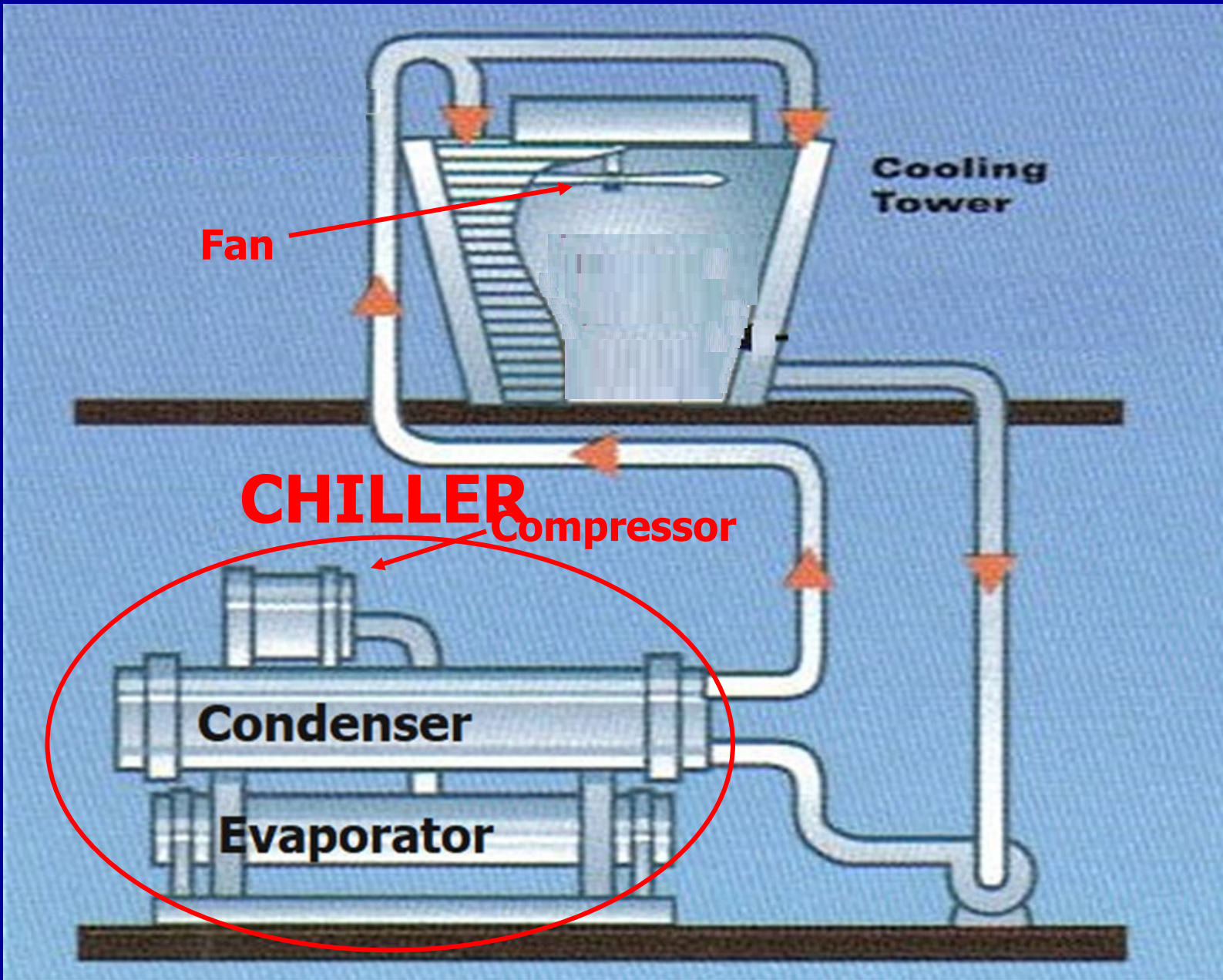
220-Ton Induced Draft Evaporative Condenser serving a complex supermarket



Water sprayed into top section of CT

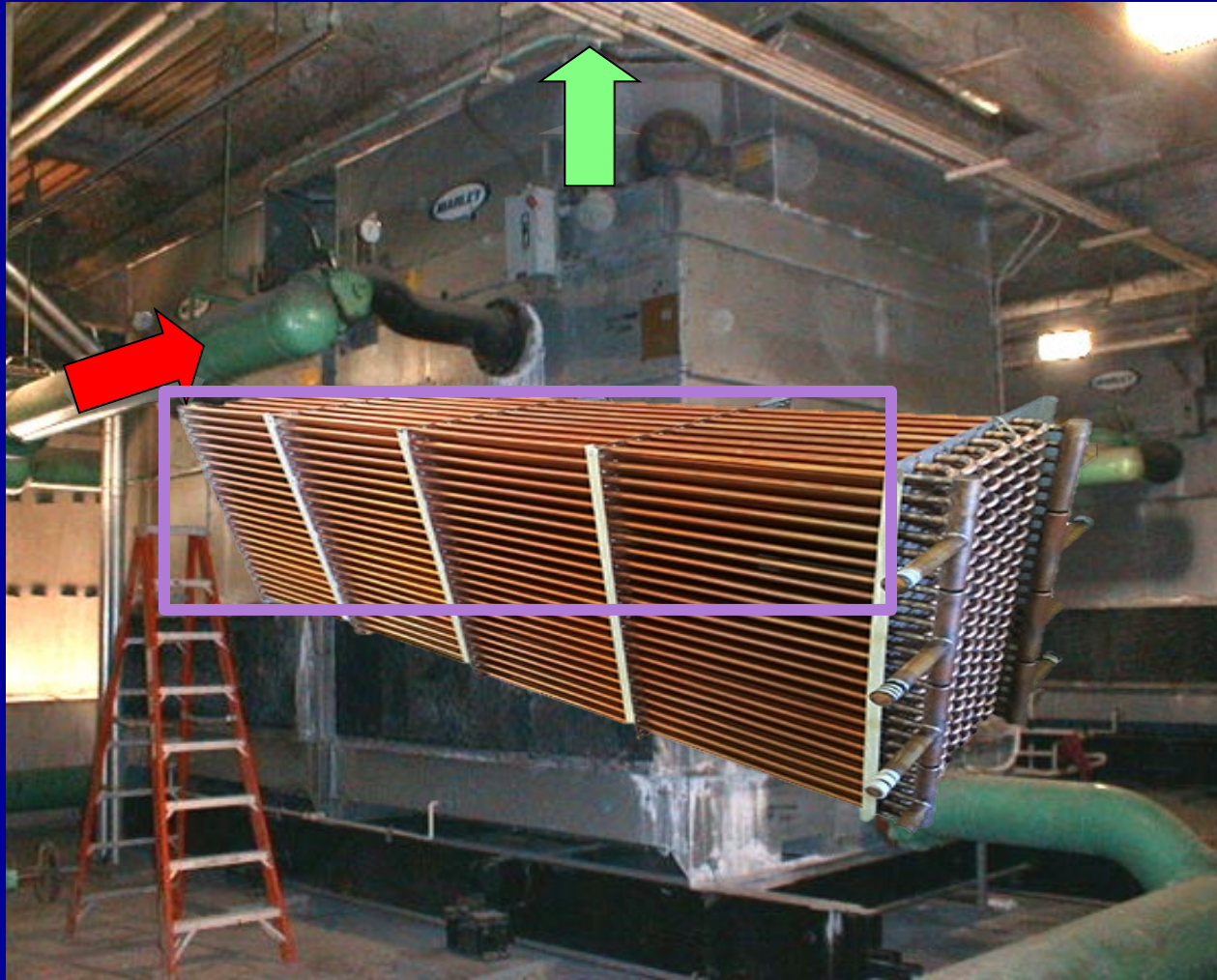
Hot Water

Condenser



What does the EC do (continued)?

Water Vapor

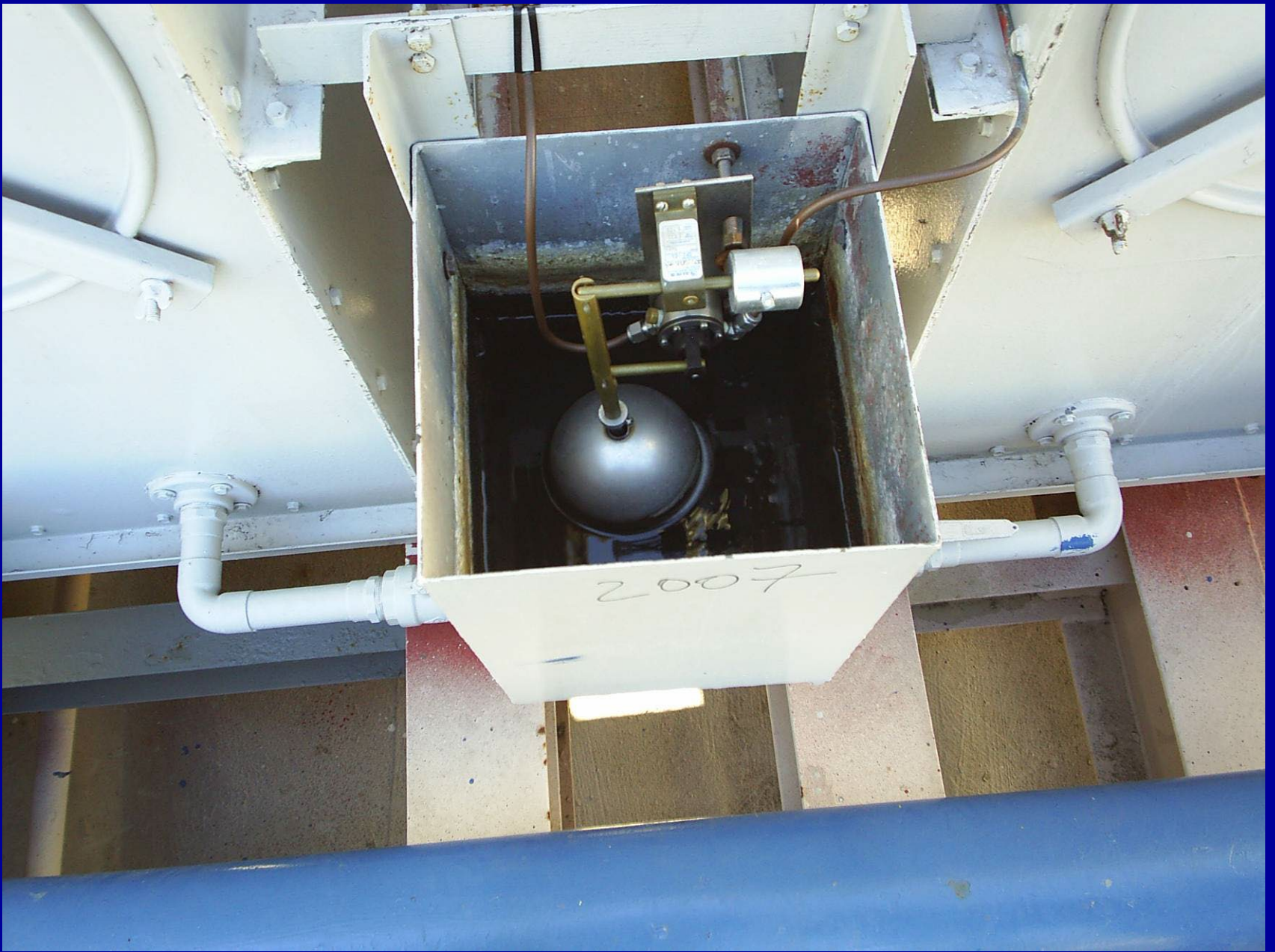


Evaporative Condenser











Water treatment for cooling towers

- Why do we treat the water circulating through cooling towers?
- Three potential problem that may arise without chemically treating the cooling tower water:
 - Corrosion (rust)
 - Slime (microbiological contamination)
 - Scale

Condenser tubes



- Surefire way to see if WT is good is to open the condenser and look at the copper tubes





Corrosion (rust) in cooling towers

- “eating away” the metal in the: (1) condenser copper tubes; or (2) steel pipes delivering water to the CT; or (3) the CT reservoir
- To prevent rust add chemicals called corrosion inhibitors
- Use coupon racks – or even Corraters



Slime in Evap Condensers

This is what slime looks like on copper tubes



This is what improperly treated copper pipes look like

Slime in cooling towers

- Made up of bacteria
- Kill it by using Chlorine (bleach) and/or bromine tablets or powder. These chemicals "burn" the bacteria. Bacteria is removed as sludge in cooling tower reservoir.

Scaling in cooling towers

- Formation of hard deposits (scale) inside of pipes
- Most scale found in cooling towers is Calcium Carbonate
- Scale forms when water gets hot and Calcium Carbonate precipitates
- Typical standard water treatment has scaling inhibitor chemicals added

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Scaling in cooling towers (cont.)

- Prevent Calcium Carbonate scale with three (minimum) different types of water treatment:
 - (1) Add Phosphonate chemistry that complexes Calcium Carbonate in the cooling tower reservoir. The phosphonate calcium complex is later dumped into sewer through the tower bleed. ← Standard Water Treatment
 - (2) Adjust pH < 8.6 ← pH Trimming or full acid
 - (3) Soften the water and remove Calcium from the equation ← Softening, D.I., Electrochemical

Scaling in cooling towers (cont.)

- Can see Calcium Carbonate scale on showerheads
- Prevent Calcium Carbonate scale in three ways
 - (1) Add scale inhibitor chemicals
 - (2) Keep the pH < 8.6
 - (3) Pre-treat by softening de-ionization)



Water Conservation in CTs

- To understand water conservation for CTs you have to understand water treatment and how minerals are measured.

Cooling Towers: *What are “cycles of concentration”?*

- Water evaporates from a cooling tower, the minerals left behind concentrate.
- The minerals in the water are measured in μmhos (micromhos).
- Incoming city water in range of 300 – 900 μmhos . When 3Xs that of incoming city water, then 3.0 Cycles of Concentration (COC). Majority of cooling towers are kept between 2-3 COC.
- Bleeding water when 2 - 3 COC is reached. Fresh water is added to maintain level.

Cycles of Concentration (COC):

500-Ton

on (COC):
5 days/week



650-ton induced draft CT serving an office complex

Cycles	Make-up	Blow-down	Savings/day from 2 to ___ COC
2	11,040	11,040	0
3	7,020	3,510	3,510
4	7,020	2,340	4,680
5	7,020	1,755	5,265
6	7,020	1,404	5,616
7	7,020	1,153	5,850
8	7,020	892	6,017
9	7,020	702	6,143
10	7,020	511	6,240

COC model
CT at 2
COC for pH control
4.5-5.5; softening
6.0-8.0



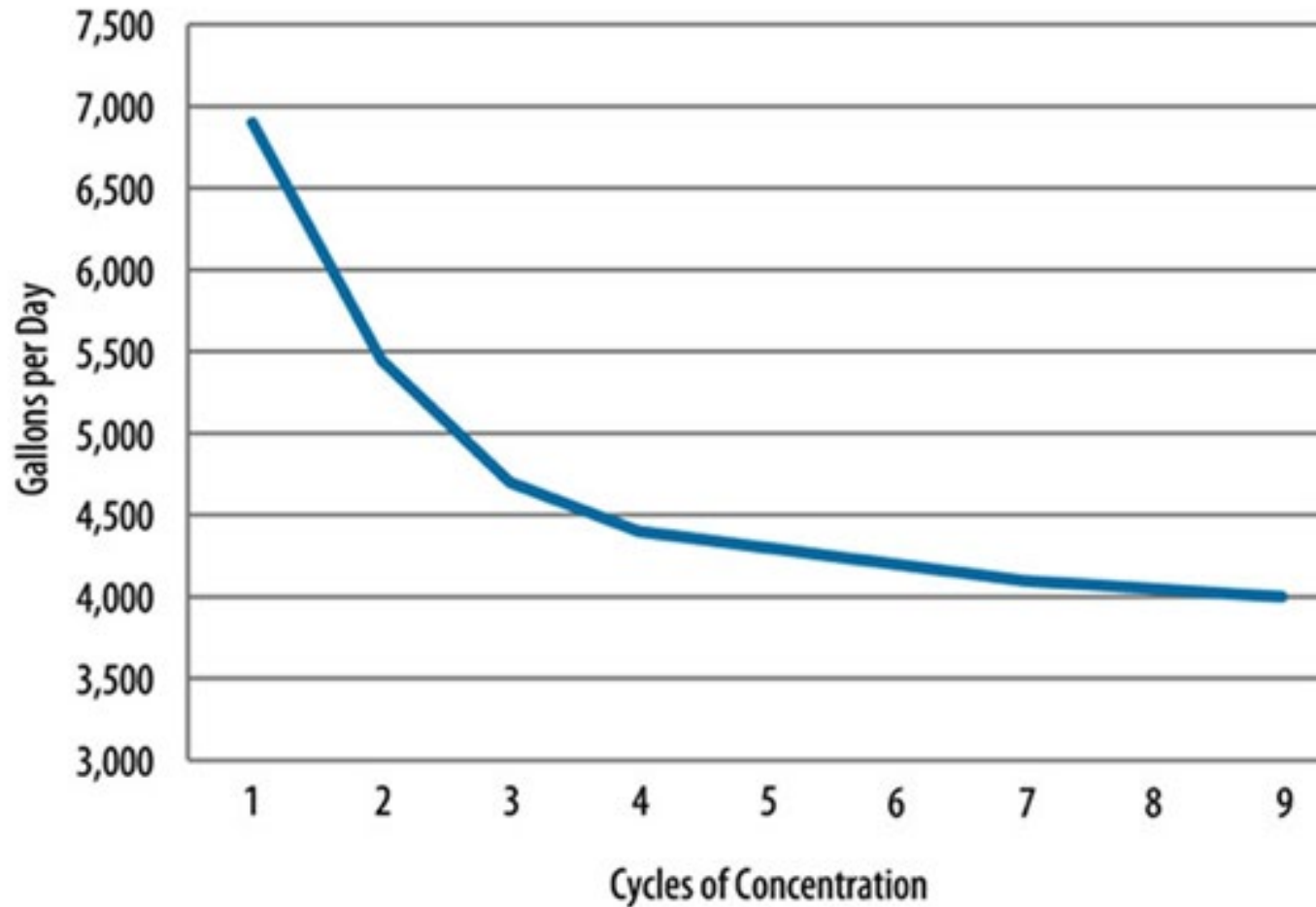
250 ton chiller #1



250 ton chiller #2

Cycles of Concentration = Make-up/Bleed (Blow-down)

Cycles of Concentration



Conductivity

- **Measurement of minerals in the water**
- **Conductivity controller usually measures μmhos**
- **The controller monitors the conductivity and opens and closes the bleed valve**
- **If too little water goes to the drain then there will be a build-up of minerals leading to scale**

Water treatment technicians do various tests to see quality of the water in the CT



Conductivity Testing

Sample from inside of CT - Blow-down or Bleed

Sample from inside of CT - Blow-down or Bleed

Cycles of Concentration:
 $1,416/979.6 = 1.4$ COC



pH trimming

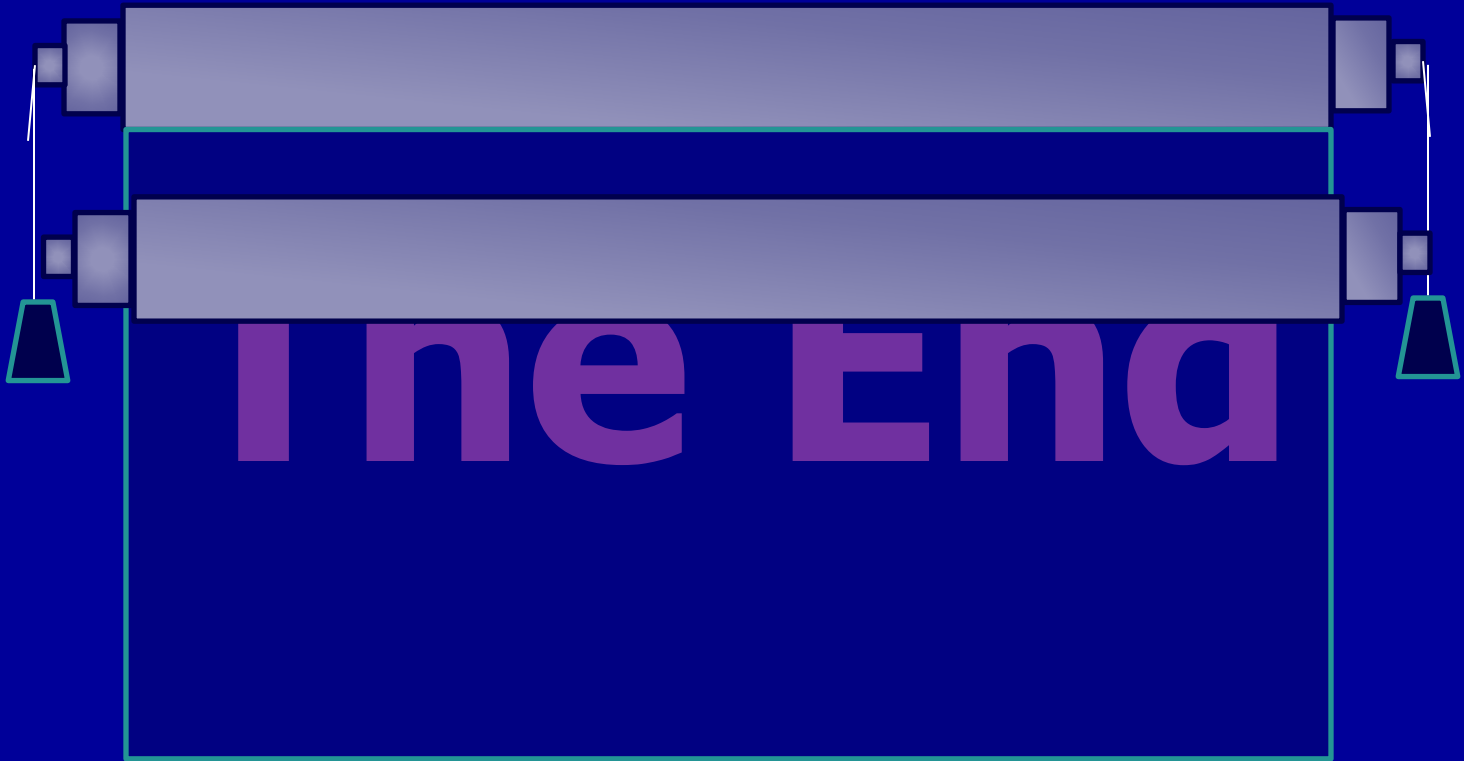
- **pH trimming: adding sulfuric acid to bring pH below 8.6. Scale (Calcium Carbonate) will form at this pH but inhibitor will make it drop to bottom reservoir**
- **pH in city water is normally in the 7.6-7.8 range**
- **pH in standard water treatment (3.0 COC) is in the 8.7-9.0 pH range**
- **Neutral is 7.0 pH**

Softeners for Cooling Towers

- **A softener has resin beads that attract Calcium and Magnesium**
 - Sodium on exchange sites of the resin is exchanged w/Calcium and Magnesium
 - Resin gets filled to capacity with Calcium and Magnesium and then resin is regenerated with a saline solution
 - The regeneration releases the calcium and magnesium to the waste stream
 - When calculating savings for a CT soft water system the make-up, bleed, and regeneration waste stream should be metered



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What is WaterSense?

- WaterSense is a voluntary program launched by EPA in 2006 that provides a simple way to identify water-efficient:
 - Products
 - Programs
 - Practices
 - Homes
- Products are independently certified for water efficiency **and** performance



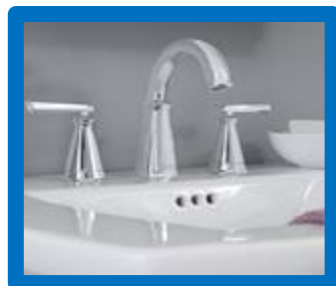


WaterSense Labeled Products

Indoor products



Showerheads



Lavatory
Faucets



NEW Point-of-use
Reverse Osmosis Systems



Tank-Type
Toilets



Flushometer
Valve Toilets



Flushing
Urinals

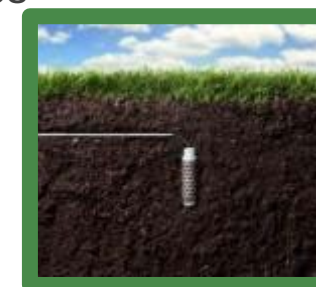
Outdoor products



Spray Sprinkler
Bodies



Weather-based
Irrigation Controllers



Soil Moisture-based
Irrigation Controllers

More than **45,000** product models have earned the label.

Best Management Practices



WaterSense at Work

Sanitary Fixtures and Equipment
3.1 Toilets (Water Closets)

Best Management Practices for Commercial and Institutional Facilities

EPA WaterSense
May 2023

WaterSense at Work

Sanitary Fixtures and Equipment
3.2 Urinals

Best Management Practices for Commercial and Institutional Facilities

EPA WaterSense
May 2023

WaterSense at Work

Sanitary Fixtures and Equipment
3.3 Faucets

Best Management Practices for Commercial and Institutional Facilities

EPA WaterSense
May 2023

WaterSense at Work

Sanitary Fixtures and Equipment
3.4 Showerheads and Bath and Shower Diverters

Best Management Practices for Commercial and Institutional Facilities

EPA WaterSense
May 2023

www.epa.gov/watersense/best-management-practices

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