WATERTECH

BOOT CAMP
LEVEL II

Welcome to

WATERTECH

BOOT CAMP
LEVEL II

TODAY’S SPEAKERS

- JOE RUSSELL – PRESIDENT – 30+ YEARS OF EXPERIENCE
- JEFF FREITAG – DIRECTOR OF SALES – 25 YEARS OF EXPERIENCE
- MATT JENSEN - DIRECTOR OF APPLIED TECHNOLOGIES – 12 YEARS

WATER TESTING TECHNIQUES

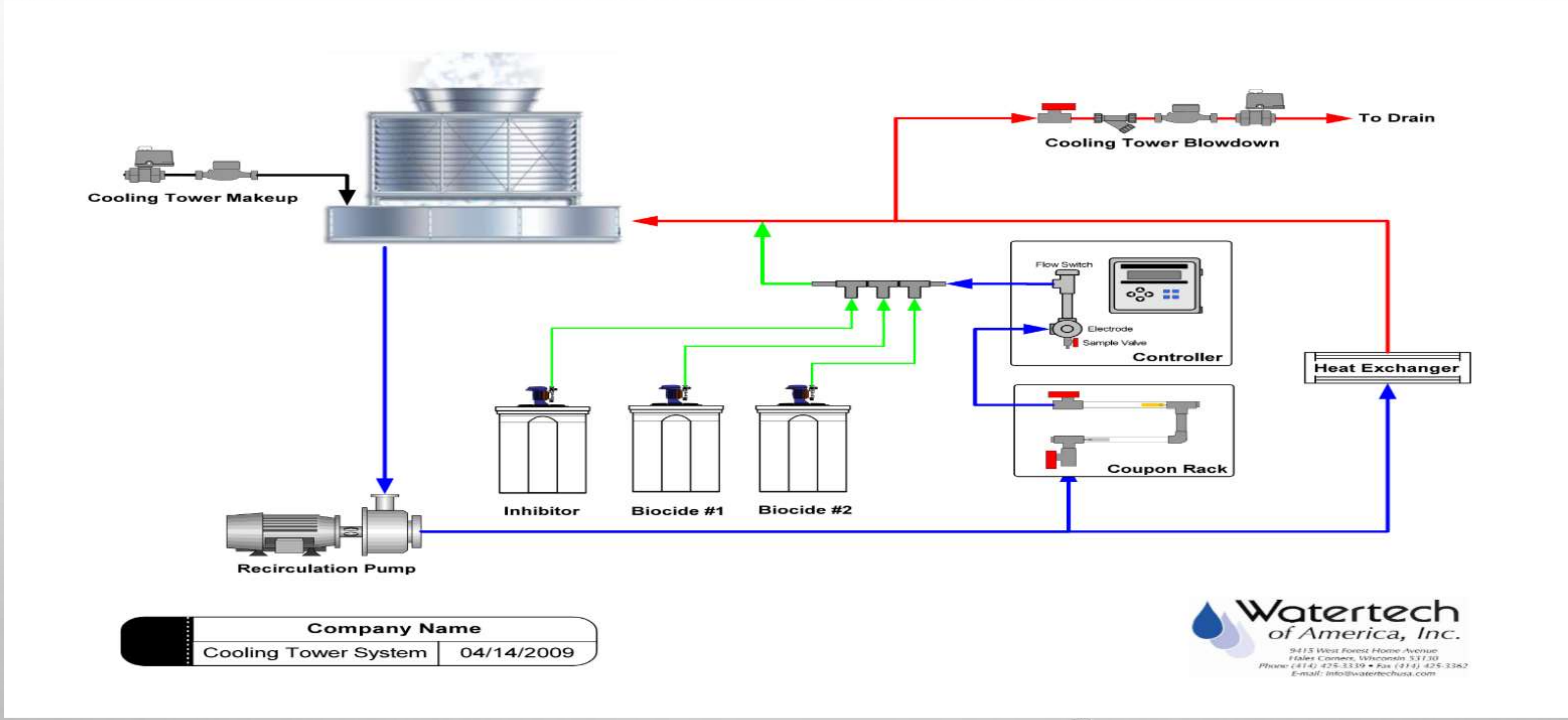
PRESENTED BY:
MATT JENSEN, CWT

- SAMPLING: PROPER LOCATIONS AND TECHNIQUES
- WORK STATION
- TESTING TECHNIQUES

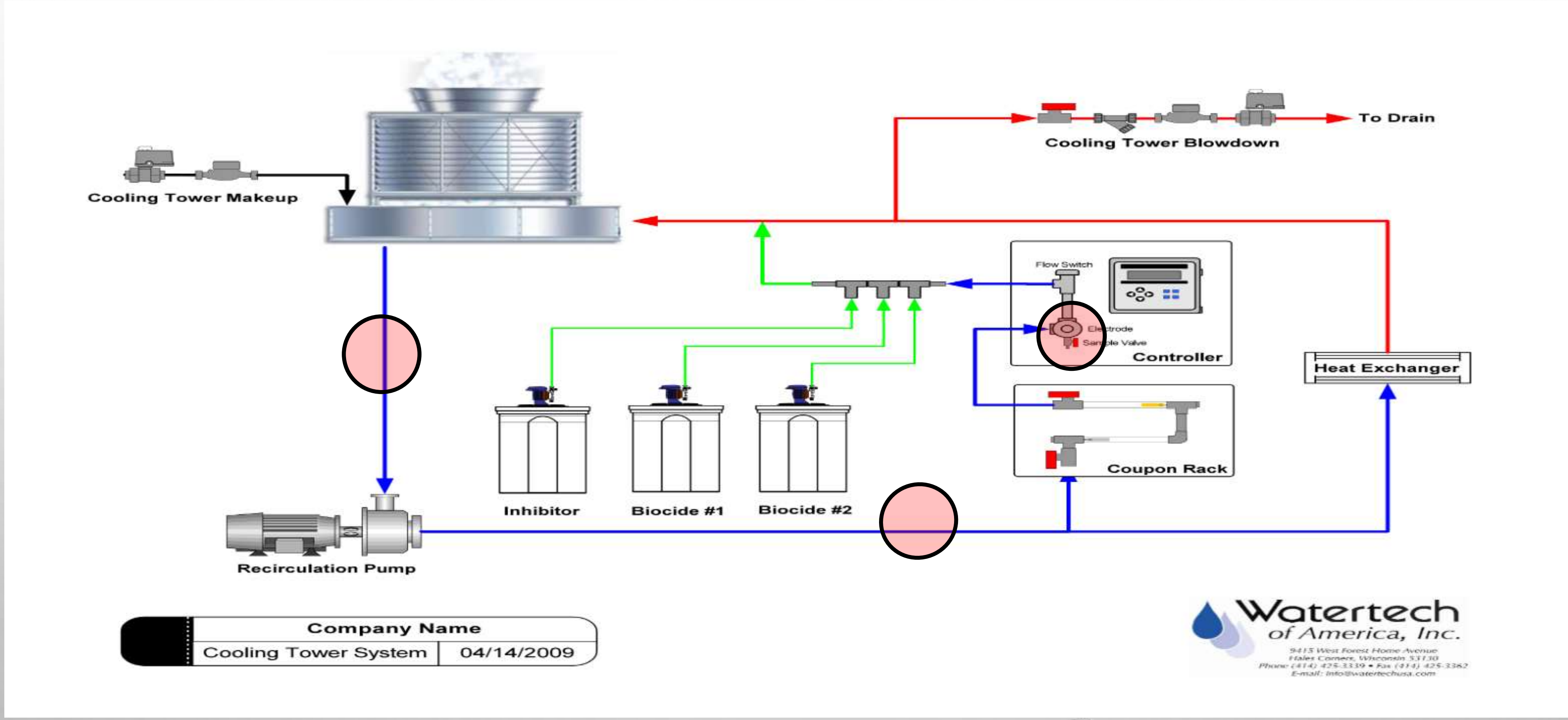
GENERAL SAMPLING TECHNIQUES

- A GOOD SAMPLING CONTAINER
  - PREFERABLY WITH A HANDLE TO MINIMIZE EXPOSURE TO WATER
- WEAR GLOVES
  - SOME OF THE REAGENTS ARE NOT NICE
    - PHENOLPHTHALEIN IS A CARCINOGEN
      - IT WAS A LAXATIVE FIRST…
- ALWAYS RINSE THE SAMPLE BOTTLE 3 TIMES
  - THIS REMOVES CONTAMINANTS AND “COMPLETES THE MATRIX”
  - BOTH SAMPLING BOTTLES AND TEST VIALS AND CUVETTES

COOLING TOWER SAMPLING



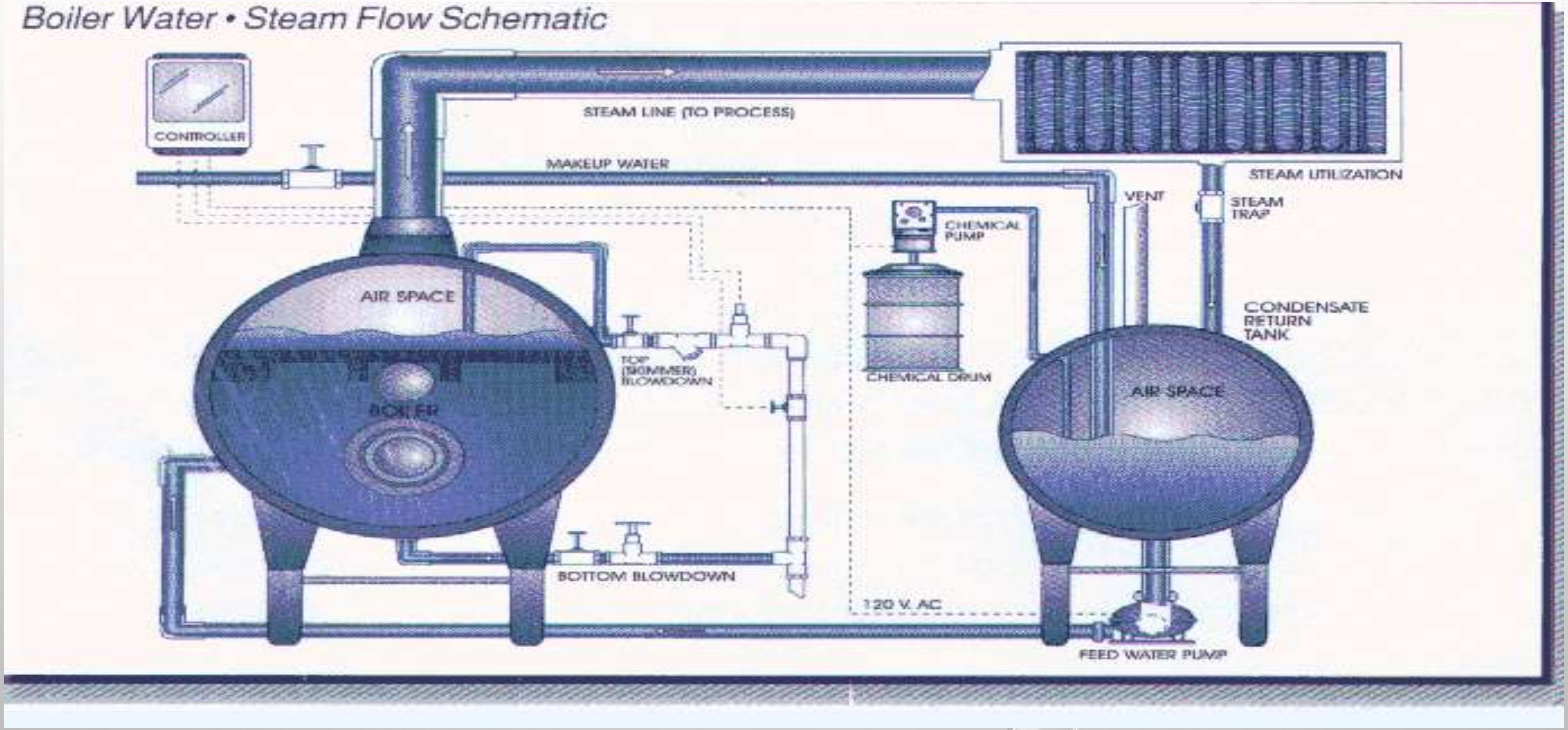
COOLING TOWER SAMPLING



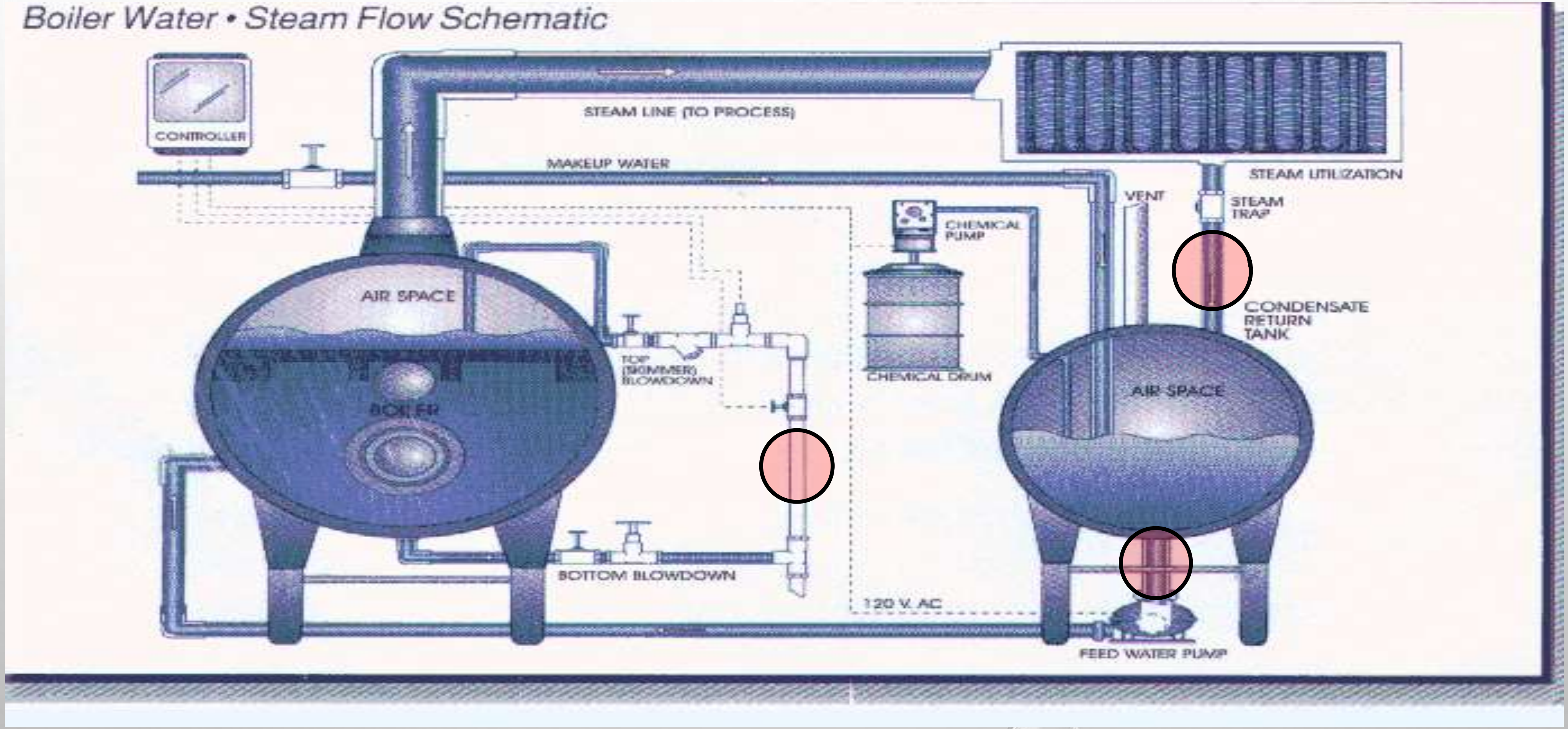
COOLING TOWER SAMPLING

- WHY THERE???
  - YOU WANT TO SAMPLE THE "DIRTIEST" WATER
    - TSS, TDS, ENVIRONMENTAL CONTAMINATION
  - YOU WANT TO SAMPLE THE WATER PRIOR TO THE CHEMICAL FEED
    - IF ITS FEEDING WHEN SAMPLING THE NUMBERS WILL BE SKEWED
  - BIOLOGICAL TESTING IS MOST REPRESENTATIVE AFTER THE TOWER
    - LOSS OF OXIDANT, ENVIRONMENTAL LOADING

BOILER SYSTEM SAMPLING



BOILER SYSTEM SAMPLING



BOILER SYSTEM SAMPLING

- BOILER
  - SAMPLE FROM THE SKIMMER OR THE BOTTOM BLOWDOWN
  - NEVER FROM THE SIGHT GLASS!!!
    - THE SAMPLE IS DILUTED
- FEEDWATER
  - SAMPLE FROM THE BOTTOM OF THE FEEDWATER TANK
    - SAMPLING FROM FEEDWATER LINE CAN BE DANGEROUS IF BOILER IS FILLING!!!
- CONDENSATE
  - SAMPLE FROM THE CONDENSATE RETURN LINE PRIOR TO FEEDWATER TANK OR FROM A CONDENSATE RECEIVER
    - IF SAMPLING FROM A RECEIVER NOTE THAT IF THE SAMPLE HAS BEEN SITTING YOUR RESULTS WILL BE SKEWED

BOILER SYSTEM SAMPLING

- SAMPLE COOLER
  - PROVIDES A SAFE, COOLED SAMPLE
  - IMPORTANT FOR TEMPERATURE SENSITIVE TESTS
    - SULFITE, CONDENSATE
  - A NECESSITY ON HIGH PRESSURE SYSTEMS

TESTING WORKSTATION

- KEEPING EVERYTHING IN ORDER WILL SPEED UP THE TESTING PROCESS
- MAINTAIN INVENTORY ON ALL REAGENTS SO THAT YOU NEVER RUN OUT
- KEEP LOG UP TO DATE AND FILE LOGS OLDER THAN 12 MONTHS
- HAVE SDS'S AVAILABLE FOR QUICK REFERENCE
- POST TEST PROCEDURES AND "WHAT TO DO" GUIDES ON THE WALL FOR EASY REFERENCE


WATERTECH 3731


WATERTECH 3731

TESTING PROCEDURES REVIEW

- METHODS FOR TESTING
- TESTING CONSIDERATIONS
- COMMON INTERFERENCES


TURNER
DESIGNS
READ
0

TESTING PROCEDURES REVIEW

- COLORIMETRY
  - USES THE ABSORPTION OF LIGHT THROUGH A SAMPLE
  - INTERFERENCES
    - TURBIDITY, COLOR IN SAMPLE PRIOR TO REAGENTS
  - WIDE RANGE OF OPTIONS INCLUDING
    - MOLYBDENUM
    - CHLORINE
    - IRON
    - POLYMER

TESTING PROCEDURES REVIEW - DIGITAL

- FLUOROMETRY
  - USES THE FLUORESCENCE OF AN ACTIVATED TRACER TO DETERMINE CONCENTRATION
- INTERFERENCES
  - OIL IN WATER
  - COLOR IN SAMPLE PRIOR TO READING
- ENVIRODOSE
  - BOILER
  - COOLING
  - CLOSED LOOP

TESTING PROCEDURES - DIGITAL

- CONSIDERATIONS
  - ALWAYS USE CLEAN GLASS WARE
    - SMUDGES/FINGERPRINTS WILL CAUSE INTERFERENCE
  - RINSE SAMPLE CELL 3 TIMES
    - REMOVES RESIDUAL FROM LAST SAMPLE TAKEN
    - COMPLETES THE MATRIX

Total Hardness Drop Count Test Procedure

1 drop = 2 or 10 ppm as $CaCO_3$

FOR BEST ACCURACY (1) ENSURE ACCURATE SAMPLE SIZE. (2) HOLD DROPPER BOTTLE VERTICALLY, NOT AT AN ANGLE.

1 Rinse vial 3 times with the solution to be tested. Fill vial to 25 mL with sample.

2 Add 5 drops of Hardness Buffer (HA7405) and swirl to mix.

3 Add 1 scoop of Hardness Indicator (HA7475) and swirl to mix. If hardness is present the sample will turn red.

4 Add Hardness Titrant drop-wise, while swirling, until the sample color changes from red to blue. Record the number of drops.

5 Record results.

ED2073 (Low): # of drops x 2 = ppm as $CaCO_3$
ED2070 (High): # of drops x 10 = ppm as $CaCO_3$

Safety Tips

- Wear appropriate safety equipment.
- Read MSDS before use.

Tech Tips

- Be sure there is adequate lighting during testing
- Rinse test vial 3 times with solution to be tested.
- Hold reagent bottles vertically for best results.
- Make sure you have an accurate sample.

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EndPoint ID Test Procedure +PLUS

REV 5/08

TEST PROCEDURES REVIEW – DROP TEST

- REAGENT BASED TEST
  - RELIES ON CHEMICAL REACTION IN SAMPLE TO SHOW ENDPOINT
- LOW INITIAL COST
- INTERFERENCES
  - IRON, PH, OXIDIZERS, TEMPERATURE
- WIDE RANGE OF OPTIONS
  - HARDNESS, OPO4, SULFITE, ALKALINITY, ETC

TEST PROCEDURES REVIEW – DROP TEST

- CONSIDERATIONS
  - ALWAYS HOLD DROPPER BOTTLE STRAIGHT UP AND DOWN
    - DROPPER BOTTLES ARE CALIBRATED FOR 0.1ML PER DROP
  - MAKE SURE SAMPLE CELL USED IS RINSED 3 TIMES
  - COMPLETE THE MATRIX

TEST PROCEDURES REVIEW - TITRATION

- REAGENT BASED TEST
  - RELIES ON CHEMICAL REACTION IN SAMPLE TO SHOW ENDPOINT
- LEAST EXPENSIVE OVERALL CONSIDERING REAGENT COSTS
  - LARGER UPFRONT COST THEN DROP TESTS
- INTERFERENCES
  - IRON, PH, OXIDIZERS, TEMPERATURE
- LESS OPTIONS BUT USED MAINLY FOR BASIC TESTS
  - HARDNESS, SULFITE, ALKALINITY, CHLORIDES

TEST PROCEDURES REVIEW - TITRATION

- CONSIDERATIONS
  - KEEP SAMPLE GLASSWARE CLEAN
  - COMPLETE THE MATRIX
  - MAKE SURE BURETTE IS READABLE
  - IF USING THE SQUEEZE STYLE BURETTE TIP, MAKE SURE IT IS IN GOOD CONDITION
    - THEY WILL DRY OUT AND CRACK OVER TIME.
  - CHOOSE SAMPLE SIZE FOR THE ENDPOINT THAT YOU ARE LOOKING FOR
    - 1PPM VS 100PPM

WATER TREATMENT CONTROL PARAMETERS

PRESENTED BY:
JOE RUSSELL

- HOW DO WE DETERMINE PROPER CONTROL RANGES?
- WHAT ARE CAUSES OF CHEMICAL READINGS?
- REVIEW TESTING CONTROL CHART
- LOGGING RESULTS IN eSERVICE

bluevantage

WATERTECH

DETERMINING PROPER CONTROL RANGES

- CONTROL RANGES
  -ASME FOR BOILERS
- BOILER PLATE
- LIMITING FACTORS
  -IRON
  -SILICA
- EXPERIENCE!!

ASME Boiler Guidelines

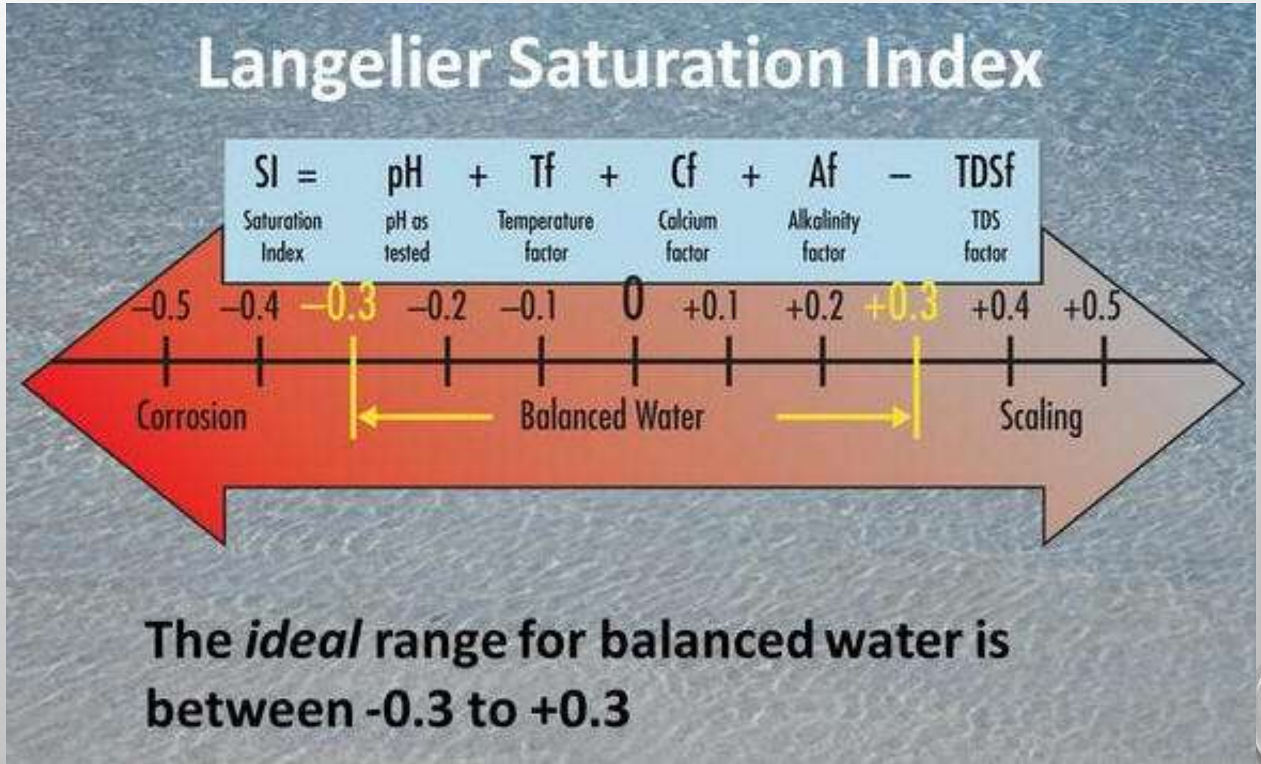
Drum Pressure (psig)	Boiler Water		
	Total Silica* (ppm SiO2)	Specific** Alkalinity (ppm CaCO3)	Conductance (micromhos/cm)
0-300	150	700	7000
301-450	90	600	6000
451-600	40	500	5000
601-750	30	400	4000
751-900	20	300	3000
901-1000	8	200	2000
1001-1500	2	0	150
1501-2000	1	0	100

DETERMINING PROPER CONTROL RANGES

- LSI, RSI INDEXES FOR COOLING TOWERS

  -FOULING VS. BIOCIDE RATES

  -CTI?/ASHRAE



KEY TESTING PARAMETERS & CORRECTIVE ACTIONS

- BOILERS
  - AUTOMATED SYSTEM DRIVEN
    - CONDUCTIVITY & TEMPERATURE
    - METER READINGS
    - TANK LEVELS
  - CHEMICAL DRIVEN
    - SULFITES
    - TOTAL POLYMER
    - OH (ALKALINITY)
    - PH

BOILER CONTROL CHART

Test	Range	Corrective Actions
Total Polymer **(*PP-3060M*)**	**.6-.8**	• If out of range, check conductivity of the boilers. High or low conductivity will cause high or low readings. • If conductivity is okay, increase addition of ***PP-3060M*** if polymer is low, decrease if polymer is high.
Sulfite **(*WT-3462*)**	**20-40 ppm**	• Check deaerator temperature. • Check conductivity in the boilers. • If both are in range, increase feed of ***WT-3462*** if the reading is low and decrease the feed of the ***WT-3462*** if the reading is high.
Alkalinity ***(WT-3732)***	**P= 300-400** **M= 350-650** **OH=200-400**	• Check conductivity levels. High or low conductivity will cause high or low alkalinity. • Check for proper feed of the ***WT-3732*** sodium hydroxide. • If both are correct, increase the feed of the ***WT-3732*** to increase alkalinity levels and decrease the pump to decrease alkalinity levels.
Total Hardness ***(Softeners, Feedwater & Condensate)***	**<.5 ppm**	• If hardness if present, check the softeners and condensate for possible contamination. • Regenerate softener on line if necessary.
Boiler Conductivity **(Un-Neutralized)**	**mmho** **1,800-2,300**	• If conductivity is out of range, check operation of blowdown controllers. • Calibrate as necessary
pH **(*WT-3516*)**	**8.3 – 8.8**	• Increase feed of the ***WT-3516*** if pH is low. Decrease feed if pH is high. • Wait for two days of below 8.0 readings to increase feed of the ***WT-3516***

WATERTECH DRAFT

advocates for innovative water management

Operator Log

Tuesday, August 23, 2016 8:55 AM CDT

Joseph Campione Inc.
Headquarters
2201 W. South Branch Blvd, Oak Creek WI 53154
(414) 761-8944

Recorded By: **Joe Russell**
(414) 425-3339
joe@watertechusa.com

On-site: **6:00 PM to 6:00 PM CDT**

Drive: **6:00 PM to 6:00 PM CDT**

Power Plant - Boilers

Test	#1 Softener	#2 Softener	Boiler Feedwater	#1 Boiler Sm Col	#2 Boiler Johnston	#3 Boiler New Col	Condensate
Conductivity, mmho — Limits	350 max	350 max	500 max	3500 - 4200	3500 - 4200	3500 - 4200	50 max
Conductivity, Controller, mmohs — Limits					3500 - 4200	3500 - 4200	
Total Hardness, ppm — Limits	0.5 max	0.5 max	1 max				0.2 max
P Alkalinity, ppm — Limits			20 max	200 - 700	200 - 700	200 - 700	
M Alkalinity — Limits			150 max	500 - 1000	400 - 1000	400 - 1000	
Hydroxide OH Alkalinity, ppm — Limits				150 min	150 min	150 min	
Sulfite, ppm — Limits				30 - 70	30 - 70	30 - 70	
PP-3060M — Limits				0.6 - 1.2	0.6 - 1.2	0.6 - 1.2	
pH — Limits							7.4 - 8
Gallons Remaining — Limits	0 min	0 min					

BOILER LOG SHEET

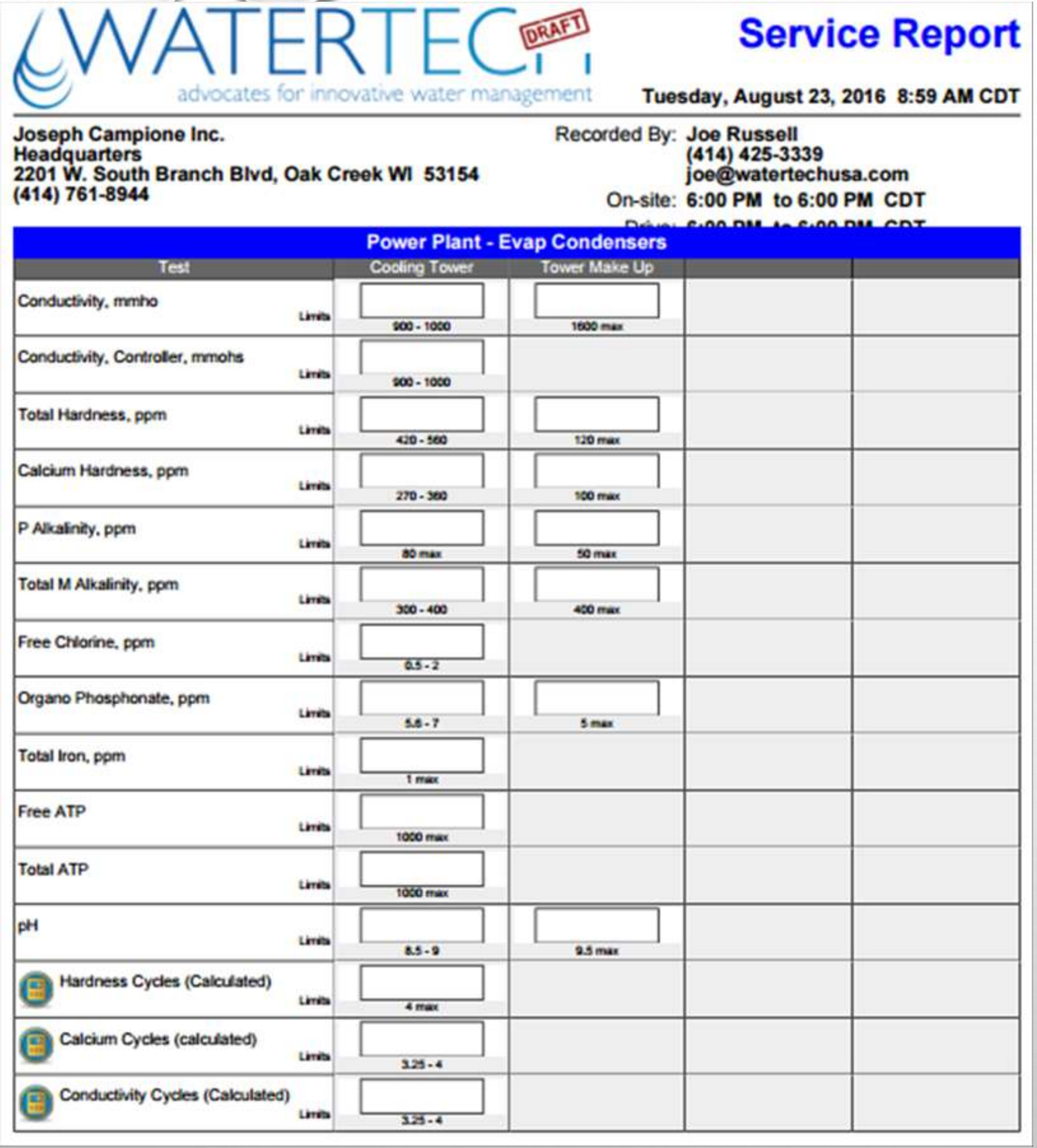
KEY TESTING PARAMETERS & CORRECTIVE ACTIONS

- TOWERS
  - AUTOMATED SYSTEM DRIVEN
    - CONDUCTIVITY & TEMPERATURE
    - ORP
    - pH
    - WATER METER READINGS
    - CHEMICAL TANK LEVELS
  - CHEMICAL DRIVEN
    - ORGANOPHOSPHONATES *OR* OP, PTSA
    - FREE CHLORINE
    - HARDNESS
    - M ALKALINITY

TOWER CONTROL CHART

Test	Range	Corrective Actions
Total Hardness	**20-80 ppm**	• If hardness if present, check the softeners. • Regenerate softener on line if necessary.
Free Chlorine	**.2-1.0 ppm**	• If levels are out of range check to see that the pump is primed and pumping. • Check conductivity levels. High or low conductivity will cause high or low free chlorine levels. •
Cooling Tower Conductivity	**2,800-3,000**	• If conductivity is high, check the operation of the blowdown solenoid. • If conductivity is low, check for uncontrolled losses or overflow of the sump. • Verify the controller is reading properly. Calibrate or replace the sensor if needed.
PTSA tracer (CWT-766)	**150-200 ppb**	• If levels are out of range check to see that the pump is primed and pumping. • Check conductivity levels. High or low conductivity will cause high or low molybdenum levels. • Check to see that the makeup water meter is turning and registering flow.

COOLING TOWER LOG SHEET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Service Report

Tuesday, August 23, 2016 8:59 AM CDT

Joseph Campione Inc.
Headquarters
2201 W. South Branch Blvd, Oak Creek WI 53154
(414) 761-8944

Recorded By: **Joe Russell**
(414) 425-3339
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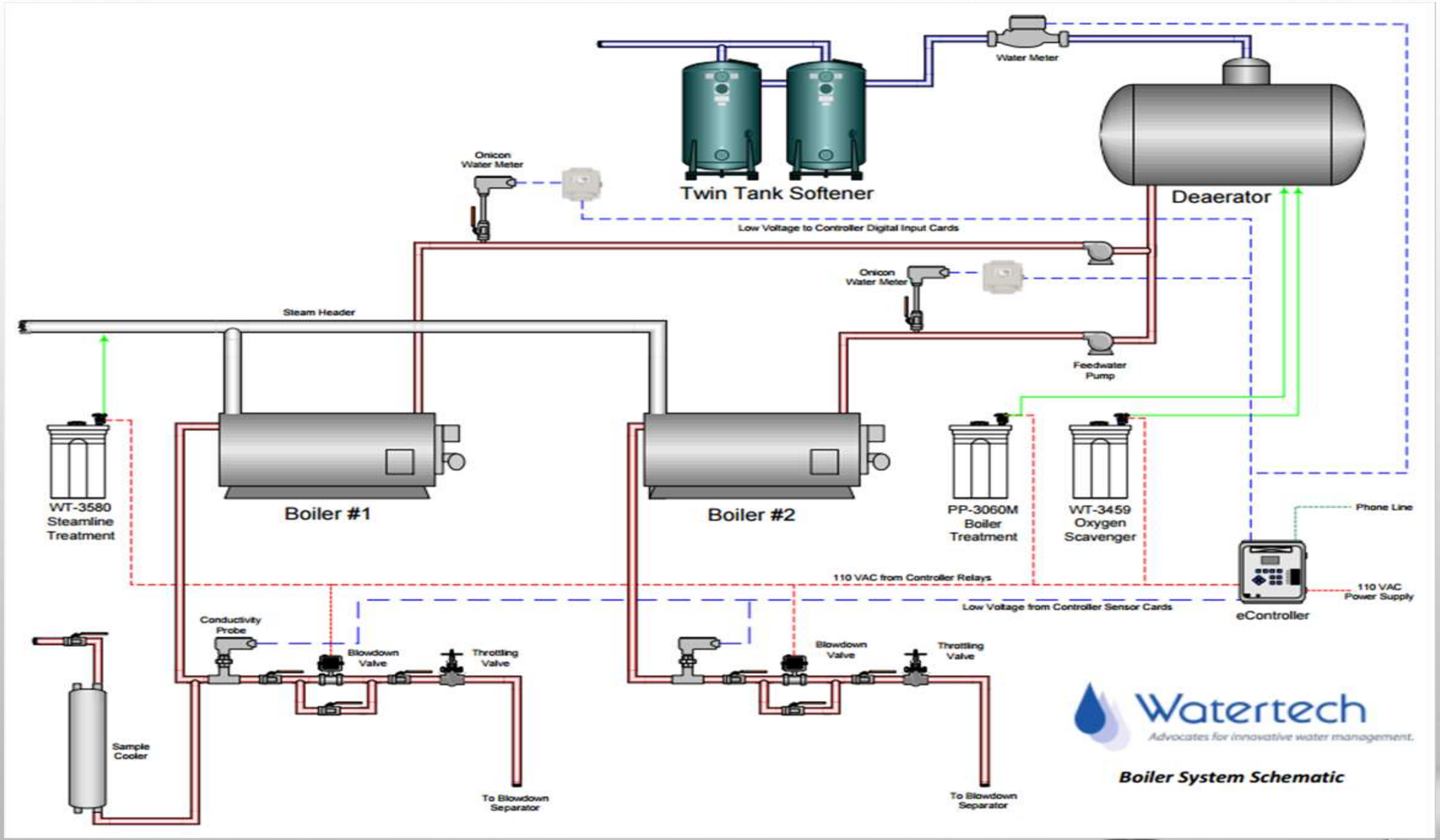
On-site: **6:00 PM to 6:00 PM CDT**

Power Plant - Evap Condensers

Test	Cooling Tower	Tower Make Up		
Conductivity, mmho — Limits	900 - 1000	1600 max		
Conductivity, Controller, mmohs — Limits	900 - 1000			
Total Hardness, ppm — Limits	420 - 560	120 max		
Calcium Hardness, ppm — Limits	270 - 360	100 max		
P Alkalinity, ppm — Limits	80 max	50 max		
Total M Alkalinity, ppm — Limits	300 - 400	400 max		
Free Chlorine, ppm — Limits	0.5 - 2			
Organo Phosphonate, ppm — Limits	5.6 - 7	5 max		
Total Iron, ppm — Limits	1 max			
Free ATP — Limits	1000 max			
Total ATP — Limits	1000 max			
pH — Limits	8.5 - 9	9.5 max		
Hardness Cycles (Calculated) — Limits	4 max			
Calcium Cycles (calculated) — Limits	3.25 - 4			
Conductivity Cycles (Calculated) — Limits	3.25 - 4			

TAKING OWNERSHIP OF YOUR BOILER SYSTEM

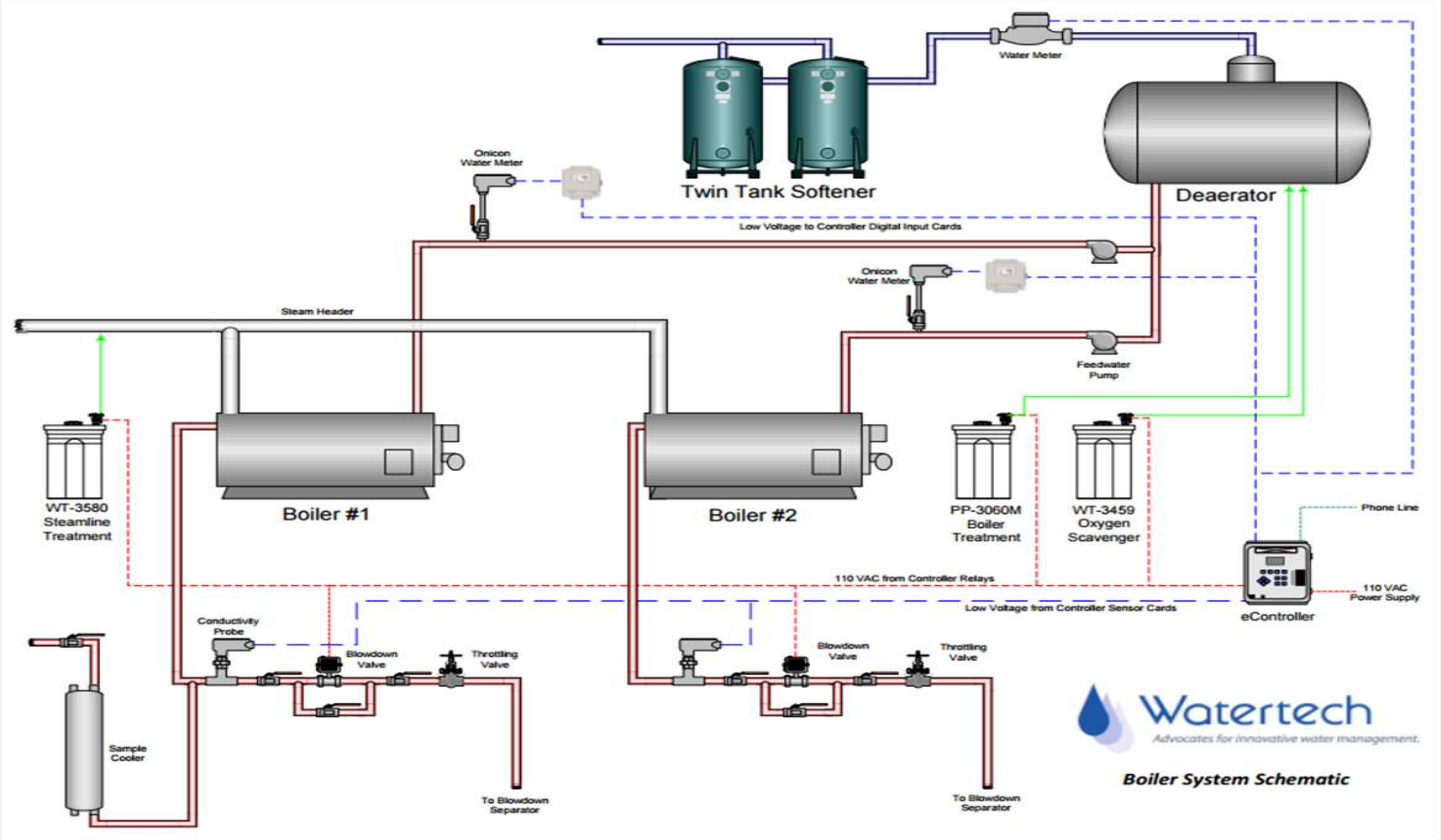


WATER TESTING

TEST PROCEDURE GUIDELINES

SAMPLE	*Total Hardness*	*Calcium Hardness*	*P Alk.*	*M Alk.*	*TDS, mmho*	*Organo Phos*	*Sulfite*	*Total Polymer*	*pH*	*Total Iron*
RAW WATER	**X**	**X**	**X**	**X**	**X**					
SOFT WATER	**X**				**X**					
RO PERMEATE	**X**				**X**				**X**	
FEEDWATER	**X**		**X**	**X**	**X**				**X**	**X**
CONDENSATE	**X**				**X**				**X**	**X**
BOILER WATER			**X**	**X**	**X**		**X**	**X**		
COOLING TOWER	**X**	**X**	**X**	**X**	**X**	**X**				

BASIC BOILER SYSTEM



FILTRATION

- A PROCESS FOR SEPARATING SUSPENDED AND COLLOIDAL IMPURITIES FROM WATER
  - PASSAGE THROUGH A BED OF GRANULAR MEDIA
  - PASSAGE THROUGH SPIRAL WOUND CARTRIDGE OR BAG.

BAG / CARTRIDGE FILTERS

ADVANTAGES - low capital cost, simple operation

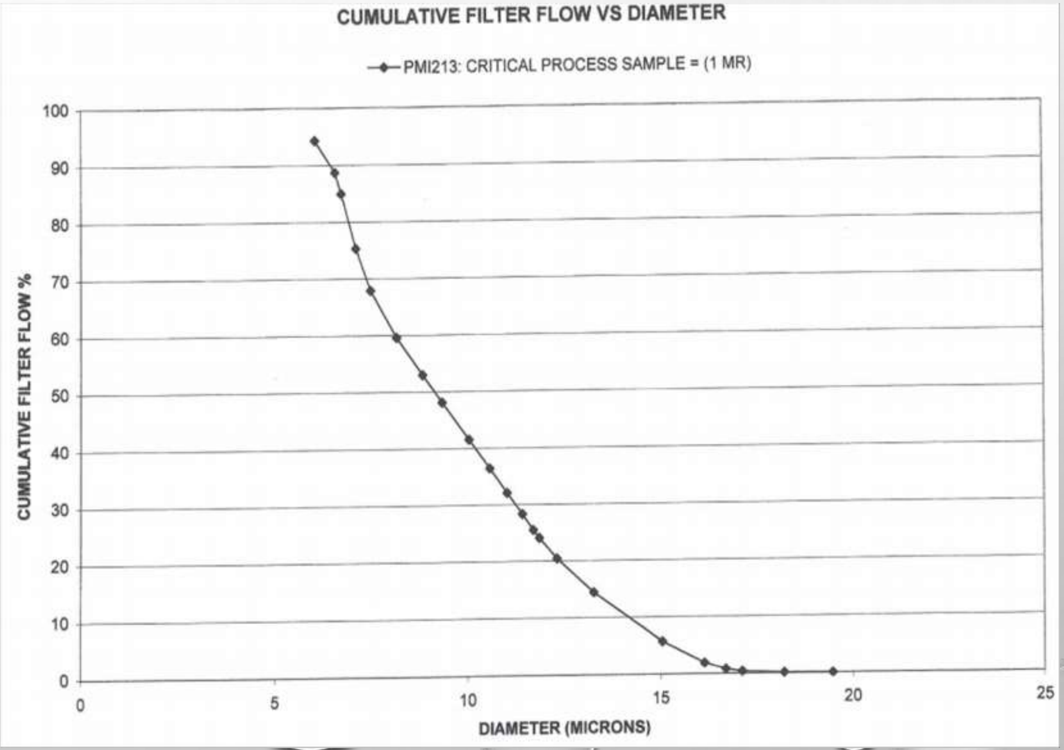
DISADVANTAGES – high operating cost, labor intensive

ALL CARTRIDGE FILTERS ARE NOT THE SAME!!!

- BUBBLE POINT TESTING INDICATES ALL FILTERS ARE NOT THE SAME……

MEAN FLOW PORE PRESSURE =	0.721 PSI
MEAN FLOW PORE DIAMETER =	9.1514 MICRONS
LARGEST DETECTED PORE DIAMETER =	19.4761 MICRONS
PRESSURE AT LARGEST PORE =	0.339 PSI
STANDARD DEVIATION OF AVG. PORE DI/	4.6433
BUBBLE POINT PRESSURE =	0.339 PSI
BUBBLE POINT PORE DIAMETER =	19.4761 MICRONS
MAXIMUM PORE SIZE DISTRIBUTION =	25.1618
DIAMETER AT MAXIMUM PORE SIZE DISTI	6.7603 MICRONS

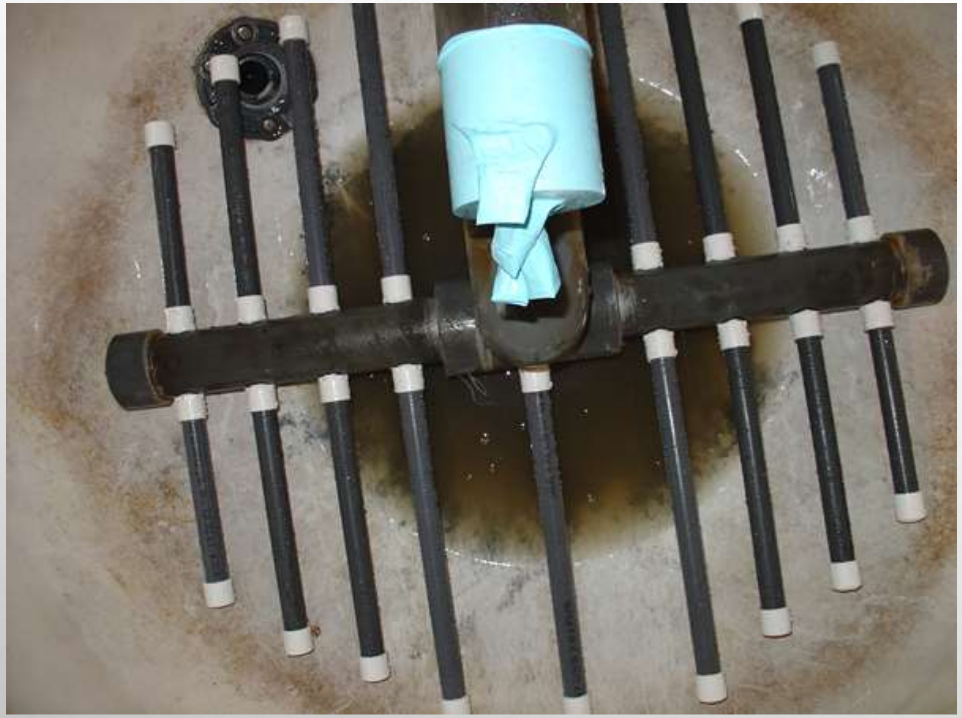
10% Cumulative Filter Flow occurs at 14.1835 microns
25% Cumulative Filter Flow occurs at 11.7682 microns
75% Cumulative Filter Flow occurs at 7.1580 microns
90% Cumulative Filter Flow occurs at 6.4729 microns



MEDIA FILTERS

- ADVANTAGES
  - FINE FILTRATION
    - 15 MICRONS
  - AUTOMATIC OPERATION
    - MINIMAL LABOR
  - LARGE SURFACE AREA
- DISADVANTAGES
  - MODERATE CAP. COST
  - HIGH BACKWASH VOL.
  - GREAT “BUG” TRAP / MEDIA

MEDIA FILTERS



Rebuilt Lower Distributor

Fouled Media

DISC FILTERS

- DISC FILTER IS ALTERNATE TO MEDIA FILTER
- USES LESS WATER TO BACKWASH.
- FILTERS RANGE DOWN TO 25 MICRON.
- IDEALLY SUITED FOR COOLING TOWERS.

KEY FILTER TAKEAWAYS

- MAKE SURE NOT TO EXCEED MAXIMUM PRESSURE DROP OF 15 PSIG BEFORE CHANGING OUT ANY TYPE OF CARTRIDGE BAG FILTER
  - TRACK INLET AND OUTLET PRESSURES
- TRACK PRESSURE DIFFERENTIALS ACROSS MEDIA FILTERS TO ENSURE THAT THEY ARE BACKWASHING PROPERLY.
- MEDIA FILTERS MAY NEED TO BE DISINFECTED ON A ANNUAL OR SEMI ANNUAL BASIS TO REMOVE MICROBIOLGICAL FOULING.
  - USE FRESH WATER FOR BACKWASH FILTERS INSTEAD OF PROCESS OR TOWER WATER.
- DISC FILTERS ARE A GOOD ALTERNATIVE TO MEDIA FILTERS AS THEY USE LESS WATER TO BACKWASH

ASME GUIDELINES

TABLE 3 — SUGGESTED WATER CHEMISTRY LIMITS INDUSTRIAL FIRETUBE, HIGH DUTY, PRIMARY FUEL FIRED

Makeup water percentage: Up to 100% of feedwater
Conditions: No superheater, turbine drives, or process restriction on steam purity
Steam purity (7): 1.0 ppm (mg/l) TDS maximum

Drum Operating Pressure	0–300 psig 0–2.07 MPa
Feedwater (3)	
Dissolved oxygen ppm (mg/l) O_2 — measured before chemical oxygen scavenger addition (1)(2)	<0.007
Total iron ppm (mg/l) Fe	<0.1
Total copper ppm (mg/l) Cu	<0.05
Total hardness ppm (mg/l)*	<1.0
pH @ 25°C	8.3–10.5
Nonvolatile TOC ppm (mg/l) C (6)	<10
Oily matter ppm (mg/l)	<1
Boiler Water	
Silica ppm (mg/l) SiO_2	<150
Total alkalinity ppm (mg/l)*	<700(5)
Free OH alkalinity ppm (mg/l)* (4)	NS
Specific conductance μmhos/cm (μs/cm) @ 25°C without neutralization	<7000(5)

*as $CaCO_3$
NS = not specified

NOTES TO TABLE 3

(1) Values in the table assume existence of a deaerator.

(2) Chemical deaeration should be provided in all cases, especially if mechanical deaeration is nonexistent or inefficient.

(3) Firetube boilers of conservative design, with internal chelant, polymer, and/or antifoam treatment can often tolerate higher levels of feedwater impurities than those in the table [≤0.5 ppm (mg/l) Fe, ≤0.2 ppm (mg/l) Cu, ≤10 ppm (mg/l) total hardness] and still achieve adequate deposition control and steam purity. Removal of these impurities by external pretreatment is always a more positive solution. Alternatives must be evaluated as to practicality and economics in each individual case.

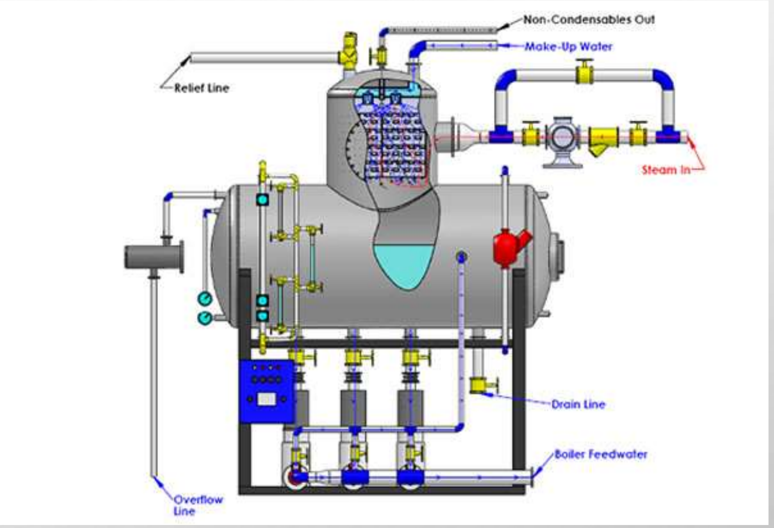
(4) Minimum and maximum levels of hydroxide alkalinity must be individually specified by a qualified water treatment consultant with regard to silica solubility and other components of internal treatment. See Section 6.6 of this document.

(5) Alkalinity and conductance guidelines are consistent with steam purity target. Practical limits above or below tabulated values should be individually established for each case by careful steam purity measurements.

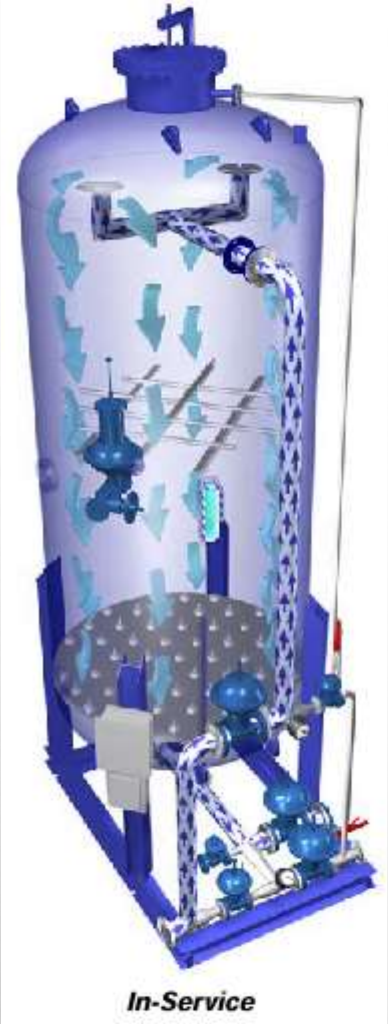
(6) Nonvolatile TOC is that organic carbon not intentionally added as part of the water treatment program. See Section 6.4 of this document.

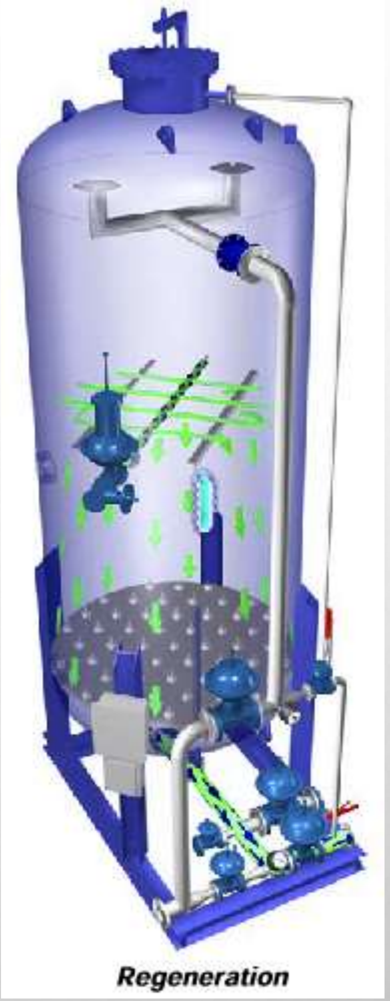
(7) Target value represents steam purity that should be achievable if other tabulated water quality values are maintained. The target is not intended to be nor should it be construed to represent a boiler performance guarantee.

PRETREATMENT SYSTEM



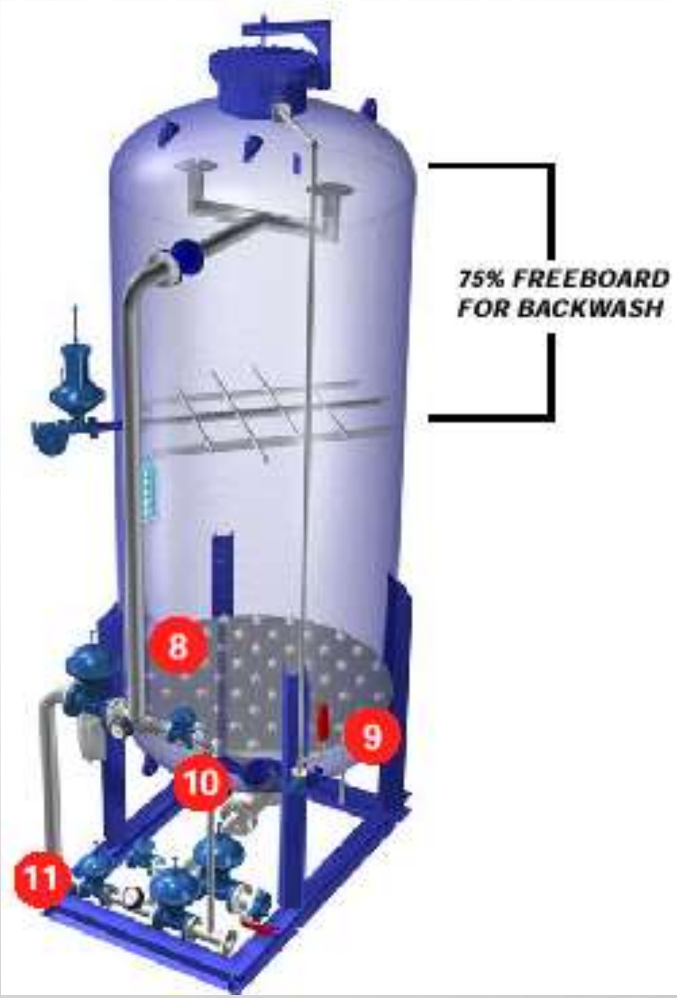
WATER SOFTENER OPERATION





WATER SOFTENER COMPONENTS

1. INLET DISTRIBUTOR (BACKWASH OUTLET COLLECTOR)
2. REGENERANT INLET VALVE
3. DOWNFLOW REGENERANT HEADER
4. SERVICE INLET VALVE
5. FALSE BOTTOM
6. SERVICE OUTLET VALVE
7. RINSE OUTLET VALVE



8. MEDIA BED
9. UNDERDRAIN STRAINERS
10. BACKWASH OUTLET VALVE
11. BACKWASH INLET VALVE

3.2 CHEMISTRY OF SODIUM ZEOLITE SOFTENING

The softening process may be illustrated by the following reactions.

$Ca(HCO_3)_2$	+	2NaZ	CaZ_2	+	2 $NaHCO_3$
Calcium Bicarbonate		Sodium Zeolite	Calcium Zeolite		Sodium Bicarbonate
$MgSO_4$	+	2NaZ	MgZ_2	+	Na_2SO_4
Magnesium Sulfate		Sodium Zeolite	Magnesium Zeolite		Sodium Sulfate

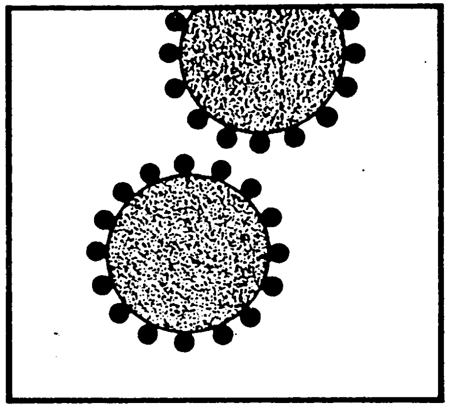
The letter Z represents the zeolite material.

The regeneration process is indicated by the following reaction:

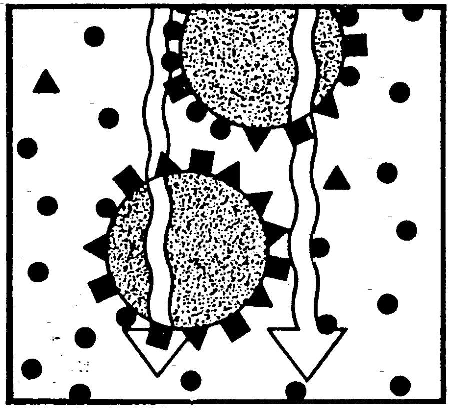
2 NaCl	+	CaZ_2	2NaZ	+	$CaCl_2$
2 NaCl	+	MgZ_2	2NaZ	+	$MgCl_2$
Sodium Chloride (Salt Brine)		Calcium & Magnesium Zeolites	Sodium Zeolite		Calcium & Magnesium Chlorides

WHAT GOES ON INSIDE A WATER SOFTENER

Ready to Start



Operation

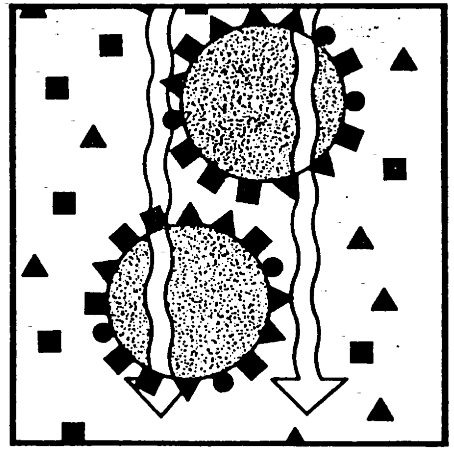


LEGEND: ▼ Calcium ions ■ Magnesium ions ● Sodium ions

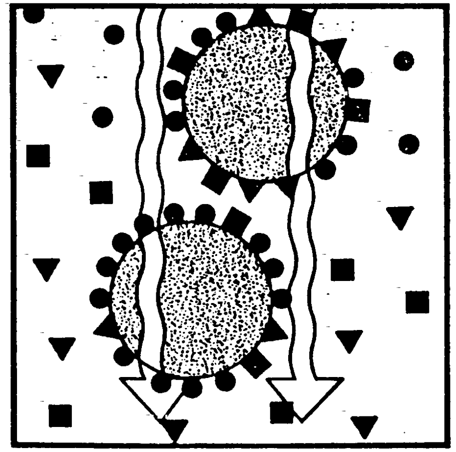
SOFTENING PROCESS takes place on the surface of the ion exchange medium in the unit, shown here as large shaded pellets. The function of this medium is to pull "hard" calcium and magnesium ions out of the water and replace them with "soft" sodium ions. In this schematic drawing, the pellets are fully charged with exchangeable sodium ions, indicated by small black circles.

HARD WATER enters the softener at the top of the column. It contains numerous calcium and magnesium ions, symbolized by triangles and squares. As the water flows through the unit, these ions become attached to the surface of the ion exchange medium which in turn releases its sodium ions. As the water emerges from the bottom of the column, it is virtually free of "hard" ions.

Exhaustion



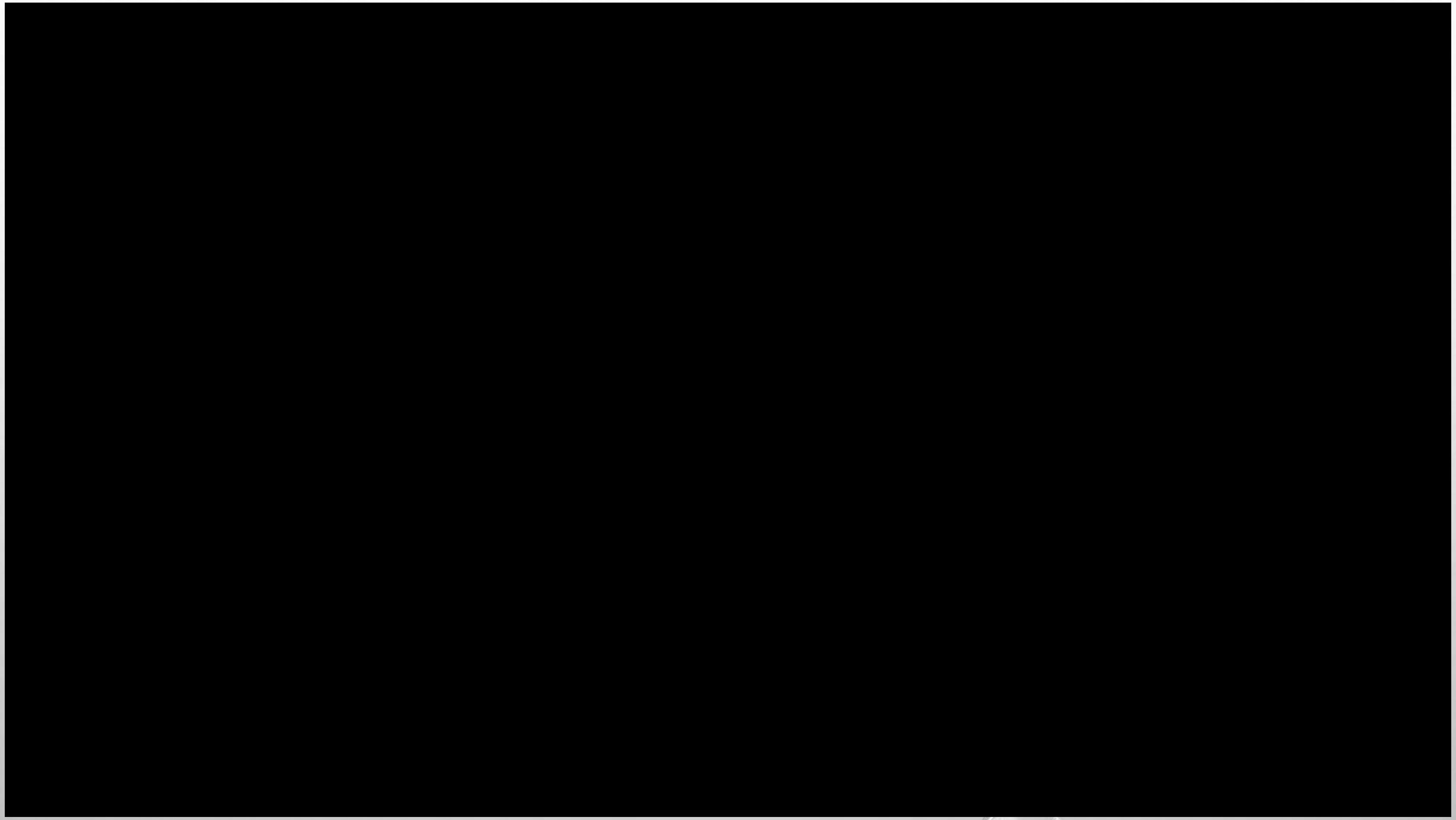
Regeneration



AFTER A PERIOD of operation, the ion exchange medium becomes "saturated" with "hard" calcium and magnesium ions, and its supply of sodium ions becomes virtually exhausted. When this occurs, no further softening can take place. As a result, hard

TO RESUME ITS EFFECTIVENESS, the ion exchange medium must be stripped of its calcium and magnesium ions and provided with a new supply of sodium ions. This is done by running a salt solution, rich in sodium ions through the unit. The sodium ions force

HOW A WATER SOFTENER WORKS



HOW DO YOU KNOW THE SOFTENER IS WORKING??

- PERFORM A TOTAL HARDNESS TEST ON THE WATER.
- SOFT WATER USED FOR BOILER MAKE UP SHOULD HAVE <0.5 PPM OF TOTAL HARDESS. THIS WILL VARY DEPENDING UPON BOILER PRESSURE. AS PRESSURE GOES UP ACCEPTABLE HARDNESS LEVELS GO DOWN.
- SOFT WATER USED FOR COOLING TOWER MAKE UP SHOULD BE LESS THAN 50 PPM AS A RULE OF THUMB. THIS WILL GO DOWN AS THE CYCLES OF CONCENTRATION IN THE TOWER GO UP.

TK3051-Z blue caps

Total Hardness Drop Count Test Procedure

1 drop = 2 or 10 ppm as $CaCO_3$

FOR BEST ACCURACY (1) ENSURE ACCURATE SAMPLE SIZE. (2) HOLD DROPPER BOTTLE VERTICALLY, NOT AT AN ANGLE.

1 Rinse vial 3 times with the solution to be tested. Fill vial to 25 mL with sample.

2 Add 5 drops of Hardness Buffer (HA7405) and swirl to mix.

3 Add 1 scoop of Hardness Indicator (HA7475) and swirl to mix. If hardness is present the sample will turn red.

4 Add Hardness Titrant drop-wise, while swirling, until the sample color changes from red to blue. Record the number of drops.

5 Record results.

ED2073 (Low): # of drops x 2 = ppm as $CaCO_3$
ED2070 (High): # of drops x 10 = ppm as $CaCO_3$

Safety Tips

- Wear appropriate safety equipment.
- Read MSDS before use.

Tech Tips

- Be sure there is adequate lighting during testing
- Rinse test vial 3 times with solution to be tested.
- Hold reagent bottles vertically for best results.
- Make sure you have an accurate sample.

WATERTECH of America, Inc
5000 South 110th Street
Greenfield, Wisconsin 53228
P: 414.425.3339 F: 414.425.3362
E: info@WATERTECHusa.com

EndPoint ID Test Procedure PLUS

REV 5/08

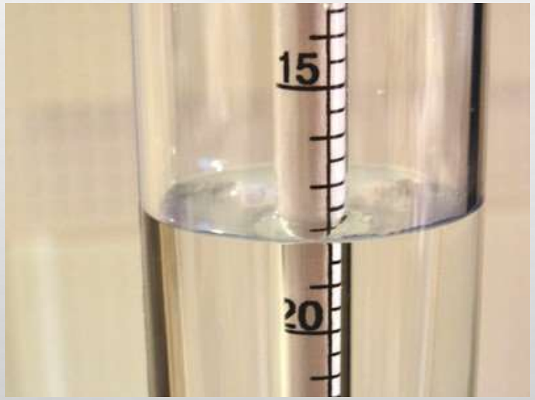
TROUBLESHOOTING

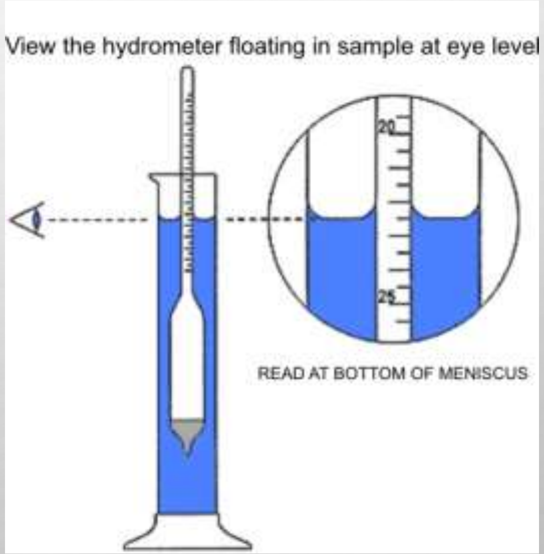
- SHORT RUNS
  - CHANGE IN RAW WATER HARDNESS
  - POOR REGENERATION
  - RESIN FOULING
  - LOSS OF RESIN

- HIGH HARDNESS
  - RAW WATER BYPASSING UNIT
  - RESIN FOULING
  - INCREASED RAW HARDNESS IN SUPPLY WATER
- HIGH PRESSURE DROP
  - BED FOULING
  - POOR BACKWASH
  - PLUGGED UNDER DRAIN
  - DETERIORATING RESIN

BRINE ELUTION STUDIES

- PROBLEMS IN ZEOLITE SOFTENER SYSTEMS ARE OFTEN DUE TO POOR REGENERATION PRACTICES.
- BRINE ELUTION STUDY IS OFTEN USED TO TROUBLESHOOT THIS PROCESS.
  - PLOTS THE CONCENTRATION OF BRINE FROM A ZEOLITE SOFTENER DURING REGENERATION USING A BRINE SALOMETER AND GRADUATED CYLINDER





BRINE ELUTION STUDIES

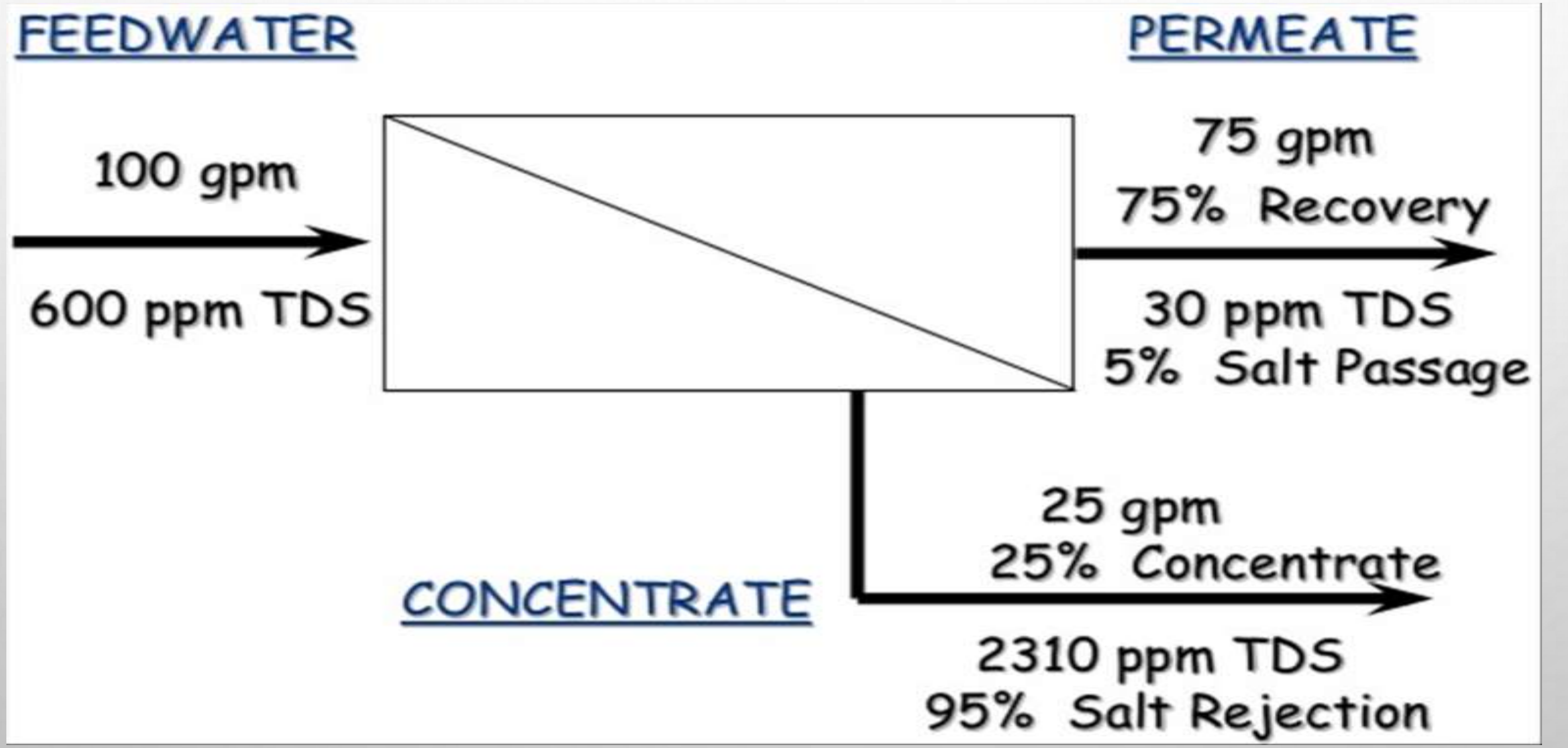
- **DESIRED CONCENTRATION OF BRINE IS 8% IN CONTACT WITH THE RESIN FOR 30 MINUTES (30 DEGREES ON SALOMETER).**

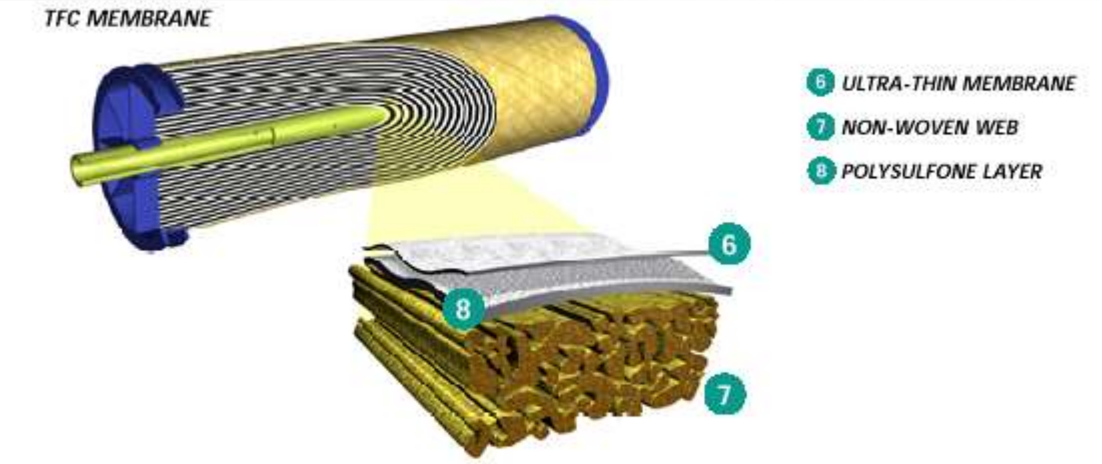
REVERSE OSMOSIS

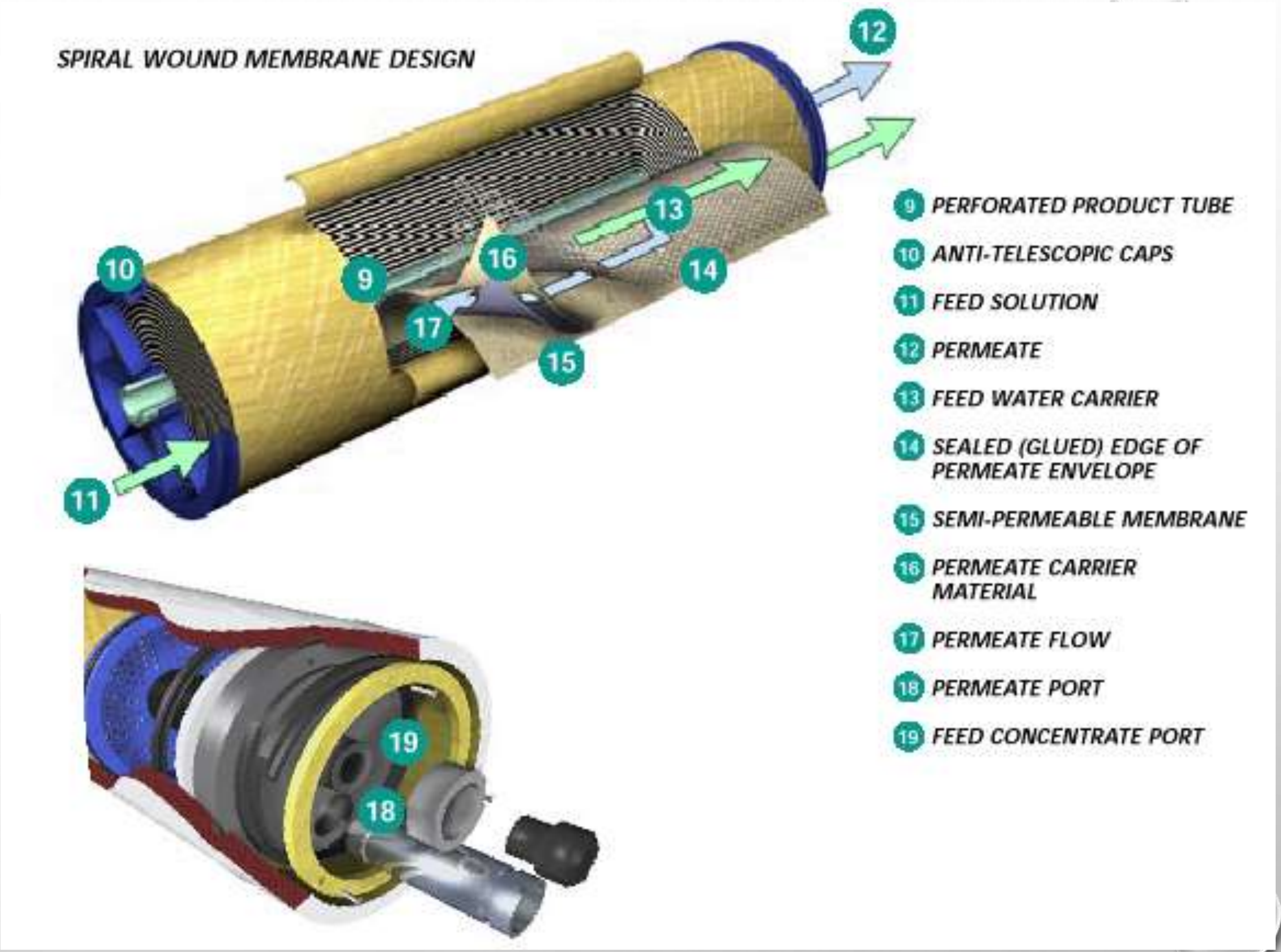
- MEMBRANE -BASED SEPARATION PROCESS
- INVOLVES THE SEPARATION OF DISSOLVED SOLIDS FROM THE FEEDWATER BY MEANS OF A SEMI-PERMEABLE MEMBRANE
  - MEMBRANES ALLOW WATER TO PASS THROUGH (PERMEATE) READILY, BUT ARE FAIRLY IMPERMEABLE TO OTHER CONSTITUENTS IN THE FEED STREAM.

REVERSE OSMOSIS

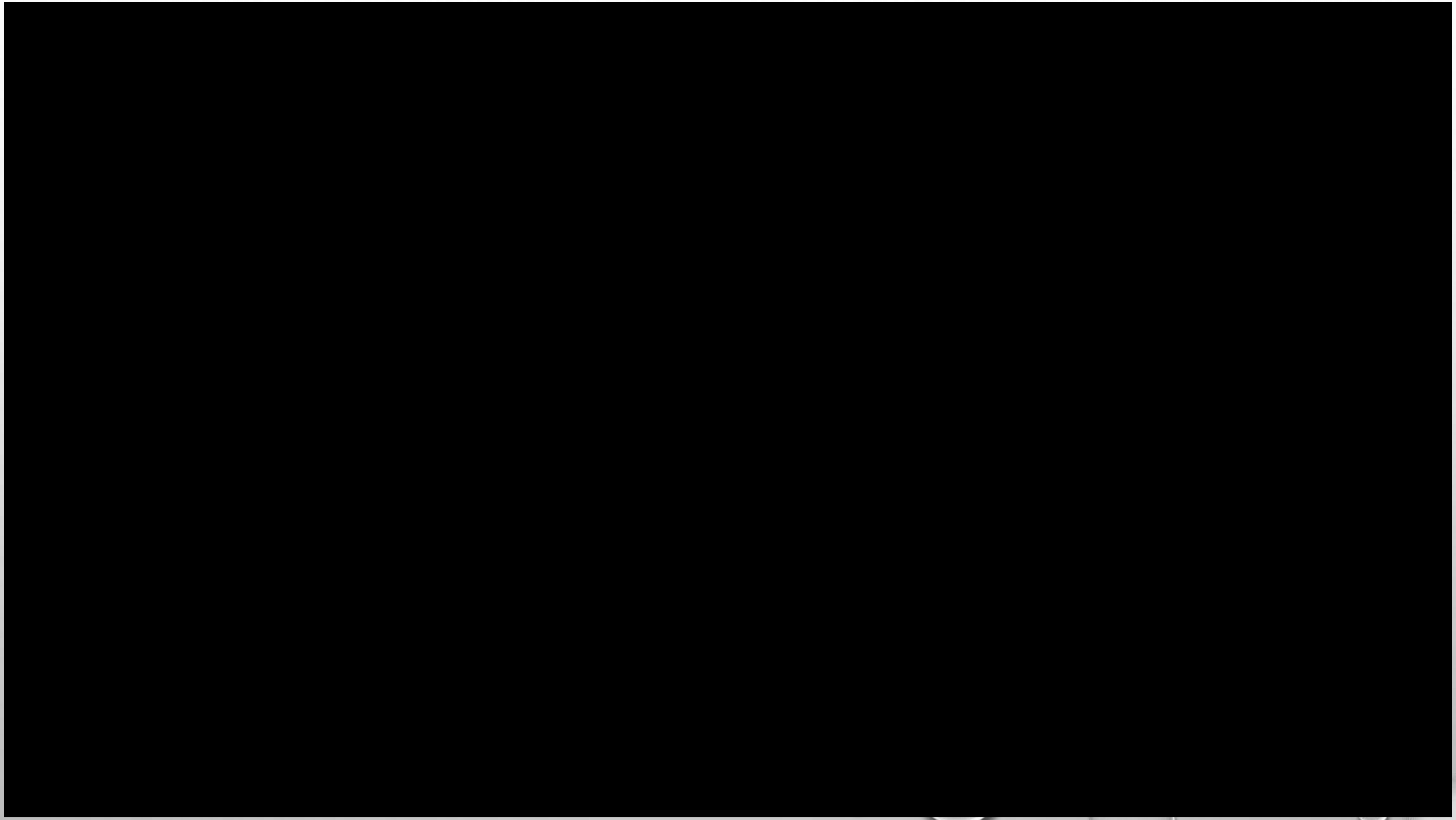
- ORIGINALLY DEVELOPED AS AN ALTERNATIVE TO DISTILLATION OF SEAWATER.
- PRODUCES A STEAM OF HIGH PURITY WATER AND CONCENTRATED WATER.




TFC MEMBRANE
6 ULTRA-THIN MEMBRANE
7 NON-WOVEN WEB
8 POLYSULFONE LAYER
6
8
7


SPIRAL WOUND MEMBRANE DESIGN
12
10
9
16
13
14
17
15
11
19
18
9 PERFORATED PRODUCT TUBE
10 ANTI-TELESCOPIC CAPS
11 FEED SOLUTION
12 PERMEATE
13 FEED WATER CARRIER
14 SEALED (GLUED) EDGE OF PERMEATE ENVELOPE
15 SEMI-PERMEABLE MEMBRANE
16 PERMEATE CARRIER MATERIAL
17 PERMEATE FLOW
18 PERMEATE PORT
19 FEED CONCENTRATE PORT

SEMIPERMEABLE MEMBRANES



CHEMICAL TREATMENT

- RO FEEDWATER MUST BE CAREFULLY PREPARED TO MINIMIZE SUSPENDED SOLIDS, SCALING IONS, FREE HALOGEN RESIDUALS AND MICROBIOLOGICAL CONTAMINATION.
- FEEDWATER SHOULD THEN BE CHEMICALLY TREATED TO PREVENT MINERAL SCALING, PLUGGING AND MICROBIOLOGICAL DEGRADATION OF THE MEMBRANES.
- CONCENTRATE CAN BE TESTED FOR AMOUNT OF RO ANTISCALANT PRESENT TO PREVENT OVERFEED OR UNDERFEED OF PRODUCT.

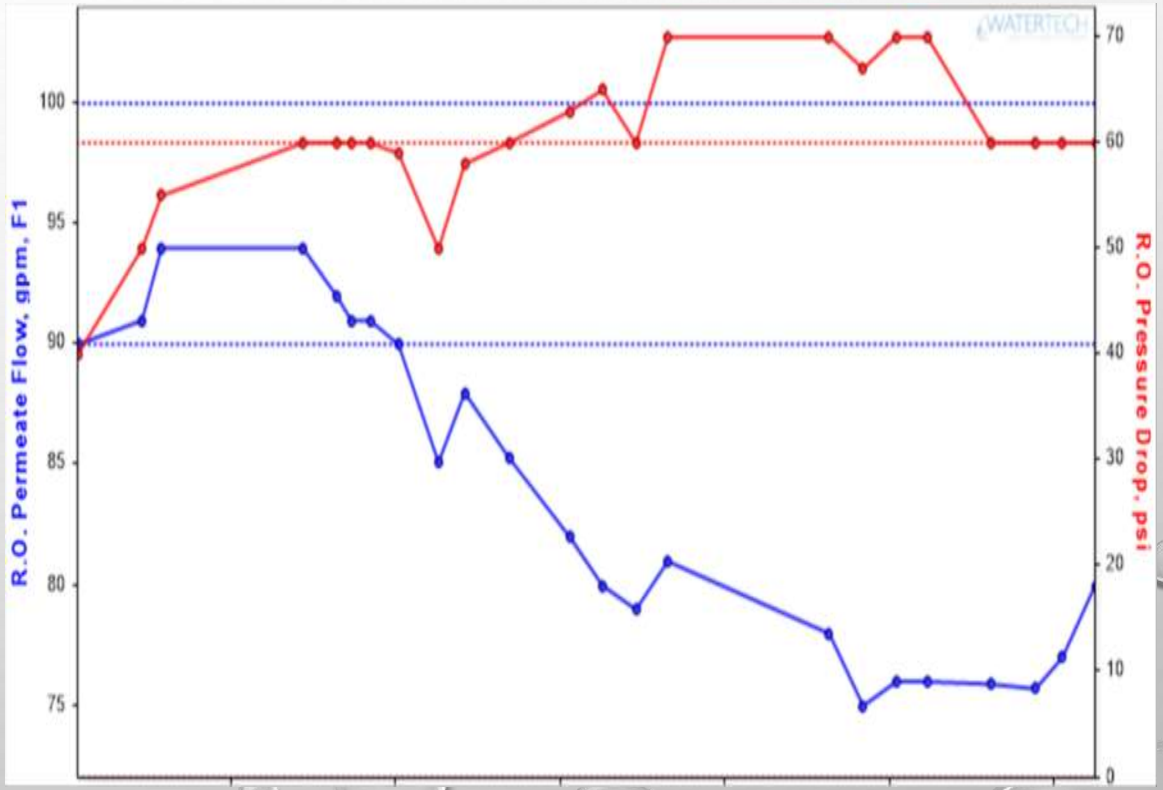
MECHANICAL/CHEMICAL TREATMENT

- SOLIDS
  - MULTIMEDIA FILTRATION
- IRON
  - OXIDATION/FILTRATION
- MICROORGANISMS
  - BIOCIDES
  - BE CAREFUL WITH THE USE OF OXIDIZING BIOCIDES!
- SCALANTS(HARDNESS, ETC.)
  - SOFTENING
  - CHEMICAL ANTISCALANTS
- FREE CHLORINE (TFC MEMBRANES)
  - 0 PPM
  - USE BISULFITE

MONITORING AND MAINTENANCE

- ENSURE THAT THE SYSTEM IS OPERATING PROPERLY.
- DETERMINE IF GRADUAL FOULING, SCALING OR MEMBRANE DEGRADATION IS OCCURRING BY OBSERVING SYSTEM PERFORMANCE OVER TIME.

Test	Boiler R.O. Train A	Boiler R.O. Train B
R.O. Permeate Conductivity, mmhos C2	14.2 10 max	10.83 10 max
R.O. Feedwater Pressure, psi, P1	46 35 - 80	40 35 - 80
R.O. Filter Outlet Pressure, psi, P2	38 30 - 80	26 30 - 80
R.O. Filter Pressure Drop, psi	8 15 max	14 15 max
R.O. Pump Pressure, psi, P3	190 165 - 230	203 165 - 230
R.O. Reject Pressure, psi, P4	127 105 - 170	152 105 - 170
R.O. Pressure Drop, psi	63 60 max	51 60 max
R.O. Feedwater Flow, gpm, FD	126 120 - 133	129 120 - 133
R.O. Permeate Flow, gpm, F1	96 90 - 100	96 90 - 100
R.O. Reject Flow, gpm, F2	30 30 - 35	33 30 - 35
Flocon 260, ppm	15.5 10 - 15	19.0 10 - 15
R.O. % Recovery	76.2 70 - 80	74.4 70 - 80



MONITORING AND MAINTENANCE

Table 2-23: RO Performance Data Monitoring Form

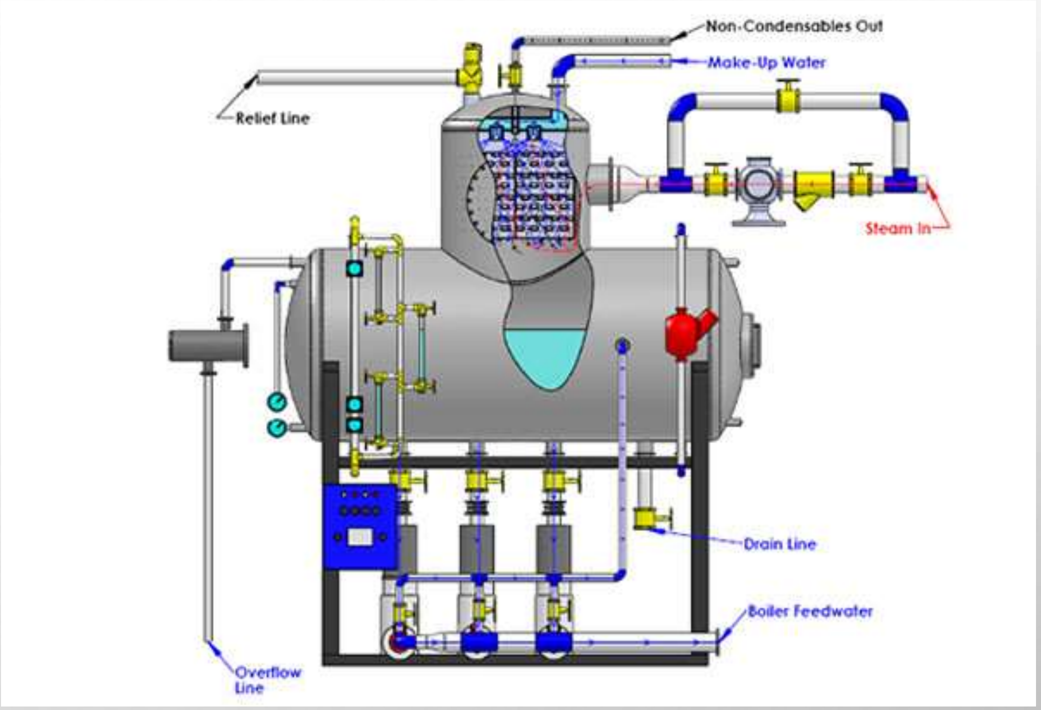
Parameter	RO Inlet	RO Interstage	RO Concentrate	RO Permeate	Other
Pressure	X	X	X	X	Across each prefilter
Flow rate	X	X	X	X	
Conductivity	X	X	X	X	
Temperature	X		X		
PH	X		X		
SDI	X				Inlet and outlet to each multimedia filter
Chlorine, free	X		X		
Turbidity	X				
LSI			X		
MB plates (one/week)	X		X	X	Before/after each piece of upstream equipment

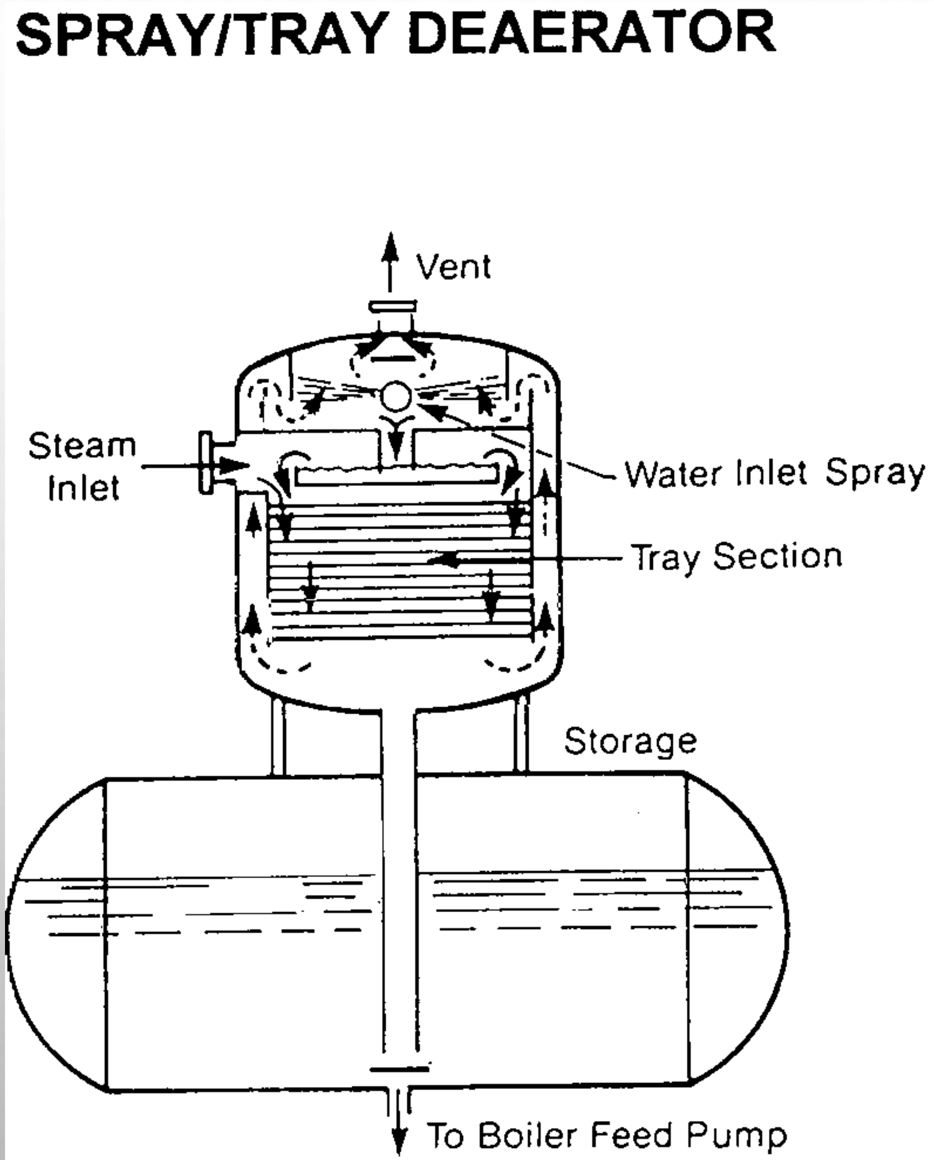
DEAERATION

- OXYGEN IS A NATURAL COMPONENT OF VIRTUALLY ALL WATER SUPPLIES.
- AT FEEDWATER AND BOILER TEMPERATURES, EVEN SMALL AMOUNT OF OXYGEN GREATLY ACCELERATE CORROSION.
- CORROSION WILL TYPICALLY BE OBSERVED IN A FEW SPECIFIC LOCATIONS.
  - ECONOMIZER - DRAMATIC INCREASE IN TEMPERATURE
  - STEAM DRUM AT STEAM/DRUM INTERFACE
  - CONDENSATE SYSTEM

DEAERATION

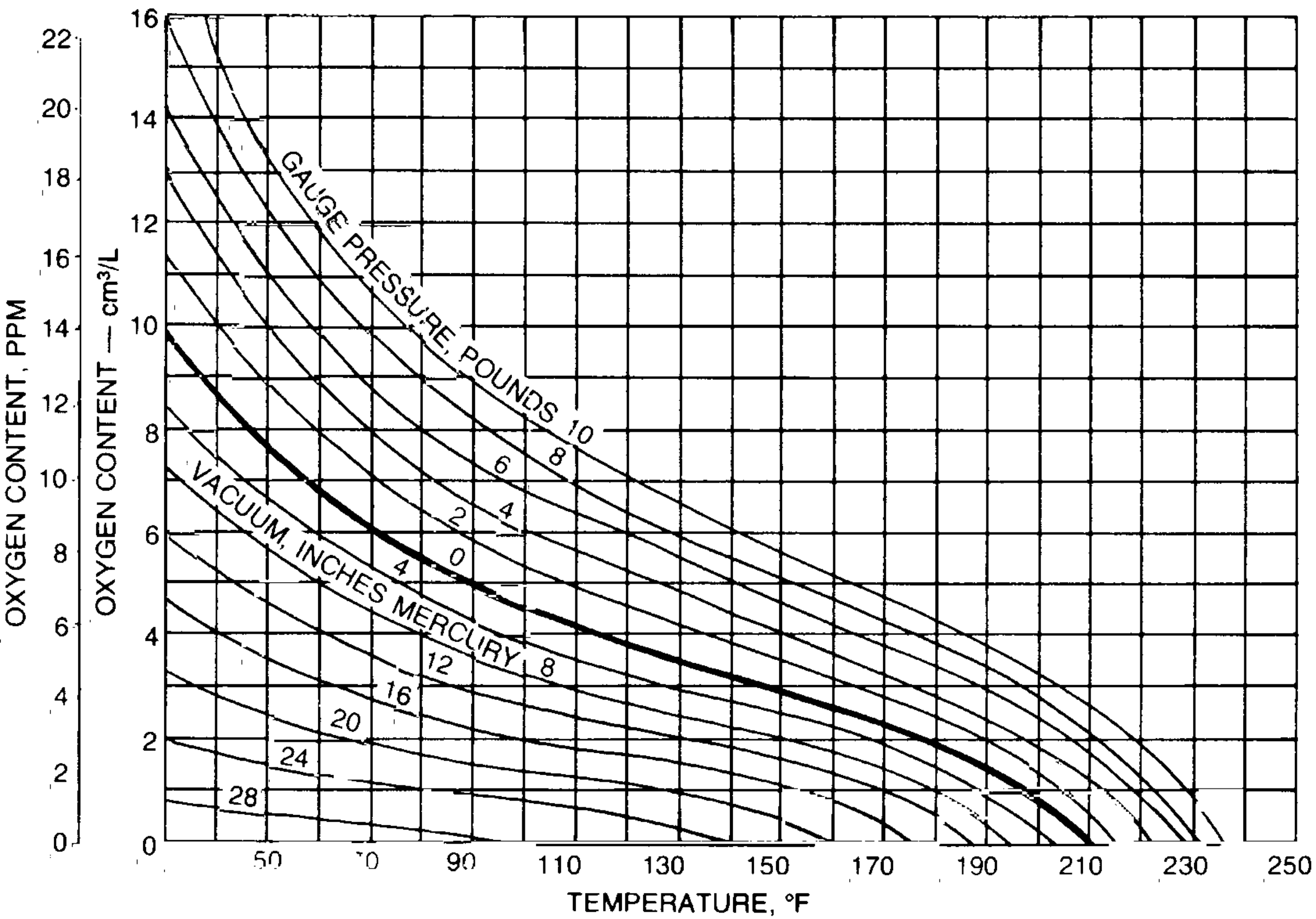
- PURPOSE
  - PRIMARY PURPOSE IS TO REMOVE OXYGEN AND OTHER DISSOLVED GASSES FROM THE FEEDWATER.
  - PREHEAT THE FEEDWATER TO PREVENT THERMAL SHOCK ON THE BOILER
- DISSOLVED GASSES THAT MAY BE REMOVED:
  - OXYGEN
  - CARBON DIOXIDE
  - AMMONIA
  - HYDROGEN SULFIDE



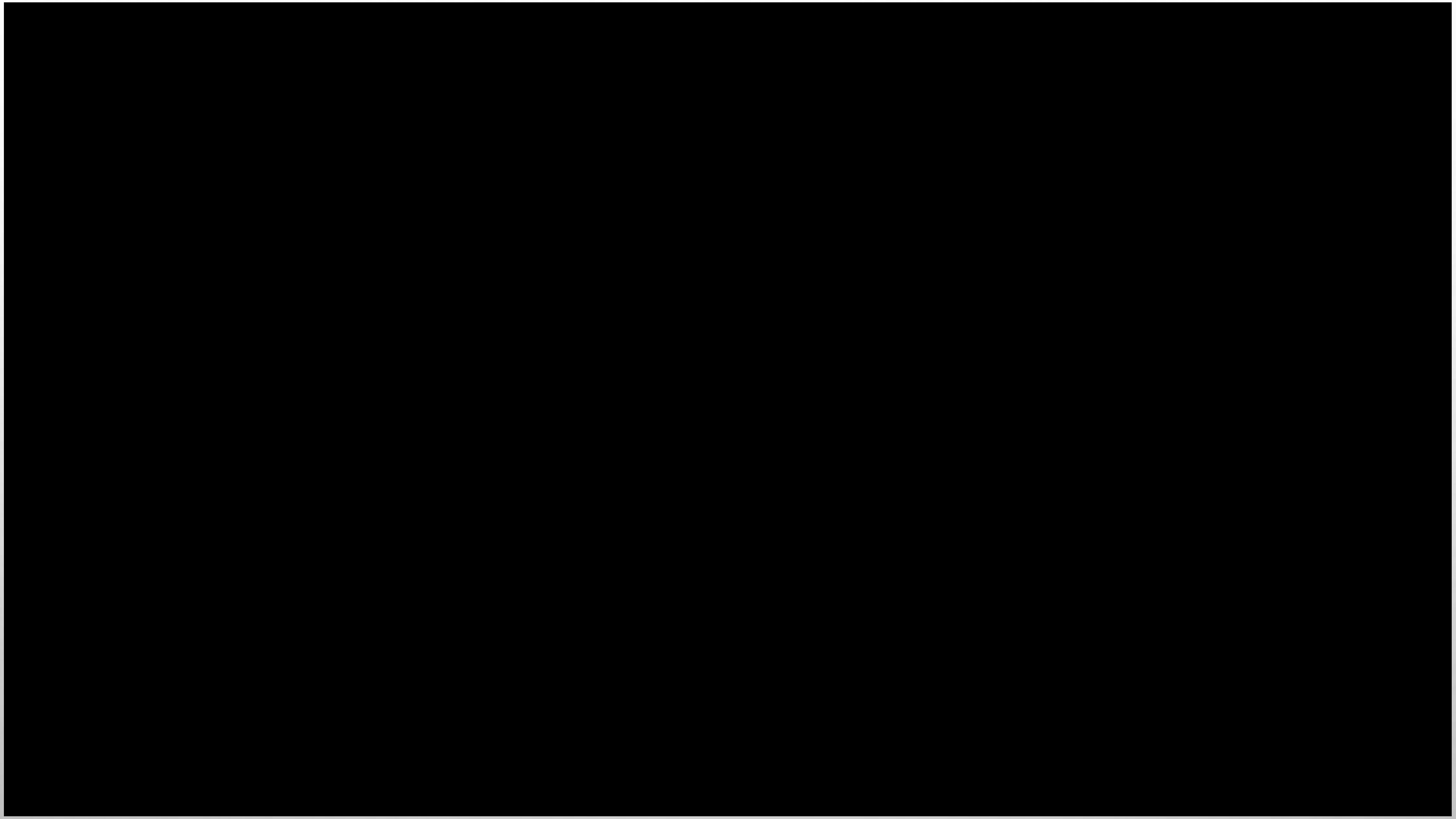


- TWO LAWS THAT GOVERN OPERATION:
  - SOLUBILITY OF GASSES IN LIQUIDS DECREASES WITH AN INCREASE IN TEMPERATURE. THIS ACTS TO RELEASE ALL DISSOLVED GASSES TO THE SPACE ABOVE THE LIQUID(HENRY'S LAW).
  - THE CONCENTRATION OF A DISSOLVED GAS IN SOLUTION IS DIRECTLY PROPORTIONAL TO THE PARTIAL PRESSURE OF THAT GAS IN THE FREE SPACE ABOVE THE LIQUID (DALTON'S LAW OF PARTIAL PRESSURES)

Solubility of Oxygen in Water



SPRAY TYPE DEAERATOR OPERATION



CHEMICAL DEAERATION

- EFFLUENT FROM A PROPERLY OPERATING DEAERATOR CONTAINS NO MORE THAN 7 PPB OXYGEN.
- LAST TRACES OF OXYGEN MUST BE CHEMICALLY SCAVENGED FROM THE FEEDWATER.
- TWO TYPES OF SCAVENGERS
    - INORGANIC - SULFITES
    - ORGANIC - DEHA, ERYTHORBATE, ETC.

CHEMICAL DEAERATION

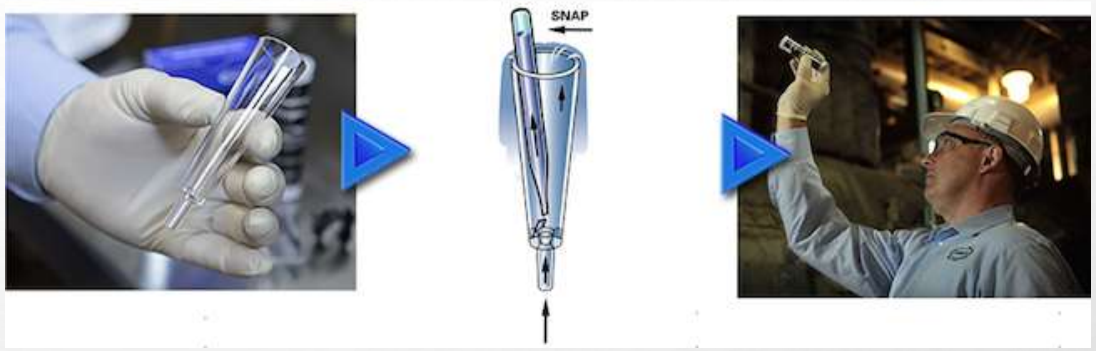
- **WATERTECH 3425**
  - CATALYZED SODIUM SULFITE
- **$2Na_2SO_3 + O_2 \rightarrow 2Na_2SO_4$**

(SODIUM SULFITE) (OXYGEN) (SODIUM SULFATE)

- THE CATALYST, LOW CONCENTRATIONS OF COBALT, SUBSTANTIALLY INCREASE THE REACTION RATE WITH THE OXYGEN.

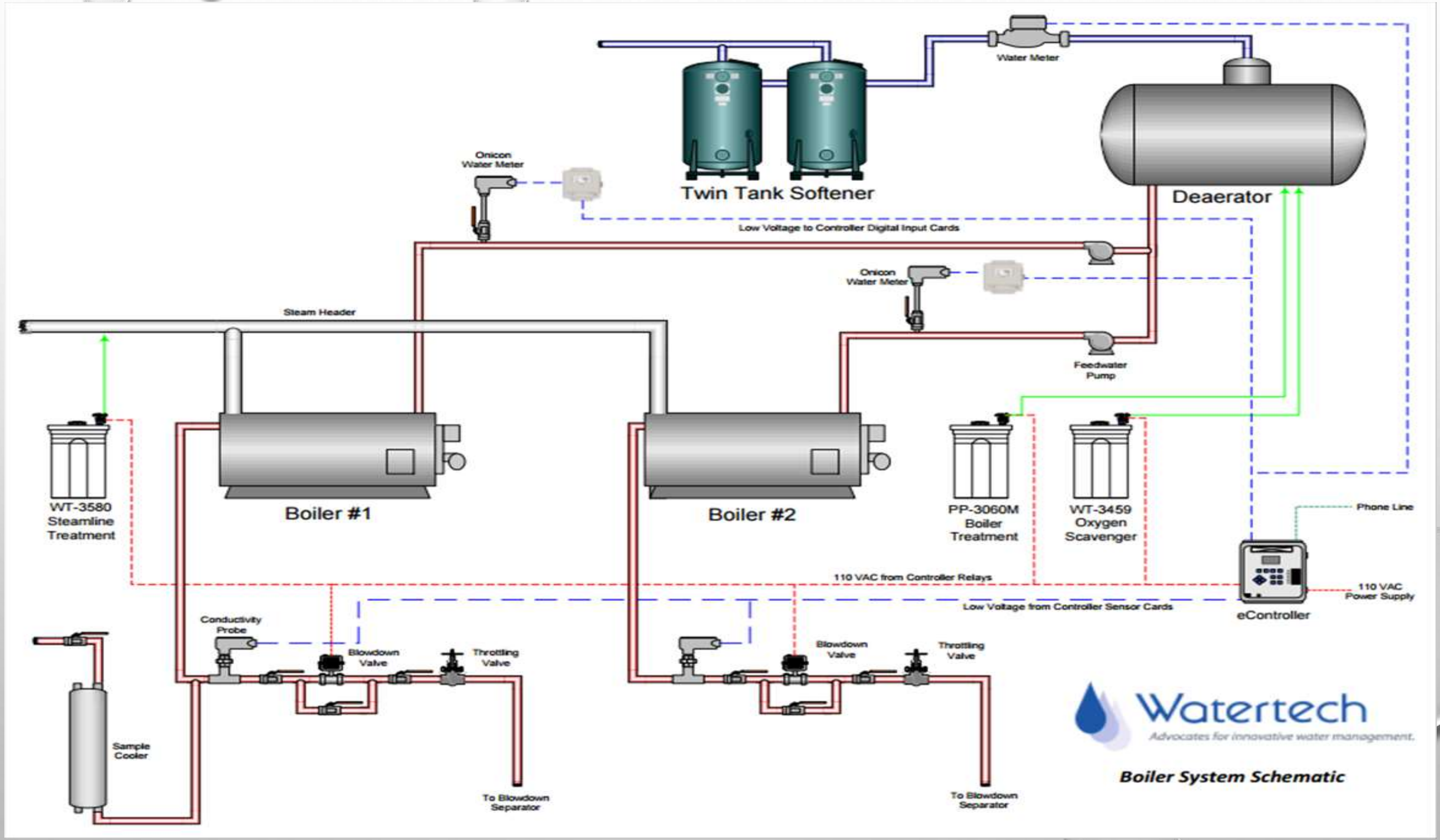
DEAERATOR TROUBLESHOOTING

- DEAERATOR PERFORMANCE IS MONITORED WITH A DISSOLVED OXYGEN ANALYZER AND CHEMETRICS TESTS.



- IF EFFLUENT LEVEL OF OXYGEN IS HIGH
    - CHECK PRESSURE AND TEMPERATURE FOR INSUFFICIENT STEAM FLOW.
    - CHECK VENT VALVE - SHOULD HAVE 18" PLUME
    - POOR SPRAY PATTERN - CHECK SPRAY SYSTEM
    - BROKEN SCRUBBER OR TRAYS - INSPECT

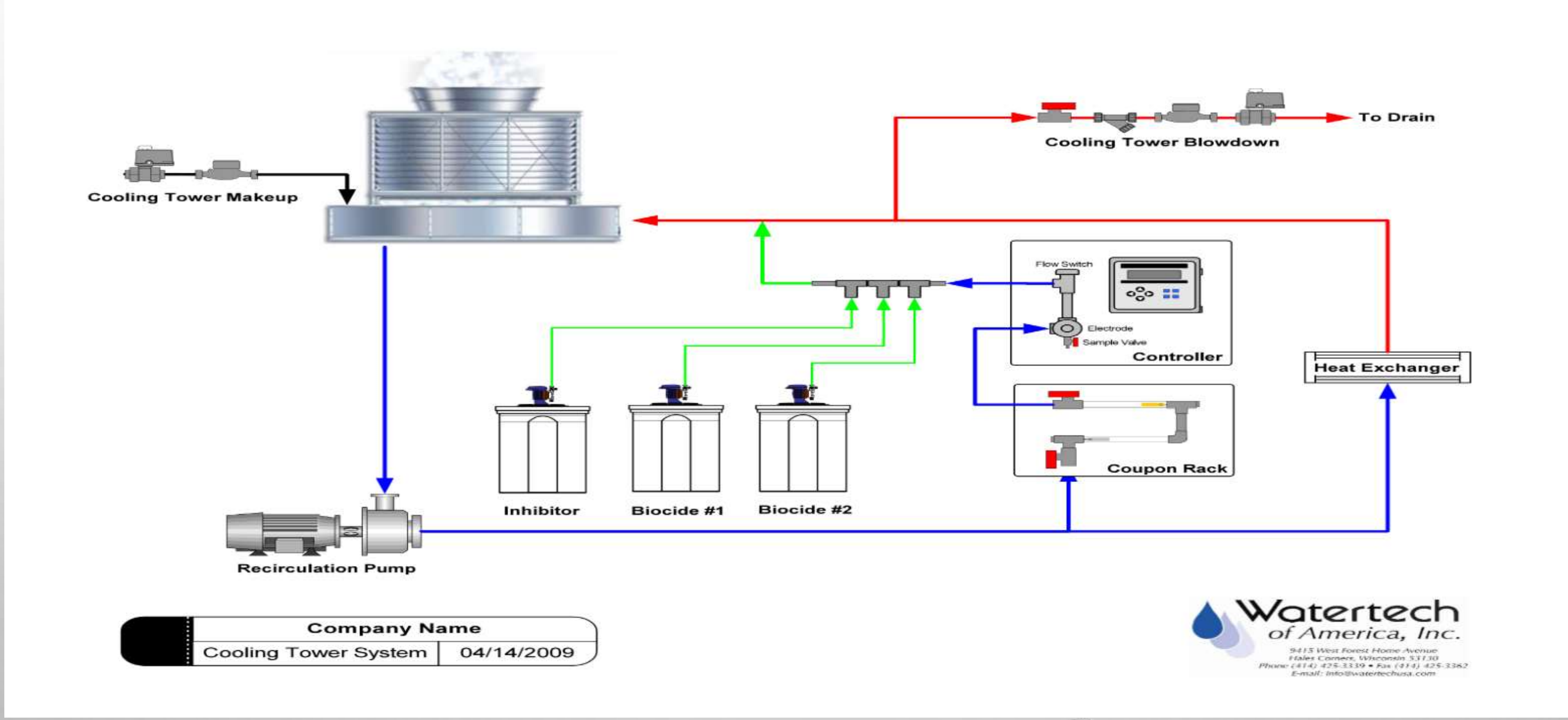
BASIC BOILER SYSTEM



THE BOILER SYSTEM…..WHAT TO KNOW

- FEEDWATER HARDNESS TEST IS THE MOST CRITICAL TEST TO RUN AND KEEP IN RANGE.
- CONDUCTIVITY CONTROL IS CRITICAL TO PROPER WATER CHEMISTRY.
  - USE AUTOMATION TO ACCOMPLISH THIS
- MAINTAIN PROPER OXYGEN SCAVENGER LEVELS
  - CHECK DEAERATOR, CHEMICAL FEED PUMP, TANK LEVELS IF READINGS ARE LOW
- MAINTAIN PROPER LEVELS OF INTERNAL TREATMENT/DISPERSANT
  - ADJUST CHEMICAL FEED PUMP AS NEEDED
- TRACK CONDENSATE AND FEEDWATER TOTAL IRON LEVELS TO MONITOR FOR CORROSION BYPRODUCT CONCENTRATION.
- TRACK CONDENSATE PH TO ENSURE PROPER FEED OF STEAM AND CONDENSATE TREATMENT.

BASIC COOLING TOWER SYSTEM



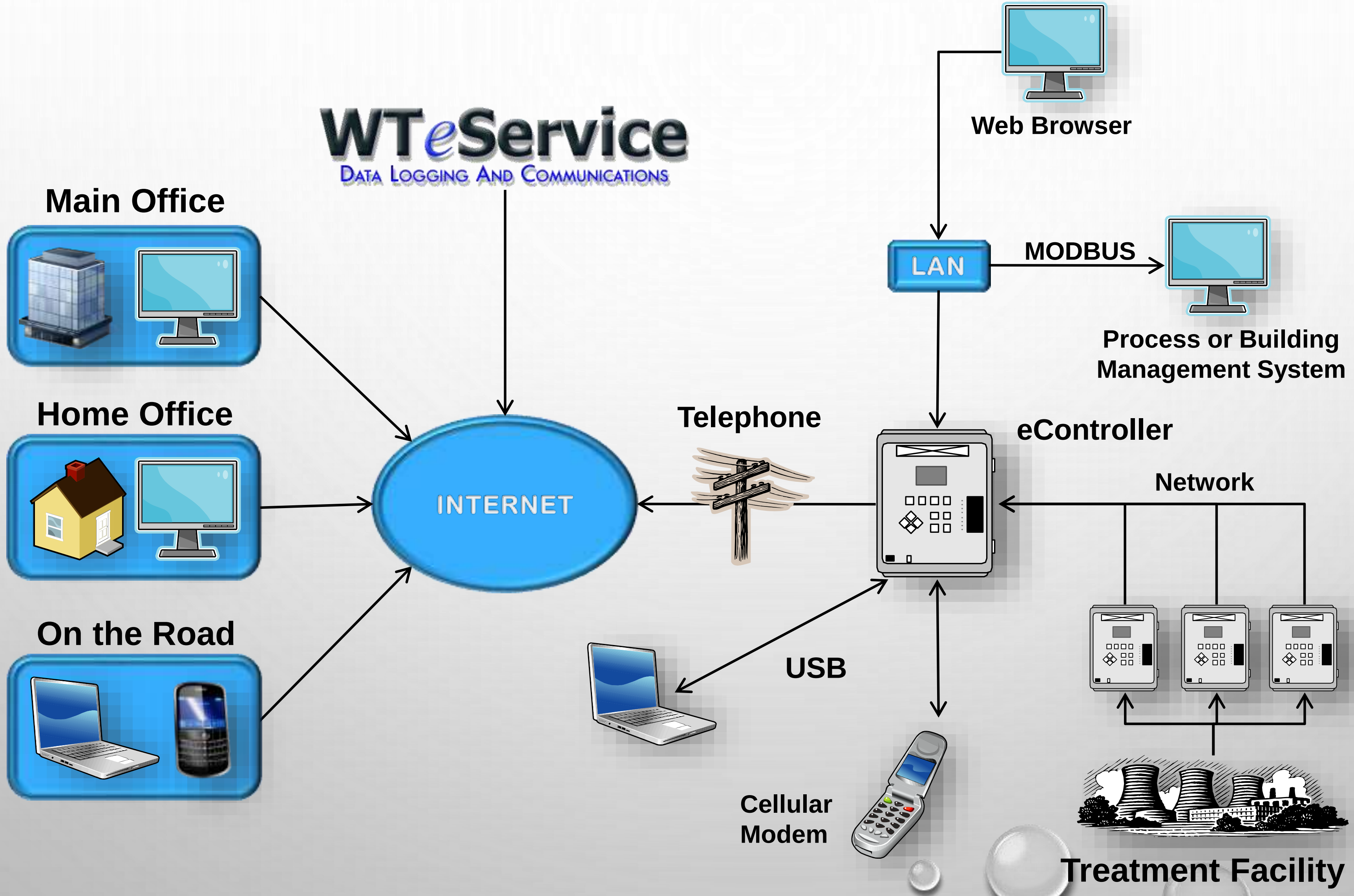
BASIC WATER TREATMENT COMPONENTS

- MAKE UP AND BLOWDOWN WATER METERS
- BLOWDOWN VALVE
- CONDUCTIVITY, PH, ORP CONTROL
- INHIBITOR PUMP
- BIOCIDE PUMPS
- OPTIONAL
    - TANKS, LEVEL SENSORS FLOW METERS

THE COOLING SYSTEM…..WHAT TO KNOW

- CONDUCIVITY CONTROL IS CRITICAL TO PROPER WATER CHEMISTRY
  - USE AUTOMATION TO ACCOMPLISH THIS
  - CHECK CALIBRATION WITH HAND HELD CONDUCTIVITY METER
- MAINTAIN PROPER SCALE AND CORROSION INHIBITOR LEVELS
  - ENVIRODOSE AUTOMATION, OP TESTING AND OTHERS.
- ENSURE BIOCIDES ARE BEING FED AS PRESCRIBED
  - TRACK ORP FOR OXIDIZING BIOCIDE.
  - MONITOR TANK LEVELS, PUMP FLOW OF NON-OXIDIZING BIOCIDES.
- IF PH CONTROL IS IN USE, AUTOMATED CONTROL OF ACID PUMP WITH PH SENSOR IS A MUST!
  - CHECK CALIBRATION WITH HAND HELD PH METER.
  - RUN TOTAL ALKALINITY TEST AS A BACK UP TEST.
- INSTALL WATER METERS TO TRACK MAKE UP AND BLOWDOWN GALLONS

WATER MANAGEMENT AUTOMATION



WHAT CAN BE AUTOMATED/TRENDED BOILERS

- CONDUCTIVITY CONTROL

- HARDNESS ANALYZER

- TANK LEVELS

- CHEMICAL FLOW

- PRESSURE AND TEMPERATURE
- CONDENSATE pH
- CHEMICAL FEED AND RESIDUALS
- STEAM AND FEEDWATER FLOW

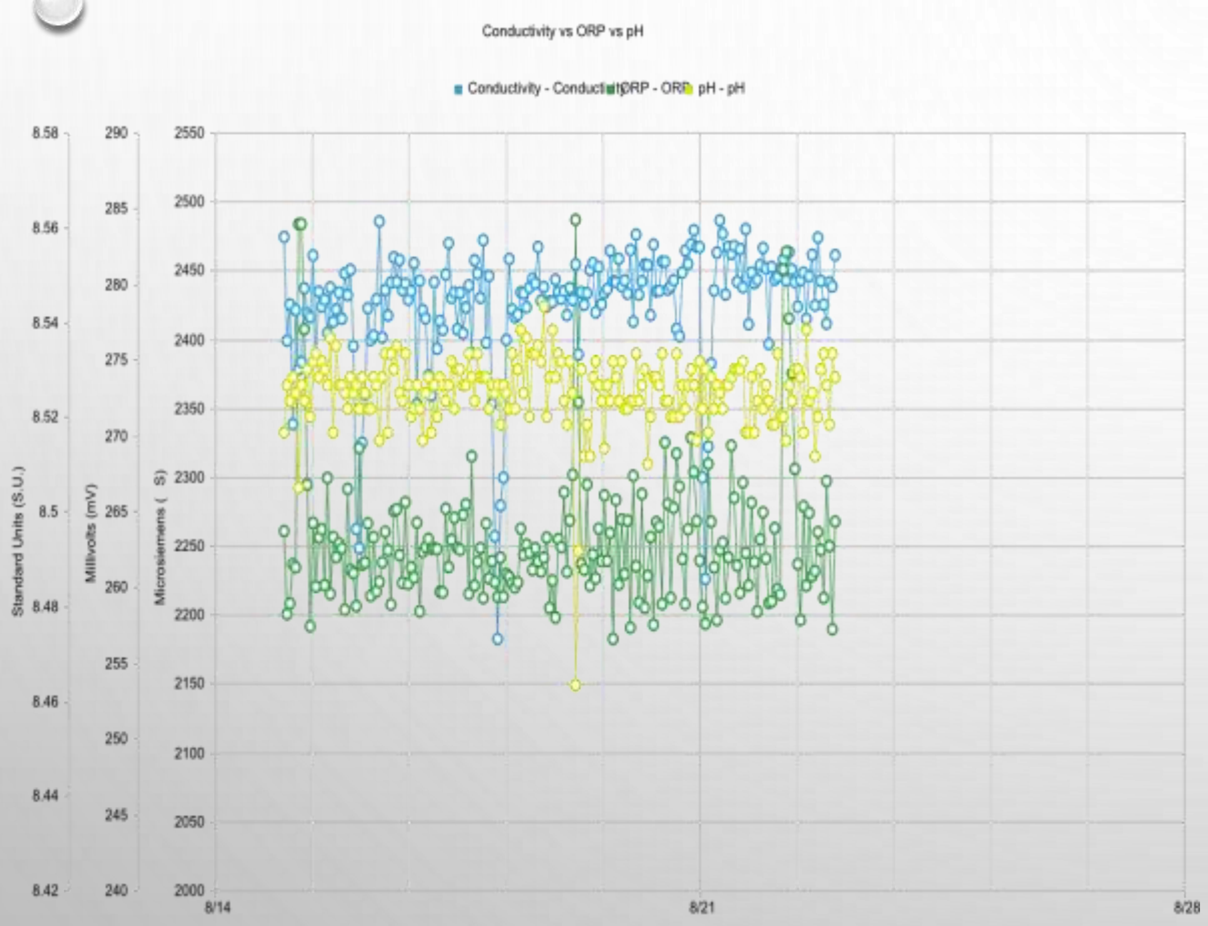
WHAT CAN BE AUTOMATED/TRENDED COOLING SYSTEMS

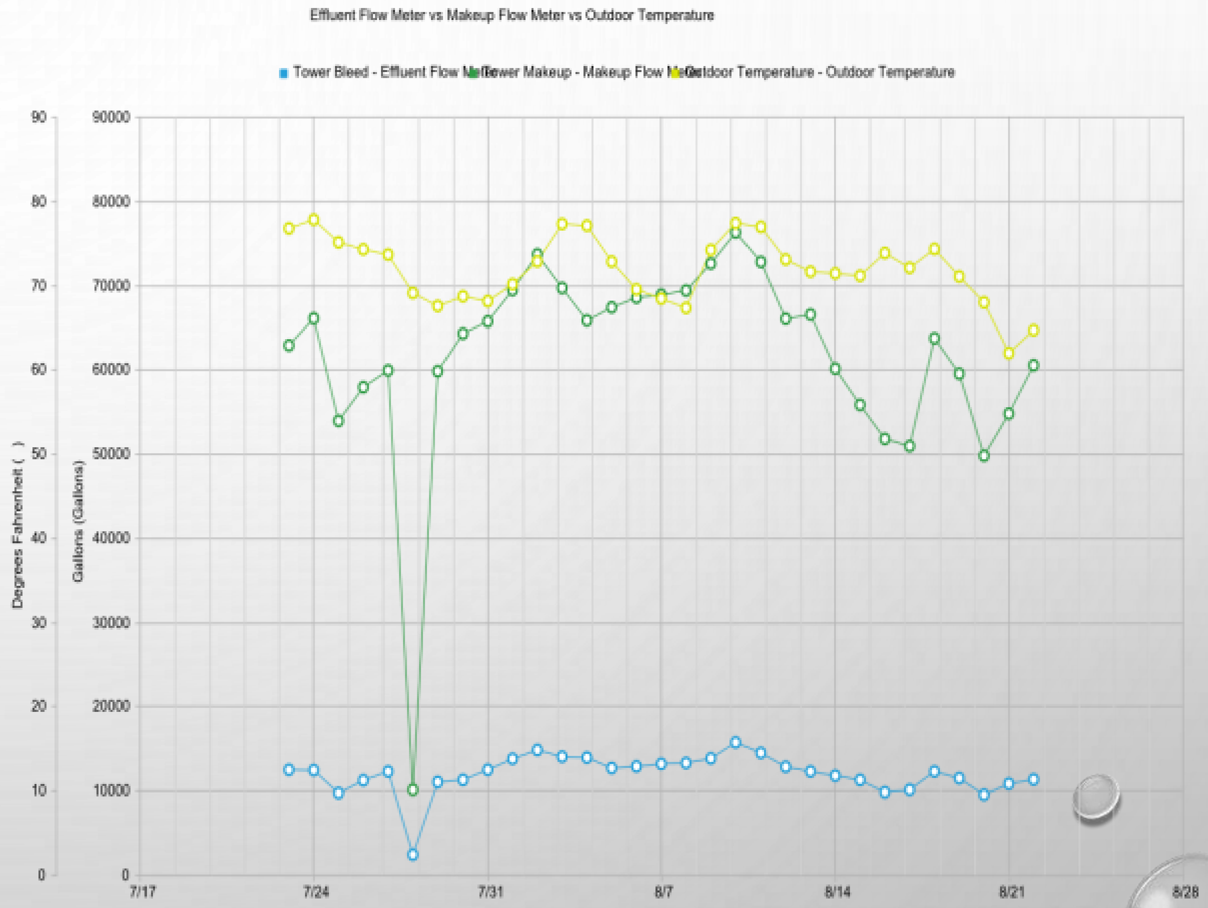
- CONDUCTIVITY CONTROL
- PH
- ORP(OXIDIZING BIOCIDE)
- Cl2, ClO2 and other sensors
- TANK LEVELS

- CHEMICAL FLOW

- CHEMICAL FEED AND RESIDUALS
    - PTSA(CORROSION INHIBITOR)
- MAKE UP AND BLOWDOWN GALLONS

DATA MANAGEMENT - BLUEVUE





CORRECTIVE ACTIONS

JEFF FREITAG

- IDENTIFY PARAMETERS OUT OF RANGE AND THE POTENTIAL CAUSE
- CHEMICAL VS MECHANICAL-BASED CORRECTIONS
- CORRECTIVE ACTION FOLLOWUP

bluevantage

WATERTECH

CORRECTIVE ACTIONS

- SO YOU KNOW WHAT TO SAMPLE, WHERE TO GRAB THE SAMPLE, HOW TO MAKE SURE IT'S A GOOD SAMPLE, HOW TO RUN THE PROPER TEST, AND WHERE TO LOG THE READING…

SO WHAT?

SCENARIOS

- LETS WALK THROUGH A COUPLE REAL LIFE EXAMPLES TO DISCUSS POSSIBLE CAUSE AND CORRECTIVE ACTION

BEFORE YOU DO ANYTHING…

- RE-SAMPLE
- RE-RINSE
- RE-TEST!

SOFTENER – CORRECTIVE ACTIONS

- MOST COMMON PROBLEMS WITH WATER SOFTENERS:
  - NO SALT
  - IMPROPER PROGRAMMING
  - IMPROPER SIZING
  - BAD SEALS OR INTERNALS

Softener

- High Hardness

- Re-run sample (flush)
- Test right after online unit
- Check status of unit online
- Check brine tank
- Switch softeners / put into regen

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User: Jeff Freitag **Group:** Sales Manager **Company:** Watertech of America, Inc. **Version:** 2.55

Test	Deaerator	Softener #1	Main Condensate	ASC Condensate	R/O
Conductivity, mmho	**24** 100 max	**317** 275 - 310	**12** 50 max	**10** 50 max	**12** 15 max
Total Hardness, ppm	**0.3** 1 max	**5** 0.5 max	**0** 0.5 max	**0** 0.5 max	**0.2** 0.5 max
pH	**9.0** 8.3 - 9.5		**8.66** 8.3 - 8.8	**8.54** 8.3 - 8.8	
P Alkalinity, ppm	**8** 4 - 30				
M Alkalinity	**20** 10 - 100				
Temperature	**230** 220 - 230				
Pressure (psi)	**7** 4 - 7				
Total Iron, ppm	**0** 0.05 max		**0** 0.05 max	**0.1** 0.05 max	

REVERSE OSMOSIS – CORRECTIVE ACTIONS

- MOST COMMON PROBLEMS WITH WATER RO'S:
  - HARDNESS COMING FROM SOFTENER
  - CHEMICAL FEED TO THE RO
  - PRE-FILTERS PLUGGING
  - BAD SEALS
  - POOR PRESSURE FROM PUMP
  - CHORINE BREAKTHROUGH
  - DUE FOR CLEANING

REVERSE OSMOSIS – CORRECTIVE ACTIONS

- SCENARIO:
  - HARDNESS OR CONDUCTIVITY ARE HIGH:
    - IF EITHER ARE HIGH, CHECK THE QUALITY OF THE INFLUENT WATER FIRST
    - CHECK ALL GAUGES
    - CHECK WATER QUALITY ON OUTLET OF EACH MEMBRANE

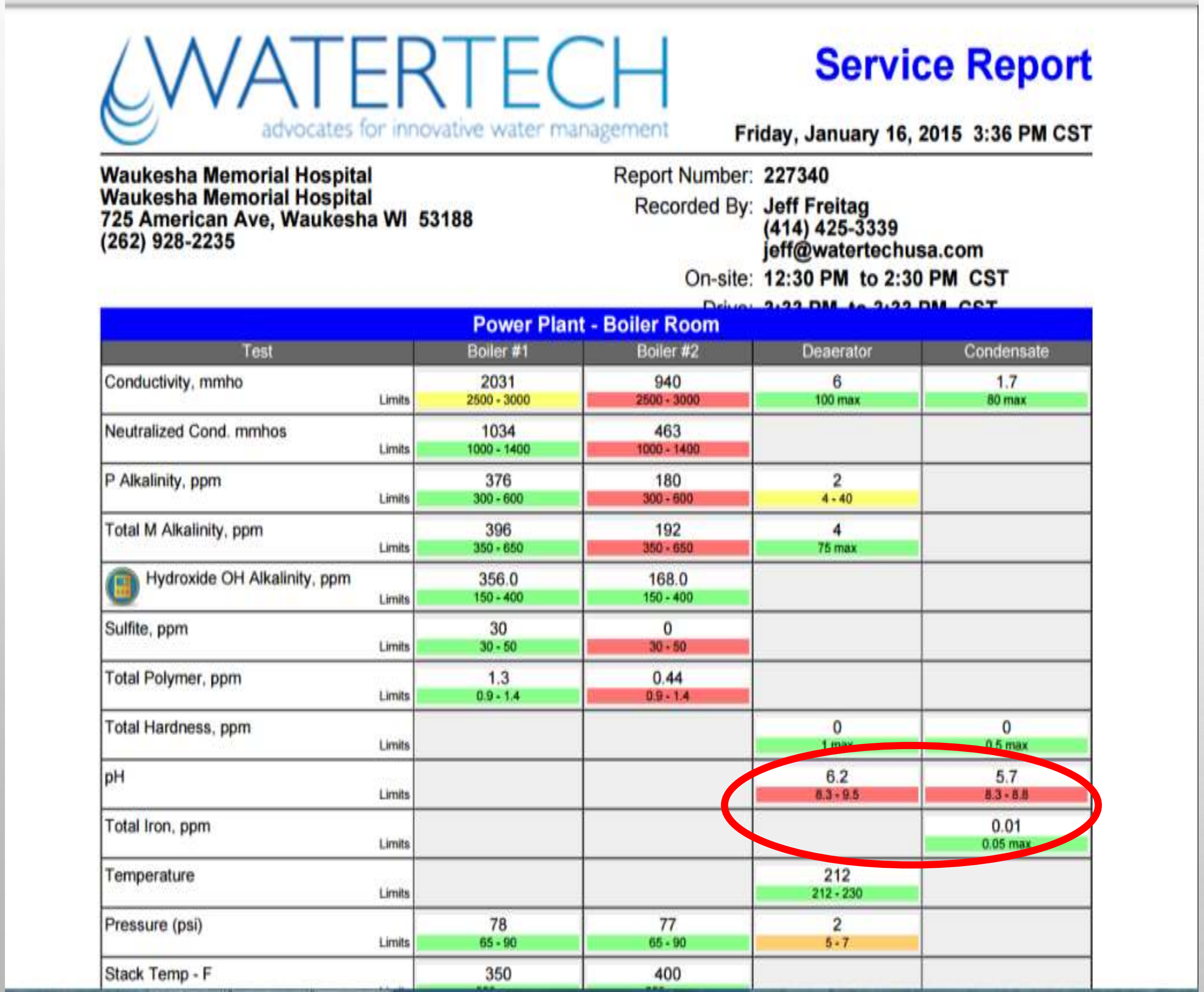
DEAERATOR – CORRECTIVE ACTIONS

- MOST COMMON PROBLEMS:
  - TEMP/PRESSURE NOT CORRELATING
  - CHEMISTRIES OUT OF RANGE
  - CONTAMINATION

DEAERATOR – CORRECTIVE ACTIONS

- SCENARIO:
  - TEMPERATURE IS LOW
    - CHECK PRESSURE
    - CHECK ACCURACY OF GAUGES
    - CHECK VENT
    - CHECK STEAM HEATING SYSTEM

DEAERATOR – CORRECTIVE ACTIONS



WATERTECH
advocates for innovative water management

Service Report

Friday, January 16, 2015 3:36 PM CST

Waukesha Memorial Hospital
Waukesha Memorial Hospital
725 American Ave, Waukesha WI 53188
(262) 928-2235

Report Number: **227340**
Recorded By: **Jeff Freitag**
(414) 425-3339
jeff@watertechusa.com
On-site: **12:30 PM to 2:30 PM CST**

Power Plant - Boiler Room

Test	Boiler #1	Boiler #2	Deaerator	Condensate
Conductivity, mmho	2031	940	6	1.7
Limits	2500 - 3000	2500 - 3000	100 max	80 max
Neutralized Cond. mmhos	1034	463		
Limits	1000 - 1400	1000 - 1400		
P Alkalinity, ppm	376	180	2	
Limits	300 - 600	300 - 600	4 - 40	
Total M Alkalinity, ppm	396	192	4	
Limits	350 - 650	350 - 650	75 max	
Hydroxide OH Alkalinity, ppm	356.0	168.0		
Limits	150 - 400	150 - 400		
Sulfite, ppm	30	0		
Limits	30 - 50	30 - 50		
Total Polymer, ppm	1.3	0.44		
Limits	0.9 - 1.4	0.9 - 1.4		
Total Hardness, ppm			0	0
Limits			1 max	0.5 max
pH			6.2	5.7
Limits			8.3 - 9.5	8.3 - 8.8
Total Iron, ppm				0.01
Limits				0.05 max
Temperature			212	
Limits			212 - 230	
Pressure (psi)	78	77	2	
Limits	65 - 90	65 - 90	5 - 7	
Stack Temp - F	350	400		

- SCENARIO:
  - LOW PH
    - CHECK MAKEUP WATER QUALITY
    - CHECK CONDENSATE RETURN WATER QUALITY
    - CHECK CHEMICAL FEED LEVELS

BOILER – CORRECTIVE ACTIONS

- MOST COMMON PROBLEMS WITH WATER BOILERS:
  - CONDUCTIVITY OUT OF RANGE
  - CHEMISTRIES OUT OF RANGE
  - CLOUDY / COLORED WATER
  - BOILER WATER CARRYOVER

Boiler

- B1 Low Conductivity & Alkalinity & Sulfite
- High Condensate pH

- **B1 Low Conductivity**
- Re-run sample (flush)
- Check for loss of water or improperly operating blowdown system

- **High pH**

- Most likely steam line treatment overfeed

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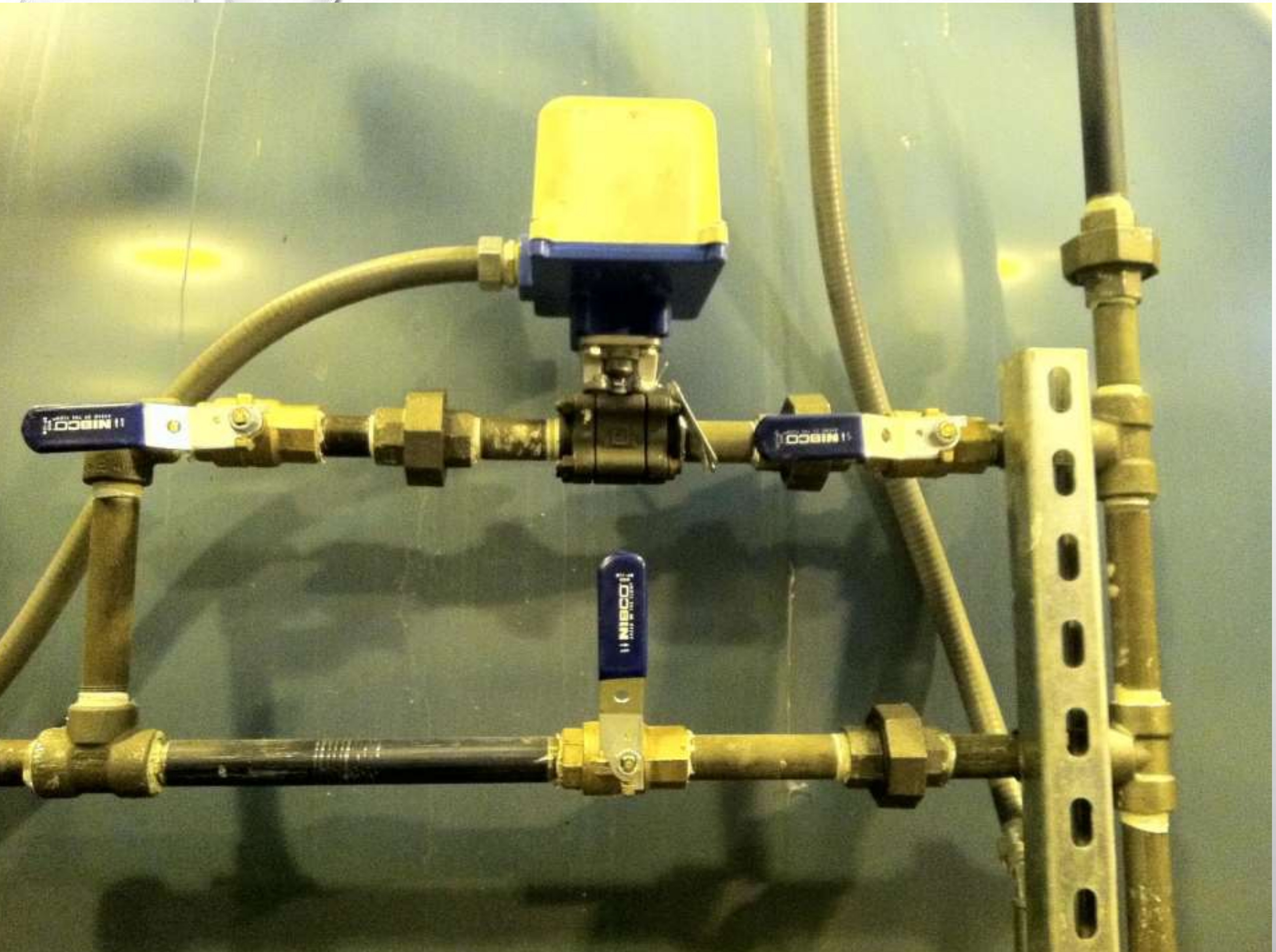
User: Jeff Freitag **Group:** Sales Manager **Company:** Watertech of America, Inc. **Version:** 2.55

Test	Boiler #1	Boiler #3	Deaerator	Condensate
Conductivity, mmho	1010 2500 - 3000	2408 2500 - 3000	26 100 max	22 80 max
P Alkalinity, ppm	120 300 - 600	428 300 - 600		
Total M Alkalinity, ppm	160 350 - 650	492 350 - 650		
Hydroxide OH Alkalinity, ppm	80.0 150 - 400	364.0 150 - 400		
Sulfite, ppm	7 30 - 50	33 30 - 50		
Total Polymer, ppm	0.945 0.9 - 1.4	1.325 1.4 - 1.6		
Total Hardness, ppm			0 1 max	0 0.5 max
pH				9.14 8.3 - 8.8



BOILER BLOWDOWN VALVE

Boiler

- B1 High Sulfite
- B2 Low Conductivity

- **B1 High Sulfite**
- Since conductivity is low, this is likely an overfeed.
- Compare to 2nd boiler

- **Low Conductivity**

- Check for loss of water or improperly operating blowdown system
- Check lead/lag operation

TeSERVICE

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User: Jeff Freitag **Group:** Sales Manager **Company:** Watertech of America, Inc. **Version:** 2.55

Test	Boiler #1	Boiler #2	Deaerator	Condensate
Conductivity, mmho	1970 2500 - 3000	1410 2500 - 3000	34.7 100 max	23 80 max
P Alkalinity, ppm	320 300 - 600	200 300 - 600		
Total M Alkalinity, ppm	400 350 - 650	276 350 - 650		
Hydroxide OH Alkalinity, ppm	240.0 150 - 400	124.0 150 - 400		
Sulfite, ppm	100 30 - 50	72 30 - 50		
Total Polymer, ppm	1.772 0.9 - 1.4	0.955 0.9 - 1.4		
Total Hardness, ppm			0 1 max	0 0.5 max
pH			8.4 8.3 - 9.5	8.7 8.3 - 8.8

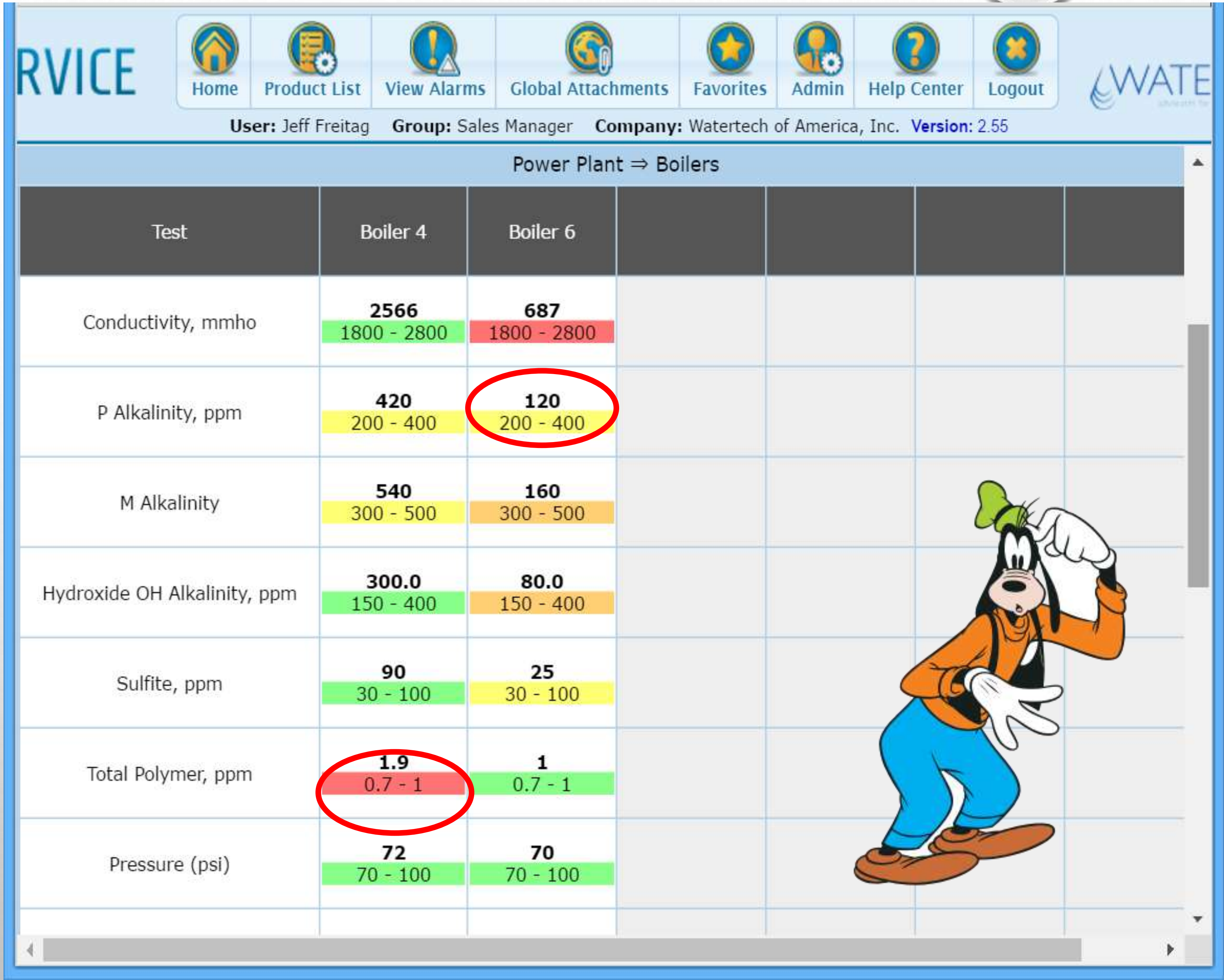
Boiler

- B1 High Polymer
- B2 Low Conductivity & Alkalinity

- **B1 High Polymer**
- Since conductivity is low, this is likely an overfeed.
- Compare to 2nd boiler

- **Low Conductivity**

- Either water loss or lag boiler taking on condensate



Test	Boiler 4	Boiler 6
Conductivity, mmho	2566 1800 - 2800	687 1800 - 2800
P Alkalinity, ppm	420 200 - 400	120 200 - 400
M Alkalinity	540 300 - 500	160 300 - 500
Hydroxide OH Alkalinity, ppm	300.0 150 - 400	80.0 150 - 400
Sulfite, ppm	90 30 - 100	25 30 - 100
Total Polymer, ppm	1.9 0.7 - 1	1 0.7 - 1
Pressure (psi)	72 70 - 100	70 70 - 100

WTH?

- Never hesitate to question everything!
- This was the sulfite chemical.

INTERPRETATION OF RESULTS – EXAMPLE 1

- SCENARIO:
  - LOW ALKALINITY AND HIGH CONDUCTIVITY
  - RO MAKEUP
- CORRECTION:
  - LOSS OF PRIME OR FEED OF ALKALINITY BOOSTER
  - DETRIMENTAL TO THE BOILER INTERNALS
  - ALWAYS MAINTAIN 250PPM MINIMUM OF OH ALKALINITY IN BOILER

INTERPRETATION OF RESULTS – EXAMPLE 2

- SCENARIO:
  - SULFITE RESIDUAL IS HIGH
  - CONDUCTIVITY IS IN RANGE
  - FEEDWATER TEMPERATURE IS HIGHER THAN NORMAL
- CORRECTION:
  - THE FEEDWATER TEMPERATURE IS RELATED TO THE SULFITE RESIDUAL
  - NO ACTION IF THE FEEDWATER TEMPERATURE WILL COME BACK DOWN
    - IF YOU TURN IT DOWN IT WILL BE LOW

STEAM & CONDENSATE – CORRECTIVE ACTIONS

- MOST COMMON PROBLEMS WITH WATER CONDENSATE SYSTEMS:
  - CONDUCTIVITY HIGH
  - PH HIGH OR LOW
  - TOTAL HARDNESS HIGH
  - IRON DETECTED
  - COLD CONDENSATE

STEAM & CONDENSATE – CORRECTIVE ACTIONS

- SCENARIO:
  - SLIGHT ELEVATED HARDNESS:
    - CHECK INDIVIDUAL RETURN LINES
    - CHECK CONDUCTIVITY LEVELS
    - TRY TO FIND SPECIFIC SOURCE
    - MOST LIKELY BAD HEAT EXCHANGER

COOLING TOWER – CORRECTIVE ACTIONS

- MOST COMMON PROBLEMS WITH WATER COOLING TOWERS:
  - CONDUCTIVITY OUT OF RANGE
  - INHIBITOR OUT OF RANGE
  - MICROBIOLOGICAL ACTIVITY
  - SEDIMENT AND/OR ALGAE NOTICED IN TOWER
  - AUTOMATION ISSUES

Towers

- Low Molybdenum / Inhibitor

- Check conductivity level
- Check log book for trending data
- Check that pump is primed
- Check for chemical in the tank
- Turn up feed rate

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Power Plant ⇒ Towers

Test	Tower #2	Tower #3
Conductivity, mmho	**944** 900 - 1000	**1045** 900 - 1000
Molybdenum, ppm	**1** 1 - 1.5	**0.4** 1 - 1.5
Total Hardness, ppm	**408** 430 - 575	**460** 400 - 575
Free Chlorine, ppm	**0.4** 1 max	**0.3** 1 max
Bacteria Dip Slide, cfuml	**10.2** 10.4 max	**10.3** 10.4 max

Towers

- FUBAR
  - Check automation!
  - Most likely flow switch is off or "open"

Test	Tower/chiller
Conductivity, mmho	4200 3400 - 3600
Total Hardness, ppm	120 80 max
Free Chlorine, ppm	0 1 max
ORP, mV	150 400 - 500
Organo Phosphonate, ppm	4.2 12.6 - 19.5
Calcium Hardness, ppm	62 40 max
M Alkalinity	1800 1400 max
Bacteria Dip Slide, cfuml	10.6 10.5 max
Fungi mold Dip slide	0 10.2 max
Molybdenum, ppm	0.1 0.4 - 0.8

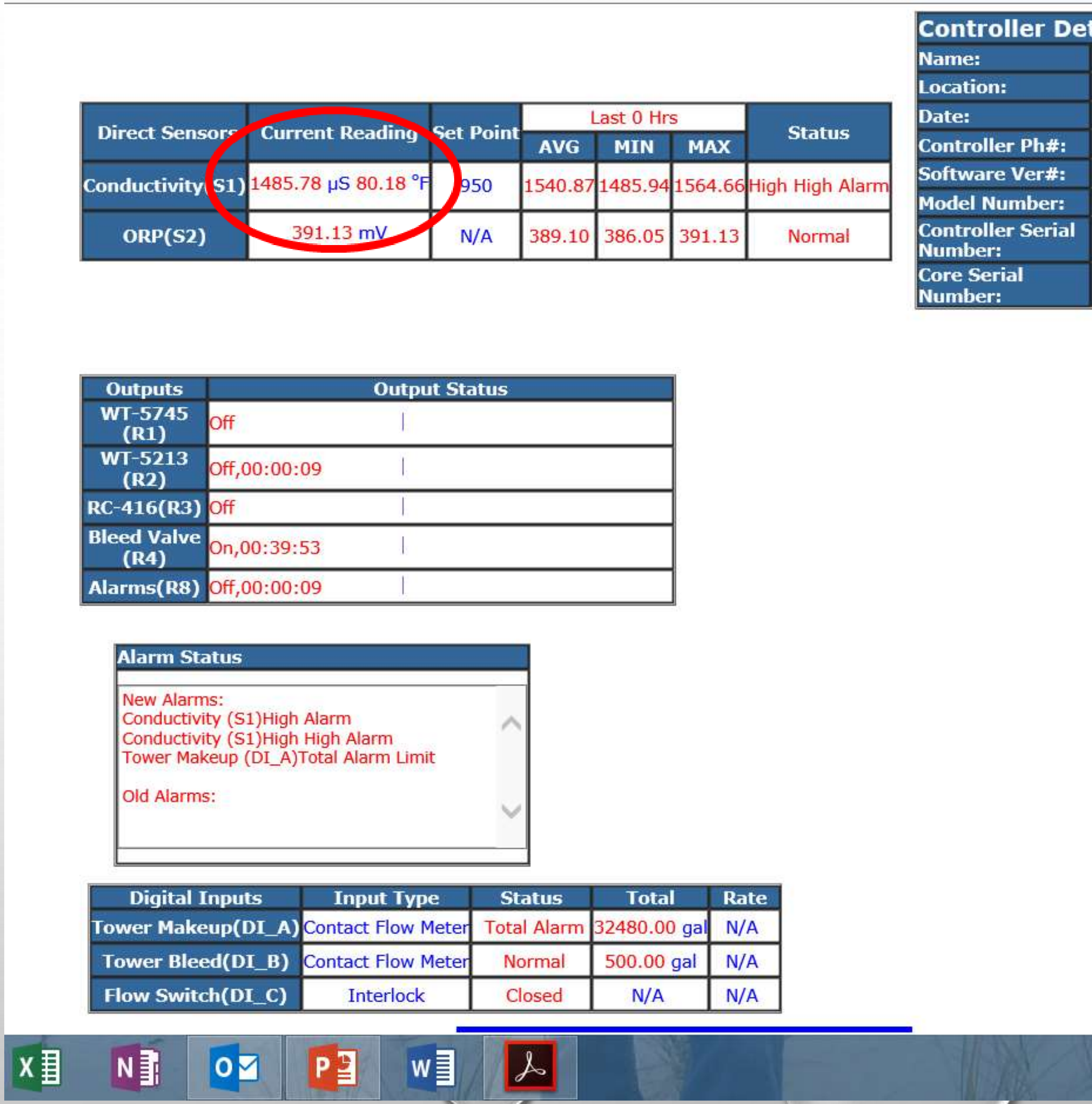
West Office Building - Tower and Closed		
Test	Cooling Tower	
Conductivity, mmho Limits	1029 900 - 1000	
Total Hardness, ppm Limits	516 390 - 475	
M Alkalinity Limits	460 300 - 400	
Bacteria Dip Slide, cfuml Limits	10.5 10.4 max	
Fungi mold Dip slide Limits	0 10.2 max	

Towers

- High Bacteria
  - Check conductivity level
  - Check sediment build up in tower
  - Check that the biocide pumps are primed
  - Check for chemical in the tanks
  - Turn up feed rate
  - Test for proper biocide residuals
  - Retest bacterial levels in one week

Towers

- High conductivity
  - Check operation of bleed valve
  - Check flow to drain when bleed valve is open
  - Check conductivity sensor
  - Run graph on bleed meter vs. makeup meter



Direct Sensors	Current Reading	Set Point	Last 0 Hrs			Status
			AVG	MIN	MAX	
Conductivity(S1)	1485.78 µS 80.18 °F	950	1540.87	1485.94	1564.66	High High Alarm
ORP(S2)	391.13 mV	N/A	389.10	386.05	391.13	Normal

Controller Det
Name:
Location:
Date:
Controller Ph#:
Software Ver#:
Model Number:
Controller Serial Number:
Core Serial Number:

Outputs	Output Status
WT-5745 (R1)	Off
WT-5213 (R2)	Off,00:00:09
RC-416(R3)	Off
Bleed Valve (R4)	On,00:39:53
Alarms(R8)	Off,00:00:09

Alarm Status

New Alarms:
Conductivity (S1)High Alarm
Conductivity (S1)High High Alarm
Tower Makeup (DI_A)Total Alarm Limit

Old Alarms:

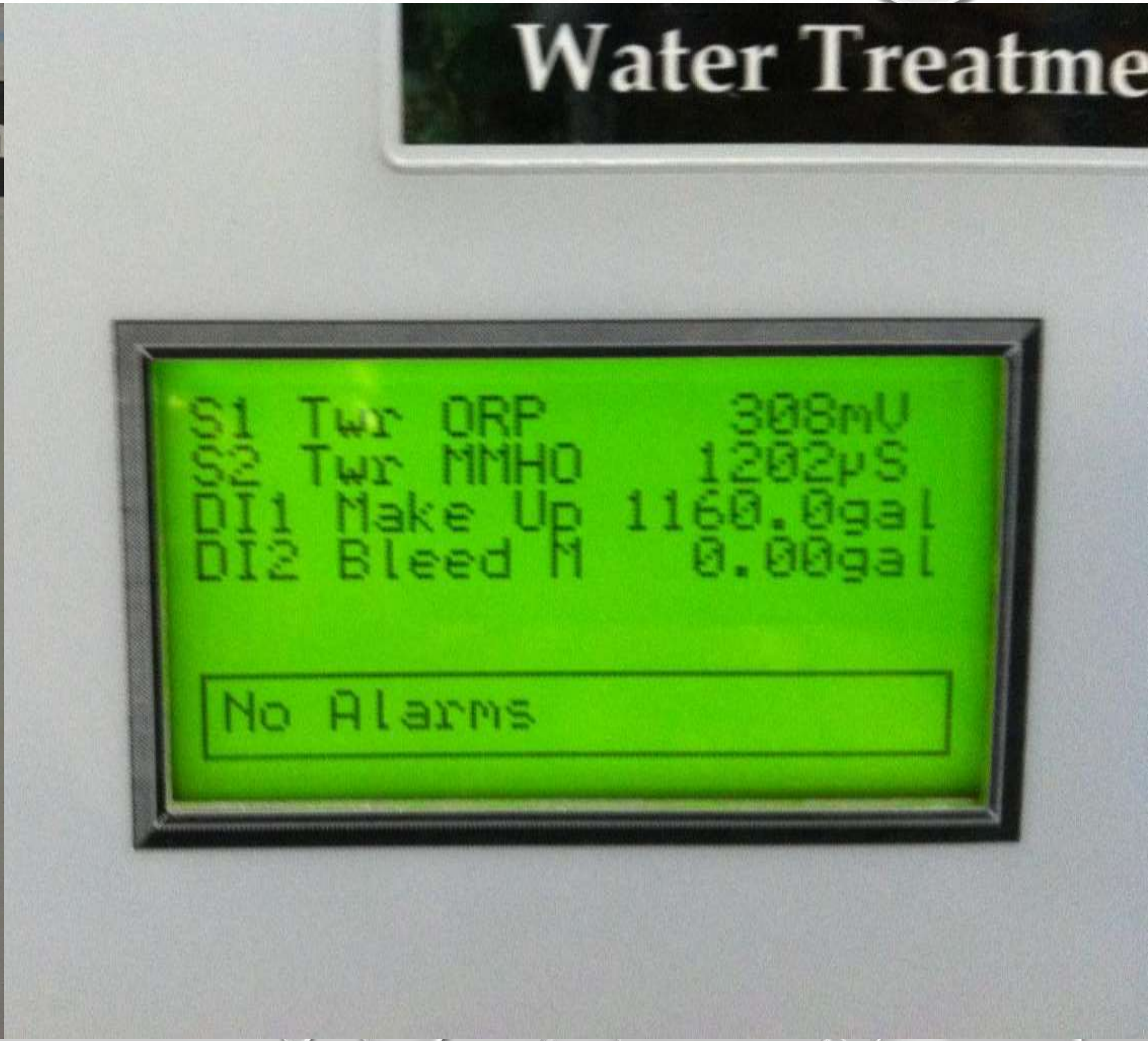
Digital Inputs	Input Type	Status	Total	Rate
Tower Makeup(DI_A)	Contact Flow Meter	Total Alarm	32480.00 gal	N/A
Tower Bleed(DI_B)	Contact Flow Meter	Normal	500.00 gal	N/A
Flow Switch(DI_C)	Interlock	Closed	N/A	N/A

High Conductivity Corrective Action

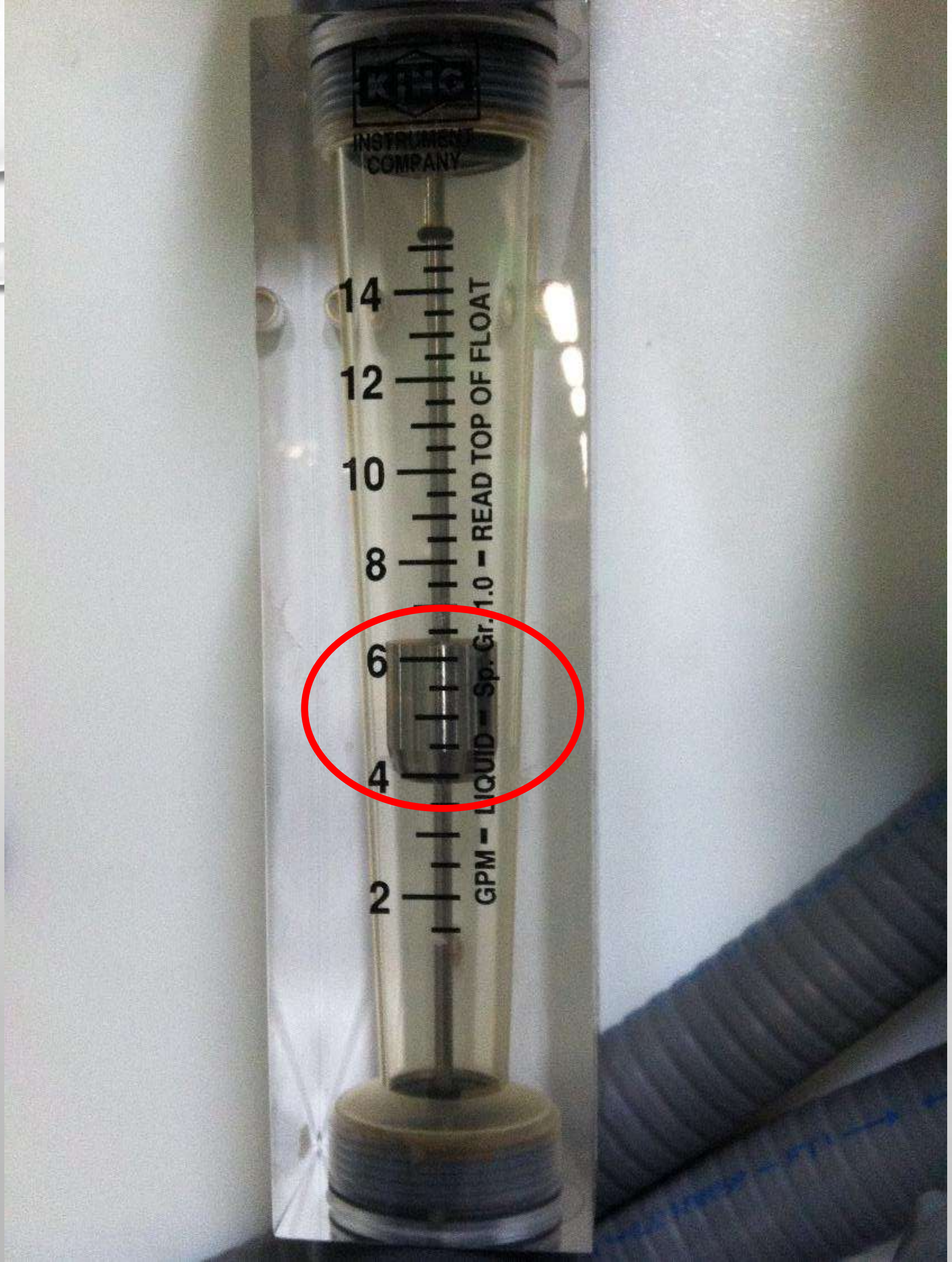
- Valve would only open partially
- Actuator was bad. Ordered a new one

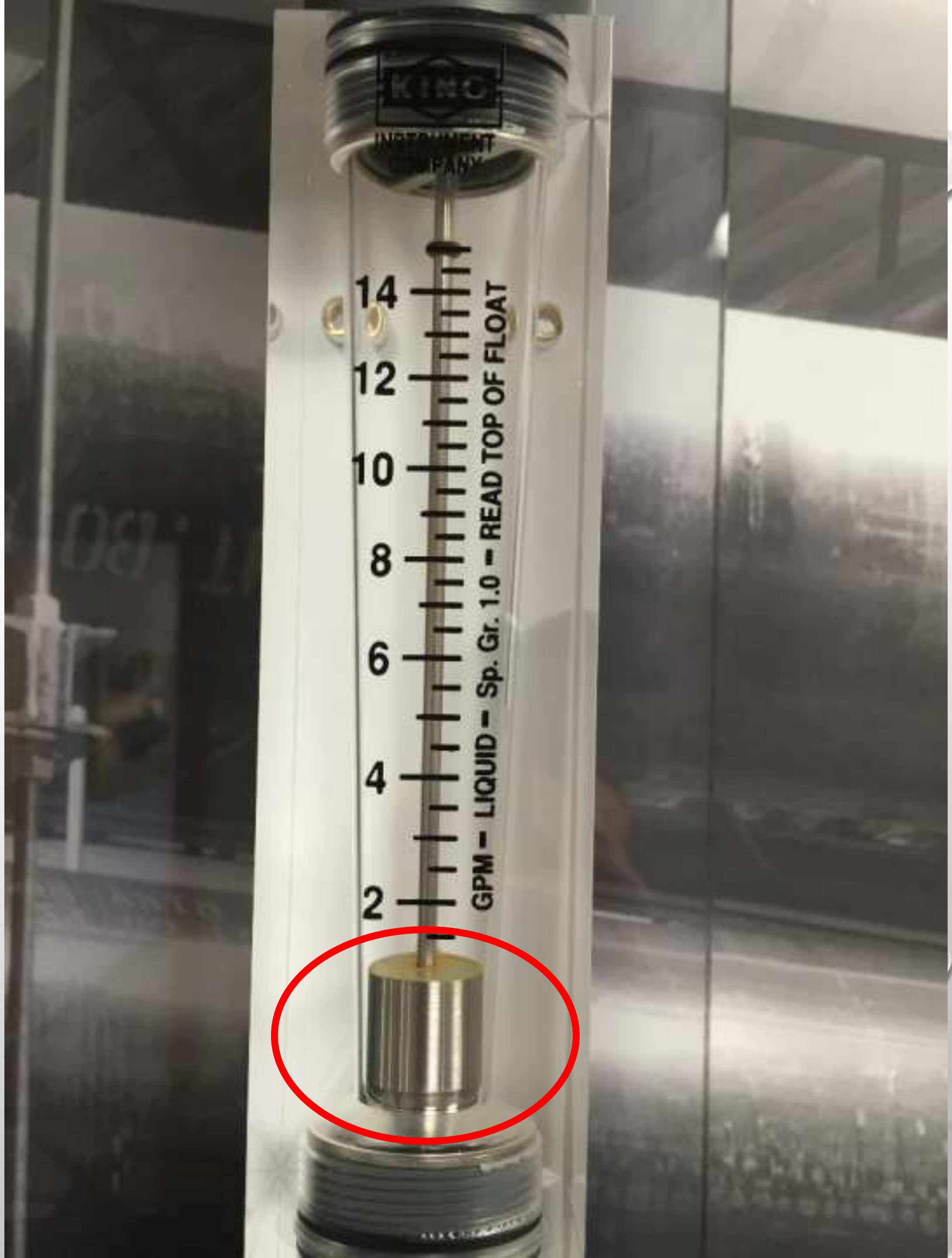
LOW OR NO CHEMICAL IN TANK


S1 Tower Co 0µS
S2 Boiler C 355µS
S3 Tower pH 7.65pH
S4 Tower OR 209mV
AI5 PTSA 4.75ppm
(S1) Low Alarm


S1 Twr ORP 308mV
S2 Twr MMHO 1202µS
DI1 Make Up 1160.0gal
DI2 Bleed M 0.00gal
No Alarms

FLOW METERS


KING
INSTRUMENT COMPANY
14
12
10
8
6
4
2
GPM – LIQUID – Sp. Gr. 1.0 – READ TOP OF FLOAT


KING
14
12
10
8
6
4
2
GPM – LIQUID – Sp. Gr. 1.0 – READ TOP OF FLOAT

CLEAN SENSORS

STRAINERS

FLOW SWITCH

INTERPRETATION OF RESULTS – EXAMPLE 1

- AMMONIA SYSTEM
  - CONDUCTIVITY IS IN RANGE BUT PH IS VERY HIGH
  - USING WT-5230 AND THERE IS A PINK COLOR TO THE WATER
- TOWER SYSTEM
  - AMMONIA LEAK IN SYSTEM
  - AMMONIA HAS AN EXTREMELY HIGH PH WHEN INTRODUCED TO WATER AND WILL REACT WITH GLUTARALDEHYDE TO COLOR THE WATER PINK
  - CALL YOUR AMMONIA CONTRACTOR ASAP!!!

INTERPRETATION OF RESULTS – EXAMPLE 2

- TOWER SYSTEM
  - CONDUCTIVITY AND PH ARE IN RANGE BUT HARDNESS AND ALKALINITY ARE LOW
  - LOW SCALE INHIBITOR LEVEL
- TOWER SYSTEM
  - THE LOSS OF HARDNESS AND ALKALINITY INDICATE SCALE FORMATION
  - COMPARE CYCLES OF CONCENTRATION (COC) TO HARDNESS CYCLES BASED ON MAKEUP WATER
  - MAKE SURE INHIBITOR PUMP IS PRIMED AND PUMPING