



# IWAKI AMERICA - Walchem

## Efficiency Improvements in Plating Shop Operations via Automation

May 2022





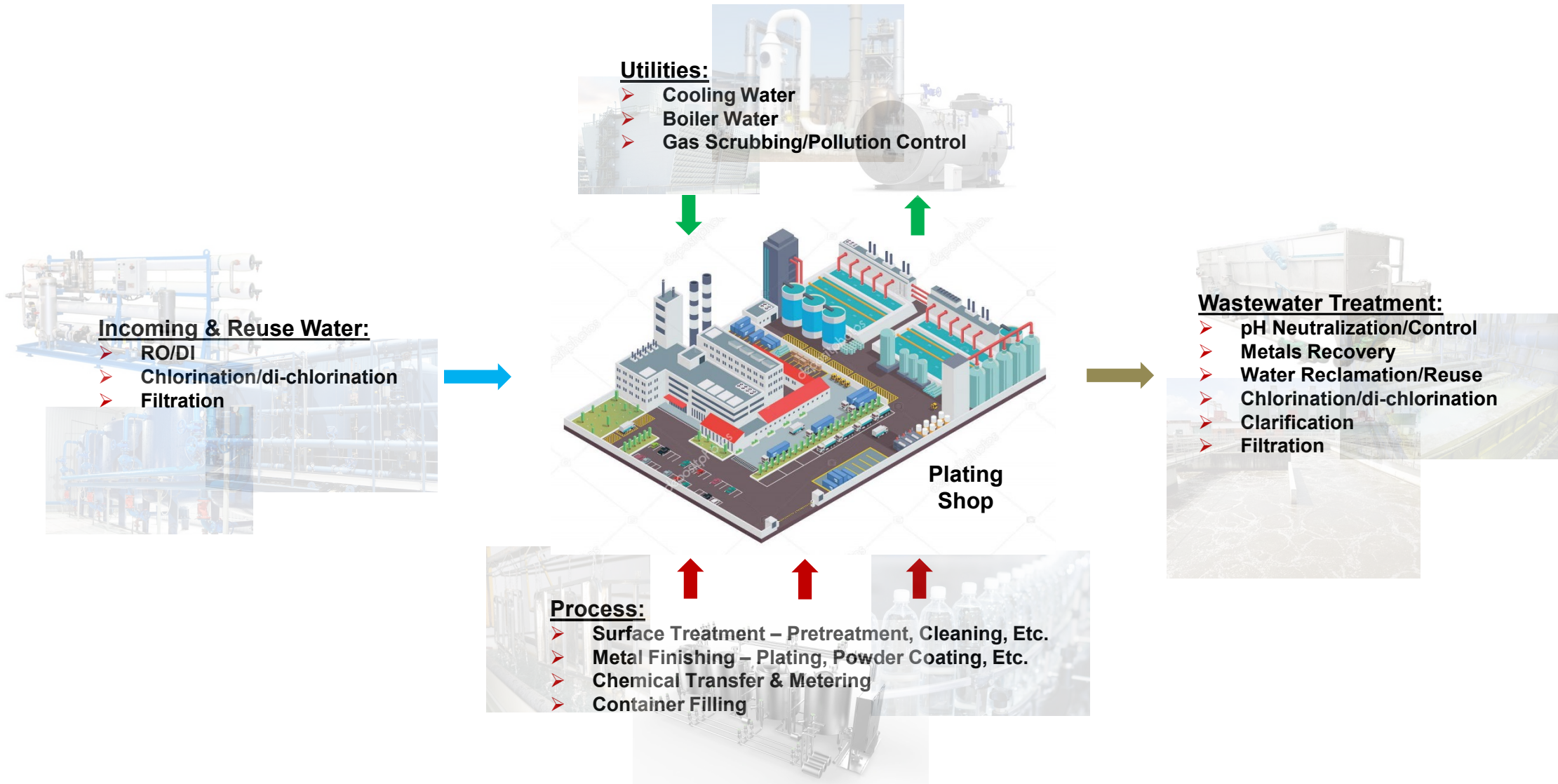
# Why Automate?

The Most Damaging Phrase in the Language



# Improving Operational Efficiencies

## Plating Shop – Chemical Metering & Control Opportunities





# Improving Operational Efficiencies

## What Are The Opportunities?

- **Process (pre-treatment & final product)**
  - **Improved results**
    - ❑ More robust and stable plating bath
    - ❑ Allows operation within a tighter process window
    - ❑ More consistent plating deposition finish
    - ❑ Real time data collection/warehousing
    - ❑ Real time alarm notification
  - **Time and cost improvements**
    - ❑ Real time analysis reduces time and cost of manual testing
    - ❑ Minimized chemical over/under feed
      - *Better inventory management*
      - *Reduced chemical usage*
      - *Reduced waste*
    - ❑ Resources freed up for other important value-added tasks
- **Incoming and reuse water**
  - **Improved water quality for the process**
    - ❑ Assures a clean surface coming out of the pretreatment part of the process
    - ❑ Minimize potential for spotting, streaking, etc. of the final product surface
  - **Ability to reclaim used water reduces need incoming water**

# Improving Operational Efficiencies

## What Are The Opportunities?

- **Wastewater**
  - Improved adherence to regulatory permits
    - ❑ Know of a potential problem before it become a problem
    - ❑ Historical data collection – system trend analysis
- **Utilities**
  - Includes cooling towers, boilers, pollution controls (fume scrubbers)
    - ❑ Improved heat transfer
    - ❑ Proper operation of your pollution controls
    - ❑ Longer lifetime of equipment
    - ❑ Legionella control
- **Other**
  - Workforce challenges
    - ❑ Having and keeping the right people in place to do the jobs
  - Competitive pressures
    - ❑ Impact on the bottom line
    - ❑ Global economy
      - *Shops overseas are automating*

# Improving Operational Efficiencies

## Pretreatment: Industrial Parts Washer Applications

- One of the most important steps in an industrial manufacturing processes
  - Clean, degrease and dry industrial parts
  - Ensures adhesion of intermediate or final finishes
    - ❑ Plating
    - ❑ Anodizing
    - ❑ Powder coating
    - ❑ Paint
- Parts washers vary, but have various stages
  - Run from single to multi-stage systems
  - Stages may include
    - ❑ Wash/Clean stage(s)
    - ❑ Phosphatizing
    - ❑ Sealer stage(s)
    - ❑ Rinse stage(s)



*Source:* <https://www.bendpak.com/shop-equipment/parts-washers/parts-washers-explained/>



*Source:* <https://www.internationalthermalsystems.com/2017/07/industrial-parts-washer-division-growing-since-acquiring-continental-equipment-corporation-cec/>



# Improving Operational Efficiencies

## Pretreatment – What are the Opportunities

MANUAL CONTROLS							CONTROL EQUIPMENT	
Cleaners Rinses	Total Acid	Free Acid	Total Alkali	Free Alkali	A-B/3	Total/Free Ratio	Conductivity	pH
Alkaline Cleaners			X	X	X (1)	X (2)	X	
Acid Cleaners	X	X				X	X	
Cleaner Rinse	X (3)		X (3)				X	X
Conventional Pretreatments	Total Acid	Free Acid	Activator	Accelerator	Zinc	Active Ingredient	Conductivity	pH
Iron Phosphate	X	X (4)					X	X
Zinc Phosphate	X	X	X	X	X		X	
Sealer	X	X				X	X (5)	
Chrome Containing Conventional Pretreatments	Total Acid	Free Acid	Hexavalent Chrome	Accelerator	Total Chrome		Conductivity	pH
Chrome Phosphate	X	X	X	X	X		X	
Chromate	X	X	X	X	X		X	
Rinse	X						X	
Dried-In-Place Pretreatments	Total Acid	Free Acid	Hexavalent Chrome			Active Ingredient	Conductivity	pH
Chrome			X				X	X
Non-chrome		X				X	X	X

- (1) For baths containing high amounts of aluminum
- (2) For baths processing minimal or no aluminum
- (3) Dependent upon the cleaner type
- (4) A reverse of free acid titration can be used instead of pH
- (5) Inorganic chrome post treatment

*Adapted from:* Powder Coating: The Complete Finisher's Handbook, 4<sup>th</sup> Edition, The Powder Coating Institute 2012, page 91.

# Improving Operational Efficiencies

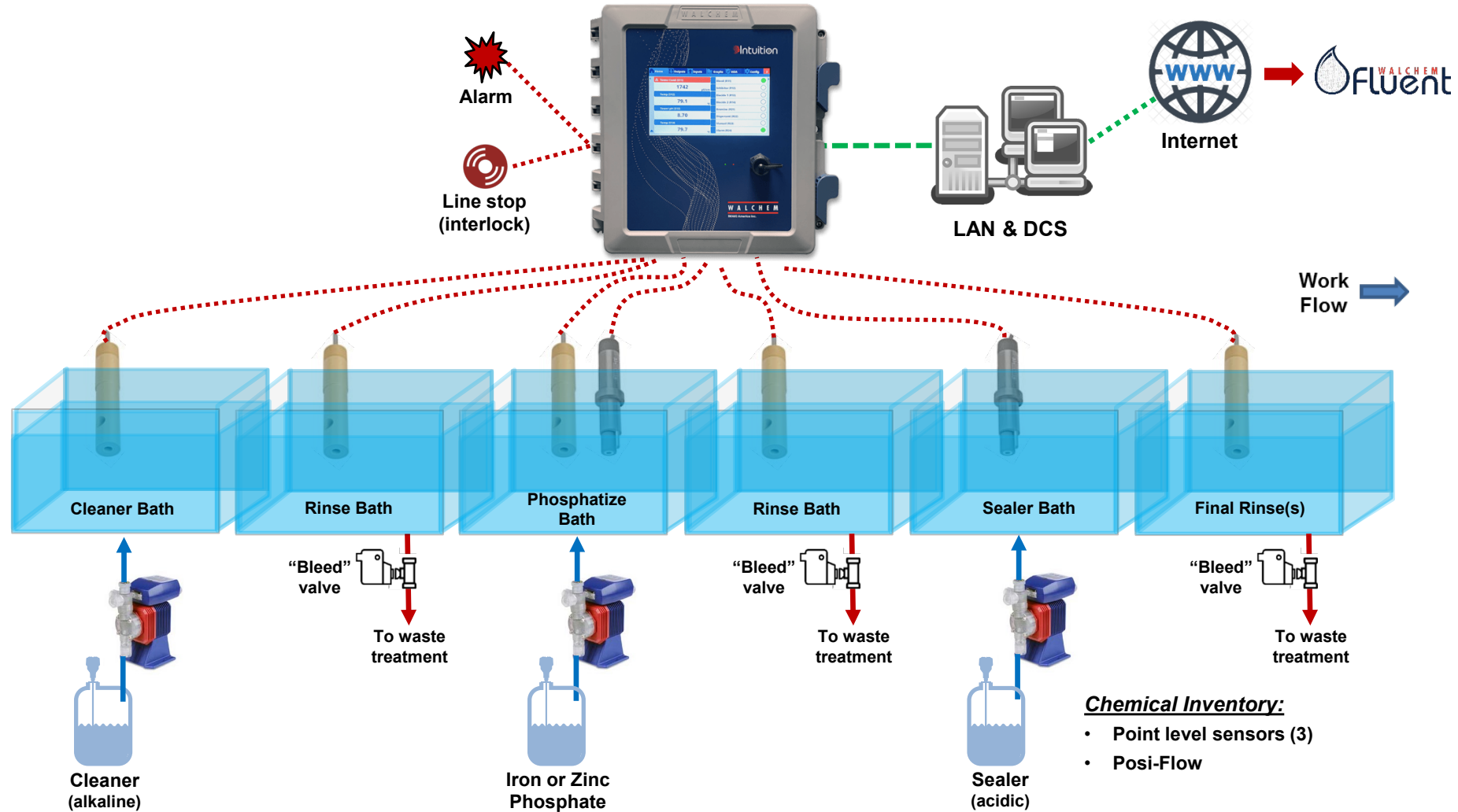
Industrial Parts Washer - How are stages controlled?

- **Cleaners**
  - **Conductivity – electrodeless**
    - ❑ Titration of % chemical which is correlated to conductivity
- **Phosphate and sealer baths**
  - **Conductivity and/or pH depending on chemistry used**
- **Rinses**
  - **Conductivity – both contacting and electrodeless**
    - ❑ Contacting conductivity sensors typically used when RO water is utilized
  - **pH**
- **Other**
  - **Other parameters of importance**
    - ❑ Temperatures – various stages of the baths
    - ❑ Spray pressures – if using spray system
    - ❑ Part count
    - ❑ Overflow to waste
  - **Historical data can be used for troubleshooting performance problems**



# Improving Operational Efficiencies

## Metal Finishing Pretreatment: Parts Washer System Installation



# Improving Operational Efficiencies

## Plating Process Control

- **Electroplating bath**

- **Metal concentration by titration or absorbance (Cu, Ni)**

- ❑ Copper or nickel electroplating baths can be controlled using spectrophotometry

- *In many cases the metal concentration does not change quickly enough to require automation or too high in concentration*

- **Electroplating bath pH is frequently monitored and controlled**

- ❑ Used in Ni plating (pH in the 3.0 to 4.5 range) and Zn plating (pH in the 5.0 to 6.0 range)

- *End user will in many cases also do a titration to confirm*

- **Conductivity (electrodeless) – *Hard chrome plating***

- ❑ New baths: ~400-575 mS/cm (based concentration of chromic acid in bath, ~180 to 350 g/L)

- ❑ As process proceeds, tramp metals build up and conductivity drops

- *Conductivity determines how effectively and efficiently current or amperage travels through the bath*

- *Impacts plating quality*

- **Electroless plating bath**

- **Metal concentration by titration or absorbance (Cu, Ni)**

- ❑ Readily control copper or nickel in the electroless plating bath using spectrophotometry

- ❑ Calculation of metal turns (MTOs)

- **pH controlled in ENi baths**

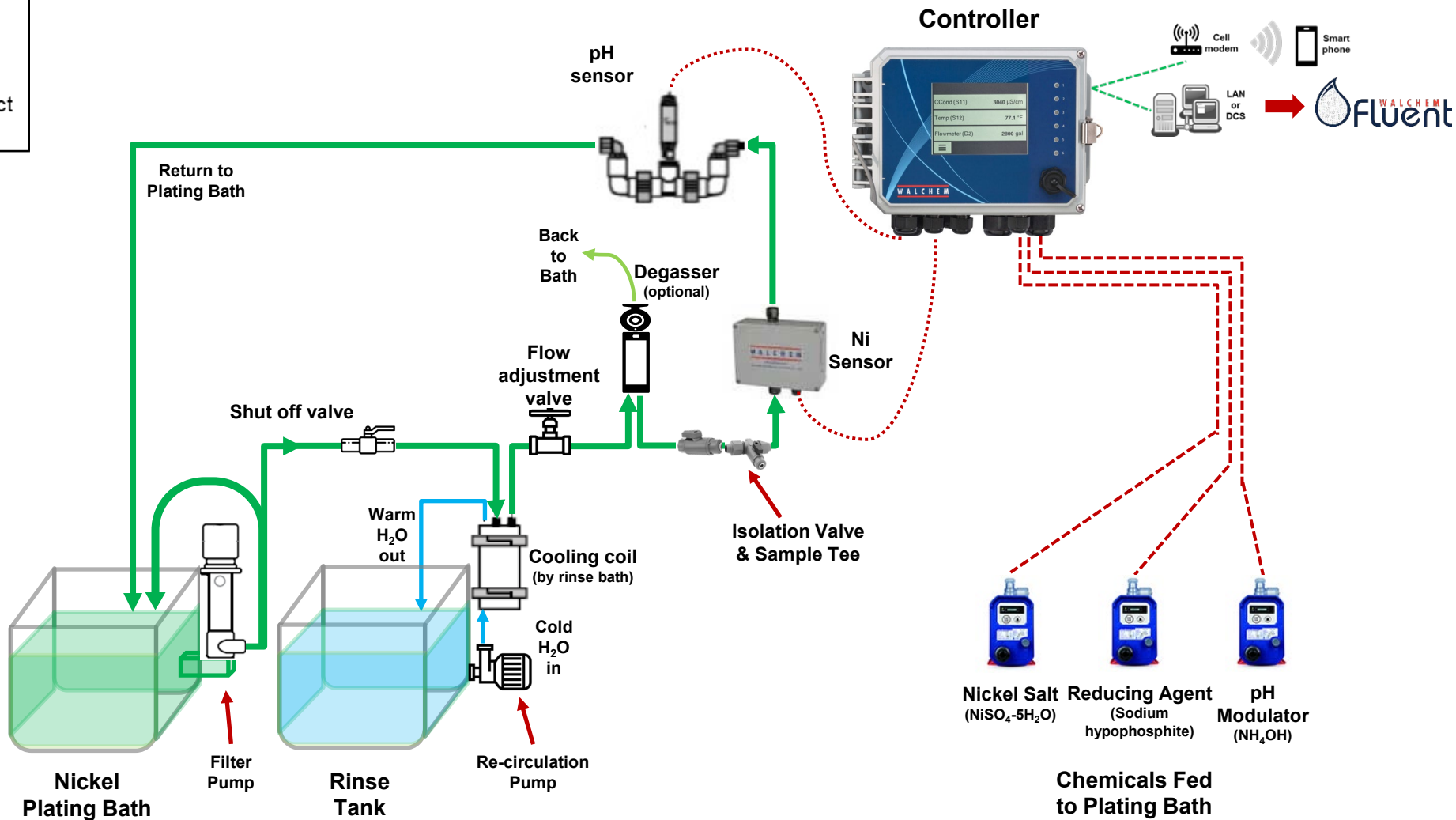


# Improving Operational Efficiencies

## Electroless Nickel Bath: Typical Installation for Automating the Bath

**Legend:**

- Nickel solution flow
- ⋯ Sensor cables
- Cooling water flow
- - - AC power or dry contact closure – pump dependent



# Improving Operational Efficiencies

## Single Electroless Nickel Bath Setup

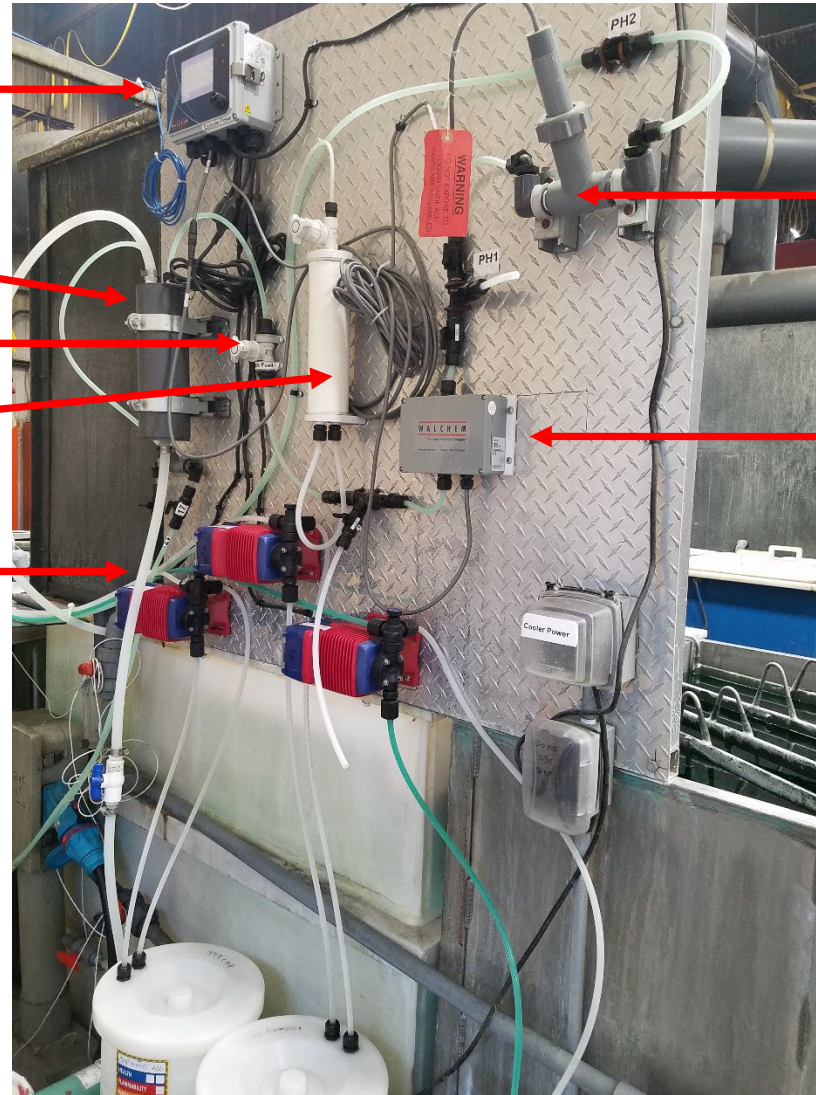
Controller

Cooling  
Coil

Flow Control  
Valve

Degasser

Chemical  
Feed  
Pumps



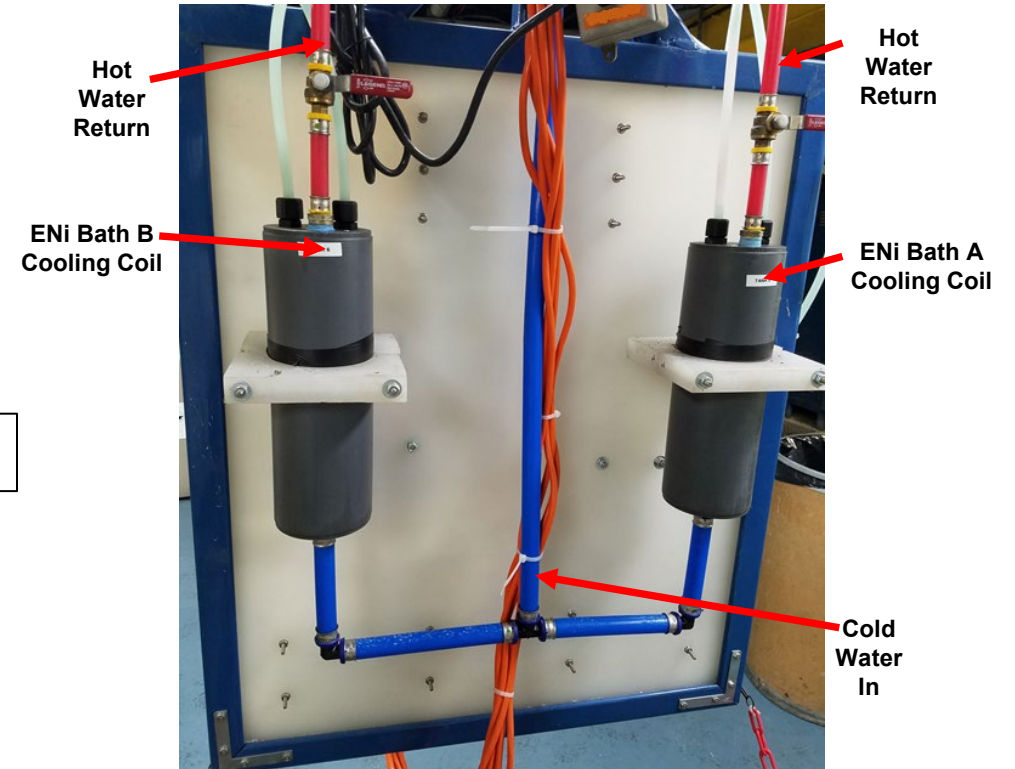
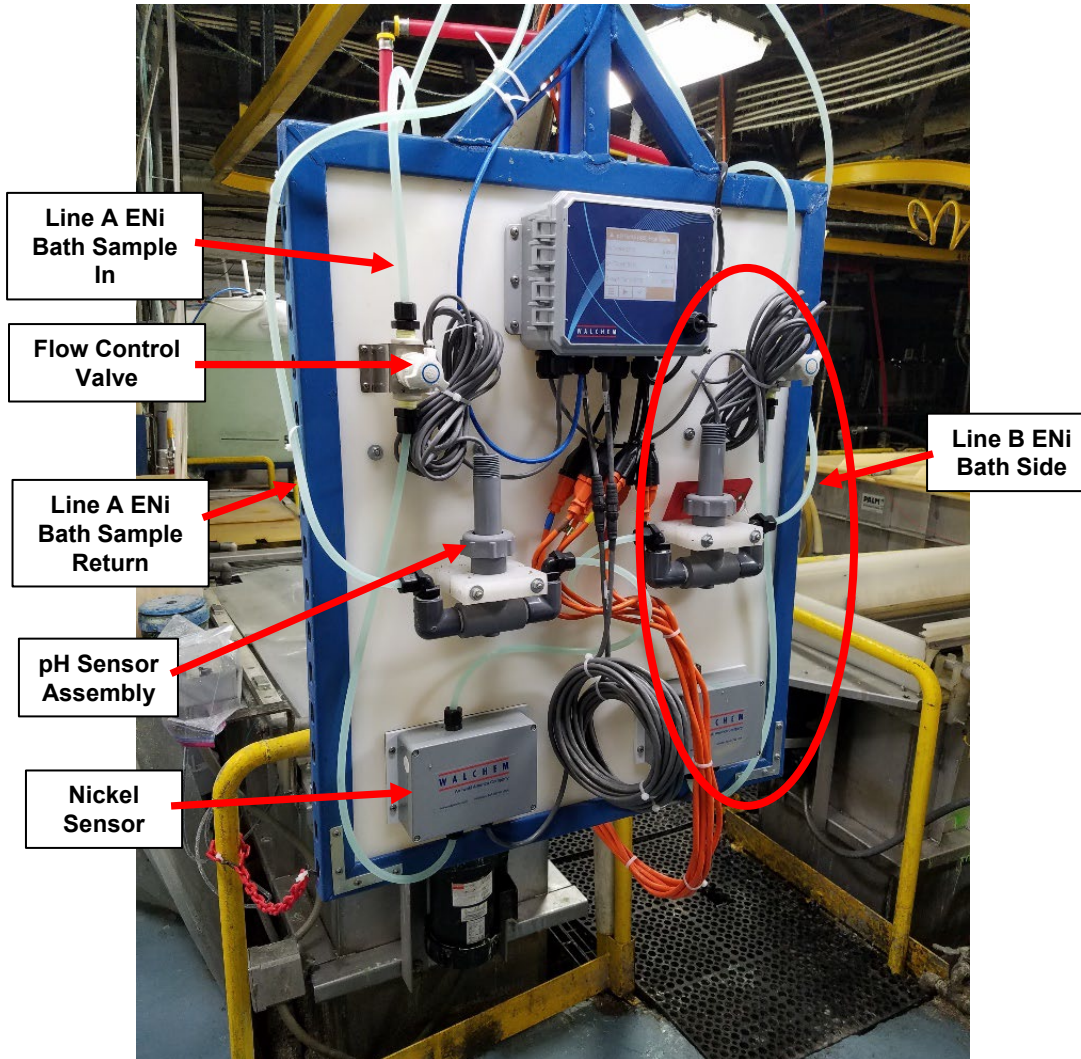
pH Sensor  
Assembly

Nickel  
Sensor



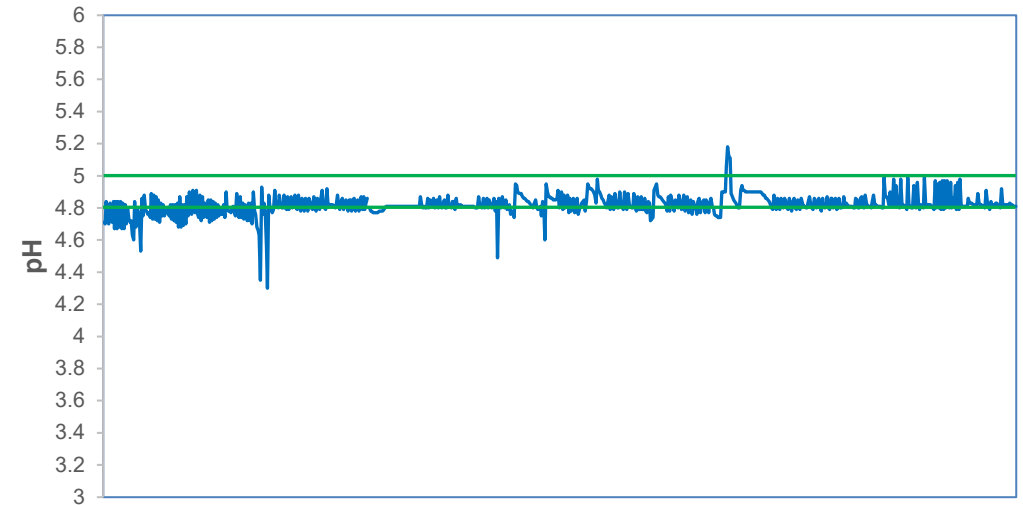
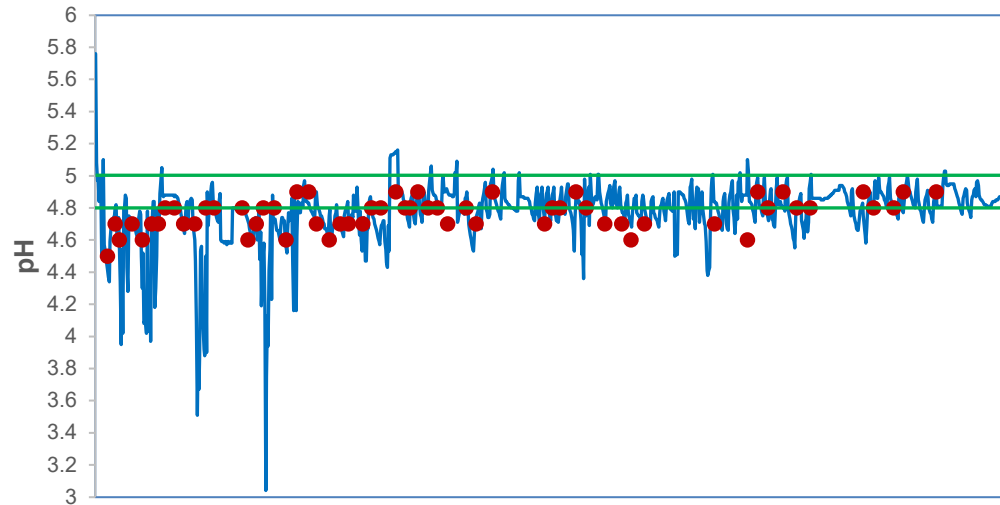
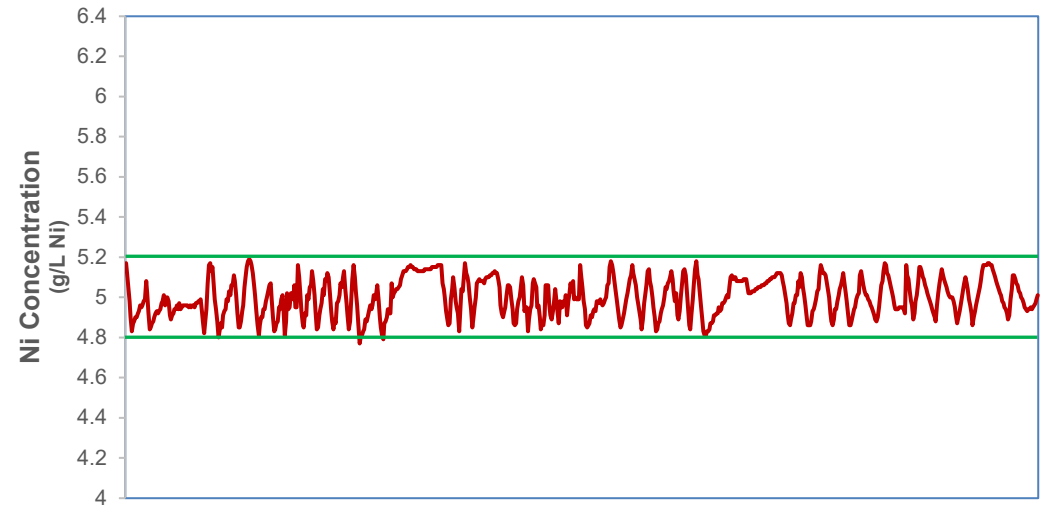
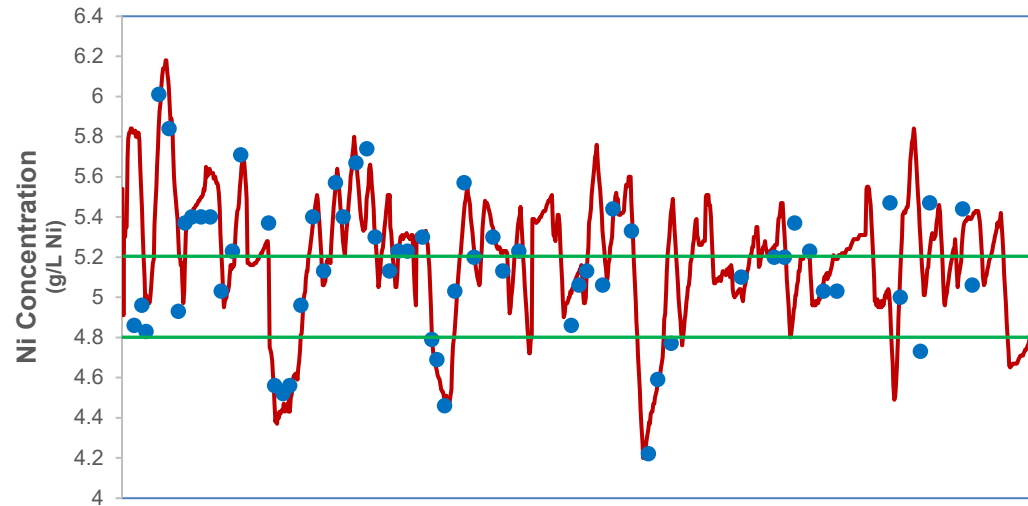
# Improving Operational Efficiencies

## Dual Electroless Nickel Bath Setup



# Improving Operational Efficiencies

## Electroless Nickel Bath: Before and After Automation





# Improving Operational Efficiencies

Electroless Nickel Bath: Before and After Automation, Final Numbers

- **Nickel manual control results**

- **Plant EDTA titration**

- Nickel Results: 5.15 g/L

- Std Deviation: 0.35

- **Controller readings**

- Nickel Results: 5.19 g/L

- Std Deviation: 0.32

- **Nickel automated control results**

- **Controller readings**

- Nickel Results: 5.00 g/L

- Std Deviation: 0.09

- **pH manual control results**

- **Plant lab**

- pH Results: 4.8

- Std Deviation: 0.1

- **Controller readings**

- pH Results: 4.77

- Std Deviation: 0.19

- **pH automated control results**

- **Controller readings**

- pH Results: 4.82

- Std Deviation: 0.07

# Improving Operational Efficiencies

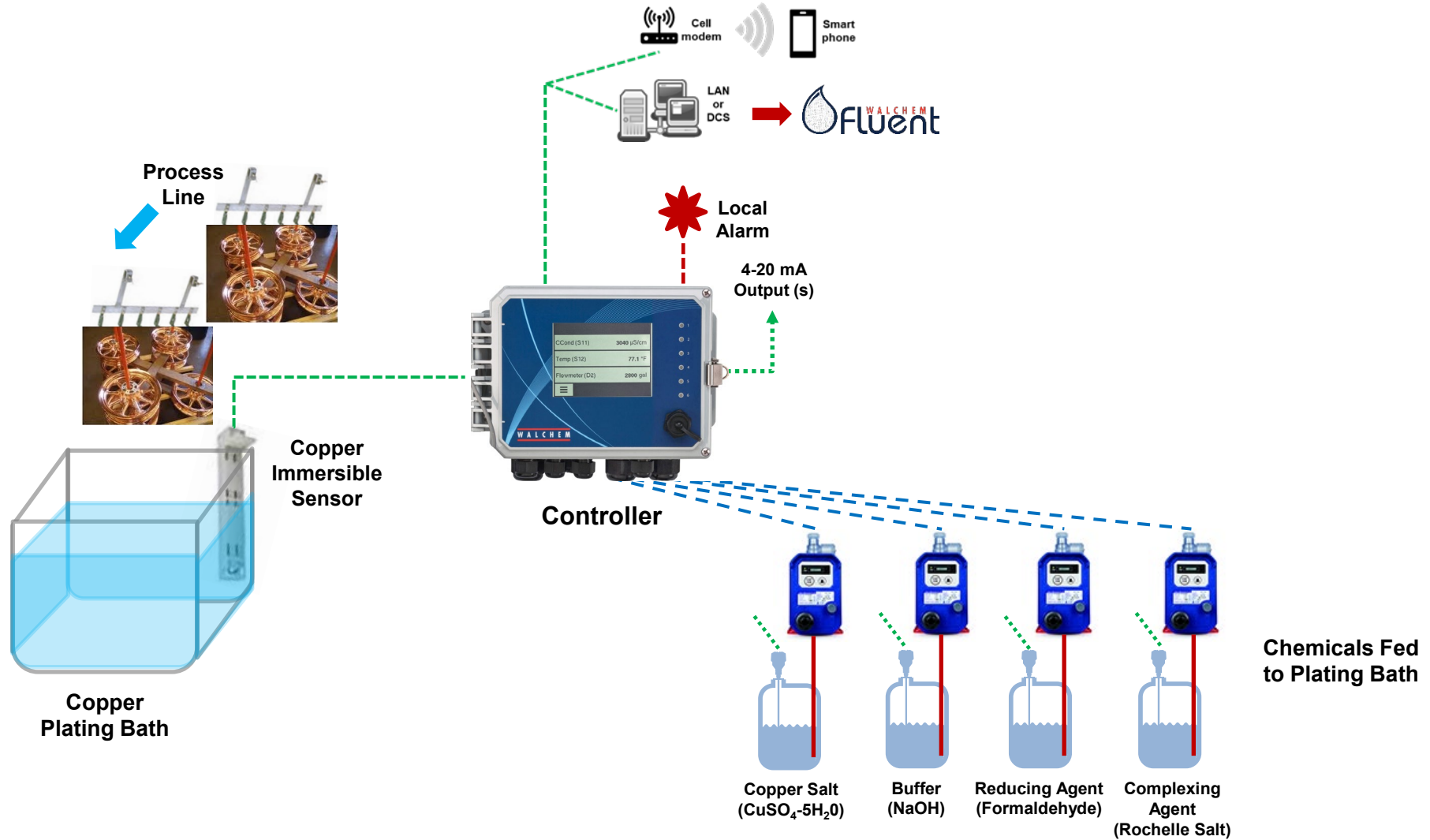
## Plating Shop Benefits Realized via Automation

- **Reduced labor for maintaining automated baths**
  - **Testing time reduced: 75% (compared to pre-automation)**
    - ❑ Operators freed up to focus on other critical aspects of bath operation
    - ❑ Annual cost savings: \$ 2600 to \$ 3900 (per bath)
  - **More consistent quality of plating with less operator interface with bath**
- **Cost reductions**
  - **Total LNS use down 6-8% with the same plating coverage**
    - ❑ This based on only 2 of 6 ENi baths automated - **savings of ~\$100 per every 100 gallons LNS consumed**
    - ❑ Additional savings expected once all baths are automated
  - **Reduced need for manual testing materials – titrations, etc.**
    - ❑ Annual cost savings: \$ 1702 (per bath)
- **Lower percentage of plate out**
  - **Chemistry related plate out on automated baths reduced to near “0”**
    - ❑ Operators more focused on minimizing/eliminating non-chemistry related plate out
- **Longer-term plans for plant**
  - **Automate all ENi baths – eight (8) baths in total**
  - **Automate pretreatment lines – washer & rinse baths**
  - **Upgrade automation on wastewater treatment side**



# Improving Operational Efficiencies

Electroless Copper Bath: Typical Installation for Automating the Bath



# Improving Operational Efficiencies

Aluminum Anodizing: Where Are the Opportunities for Monitoring & Control?

- **Pretreatment**

- **Cleaning baths**

- ❑ Electrodeless conductivity to control alkaline cleaner levels
    - ❑ Metering pumps for alkaline cleaner feed

- **Etch tanks**

- ❑ Electrodeless conductivity for etchant chemistry

- **Rinses**

- ❑ Conductivity and pH

- **Process**

- **Anodizing bath**

- ❑ pH is typically too low to control well with pH controller
      - *Titration to control level of sulfuric or chromic acid in bath*

- ❑ Conductivity - electrodeless

- **Dye baths**

- ❑ pH can be controlled with pH controller
      - *High temperatures (upwards of 150°F) limits electrode life if no sample cooling is applied*

- **Sealing baths**

- ❑ pH may be controlled with pH controller if using acid (other than acetic)
      - *Short electrode life if no cooling*



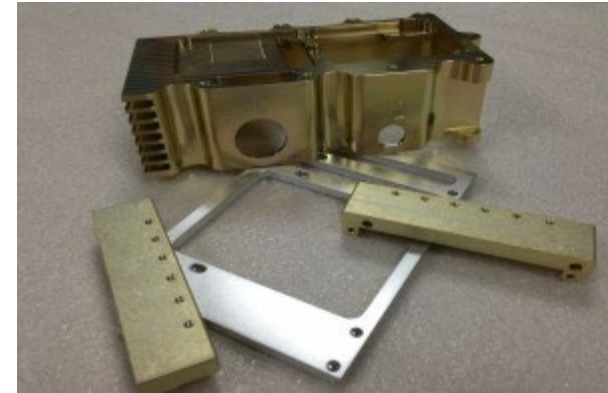
Source: <https://www.anoplate.com/finishes/hardcoat-anodize/>



# Improving Operational Efficiencies

## Chromate Conversion Coatings: Where Are the Opportunities for Monitoring & Control?

- **Pretreatment**
  - **Cleaning baths**
    - ❑ Electrodeless conductivity to control alkaline cleaner levels
    - ❑ Metering pumps for alkaline cleaner feed
  - **Rinses**
    - ❑ Conductivity and pH
- **Process**
  - **May be automated via a controller**
    - ❑ Chromic acid controlled by pH (typically 2-3)
      - **Beware of baths with fluoride activators!**
        - Acid fluorides will dissolve the glass pH electrodes
    - ❑ Electrodeless conductivity also can be used
    - ❑ Ion selective electrodes
      - **Chloride and fluoride**
  - **Other components by titration**



**Source:** <https://www.astfinishing.com/plating-service/chromate-conversion-coating/>



**Source:** [https://en.wikipedia.org/wiki/Chromate\\_conversion\\_coating](https://en.wikipedia.org/wiki/Chromate_conversion_coating)

# Improving Operational Efficiencies

## Incoming & Reuse Water: What Are The Opportunities?

- **Incoming and reuse water**

- **Where this is important**

- ❑ Purification of water supply for process needs
- ❑ Recovery of chemicals from plating drag out
- ❑ Wastewater purification and reuse

- **Improved water quality for the process**

- ❑ Assures a clean surface coming out of the pretreatment part of the process
- ❑ Minimize potential for spotting, streaking, etc. of the final product surface

- **Increased membrane operational lifetimes in RO system**

- ❑ De-chlorination step

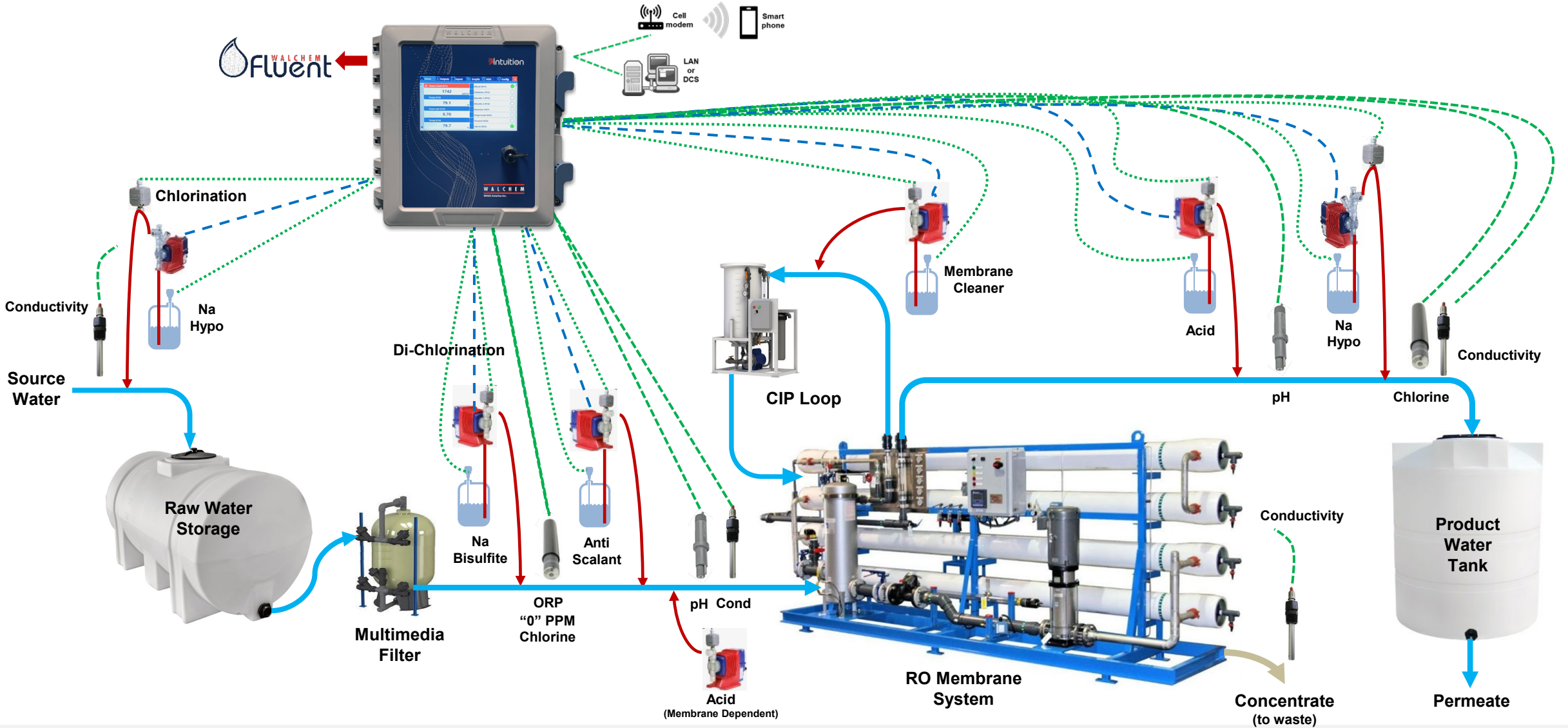
- **When applied to plating drag out**

- ❑ Allows for return of chemical concentrate (recovered chemical solution) to process bath
  - *Valuable process chemicals may be recovered*
  - *Recovery of metals to meet metal discharge limits.*
- ❑ Reuse of the permeate (purified water) as fresh rinse water
  - *Less fresh water is needed – lower water costs*
- ❑ Minimizes or eliminates water discharge to the POTW (publicly owned treatment works)



# Incoming & Reuse Water

## RO Installation Application



# Improving Operational Efficiencies

## Utilities: What Are The Opportunities?

- **Utilities**

- **Cooling towers**

- ❑ Reduced water consumption allows for recycling most of the water used in process cooling or air conditioning
    - ❑ Potential for sewer credits due to evaporative losses
    - ❑ Reduced chemical usage
      - *Savings often outweigh the water reduction savings*
    - ❑ Reduced corrosion and scale formation
      - *Longer equipment lifetime*
    - ❑ Legionella control

- **Boilers & condensate return**

- ❑ Improved heat transfer
    - ❑ Reduced corrosion and scale formation
      - *Longer equipment lifetime*
    - ❑ Energy savings – via proper control of condensate return to boiler feed water
      - *Also reduces chemical, make up water & sewer disposal costs*

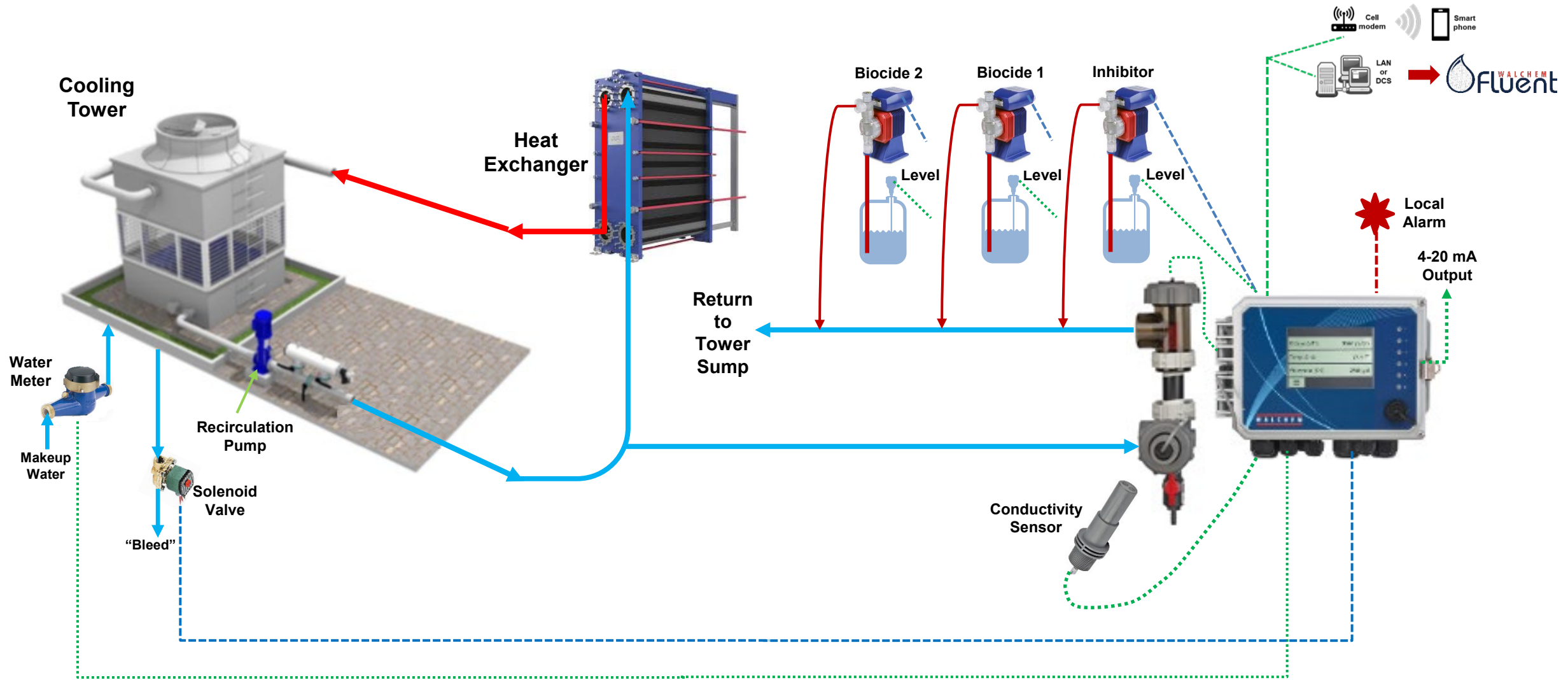
- **Pollution controls – fume scrubbers**

- ❑ Minimization/elimination of pollutants and/or odors
    - ❑ Keep workers safe
    - ❑ Regulatory compliance – nonadherence to emission requirements results in high fines!



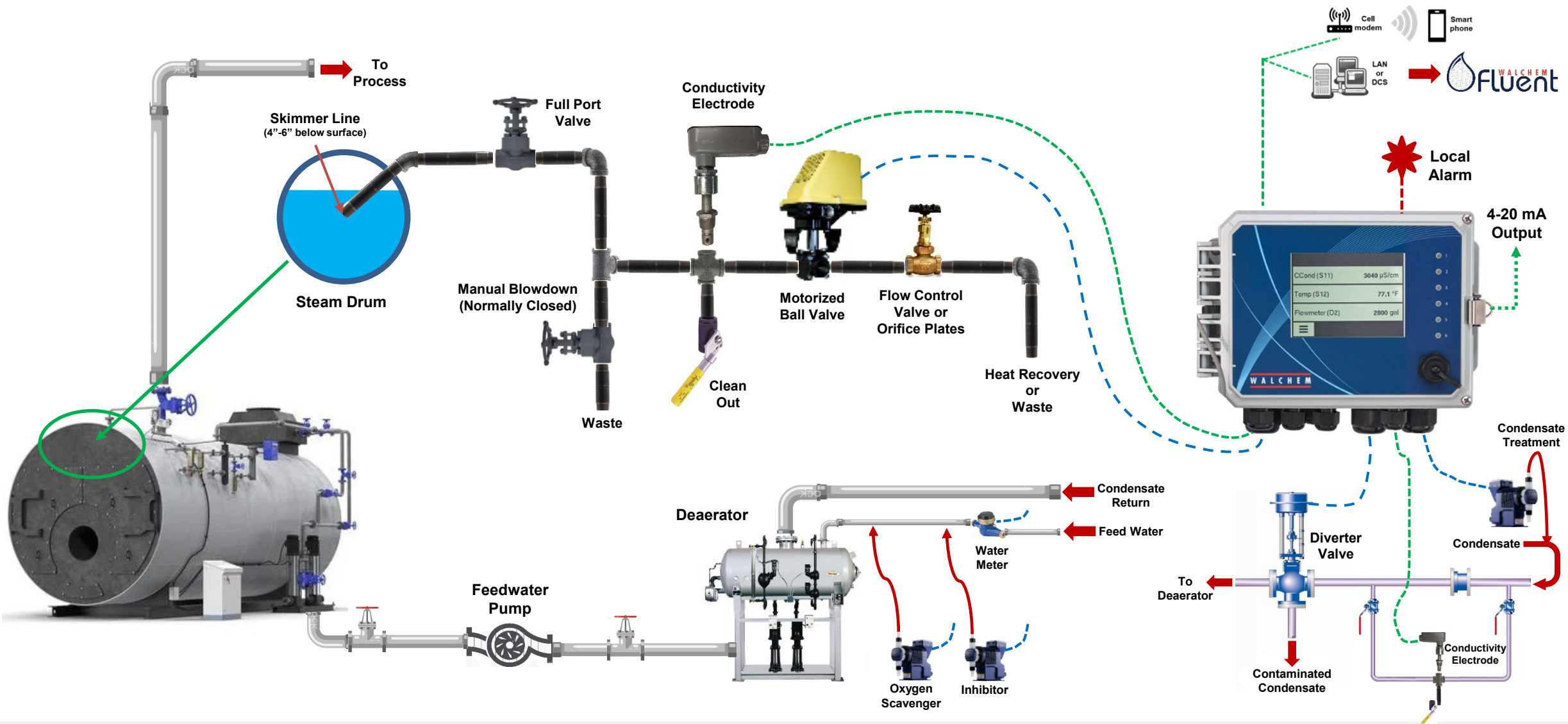
# Markets & Applications

Industrial, Utilities - Cooling Tower Application



# Markets & Applications

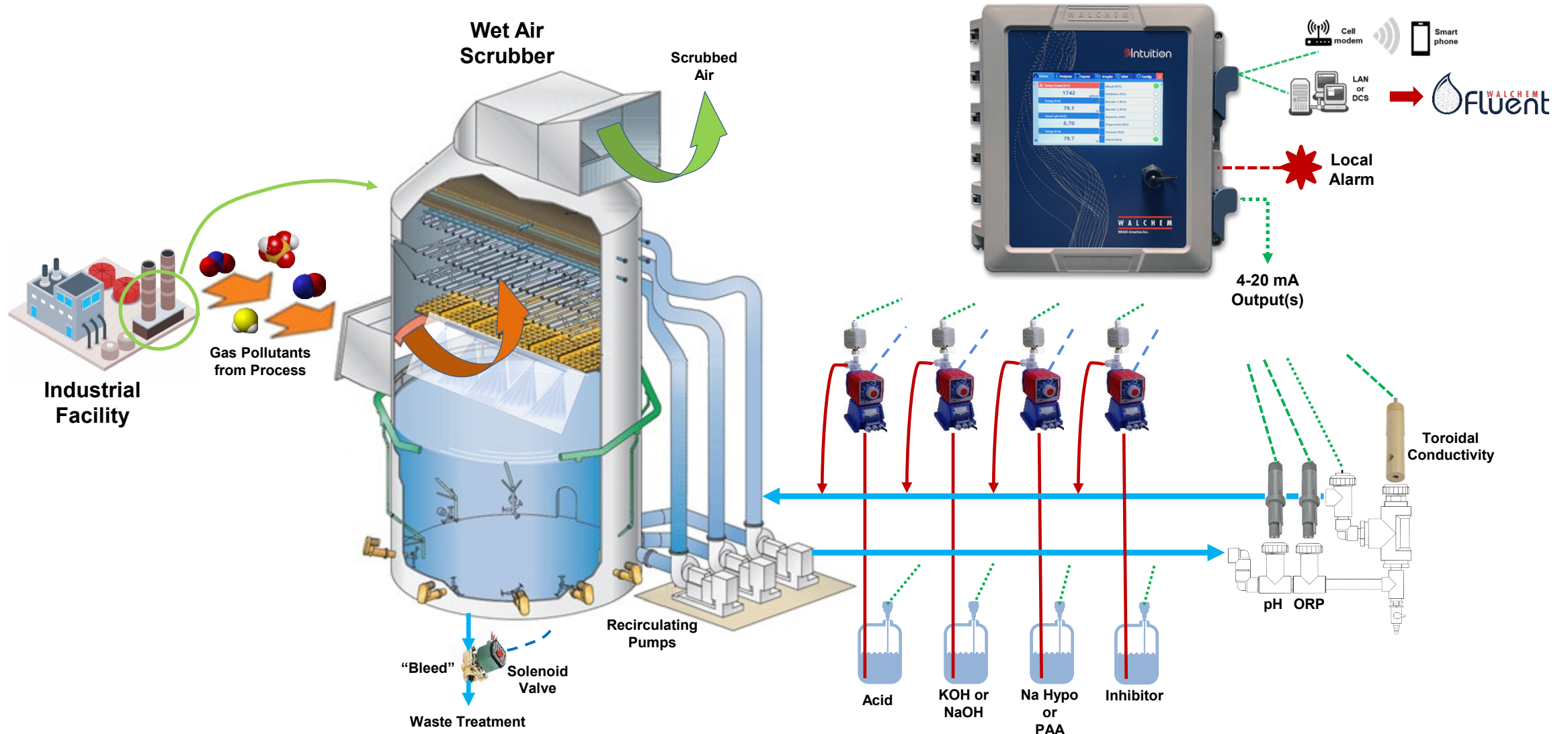
Industrial, Utilities – Boiler System & Condensate Return Application





# Markets & Applications

## Industrial – Utilities: Wet Air Scrubber Application Installation



# Improving Operational Efficiencies

## Wastewater: What Are The Opportunities?

- **Wastewater**

- **Improved adherence to regulatory permits**

- ❑ Know of and resolve a potential problem before it become a problem
- ❑ Avoid fines due to noncompliance

- **Reduced energy costs**

- ❑ Recovery and reuse of water throughout the plant

- **Process improvements**

- **Constant access to data**

- ❑ Increasing the wastewater process efficiencies
- ❑ Ability to better evaluate trends and how different patterns emerge in both low and high usage times
  - *Better make use of resources*

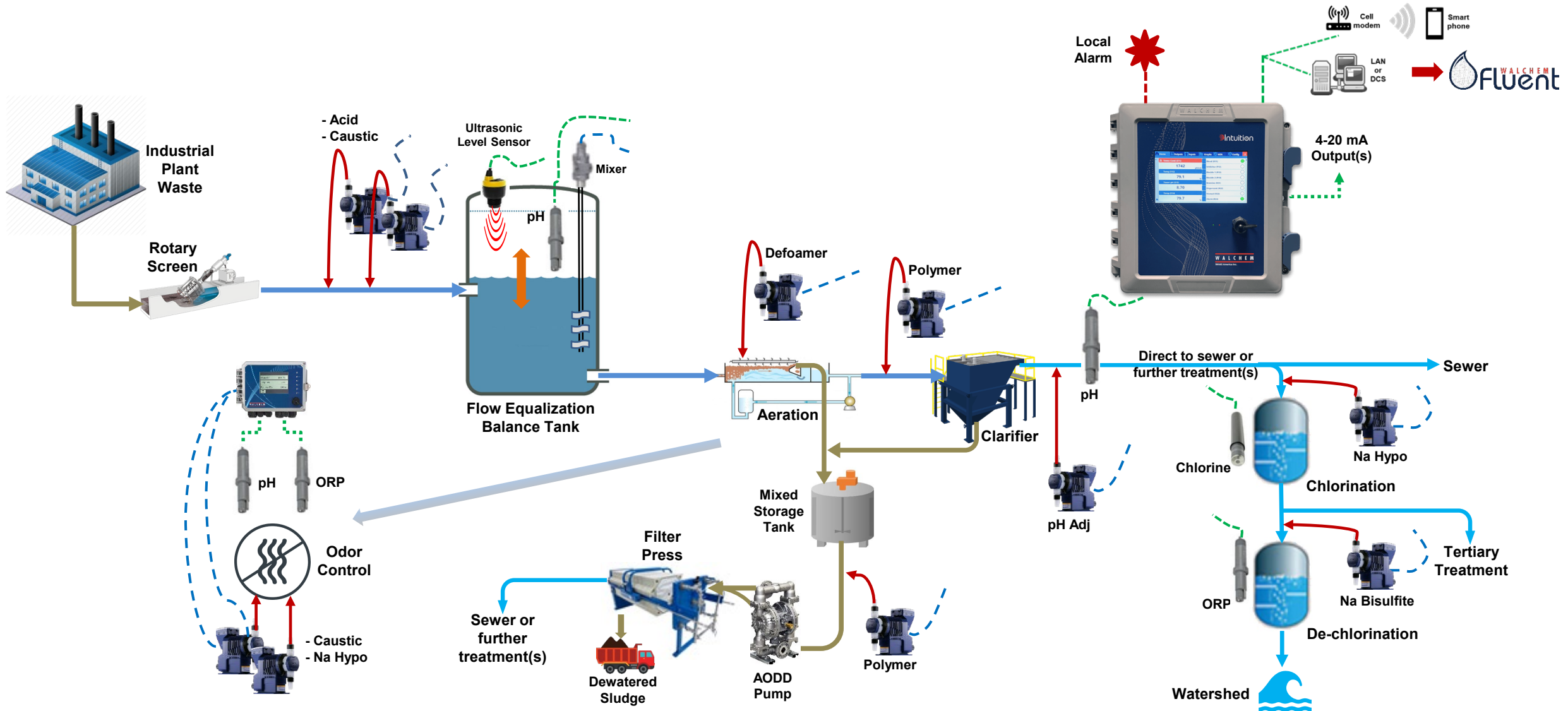
- **Better use of labor**

- ❑ Allows better use of your human capital to more value added and important tasks and issues



# Markets & Applications

## Industrial – Wastewater: Wastewater Treatment Installation



# Improving Operational Efficiencies

## Summary

- **More robust process operation**
  - Improved consistency of plating rate and bath stability
  - More uniform deposit
  - Allows operation within a tighter process window
  - Overall higher quality to better meet your customer requirements
- **Time and cost reductions**
  - Both in testing time and expense and overall tank maintenance
  - Water, energy and chemical usage improvements
  - Longer equipment lifetimes
- **Ability to see “real-time” data and alarm notifications**
  - Ability to quickly respond to a process upset
  - Anywhere and anytime
  - Minimize/eliminate potential for non-compliance with permits
- **Improved efficiencies**
  - Free up resources to perform other important and value-added tasks



# Open Discussions

Questions & Answers & Discussions



**W A L C H E M**

IWAKI America Inc.

*THANK YOU*

