

Problems with Hypo: Best Design Practices for Smooth and Efficient Sodium Hypochlorite Feed Systems

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HDR

Outline

- Common Options Available for Chlorine Disinfection (water and wastewater)
- Case Study: Bremerton Water System and New Advanced Disinfection Facility (ADF)
  - Overview of Hypochlorite Feed System
  - Initial Design Layout and Problems Encountered
  - Troubleshooting
- Best Management Practices for System Operation and Design
- Equipment Examples and Suggestions

Chlorination

Water

- Common for disinfection
- Targets crypto/giardia/virus
- Based on DOH requirements for contact time (CT)
- Residual in distribution system
- Disinfection Byproducts (DBP) a common challenge
- Storage and handling very similar to wastewater treatment

Wastewater

- Common for disinfection
- Targets fecal/E.coli/enterro
- Based on DOE requirements for contact time (CT) as required by NPDES permit
- Residual in discharge not allowed – quenching (sodium bisulfite, etc.)
- Common to form chloramines due to ammonia in wastewater effluent
- Storage and handling very similar to water treatment

Typical Chlorine Alternatives

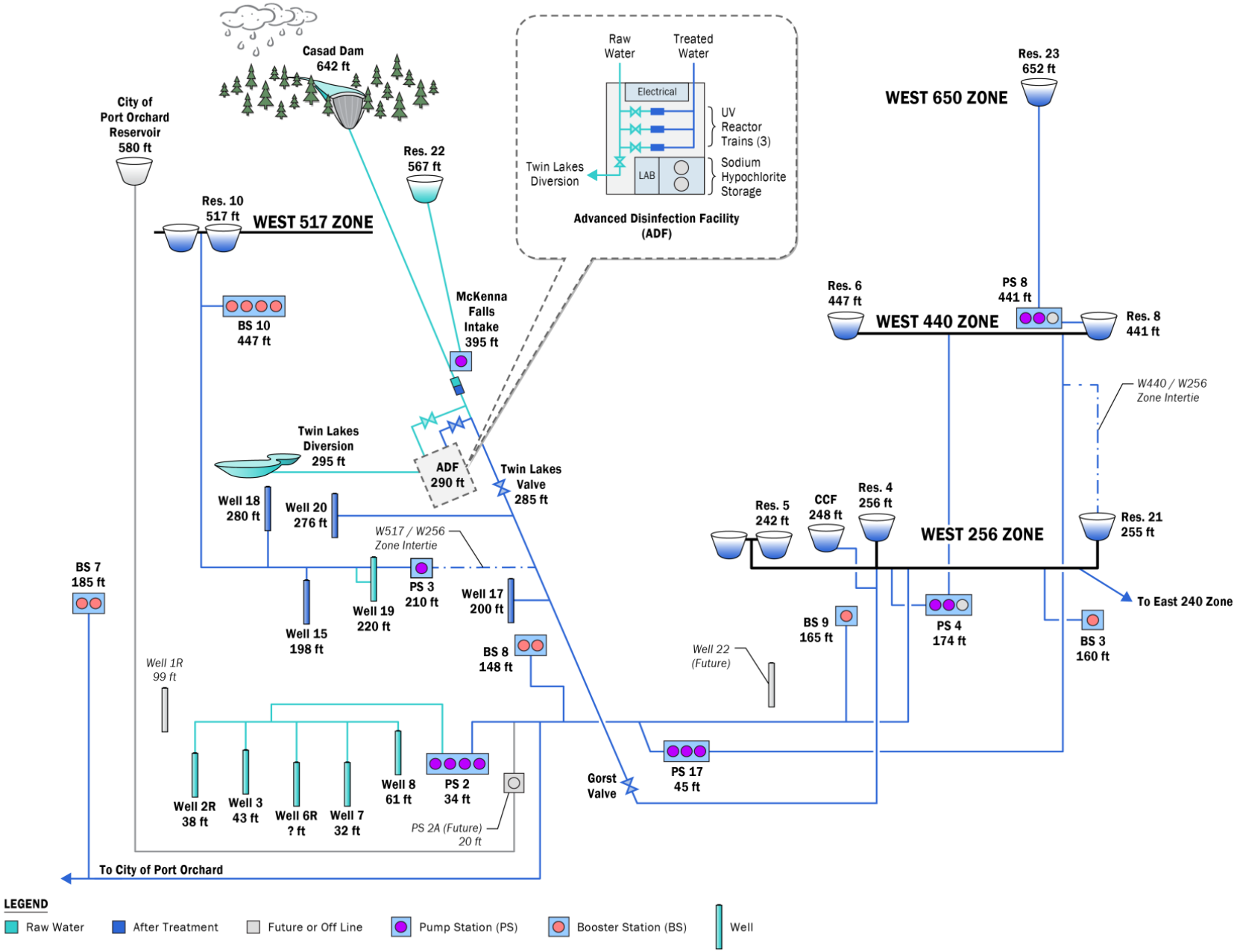
Disinfection Alternative	Process Overview	Process Pros/Cons
Delivered Chlorine Gas	▪ Gas chlorine system previously used by Bremerton. ▪ Delivered in 150 lb or ton containers.	▪ Safety risks, emergency planning and regulatory requirements with use of gas. ▪ Often the most inexpensive option. ▪ Low footprint.
Delivered (Bulk) Sodium Hypochlorite Liquid 	▪ Liquid sodium hypochlorite as a disinfectant is similar to use of chlorine gas and equally as effective. ▪ Liquid storage and feed is safer than gas under pressure. Although, NaOCl is a corrosive liquid with unique code and safety considerations. ▪ Requires contract with chemical supplier to deliver bulk liquid to storage facilities at the plant site.	▪ Safety risks with liquid systems (corrosive). ▪ Requires more pumping/instrumentation control features. ▪ Carrier water system/pumps often required. ▪ Higher footprint.
On-Site Generated Sodium Hypochlorite Liquid (0.8%) Electrolytic Technologies MiOX, Evoqua (OSEC)	▪ Hypochlorite generation is based on electrolysis of brine, an electrochemical process that consumes salt, water, and power to produce a liquid hypochlorite solution. ▪ Liquid storage and feed system required. However, the storage volume can be reduced as the chemical is continuously generated.	▪ Auxiliary equipment that must be maintained. ▪ Higher footprint for storage if lower concentration used.

Casad Dam

Casad Dam

Casad Dam

- Height: 190 feet
- Length: 416 feet
- Elevation at top: 643.7 feet above sea level
- Thickness at base: 56 feet
- Drainage Area: 3,000 acres
- Surface area at crest: 40 acres
- Water storage at crest: 1.4 billion gallon
- Provides 65% of City water supply


Casad Dam
642 ft
City of
Port Orchard
Reservoir
580 ft
Res. 22
567 ft
Res. 10
517 ft
WEST 517 ZONE
BS 10
447 ft
McKenna
Falls
Intake
395 ft
Raw
Water
Treated
Water
Electrical
UV
Reactor
Trains (3)
Twin Lakes
Diversion
LAB
Sodium
Hypochlorite
Storage
Advanced Disinfection Facility
(ADF)
Res. 23
652 ft
WEST 650 ZONE
Res. 6
447 ft
PS 8
441 ft
WEST 440 ZONE
Res. 8
441 ft
W440 / W256
Zone Intertie
Twin Lakes
Diversion
295 ft
ADF
290 ft
Twin Lakes
Valve
285 ft
Well 18
280 ft
Well 20
276 ft
W517 / W256
Zone Intertie
Res. 5
242 ft
CCF
248 ft
Res. 4
256 ft
WEST 256 ZONE
Res. 21
255 ft
To East 240 Zone
BS 7
185 ft
Well 15
198 ft
Well 19
220 ft
PS 3
210 ft
Well 17
200 ft
BS 8
148 ft
BS 9
165 ft
PS 4
174 ft
BS 3
160 ft
Well 22
(Future)
Well 1R
99 ft
Well 2R
38 ft
Well 3
43 ft
Well 6R
? ft
Well 7
32 ft
Well 8
61 ft
PS 2
34 ft
PS 2A (Future)
20 ft
Gorst
Valve
PS 17
45 ft
To City of Port Orchard
LEGEND
Raw Water
After Treatment
Future or Off Line
Pump Station (PS)
Booster Station (BS)
Well

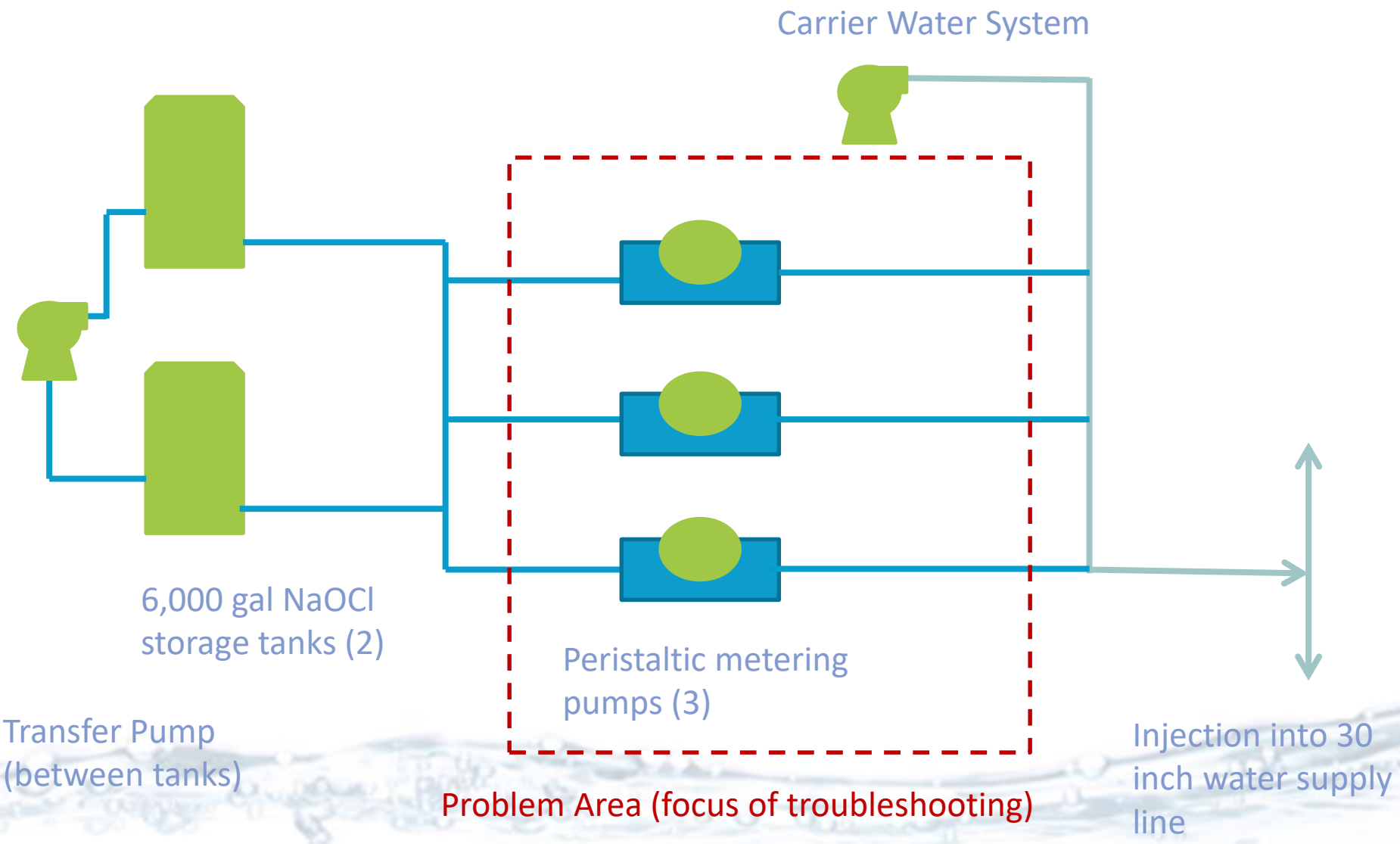
New Advanced Disinfection Facility (2.9 – 23 MGD)

Medium Pressure UV System

Control Valves (Cla-Val)

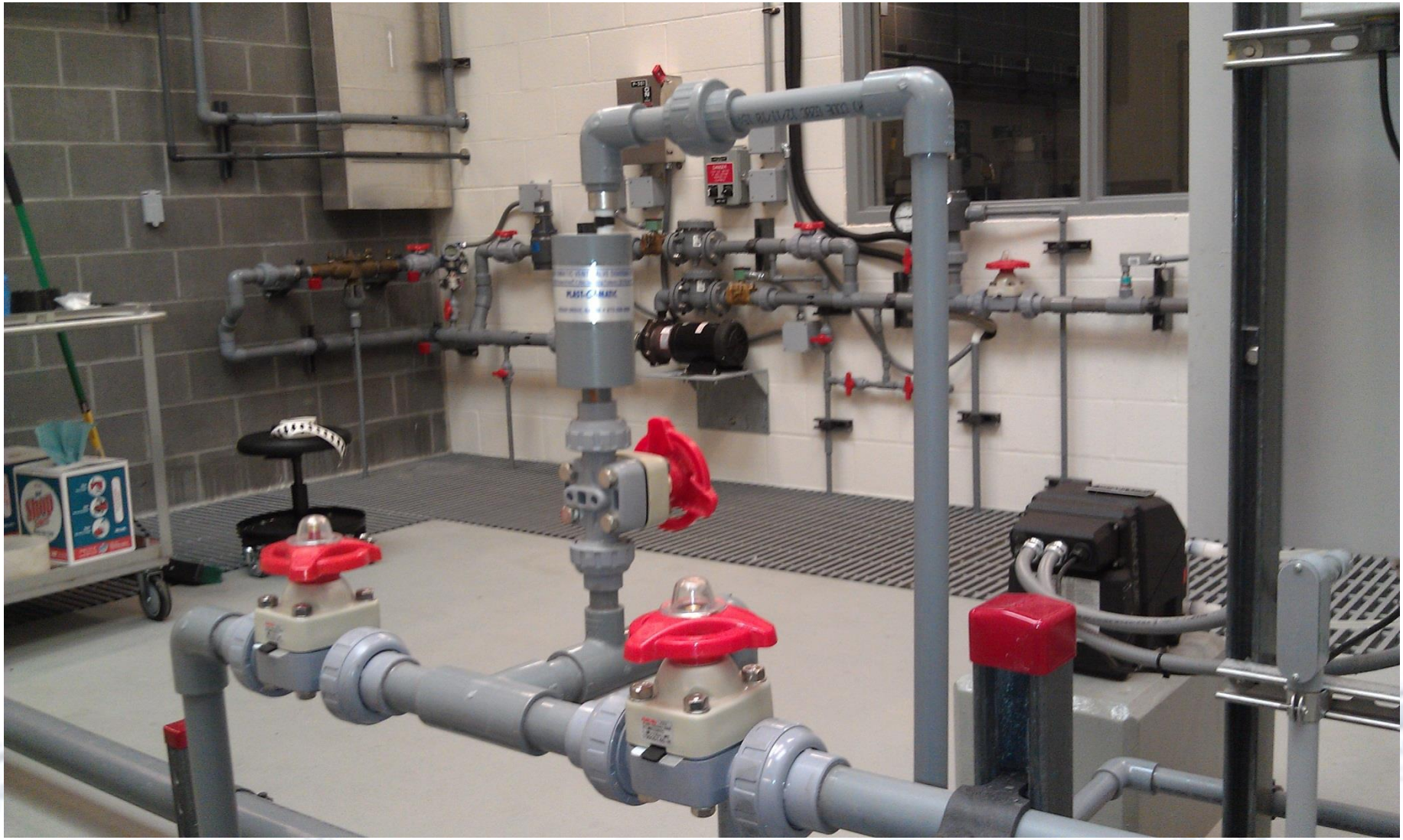
UV Reactor Control Screen

New ADF Chlorine System

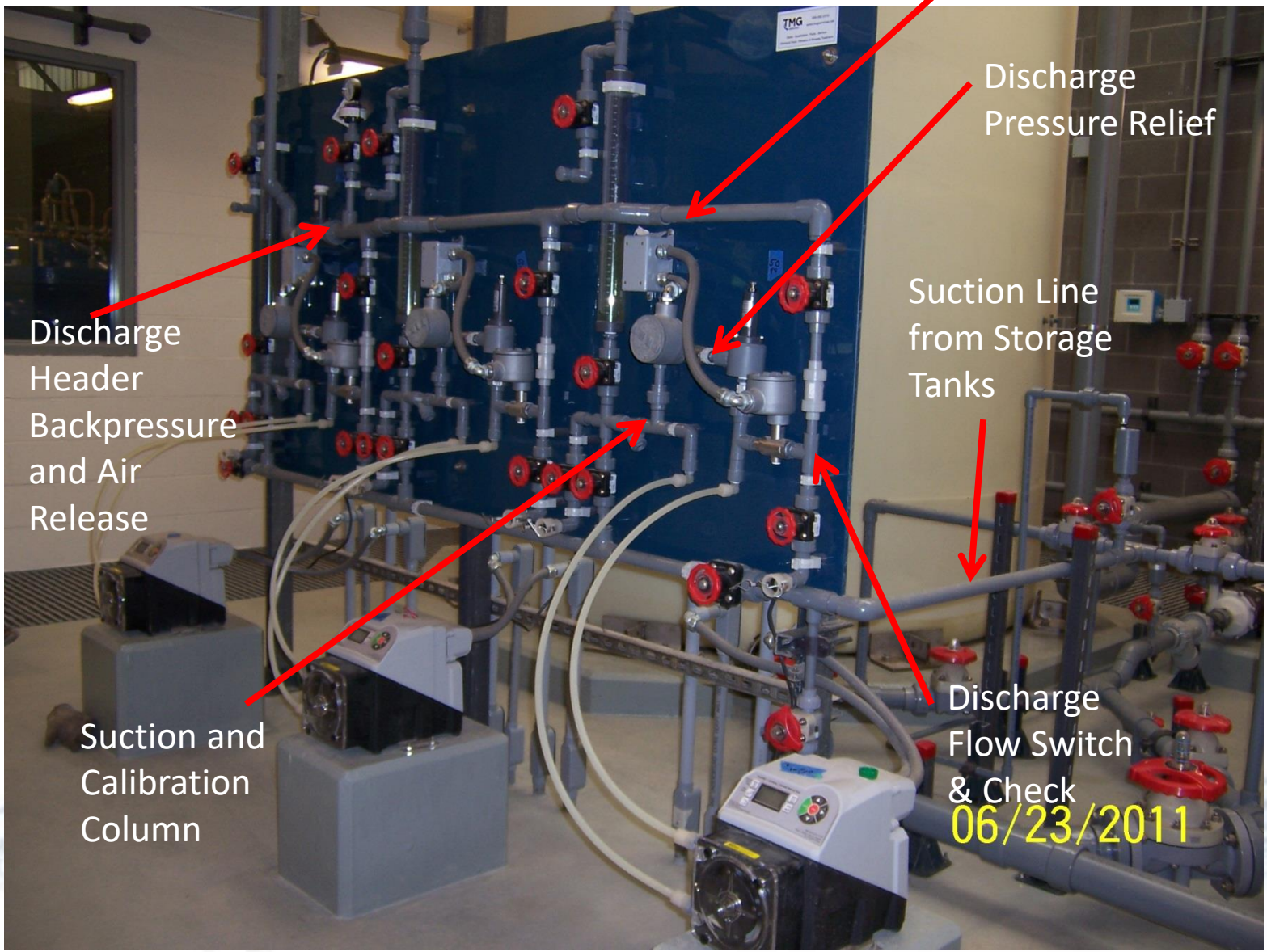


Carrier Water System

Gas Relief Valves



Original Metering Pump Board 1

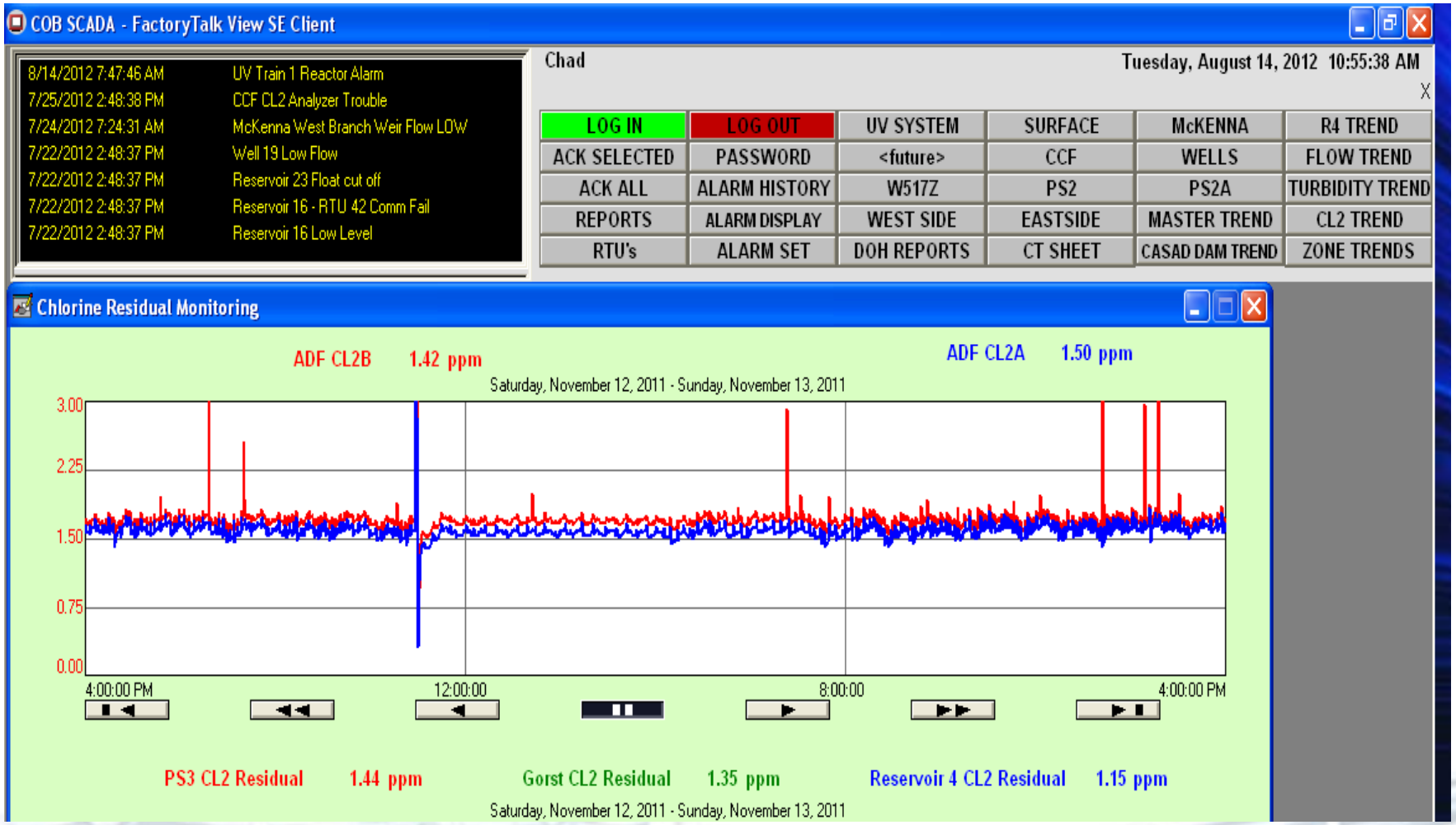


Original Metering Pump Board 2

Problems with Initial System

- Air binding on suction side of pumps
  - Air traps, 90 deg bends, flat piping
- Inability to maintain a smooth (flat line) chlorine residual
- Tubing failures within 24-100 hours of operation
- No flow and pressure relief alarms
  - Gas trapping in thermal flow switches

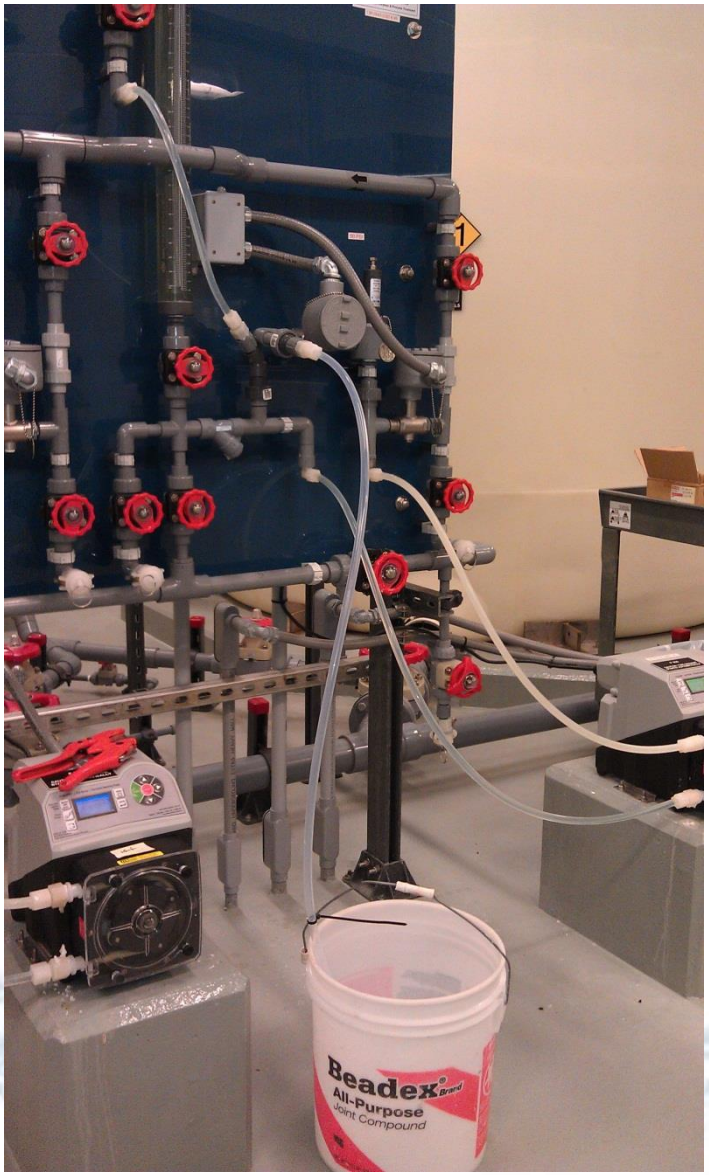
Erratic Chlorine Residual



Troubleshooting (First Round)

- Disconnected pressure relief line and ran tubing to an open bucket
- Plumbed the suction side connection to the vent line
- Helped to smooth chlorine residual, but still problems with air on suction piping, poor degassing on discharge side

Pressure Relief Check 1



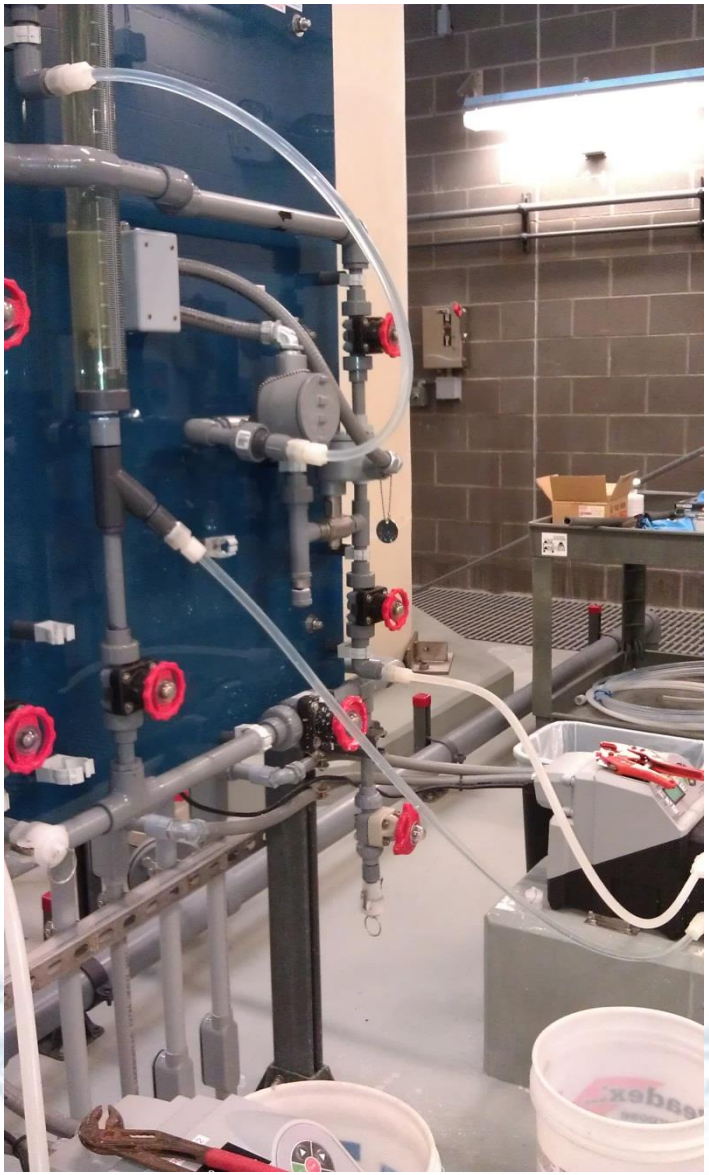
Pressure Relief Check 2

Residual after First Round

Troubleshooting (Second Round)

- Removed horizontal pipe, strainer, and 90 deg bends on suction side of pump
- Utilized vertical wye fittings
- Bypassed the flow switch on the discharge side of the pump
- This reduced air binding on pump suction and the chlorine residual was much smoother
- Still occasional spikes in residual, followed by drop (1-2 times per day)

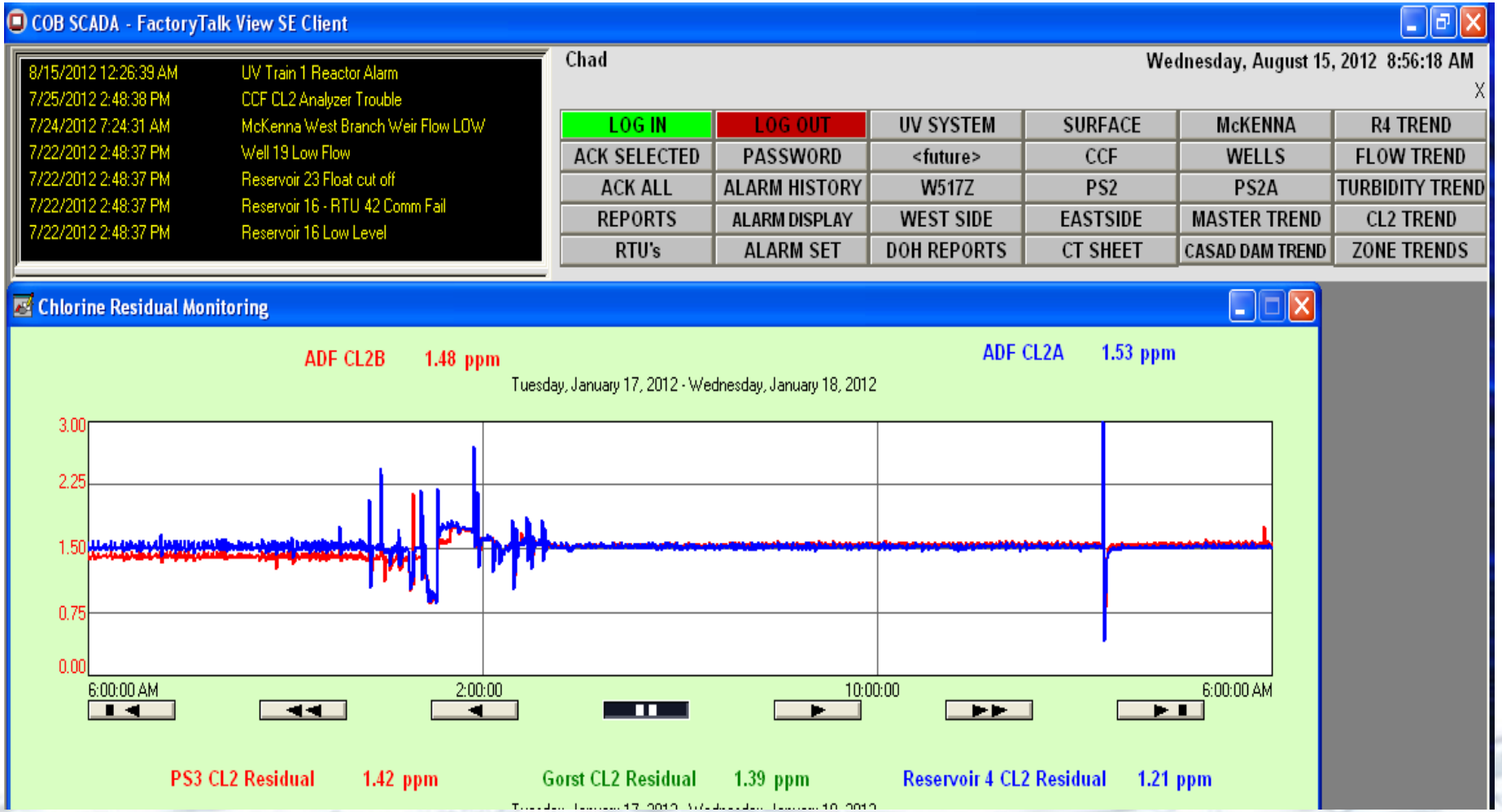
Partially Modified Board



Flow Switch Inlet

Flow Switch Outlet

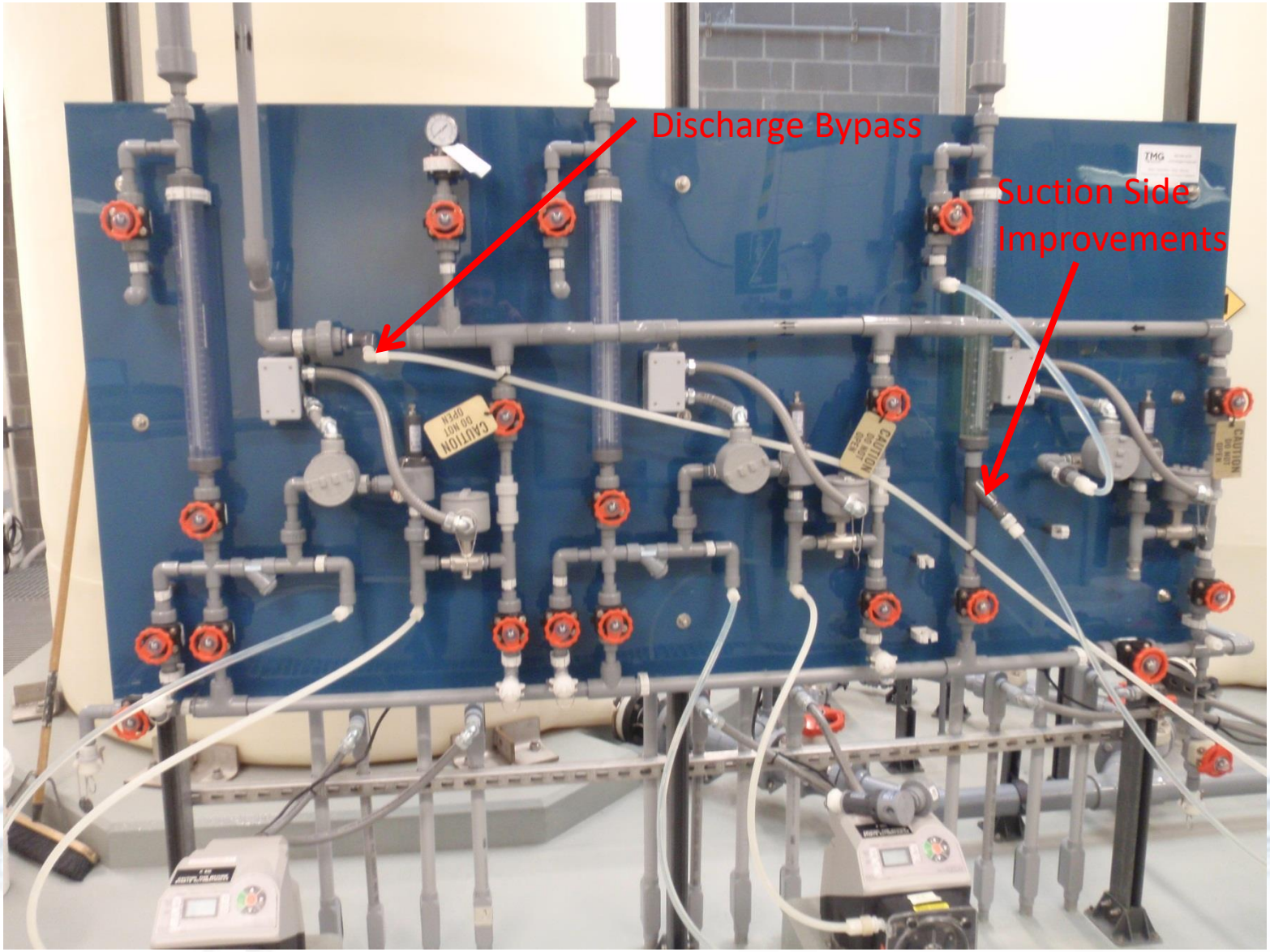
Residual after Second Round



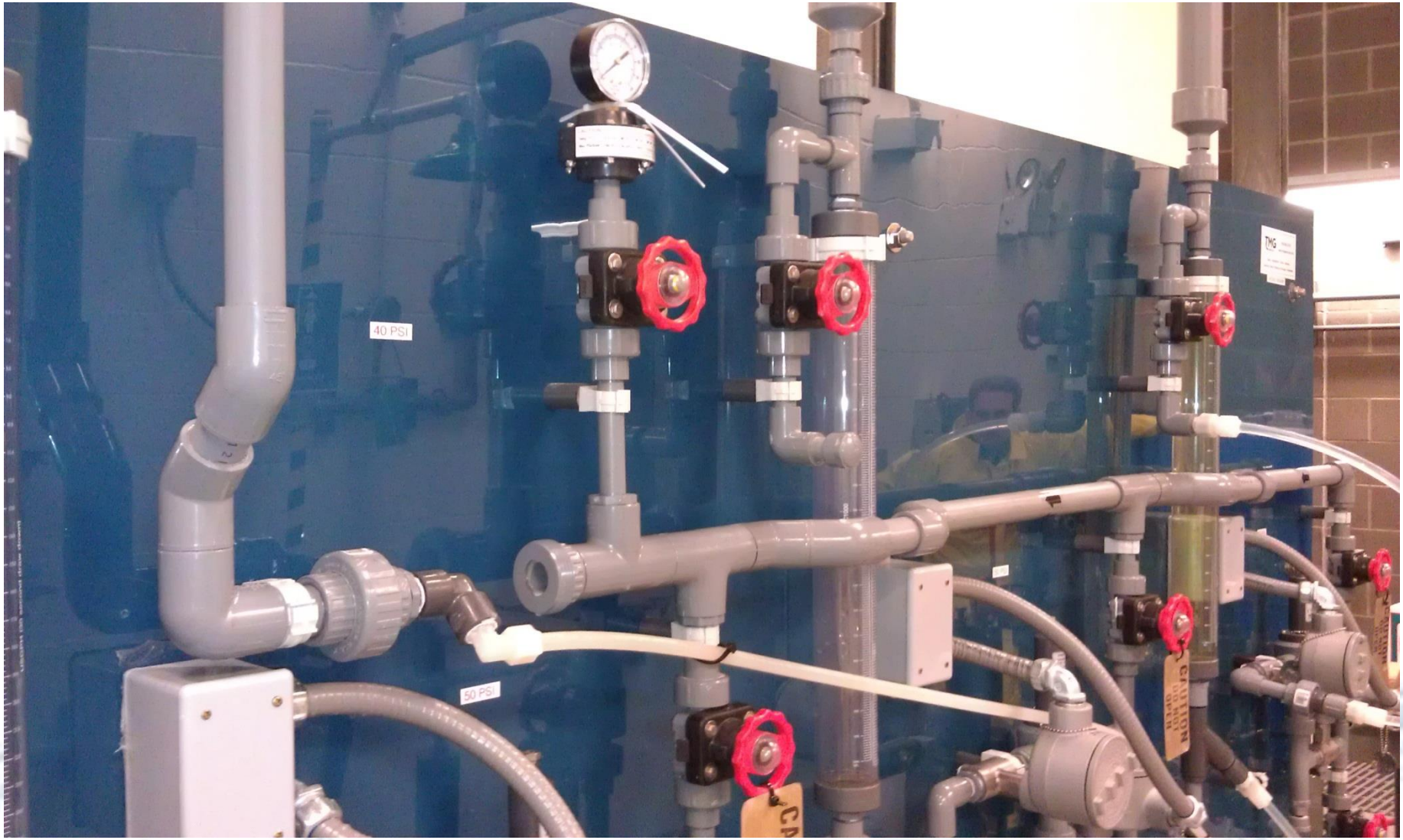
Troubleshooting (Third Round)

- Bypassed the discharge piping backpressure valve
- The 1 inch to ½ inch connection at the valve may have an air pockets developing; building with occasion pulses to release
- This cleared up the remaining residual spikes

Discharge Piping Bypass



Discharge Piping Bypass



Final Update of Piping

- Keep wye fittings
- Eliminate flow switches
- Simplify piping – keep things vertical
- Eliminate backpressure valve
- Route carrier water to hypo panel (not hypo panel to carrier water)
- Results
  - 1,000 plus hours of tube life with 1-1.5 million revolutions
  - No spikes, smooth residual

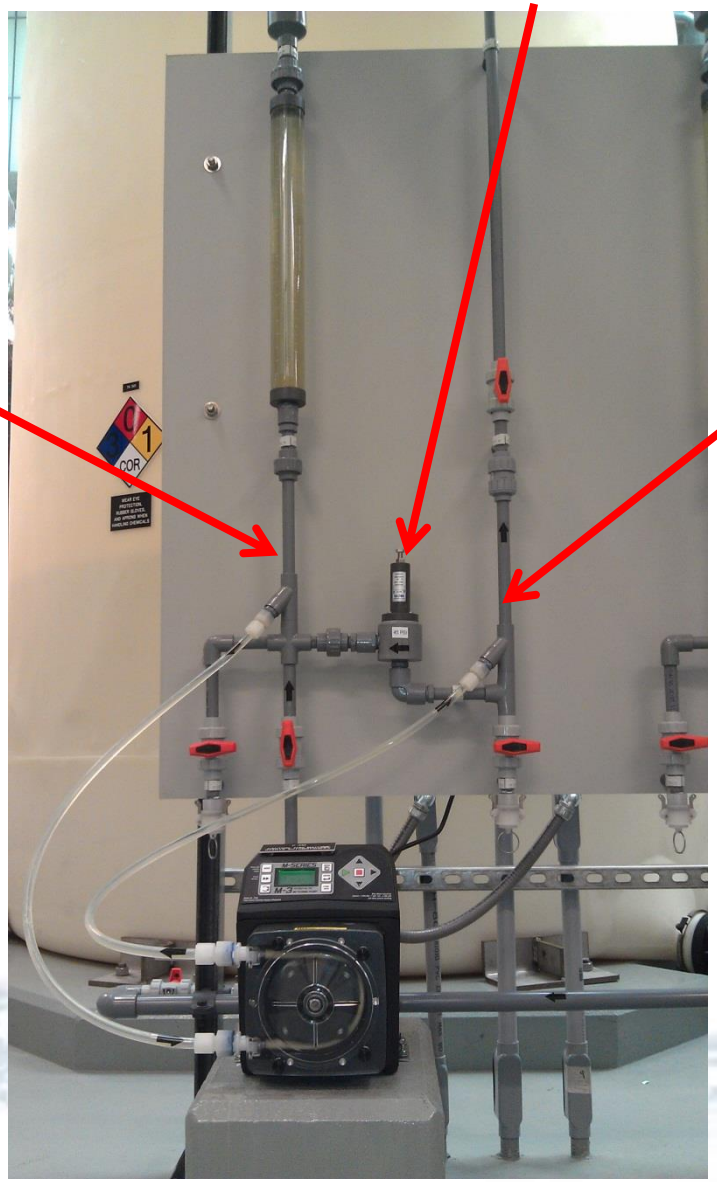
New Hypo Panel

Pump 1 Piping

Pressure Relief
(no high point)

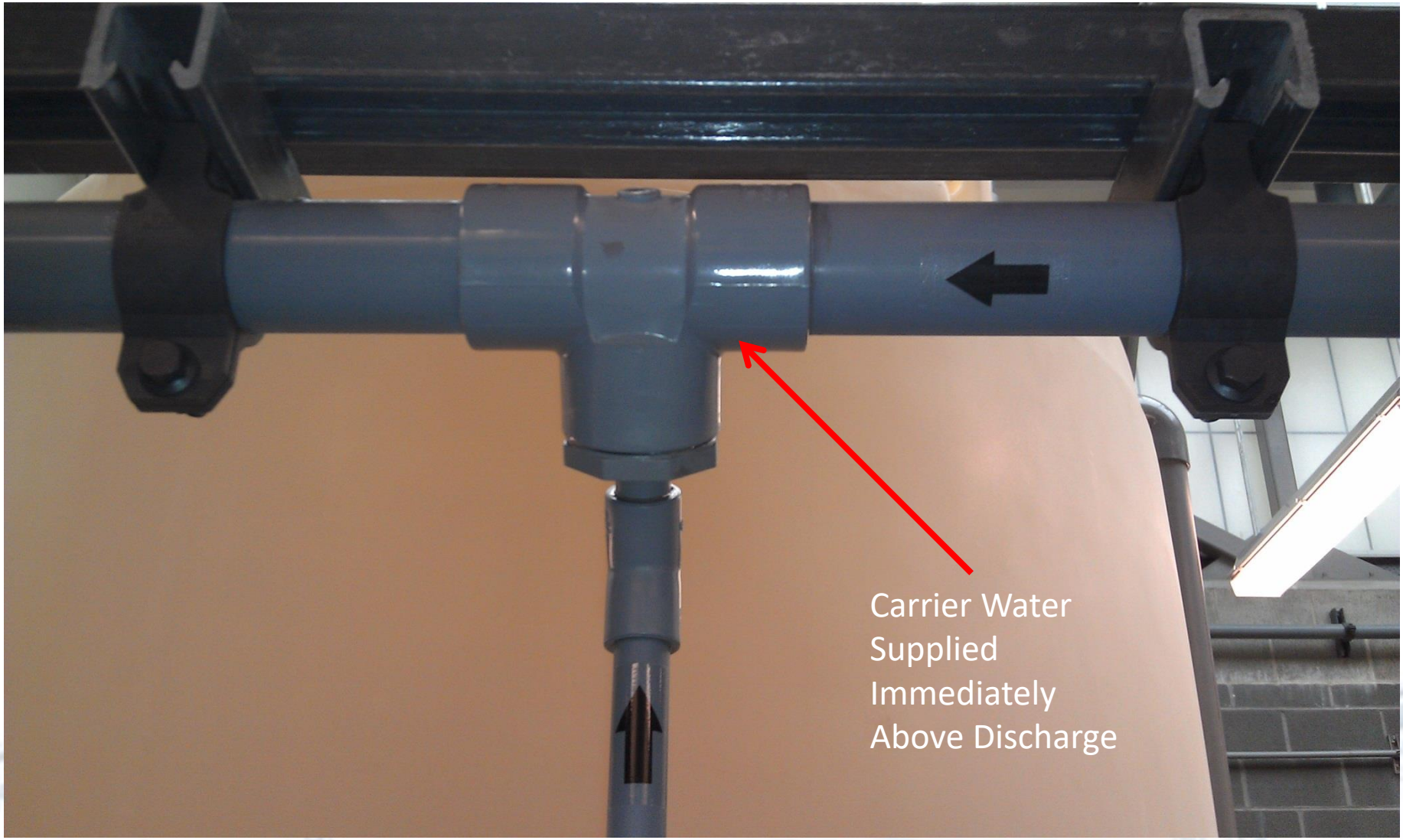
Vertical Suction
with Wye Fittings

Vertical
Discharge with
Wye Fittings, no
Flow Switch

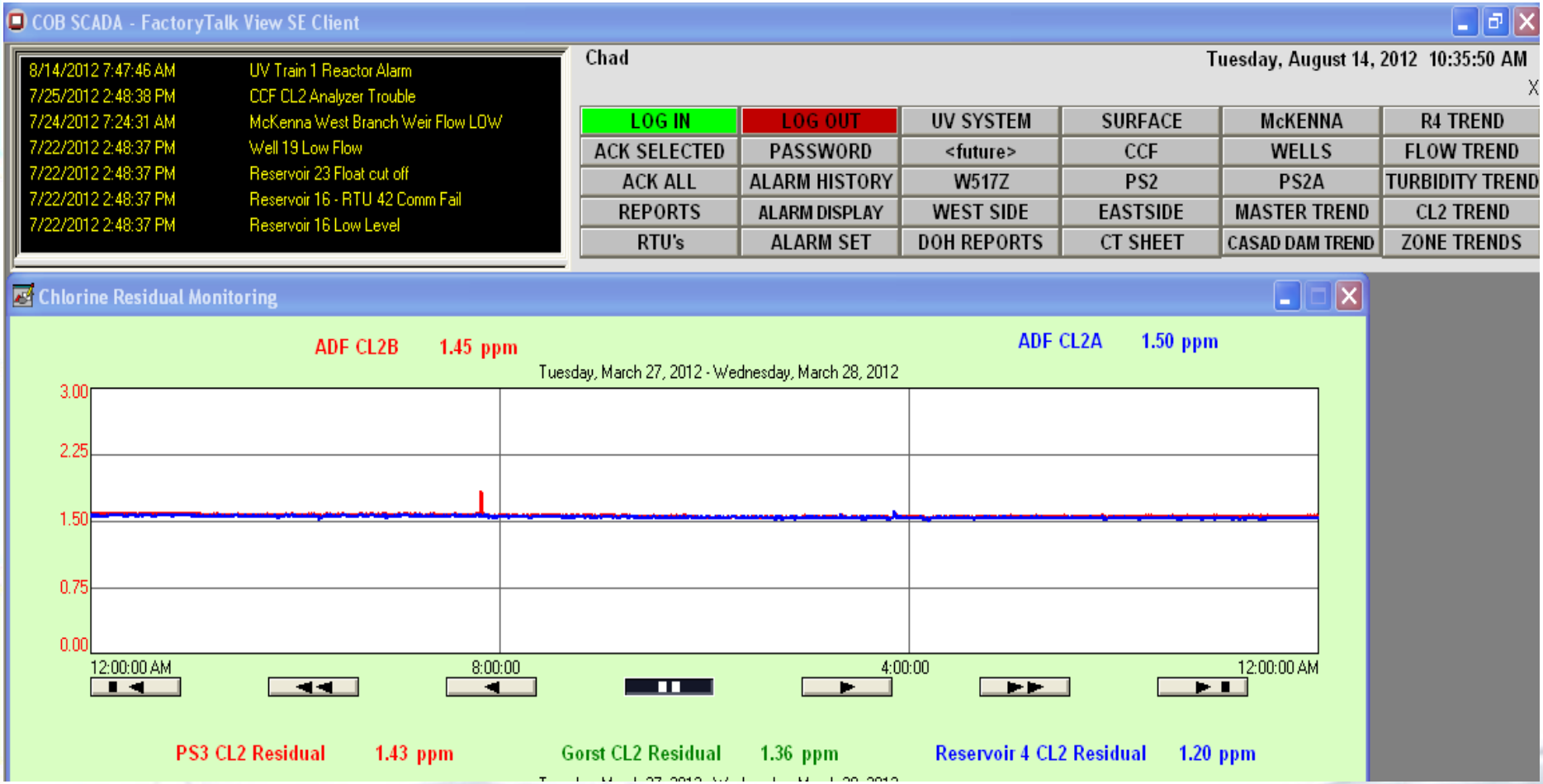


Pump 2 Piping

Hypo Injection Point



Final Residual Trend with New Panel



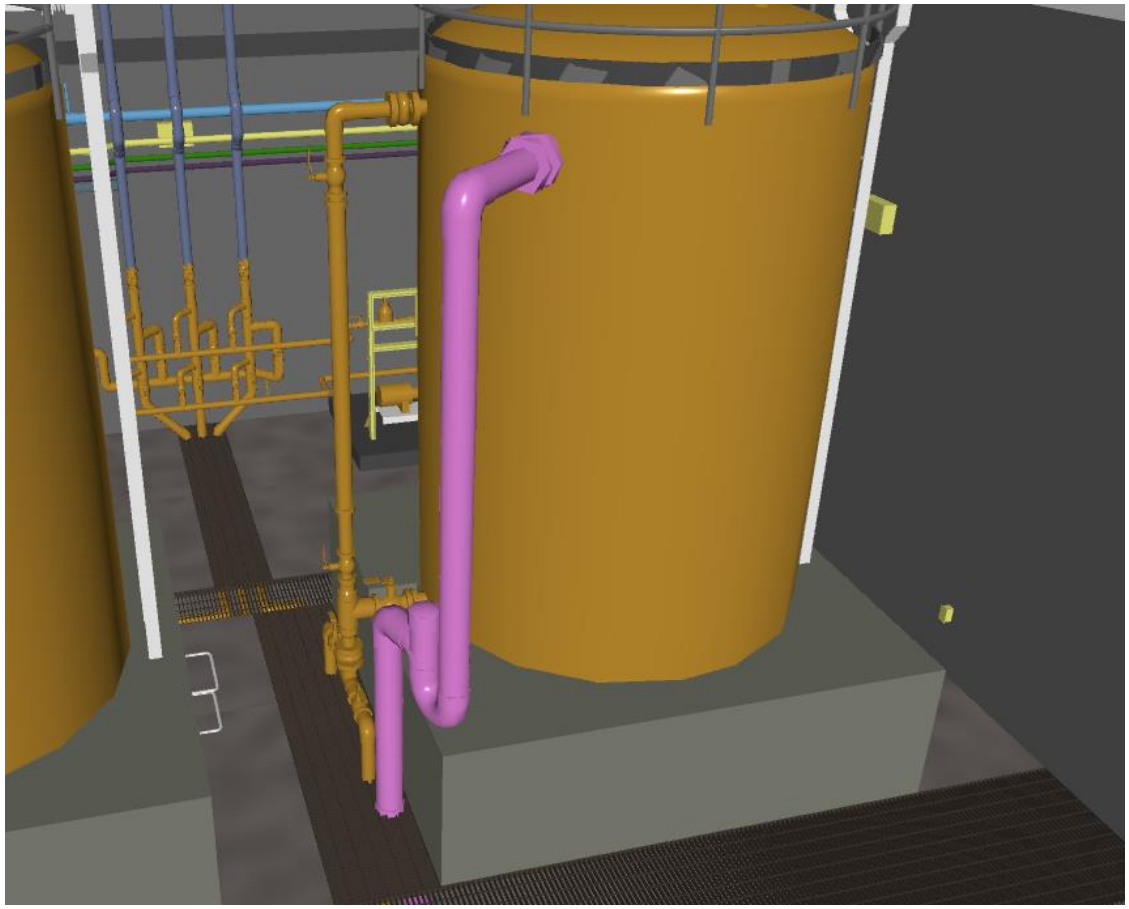
Best Management Practices for Hypo System Operation & Design

- Keep system piping “vertical” as much as possible
- Be cautious about flow switches versus flow meters
- Do you really need that valve?
  - Determine whether backpressure valves, check valves, etc., are really needed or if a modification in piping could potentially eliminate them
- Get carrier water to the hypo, not neat hypo to the carrier water
- Be aware of tubing “extensions” from peristaltic pumps to hard piping
  - Can be twisted, overly long, etc.

Best Management Practices for Hypo System Operation & Design

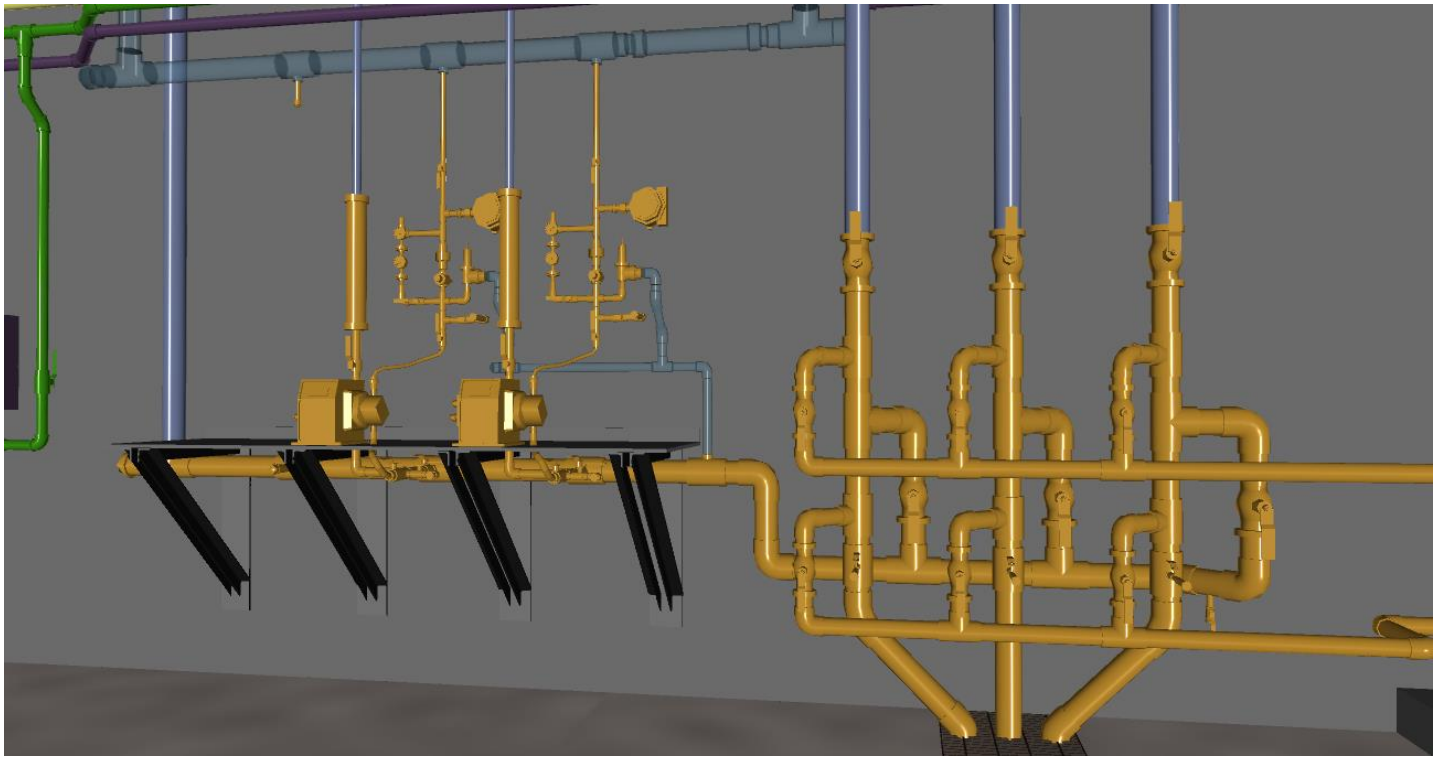
- Use a simple approach to pressure relief/protection
  - Avoid high points
- Use gas relief/air relief valves as needed (cheaper than potential problems)
- Avoid hard 90 elbows - smooth out with wye fittings or 45 deg bends
- Avoid long “horizontal runs” of piping
- Get pump and tank bottom at same elevation and don’t use small, convoluted, long suction runs
- **Key Point: avoid complexity when precision is demanded. Keep it simple.**

Make the Suction Side Easy on the Pump



- Tank on High Pad
- Big Suction Line with Vertical Vents

Make the Suction Side Easy on the Pump



- Pumps “see” the tank as a foot away (no suction pressure loss)
- Vertical pipe movement on mainline and vents

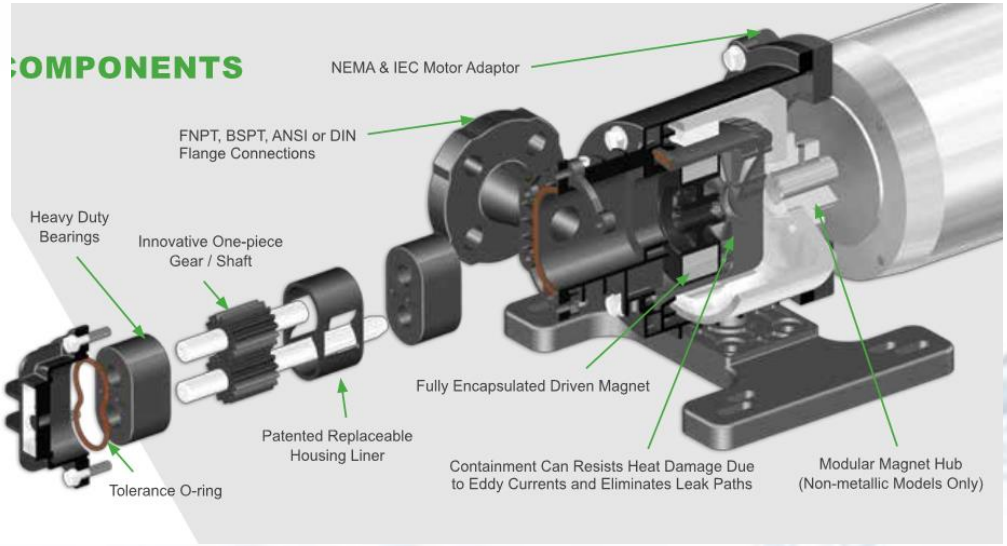
Some Quick Equipment Recommendations

Pumps

Progressive Cavity

Peristaltic

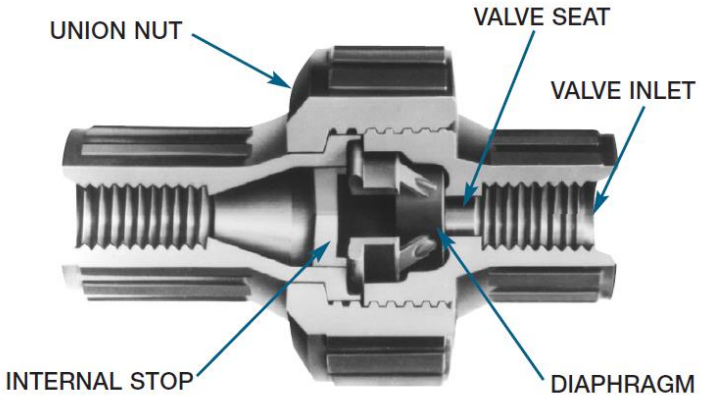
Gear



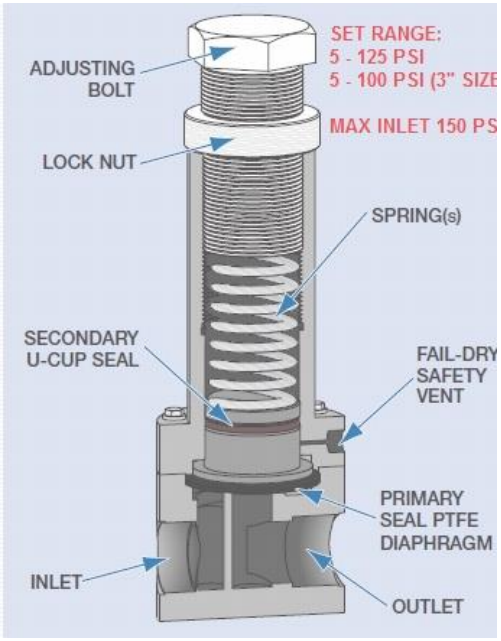
Valves

Degassing

Diaphragm Check



Pressure Control



More Valves

Vented Ball

Diaphragm

Chemical Feed Solenoid

Questions?

Color Palette