LifeShield™ NoPhos

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SAWEA Water Treatment Conference
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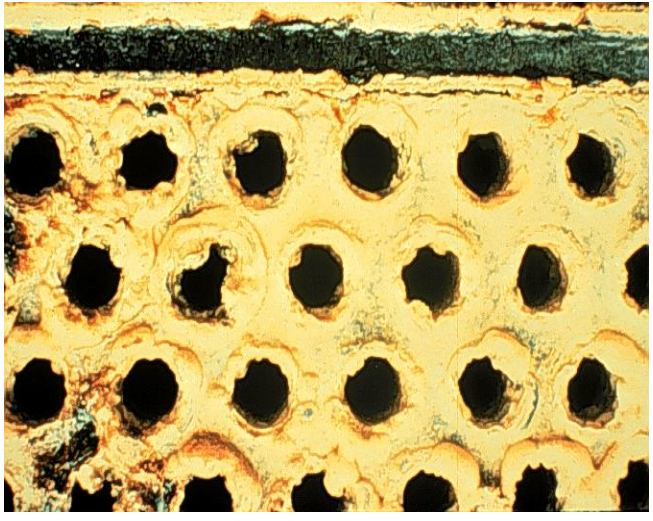
LifeShield NP Launch

- Introduction to LifeShield
  - Why NP?
  - How did we evaluate the material
    - Standard PO4 (Neutral and Alkaline) vs. LifeShield
    - Performance of Standard PO4 program vs LifeShield
- Zero Hardness Water Evaluation
- Case History
  - Mid-West Refining Complex (coming)
- Problem Solving
  - Phosphate Treatment vs LifeShield at Elevated Skin Temperatures

Phosphates In Water Treatment

- Phosphates are used everywhere in water treatment
- Phosphates have been the primary corrosion inhibitors in cooling water treatments for over 30 years and for potable water and once through cooling water corrosion control for over 70 years.
- Phosphates are very **insoluble** in water that contains calcium. As the water gets hotter and hotter it is less and less soluble
- In cooling water treatments **dispersants** are required to **extend the solubility of phosphates** to allow them to function as corrosion inhibitors
- Failure to control the solubility of phosphates can result in fouling→



Phosphates In Water Treatment

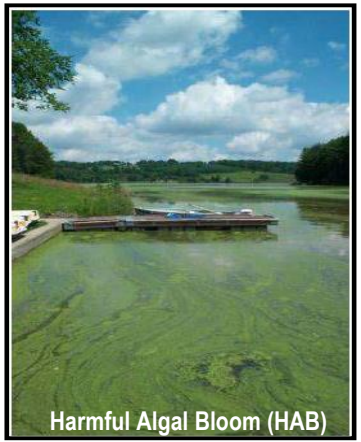
- Phosphates to a lesser degree are used in boiler water treatments
- Organic phosphate compounds are often used as calcium carbonate inhibitors in cooling water programs as well as in reverse osmosis, thermal desal and boilers
- **Phosphates are a required nutrient for biological aeration systems**
- Phosphates are being scrutinized more and more for their environmental impact and contribution to eutrophication of receiving streams around the globe including the USA.

Phosphates Are Under Scrutiny by Environmental Groups

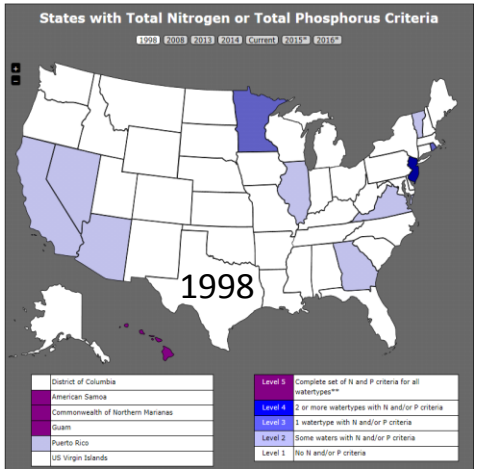
Environmental Sustainability

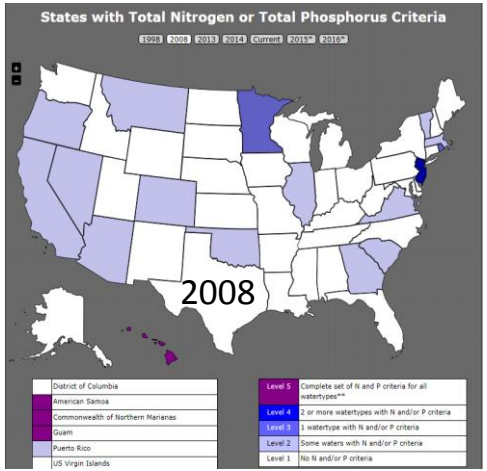
Significant changes in global regulations. Governments are imposing strict regulation on phosphorous discharge around the globe.

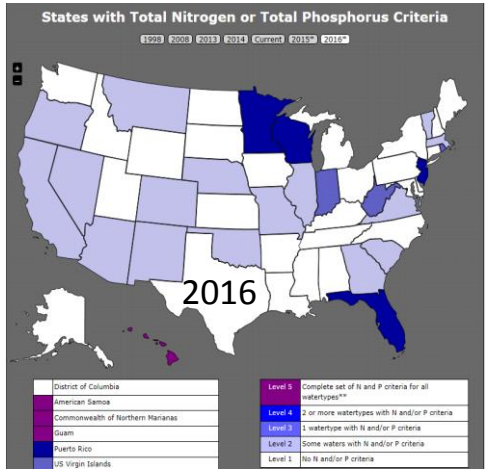
- US states with phosphorous regulations continues to increase.
- China and Southeast Asia have restricted phosphorous use in all new water treatment facilities.



- Removing phosphorous from chemical treatments has significant operational as well as environmental benefits







*US Environmental Protection Agency

Saudi Arabia Phosphate and Zinc Limits

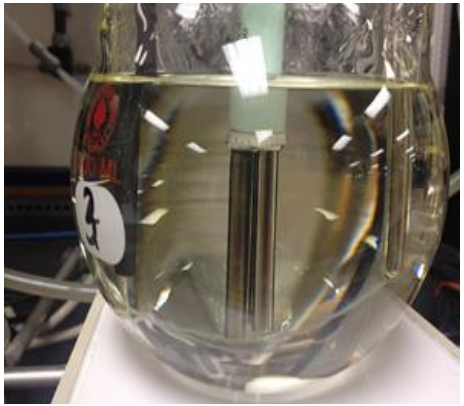
- Royal Commission Environmental Regulations for Jubail and Yanbu (RCER-2015)

Analysis	Max	Avg
Phosphorous, as P (as PO4)	2 (6)	1 (3)
Zinc, as Zn	5	2

Performance Comparison

How did we evaluate the treatment?

- **Gamry Stirred Vessel Corrosion Test**
- **BHI-STU; Dynamic Scale Testing Unit**
- **Pilot Cooling Tower**

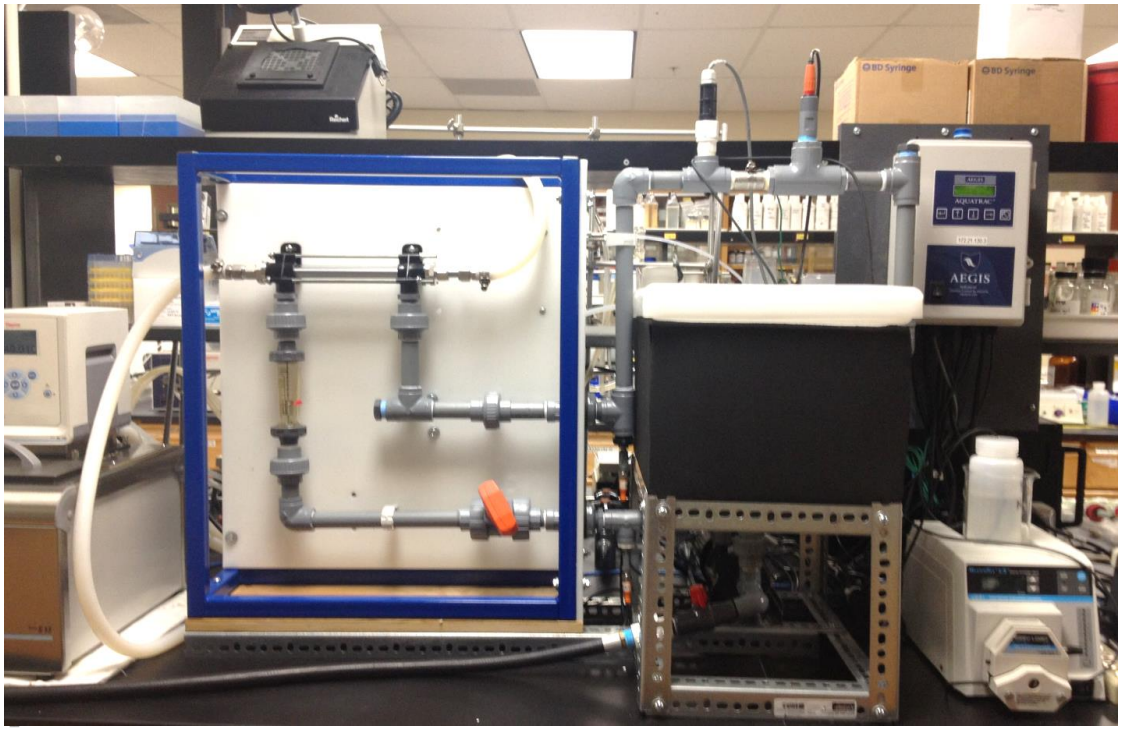


Gamry Mixed Vessel corrosion test

BHI-STU
Dynamic Scale Testing Unit

Pilot Cooling Tower Testing

Dynamic Laboratory Testing: STU

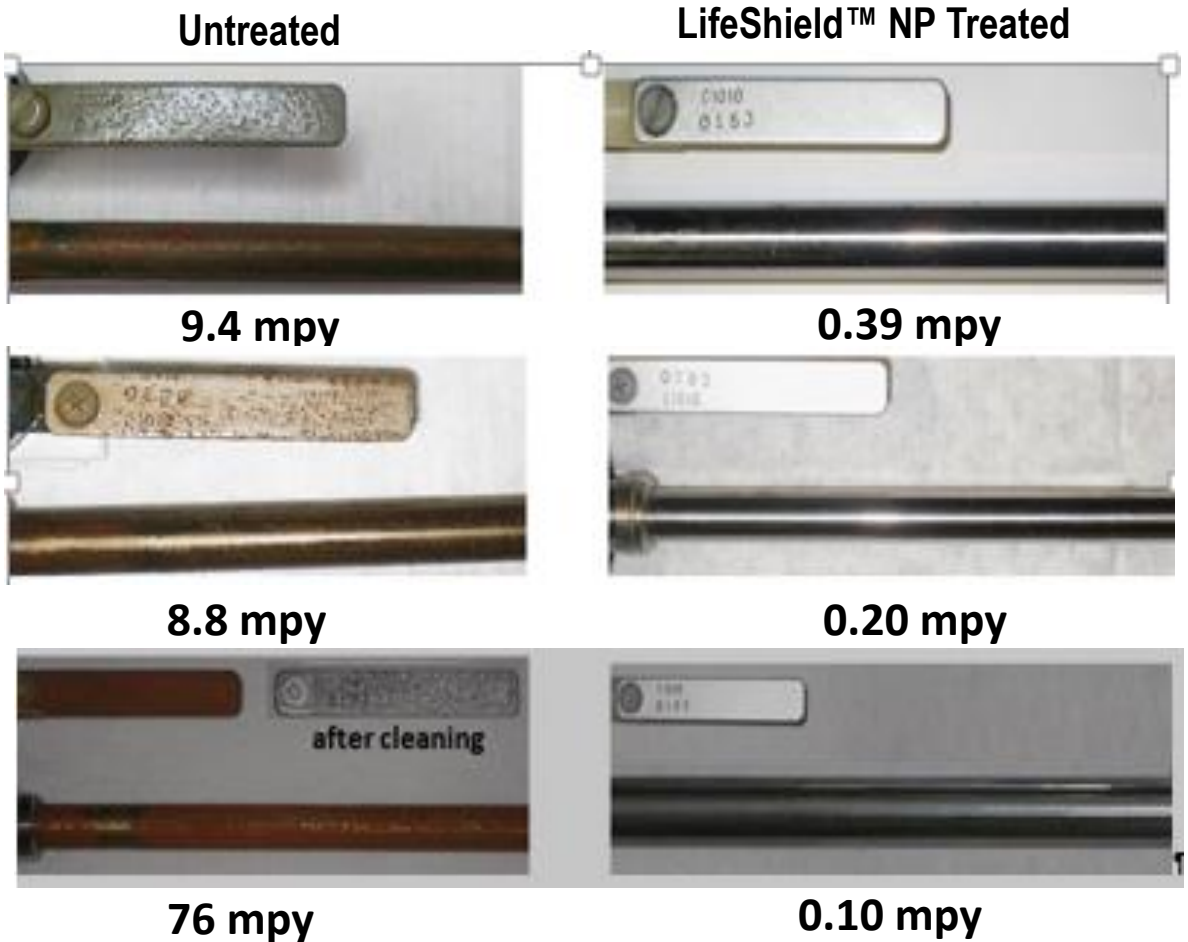


- Recirculating System
- Water Sump
- Liquid to Liquid Heat Transfer
- On Line Monitoring of Heat Exchanger
  - Outlet temperature
  - Inlet temperature
  - Controlled temperature
  - Controlled pH
- 6-8 days testing
- Provides observation window to the test metal surface

Three waters were evaluated

	Test A	*Test B*	*Test C*
	High LSI & TDS	Medium LSI & TDS	Low LSI & Low TDS (zero Calcium)
Langelier's Saturation Index, LSI	**2.3** **Heavy scale**	**1.5** **Moderate Scale**	**-2.3** **Severe corrosion**
Skin Temperature,	50°C (120°F)	50°C (120°F)	50°C (120°F)
pH	8.3 – 8.5	8.3 – 8.5	8.3 – 8.5
Calcium as CaCO3	350	150	0
Bicarbonate, as CaCO3	540	122	< 10
Chlorides, as Cl	540	107	< 10
Sulfates, as SO4	500	10	0
Free Chlorine, FRC	0.5 ppm	0.5 ppm	0.5 ppm

LifeShield™ NP Shows Excellent Inhibition Efficiency under Widely Varied Chemistries



LSI: 2.1
pH 8.4
120oF (49°C) Skin Temp.
Ca = 350 ppm as CaCO3
$HCO_3^=$ = 540 ppm as CaCO3
Cl = 540 ppm
SO4 = 500 ppm

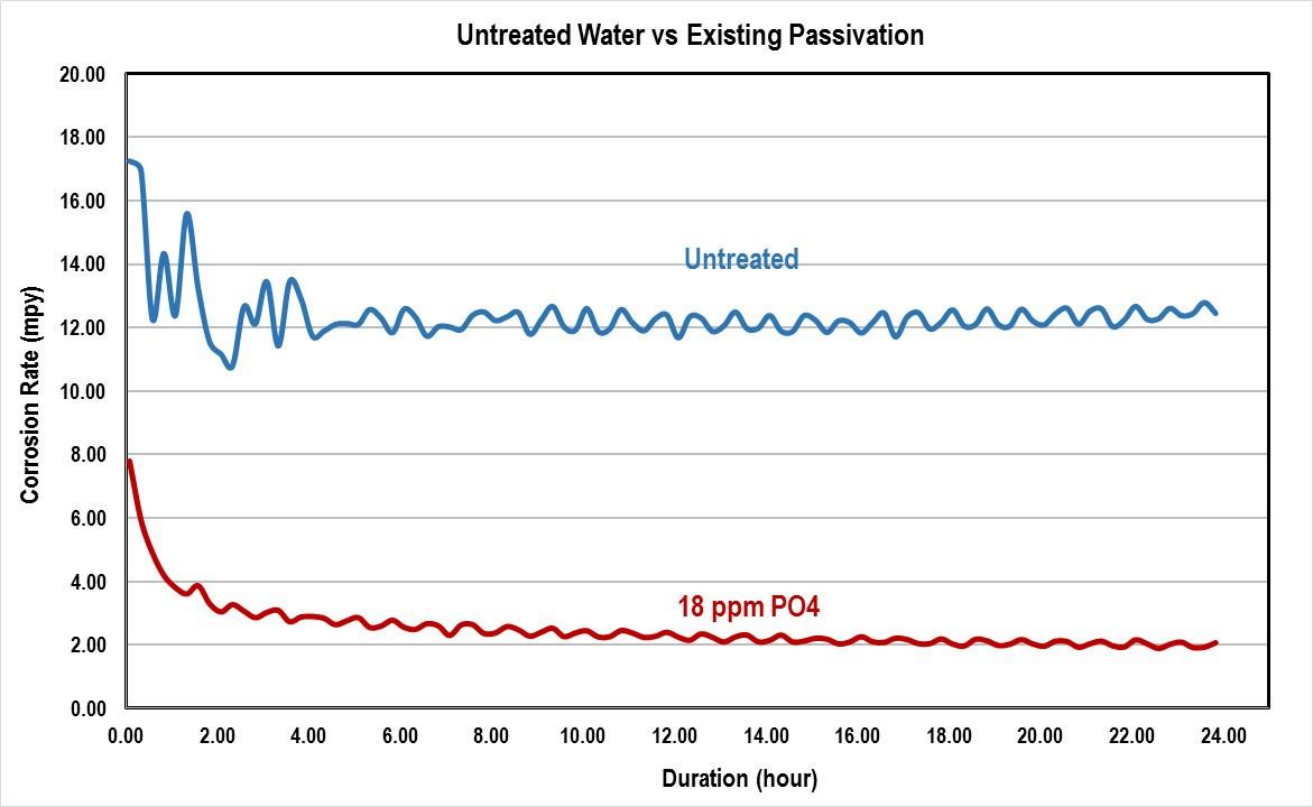
LSI: 1.2
pH 8.4
120oF (49°C) Skin Temp.
Ca = 150 ppm as CaCO3
$HCO_3^=$ = 122 ppm as CaCO3

LSI: -2.3
pH 8.4
120oF (49°C) Skin Temp.
Ca = 0 ppm as CaCO3
$HCO_3^=$ = <10ppm as CaCO3

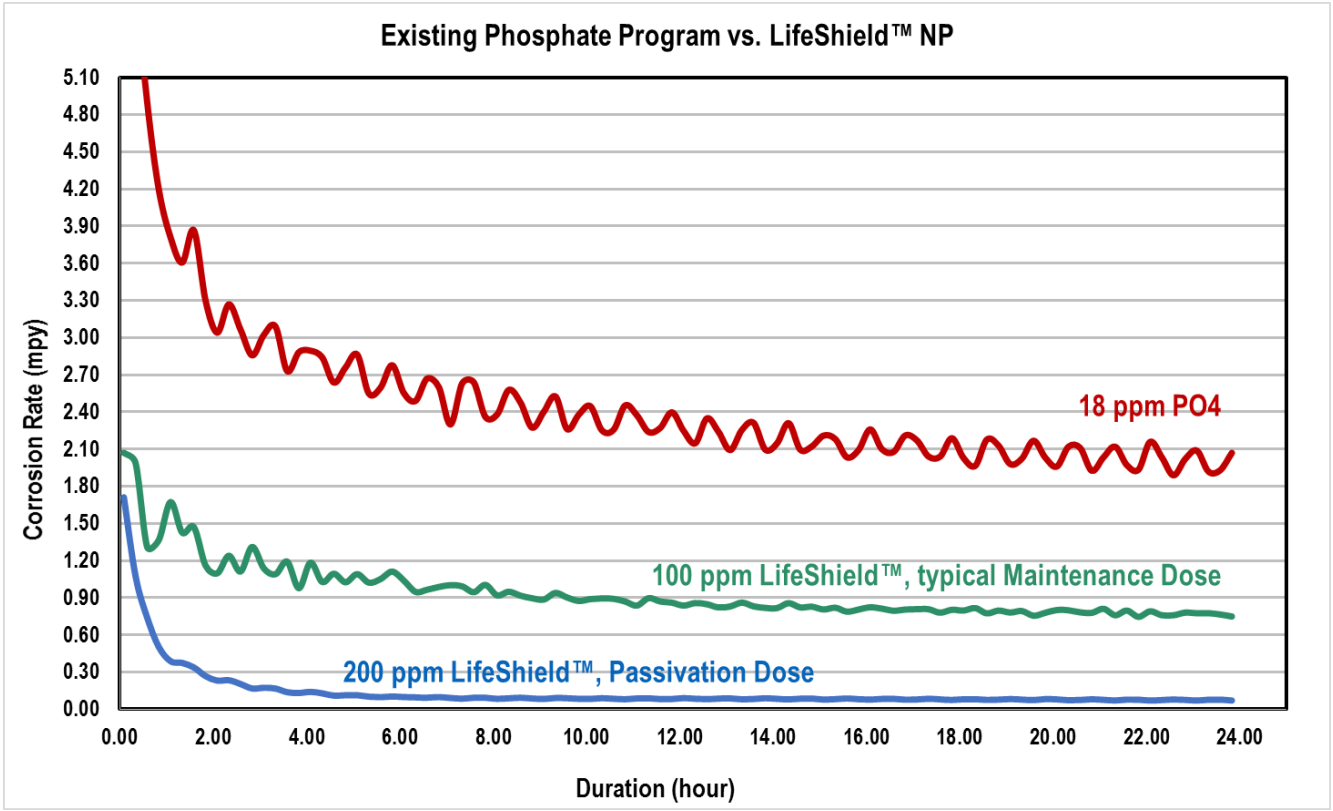
LifeShield™ NP Compared to PO4 Treatment

A typical passivation:

- 200 ppm of Calcium as $CaCO_3$
- 18 ppm of o-PO_4.
- pH 7.2 to 7.5



LifeShield™ NP Passivation Evaluation

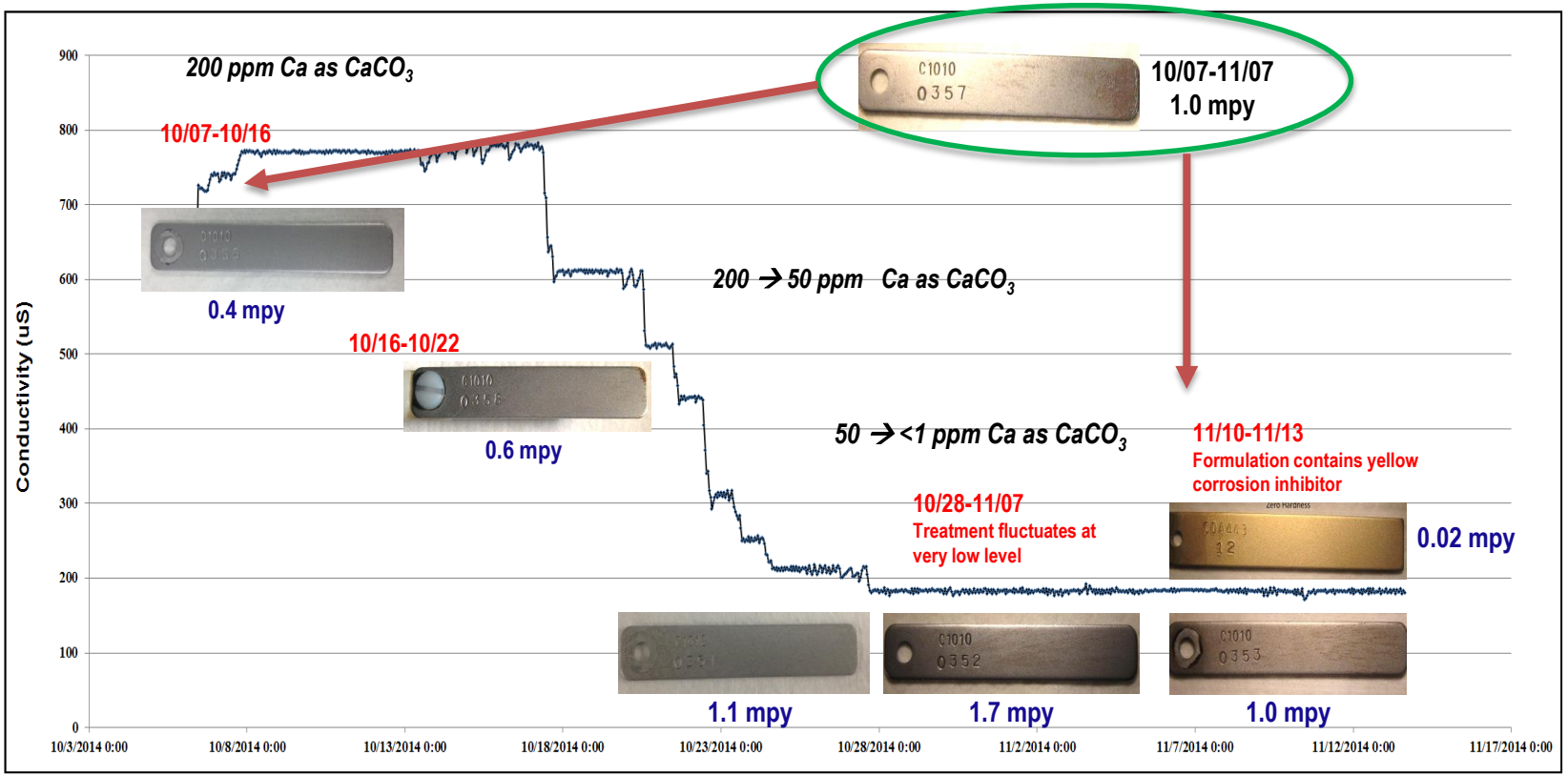


LifeShield Passivates faster and deeper than Phosphate even at normal dosages.

Zero Hardness Testing

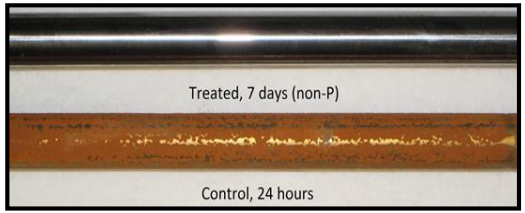
Analysis	MU	CT
pH	5.7	7.9
Conductivity, µmhos	<1	170
M-Alkalinity, ppm as CaCO3	<1	15
Calcium, ppm as CaCO3	0.1	2
Sodium, ppm as Na	0.01	50
Chlorides, ppm as Cl	<1	60
PO4, total as PO4	<0.02	0.3
Free Residual Chlorine, ppm as FRC		0.2-0.3

Pilot Testing Confirms LifeShield™ NP Corrosion Inhibitor Performance

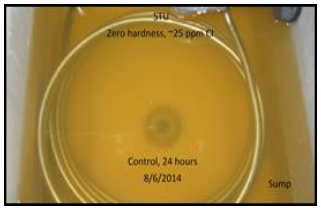


LifeShield™ NP corrosion Inhibitor shows unique corrosion inhibition efficiency at 0 hardness

	Before cleaning	After cleaning
Control		 **76 mpy**
Non-P		 **0.01 mpy**

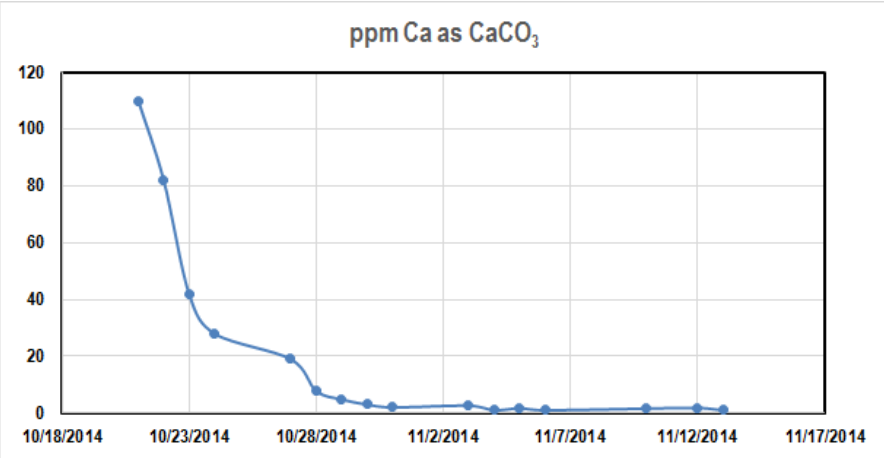


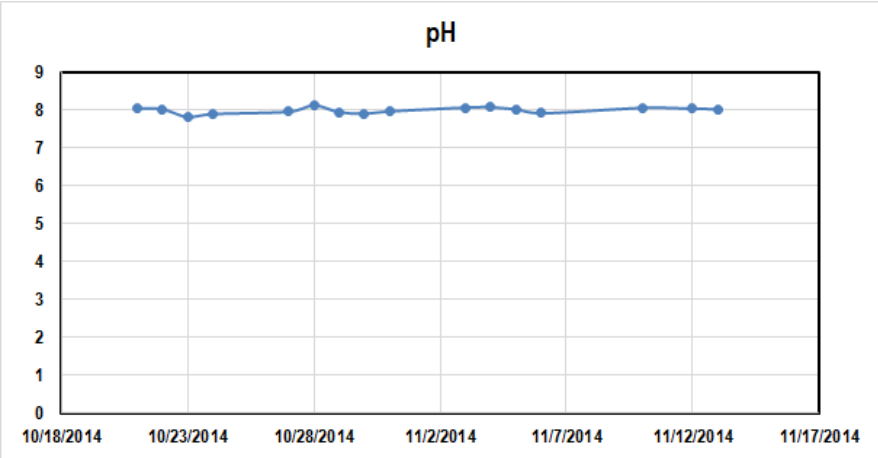
Test Metal: C1010

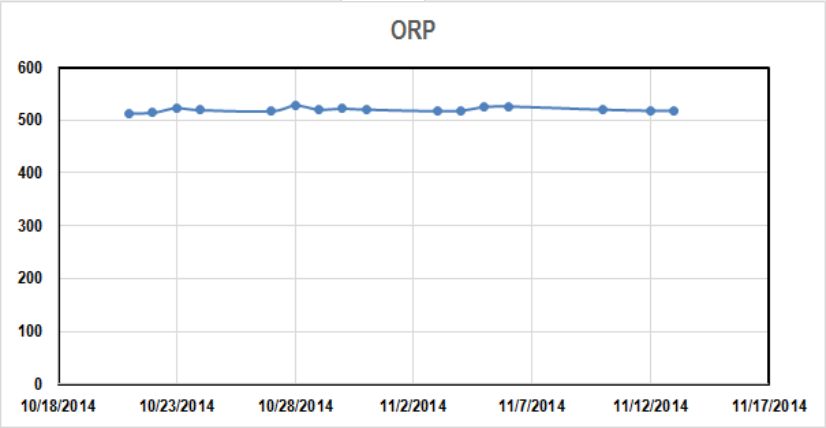


Sump

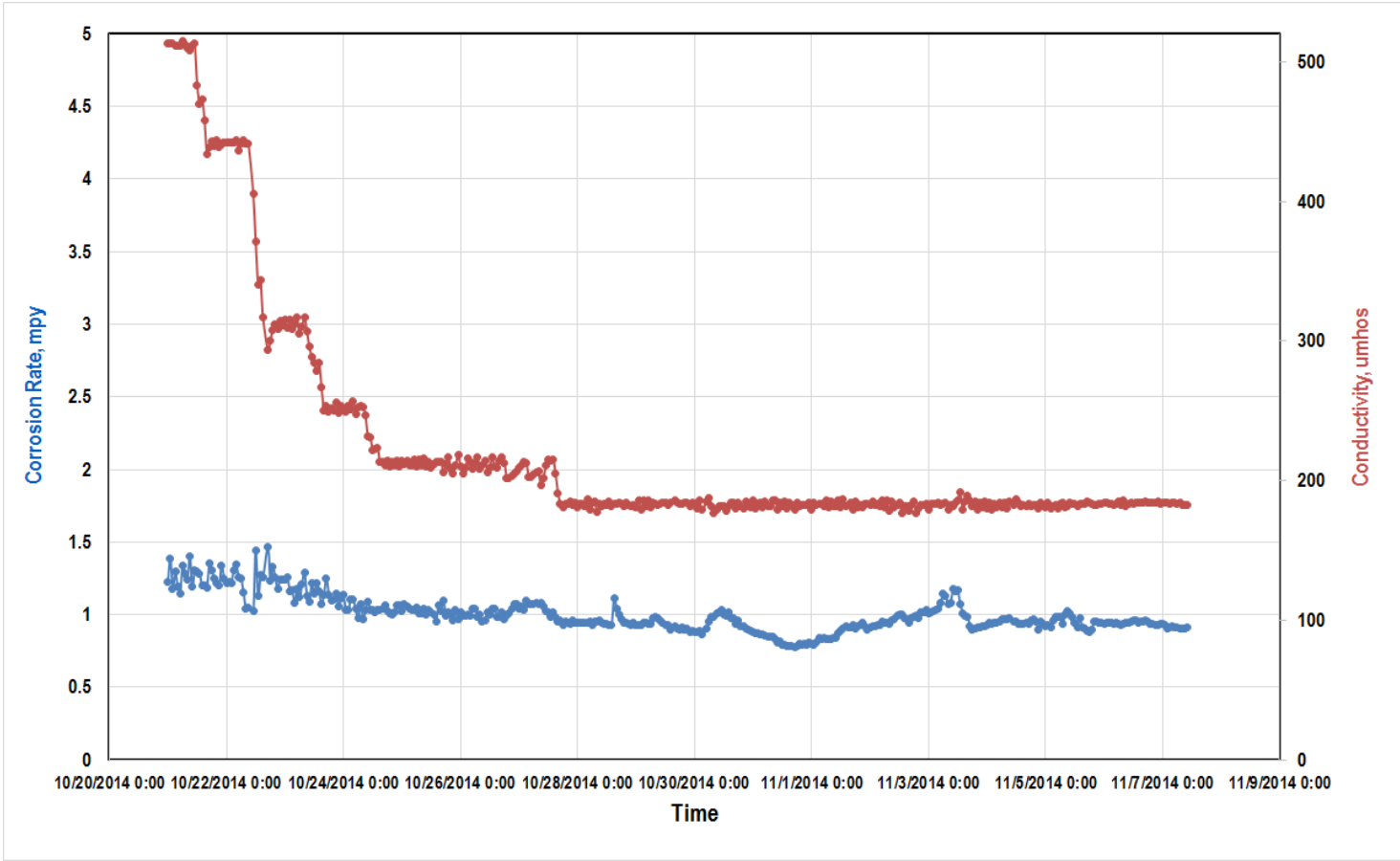
Cooling Tower Conditions during Test



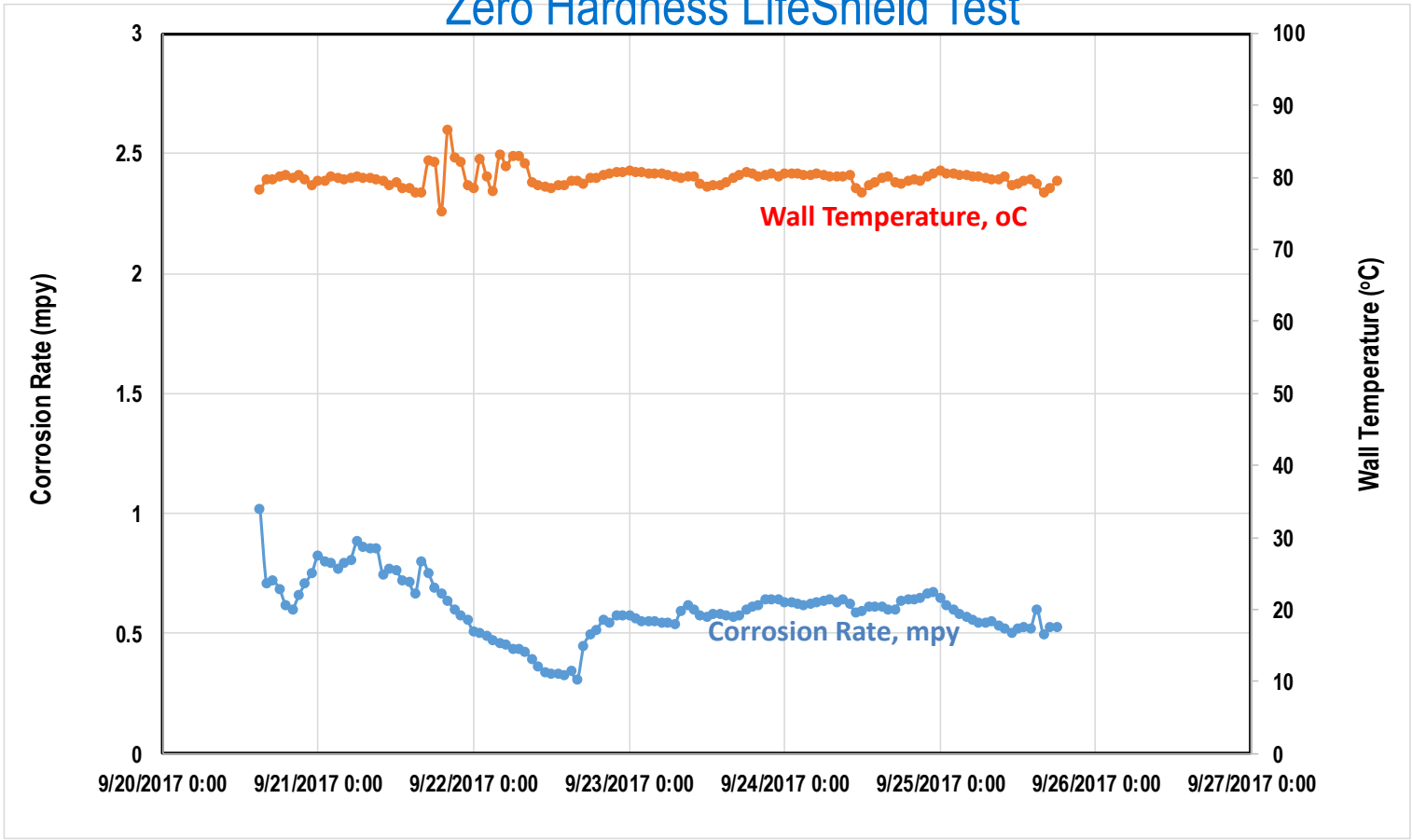




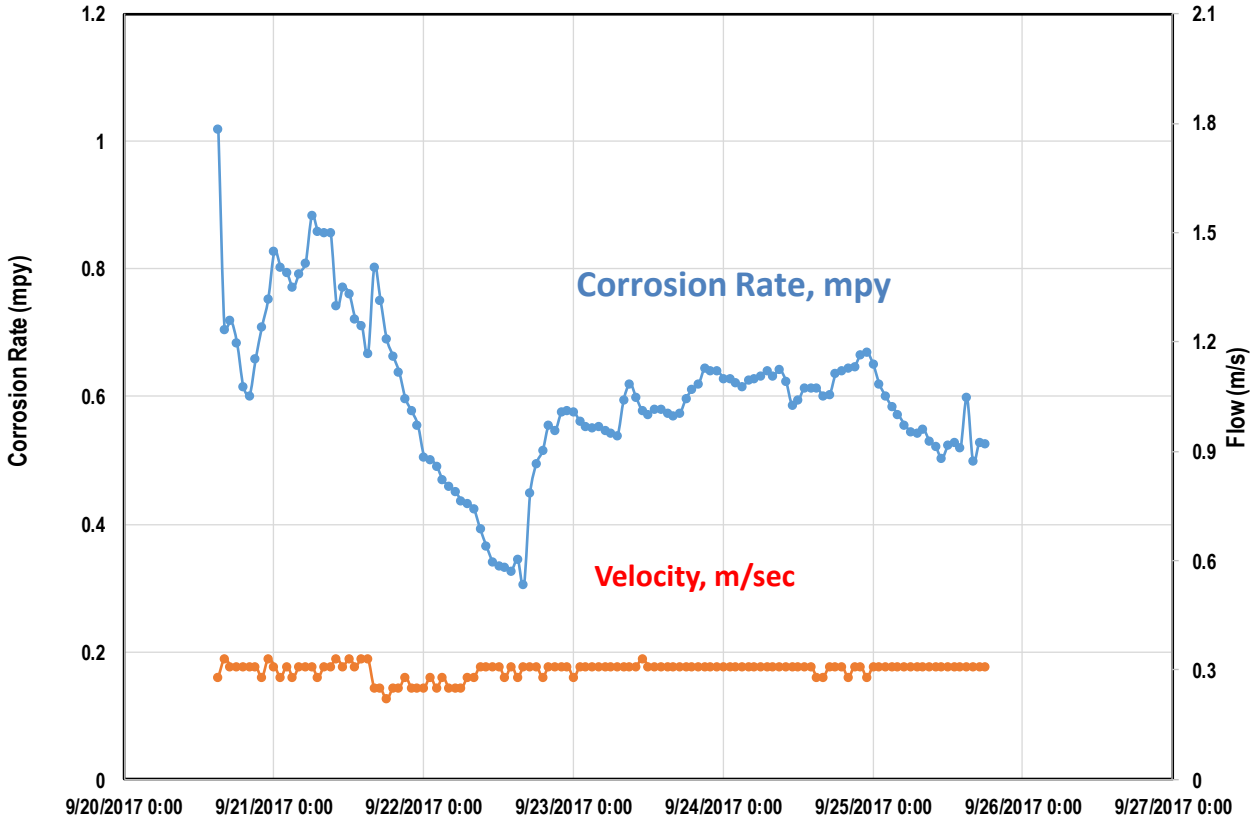
Pilot Cooling Tower Corrosion Rate Test - Zero Hardness



Elevated Skin Temperatures (80°C)
Zero Hardness LifeShield Test



Elevated Skin Temperatures (80°C), Low Velocity (0.3 m/sec) , Zero Hardness LifeShield Test



Problem Solving

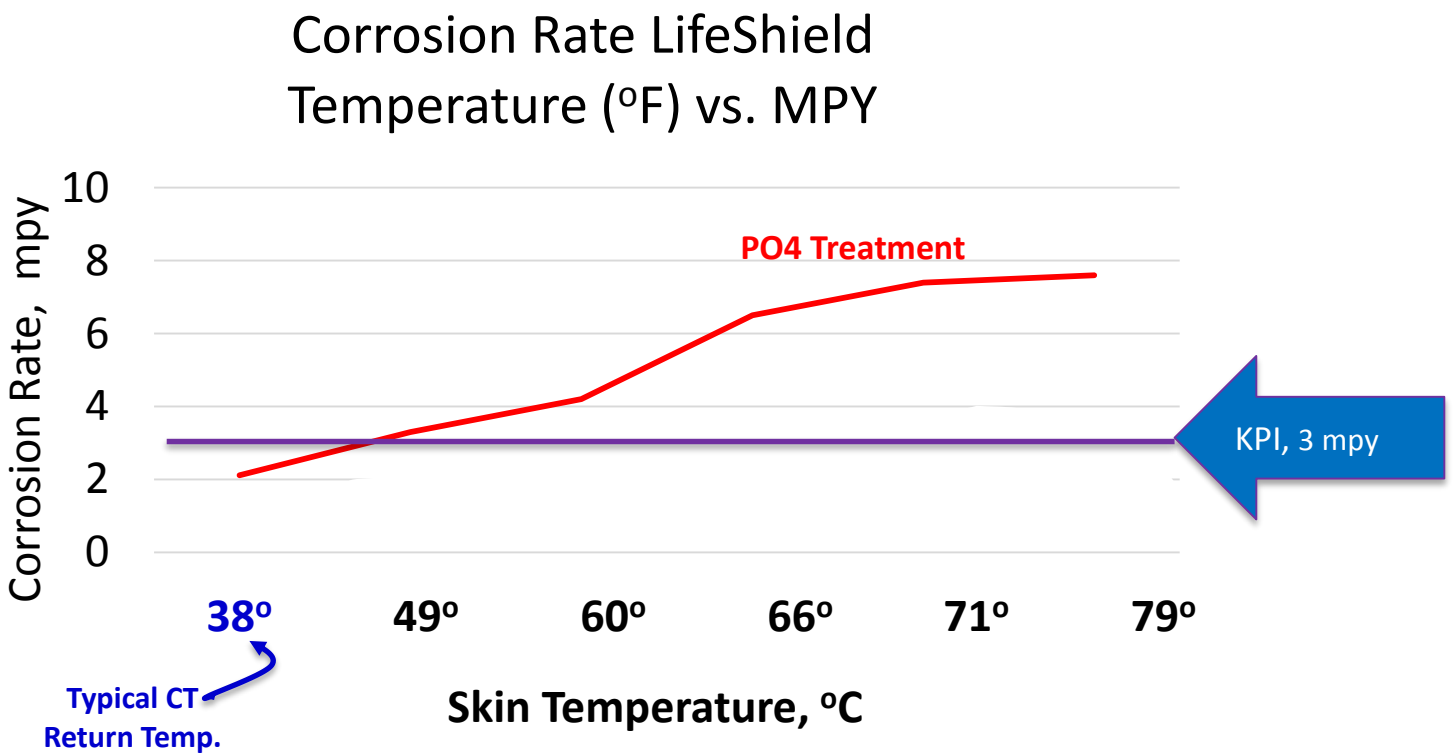
- Recycle Waste Water Corrosion Rate vs. Skin Temperature

Reuse Water--Title 22 Recycle Water in Los Angeles California,

Very corrosive and fouling prone water supply

Analysis	Typical MU Analysis	CT
pH	7.0	7.6
Conductivity, µmhos	1,400	**7,000**
M-Alkalinity, ppm as $CaCO_3$	220	100
Calcium, ppm as $CaCO_3$	122	**585**
Magnesium, as $CaCO_3$	97	**450**
Chlorides, ppm as Cl	266	**1400**
Sulfates, ppm as SO_4	100	**900**
Silica, ppm as SiO_2	17	65
Ammonia, ppm as N	42	?
COD, ppm as carbon	37	?

PO4 Program vs. LifeShield Corrosion Rates vs. Skin Temperature (°C)



Thank you

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