

Brown AND Caldwell

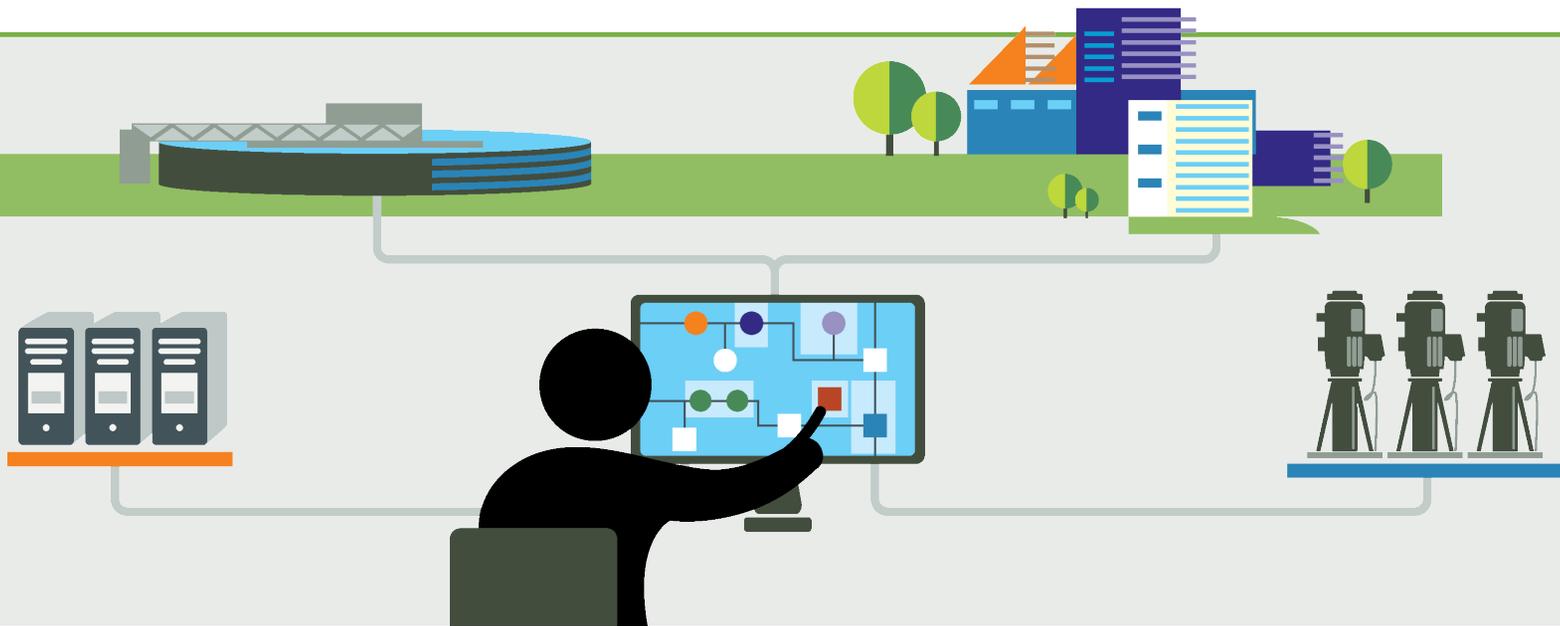


American Water Works Association
Pacific Northwest Section

PNWS AWWA

Effective SCADA Graphics - Enable Situational Awareness

Michael Karl, National Smart Utility Technology Lead mkarl@brwnncald.com

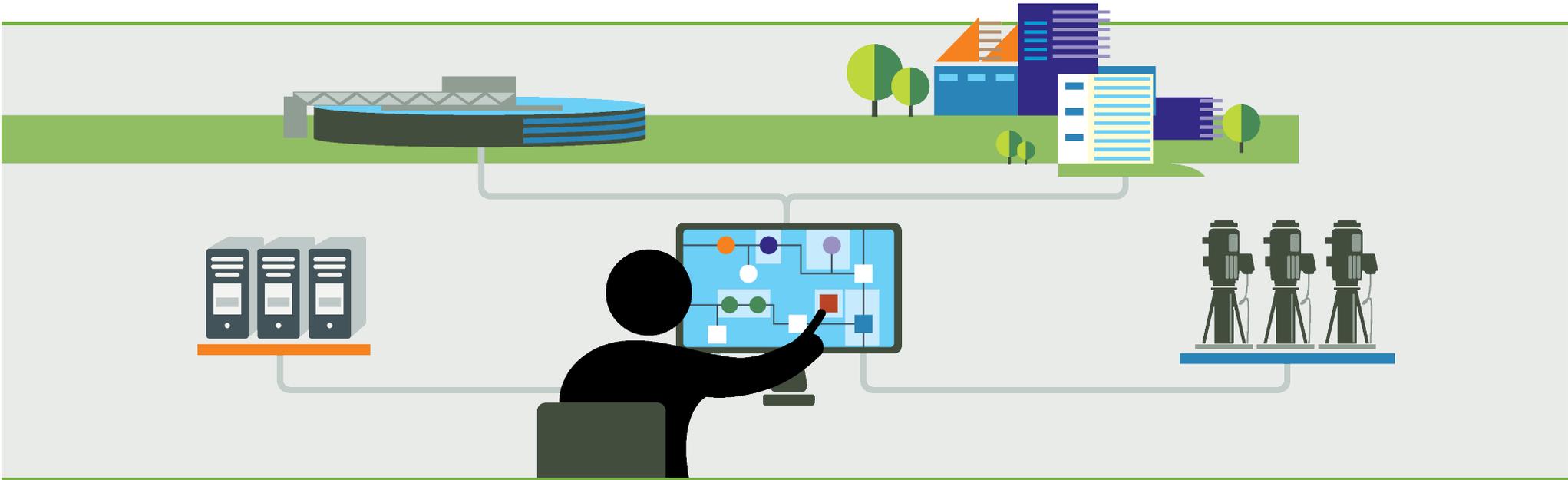


Today's Agenda >

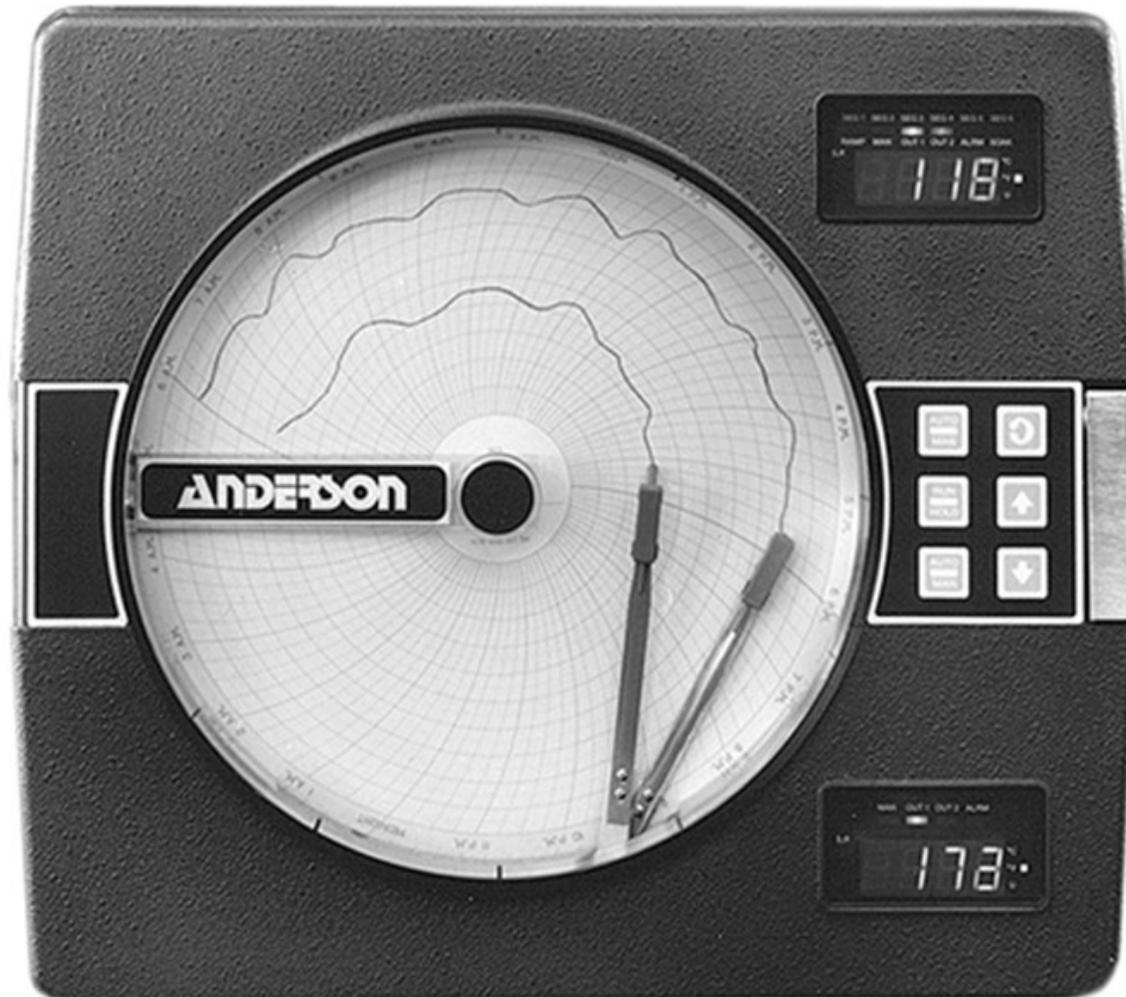


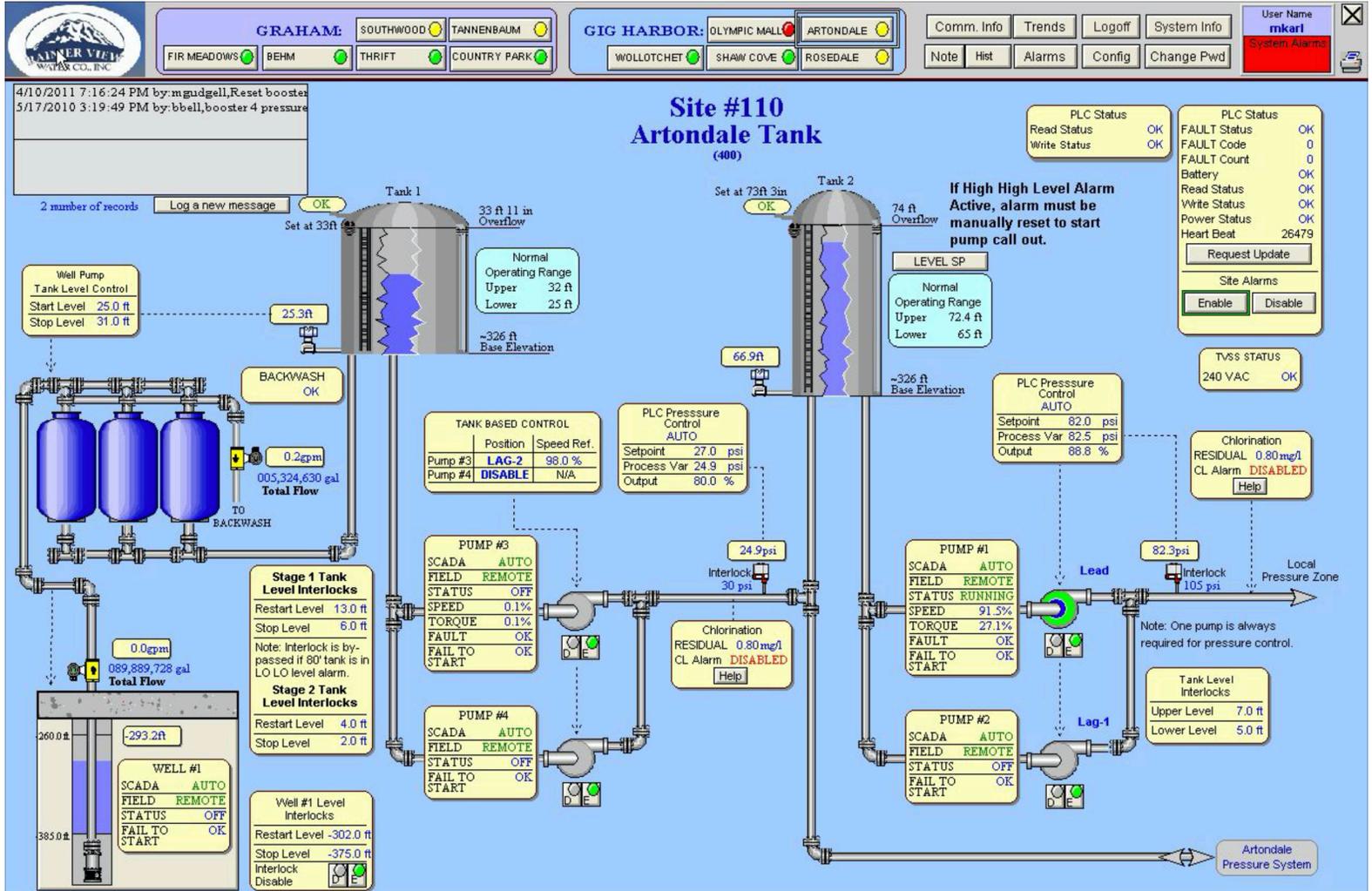
1. Historical Interface
2. Why do we need to change
3. Science of interface design
4. Best Practices
5. Discussion

Historical Interfaces

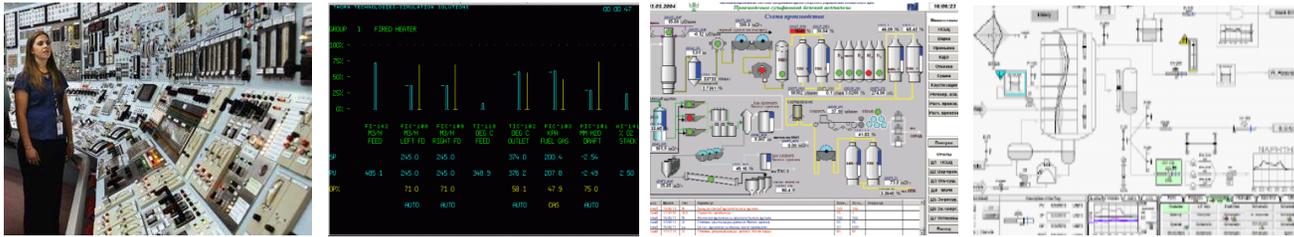


Brown
Calwell





Process Graphics Evolution



1970s

1980s

1990s

2000s



- ✓ Safe
- ✓ Reliable
- ✓ Efficient
- ✓ Effective

A quick Google for “HMI Screens...”



What is HMI? | Inductive Automation
inductiveautomation.com



What is HMI? | Inductive Automation
inductiveautomation.com



HMI Best Practices | Library ...
library.automationdirect.com



What are Human Machine Interface...
machinedesign.com



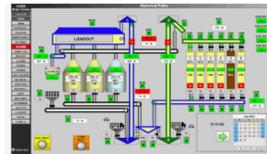
HMI Touch Screens | Phoen...
phoenixsalesinc.com



Human Machine Interface (HMI ...
automationdirect.com



Touch screens of the HMI software ...
researchgate.net



HMI - Human Machine Interface, MMI ...
kasacontrols.com



HMI Operator Panel - Human Machine ...
americas.fujielectric.com



HMI | Human Machine Interfaces
anaheimautomation.com



Ignition HMI Software
inductiveautomation.com



What
induc



The high performance HMI ...
isa.org



Power Plant HMI Design - the Creative ...
thecreativeadvantage.com



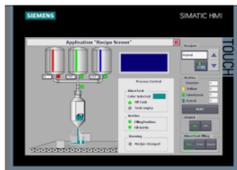
2711R-TTT | Allen Bradley Pan...
uk.rs-online.com



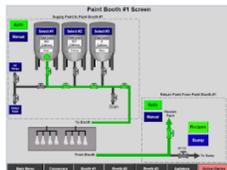
Power Plant HMI Design - the Creative ...
thecreativeadvantage.com



PLC Logics and HMI Screenshot...
amazon.com



Recipe Screen with WinCC (TIA ...
support.industry.siemens.com



HMI Development — RAMZ Controls
ramzcontrols.com



HMI Screens | GRIDLink User Manual
gridlinktechnology.info



HMI Display Editor
unitronicsplc.com

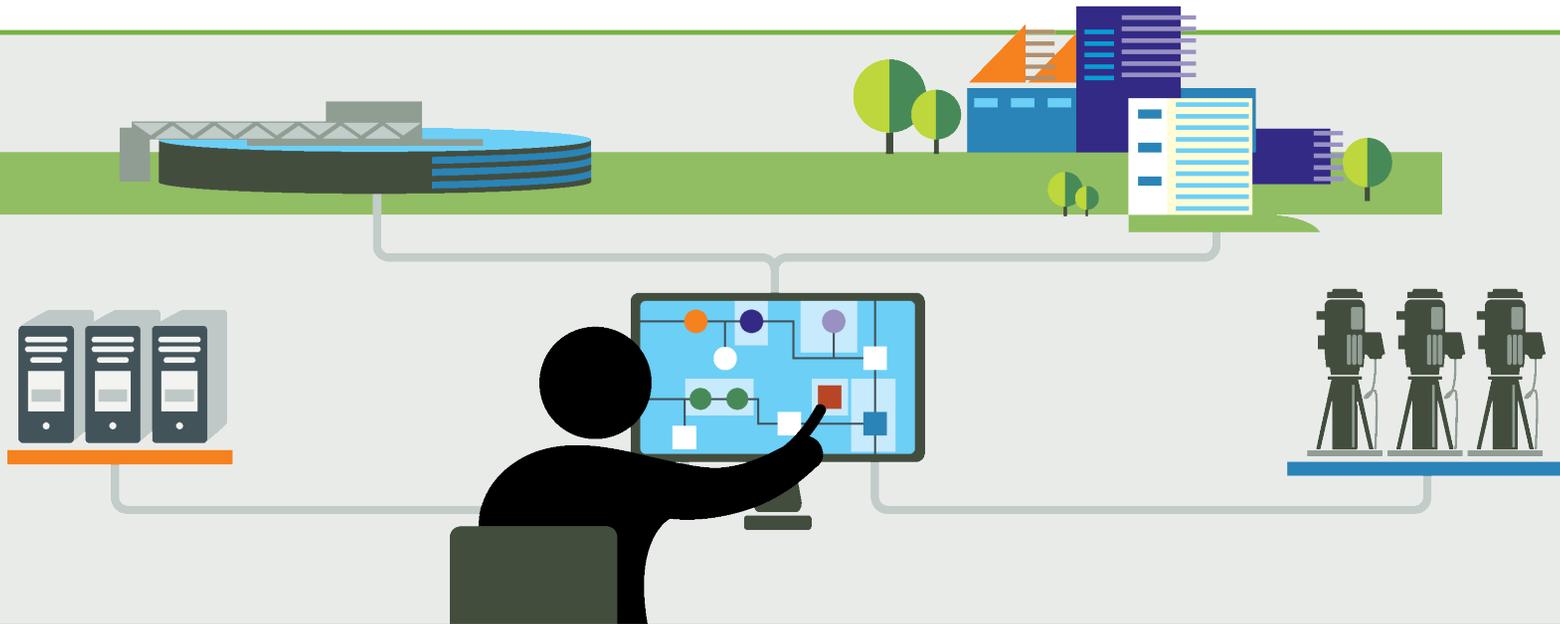


High Performance HMI Techniques
totallyintegratedautomation.com

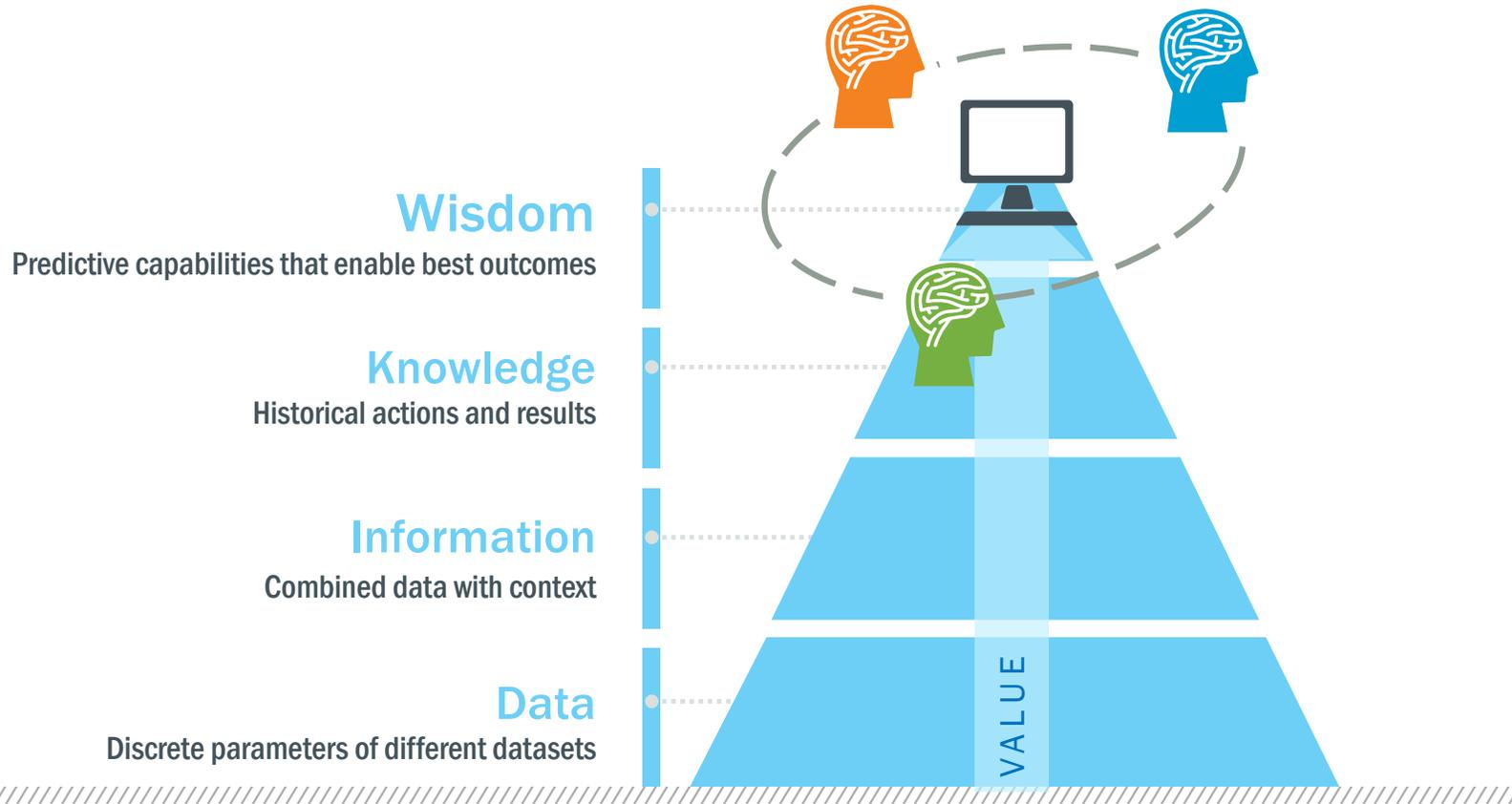
HMI practices are varied, and most are bad.

So what are good ones?

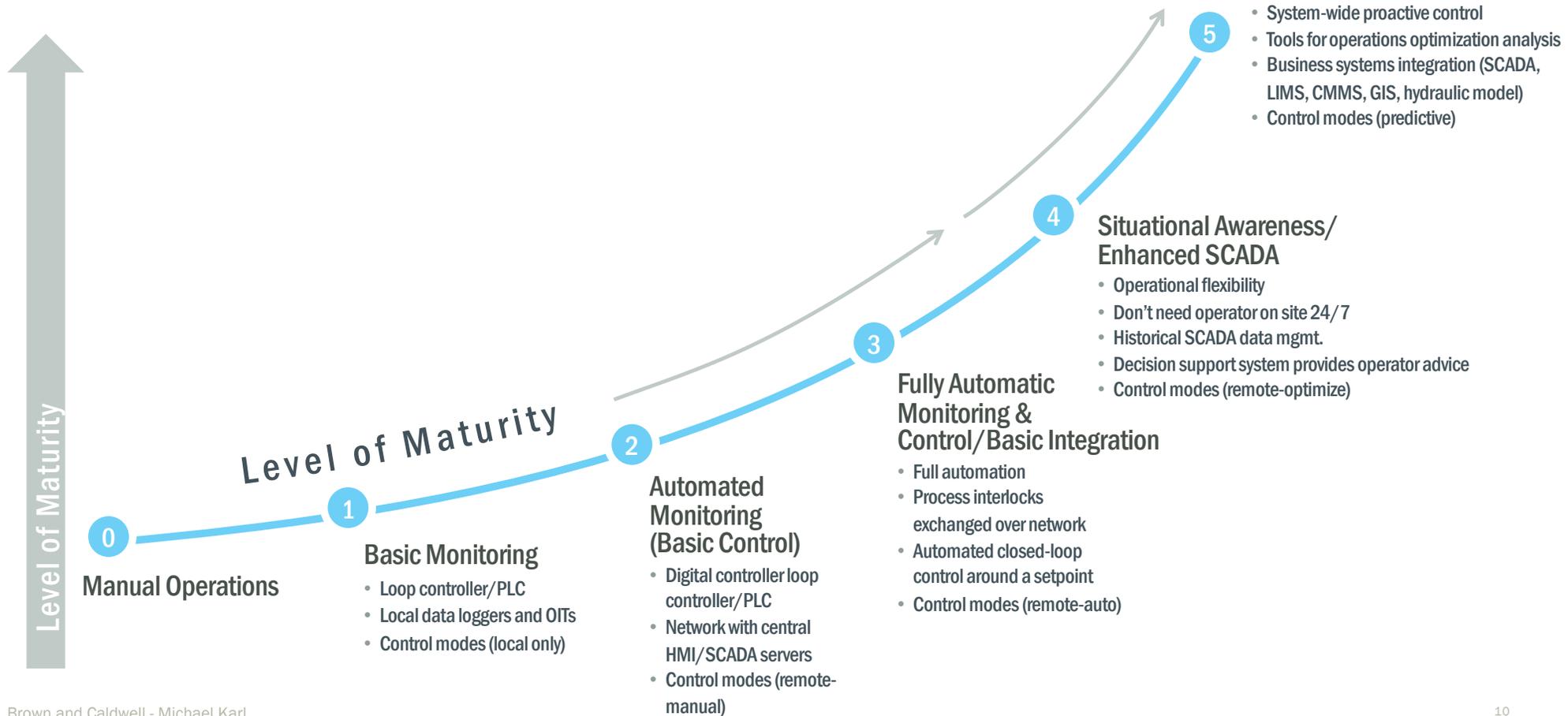
Why do we need a different methodology “Review some legacy graphics”



Fully leveraging technology to empower our workforce

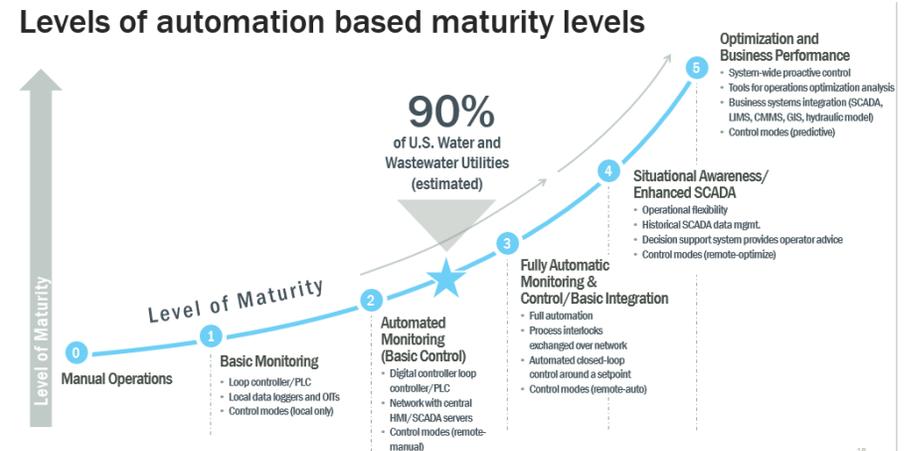


Progressing up the Smart Utility Maturity Curve

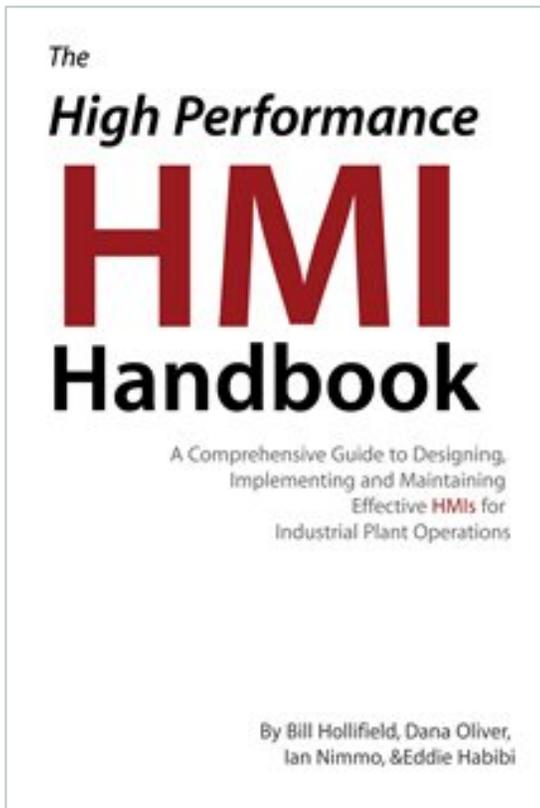


Moving up automation maturity curve

- As utilities move up automation maturity curve, important HMI elements are:
 - Use of HMI to convey prioritized, contextual information
 - Appropriate process alarm handling is top priority
 - HMI provides critical operational status
 - Use for process optimization and improved business performance



High Performance HMI Principles



Easy to identify
alarms and
abnormalities

Quick look KPI
trends

Actionable
information not
data

Control logic
awareness/
accessibility

Science of interface design

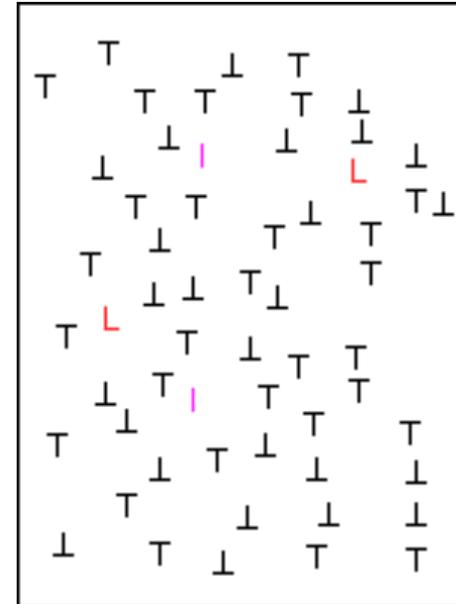


Color and Attention

Color is a powerful way to guide attention

- Your eye is automatically drawn to colored objects
 - This is called the “pop out” effect

- ~~Now try to find~~ **the this ‘L’s and ‘I’s**
in this picture...

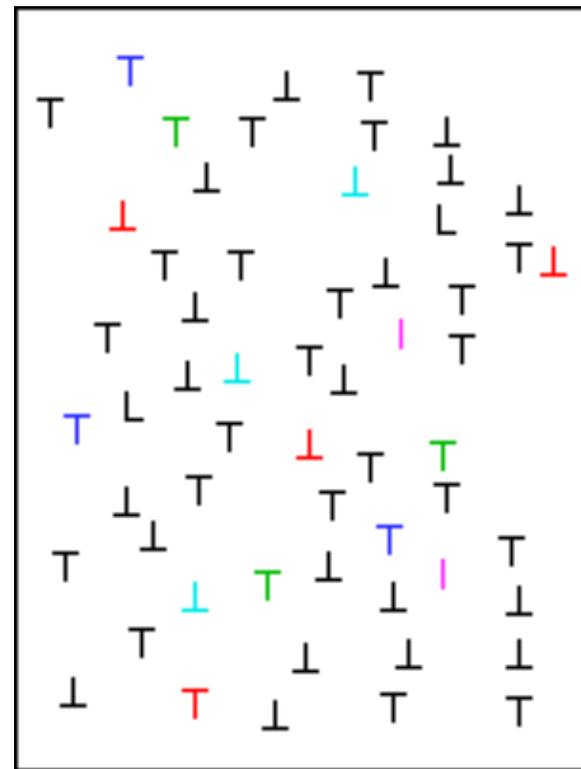


Source: NASA Ames Research Center Color Usage Lab
<http://colorusage.arc.nasa.gov/popout.php>

Color and Attention

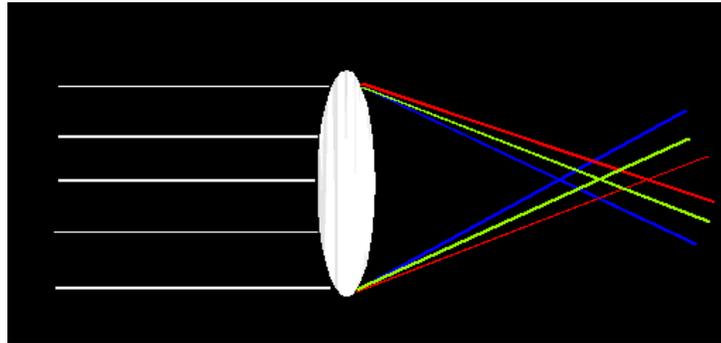
BUT – if you use too much color, the “pop out” effect doesn’t work anymore

Click and then try to find the “I”s in the picture...



Color and Eye-Strain

- Another reason for limiting the use of color is to reduce eye-strain
 - Different wavelengths of light are focused at different distances behind the lens of the eye
 - Your eye has to re-focus slightly when moving between different colors, esp. saturated (pure) blue/red
 - Constant re-focusing leads to fatigue, headaches



Color and Equipment States

Traditional graphics often use color to show equipment status

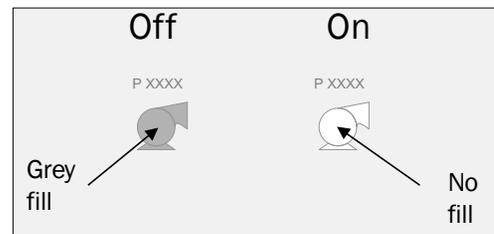


Which one is on and which one is off?

It depends! In some plants red means on, while other plants use red to mean stopped or off

Sometimes it even changes for different parts of the same plant

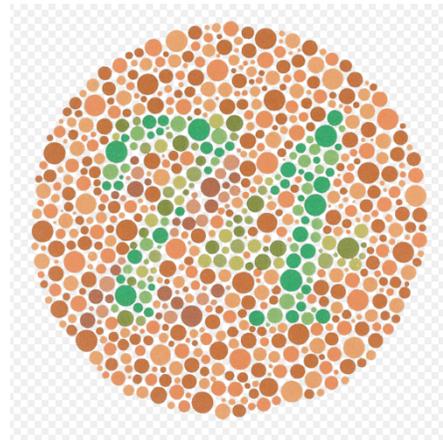
On and Off are always shown the same way



Color Deficiency

- Yet another reason to concern ourselves with color is color deficiency (aka “color blindness”)
 - ~8% of men and ~1% of women have some form of color deficiency
- Red-green deficiency is most common
 - What do you see?

People with normal color vision see '74' clearly; if you see '21' or don't see numbers at all, you may have some red-green color deficiency



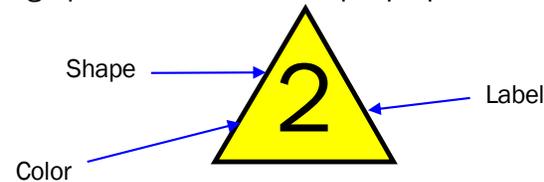
Using Alarm Shape Coding

- Have you ever noticed that important signs often have highly recognizable shapes?
- This is purposefully done to help people identify the signs

A “STOP” sign has 3 unique properties...



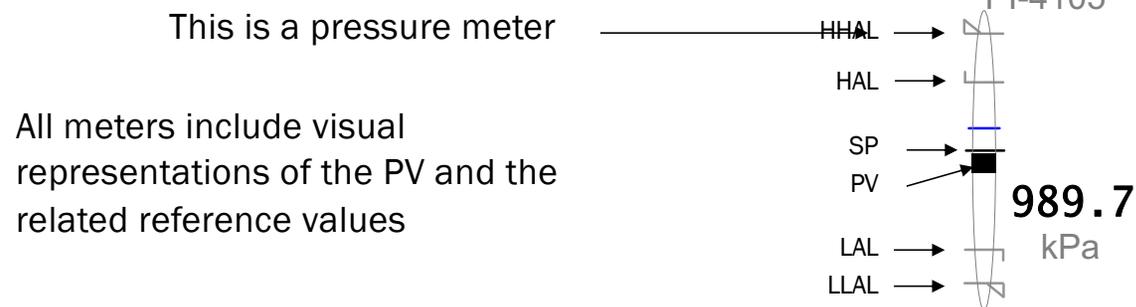
The alarm symbols on graphics also have 3 unique properties...



Analog Meters

How can we avoid forcing people to calculate these things in their heads?

- By using a visual representation – such as an analog meter...

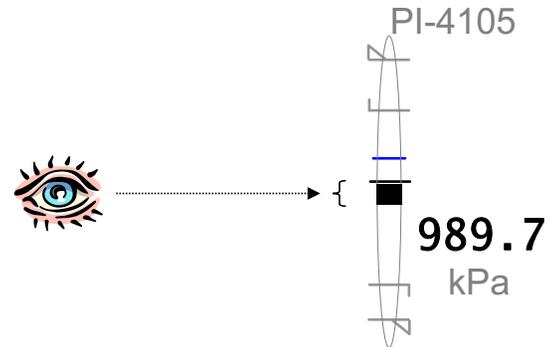


Analog Meters

Now the calculations disappear...

How far is the PV from setpoint?

By *looking* you can tell that it's relatively close to setpoint



Analog Meters

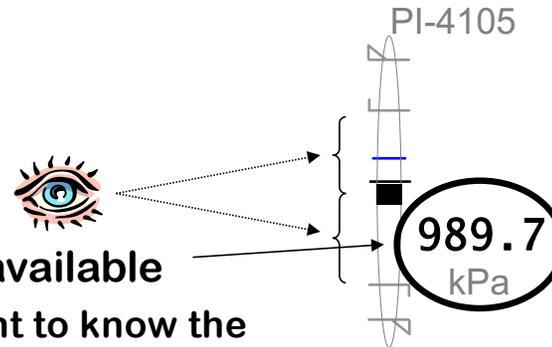
Now the calculations disappear...

Which alarm limit is the PV closest to?

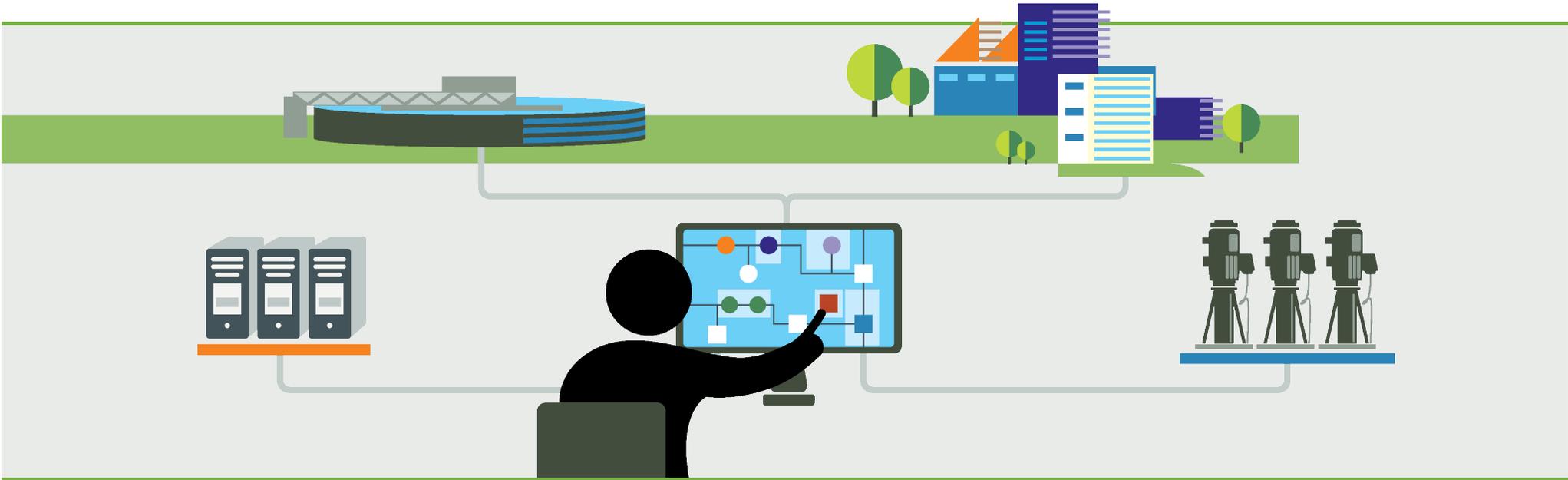
By *looking*, you can tell it's about halfway between the hi and lo alarm limits

Note that the numeric PV is still available

- Sometimes operators still want to know the precise value of a PV, so it is included with the meter

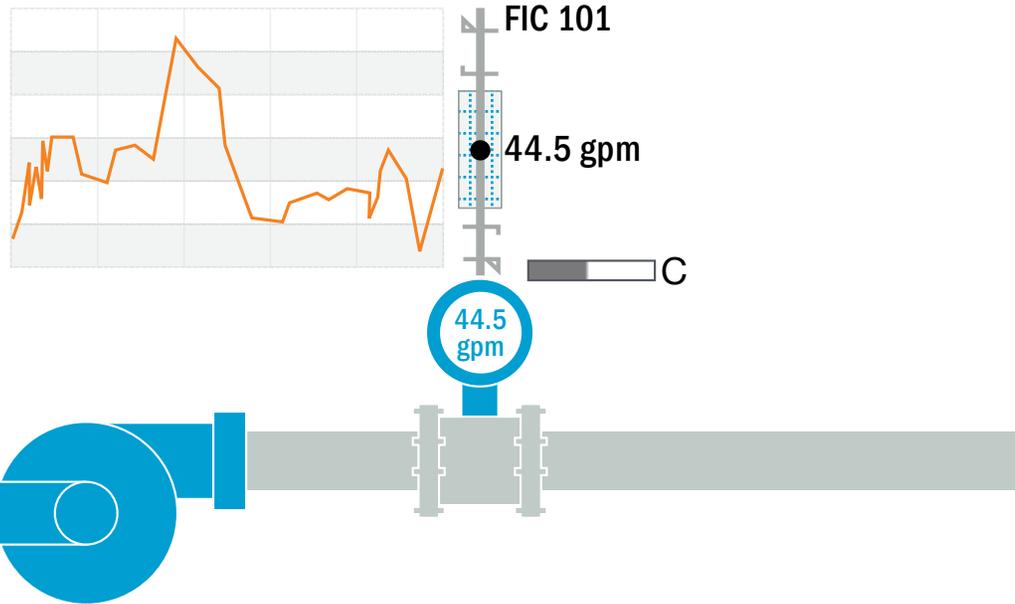


Smart Objects



Increasing operational excellence by providing insight to operators

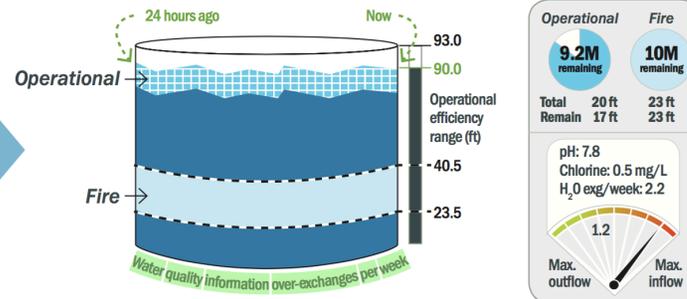
Leveraging wisdom from senior staff for intuitive knowledge transfer



Process graphics utility wide



Smart objects that can be interpreted easily.



Building standards around smart objects result in SCADA systems that provide greater transparency into the water system and enhance operator training

Process – Tank Detail

A - Information:

Text

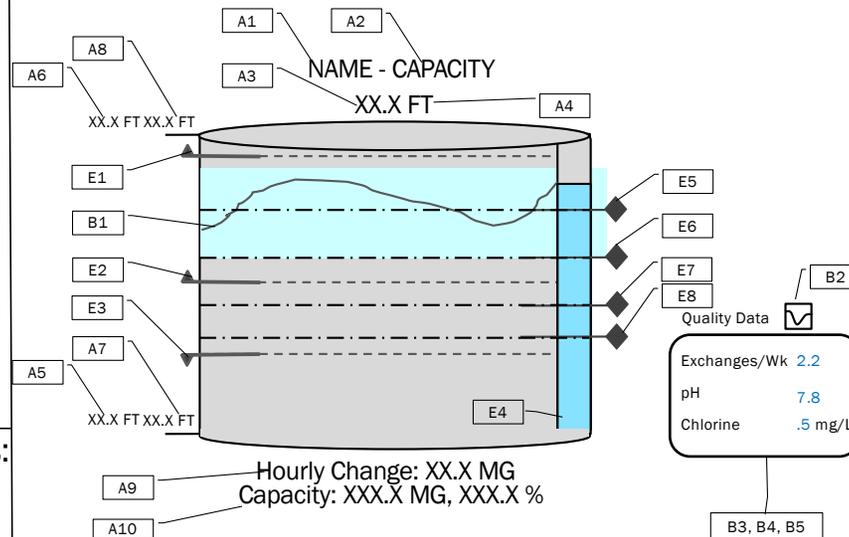
- A1 = NAME
- A2 = CAP (Tank Capacity)
- A3 = LVL (Tank Level)
- A4 = UNTS (Units)
- A5 = ELLO (Low Elevation)
- A6 = ELHI (High Elevation)
- A7 = TNKLO (Tank Feet Low)
- A8 = TNKHI (Tank Feet High)
- A9 = HRCHNG (Hourly Change)
- A10 = CAP (Current Tank Capacity)

B - Other Data Sources:

Trend Display

- B1 - LV (Level, Analog Value) for Tank
- B2 - Trend of Quality Data
- B3 - Exchanges/Week
- B4 - pH
- B5 - Chlorine Residual

Sketch:



C - Alarms:

Visibility, Color & Blinking per Alarm Acknowledgement

State

- C1 = See Status Symbol/Alarm Symbol for more details
- C2 = See Alarm Border Symbol

D - Pop-Ups:

Comments

D1 - Tank status indications duplicated on popup and additional items below are included.

Numeric Entry

- D2 = LGST (Lag Start)
- D3 = LDST (Lead Start)
- D4 = LGSP (Lag Stop)
- D5 = LDSP (Lead Stop)

Link

D6 = Popup select mouse over range, highlight outline only visible when mouse is over

E - Animation:

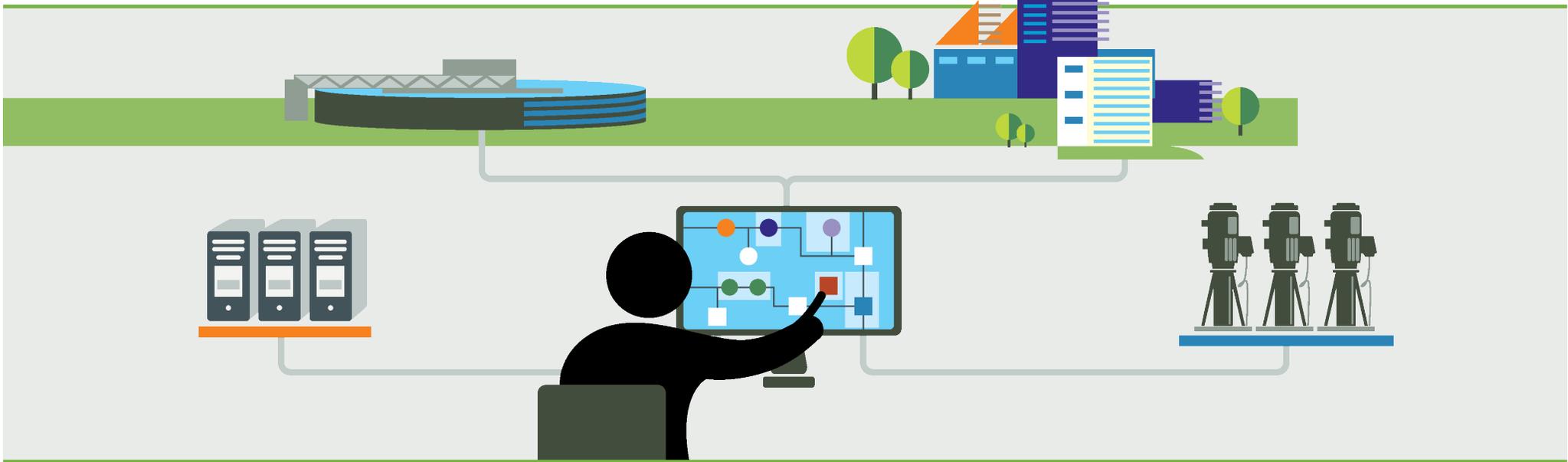
Position

- E1 = HSP (High Alarm Setpoint)
- E2 = LSP (Low Alarm Setpoint)
- E3 = LLSP (Low Low Alarm Setpoint)
- E5 = LDSP (Lead Stop)
- E6 = LGSP (Lag Stop)
- E7 = LDST (Lead Start)
- E8 = LGST (Lag Start)

Bar Graph

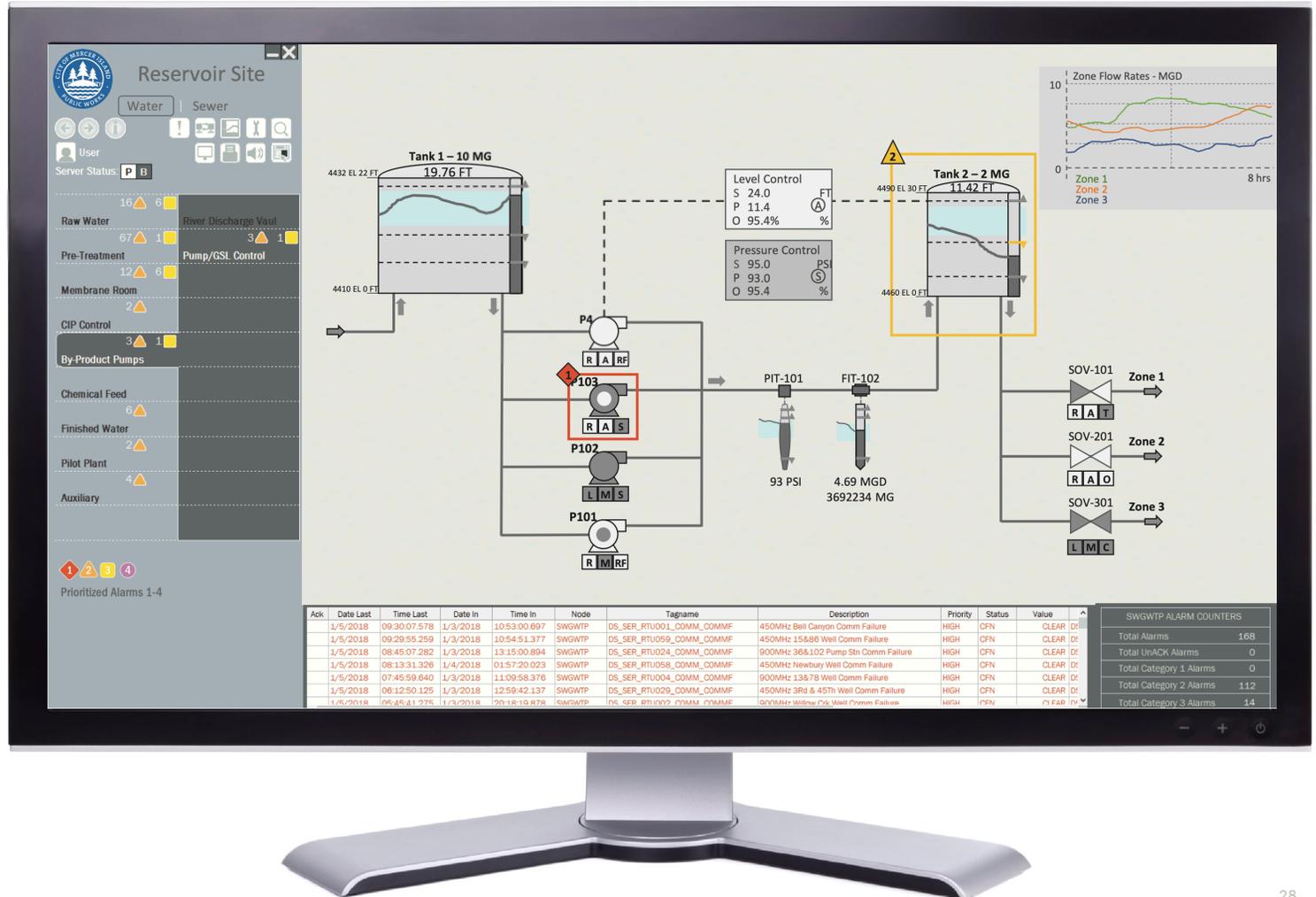
E4 = LVL (Tank Level)

Best Practices



Blue SCADA

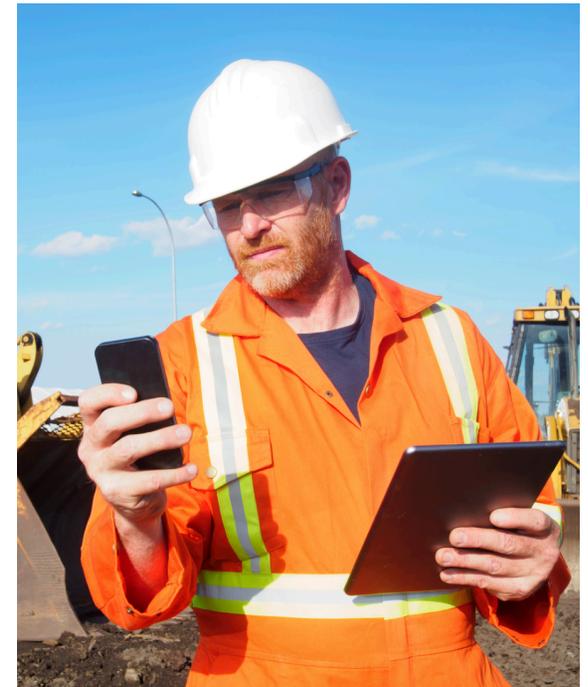
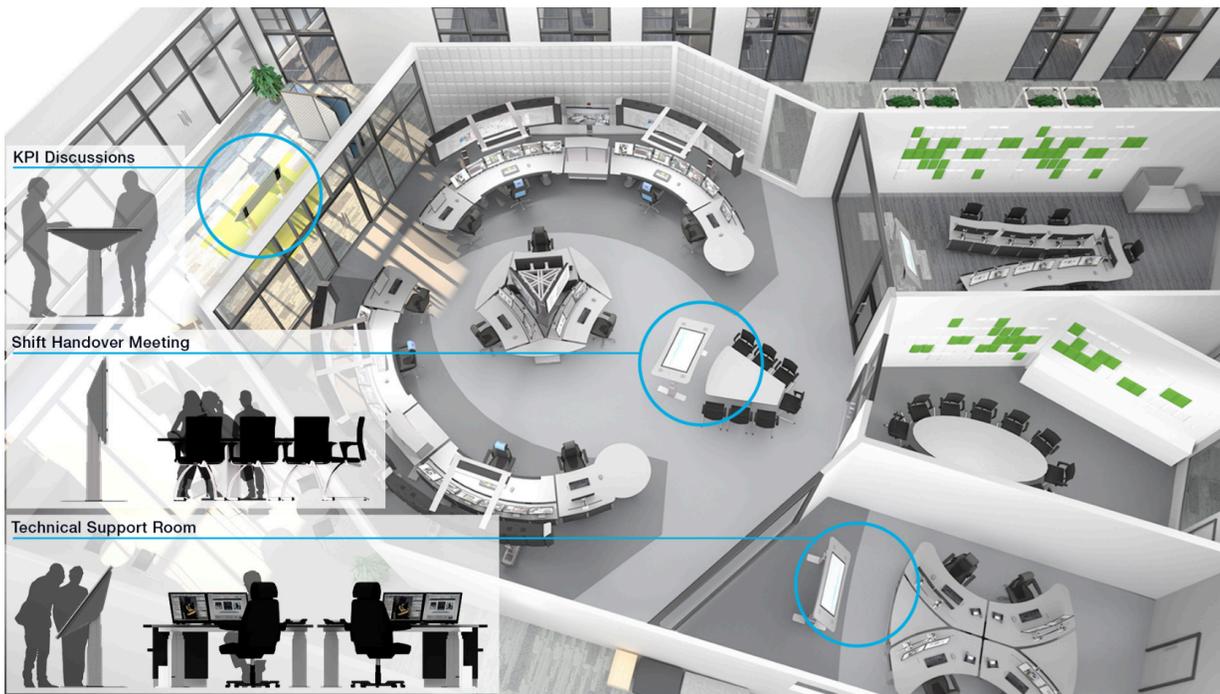
Is designed specifically for the water/wastewater industry to transform data to wisdom and enable Smart Utility.



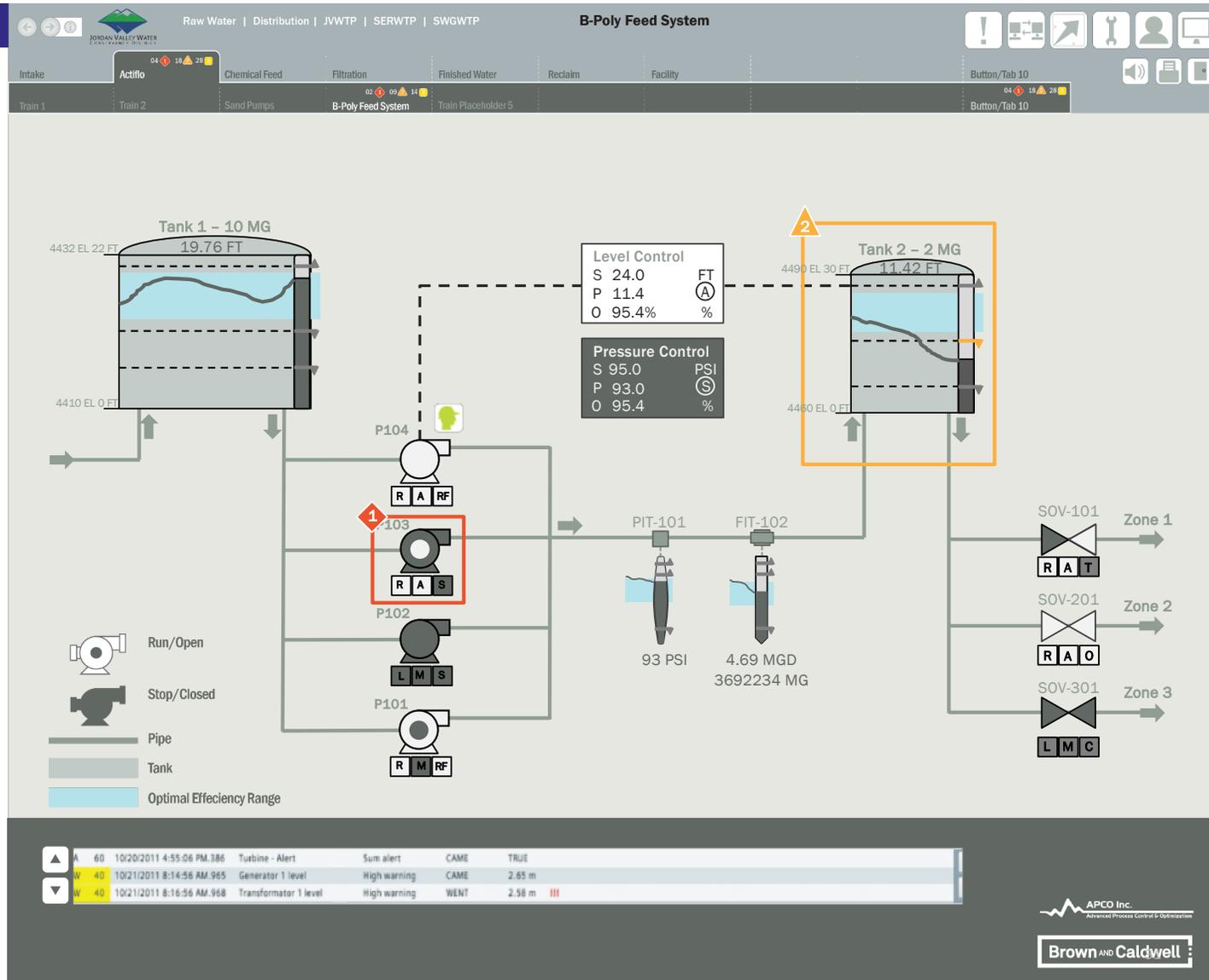
Developed for Operators



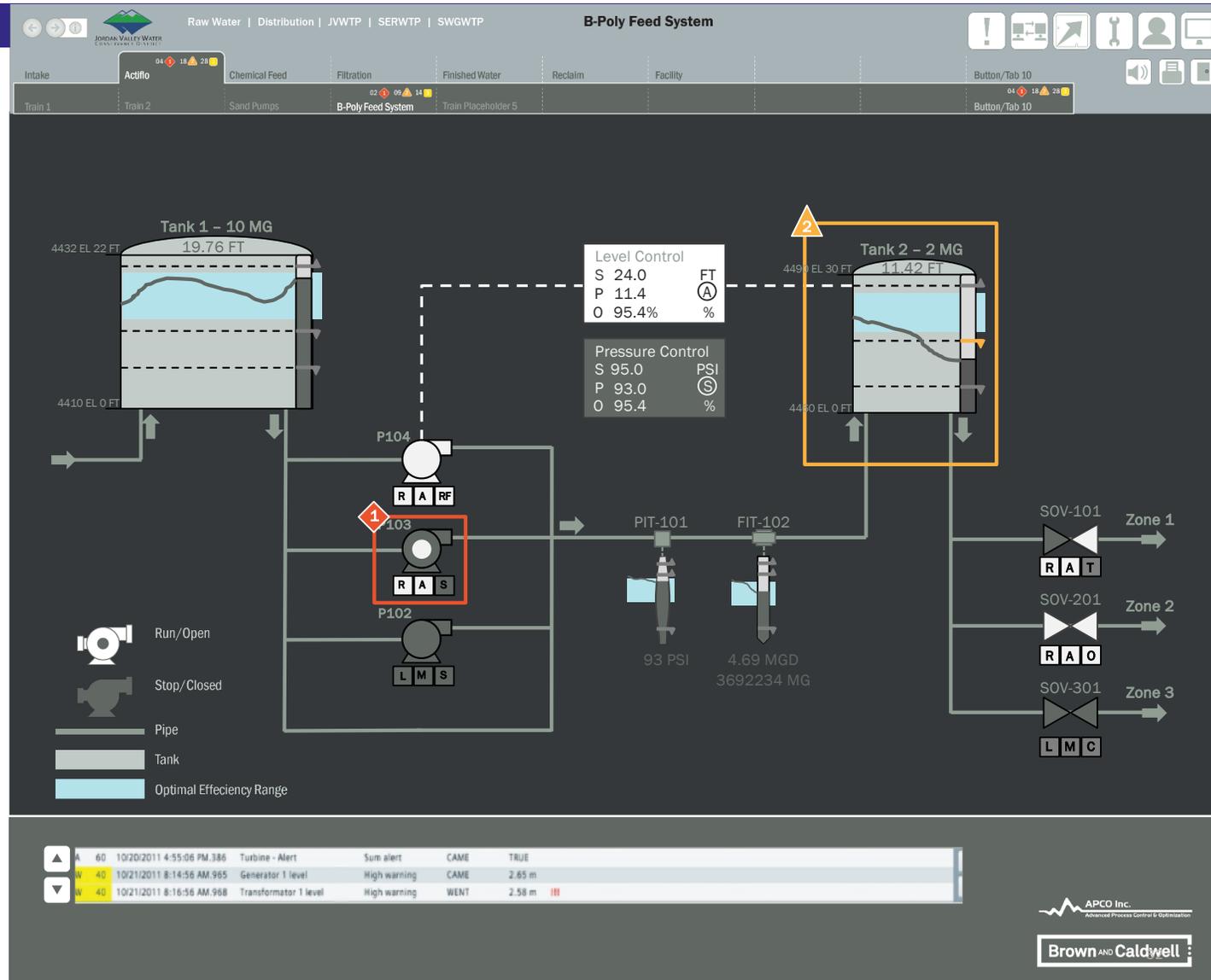
Flexible application for Mobile and Command Central



iPad/4x3
 Light background
 traditional screen



iPad/4x3
 Dark
 background
 traditional screen



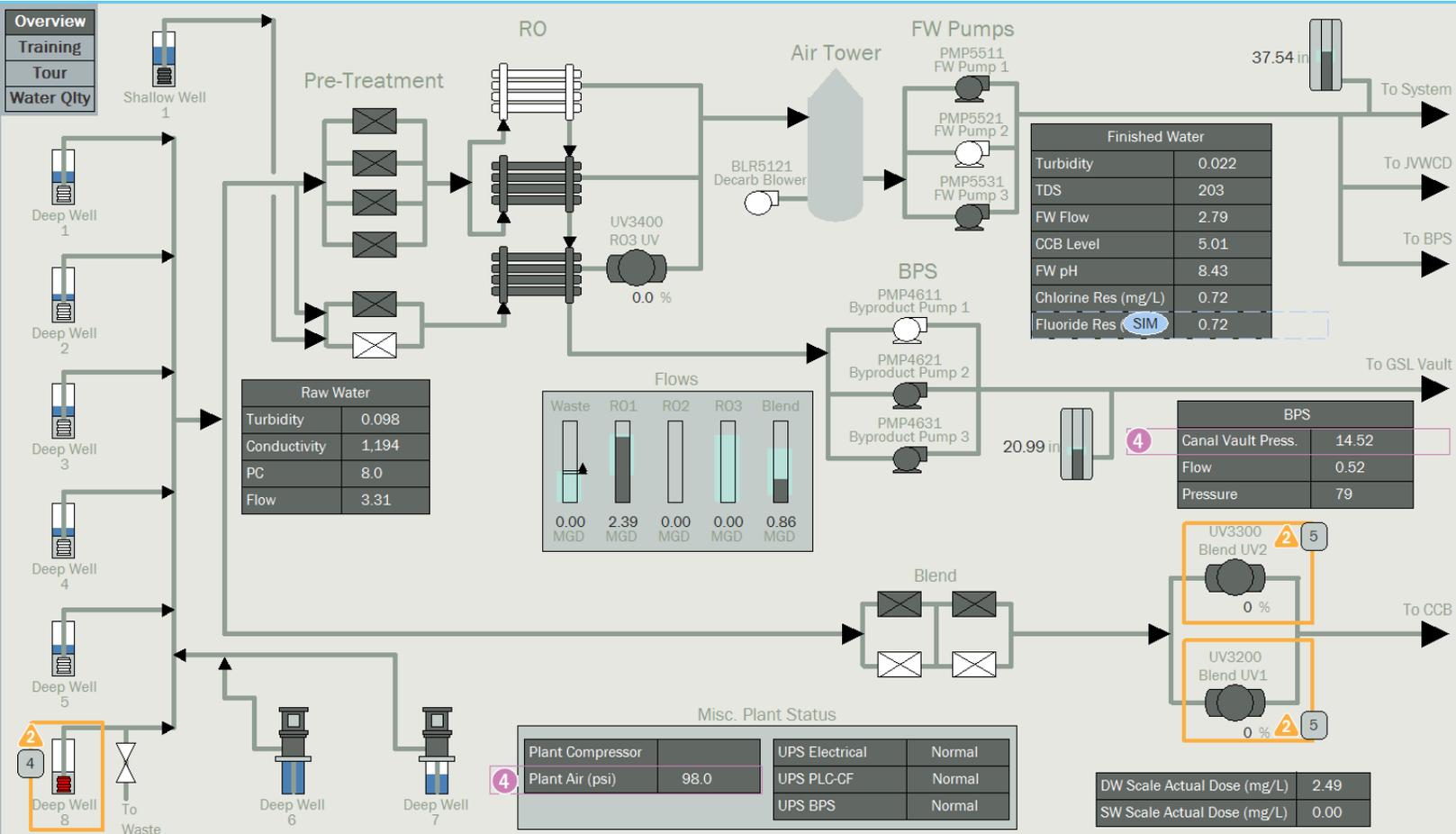
JORDAN VALLEY WATER CONSERVANCY DISTRICT

SWGTP Overview

Distribution | JWTP | SERWTP | **SWGTP**

User: ADMIN
Server Status: **P B**

- Raw Water: 20 ▲ 2 ■
- Pre-Treatment: 66 ▲ 3 ■
- Membrane Room: 6 ▲ 5 ■
- CIP Control: 1 ▲
- By-Product Pumps: 2 ▲
- Chemical Feed: 1 ▲ 1 ■
- Finished Water: 1 ▲ 18 ▲
- Auxiliary: 1 ▲ 18 ▲

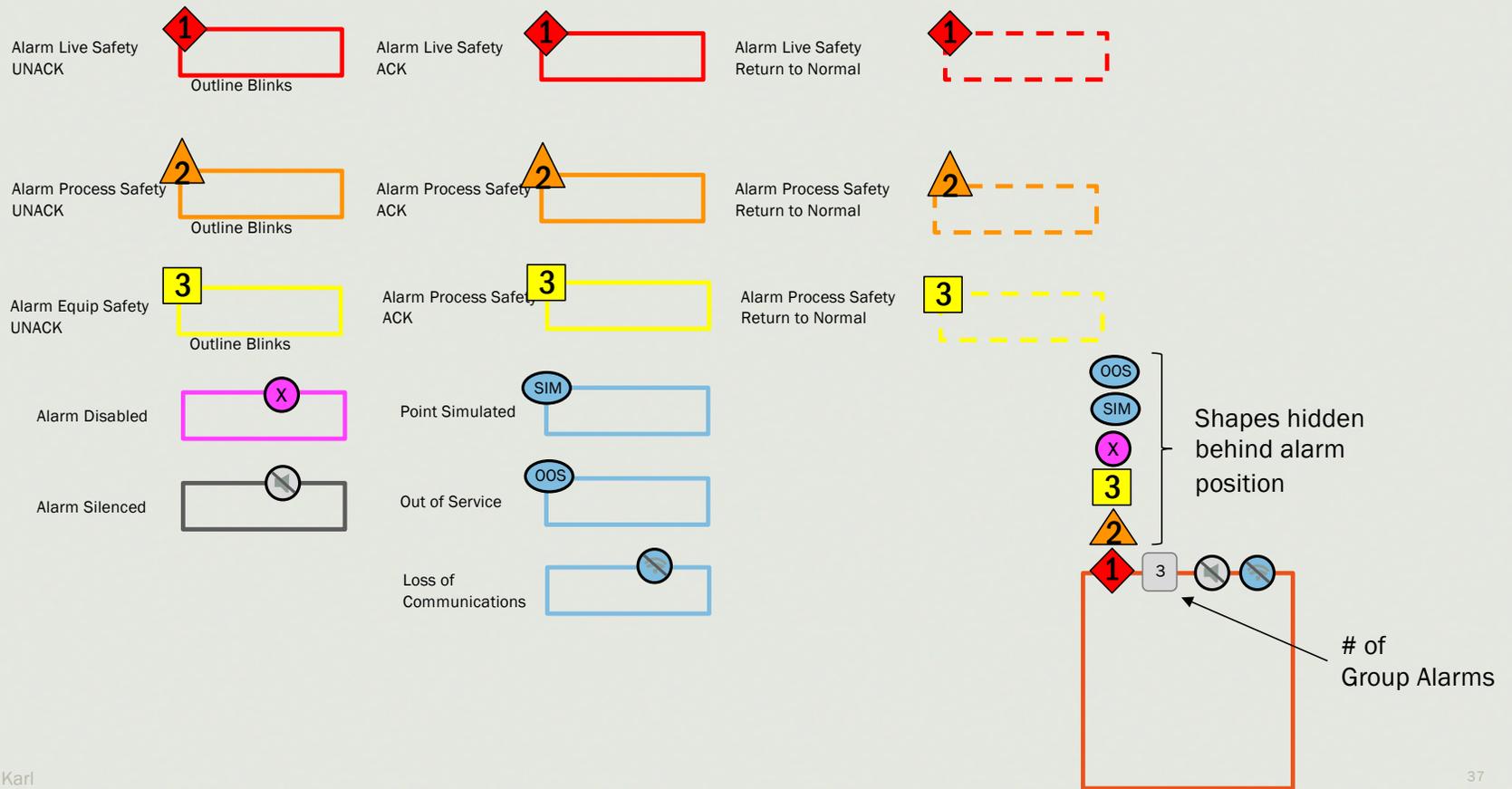


Ack	Date Last	Time Last	Date In	Time In	Node	Tagname	Description	Priority	Status	Value
✓	10/4/2017	17:02:22.218	10/4/2017	17:02:22.218	SWGTP	SW_RO_UV_UV3413_INT_PV	Train 3 UV Lamp 3 Intensity	MEDIUM	LO	0.0
✓	10/4/2017	17:02:22.218	10/4/2017	17:02:22.218	SWGTP	SW_RO_UV_UV3412_INT_PV	Train 3 UV Lamp 2 Intensity	MEDIUM	LO	0.0
✓	10/4/2017	17:02:22.218	10/4/2017	17:02:22.218	SWGTP	SW_RO_UV_UV3411_INT_PV	Train 3 UV Lamp 1 Intensity	MEDIUM	LO	0.0
✓	10/4/2017	17:02:22.218	10/4/2017	17:02:22.218	SWGTP	SW_PRE_UV_UV3313_INT_PV	Blend UV2 S3 Intensity	MEDIUM	NO DATA	
✓	10/4/2017	17:02:22.218	10/4/2017	17:02:22.218	SWGTP	SW_PRE_UV_UV3312_INT_PV	Blend UV2 S2 Intensity	MEDIUM	NO DATA	
✓	10/4/2017	17:02:22.207	10/4/2017	17:02:22.207	SWGTP	SW_RO_RO2_AIT3252_COND_PV	Train 2 Stage 2 Permeate Conductivity	MEDIUM	OFF	
✓	10/4/2017	17:02:22.178	10/4/2017	17:02:22.178	SWGTP	SW_RO_RO2_AIT3262_COND_PV	Train 2 Stage 1 Permeate Conductivity	MEDIUM	OFF	

Total Alarms: 22 | Filter: Node in "SWGTP" | Sort: Ack/Time Last, Descending | Run

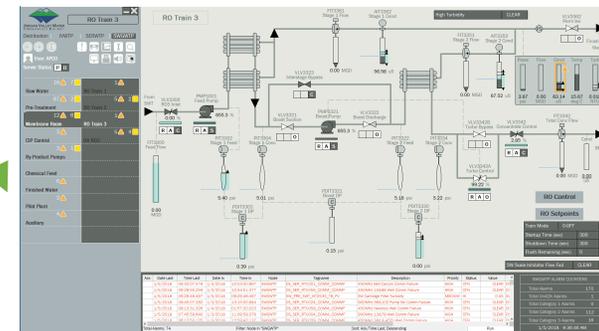
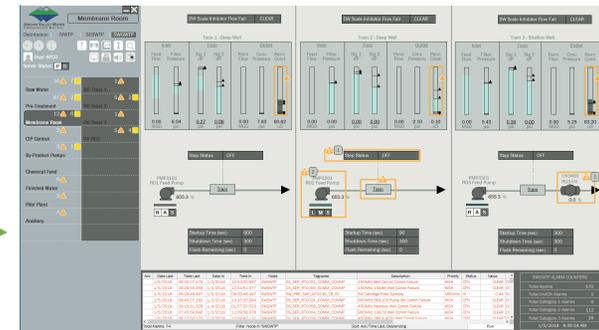
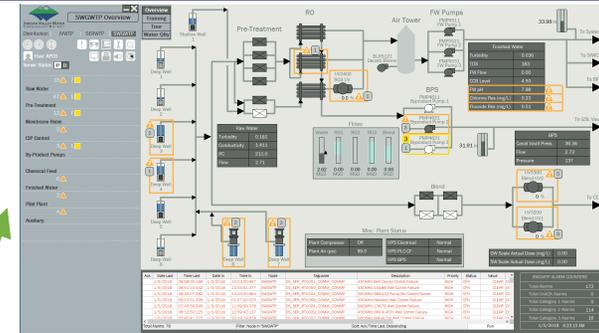
SWGTP ALARM COUNTERS	
Total Alarms	188
Total UnACK Alarms	22
Total Category 1 Alarms	2
Total Category 2 Alarms	116
Total Category 3 Alarms	11
10/10/2017 8:46:01 AM	

Status/alarm symbol with alarm border examples

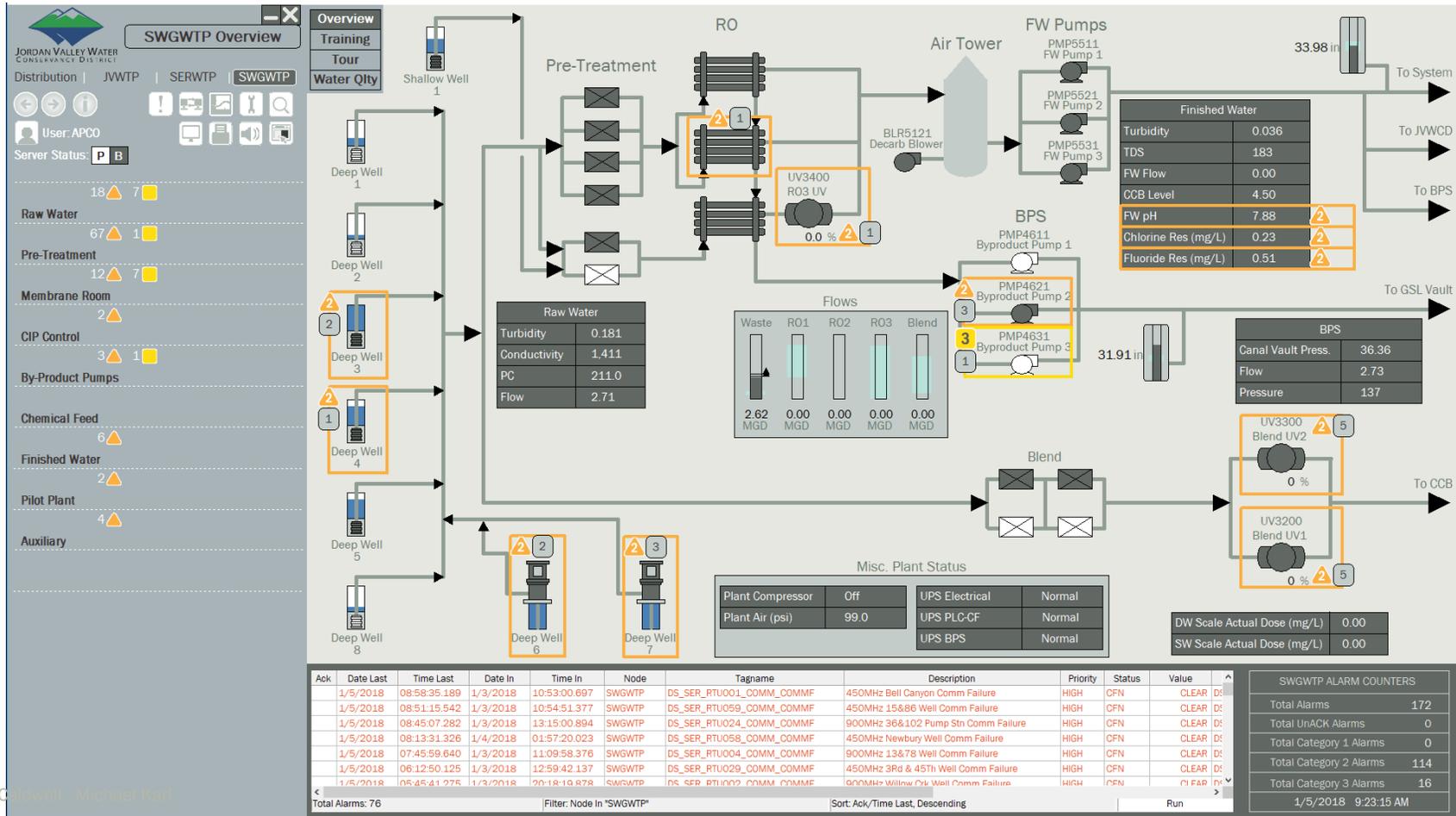


Navigation Levels

Type	Description	Example
Overview	District-wide or division overview	SWGWTP
Level 1	Process area or pressure zone overview	Membrane Room
Level 2	Process train or site screen	RO Train 3
Level 3	Process or site unit detail and/or support	



Navigation: Perspectives “Overview”



Navigation: Perspectives “Tour”

JORDAN VALLEY WATER CONSERVANCY DISTRICT

SWGWTP Overview

Distribution | JWVTP | SERWTP | **SWGWTP**

User: ADMIN

Server Status: **P B**

Raw Water: 20 ▲ 5 ■

Pre-Treatment: 1 ◆ 69 ▲ 2 ■

Membrane Room: 15 ▲ 7 ■

CIP Control: 2 ▲

By-Product Pumps: 1 ▲

Chemical Feed: 4 ▲ 2 ■

Finished Water: 2 ▲

Pilot Plant: 6 ▲

Auxiliary:

Overview
Training
Tour
Water Qty

Toggle

SWGWTP ALARM COUNTERS

Total Alarms	178
Total UnACK Alarms	12
Total Category 1 Alarms	1
Total Category 2 Alarms	119
Total Category 3 Alarms	16
12/21/2017 1:13:06 PM	

Ack	Date Last	Time Last	Date In	Time In	Node	Tagname	Description	Priority	Status	Value	
	12/21/2017	13:05:24.272	12/21/2017	13:05:24.272	SWGWTP	DS_SER_RTU004_COMM_COMMF	900MHz 13&78 Well Comm Failure	HIGH	CFN	CLEAR	DS
	12/21/2017	13:04:47.716	12/21/2017	10:37:47.950	SWGWTP	SW_PRE_DWT_AIT2526_PC_FV	DW Filter Effluent Particle Counts	HIGH	HIHI	137	SV
	12/21/2017	13:03:45.759	12/21/2017	13:03:45.759	SWGWTP	SW_ETH_RTU112_COMM_ERR	INFPC Comm Seconds In Error	HIGH	HIHI	0	SV
	12/21/2017	12:59:42.835	12/21/2017	12:46:21.666	SWGWTP	DS_SER_RTU001_COMM_COMMF	450MHz Bell Canyon Comm Failure	HIGH	CFN	CLEAR	DS
	12/21/2017	12:59:08.614	12/5/2017	13:20:02.527	SWGWTP	SW_RAW_DW4_AIT1641_TB_FV	DW4 Turbidity	HIGH	HIHI	0.99	SV
	12/21/2017	12:58:27.483	12/21/2017	12:50:16.386	SWGWTP	DS_SER_RTU059_COMM_COMMF	450MHz 15&86 Well Comm Failure	HIGH	CFN	CLEAR	DS
	12/21/2017	12:57:57.726	12/21/2017	11:21:03.605	SWGWTP	SW_ETH_RTU117_COMM_ERR	DW7 PC Comm Seconds In Error	HIGH	HIHI	2.106	SV

Total Alarms: 71 Filter: Node in *SWGWTP* Sort: Ack/Time Last, Descending Run

Navigation: Perspectives “Training”

SWGTP Overview

JORDAN VALLEY WATER
CONSERVANCY DISTRICT

Distribution | JWTP | SERWTP | SWGTP

User: APCO
Active Node: Primary

- Raw Water: 18 ▲ 1 ■
- Pre-Treatment: 5 ■
- Membrane Room: 16 ▲ 6 ■
- *T* CIP Control: 7 ▲
- *T* By-Product Pump: 1 ◆ 11 ▲ 1 ■
- *T* Chemical Feed: 5 ▲
- *T* Finished Water: 4 ▲
- *T* Pilot Plant: 4 ▲ 10 ■
- *T* Auxiliary: 4 ▲

SW Training

```

graph LR
    Wells --> Pre-Treatment
    Pre-Treatment --> RO_Membranes[RO Membranes]
    RO_Membranes --> Tower_CCB[Tower CCB Final Treatment]
    Tower_CCB --> Distribution
    RO_Membranes --> Byproduct_Pump[Byproduct Pump Station]
    Byproduct_Pump --> GSL_Vault[GSL Vault]
    GSL_Vault --> To_GSL[To GSL]
    
```

Overview Selection

Overview Training Tour Water Qlty

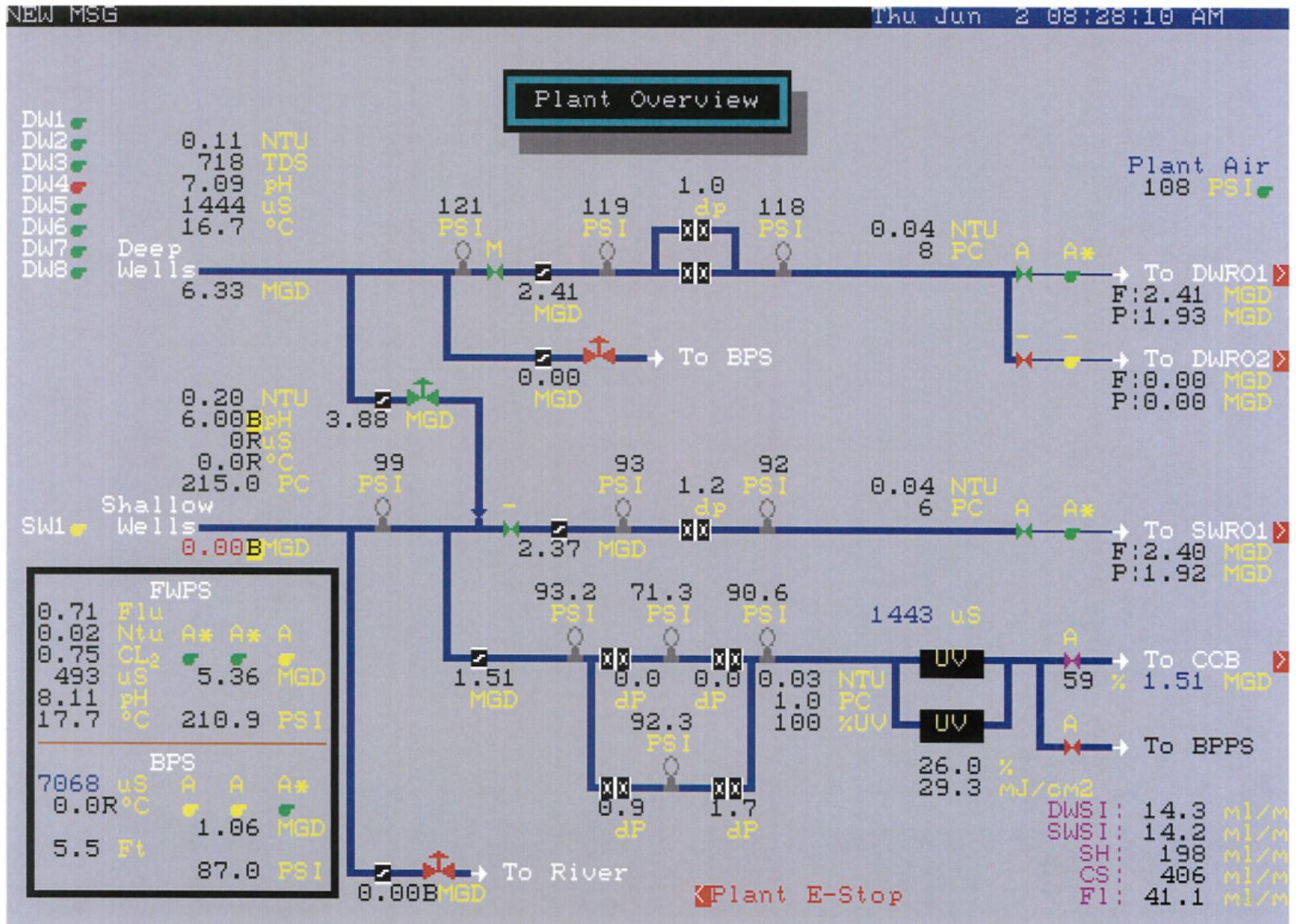
ALARM BANNER

Ack	Date In	Time In	Time Last	Node	Tagname	Description	Priority	Status	Value	Area
	7/12/2017	08:48:27.82	08:48:27.82	SWGTP	SW_CF_CSF_UT6521_LEV_PV	Caustic Soda Tank 2 Level	HIGH	LLOL	0.00	SW,SW_CF,SW_C
	7/12/2017	08:48:15.32	08:48:15.32	SWGTP	SW_RAW_DW6_FIT1661_F_PV	DW6 Well Flow	HIGH	LLOL	0.00	SW,SW_RAW,SW
	7/12/2017	08:48:15.32	08:48:15.32	SWGTP	SW_RAW_DW1_FIT1611_F_PV	DW1 Well Flow	HIGH	LLOL	0.00	SW,SW_RAW,SW
	7/12/2017	08:48:15.32	08:48:15.32	SWGTP	SW_FW_AT_AIT5312A_PH_PV	Finished Water Chlorine Contact Basin pH	HIGH	LLOL	6.00	SW,SW_FW,SW_F
	7/12/2017	08:48:15.32	08:48:15.32	SWGTP	SW_FW_AT_AIT5312A_PH_AO	Finished Water CCB pH Analog Output	HIGH	LLOL	6.00	SW,SW_FW,SW_F

Total Alarms: 90 Filter: Off Sort: Time In, Descending Run

7/12/2017 8:48:48 AM	
ALARM COUNTERS	
Total Alarms	90
Total UniACK Alarms	90
Total Category 1 Alarms	1
Total Category 2 Alarms	66
Total Category 3 Alarms	23

Plant Overview Screen - BEFORE



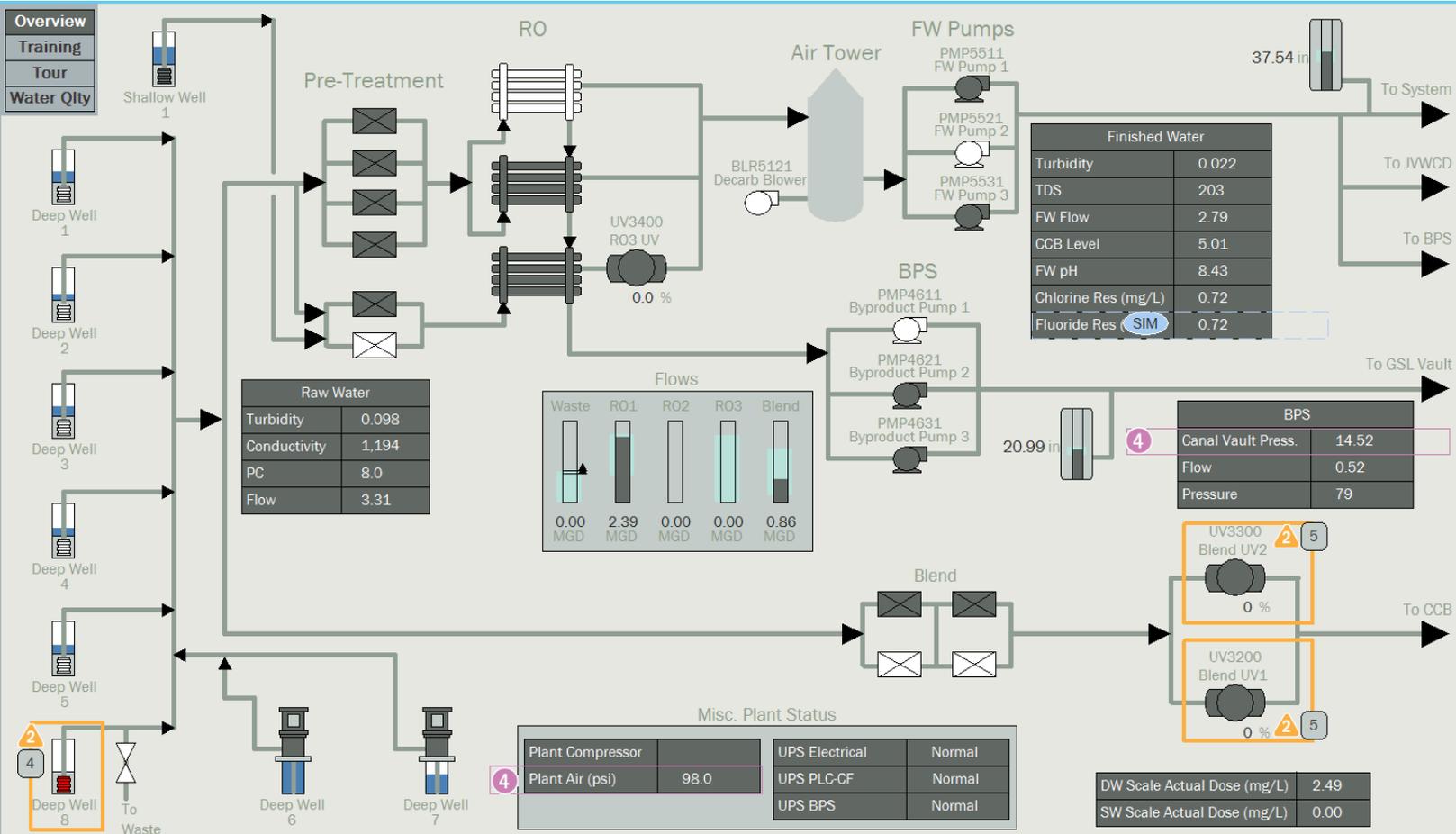
JORDAN VALLEY WATER CONSERVANCY DISTRICT

SWGTP Overview

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- Chemical Feed: 1 ▲ 1 ■
- Finished Water: 1 ▲ 18 ▲
- Auxiliary: 1 ▲ 18 ▲



Ack	Date Last	Time Last	Date In	Time In	Node	Tagname	Description	Priority	Status	Value
✓	10/4/2017	17:02:22.218	10/4/2017	17:02:22.218	SWGTP	SW_RO_UV_UV3413_INT_PV	Train 3 UV Lamp 3 Intensity	MEDIUM	LO	0.0
✓	10/4/2017	17:02:22.218	10/4/2017	17:02:22.218	SWGTP	SW_RO_UV_UV3412_INT_PV	Train 3 UV Lamp 2 Intensity	MEDIUM	LO	0.0
✓	10/4/2017	17:02:22.218	10/4/2017	17:02:22.218	SWGTP	SW_RO_UV_UV3411_INT_PV	Train 3 UV Lamp 1 Intensity	MEDIUM	LO	0.0
✓	10/4/2017	17:02:22.218	10/4/2017	17:02:22.218	SWGTP	SW_PRE_UV_UV3313_INT_PV	Blend UV2 S3 Intensity	MEDIUM	NO DATA	
✓	10/4/2017	17:02:22.218	10/4/2017	17:02:22.218	SWGTP	SW_PRE_UV_UV3312_INT_PV	Blend UV2 S2 Intensity	MEDIUM	NO DATA	
✓	10/4/2017	17:02:22.207	10/4/2017	17:02:22.207	SWGTP	SW_RO_RO2_AIT3252_COND_PV	Train 2 Stage 2 Permeate Conductivity	MEDIUM	OFF	
✓	10/4/2017	17:02:22.178	10/4/2017	17:02:22.178	SWGTP	SW_RO_RO2_AIT3262_COND_PV	Train 2 Stage 1 Permeate Conductivity	MEDIUM	OFF	

Total Alarms: 22 | Filter: Node in "SWGTP" | Sort: Ack/Time Last, Descending | Run

SWGTP ALARM COUNTERS	
Total Alarms	188
Total UnACK Alarms	22
Total Category 1 Alarms	2
Total Category 2 Alarms	116
Total Category 3 Alarms	11
10/10/2017 8:46:01 AM	

JORDAN VALLEY WATER CONSERVANCY DISTRICT

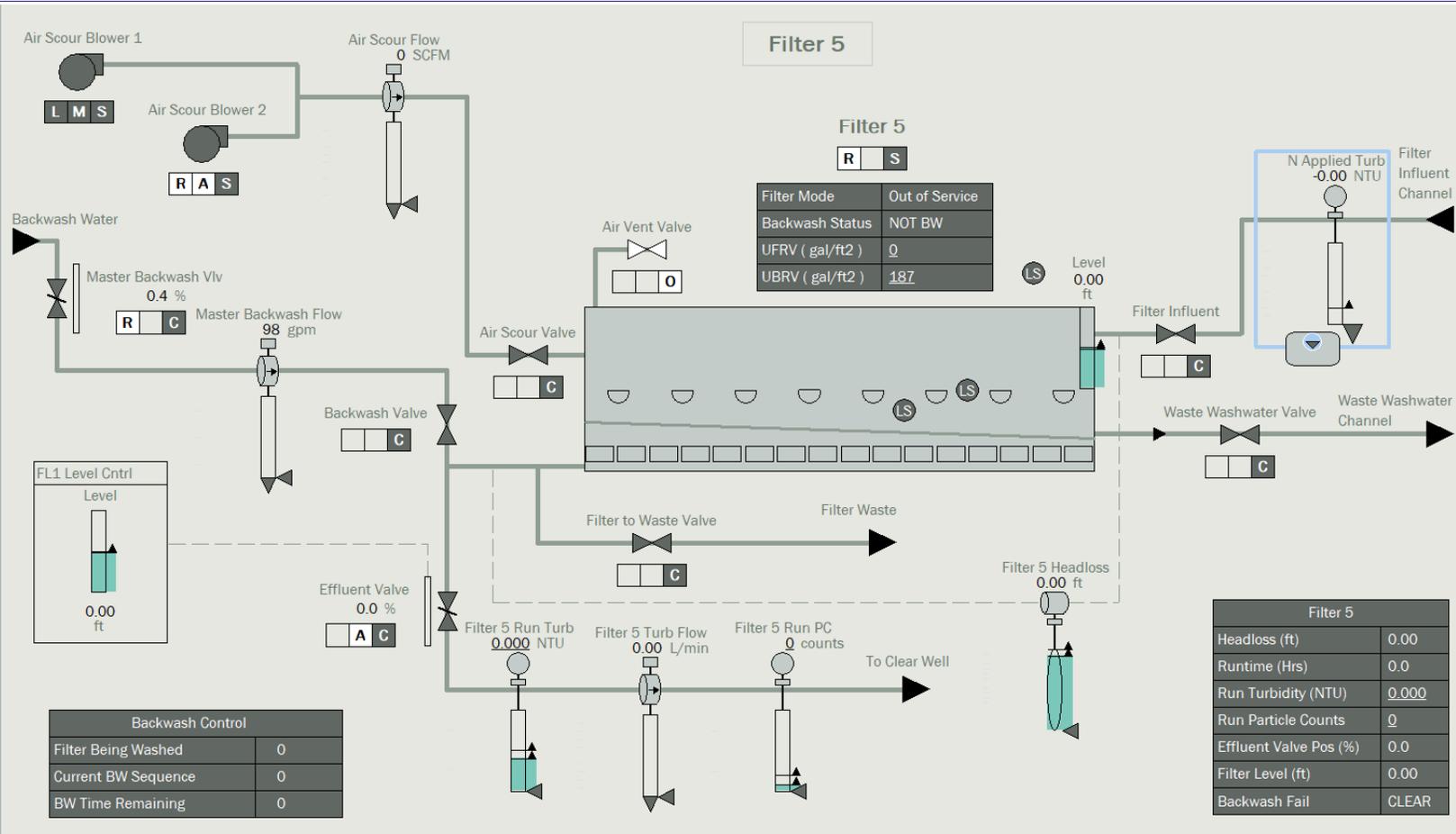
Filter 5

Distribution | JWWTWP | SERWTP | SWGWTP

User: APCO

Server Status: **P B**

Raw Water	11 ▲ 5 ■
Sedimentation	22 ▲ 1 ■
North Filters	Filter 5
South Filters	Filter 7
Backwash	Filter 9
Finished Water	1 ▲
Water Quality	7 ▲ 46 ■
Chemical Feed	1 ◆ 21 ▲ 26 ■
Auxiliary	



Ack	Date Last	Time Last	Date In	Time In	Node	Tagname	Description	Priority	Status	Value
	1/5/2018	09:48:12.133	1/4/2018	14:17:30.468	JWWTWP	JV_CF_CL2_FIT6344_F_PV	CL2 Feeder 4 Flow	MEDIUM	HI	-0.1 JV
	1/5/2018	09:46:32.387	1/5/2018	00:00:00.322	JWWTWP	JV_CF_CL2_WIT6354_WG_PV	CL2 Tank Weight 4	MEDIUM	HI	4 JV
	1/5/2018	09:45:37.362	1/4/2018	18:00:15.991	JWWTWP	JV_CF_CL2_WIT6351_WG_PV	CL2 Tank Weight 1	MEDIUM	HI	4 JV
	1/5/2018	09:45:35.397	1/4/2018	14:33:02.492	JWWTWP	JV_CF_CL2_WIT6357_WG_PV	CL2 Tank Weight 7	MEDIUM	HI	3 JV
	1/5/2018	09:44:31.513	1/4/2018	14:19:31.568	JWWTWP	JV_HIST_HB	JWWTWP Historian Collector Hearbeat	HIGH	HI	-1.0 JV
	1/5/2018	09:43:03.470	1/4/2018	15:00:15.510	JWWTWP	JV_ETH_RTU029_COMM_ERR	North Channel PC PLC Comm Secs Err	HIGH	HIHI	373 JV
	1/5/2018	09:43:02.487	1/5/2018	09:43:02.487	JWWTWP	IV_FW_CW_1IT4191_IV_PV	Backwash Tank Level	MEDIUM	LO	14.9 IV

Total Alarms: 151 | Filter: Node In 'JWWTWP' | Sort: Ack/Time Last, Descending | Run

Filter 5	
Headloss (ft)	0.00
Runtime (Hrs)	0.0
Run Turbidity (NTU)	0.000
Run Particle Counts	0
Effluent Valve Pos (%)	0.0
Filter Level (ft)	0.00
Backwash Fail	CLEAR

JWWTWP ALARM COUNTERS	
Total Alarms	172
Total UnACK Alarms	26
Total Category 1 Alarms	1
Total Category 2 Alarms	74
Total Category 3 Alarms	82

1/5/2018 9:48:17 AM

Thank you.
Questions?



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