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Ultrasound for Cooling Water Application

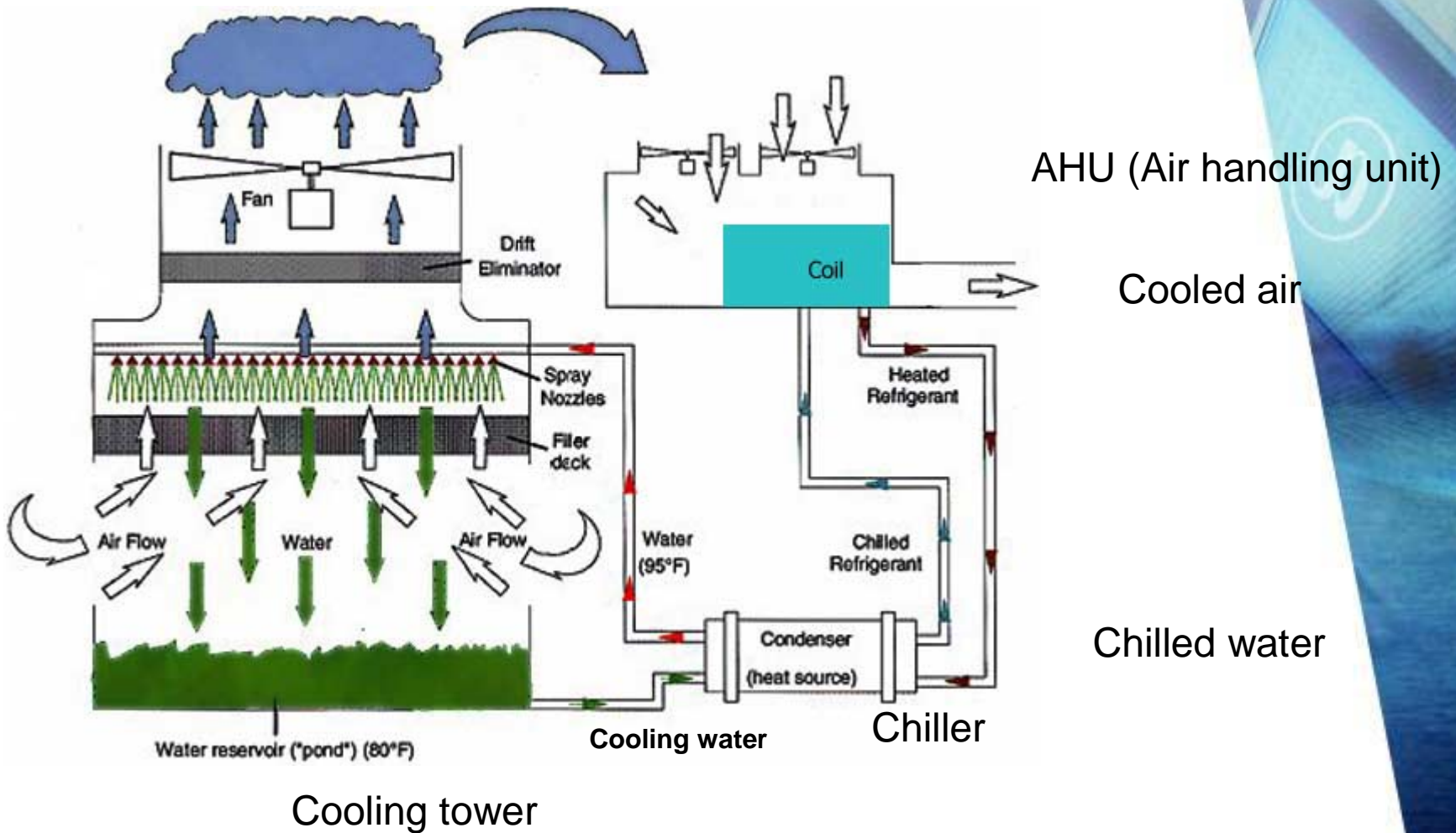
February 2, 2007

WINTECS CORPORATION

Consultant & Engineering

Cooling water System on Air conditioning

Drift with Legionella Bacteria



Cooling Tower (Hospital)

Drift



Circulating water : 1,000 tons/h
Holding water : 25m³



Inside of Tower

Scale & Deposit problem

Heavily scaled pipe

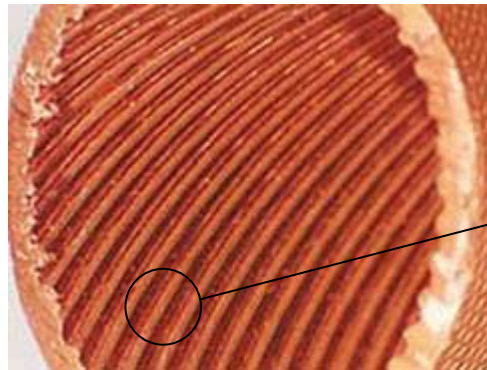


Heavily fouled
Chiller condenser

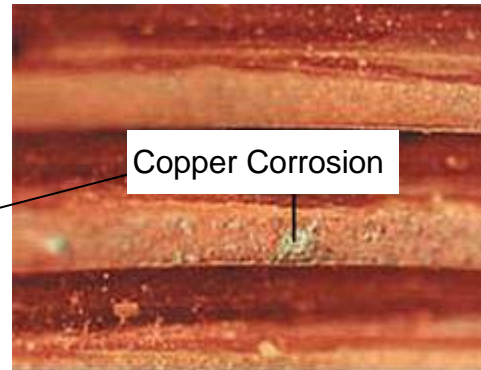


Scale formed in condenser tube

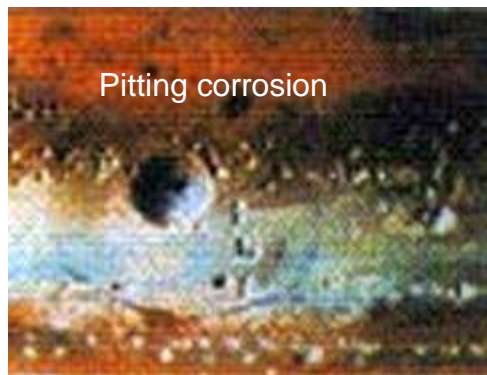
Corrosion problem



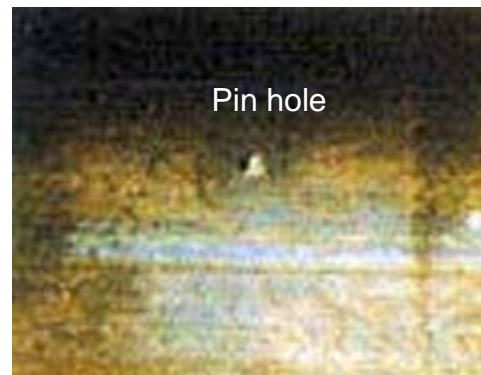
Inside of Condenser tube



Copper Corrosion



Pitting corrosion



Pin hole



Algae growth and Biofouling



Algae growth

Cooling tower pond



Upper basin



From Betz Water handbook

Bio-fouled sludge in pond

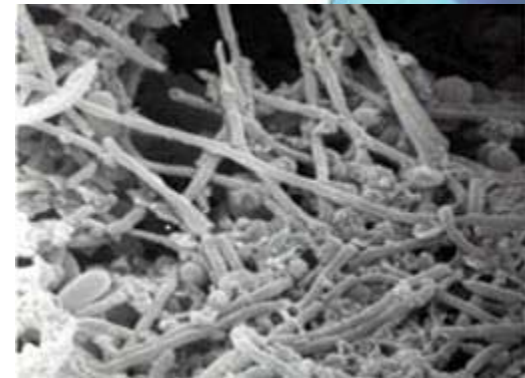


Legionella

Legionella is a major cooling water treatment control issue. Biofilm provides an environment for its rapid growth, then releases it into bulk water.

Legionella Ecology

- Rivers, lakes, sediment, sludge, scale, soils, organically-rich environments
- Growth between 68 - 113 F
 - dormant @ lower temperatures and does not survive above 140 F
- Aerobic, parasitic, protozoonotic



Biofilm

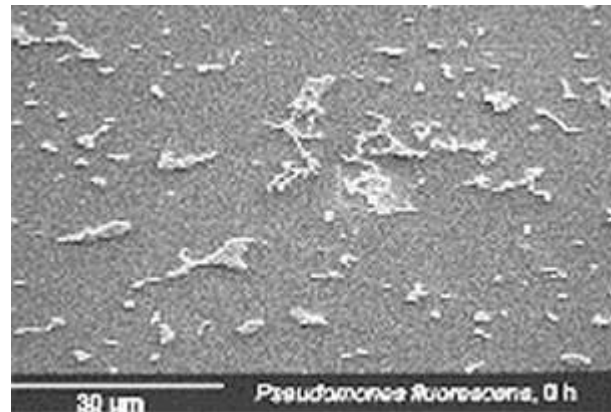


Legionella

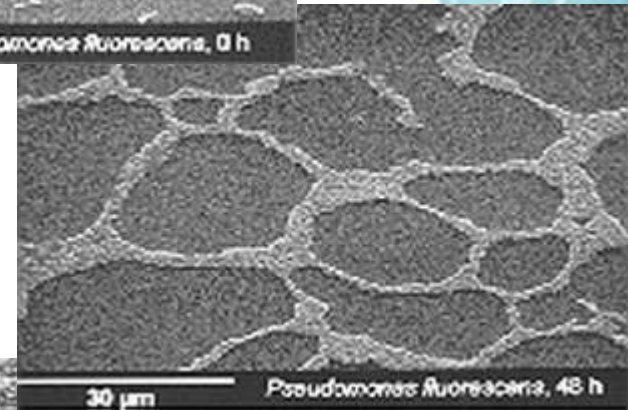
Biofilm Grows Exponentially On Surfaces

- **Initial population**

- Only two hours contact

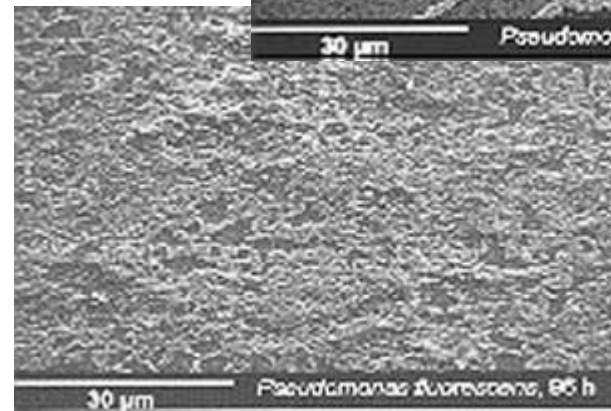


- **2 Days later**

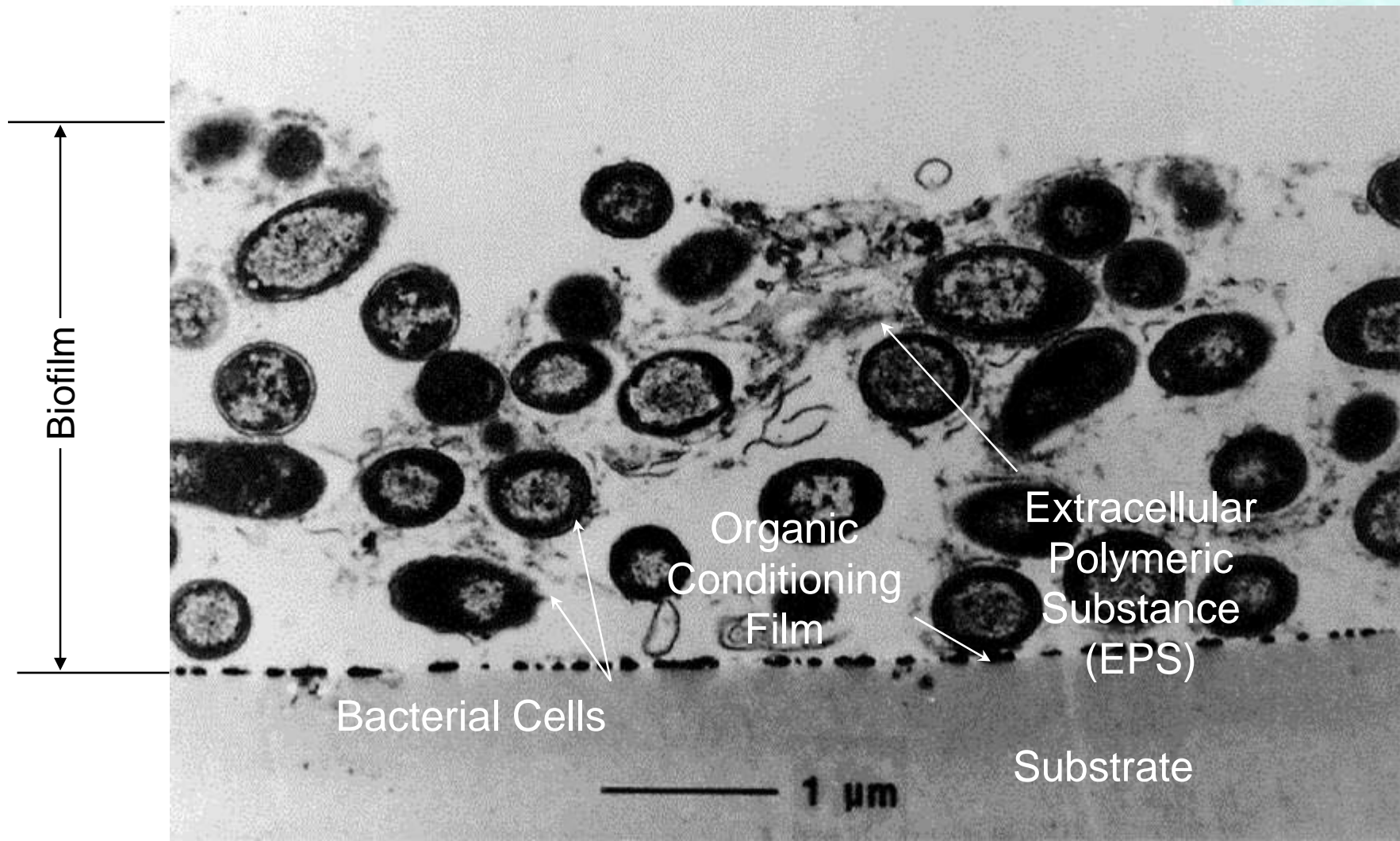


- **4 Days later**

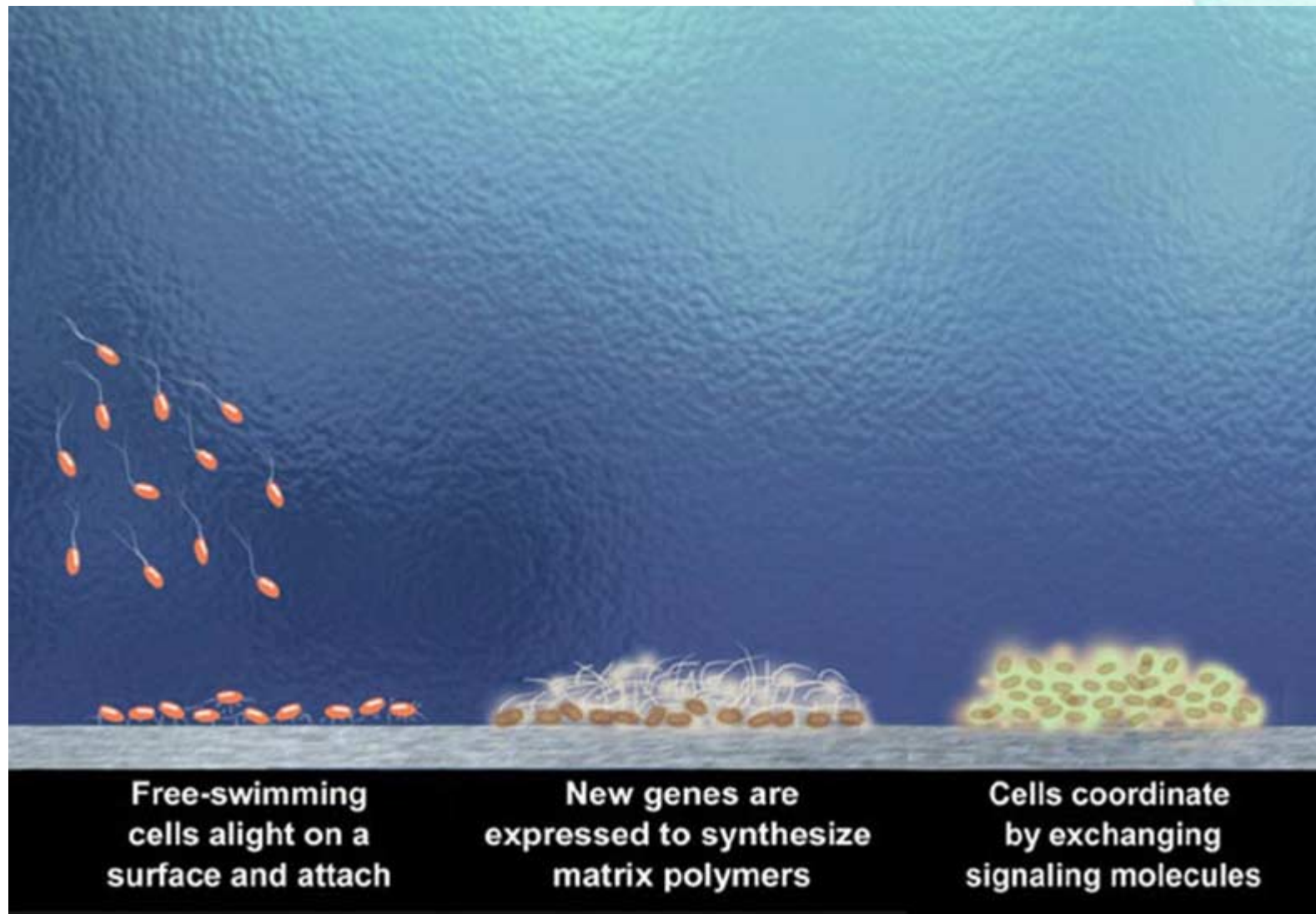
- A protective biofilm is formed
- Film thickness can be 100 microns



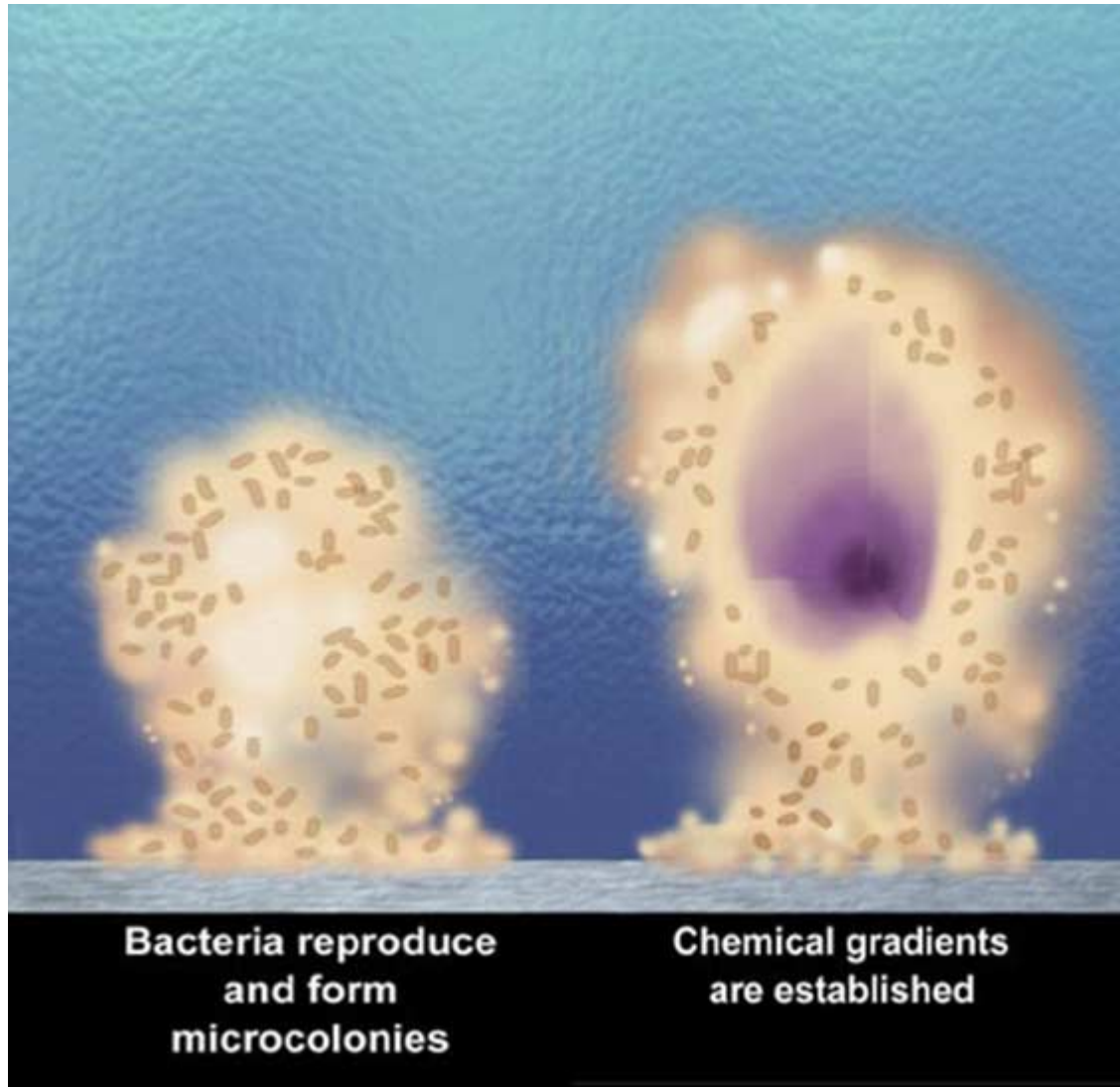
Biofilm section observation



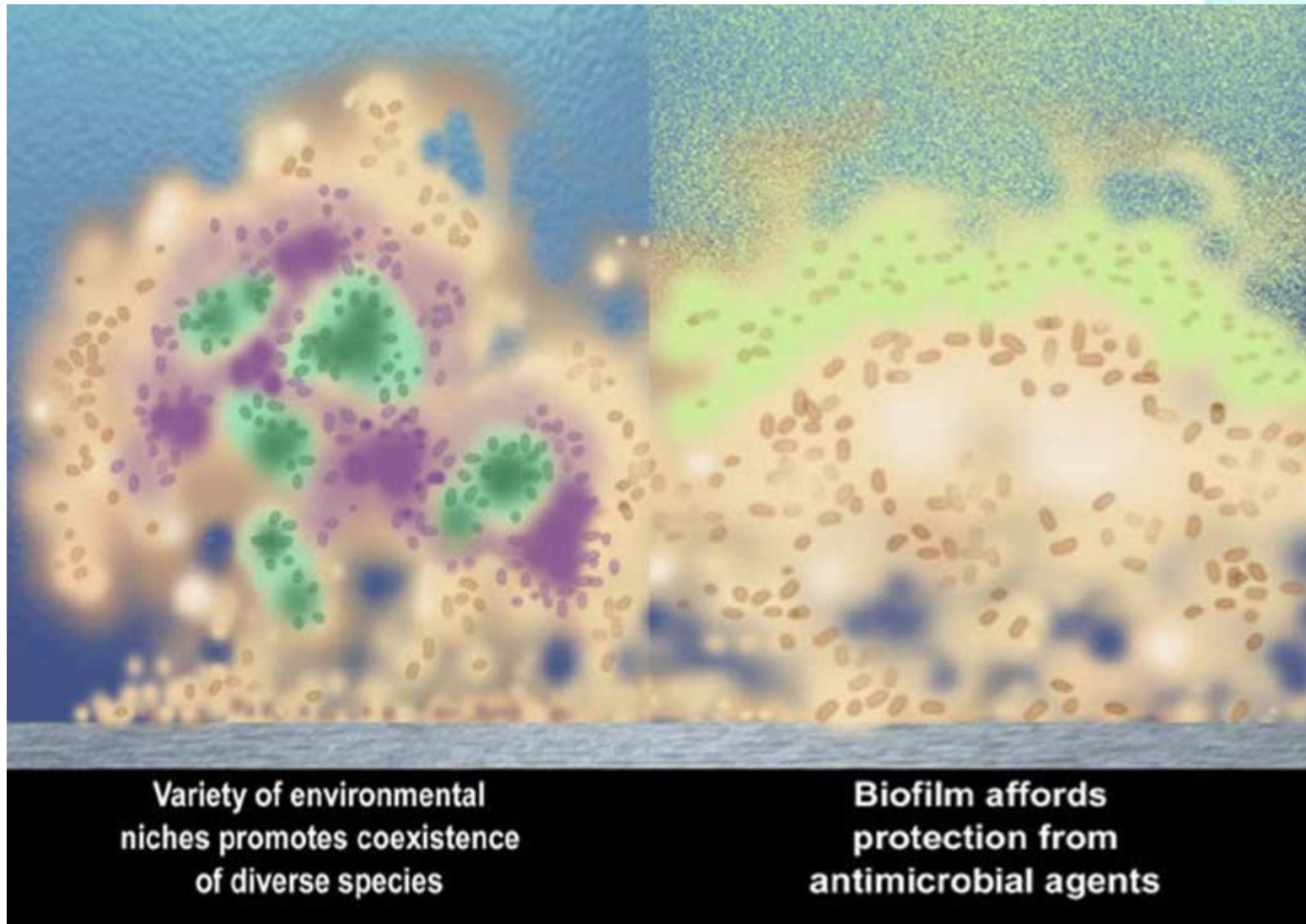
Biofilm Forming Process - Stage 1



Biofilm Forming Process - Stage 2



Biofilm Forming Process - Stage 3



Biofilm The fact of life

BULK LIQUID

- Most (99%) microorganisms are on surfaces and in aggregates
- Biofilm and cell aggregates are root causes of most problems

- ◆ Most biocides were designed to kill planktonic (free-floating) cells
- ◆ Trends in water treatment inhibit biocide performance



SUBSTRATUM

Problem on conventional cooling water treatment

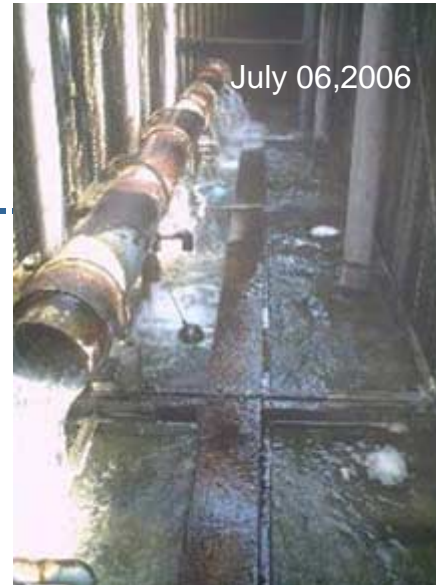
- Corrosion of cooling water mild steel pipe can be protected by corrosion inhibitor dosing, but condenser tube (copper tube) can undergo serious pitting corrosion caused by Microbiologically Influenced Corrosion (MIC) with improper microbiologic treatment due to poor biocide selection or incorrect operation of dosing timer.
- Legionella bacteria halogen (Chlorine or Bromine, etc.) treatment at higher dosage rates cooling water treatment, can sometimes accelerate corrosion problems. Ultrasound application would be expected to minimize the corrosion risk and simultaneously reduce consumption of halogen dosing.
- Higher water reuse and recycle trends predominant in the microelectronic industry, prefer alternative treatment like ultrasound, ozone and UV more so than chemical treatment.

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Cooling Tower for LG-XL Evaluation

Holding water : 18m³
Circulating water : 900 t/hr



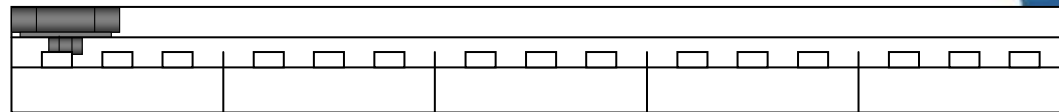
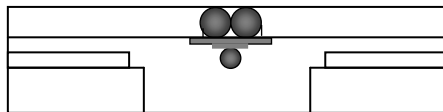
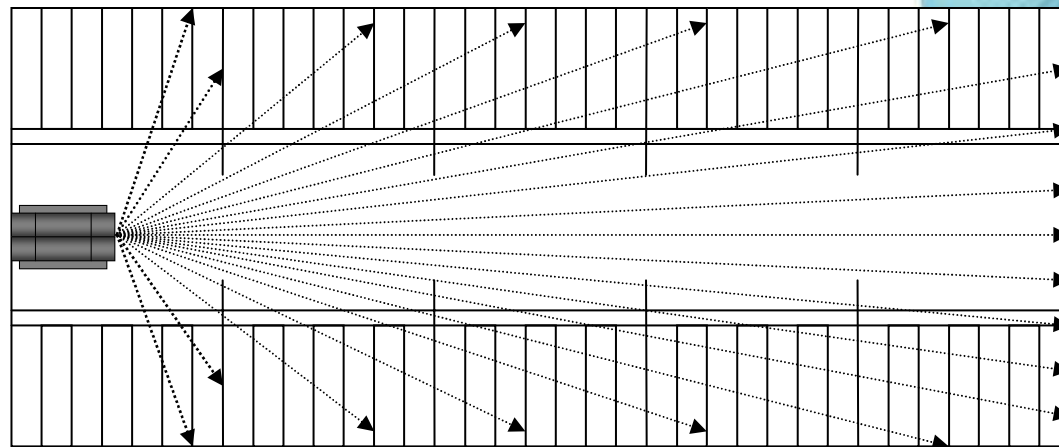
Inside of Tower



Pit bottom

Ultrasonic LG XL

Ultrasonic beam seems to be not reached to the end of pit, but cooling water is circulated all the time.



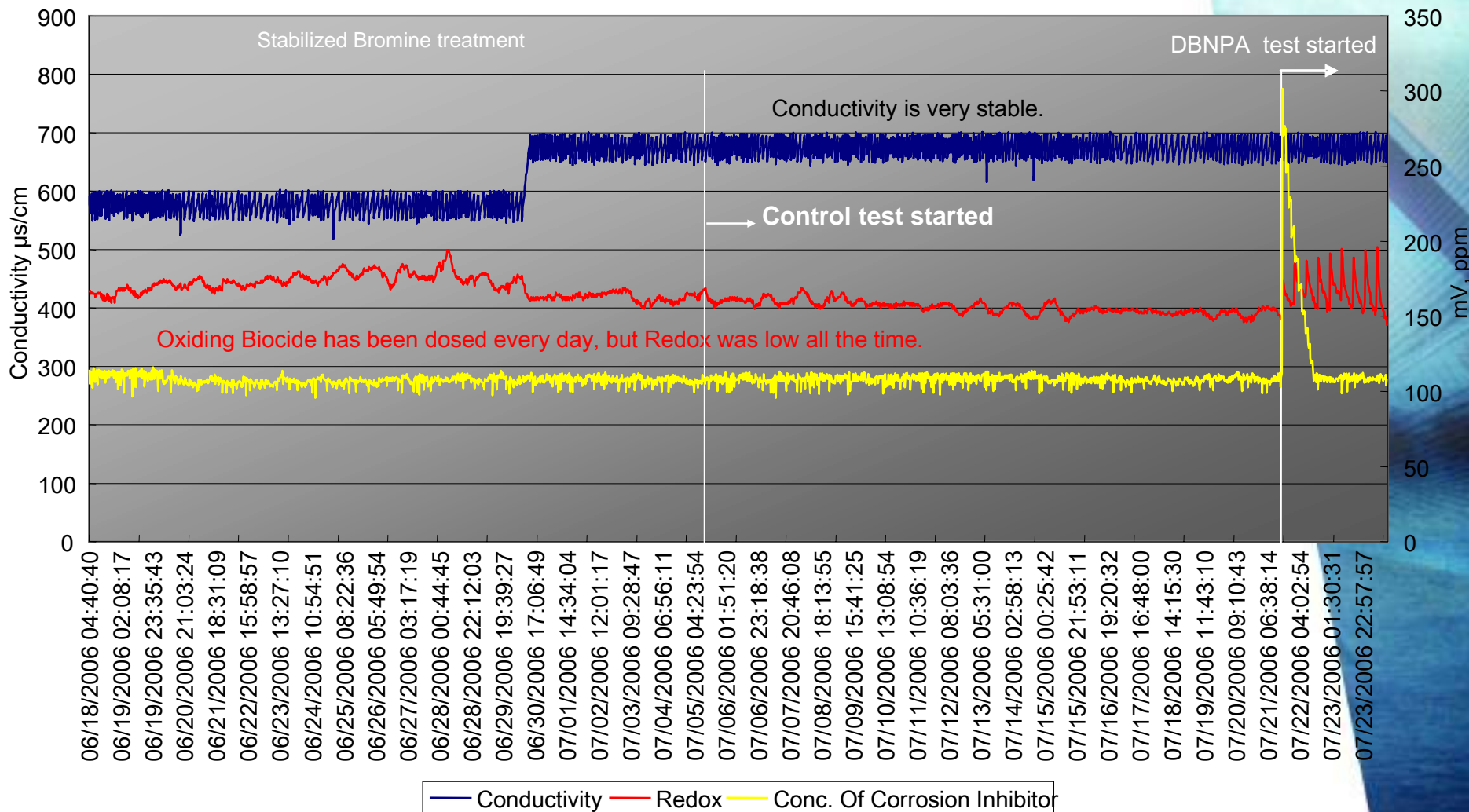
R-1 Control Cooling Tower (No LG Treated)



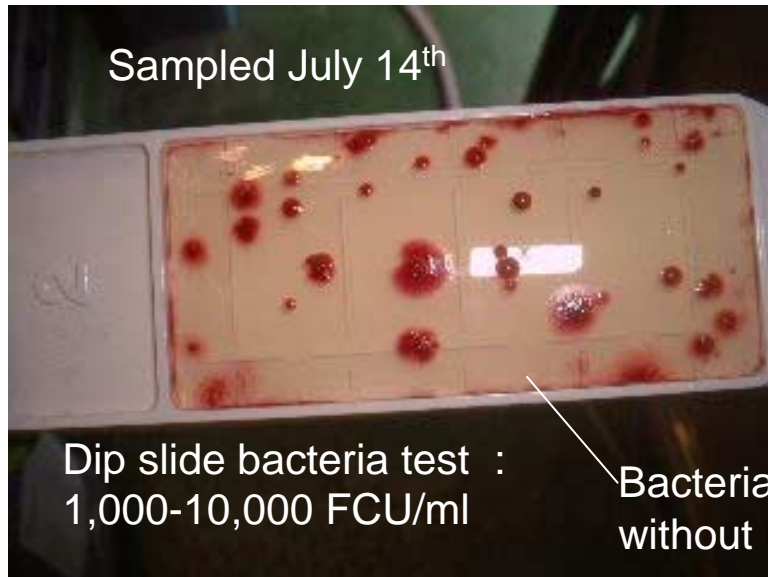
Black sludge is covered
the bottom of the pit.

- Tower pit looks very dirty because of standby in winter time.
- Oxidizing Biocide has been fed by timer several times in a day.
- Organic Bromine Biocide test started from July 21st.

R-1 Chiller (No LG Treated)



R-2 Cooling Tower LG XL Treated



Bacteria count seems to be lower even without Biocide dosing



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Started



July 06,2006

A lot of foaming observed

July 14,2006



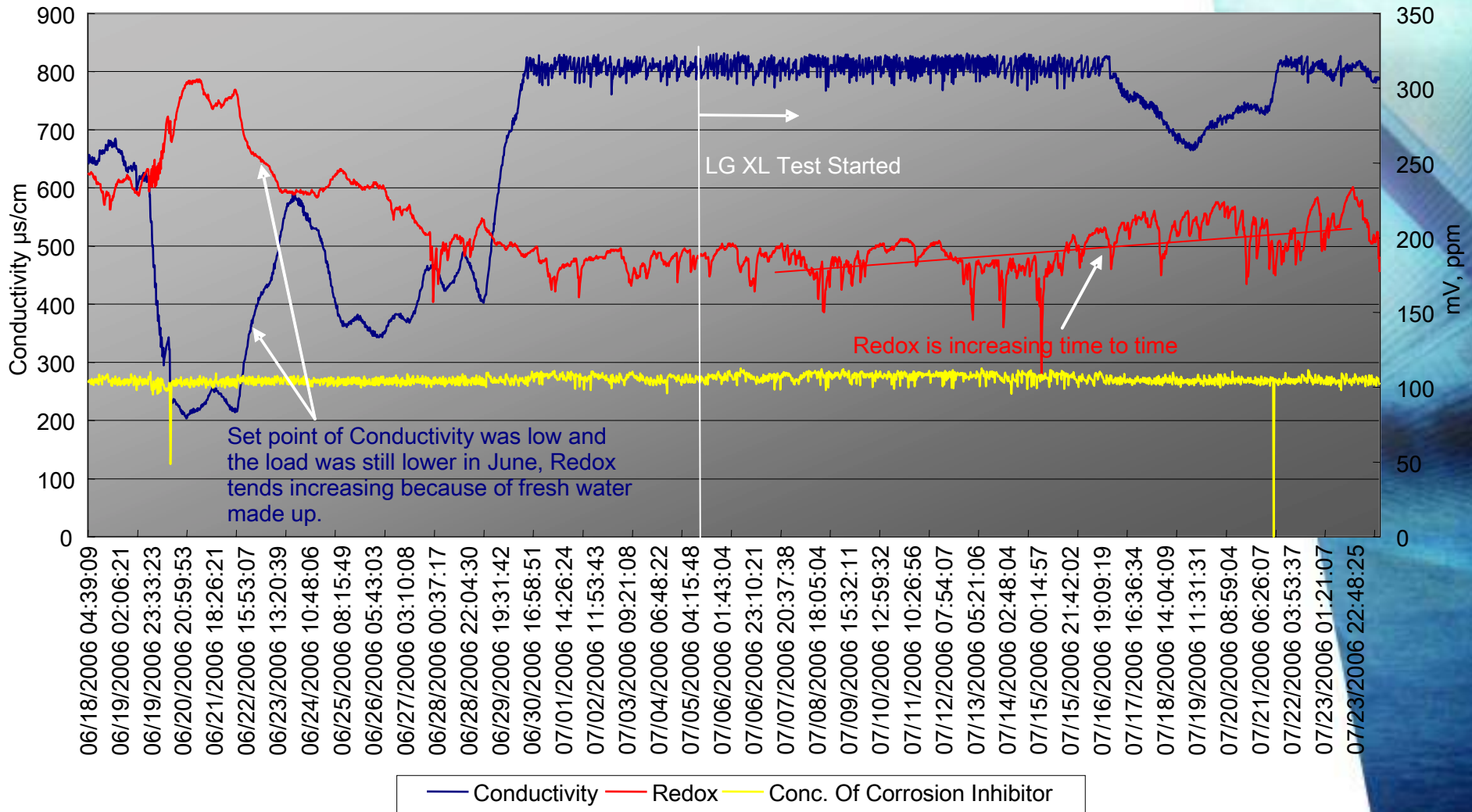
1 week later

July 24,2006



3 weeks later

R-2 Chiller (LG XL Ultrasonic Treated)



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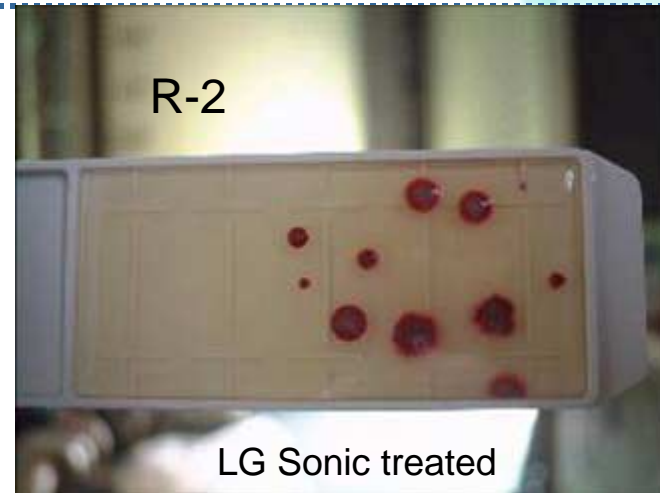
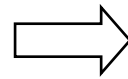
July 31st, 2006 R-2 LG XL Ultrasonic Treated



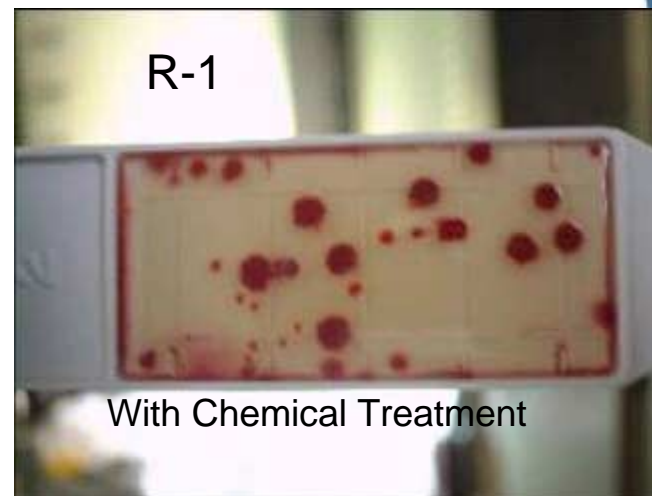
Bacteria Counts measurement



Sampled July 14th



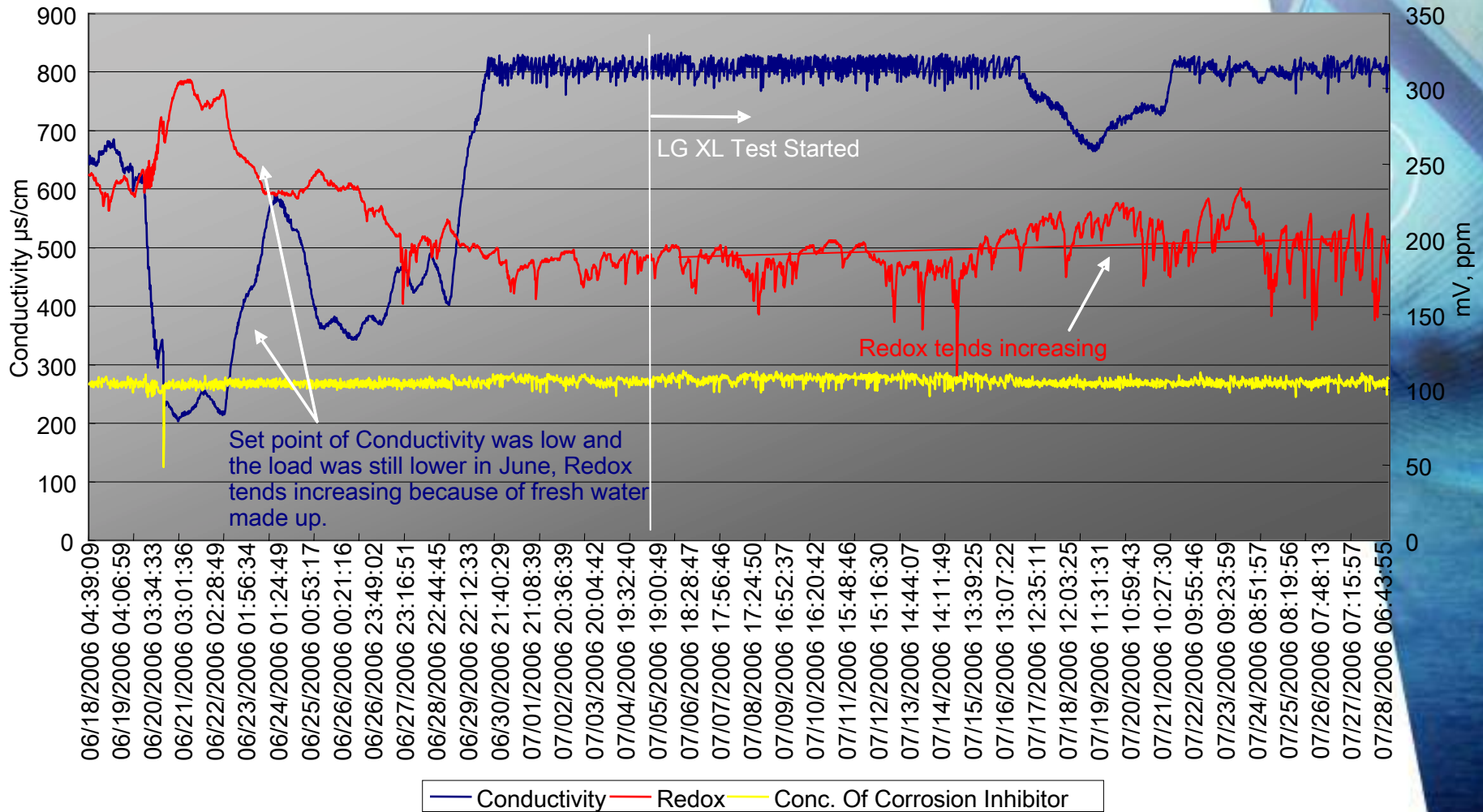
Sampled July 28th
Bacterial count is lower than
two weeks ago.



With Chemical Treatment

R-2 Water Quality trend

R-2 Chiller (LG XL Ultrasonic Treated)



Legionella Count Measurement

Legionella bacteria was determined as following;

(Sampled July 31)

R-1 DBNPA treatment	300 CFU/100mL
R-2 LG treatment	110 CFU/100mL

(Sampled Aug 03)

R-1 DBNPA treatment	150 CFU/100mL
R-2 LG treatment	50 CFU/100mL

(Sampled Aug 08)

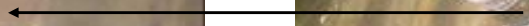
R-1 DBNPA treatment	120 CFU/100mL
R-2 LG treatment	80 CFU/100mL

R-2 result shows that Ultrasonic is able to control Bacteria, even effective for Legionella by controlling biofilm formation.

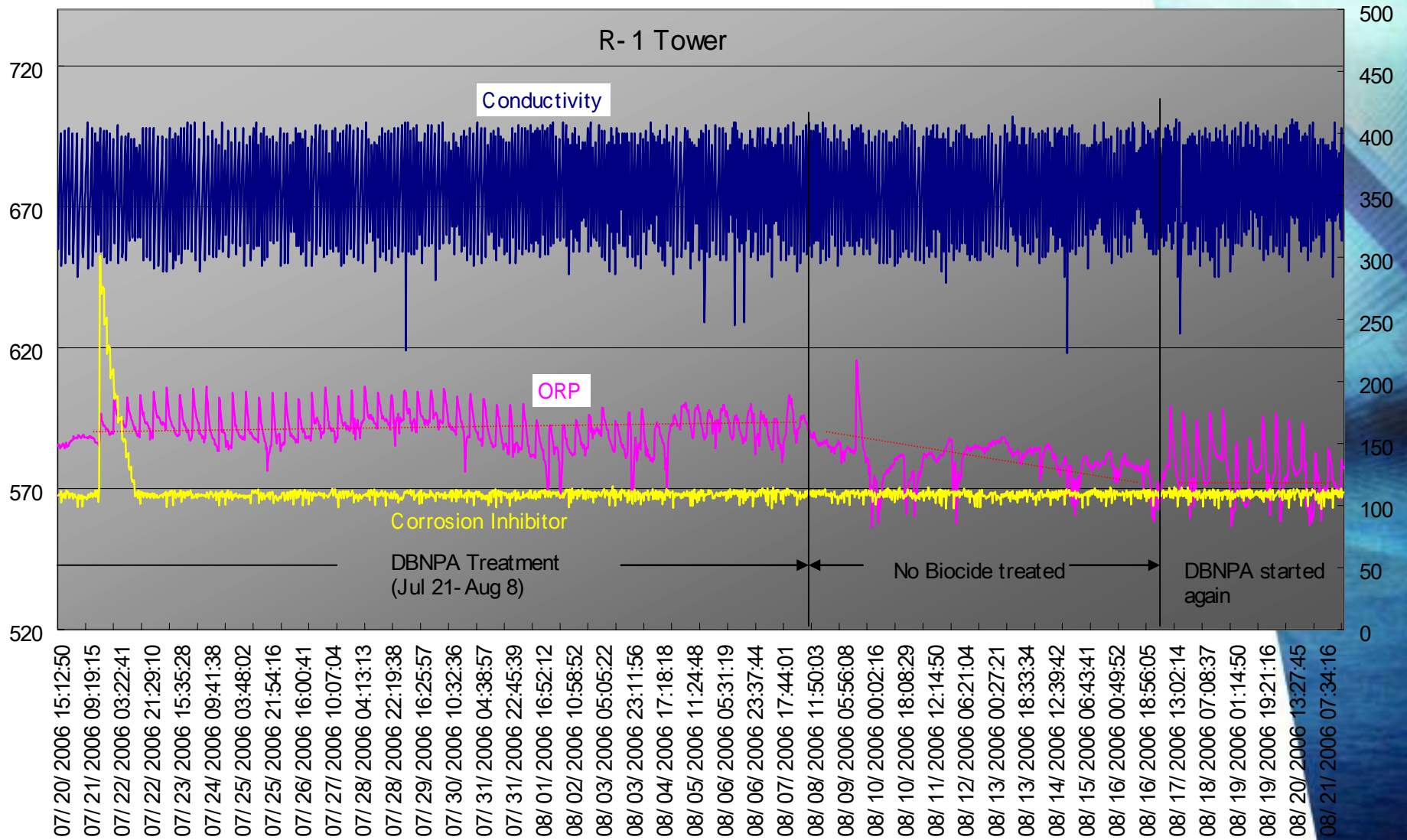
Limitation : <100CFU/100mL

August 15, 2006

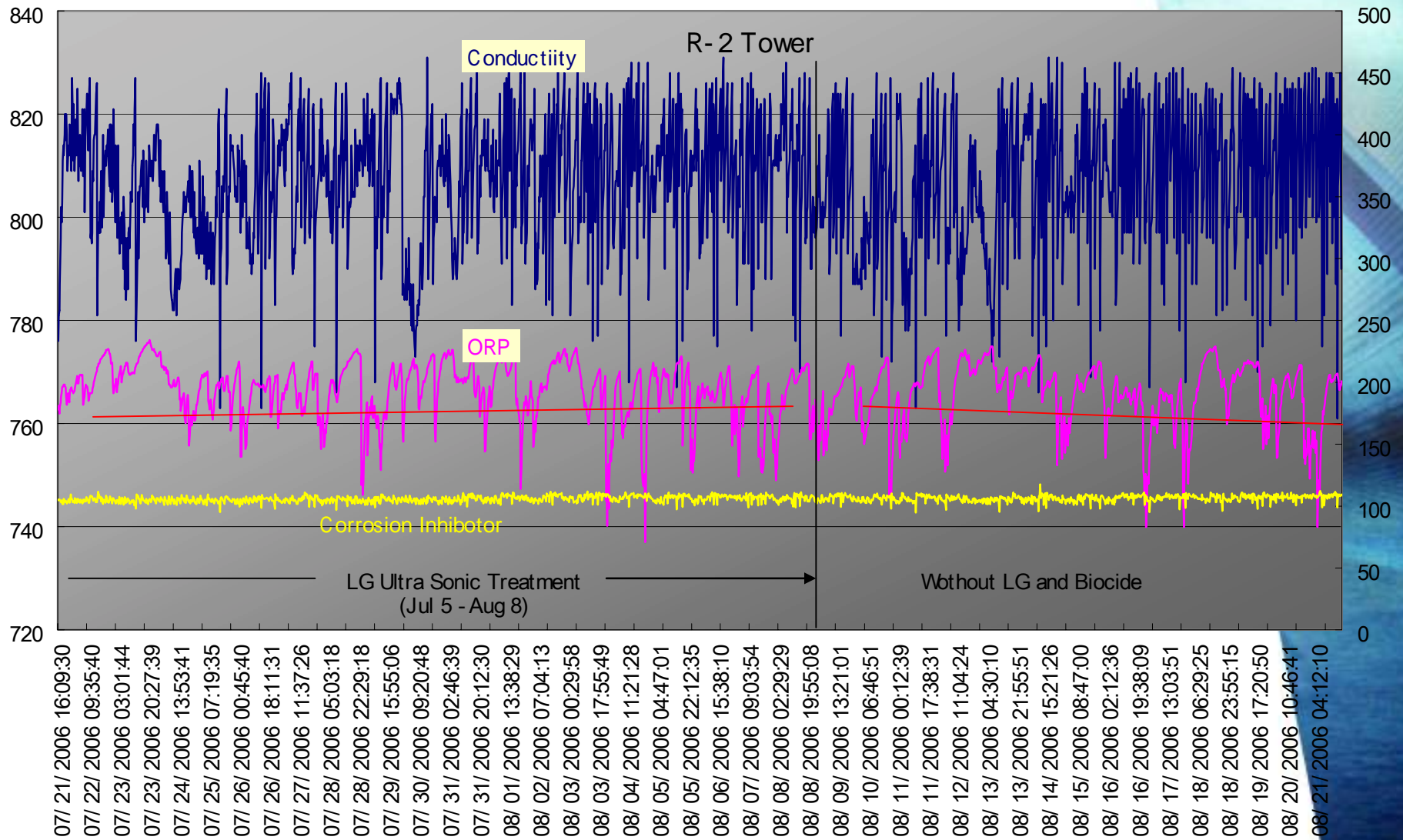
A week after stopped LG XL treatment



ORP trend on R-1 Decreased after DBNPA treatment



ORP on R-2 Showed Little Change After LG XL Treatment



Another Trial: Small Cooling Tower



-Operation Condition : Operated from June to October

Recycled water (RO treated water, having Conductivity of 6-8ms/m) is supplied under the concentration cycle of 3-4, in set point 20ms/m Conductivity controller.

- Location : C-1 Cooling tower has the location having most sunlight in 3 Cooling towers on this building..

- Capacity : 120 USRT Chilling Unit having 1.5 m3 holding water in the system

- Chemical Treatment:

Stabilized Bromine as Biocide (Stopped during this evaluation)

Phosphonate, Polyacrylate, Corrosion Inhibitor maintained 100ppm level in cooling water.

2-2C C-1 (started test in August 7)



- Algae grows in pit and on the wall.

- Bleed water stream shows very heavy algae growth.



Drain stream of Cooling tower bleed

2-2C C-1 (September 9)

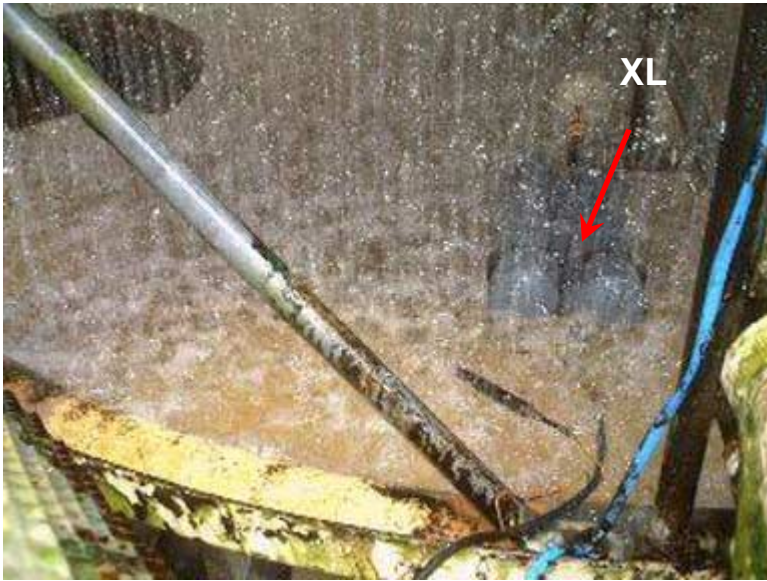


- Much of the algae removed.
- Drain stream algae was also reduced.

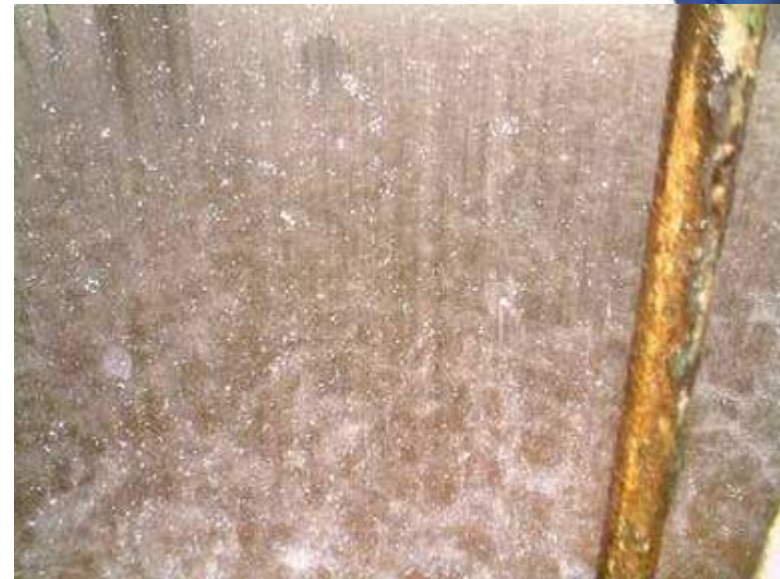


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2-2C C-1 (September 12)



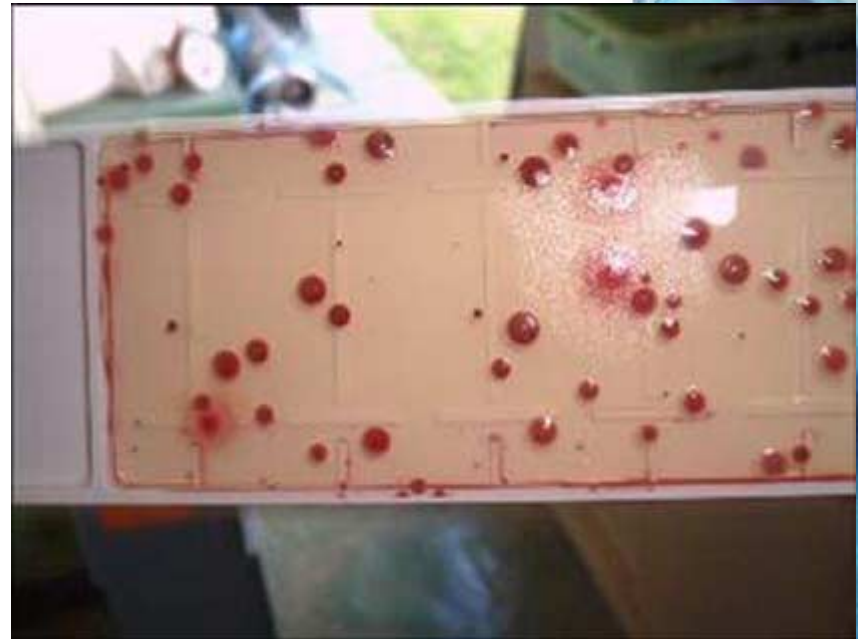
2-2C C-2 Cooling tower (September 12)
With chemical treatment



Bacterial Count Test (August 29)

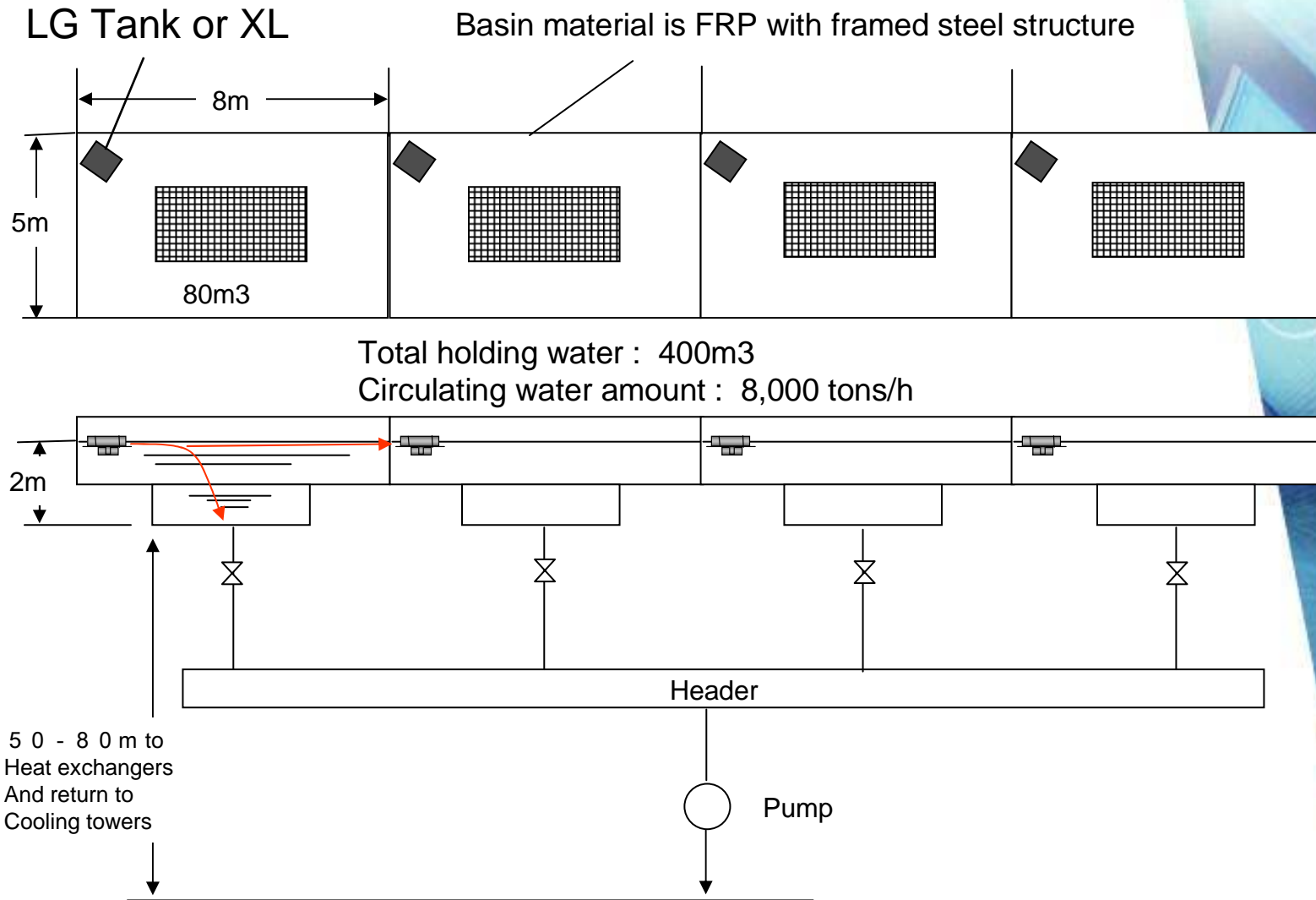


**C-1 Cooling Tower
(with LG Ultrasonic)**

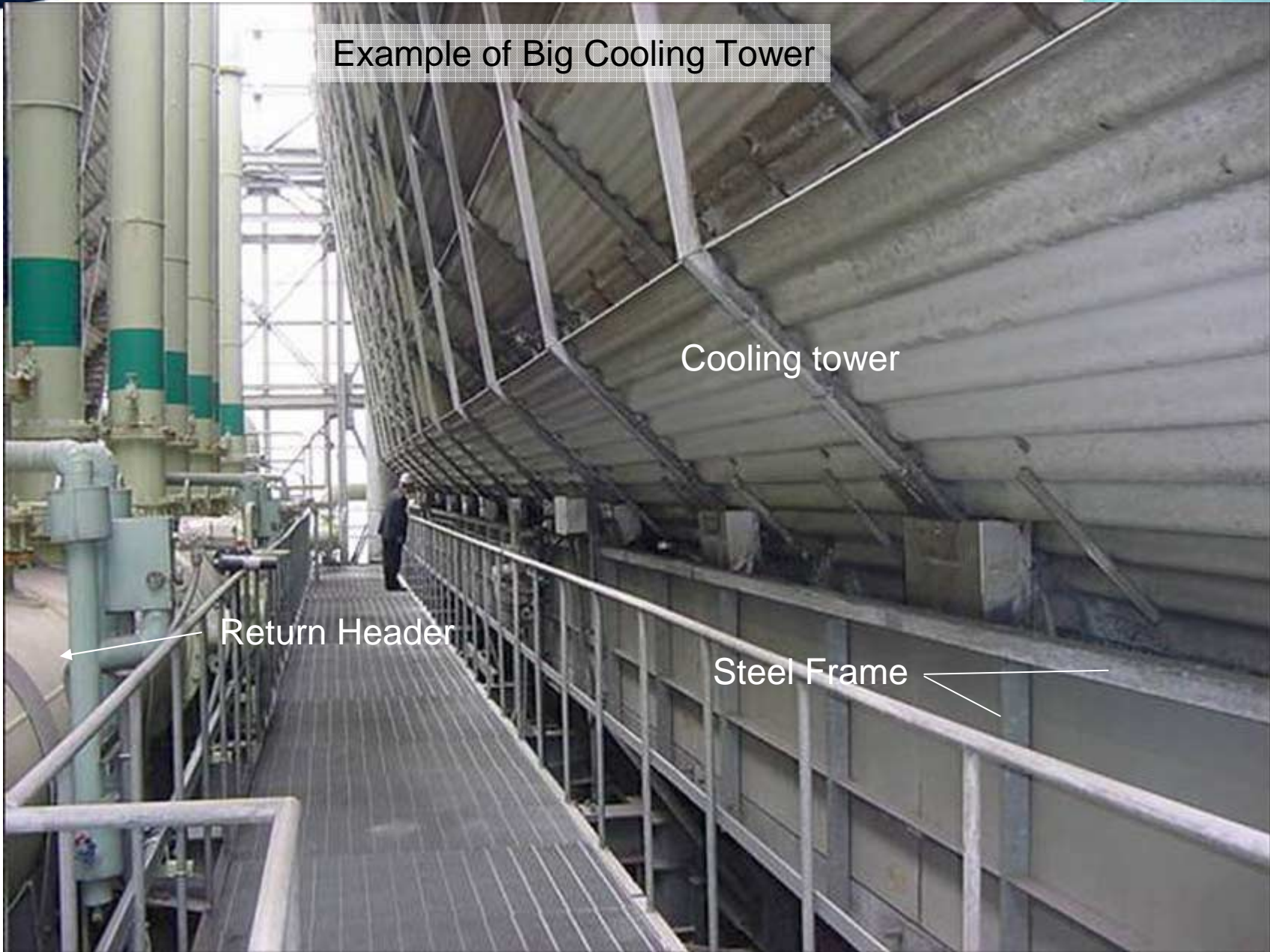


**C-2 Cooling Tower
(with Chemical Treatment)**

Discussion for Large Cooling Tower System



Example of Big Cooling Tower



Cooling tower

Return Header

Steel Frame



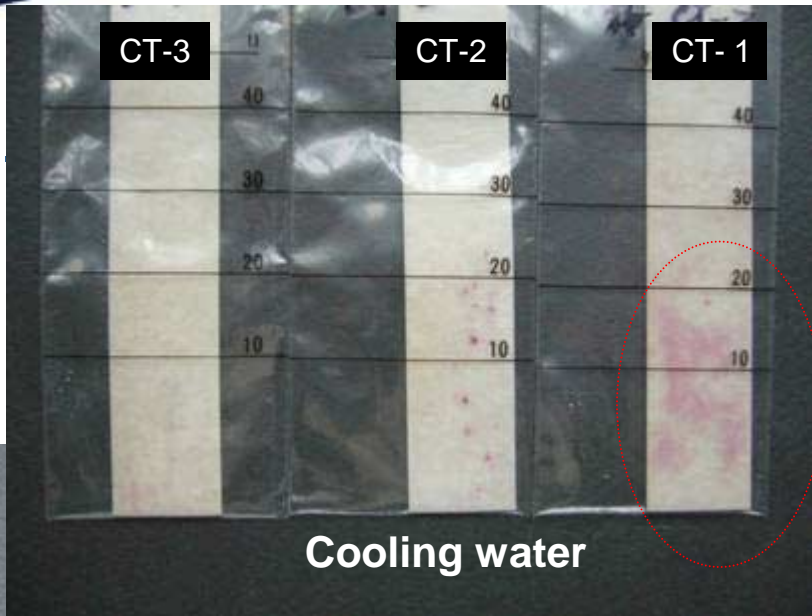
Overflow

Eliminator

Makeup water

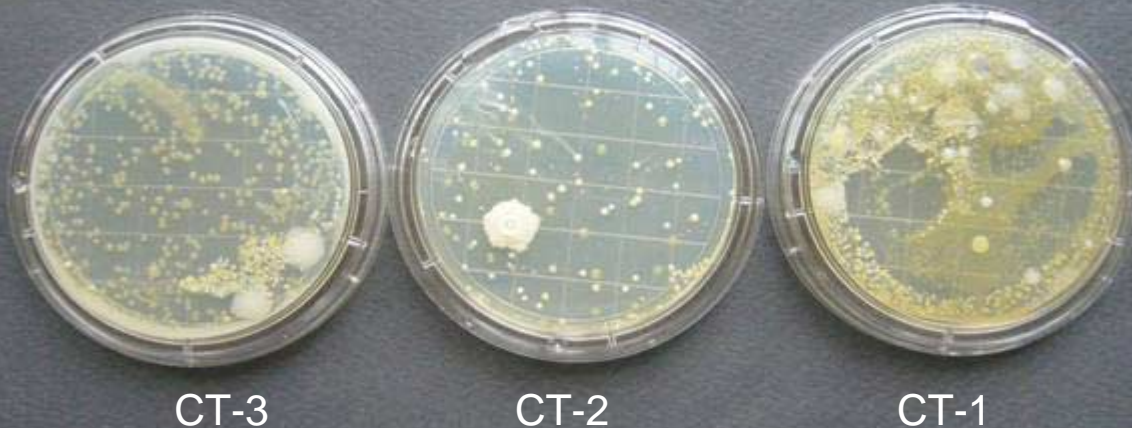
Pond

Inside of Cooling tower pond



Contamination level of Cooling water and tower pond wall

Co-gen cooling tower

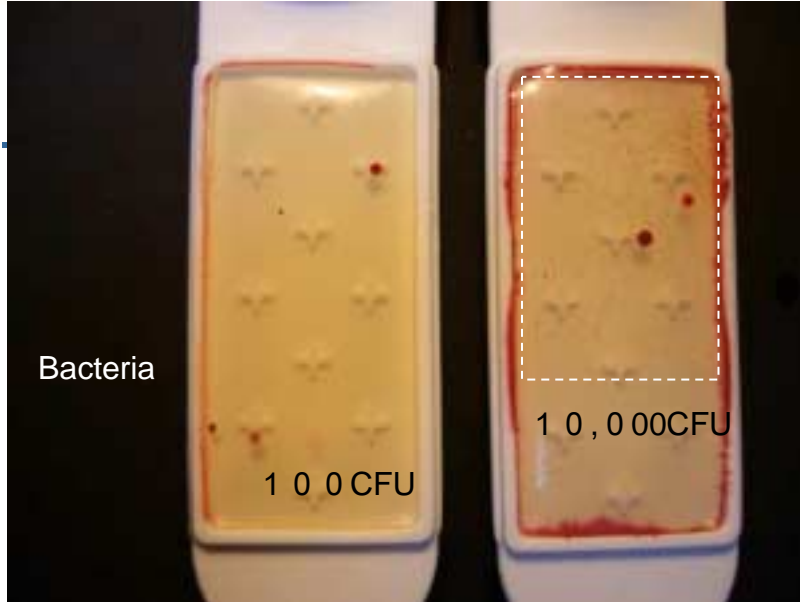


Cooling tower pond wall

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Cooling water

Tower wall



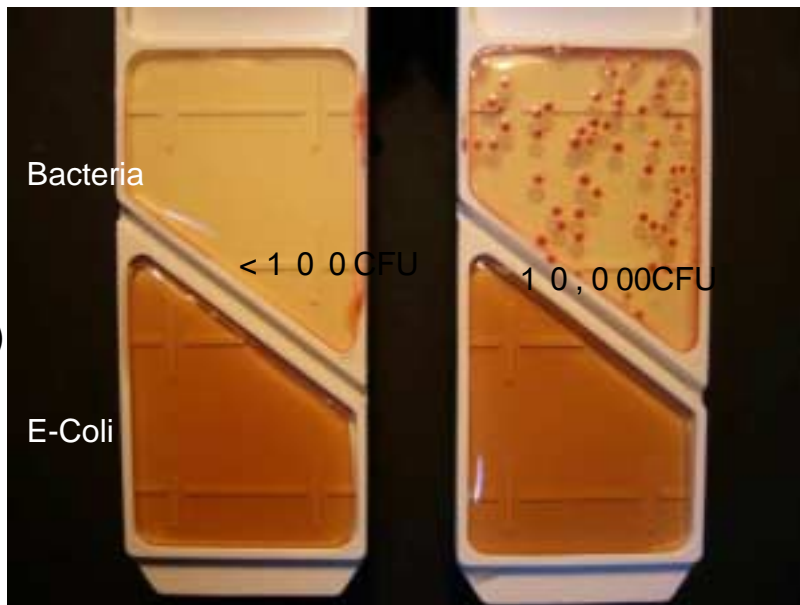
Cooling water

Tower wall



Cooling water

Tower wall



Cooling water

Tower wall



Palintest
(UK)

Bio-check
(Japanese)

Possibility & Expectation

- LG Sound Ultrasonic products control bacteria population in cooling tower systems by severely inhibiting biofilm formation providing a large market potential in cooling water treatment applications.
- It is well known that Legionella propagate by reproduction within larger bacterium hosts as a parasitic organism. Biofilm reduction in these systems by ultrasonic treatment lowers the probability of Legionella finding a suitable host, thus reducing their numbers.
- Air conditioning small cooling towers (100-1000 USRT) are easily treated by ultrasonic treatment. Larger more complex towers will require multiple units for coverage.
- Ultrasound treatment impact on reduced biofilm growth can significantly reduce overall chemical treatment costs.