SCADA Current Trends & Opportunities

Leveraging SCADA as a Tool for Operations

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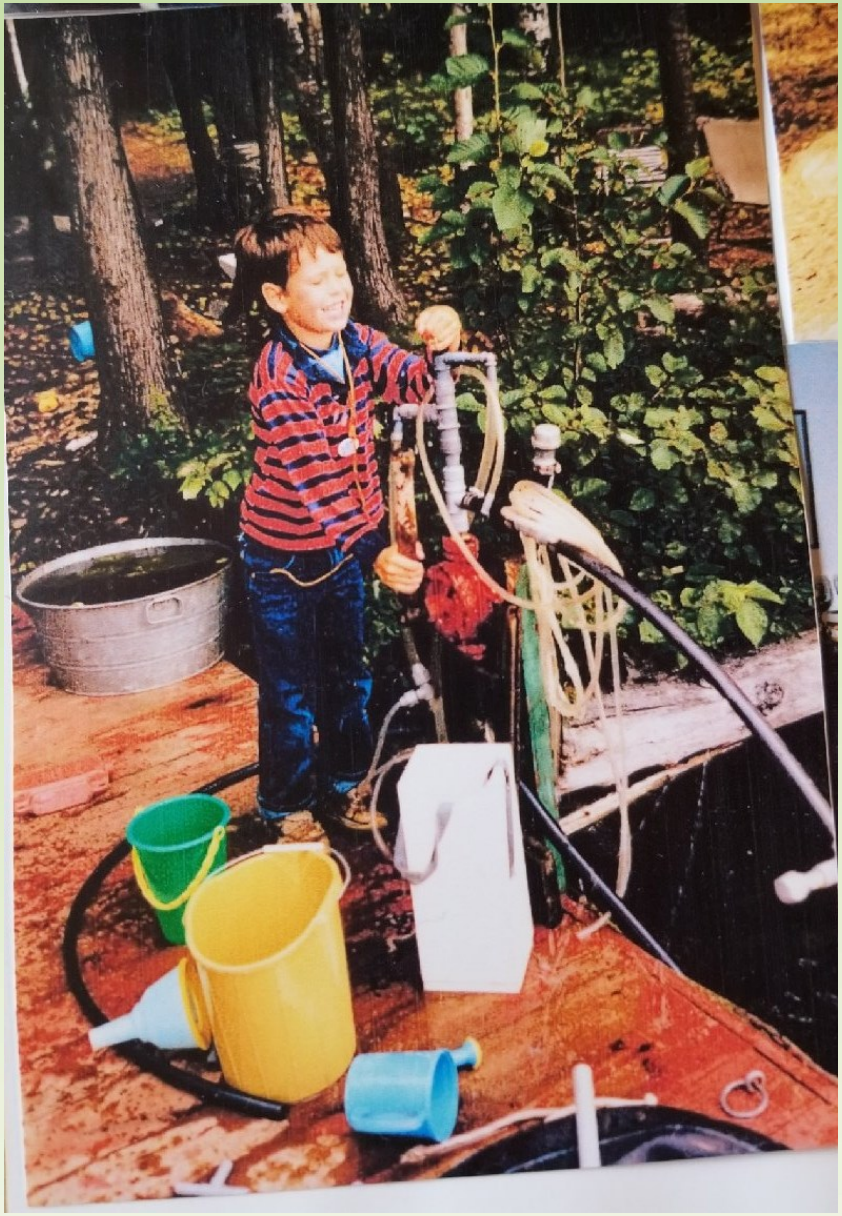
Halton Region SCADA Seminar
June 21, 2019 – Mid-Halton WWTP – Oakville, Ontario, Canada

Presentation Outline

- Some Background
- Review of what SCADA is
- State of Most SCADA Systems

- Situational Awareness
- High Performance HMI
- Alarm Management
- Data Redundancy – making it easier
- SCADA communication networks
- Cyber Security

- Building on What You Have
- What Guelph Water is Doing



I wanna be a Water Guy when I grow up!

So I got to live the dream!

About the Speaker

Graham Nasby, P.Eng., PMP, CAP
Water SCADA & Security Specialist
City of Guelph Water Services

- 10 years in the consulting sector;
- Joined Guelph Water Services in 2015

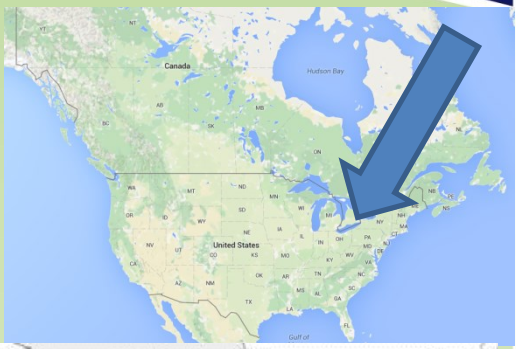
- OWWA and WEAO Member, Member of OWWA Automation Committee
- Co-chair of ISA112 SCADA Systems standards committee
- Voting member of ISA101 HMI Design standards committee
- Voting member of ISA18 Alarm Management standards committee
- Named Canadian Expert on IEC/SCC-TC65 with Standards Council of Canada

- Guest instructor at McMaster University and Fleming College
- Has published over 40 papers and articles on automation topics
- Received University of Guelph “Mid Career Achievement Award” in 2014
- Named ISA’s technical division leader of the year award in 2013.

- Contact: graham.nasby@guelph.ca

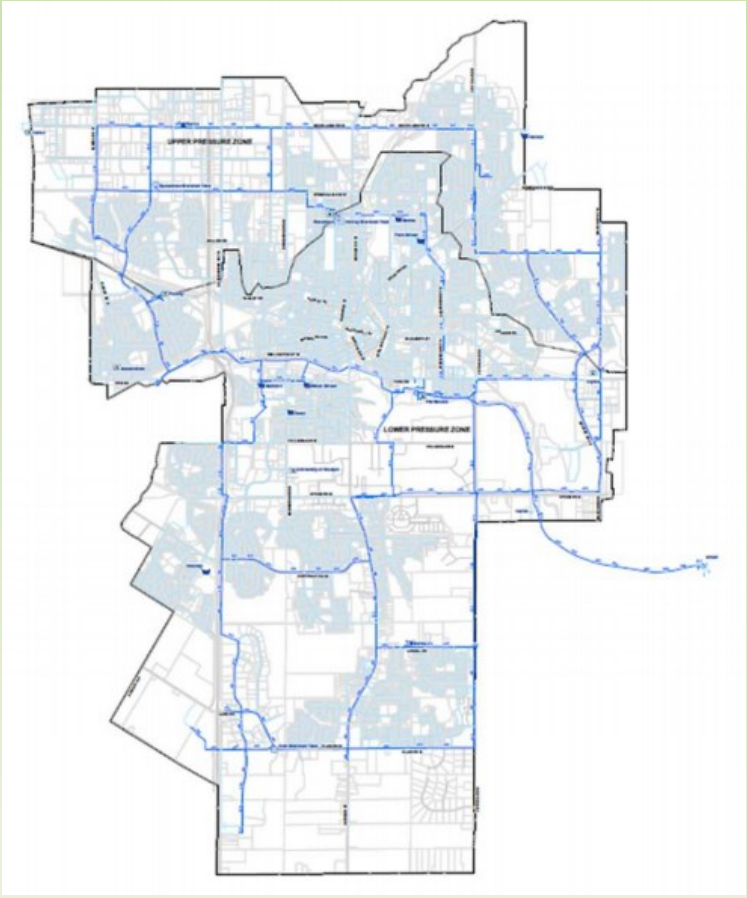
City of Guelph Water Services

- Guelph, Ontario, Canada
- 130,000 residents
- 21 groundwater wells
- 3 water towers
- 549 km of water mains
- 49,000 service connections
- 2,750 fire hydrants
- 46,000 m^3/day [12 MGD]



Guelph Water Facilities

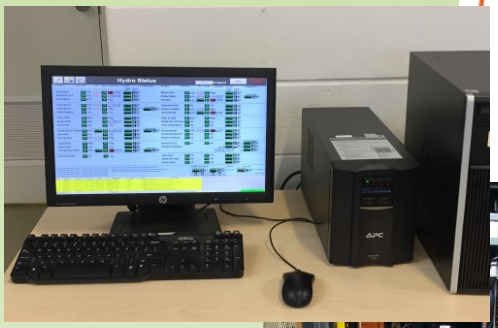
- Approx. 15km x 15km area
- 35 Facilities
  - 4 booster stations
  - 21 wells
  - 2 valve chambers
  - 3 water towers
  - 5 monitoring sites
- 40 PLCs plus 2 data centers
- Redundant Datalogging
  - Realtime datalogging
  - QuickPanels with store/forward
  - DNP3 Dataloggers with Store/Forward
- High availability SCADA network
  - Primary: private fibre optic
  - Secondary: private wireless, with 45 second auto-failover

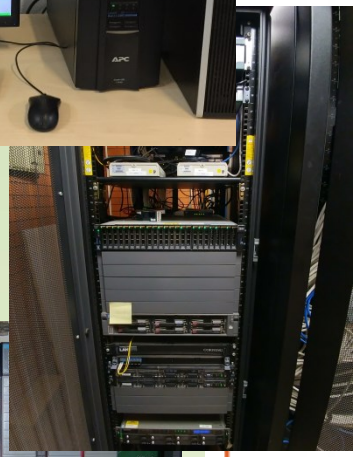


Review:
What is SCADA?

SCADA = Supervisory Control and Data Acquisition

Typical SCADA Architecture





SCADA View Terminals
SCADA View Terminals
SCADA network
SCADA Servers
SCADA Reporting Servers
SCADA Servers
SCADA network
SCADA Control Panels
SCADA Control Panels
Field Wiring
Motor Control Centres (MCCs)
Pumps
Blowers
Control Devices
Flow
Analyzer
Level
Instruments
Valves
Packaged Equipment
Control Devices
Field Devices

Why we have SCADA systems

- Unattended automatic control of water facilities
- Logging of critical control parameters
  - Chlorine Residuals (e.g., 5 minute recording intervals)
  - Turbidity
  - Well Flow Rates & Daily Flow Totals
  - POE Flow Rates & Daily flow Totals
  - Tower Levels & Pressure

- Provides “visualization” of water facilities to Operators
- Enables remote monitoring and control by Operators
- Triggering and Annunciation of Alarms
- Automated responses (increase chlorine dose, shutdown, etc.)
- Reporting based on logged process data

Current State of SCADA Systems

- **"Automation projects have the greatest opportunity to add value when process improvements are made along with the application of new technology."**

Peter Martin, VP of Schneider Electric

(previously CEO of Invensys, maker of Wonderware HMI software)

So why do so many of our SCADA systems "barely work"?

Current State of SCADA Systems

Should this guy be designing your water utility's automatic control system?

Current State of SCADA Systems

How about this person?

They seem to know a lot about concrete and pipe…

Current State of SCADA Systems

Do we need to involve operations and maintenance in the design process?

Current State of SCADA Systems

Does this programmer need to understand the process to be able to program the control system?

Good Control System Design is a team effort and requires time

Rushed Design & Programming = Crappy SCADA

Designing Process Limits & Operating Envelopes

7.6 Post-Contact Chamber Chlorine Residual

Using sodium hypochlorite addition, we aim for an operating envelope as follows from the post-contact chamber sample line. Operationally we have found that a target of 0.80 mg/L (0.60 to 1.10) results in good chlorine residual readings in the distribution system.

Table 16 – Post Contact Chamber Free Chlorine Operating Envelope

4.00 mg/L	High Regulatory Limit
2.50 mg/L	High Chlorine Shutdown Interlock
2.25 mg/L	HIHI Chlorine Alarm
2.00 mg/L	HI Chlorine Alarm
1.90 mg/L	Extreme top of Envelope
1.70 mg/L	Top of Envelope
0.80 mg/L	Target
0.70 mg/L	Bottom of Envelope
0.60 mg/L	Extreme bottom of Envelope
0.55 mg/L	LO Chlorine Alarm
0.45 mg/L	LOLO Chlorine Alarm
0.40 mg/L	Low Chlorine Shutdown Interlock
0.30 mg/L	Low limit to meet CT (regulatory)
0.05 mg/L	Low Distributions Limit (regulatory)

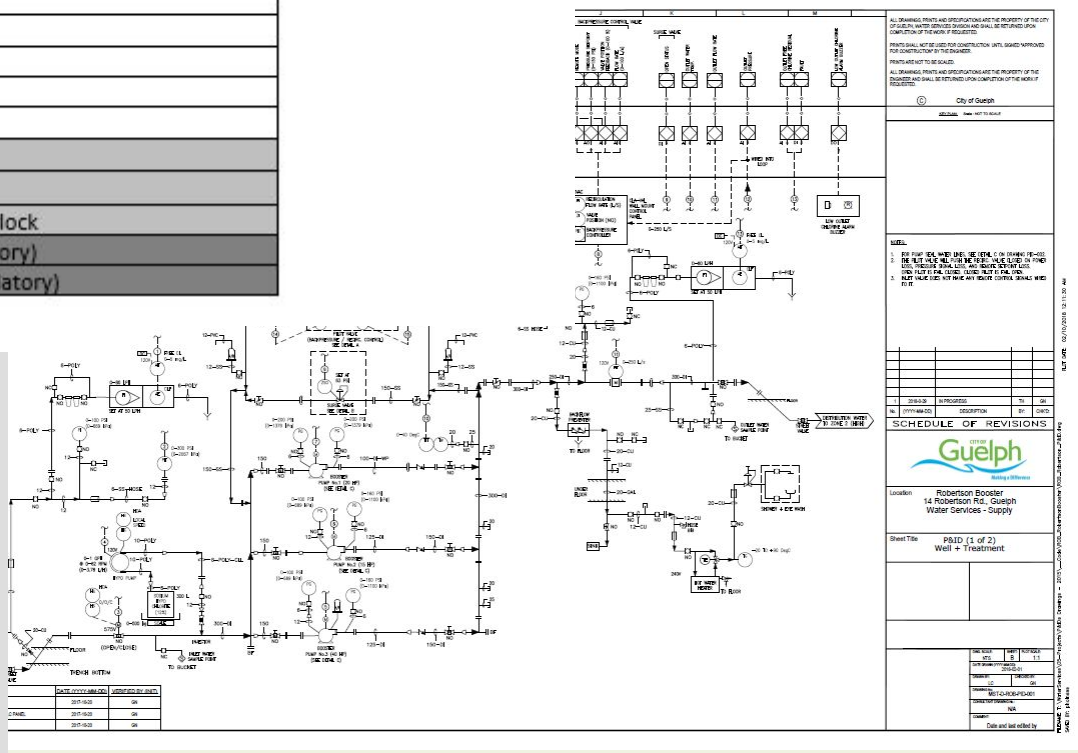
City of Guelph Water Services

Emma Well

EMMA WELL UPGRADE PROJECT

Process Control Narrative

(PCN)



There is an Automatic Control Systems Profession!

Depending on the project you may need to get a professional who designs automatic control systems involved!

This is not the same as a "programmer."

An Automation Professional's expertise includes: Control System Theory, Instrumentation, Instrumentation, Safety Systems, Motor Control, Valves, Actuators, Electrical Design, I/O Design, Programming, and Commissioning.

In the USA, where Engineering Licences are discipline-specific, there is a separate Engineering License for "Control Systems Engineer."

There are also certifications individuals can get to demonstrate their skills/knowledge/experience with Automatic Control Systems.

Common Problems with SCADA Design

- Use of old out-dated technology
- Use of old outdated programming templates and hardware, many of the templates and techniques still being used <u>are over 30 years old</u>

- "Let's just copy what we did on the last job"
- "Let's just replicate what the old PLC/HMI did"

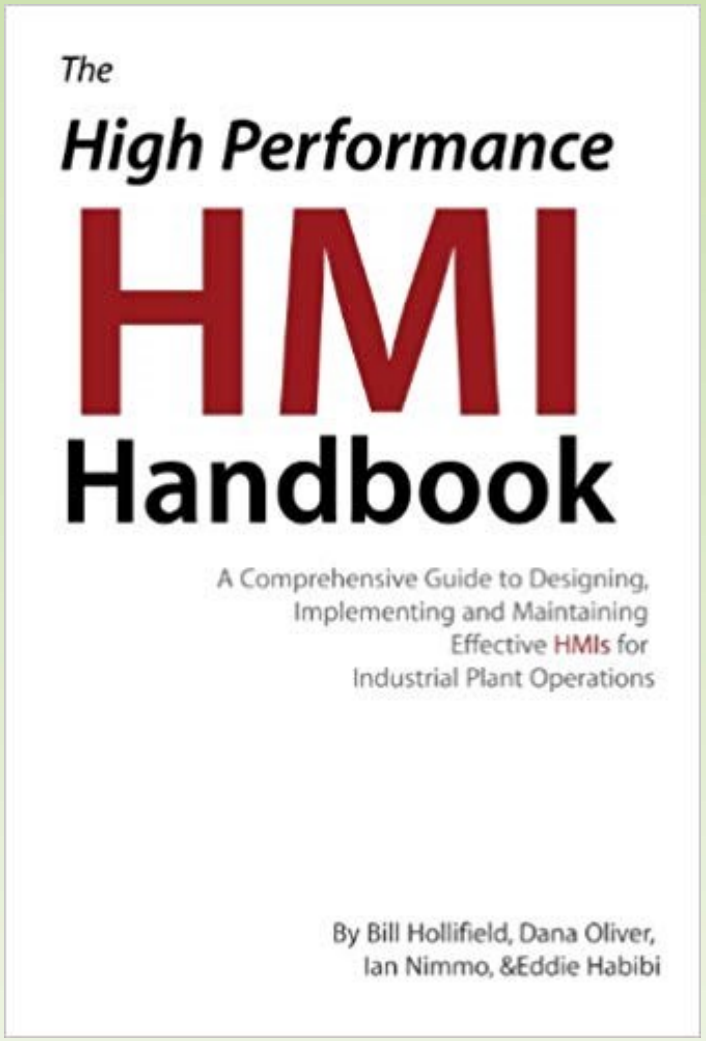
- "How the control system will work" often left until too late in design process
- Not enough time allocated to properly design the control system with participation from operations, so programmers always playing catch-up

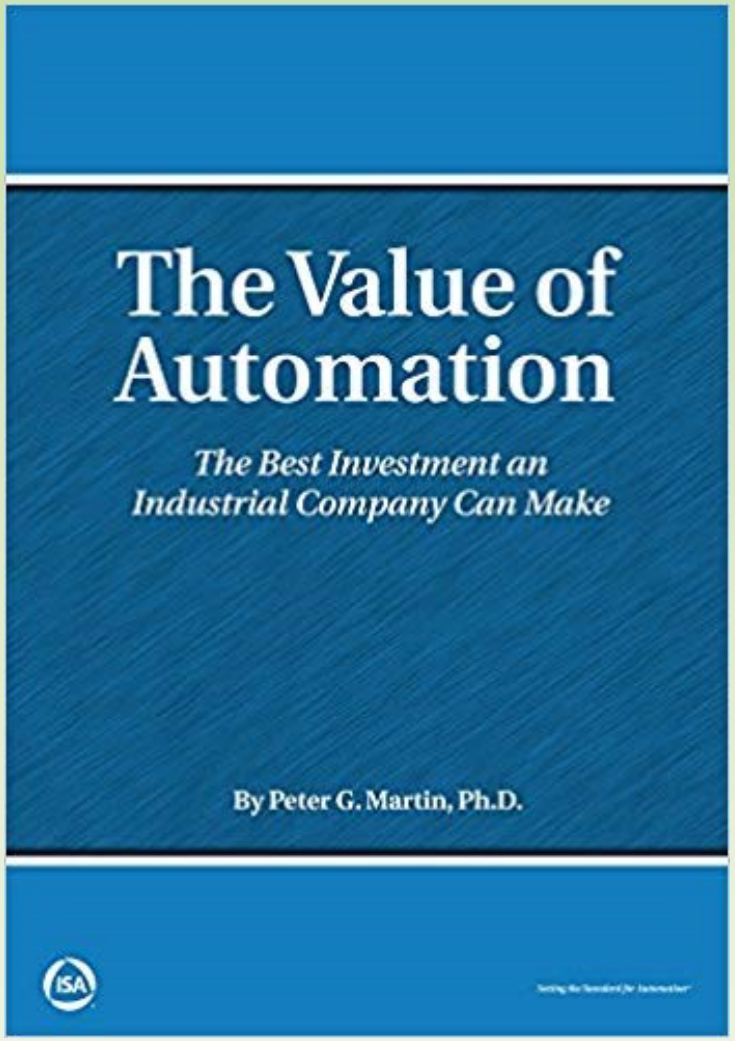
- Not enough time is spent to model what operating ranges of the plant will be, and when permissives, alarms and interlocks should be activated

- Not enough time invested to write a proper Process Control Narratives and P&ID drawings to define what process is supposed to be doing

- Not enough time allocated in programming & commissioning schedules
- Older SCADA programming packages often labour-intensive to program!

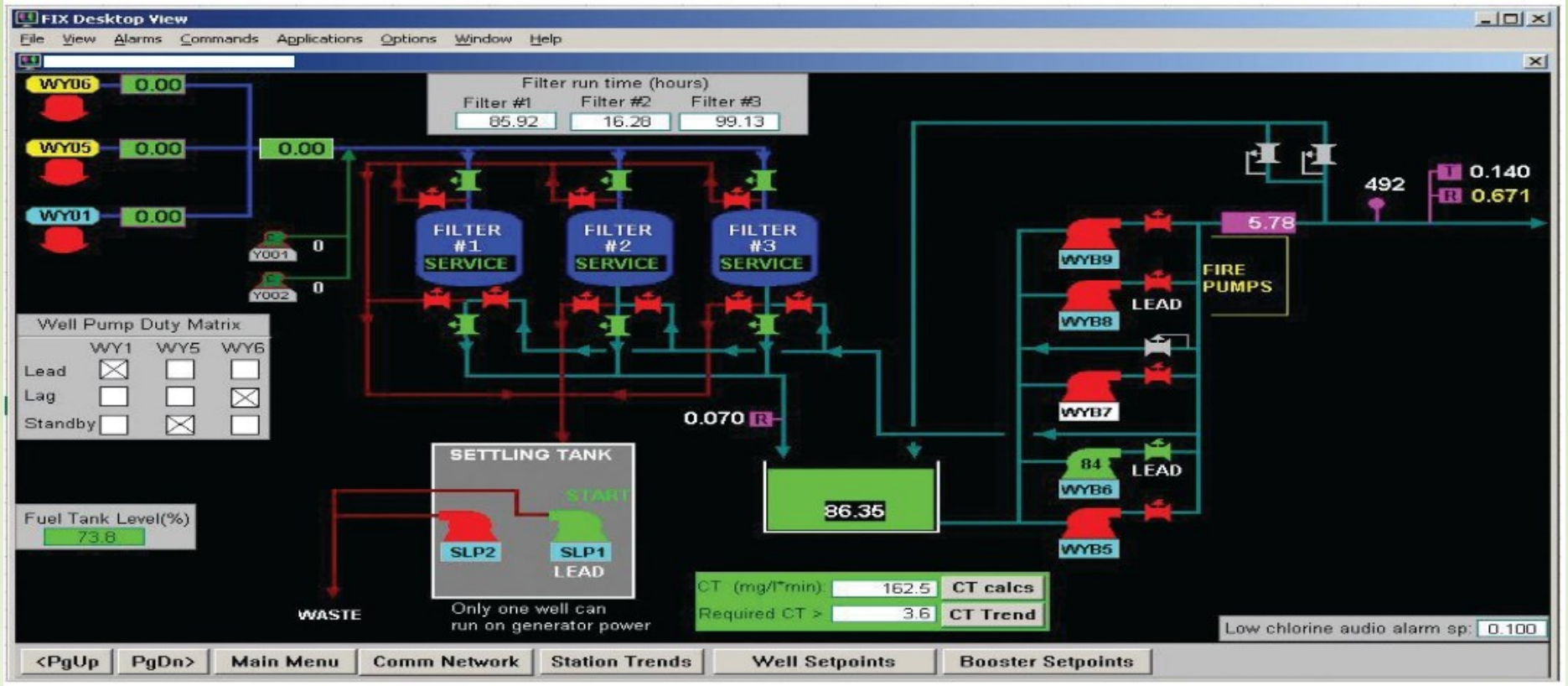
Two SCADA Books You Should Read





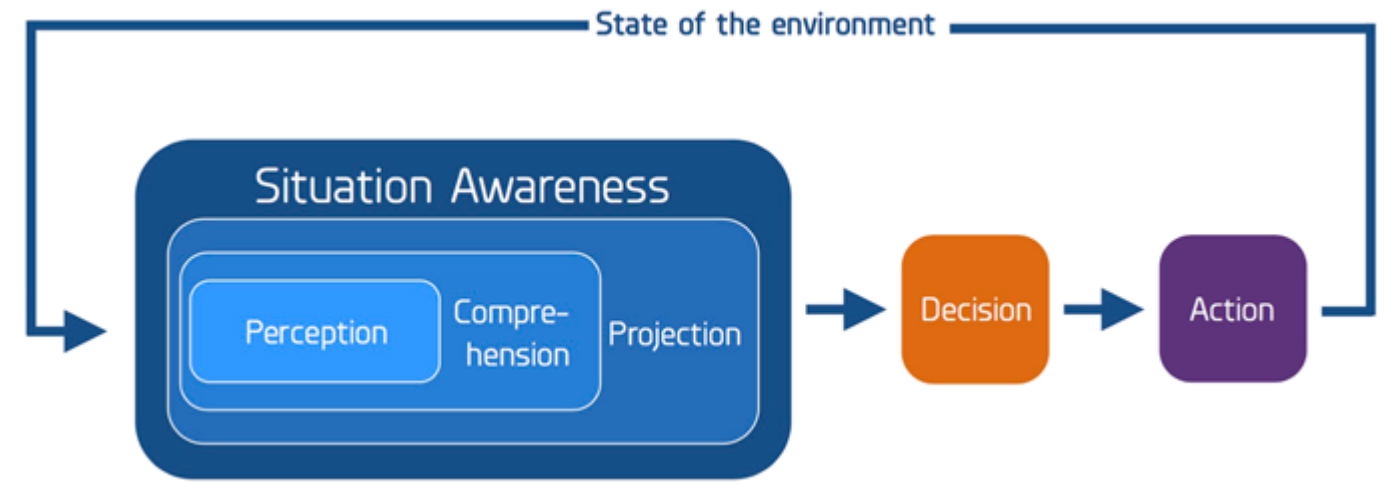
So, what is new with SCADA?

What's new in SCADA?



- What is running?
- Is the process running well?
- Is anything abnormal?
- What if your are colour blind?

SCADA: Situational Awareness



To be an effective operator

–

you have to be aware of what your plant is doing

Common SCADA problem

In some SCADA systems….
You can't see the whole picture

Common SCADA problem

What your SCADA system may not be showing you

CAN

YOU

FIND

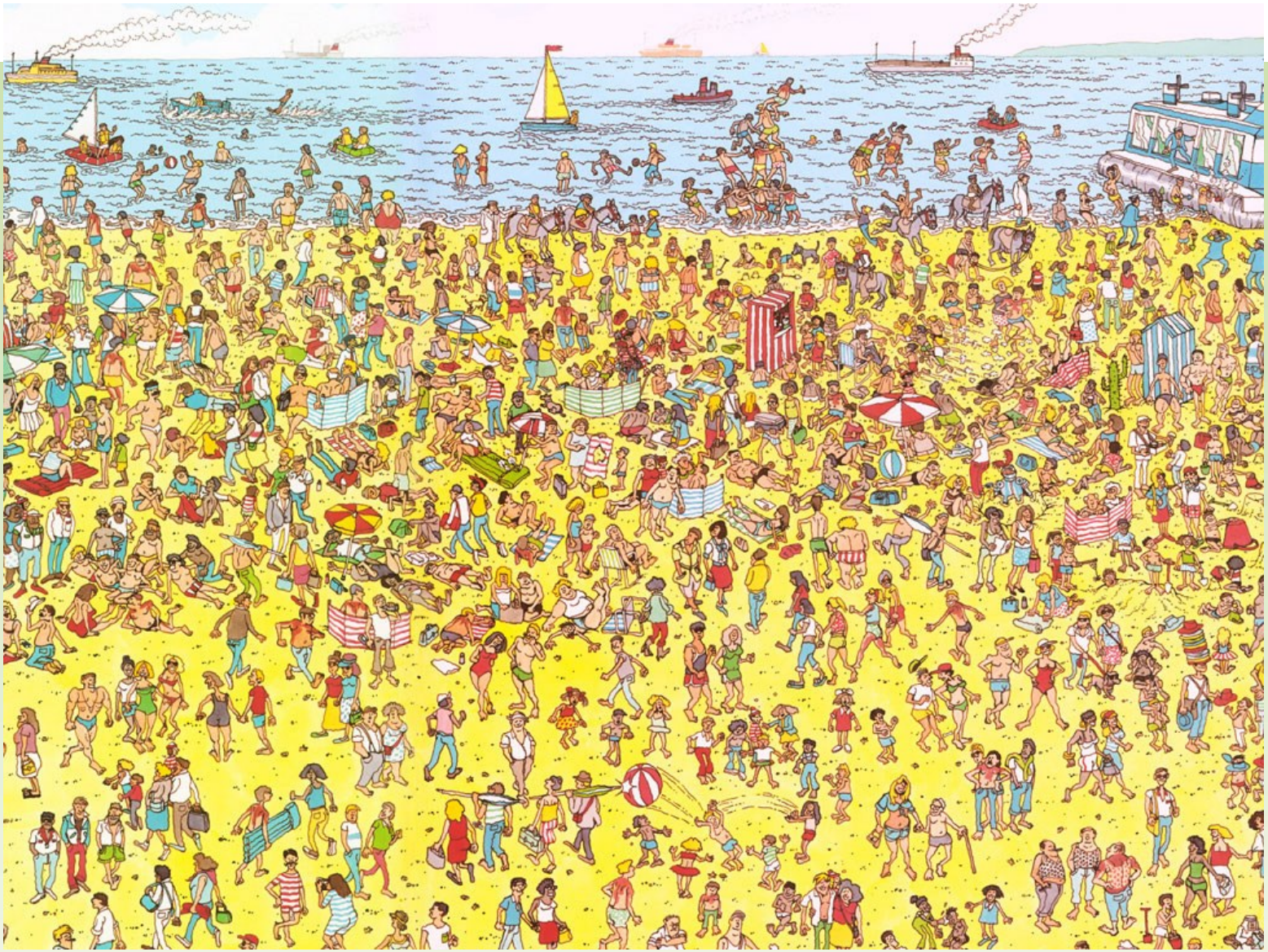
THE

PROBLEM

ON THE

SCADA

SCREEN?



Friendly
SCADA Guy

Situational Awareness

- **To be able to react to a problem,**
  Operators need to be aware of the problem

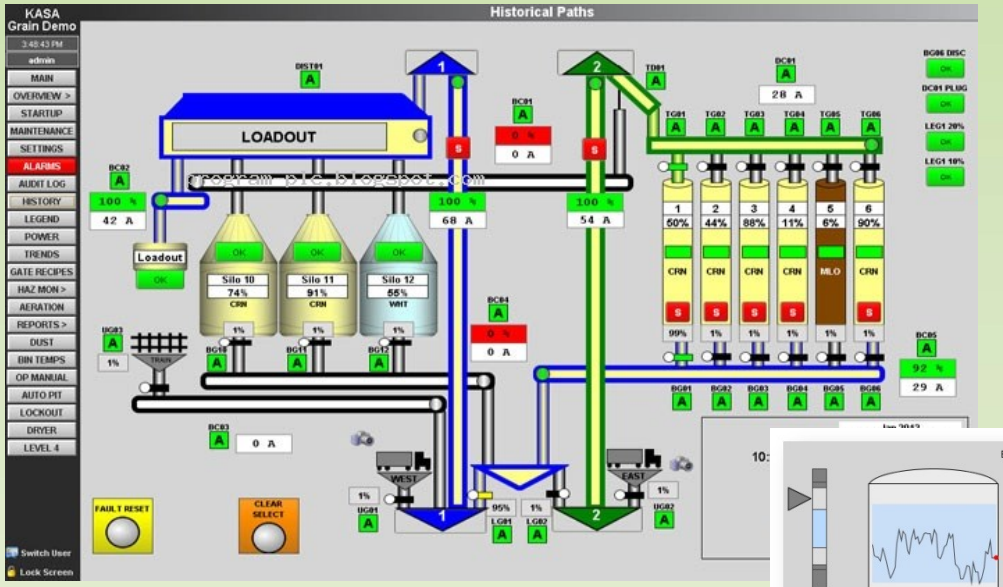
- Old way operating “by alarm” (reactively)
- New approach: Present data to operators so they can proactively respond to problems as they develop
- Reserve alarms only for events that require immediate action

- High Performance HMIs (Human Machine Interfaces)
- Alarm Management (better designed alarm systems)
- Understanding your operating envelope (know your plant’s limits)

High Performance HMIs

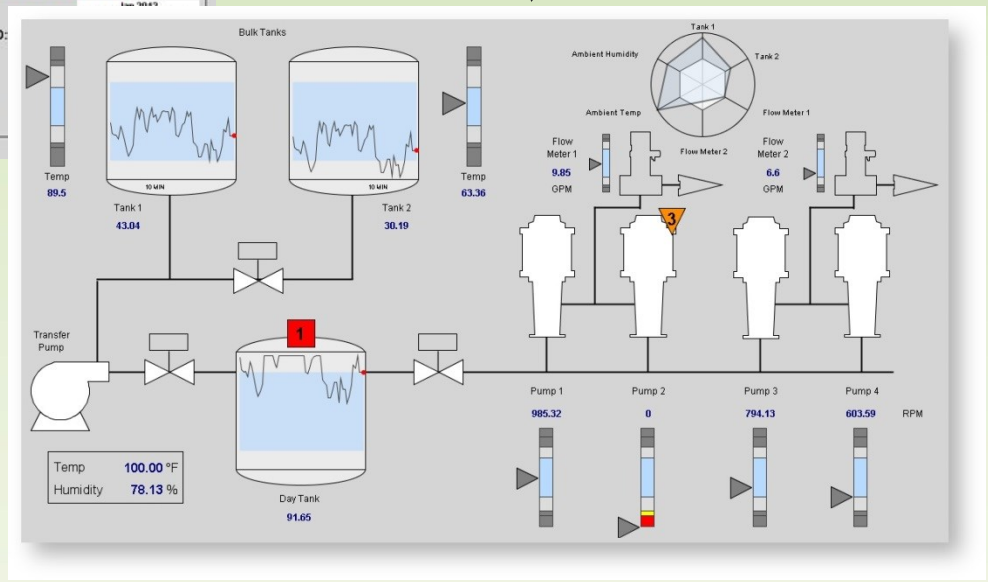
High Performance HMIs

HMI = Human Machine Interface (computer screen)

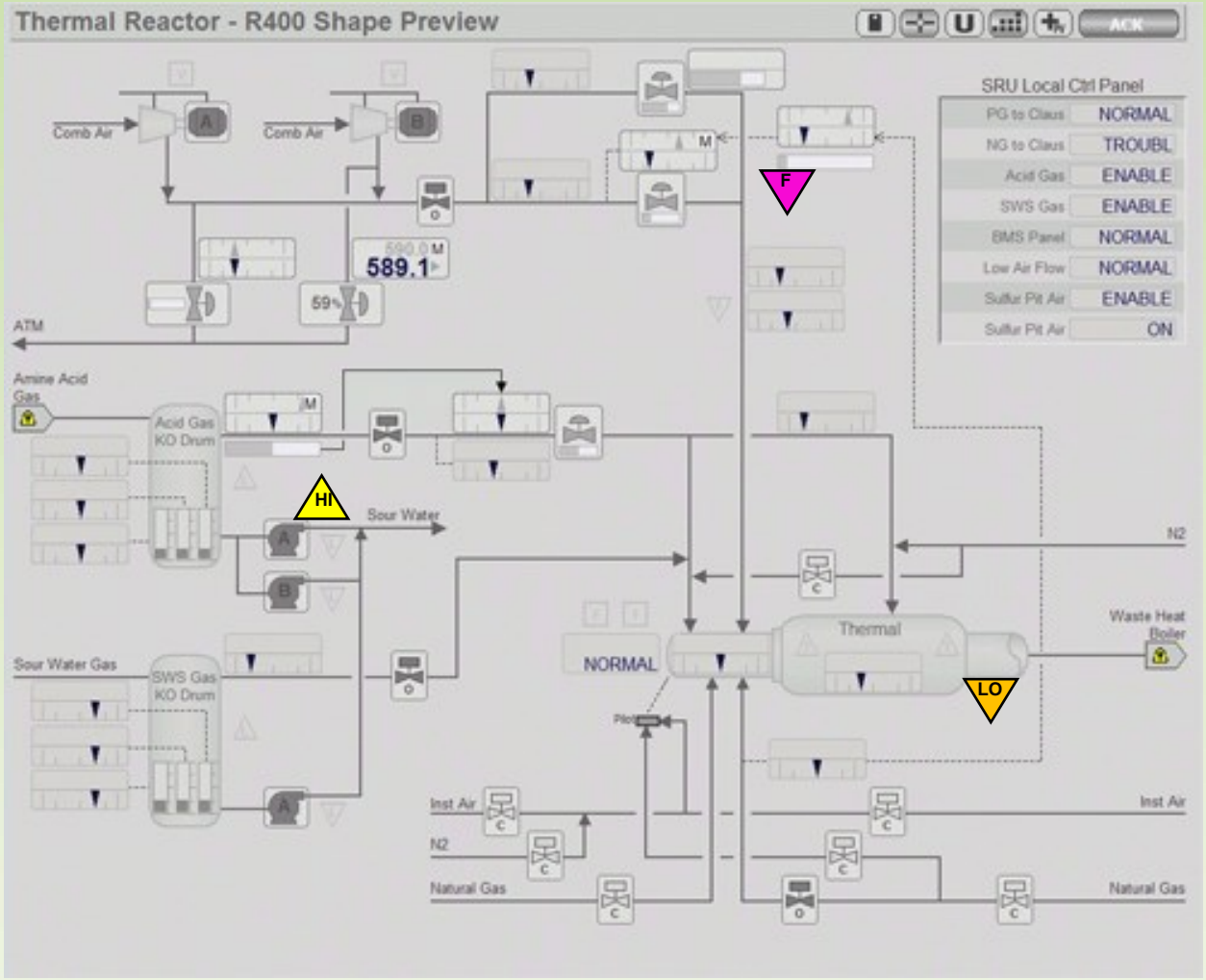


Poor Colour Scheme

High Performance HMI
Colour scheme



High Performance HMI – Plant Running Normally



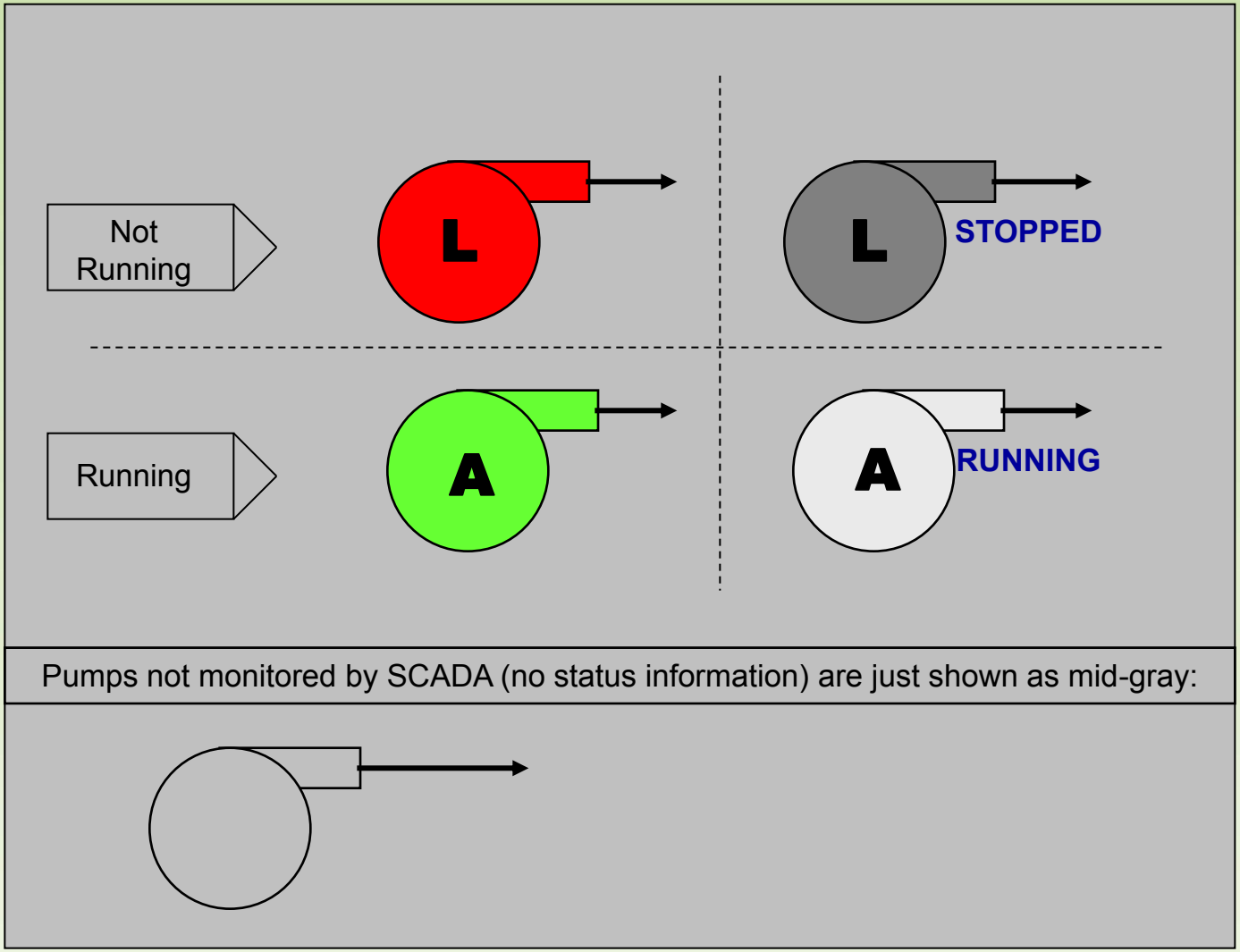
Notice the
Lack of Colour

High Performance HMI – Showing Pump Statuses

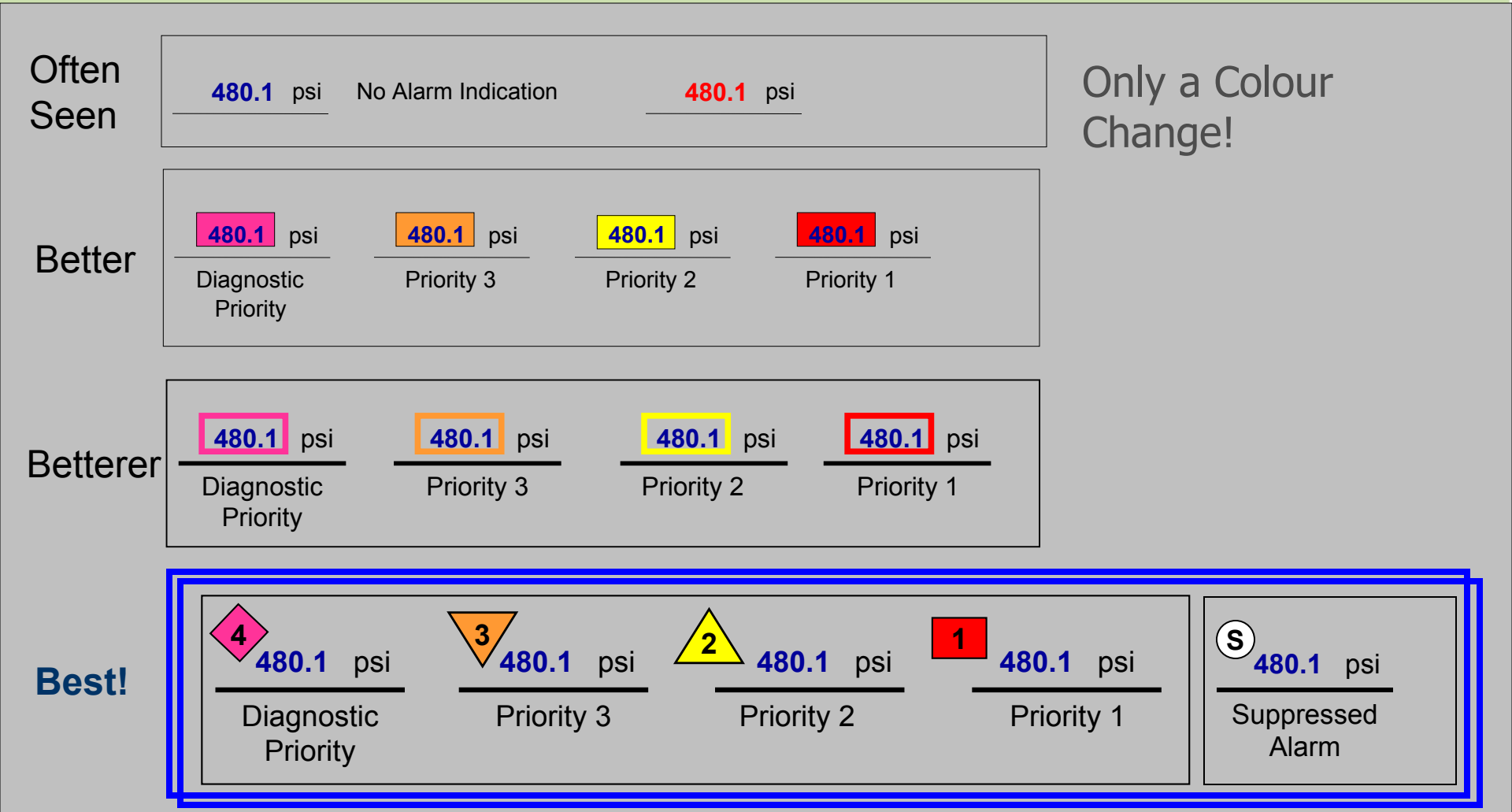
Red/Green for status

vs.

Greyscale & redundant coding (colour & text)



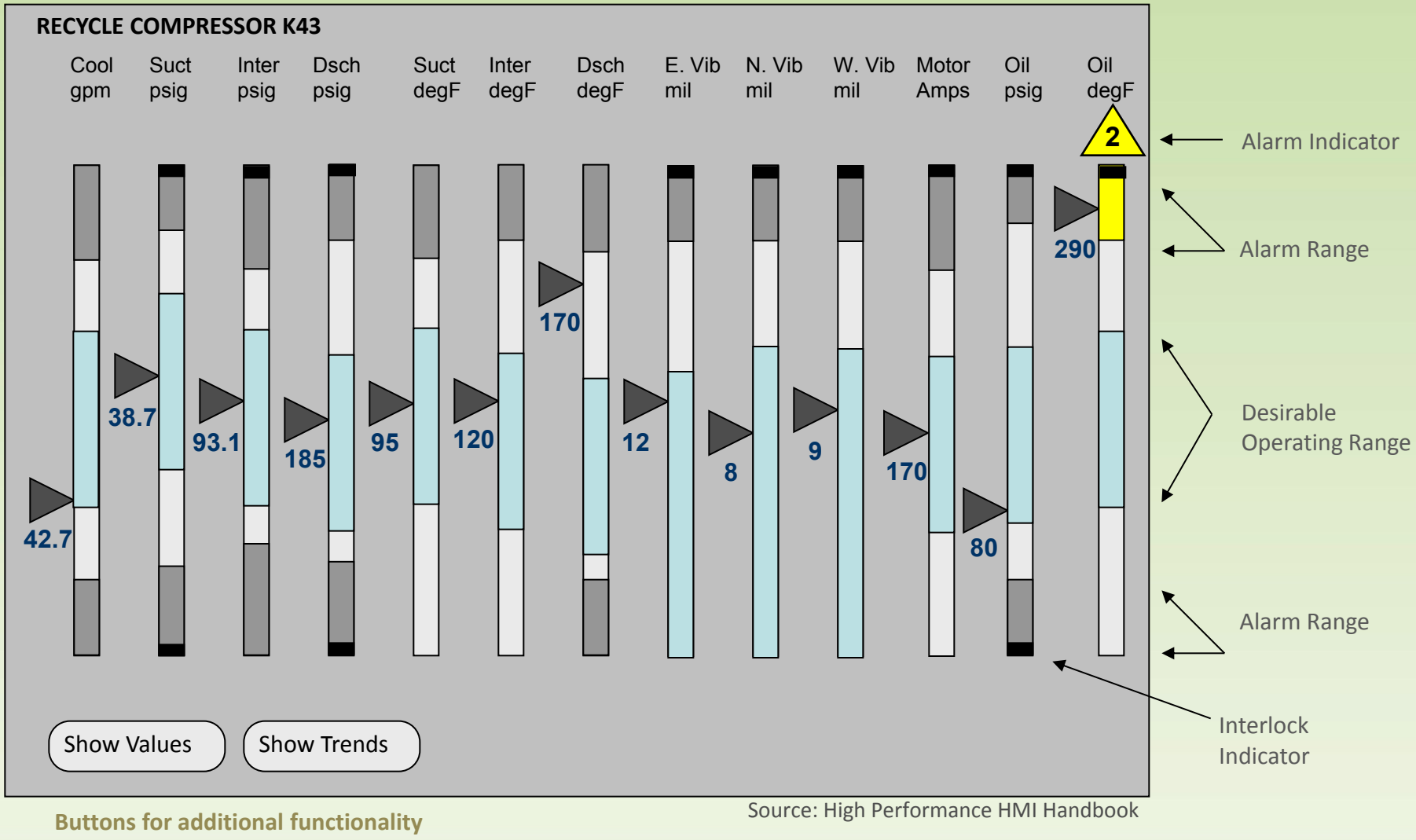
High Performance HMI – Analog Values



Show alarms in multiple ways: Colour, Shape, Text ("redundant coding")

Source: High Performance HMI Handbook

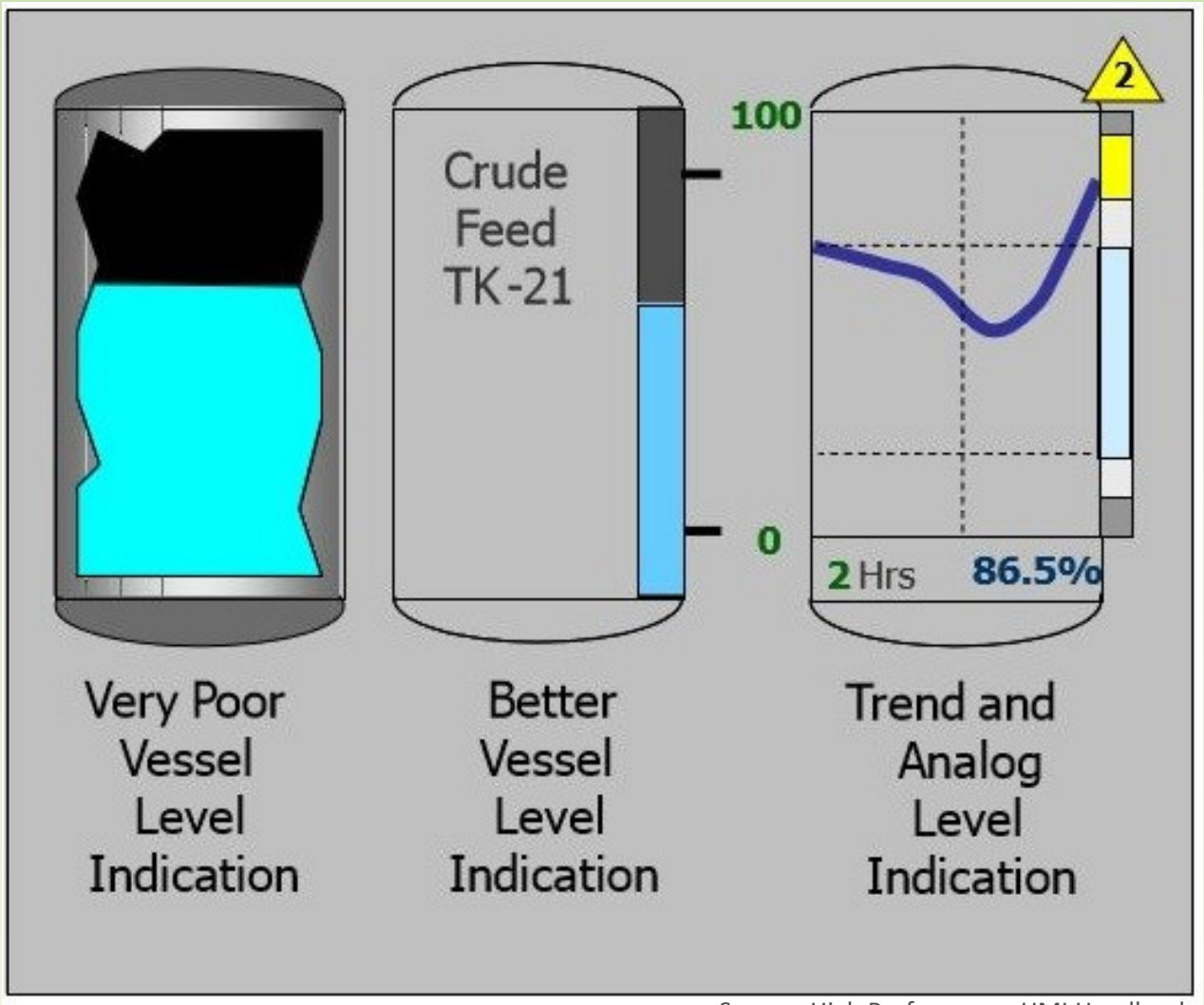
High Performance HMI – Analog Values Another Way



Buttons for additional functionality

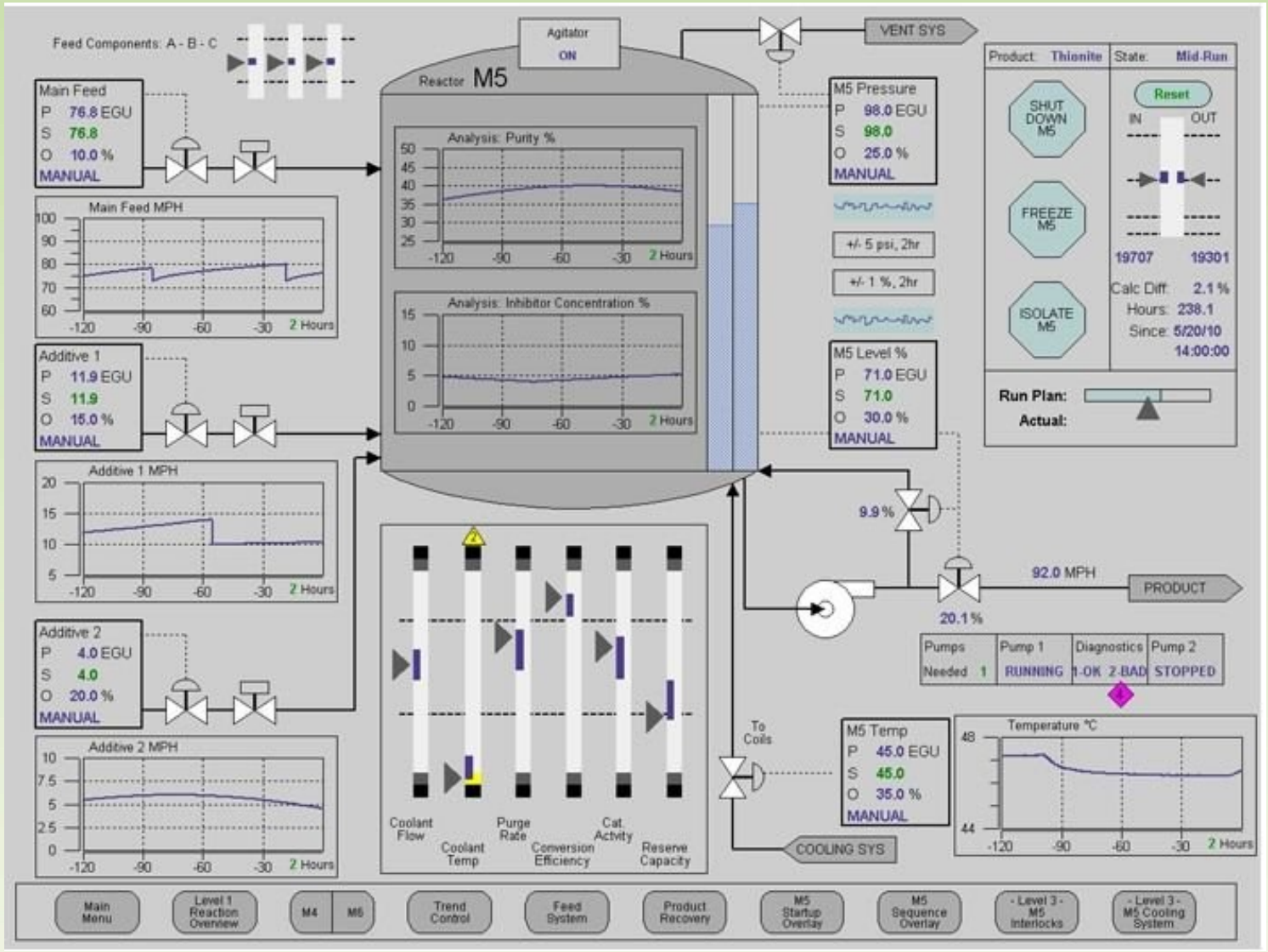
Source: High Performance HMI Handbook

High Performance HMI – Tank Levels Depiction



Source: High Performance HMI Handbook

High Performance HMI – Embedding Trends



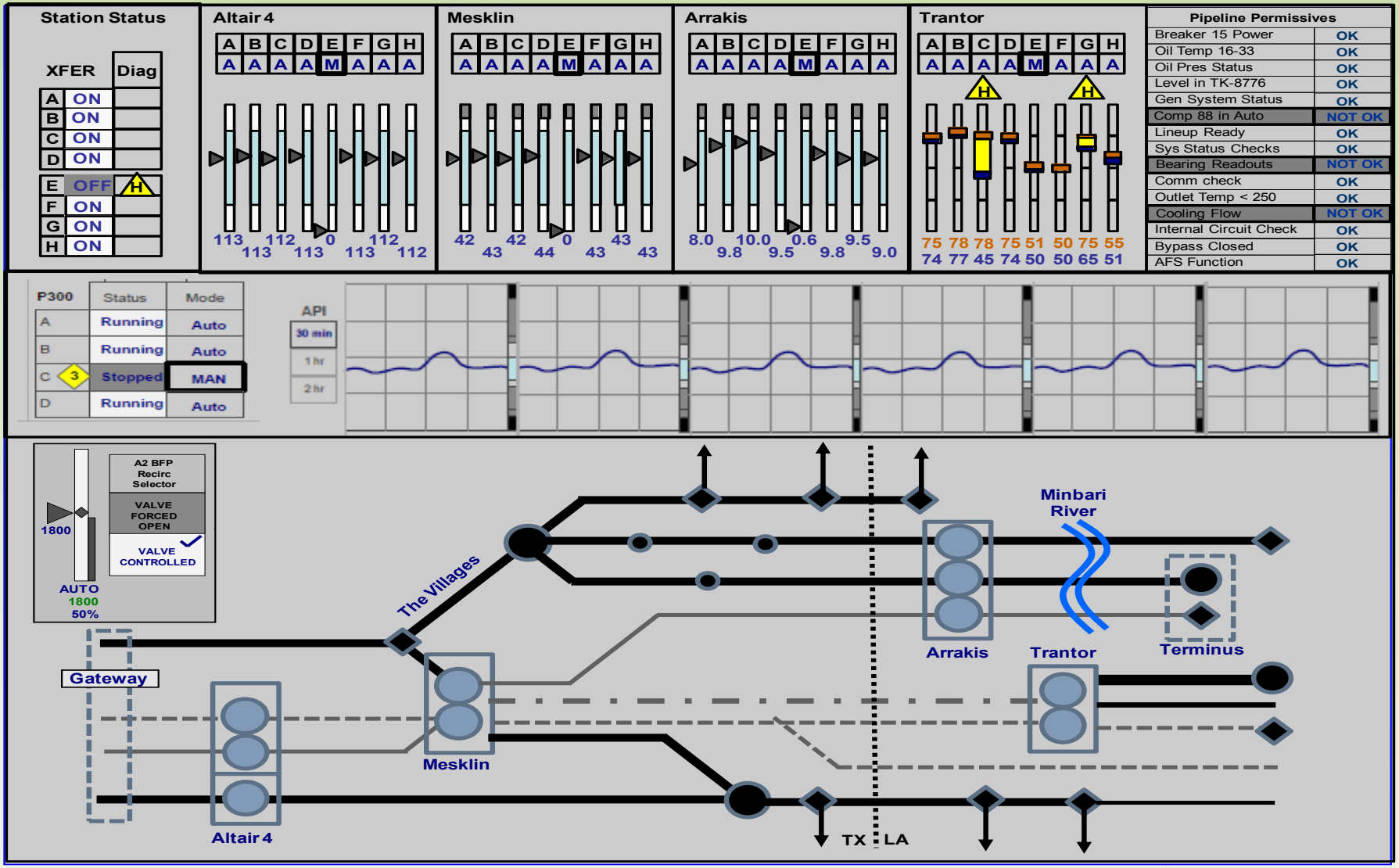
Source: High Performance HMI Handbook

High Performance HMI – Display Hierarchy

- **Level 1 – Plant or Entire System Overview**
  - Entire Operator Span of Control. “Single-Glance”
- **Level 2 – Sub-Process Overview**
  - More details than a Level 1 display, smaller area
- **Level 3 – Equipment or Details Screen**
  - Specific details about part of the process or control
- **Level 4 – Specific Task or Diagnostic Screen**
  - Very detailed screen, only used for diagnostics

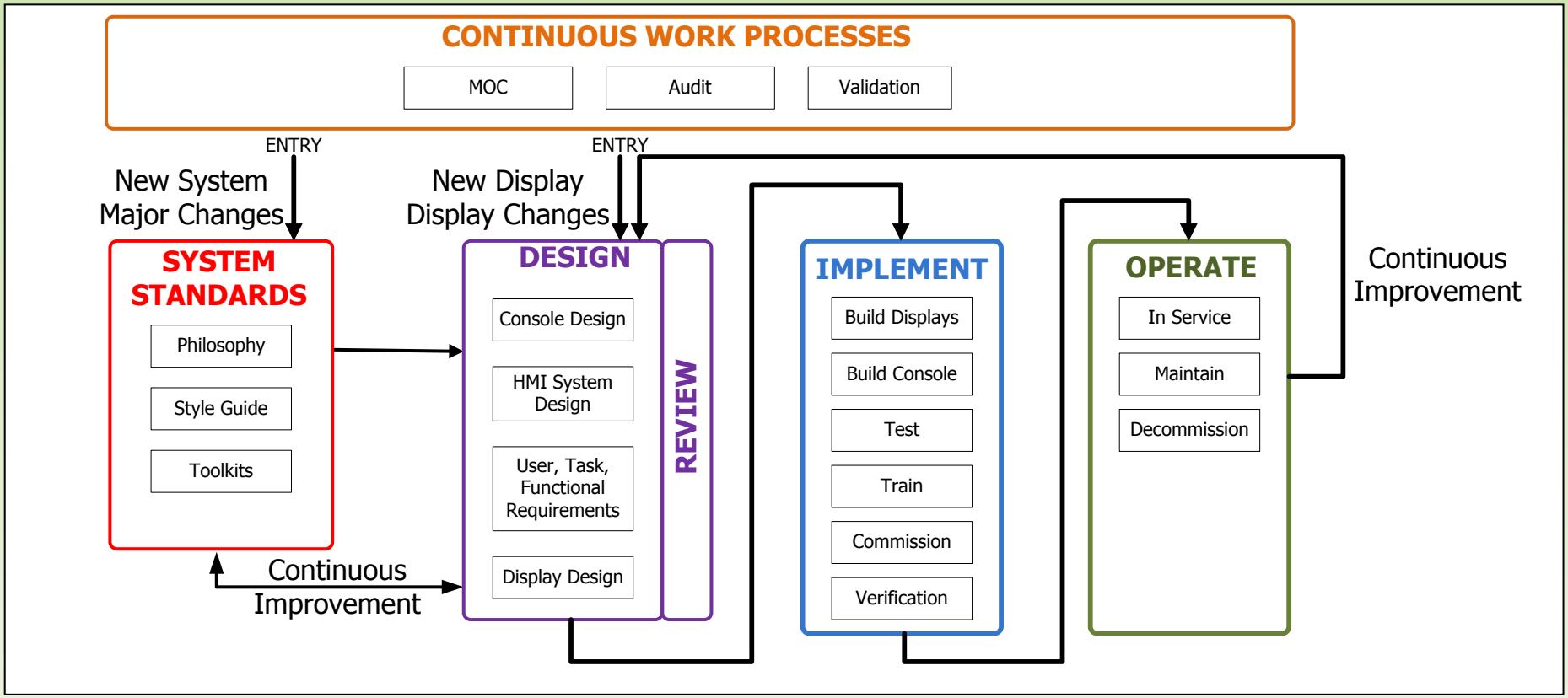
High Performance HMI – The old way

High Performance HMI – Proper Level 1 Display



Source: High Performance HMI Handbook

High Performance HMI – ISA101 Standard



Source: ISA101 HMI Lifecycle Diagram

Alarm Management

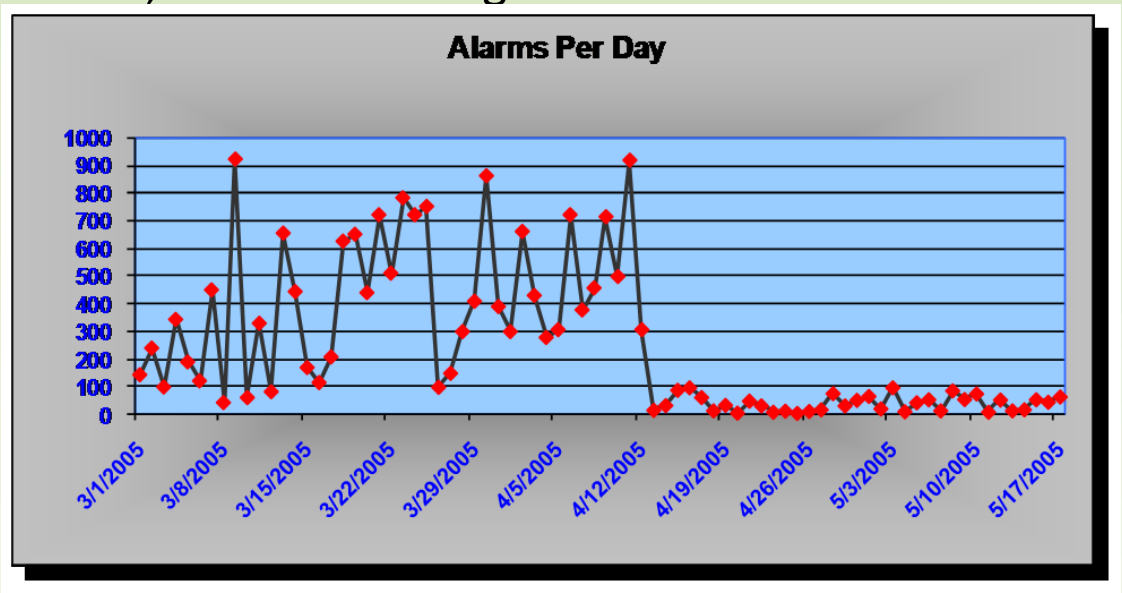
Alarm Management: ISA18.2

ANSI/ISA-18.2-2016 *

Management of Alarm Systems for the Process Industries

> **Alarm:** *An audible and/or visible means of indicating to the operator an equipment malfunction, process deviation or abnormal condition requiring a timely response.*

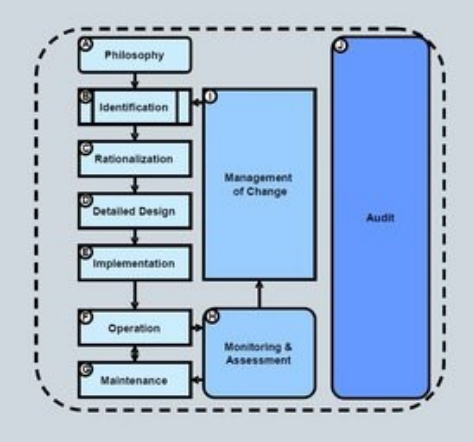
Methodology for identifying, rationalizing and designing alarms to be a powerful tool for operations, and eliminating non-useful alarms



Typical example of results of 18.2 being implemented (showing before/after)

*originally published as ISA-18.2-2009, now also IEC-62682

Alarm Management: ISA18.2



ANSI/ISA-18.2-2016:
Management of Alarm Systems for the Process Industries

-Addresses the development, design, installation, and management of alarm systems in the process industries

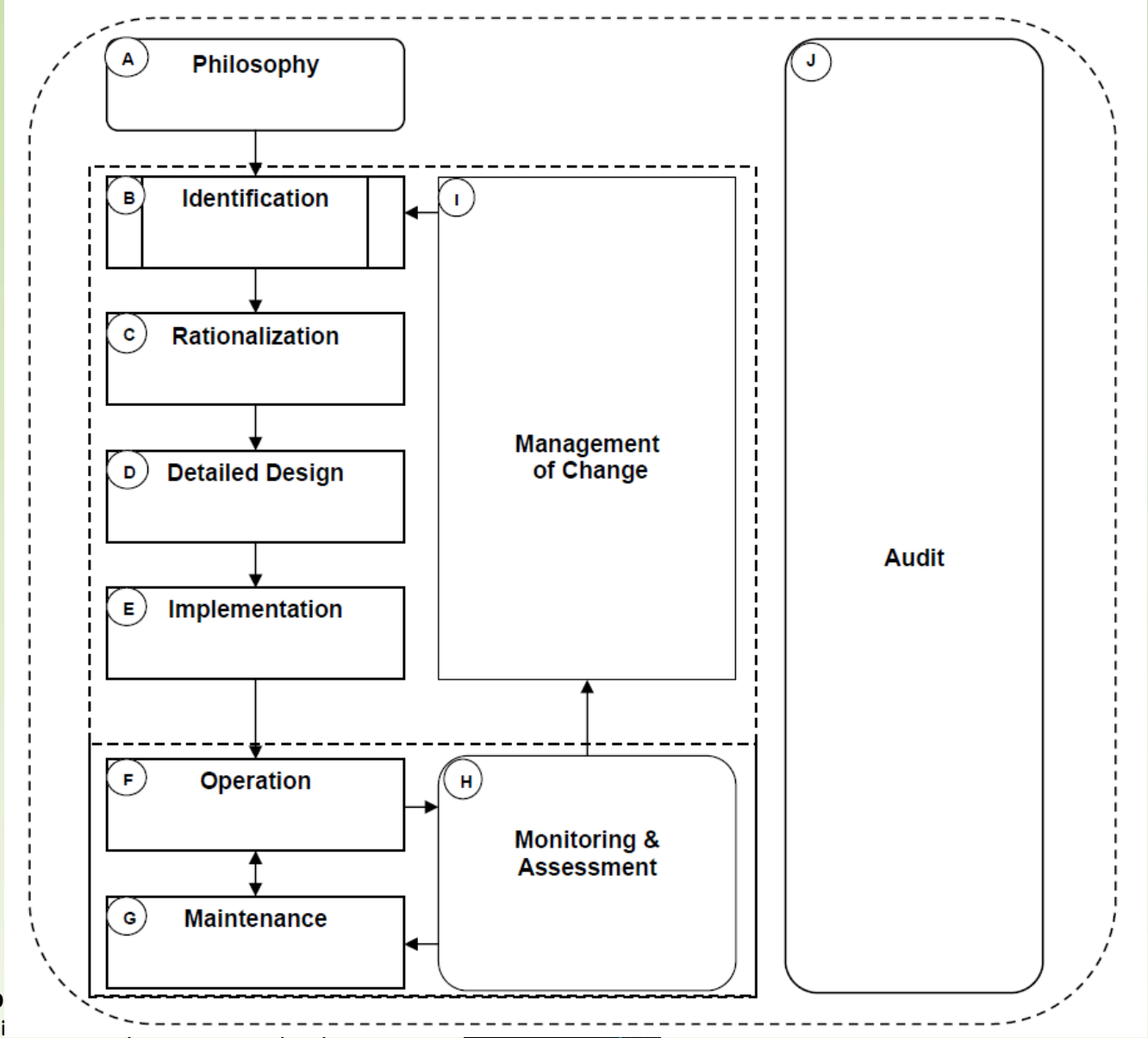
-Defines the terminology and models to develop an alarm system – and the work processes to effectively maintain it throughout its lifecycle

-Six technical reports available to explain specific applications in greater detail

-Based on work by the ISA18 committee, which has been active since 2003.

-First version of ISA18.2 standard published in 2009, became IEC-62682 in 2015, and updated version published in 2016.

Alarm Management: ISA18.2 Alarm Mgmt. Lifecycle



Alarm Management: Master Alarm Database (MADB)

Centralized repository of approved alarms and their configuration.

An approved/documented list of all your alarms in one place.

Tag	Priority	Desc.	Condition	Consequence If Ignored	Consequence Severity	Expected Operator Response	Time to Respond
P1-380-LAH-201	LOW	Aeration 1 High Level	High Level Switch Activated for 10sec	Overflows in Secondary clarifiers.	MINOR	Check Level Controller	2 hours
P1-380-AAL-102	MED	Aeration 1 Low DO	DO below 3ppm for 30min	Loss of Biological Action, Risk of Damage to Biological Mass	MAJOR	Investigate and turn on additional blowers	1 hour
P1-380-PALL-456A	LOW	Aeration 1 Air Pres. Low Low	Less than 15psi for 5min	Loss of Energy if Air Leak, Poor Aeration (Note: there is a low DO alarm)	MINOR	Check pressures in air distribution system via HMI, check valves in field	4 hrs

Alarm Management: Master Alarm Database

- **Alarm Tag**
- **Alarm Description** (full description & what is shown on HMI)
- **Identification:** Trigger Condition, Purpose
- **Rationalization**:
  - Consequence & Severity if Ignored
  - Expected Operator Response, Time to Respond
  - Alarm Priority & Alarm Class
  - Justification for having this alarm configured!
- **Design:** Trigger Condition, On/Off Delays, Additional Filtering Logic, Setpoints, Routing/grouping information for the HMI
- **Operation:** When put into service, If Periodic Testing is required

Alarm Management: Key SCADA Features

- Master Alarm Database
- Ability to create non-alarm messages and logged events
- Support for Alerts, Prompts, and Maintenance Messages
- HMI Alarm Summary Display Screen
- Alarm Sorting, Filtering, Routing
- Alarm Areas/Grouping
- Alarm Priorities
- Alarm Classes

Alarm Management: Key SCADA Features cont'd

- Standardizing Alarm Features with Function Blocks
- On-Delay, Off-Delay, Deadband
- Conditional Alarming: base condition plus additional logic
- Alarm Shelving Method with Authorization / Logging
- Alarm Out of Service
- Change Control – Permissions, Setpoints, Configuration
- Configuration Change Logging
- Alarm Setpoint/Attribute verification & enforcement

Alarm Management: Non-Alarms

HMI: Alarms, Events and Notifications

- SCADA Systems can have multiple types of notifications

Operator notification types	Operator is expected to take an action	Operator might need to be aware but is not required to take action *(Action might be expected from someone other than the operator.)*
Arises from an abnormal process or equipment situation	Alarm	Alert
Arises from a normal situation	Prompt	Status

Figure 6 – Sample criteria for notification types from an alarm philosophy

- SCADA systems should have support for:
  - Alarms
  - Other notifications: alerts, prompts, maintenance messages
  - Event messages
  - Logged-only events

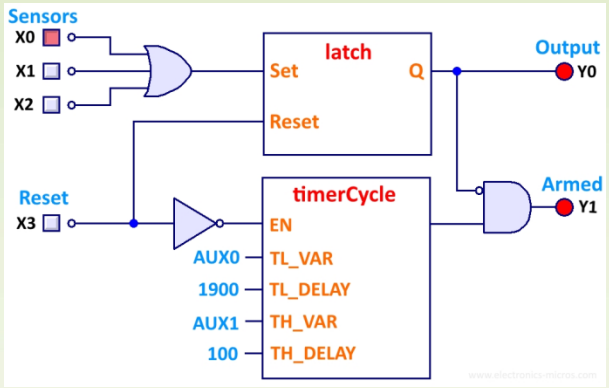
Alarm Management: Dedicated Alarm Display

- Dedicated screen for displays alarms – only alarms
- Ideally on its own dedicated monitor in multi-monitor setup

Date/Time	Type	Name	Tag Name	Value/Diff	Severity	Quality	Message	Acknowledgem...
2009-06-02 09:23:02	Limit	SULPHURIC	Channel_0_User_Defi...	0.009421819	Critical	192	lohi message sul	Required
2009-06-02 09:23:02	Deviation	TEST	Channel_0_User_Defi...	612.0	Catastrophic	192	hihi deviation message test	Required
2009-06-02 09:23:02	Limit	TEST	Channel_0_User_Defi...	48.0	Critical	192	lohi limit message test	Required
2009-06-02 09:22:58	Limit	HCL	Channel_0_User_Defi...	0.62438214	Catastrophic	192	hihi message hcl	Required
2009-06-02 09:22:58	Limit	MIXTURE	Channel_0_User_Defi...	20.004639	Critical	192	lohi message limit Mixture	Required
2009-06-02 09:22:58	Limit	SULPHURIC	Channel_0_User_Defi...	0.44344157	Critical	192	lohi message sul	Required
2009-06-02 09:22:57	Deviation	TEST	Channel_0_User_Defi...	315.0	Catastrophic	192	hihi deviation message test	Required
2009-06-02 09:22:57	Limit	TEST	Channel_0_User_Defi...	45.0	Critical	192	lohi limit message test	Required
2009-06-02 09:22:53	Limit	HCL	Channel_0_User_Defi...	0.97925013	Catastrophic	192	hihi message hcl	JAVED
2009-06-02 09:22:53	Limit	MIXTURE	Channel_0_User_Defi...	30.2655	Catastrophic	192	hihi message limit Mixture	JAVED
2009-06-02 09:22:53	Limit	SULPHURIC	Channel_0_User_Defi...	0.6835348	Critical	192	lohi message sul	JAVED
2009-06-02 09:22:52	Limit	TEST	Channel_0_User_Defi...	41.0	Critical	192	lohi limit message test	JAVED
2009-06-02 09:22:48	Limit	HCL	Channel_0_User_Defi...	0.047570862	Catastrophic	192	hihi message hcl	JAVED
2009-06-02 09:22:48	Limit	MIXTURE	Channel_0_User_Defi...	2.2709394	Low	192	lolo message limit Mix	JAVED
2009-06-02 09:22:48	Limit	SULPHURIC	Channel_0_User_Defi...	0.02965525	Critical	192	lohi message sul	JAVED
2009-06-02 09:22:48	Deviation	TEST	Channel_0_User_Defi...	721.0	Catastrophic	192	hihi deviation message test	JAVED
2009-06-02 09:22:48	Limit	TEST	Channel_0_User_Defi...	39.0	Critical	192	lohi limit message test	JAVED
2009-06-02 09:22:43	Limit	HCL	Channel_0_User_Defi...	0.3043463	Catastrophic	192	hihi message hcl	JAVED
2009-06-02 09:22:43	Limit	MIXTURE	Channel_0_User_Defi...	0.21913764	Critical	192	lohi message limit Mixture	JAVED
2009-06-02 09:22:43	Limit	SULPHURIC	Channel_0_User_Defi...	0.21913764	Critical	192	lohi message sul	JAVED
2009-06-02 09:22:43	Deviation	TEST	Channel_0_User_Defi...	424.0	Catastrophic	192	hihi deviation message test	JAVED
2009-06-02 09:22:43	Limit	TEST	Channel_0_User_Defi...	36.0	Critical	192	lohi limit message test	JAVED
2009-06-02 09:22:39	Limit	HCL	Channel_0_User_Defi...	0.96717703	Catastrophic	192	hihi message hcl	JAVED
2009-06-02 09:22:38	Limit	MIXTURE	Channel_0_User_Defi...	29.449152	Critical	192	lohi message limit Mixture	JAVED
2009-06-02 09:22:38	Limit	SULPHURIC	Channel_0_User_Defi...	0.66381353	Critical	192	lohi message sul	JAVED
2009-06-02 09:22:38	Deviation	TEST	Channel_0_User_Defi...	28.0	Catastrophic	192	hihi deviation message test	JAVED
2009-06-02 09:22:38	Limit	TEST	Channel_0_User_Defi...	32.0	Critical	192	lohi limit message test	JAVED
2009-06-02 09:22:34	Limit	HCL	Channel_0_User_Defi...	0.2701796	Catastrophic	192	hihi message hcl	JAVED
2009-06-02 09:22:34	Limit	MIXTURE	Channel_0_User_Defi...	8.772794	Medium	192	lo message limit Mixture	JAVED
2009-06-02 09:22:33	Limit	SULPHURIC	Channel_0_User_Defi...	0.18136518	Critical	192	lohi message sul	JAVED
2009-06-02 09:22:33	Deviation	TEST	Channel_0_User_Defi...	830.0	Catastrophic	192	hihi deviation message test	JAVED
2009-06-02 09:22:33	Limit	TEST	Channel_0_User_Defi...	30.0	Critical	192	lohi limit message test	JAVED
2009-06-02 09:22:29	Limit	HCL	Channel_0_User_Defi...	0.06492469	Catastrophic	192	hihi message hcl	JAVED
2009-06-02 09:22:29	Limit	MIXTURE	Channel_0_User_Defi...	3.1376188	Low	192	lolo message limit Mix	JAVED

Alarm Management: Programming Best Practices

- Use a standardized function block in your PLC for all alarms
- Key Features:
  - Raw Status vs. Alarm Bit
  - Condition Inversion
  - Logic-Based Suppression
  - ON-Delay
  - OFF-Delay
  - Shelving / Out of Service support (if required at PLC-level)
- Additional Features for Analog/Value Alarms
  - Deadband
  - Alarm Masking if Signal is Bad
  - Masking of Lesser Alarms (L vs. LL)
  - Rate of Change



Data Redundancy

Data Redundancy: Logging Data

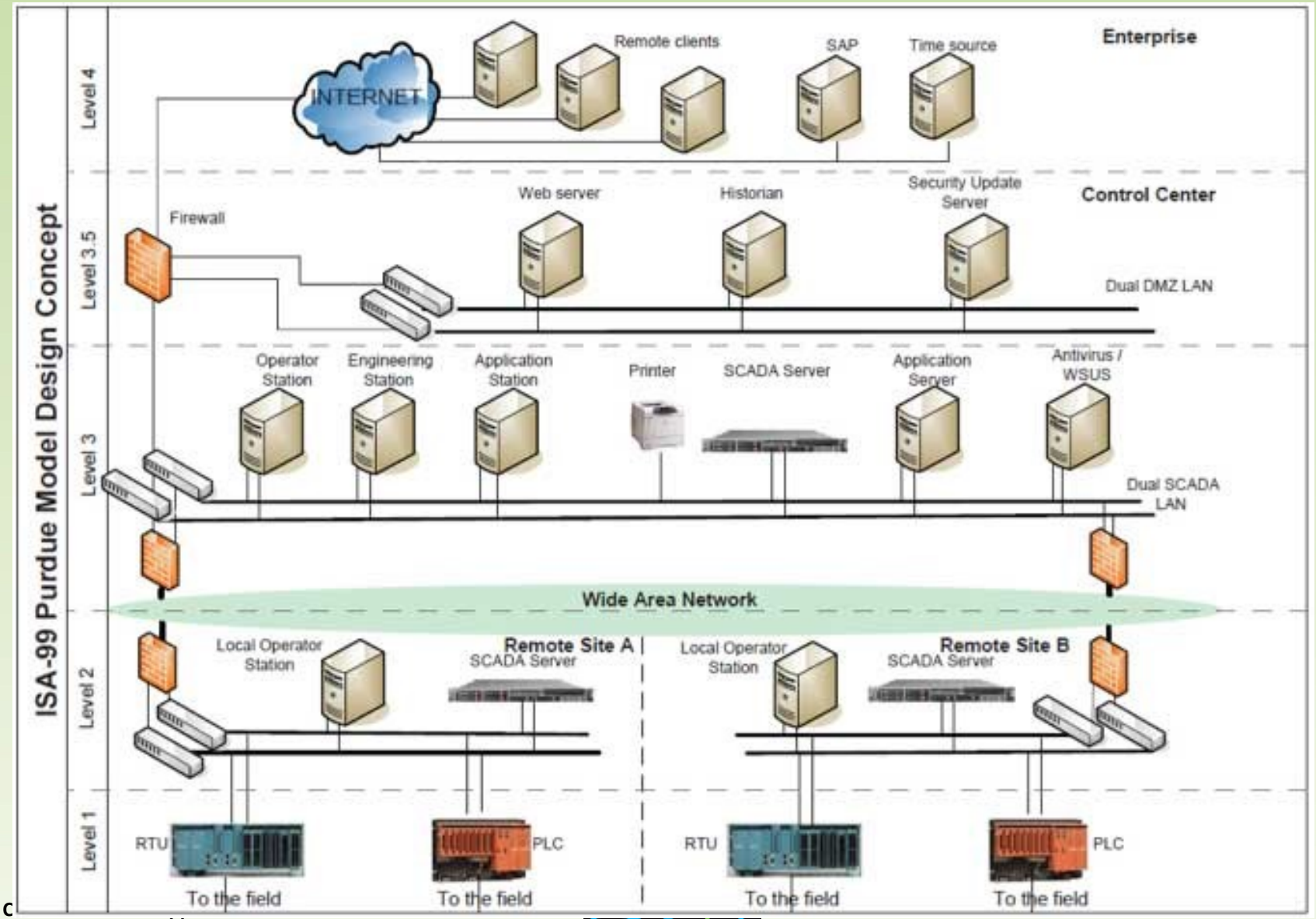
- O.Reg. 170 requires us to log chlorine residuals every 5 minutes (water)
- Permits require us to track flow rates and flow totals at facilities

- SCADA Systems are not perfect: unit failures and network outages do happen
- Best Practice is to have redundant data logging
  - Main SCADA System logging data
  - Data loggers at sites

- Existing Practice
  - Redundant data loggers. Data must be gathered or imported manually into reporting system
  - Custom programming often needed to implement backup data logging in PLCs

- New Developments
  - New data loggers and operator terminals that do store/forward data logging
  - Reporting systems and historians that can accept data from multiple sources
  - Networking Protocols, e.g., DNP3, that have built-in time- stamping & store/forward logging

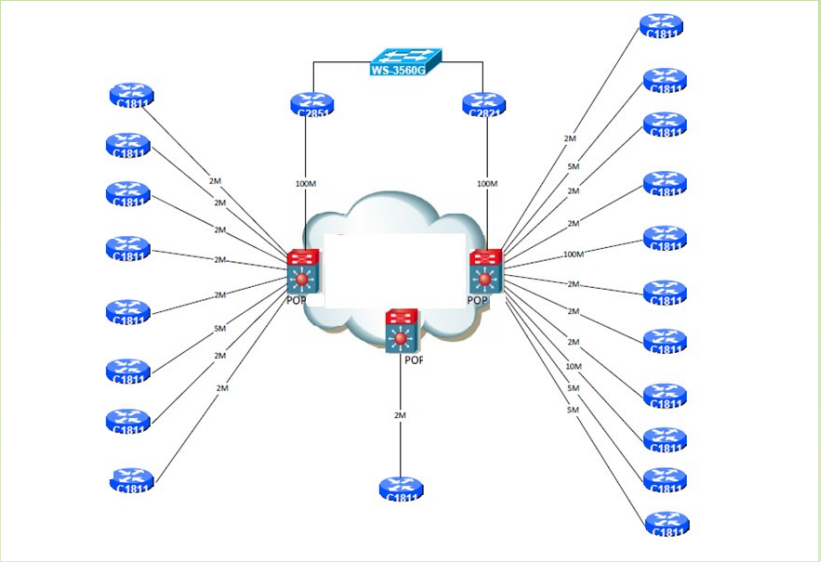
Data Redundancy: Logging Data



SCADA Network Redundancy

SCADA Network Redundancy

- SCADA is critical to operations
  - Data Logging,
  - Situational Awareness,
  - Remote Control by Operators,
  - Automatic Control,
  - Alarms,
  - Reporting



- SCADA relies on its process control network to stay online
  - In-plant Ethernet networks
  - Wide Area Networks (WAN) to remote sites

- Without the SCADA network, the SCADA system cannot operate

SCADA Network Redundancy

- **O.Reg. 170 – Drinking Water Systems**
- Free Chlorine Residuals Must be Logged Minimum Every 5 minutes
- Low chlorine alarms must be communicated promptly

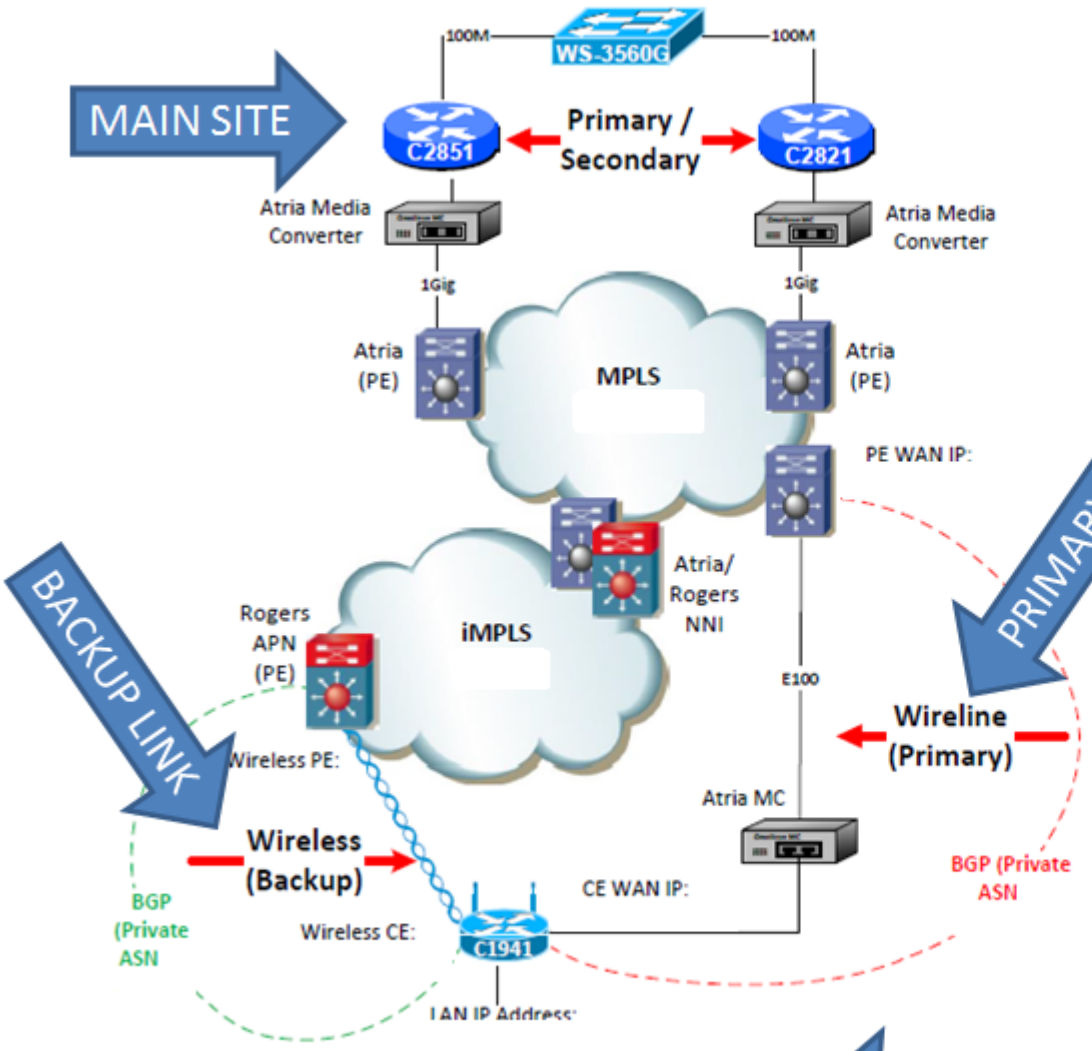
- **Very challenging to meet this uptime for a SCADA network**
- SCADA system must be online 24/7, 365 days/year
- Less than 5 min downtime/year = 99.9995% uptime
- Most IT Systems only reach 95 to 99% uptime (outages at night ok)
- SCADA system has to be **10,000 X more reliable** than an IT system

SCADA Network Redundancy

- **SCADA Network Technologies**
  - **Fibre optic (public)***
  - **Fibre optic (MPLS)**
  - **Fibre optic (utility owned)**
  - **Cellular / Wireless***
  - **DSL (private or public)***
  - **Radios – licensed***
  - **Radios – unlicensed***
  - **Bell Lines**
  - **Private Cables**
  - **?**

*these approaches usually require extra VPN routers/firewalls be used

SCADA Network Redundancy: One Solution



Main site objectives:

- Maintain status quo with existing Primary / Secondary (standby) routers (no config. changes)
- Both Primary and Secondary routers will continue to handle traffic via existing Atria MPLS network
- Rogers will extend a connection from Atria network to Rogers EON network via a new inter-as bridge specific to the customer's VRF
- Both Primary / Secondary routers will communicate to new Wireless backup accesses over this bridge via the existing Atria MPLS network over BGP

Remote sites objectives:

- Maintain current Atria access via Fiber/MC
- Replace current Atria Router with a Rogers Managed Cisco 1941 router w/HSPA+ wireless backup module & antenna
- Rogers will build a new MPLS customer VRF on the EON platform and inter-connect this with the Atria MPLS customer VRF
- Wireless backup will be via Rogers EON network back to Atria MPLS via inter-as bridge
- Wireline primary access will be direct from 1941 to Atria MPLS core via BGP
- Wireless will use AS Prepend inbound and local pref outbound for Wireline
- Assumptions:

1. Private AS different from Host AS (no AS-Override Required)
2. Hub and Spoke will be maintained and each spoke will re-use the same Private-As (not required but can be done)

Cyber Security

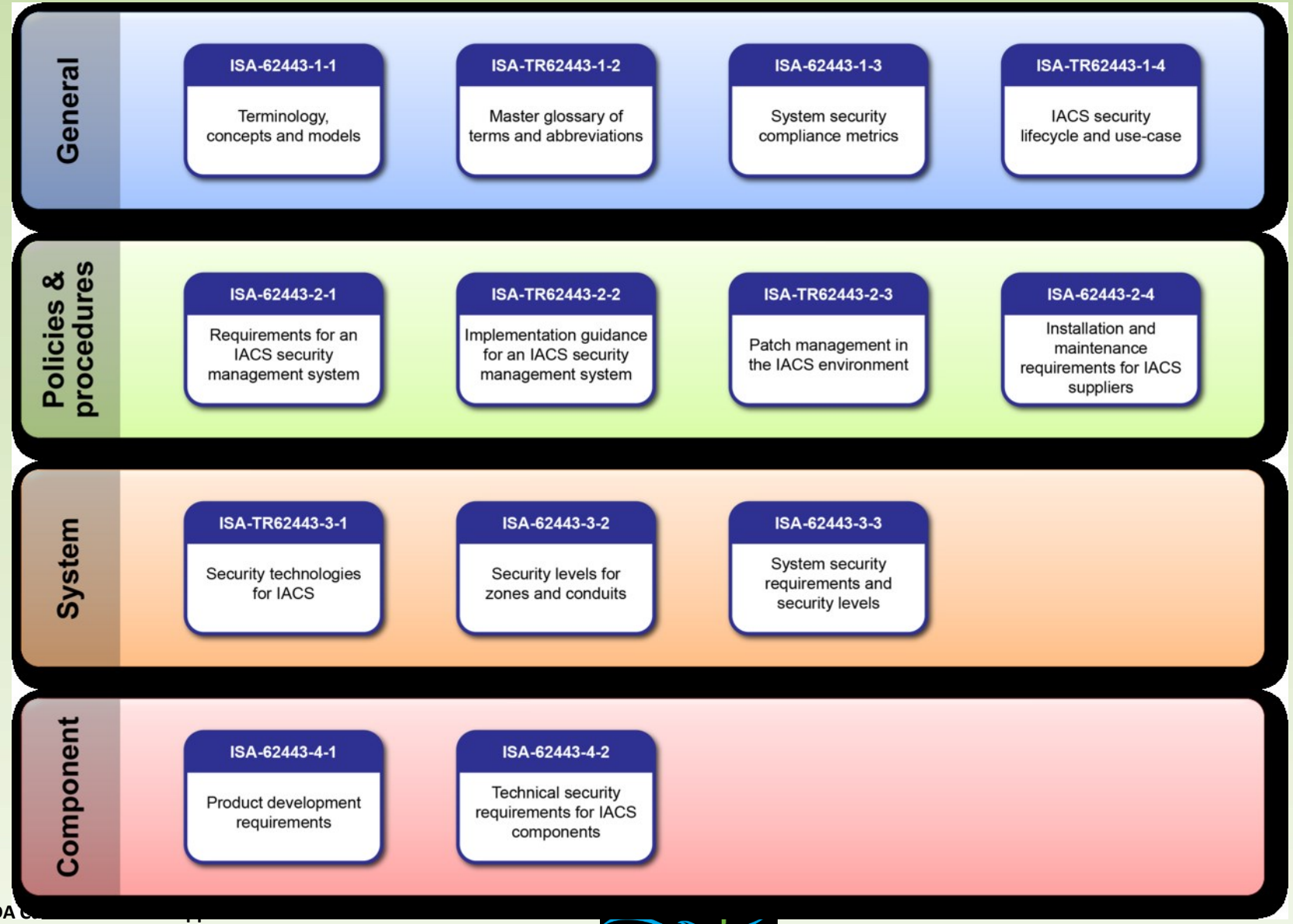
SCADA Cyber Security

- You need to protect your SCADA system for unauthorized access
- In the past this was difficult to do
- Requires multipronged approach
  - People
  - Process
  - Technology

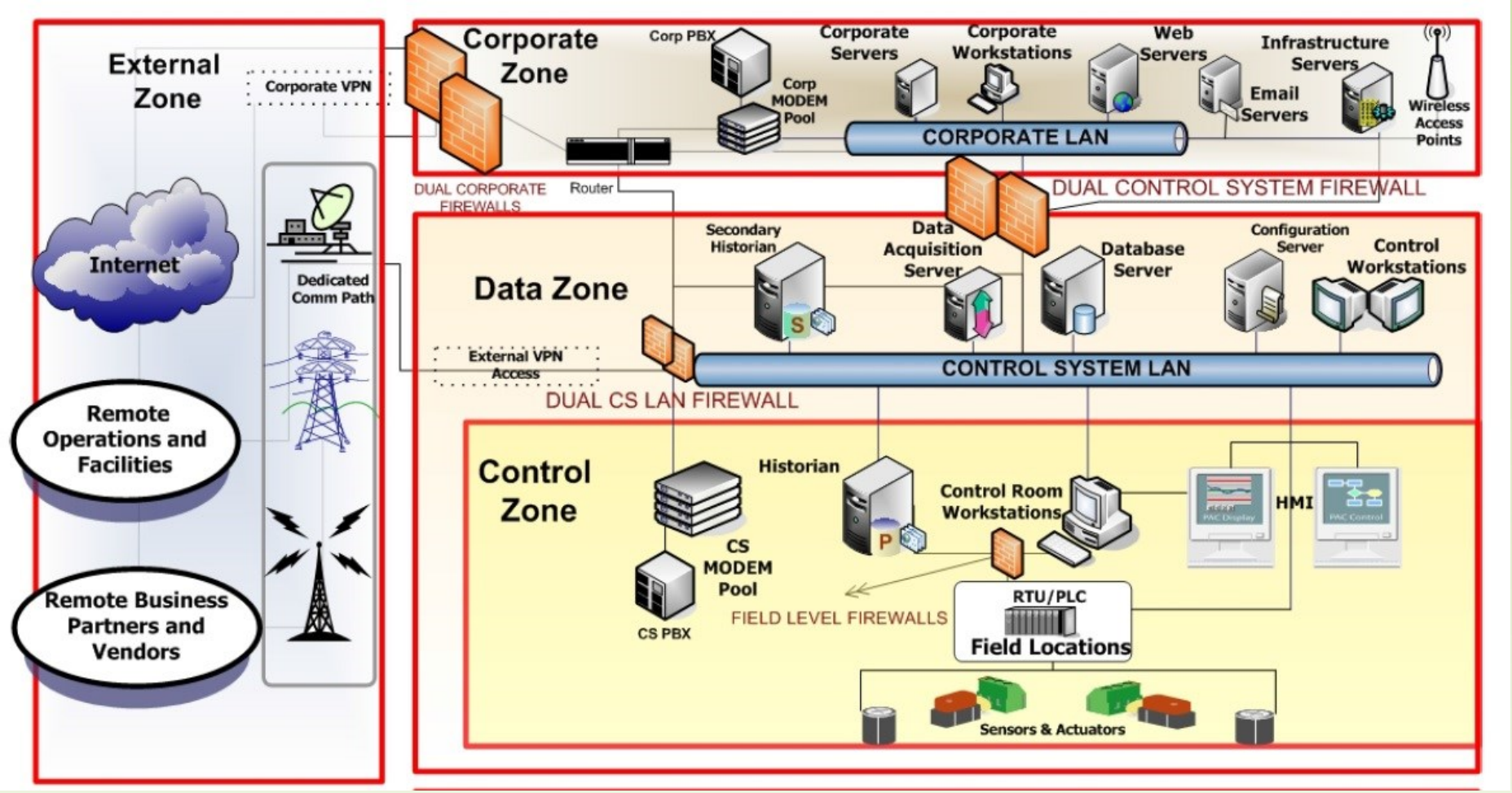
SCADA control system networks must be kept separate from Corporate IT networks

- There is guidance now available on how to do this
  - ISA/IEC-62443 (formerly known as ISA-99)
  - AWWA GW430
  - NIST Cyber Security Framework

SCADA Cyber Security: ISA/IEC-62443



SCADA Cyber Security: ISA/IEC-62443



Build on What you Have

- SCADA is essential for both Operations and Compliance

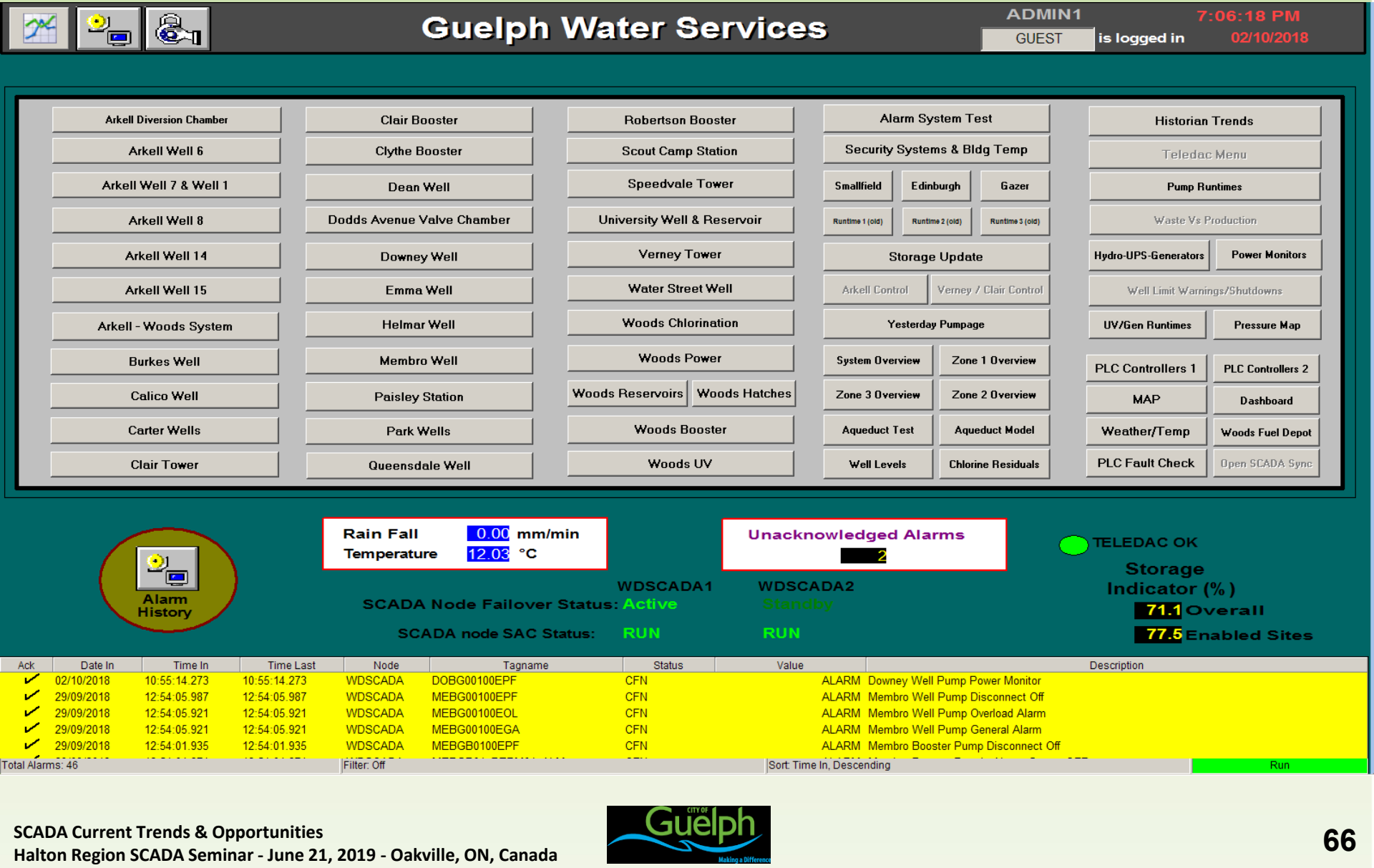
- Operators Need Situational Awareness to Operate Effectively
- Use the SCADA HMI to show the whole picture to operators
- SCADA Alarms systems must be rationalized/documented

- Pay attention to data integrity by investing in data redundancy
- SCADA networks are key to robust SCADA systems
- Cyber Security is requires a multi-pronged approach

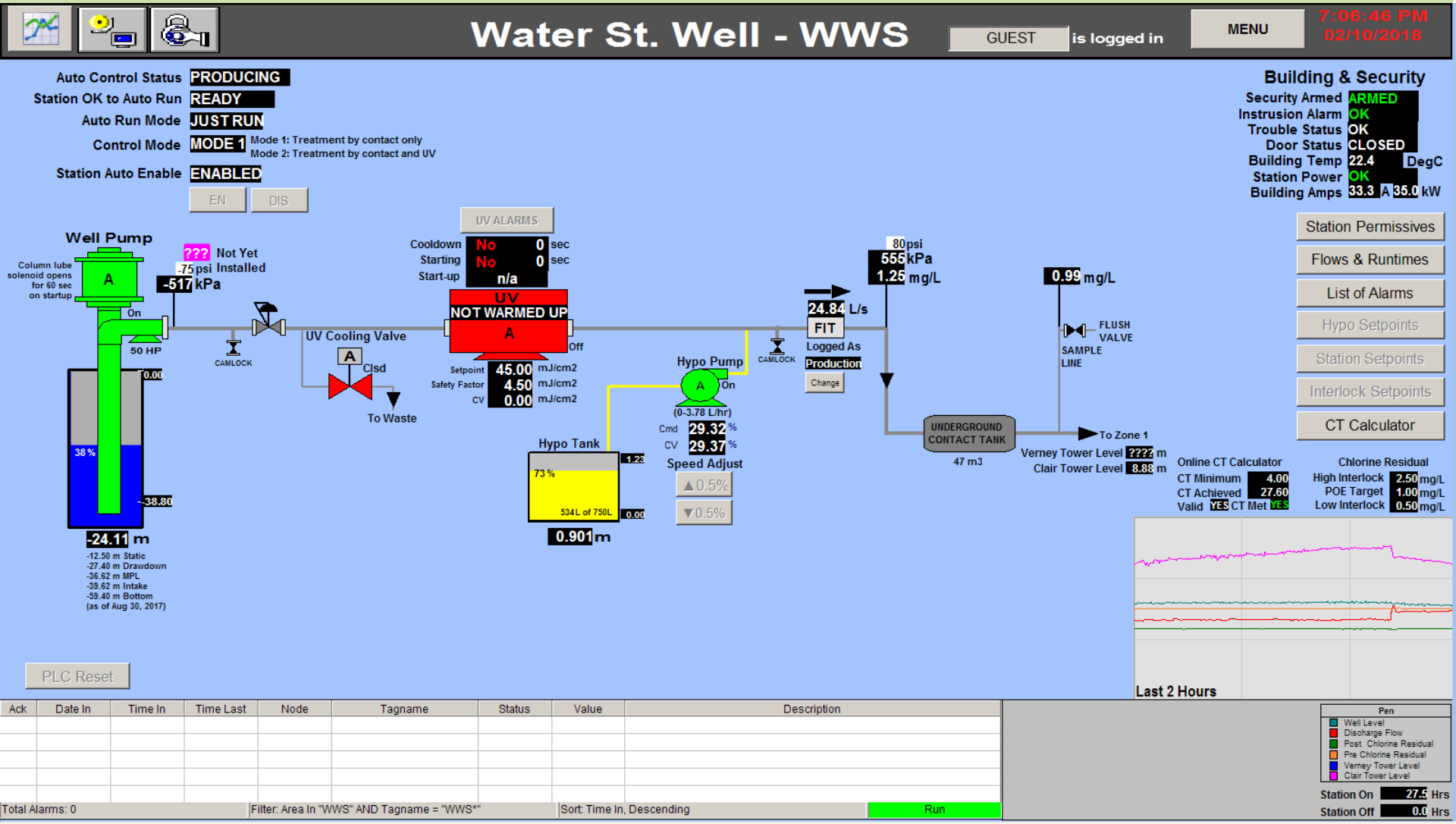
- When upgraded SCADA systems, leverage what you have
- Take advantage of new technology and ideas

How Guelph Water is Applying these Concepts

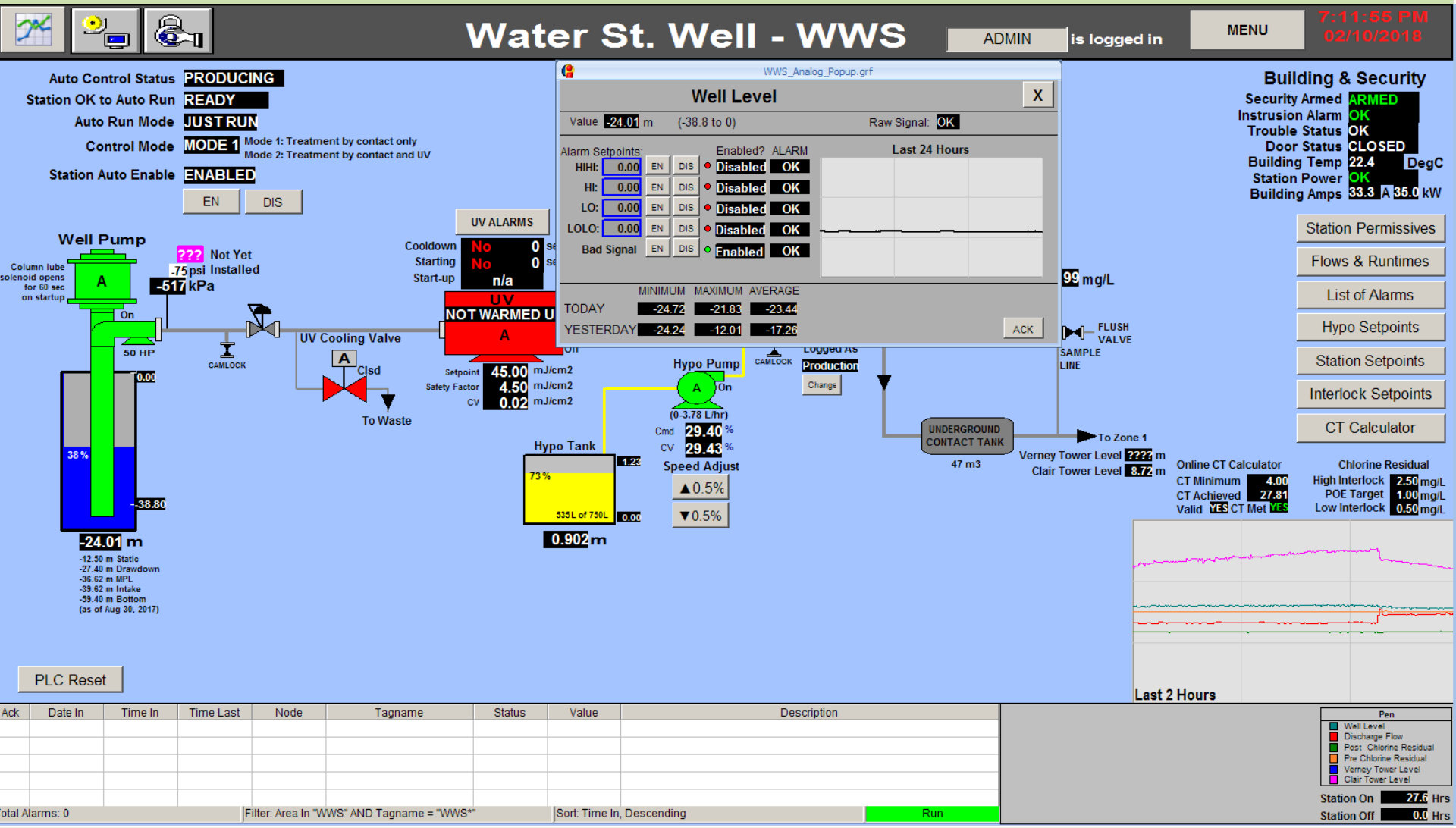
SCADA: What Guelph Water is doing



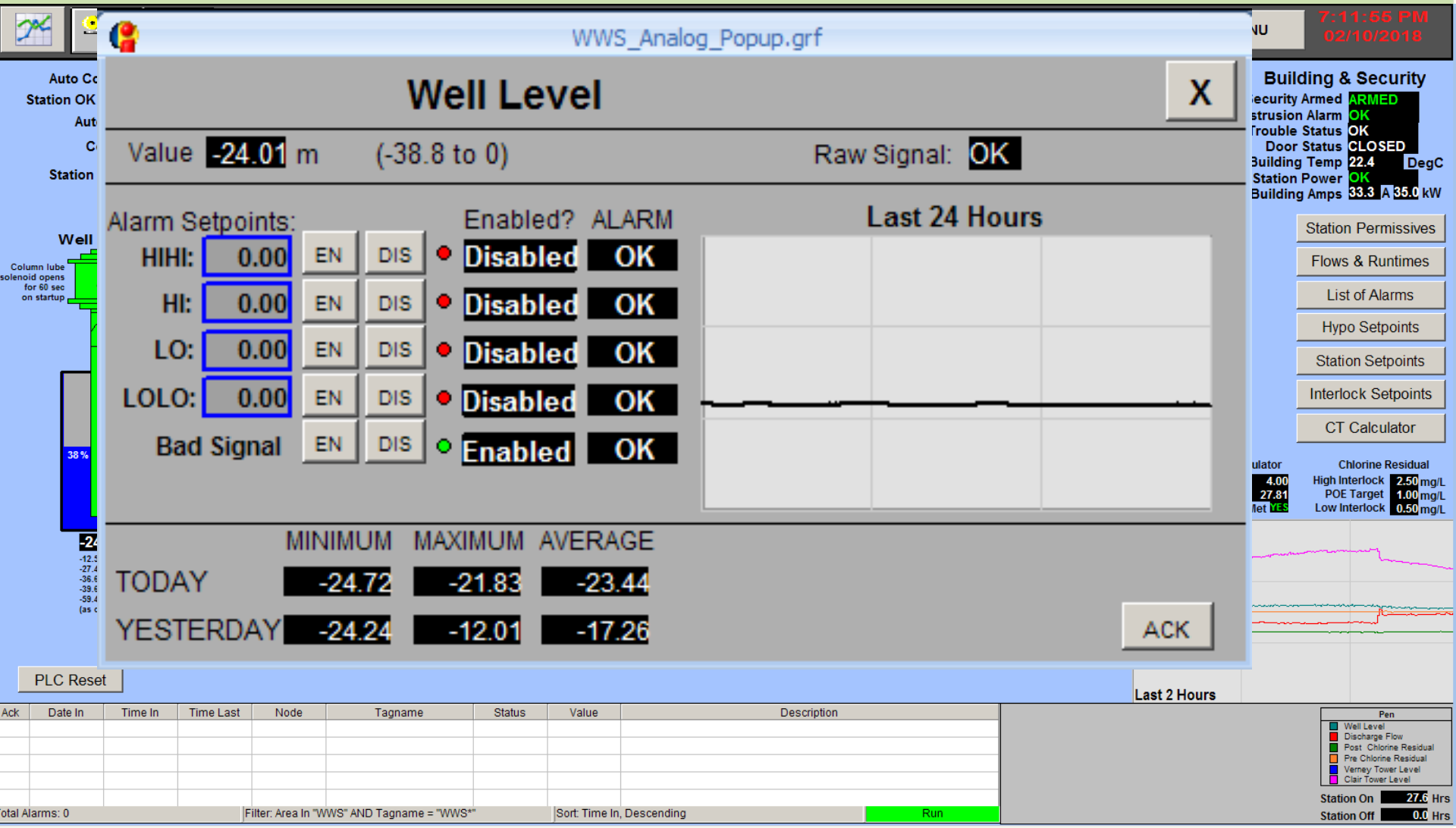
High Density Information – careful use of colour



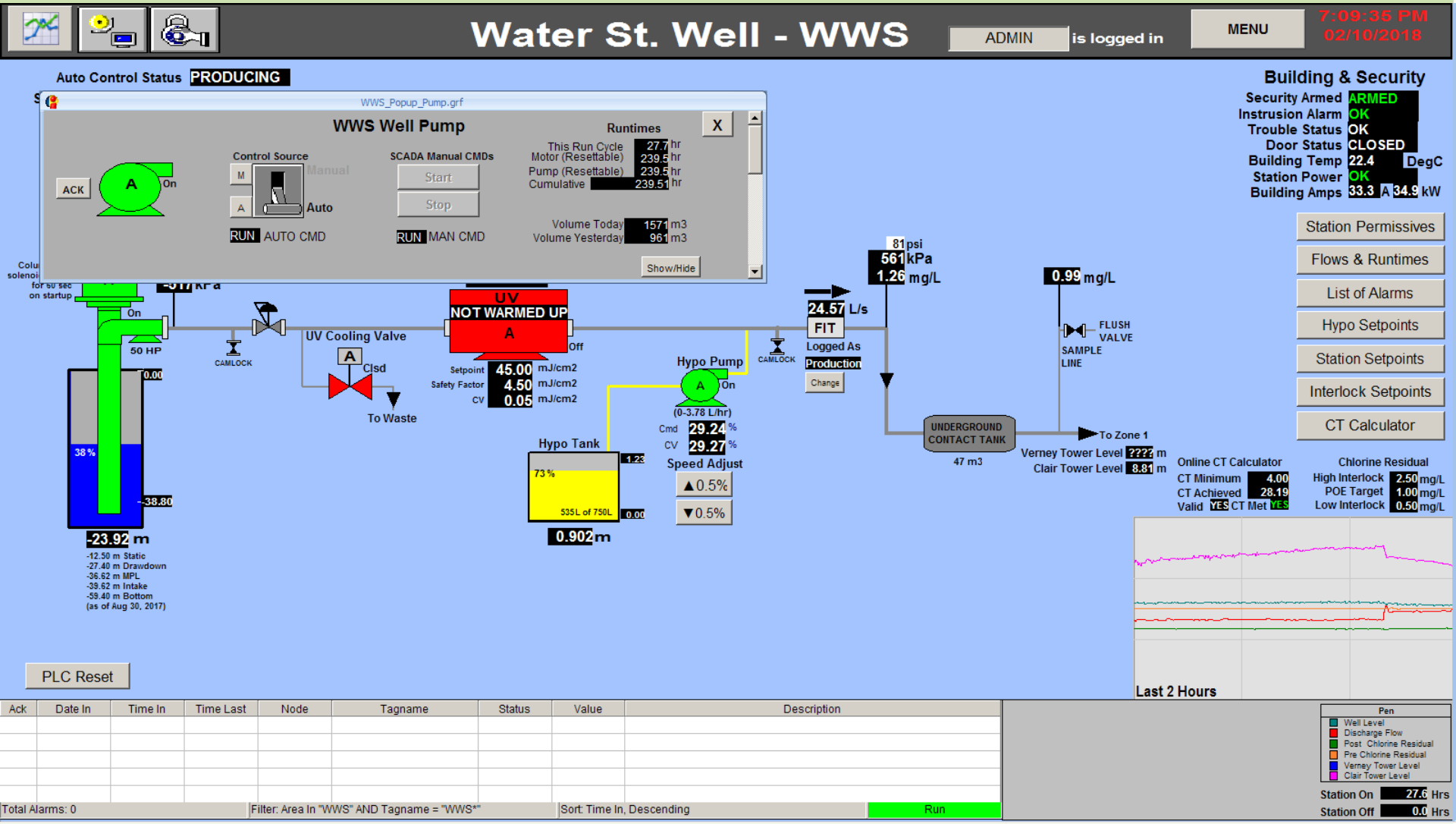
Better Pop-Up Windows



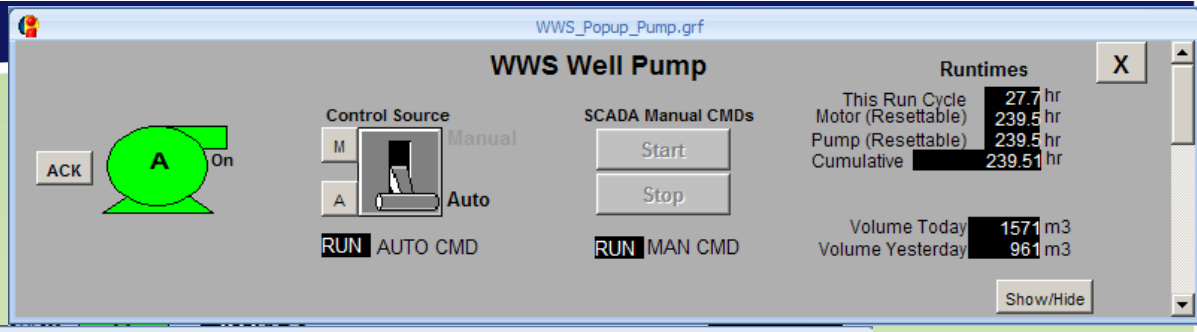
Better Pop-Up Windows – “analogs”



Better Pop-Up Windows – pump starter



Better Pop-Up Windows - pumps



WWS_Popup_Pump.grf

WWS Well Pump

X

ACK

A On

Control Source

M

A

Manual

Auto

SCADA Manual CMDs

Start

Stop

Runtimes

This Run Cycle 27.7 hr
Motor (Resettable) 239.5 hr
Pump (Resettable) 239.5 hr
Cumulative 239.51 hr

RUN AUTO CMD

RUN MAN CMD

Volume Today 1571 m3
Volume Yesterday 961 m3

Show/Hide

Permissives

Facility Power OK	01 OK
Well Pump Starter Power OK	02 OK

Interlocks (Reset Required)

		Man.	Auto
Well Level Below MPL	01	OK	OK
Well Pump Flow Rate Above Permit	02	OK	OK
Well Pump Daily Flow Above Permit	03	OK	OK
Well Pump Starter Fault	04	OK	OK
Well Pump Low Flow (< 5L/s, 30s)	05		OK
Global Chlorine Interlock	06	OK	OK
Hypo Pump Interlocked	07		OK
Hypo Pump Did Not Start In 5 Sec	08		OK
Well Level Bad Signal	09		OK
UV Lost Warmed Up Status (Mode 2)	10	OK	OK
UV Interlocked (Mode 2)	11	OK	OK
Well Pump E-Stop Pressed	12	OK	OK
Hardwired Low Chlorine Interlock	13	OK	OK

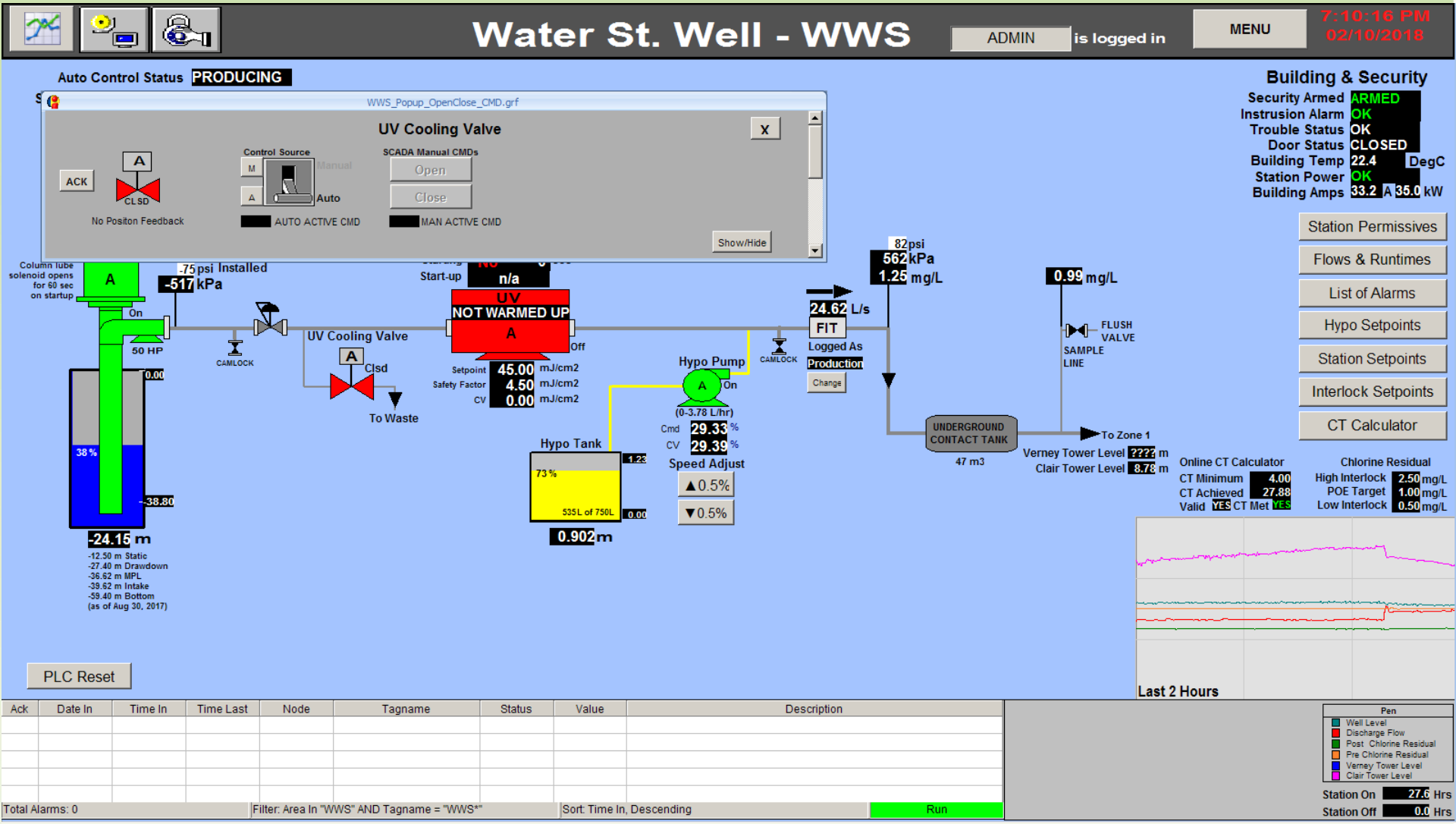
Alarms

(S) Well Pump Fail to Start Alarm	01	OK
(S) Well Pump Fail to Stop Alarm	02	OK
(S) Well Pump Uncommanded Start Alarm	03	OK
(S) Well Pump Uncommanded Stop Alarm	04	OK
Well Pump Starter No Power	05	OK
Well Pump Left In Local For 30 min	06	OK
Well Pump Starter Fault Alarm	07	OK
Well Level Near MPL Alarm	08	OK
Well Pump Daily Flow Near Permit Alarm	09	OK
Well Pump Flow Near Permit Alarm	10	OK
Well Pump Shutdown on Interlock Alarm	11	OK
Well Pump E-Stop Pressed Alarm	12	OK

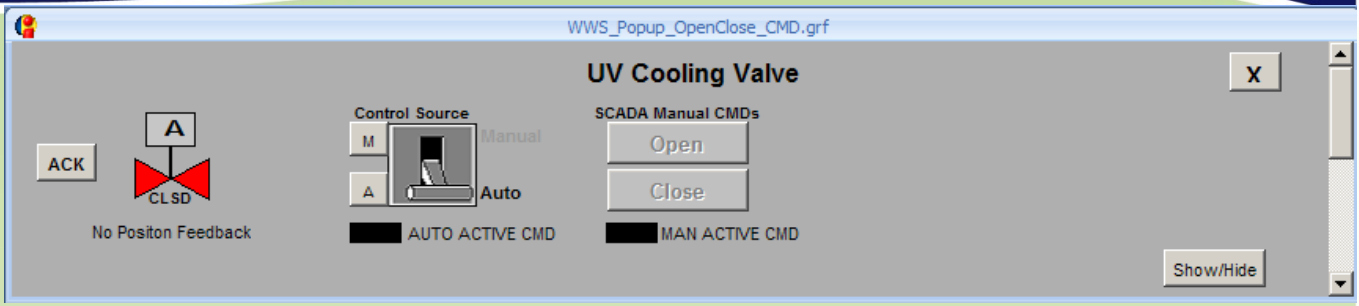
○ Enabled
● Disabled

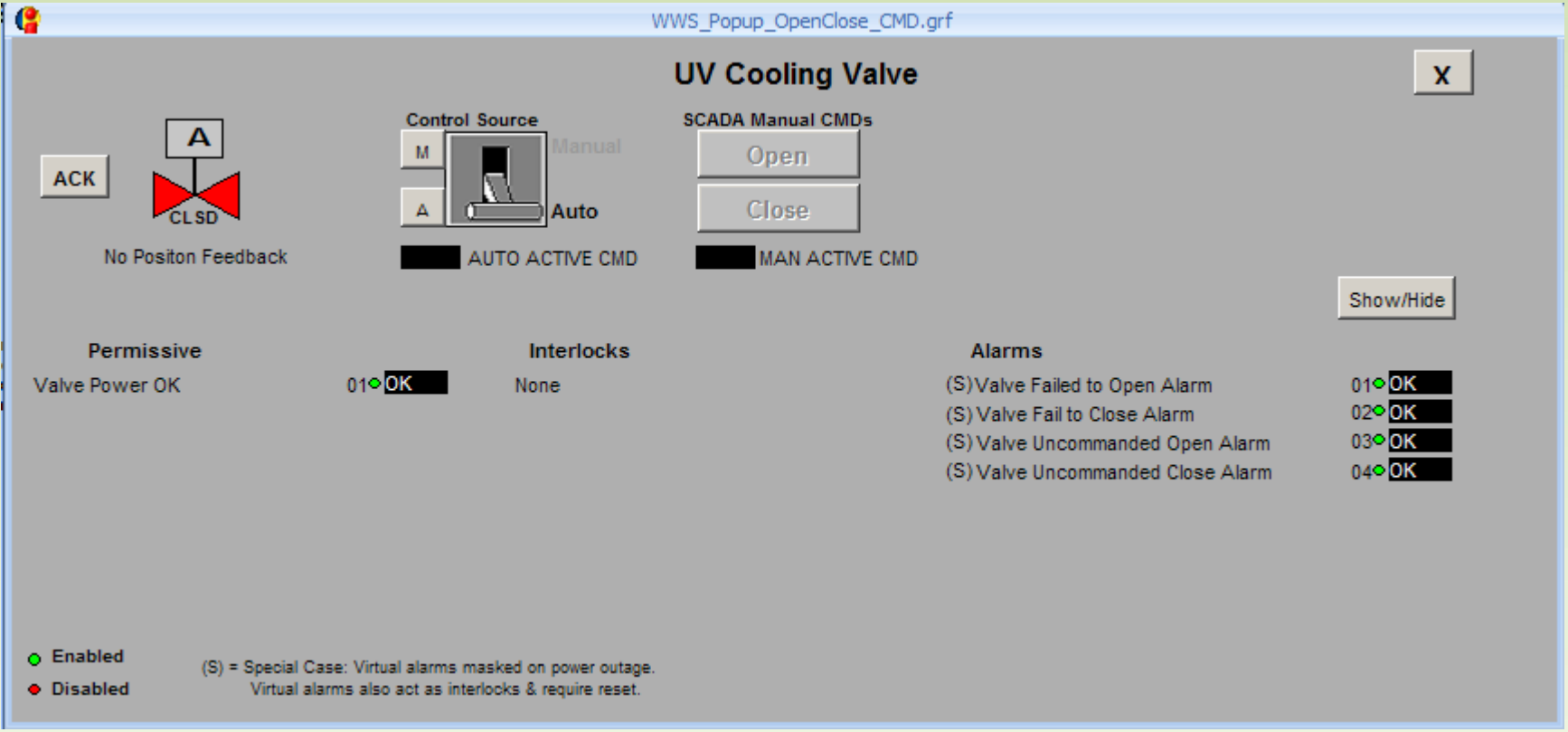
(S) = Special Case: Virtual alarms masked on power outage.
Virtual alarms also act as interlocks & require reset.

Better Pop-Up Windows – motorized valve

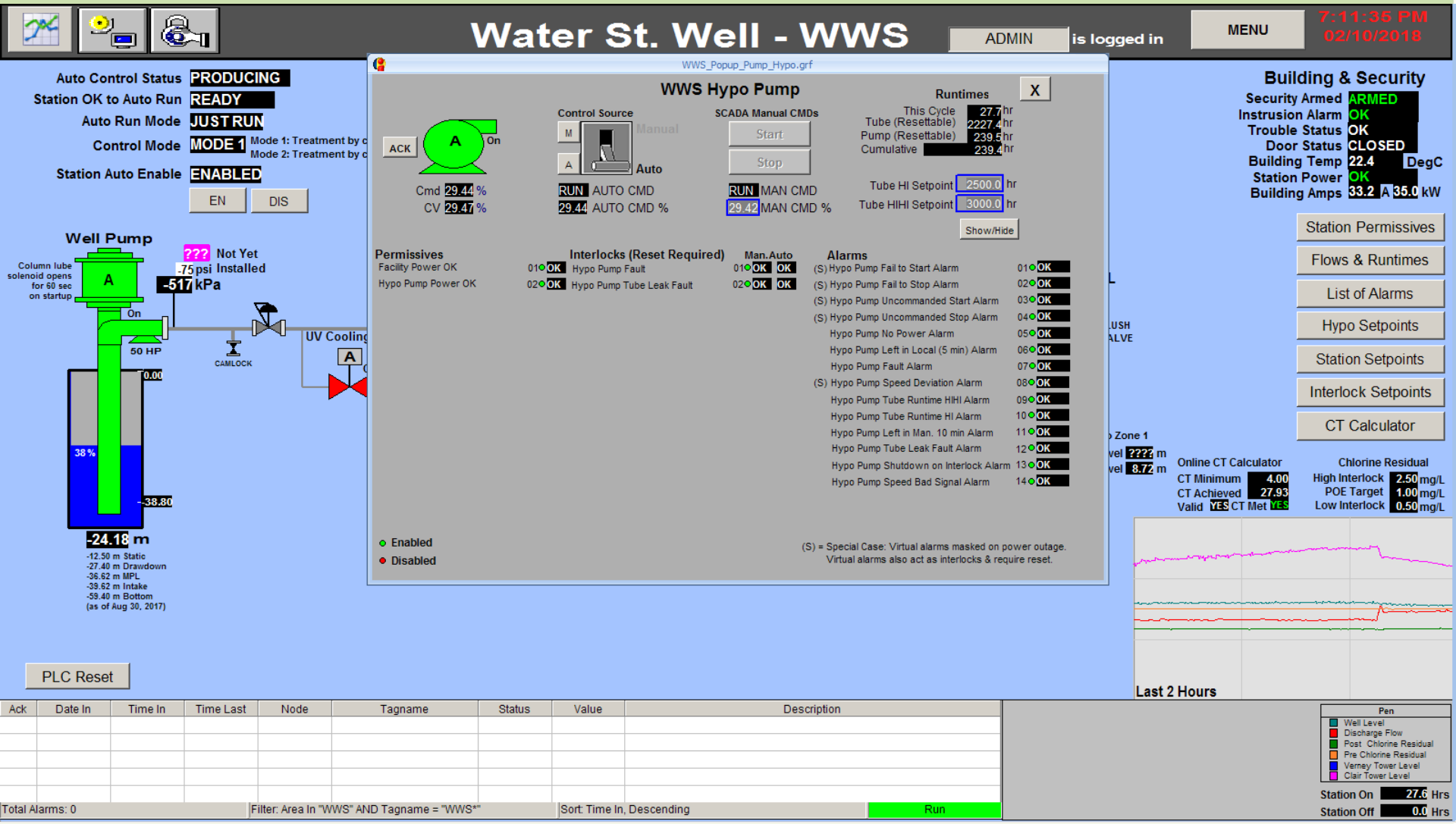


Better Pop-Up Windows - Motorized Valves

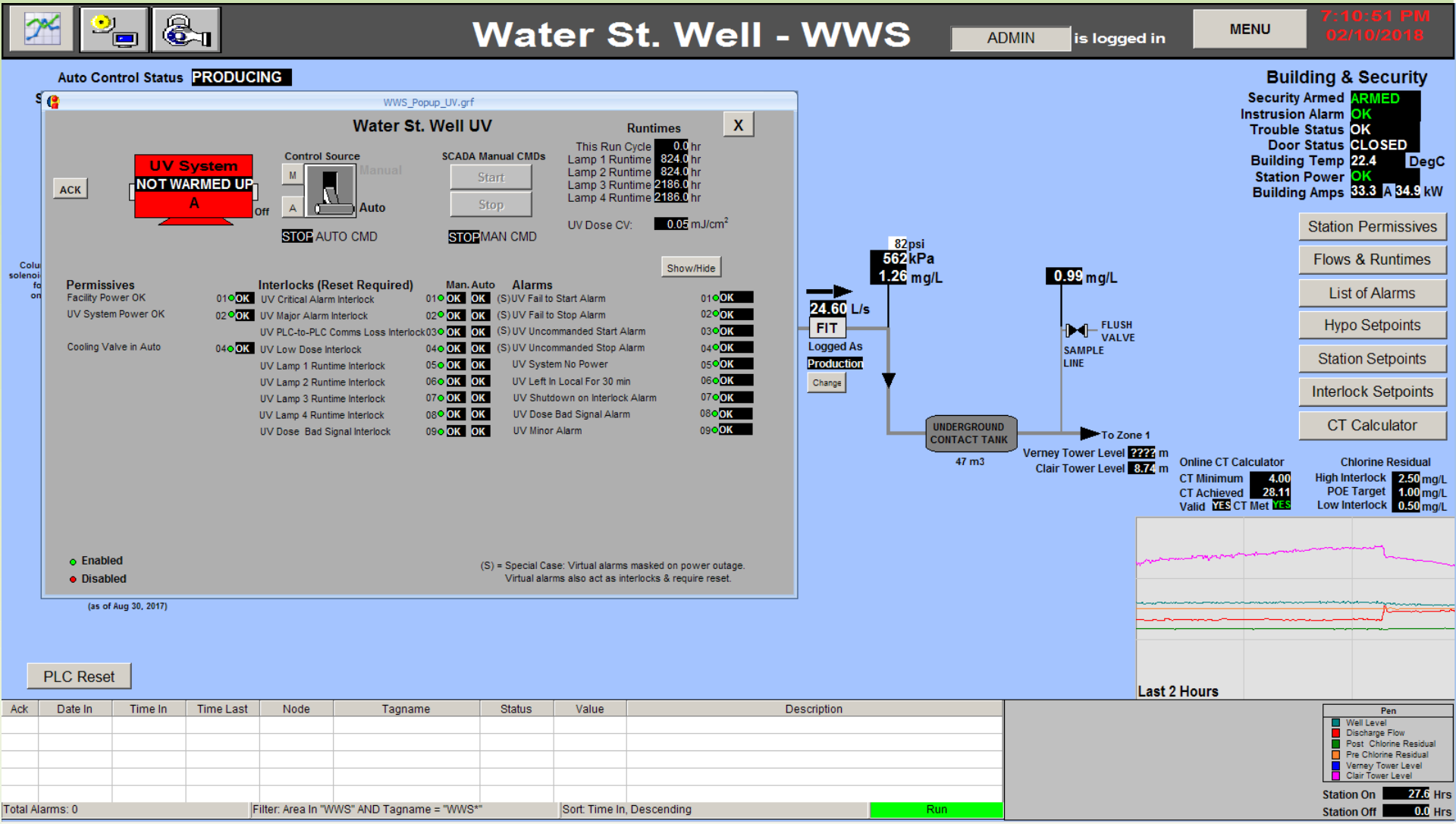




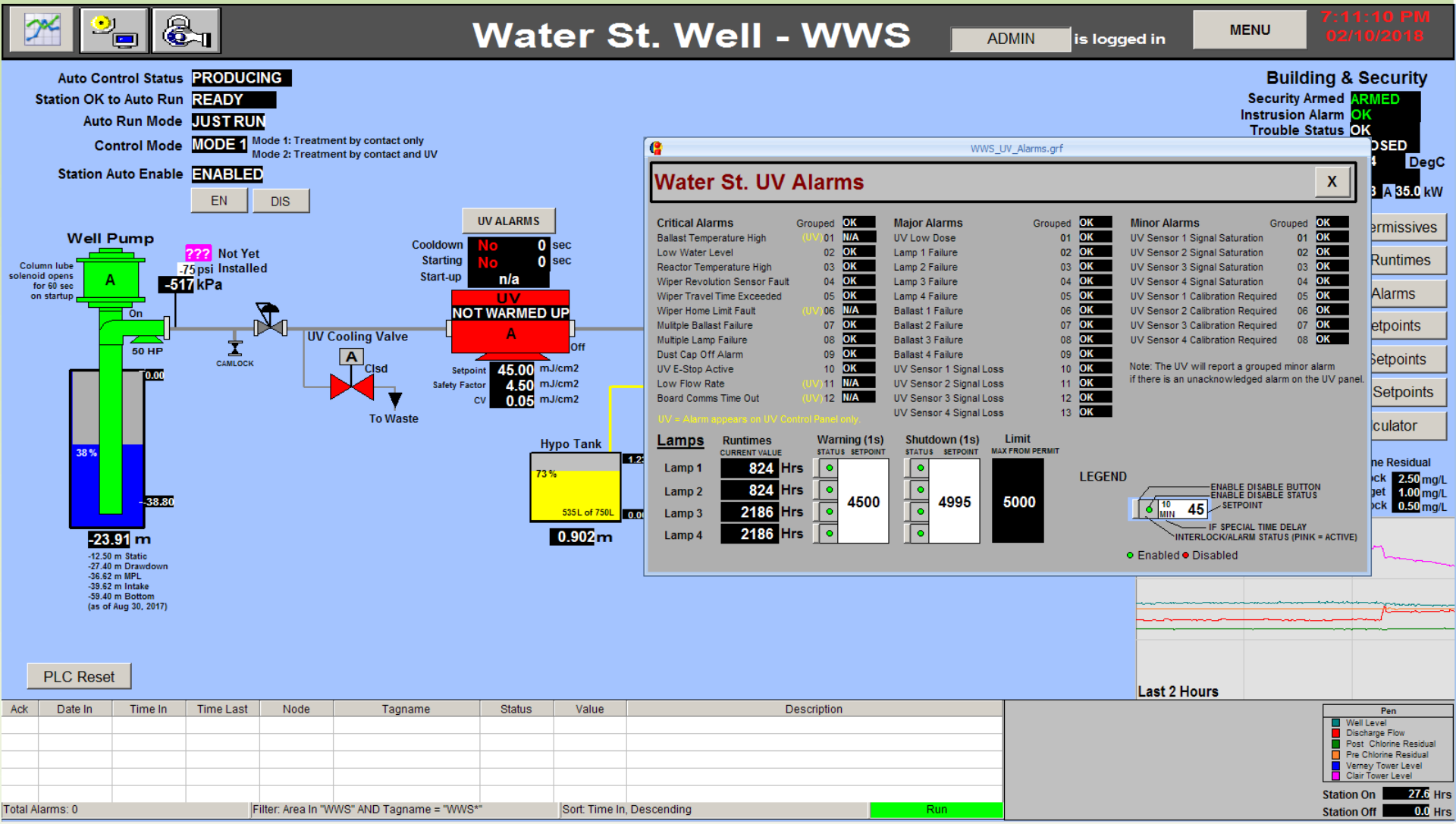
Better Pop-Up Windows – hypo dosing pump



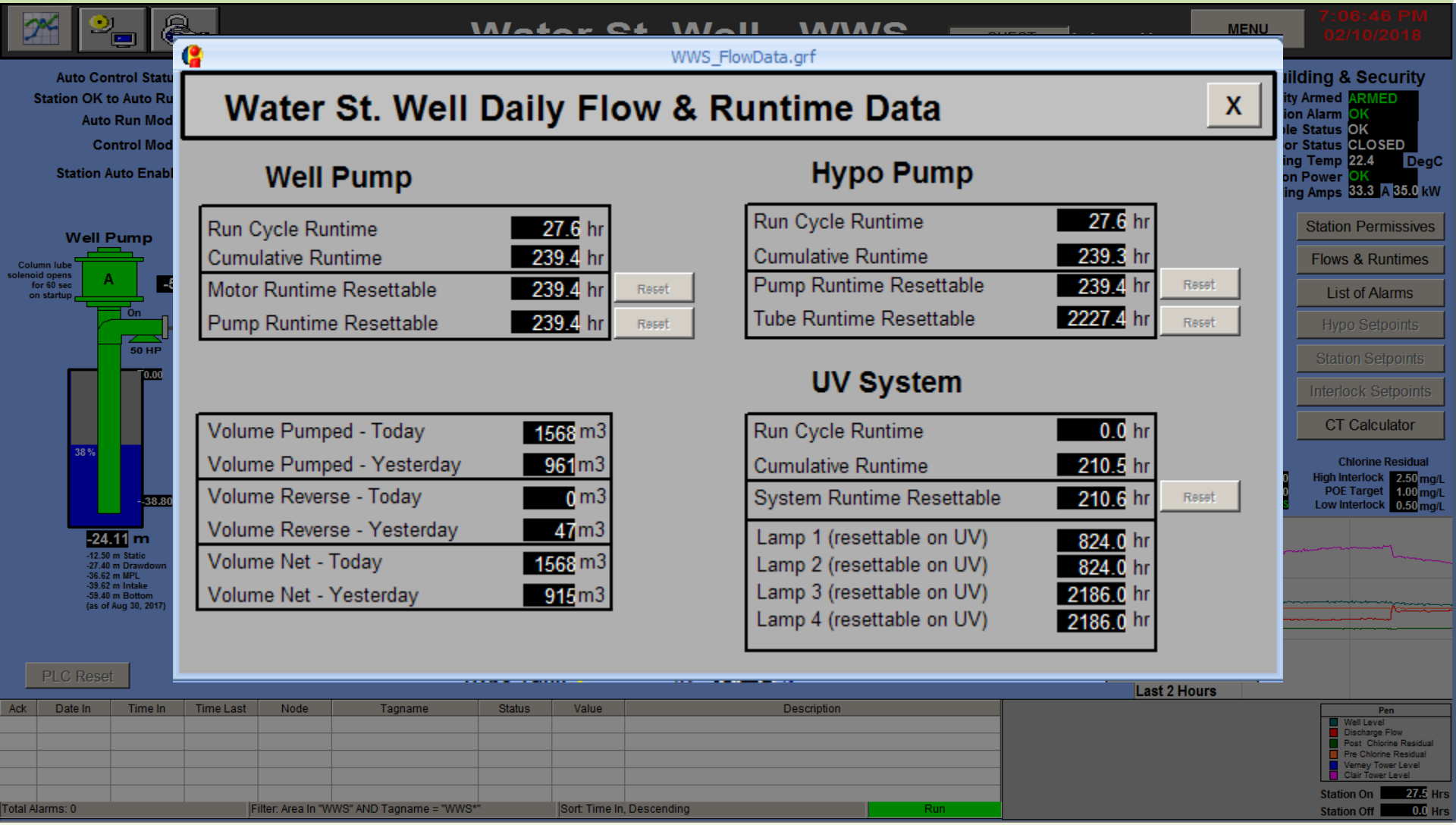
Better Pop-Up Windows – UV System



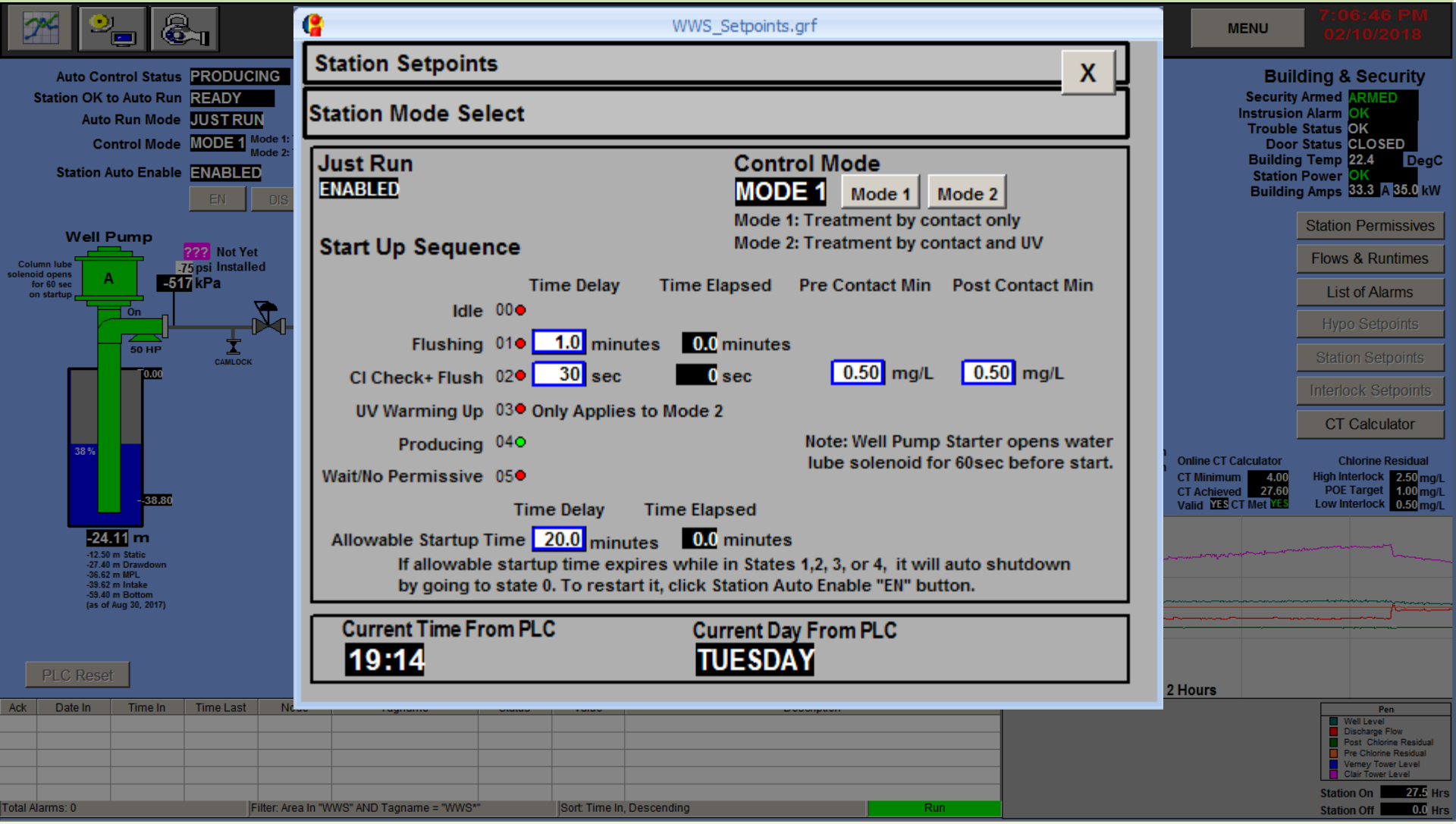
Better Pop-Up Windows – UV System specific alarms



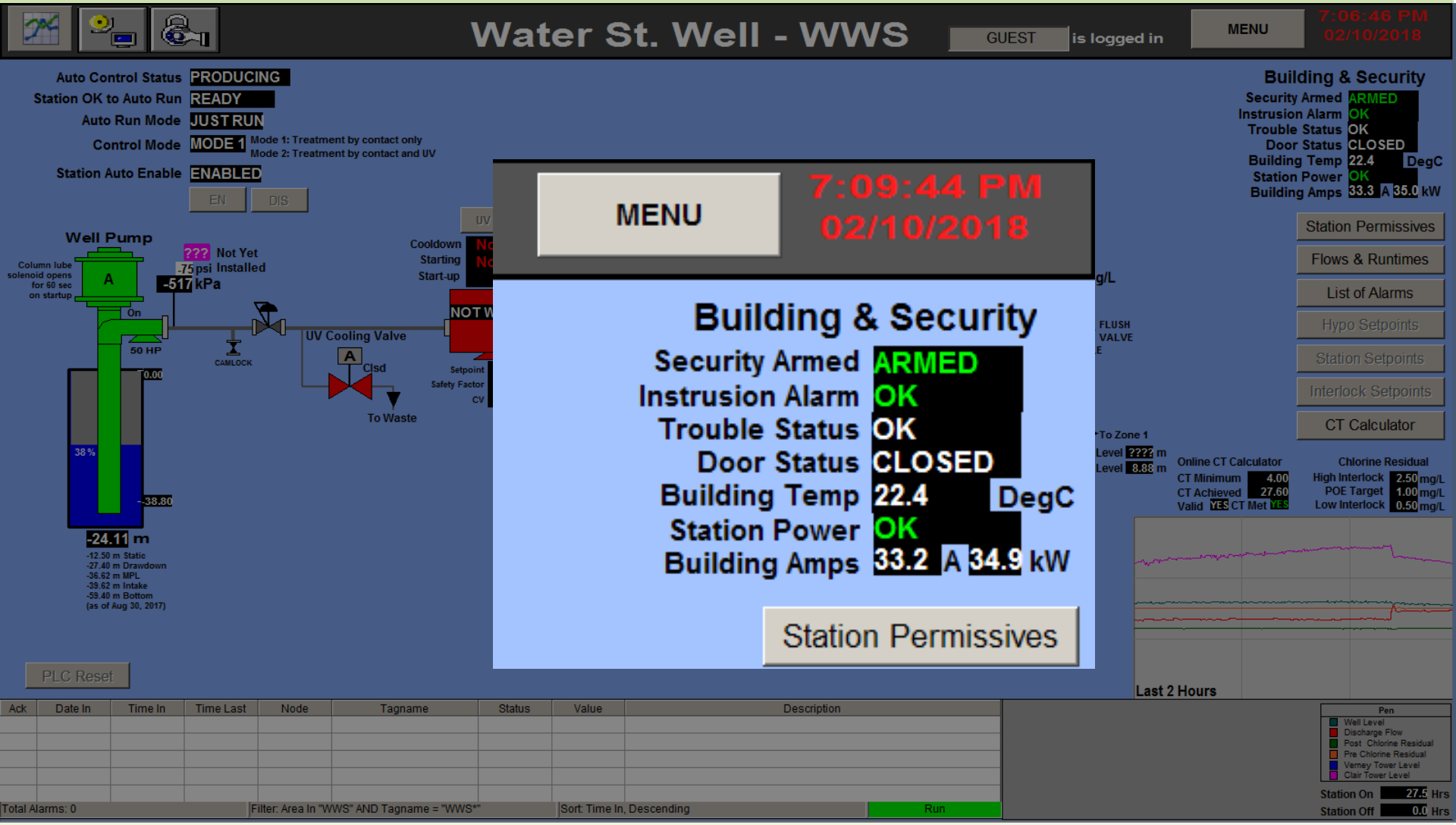
Pump Runtimes



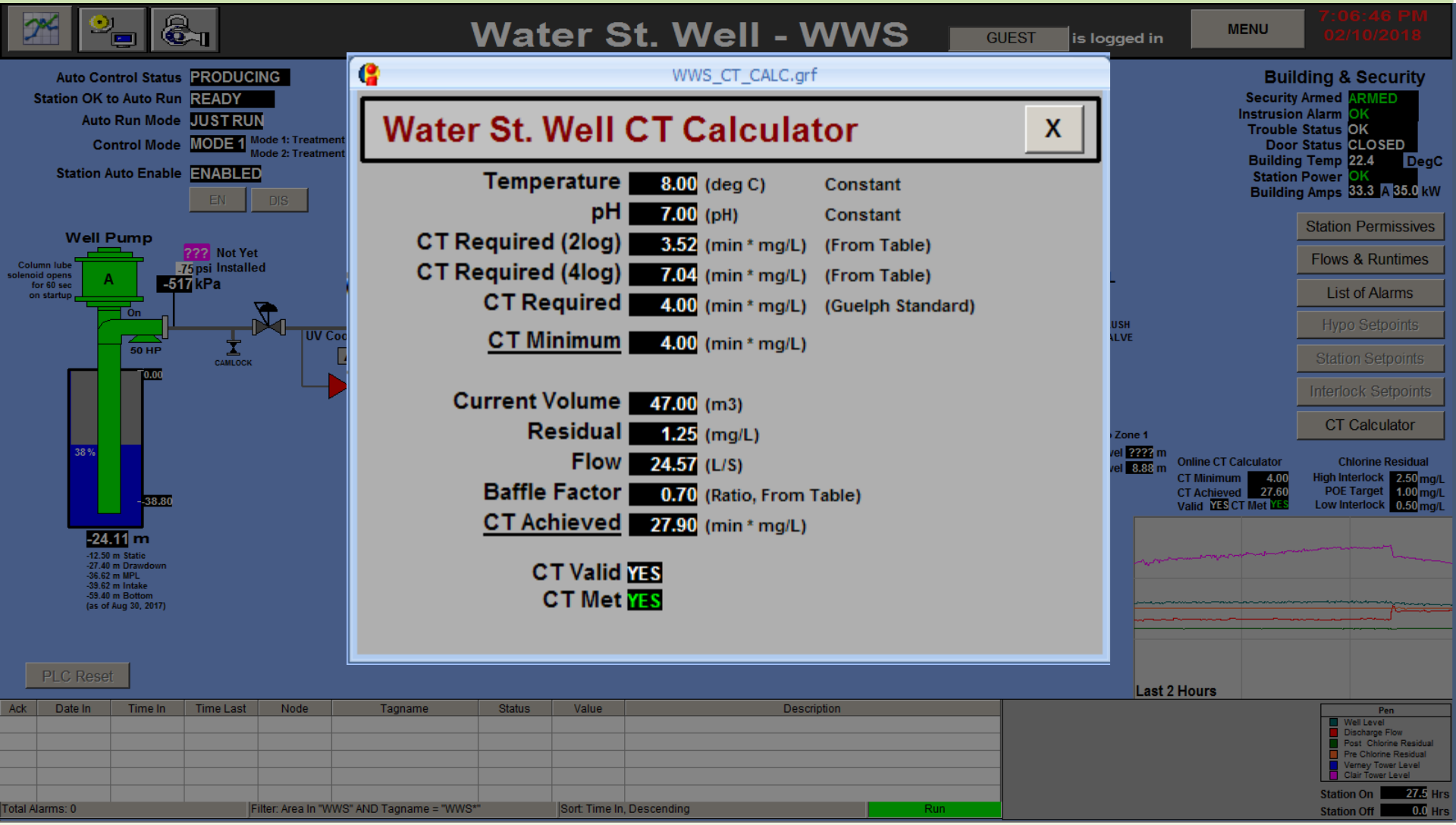
Status Information on Sequences



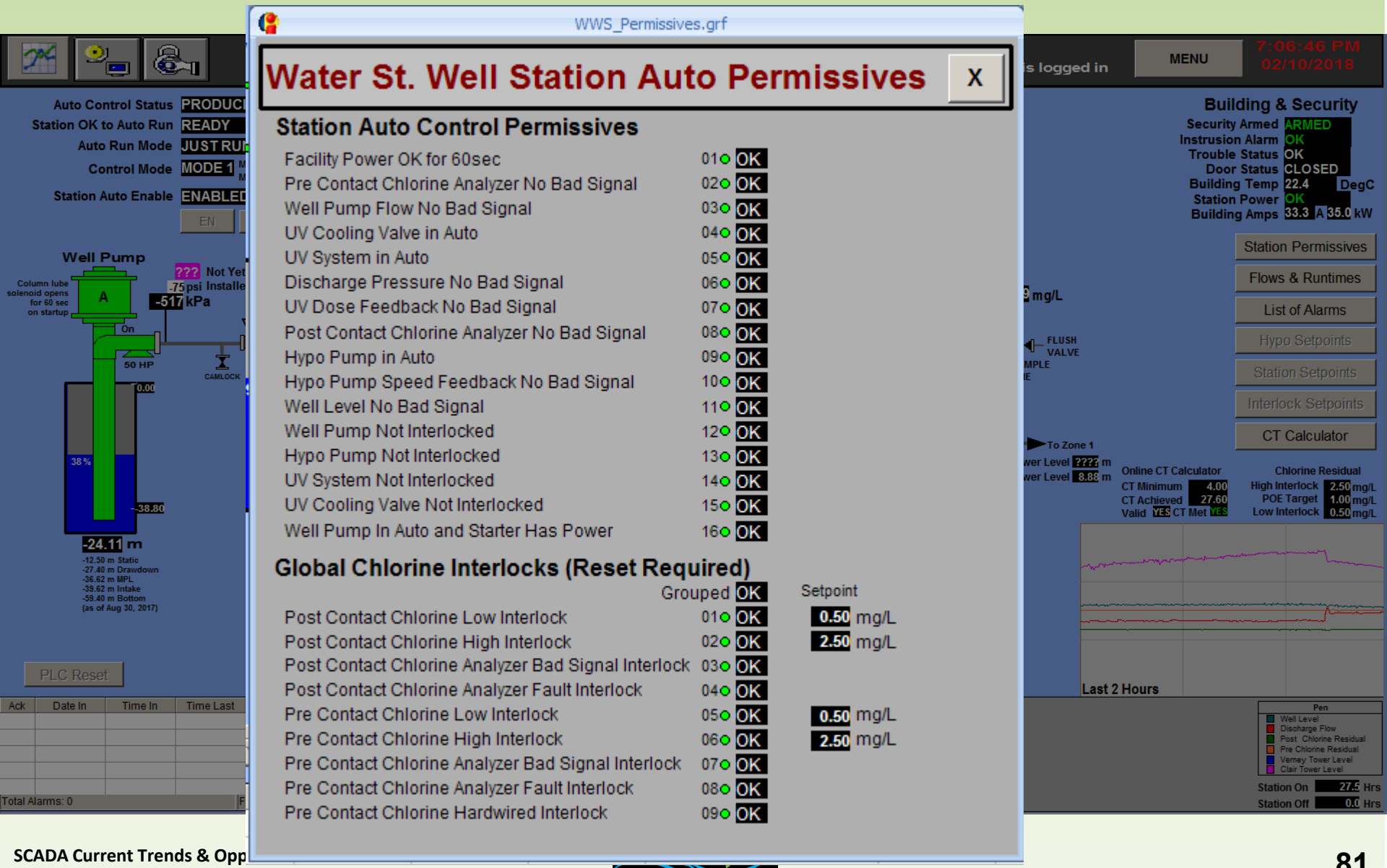
Building & Security Information



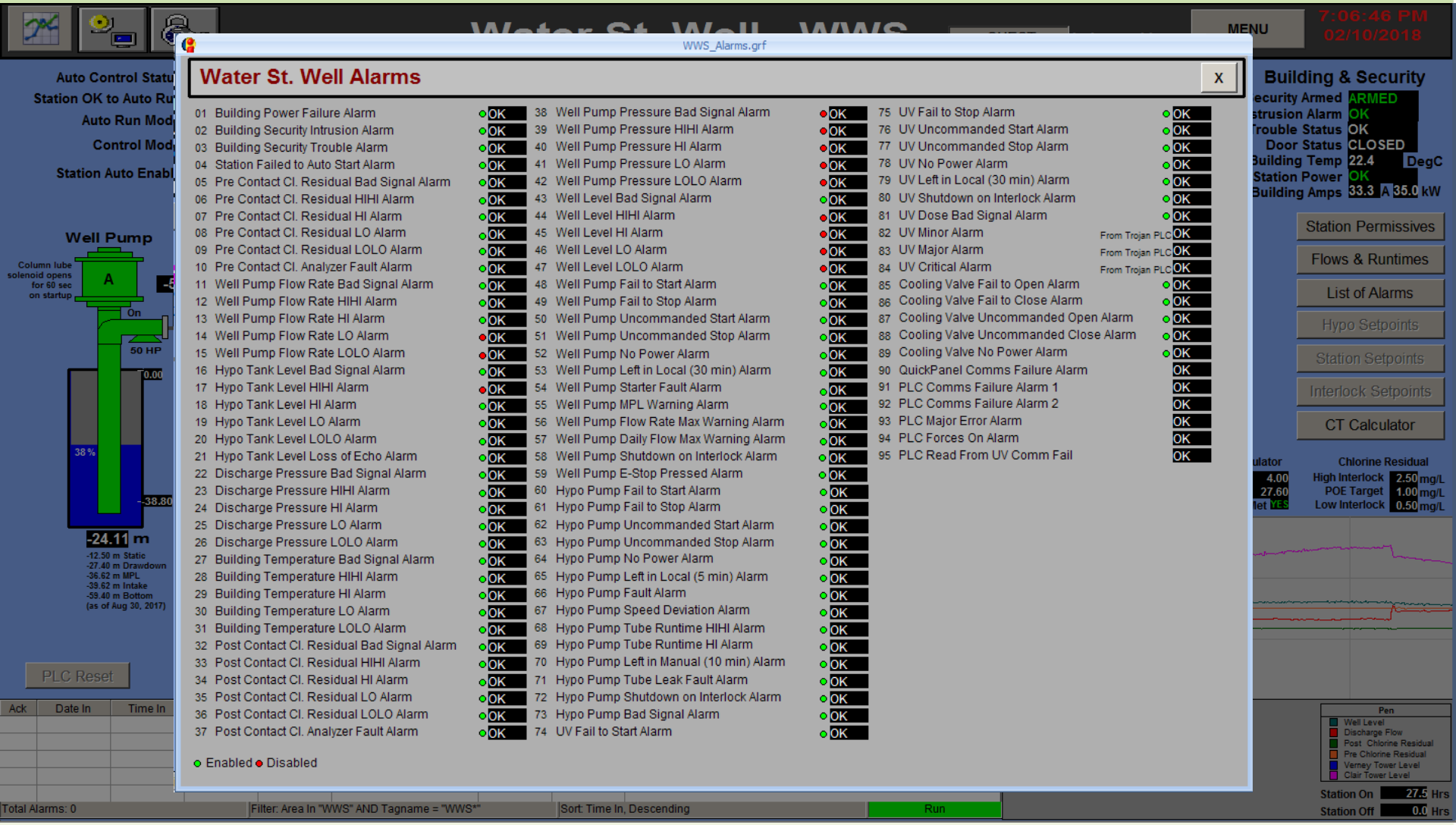
Online CT Calculator – drinking water treatment



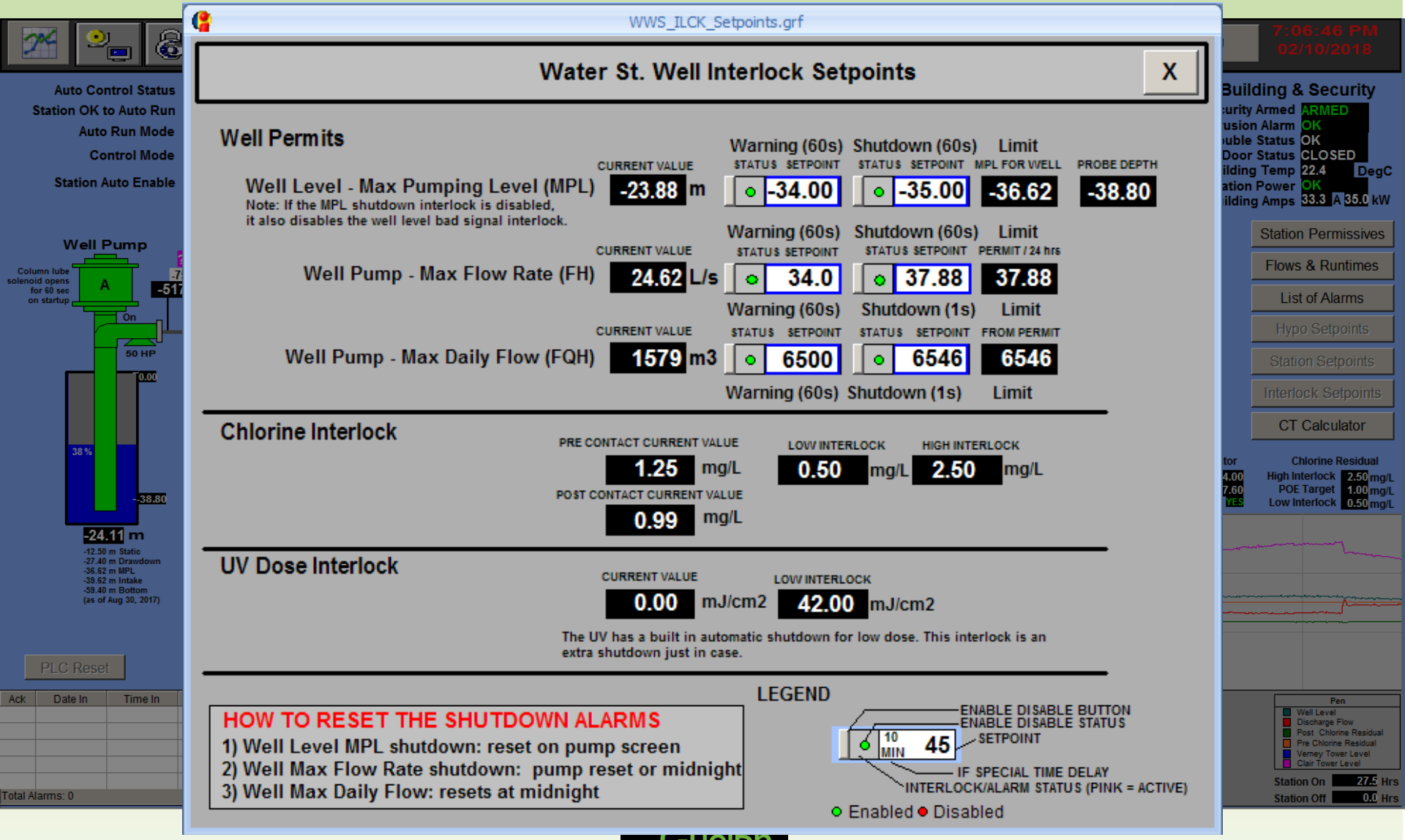
Station Permissives



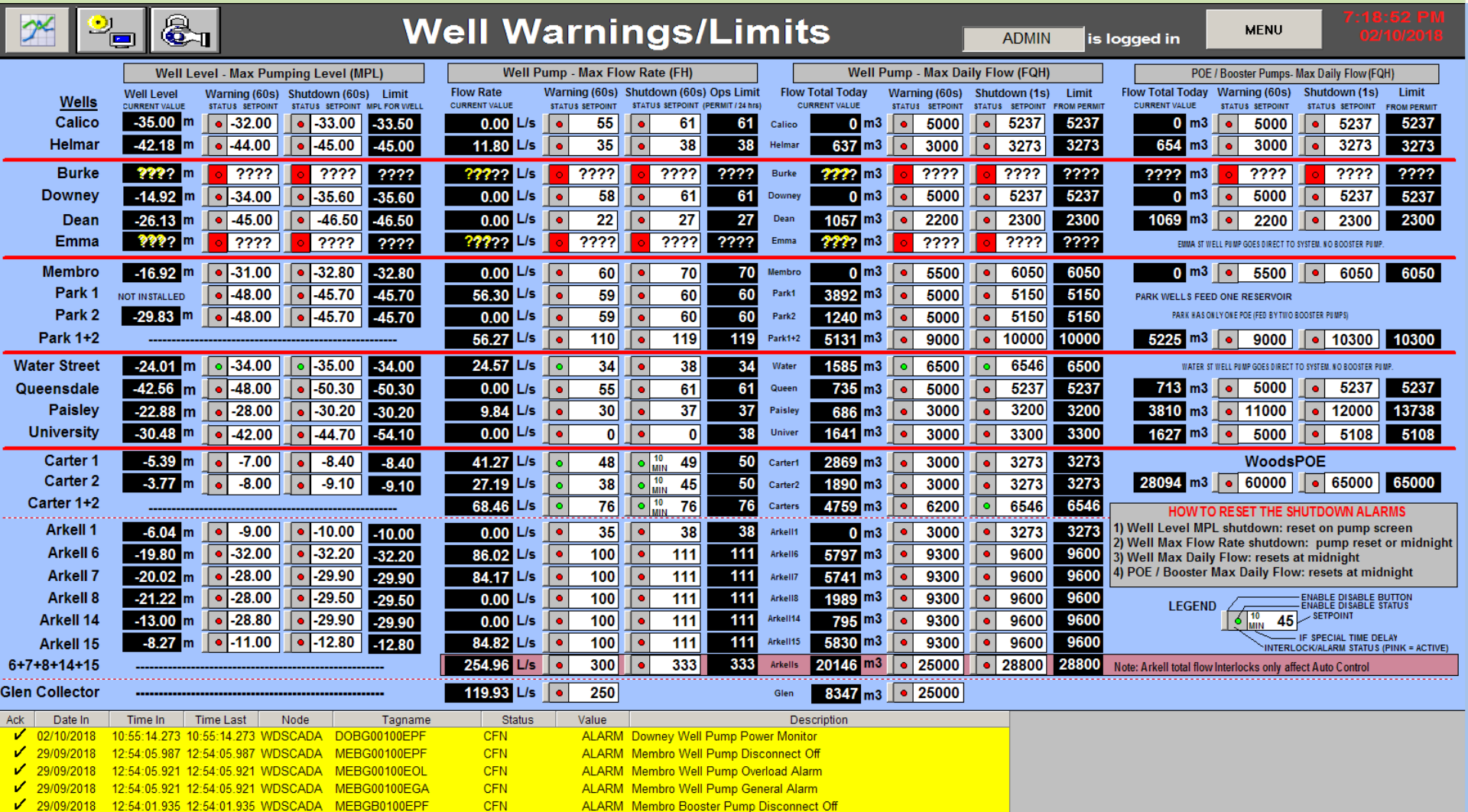
List of All Configured Alarms for a Site



Well Permit Values, Warnings and Interlocks



Well Permits – for all sites



Well Warnings/Limits

ADMIN is logged in | MENU | 7:18:52 PM 02/10/2018

Wells	Well Level - Max Pumping Level (MPL)				Well Pump - Max Flow Rate (FH)				Well Pump - Max Daily Flow (FQH)				POE / Booster Pumps- Max Daily Flow (FQH)			
	Well Level CURRENT VALUE	Warning (60s) STATUS SETPOINT	Shutdown (60s) STATUS SETPOINT	Limit MPL FOR WELL	Flow Rate CURRENT VALUE	Warning (60s) STATUS SETPOINT	Shutdown (60s) STATUS SETPOINT	Ops Limit (PERMIT / 24 hrs)	Flow Total Today CURRENT VALUE	Warning (60s) STATUS SETPOINT	Shutdown (1s) STATUS SETPOINT	Limit FROM PERMIT	Flow Total Today CURRENT VALUE	Warning (60s) STATUS SETPOINT	Shutdown (1s) STATUS SETPOINT	Limit FROM PERMIT
Calico	-35.00 m	-32.00	-33.00	-33.50	0.00 L/s	55	61	61	Calico 0 m3	5000	5237	5237	0 m3	5000	5237	5237
Helmar	-42.18 m	-44.00	-45.00	-45.00	11.80 L/s	35	38	38	Helmar 637 m3	3000	3273	3273	654 m3	3000	3273	3273
Burke	???? m	????	????	????	????? L/s	????	????	????	Burke ???? m3	????	????	????	???? m3	????	????	????
Downey	-14.92 m	-34.00	-35.60	-35.60	0.00 L/s	58	61	61	Downey 0 m3	5000	5237	5237	0 m3	5000	5237	5237
Dean	-26.13 m	-45.00	-46.50	-46.50	0.00 L/s	22	27	27	Dean 1057 m3	2200	2300	2300	1069 m3	2200	2300	2300
Emma	???? m	????	????	????	????? L/s	????	????	????	Emma ???? m3	????	????	????	EMMA ST WELL PUMP GOES DIRECT TO SYSTEM. NO BOOSTER PUMP.			
Membro	-16.92 m	-31.00	-32.80	-32.80	0.00 L/s	60	70	70	Membro 0 m3	5500	6050	6050	0 m3	5500	6050	6050
Park 1	NOT INSTALLED	-48.00	-45.70	-45.70	56.30 L/s	59	60	60	Park1 3892 m3	5000	5150	5150	PARK WELLS FEED ONE RESERVOIR			
Park 2	-29.83 m	-48.00	-45.70	-45.70	0.00 L/s	59	60	60	Park2 1240 m3	5000	5150	5150	PARK HAS ONLY ONE POE (FED BY TWO BOOSTER PUMPS)			
Park 1+2	----------				56.27 L/s	110	119	119	Park1+2 5131 m3	9000	10000	10000	5225 m3	9000	10300	10300
Water Street	-24.01 m	-34.00	-35.00	-34.00	24.57 L/s	34	38	34	Water 1585 m3	6500	6546	6500	WATER ST WELL PUMP GOES DIRECT TO SYSTEM. NO BOOSTER PUMP.			
Queensdale	-42.56 m	-48.00	-50.30	-50.30	0.00 L/s	55	61	61	Queen 735 m3	5000	5237	5237	713 m3	5000	5237	5237
Paisley	-22.88 m	-28.00	-30.20	-30.20	9.84 L/s	30	37	37	Paisley 686 m3	3000	3200	3200	3810 m3	11000	12000	13738
University	-30.48 m	-42.00	-44.70	-54.10	0.00 L/s	0	0	38	Univer 1641 m3	3000	3300	3300	1627 m3	5000	5108	5108
Carter 1	-5.39 m	-7.00	-8.40	-8.40	41.27 L/s	48	10 MIN 49	50	Carter1 2869 m3	3000	3273	3273	WoodsPOE			
Carter 2	-3.77 m	-8.00	-9.10	-9.10	27.19 L/s	38	10 MIN 45	50	Carter2 1890 m3	3000	3273	3273	28094 m3	60000	65000	65000
Carter 1+2	----------				68.46 L/s	76	10 MIN 76	76	Carters 4759 m3	6200	6546	6546				
Arkell 1	-6.04 m	-9.00	-10.00	-10.00	0.00 L/s	35	38	38	Arkell1 0 m3	3000	3273	3273				
Arkell 6	-19.80 m	-32.00	-32.20	-32.20	86.02 L/s	100	111	111	Arkell6 5797 m3	9300	9600	9600				
Arkell 7	-20.02 m	-28.00	-29.90	-29.90	84.17 L/s	100	111	111	Arkell7 5741 m3	9300	9600	9600				
Arkell 8	-21.22 m	-28.00	-29.50	-29.50	0.00 L/s	100	111	111	Arkell8 1989 m3	9300	9600	9600				
Arkell 14	-13.00 m	-28.80	-29.90	-29.90	0.00 L/s	100	111	111	Arkell14 795 m3	9300	9600	9600				
Arkell 15	-8.27 m	-11.00	-12.80	-12.80	84.82 L/s	100	111	111	Arkell15 5830 m3	9300	9600	9600				
6+7+8+14+15	----------				254.96 L/s	300	333	333	Arkells 20146 m3	25000	28800	28800	Note: Arkell total flow Interlocks only affect Auto Control			
Glen Collector	----------				119.93 L/s	250			Glen 8347 m3	25000						

HOW TO RESET THE SHUTDOWN ALARMS
1) Well Level MPL shutdown: reset on pump screen
2) Well Max Flow Rate shutdown: pump reset or midnight
3) Well Max Daily Flow: resets at midnight
4) POE / Booster Max Daily Flow: resets at midnight

LEGEND: ENABLE DISABLE BUTTON; ENABLE DISABLE STATUS; 10 MIN 45 SETPOINT; IF SPECIAL TIME DELAY INTERLOCK/ALARM STATUS (PINK = ACTIVE)

Ack	Date In	Time In	Time Last	Node	Tagname	Status	Value	Description
✓	02/10/2018	10:55:14.273	10:55:14.273	WDSCADA	DOBG00100EPF	CFN	ALARM	Downey Well Pump Power Monitor
✓	29/09/2018	12:54:05.987	12:54:05.987	WDSCADA	MEBG00100EPF	CFN	ALARM	Membro Well Pump Disconnect Off
✓	29/09/2018	12:54:05.921	12:54:05.921	WDSCADA	MEBG00100EOL	CFN	ALARM	Membro Well Pump Overload Alarm
✓	29/09/2018	12:54:05.921	12:54:05.921	WDSCADA	MEBG00100EGA	CFN	ALARM	Membro Well Pump General Alarm
✓	29/09/2018	12:54:01.935	12:54:01.935	WDSCADA	MEBGB0100EPF	CFN	ALARM	Membro Booster Pump Disconnect Off

Total Alarms: 46 | Filter: Off | Sort: Time In, Descending | Run

Logging flow to System vs. Waste – for water balance calcs.

System VS Waste Flow

ADMIN1 — ADMIN is logged in — MENU — 7:20:50 PM 02/10/2018

Station	Current (L/s)	TODAY All Flow (m3)	TODAY Going To	TODAY System (m3)	TODAY Waste (m3)	YESTERDAY All Flow (m3)	YESTERDAY System (m3)	YESTERDAY Waste (m3)
Arkell 1	0.00	0	SYSTEM	0	0	338	338	0
Arkell 6	86.01	5807	SYSTEM	5808	0	6486	6486	0
Arkell 7	84.18	5751	SYSTEM	5751	0	7344	7344	0
Arkell 8	0.00	1989	SYSTEM	1989	0	1575	1575	0
Arkell 14	0.00	795	SYSTEM	795	0	1328	1328	0
Arkell 15	84.74	5840	SYSTEM	5840	0	7323	7323	0
Burke Well	????	????		????	????	????	????	????
Carter Wells	41.26	4766	WASTE	0	4763	5910	0	5908
Calico Well	0.00	0	SYSTEM	0	0	0	0	0
Dean Well	0.00	1057	SYSTEM	1057	0	1336	1336	0
Downey Well	0.00	0	SYSTEM	0	0	0	0	0
Emma Well	????	????		????	????	????	????	????
Helmar Well	11.70	638	SYSTEM	638	0	799	0	0
Membro Well	0.00	0	SYSTEM	0	0	0	0	0
Paisley Well	9.87	687	SYSTEM	687	0	851	851	0
Park Well #1	56.40	3897	SYSTEM	1240	0	4862	1541	0
Park Well #2	0.00	1240	SYSTEM	3898	0	1541	4862	0
Queensdale Well	0.00	735	SYSTEM	735	0	873	873	0
University Well	0.00	1641	SYSTEM	1641	0	1836	1836	0
Water St. Well	24.62	1587	WASTE	1588	0	961	961	0
Glen Collector	119.81	8358	SYSTEM	8358	0	10309	10309	0

Station	Current (L/s)	TODAY All Flow (m3)	TODAY Going To	TODAY System (m3)	TODAY Waste (m3)	TODAY Recirc (m3)	YESTERDAY All Flow (m3)	YESTERDAY System (m3)	YESTERDAY Waste (m3)	YESTERDAY Recirc (m3)
Burke Booster	????	????		????	????	????	????	????	????	????
Calico Booster	0.00	0	SYSTEM	0	0	0	0	0	0	0
Dean Booster	16.15	1071	SYSTEM	1071	0	0	1340	1340	0	0
Downey Booster	0.00	0	SYSTEM	0	0	0	0	0	0	0
Helmar Booster	9.90	655	SYSTEM	655	0	0	814	0	0	0
Membro Booster	0.00	0	SYSTEM	0	0	0	0	0	0	0
Park Booster	62.20	5232	SYSTEM	5232	0	0	6558	6558	0	0
Queensdale Booster	12.58	714	SYSTEM	714	0	0	889	889	0	0
University Booster	25.05	1630	SYSTEM	1630	0	0	1992	1993	0	0
Woods Booster	373.32	28139	SYSTEM	28139	0	N/A	35677	35677	0	N/A

System	Current (L/s)	TODAY All Flow (m3)	TODAY Going To	TODAY System (m3)	TODAY Waste (m3)	TODAY Recirc (m3)	YESTERDAY All Flow (m3)	YESTERDAY System (m3)	YESTERDAY Waste (m3)	YESTERDAY Recirc (m3)
System Well*	401.11	43184	N/A	38420	4760	N/A	54360	47653	5908	N/A
System Booster*	694.09	37413	N/A	37413	0	0	47270	46456	0	0

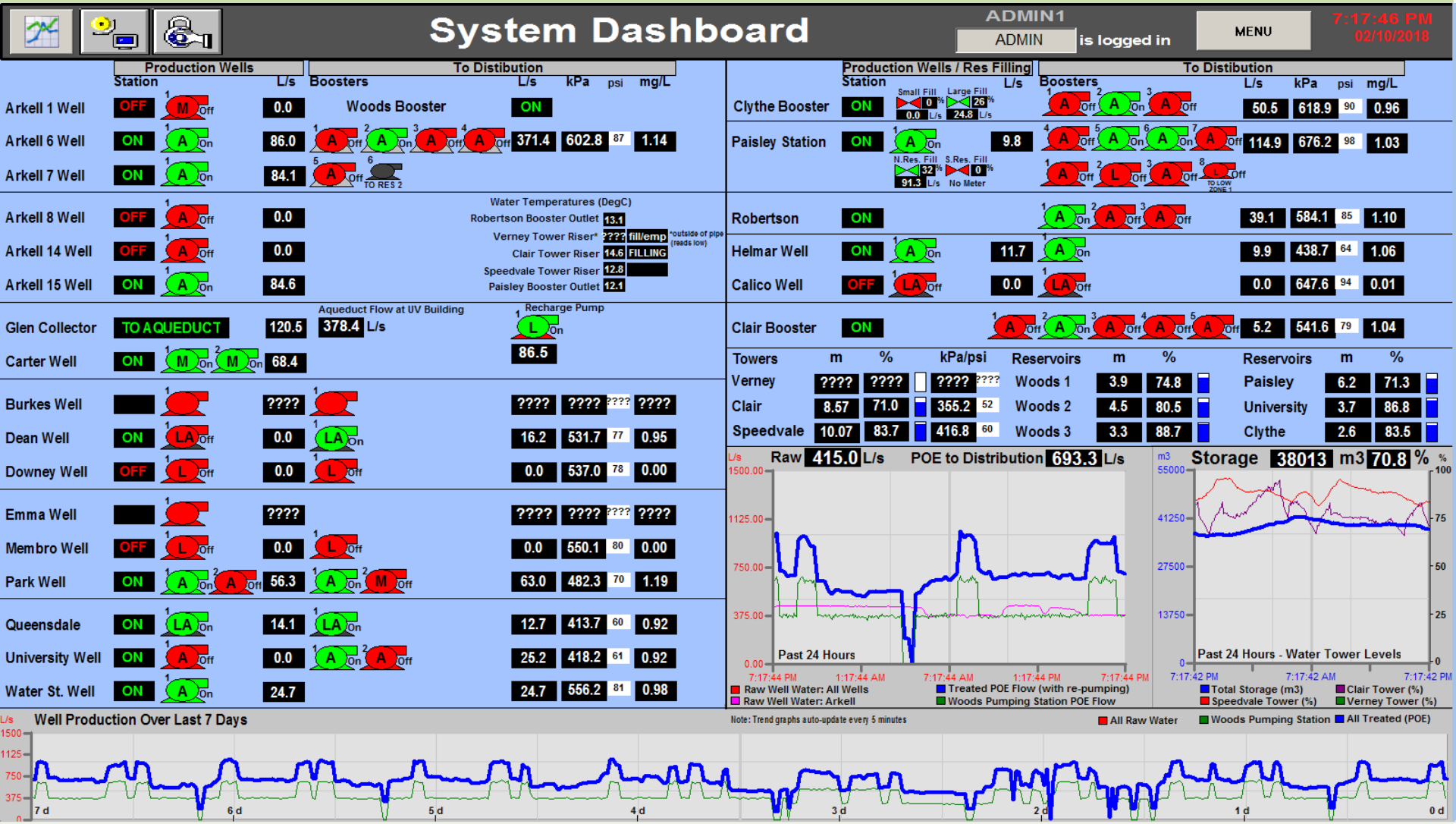
*Note: Burkes is currently not included in the System Totals

W - To Waste, S - To System, R - To Recirculation

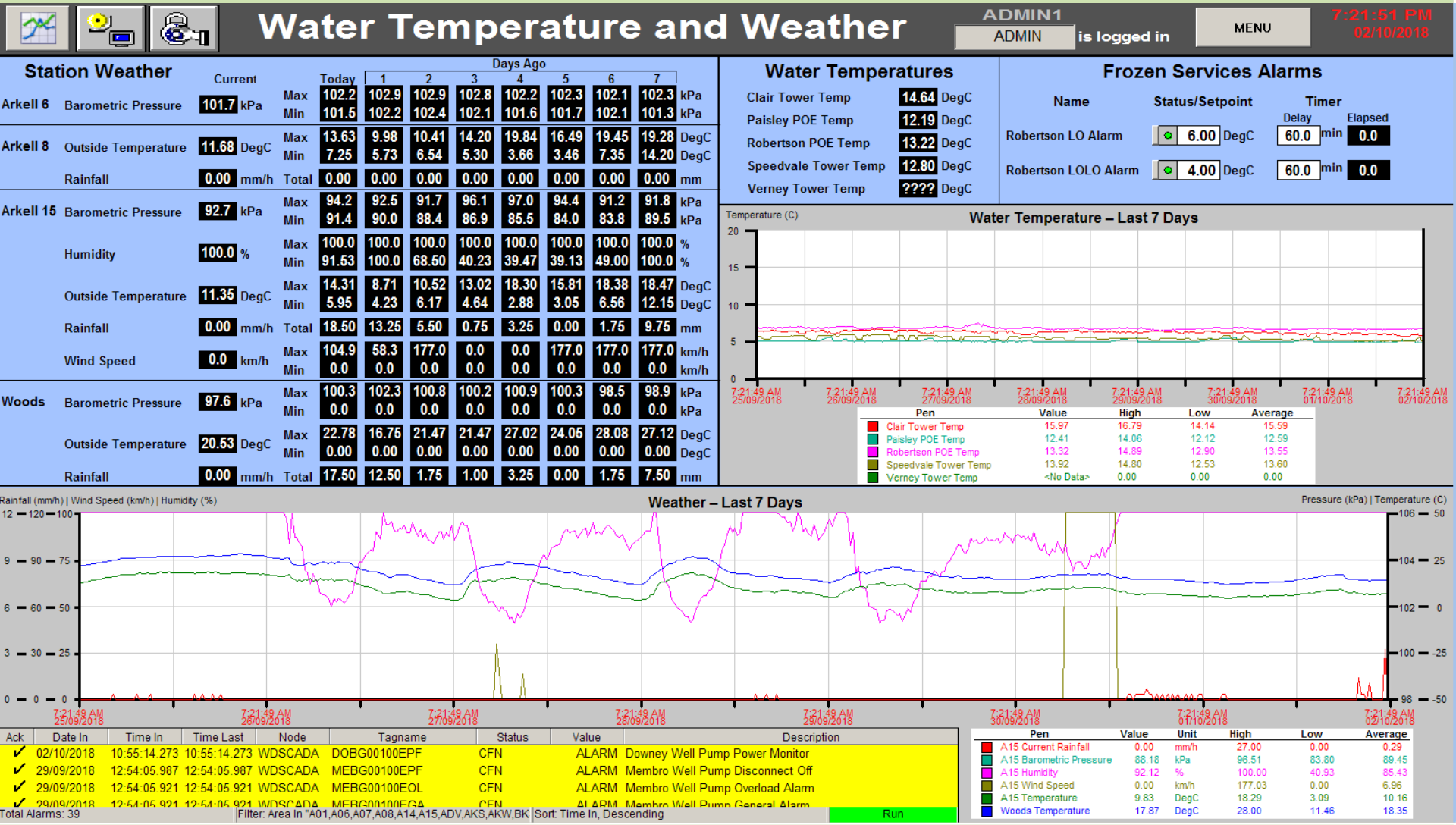
Ack	Date In	Time In	Time Last	Node	Tagname	Status	Value	Description
✓	02/10/2018	10:55:14.273	10:55:14.273	WDSCADA	DOBG00100EPF	CFN	ALARM	Downey Well Pump Power Monitor
✓	29/09/2018	12:54:05.987	12:54:05.987	WDSCADA	MEBG00100EPF	CFN	ALARM	Membro Well Pump Disconnect Off
✓	29/09/2018	12:54:05.921	12:54:05.921	WDSCADA	MEBG00100EOL	CFN	ALARM	Membro Well Pump Overload Alarm

Total Alarms: 46 | Filter: Off | Sort: Time In, Descending | Run

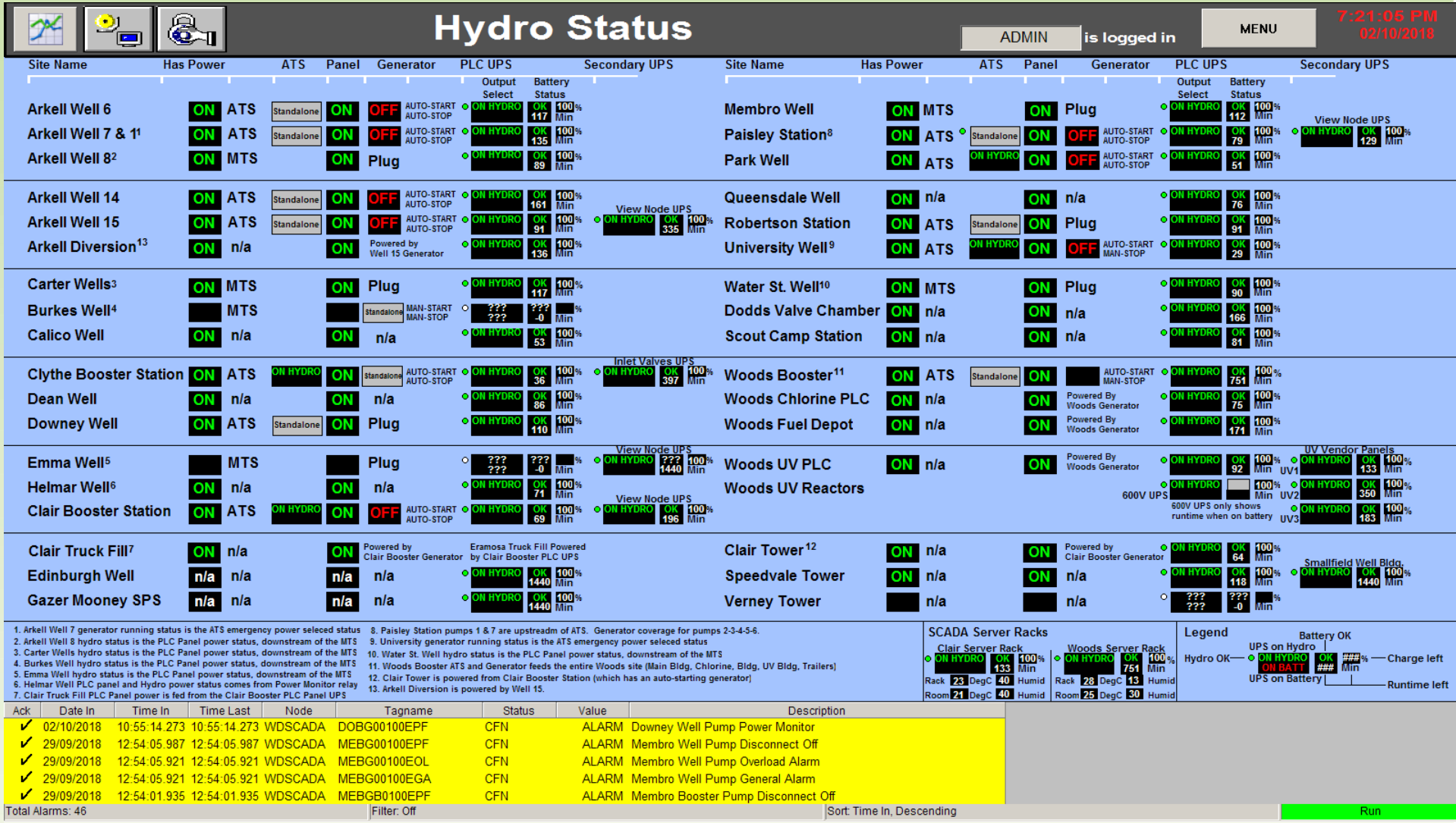
Dash Board Displays – entire system status at a glance



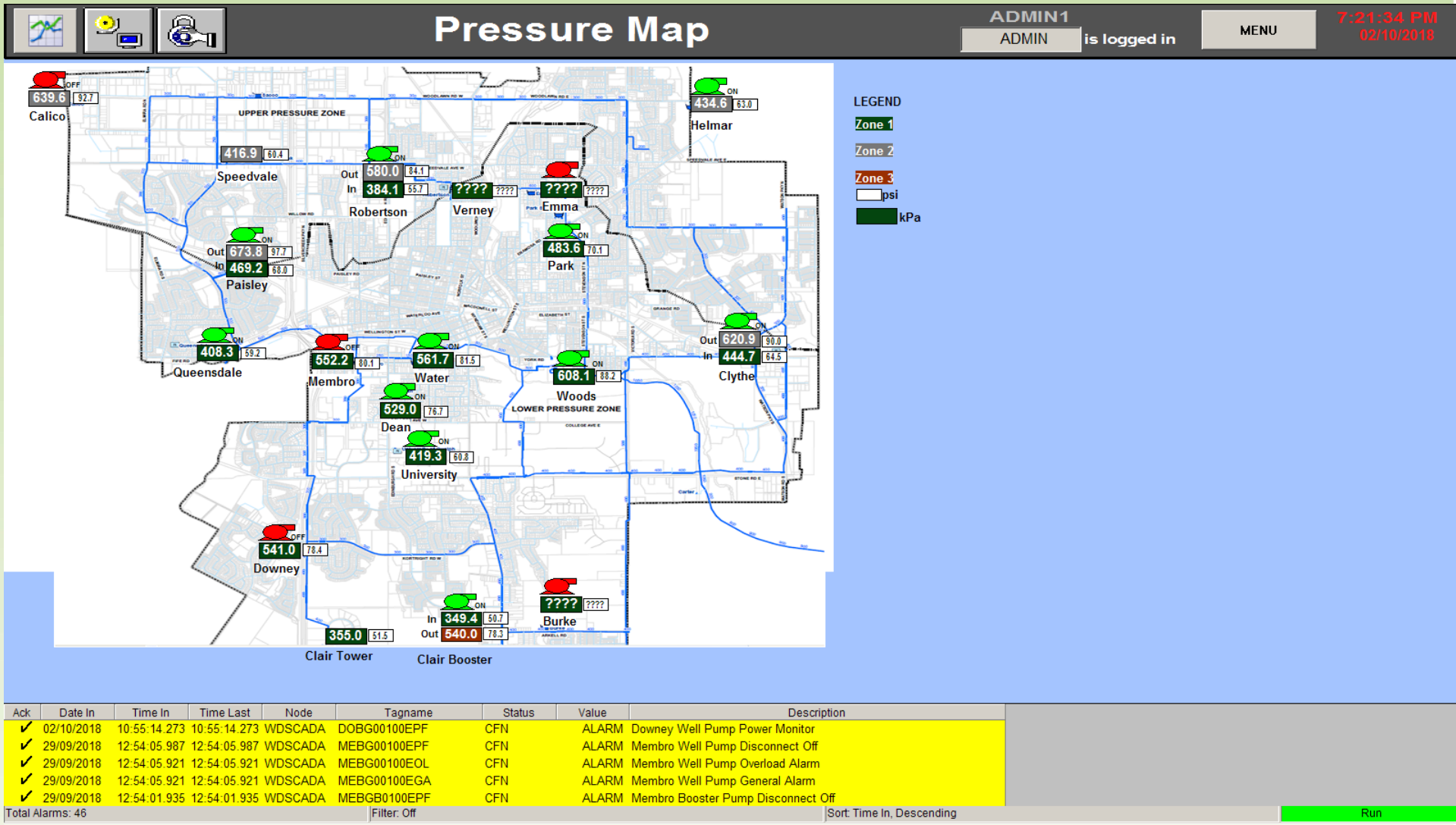
Dash Board Displays - Weather



Dash Board Displays – Which Sites have Power?



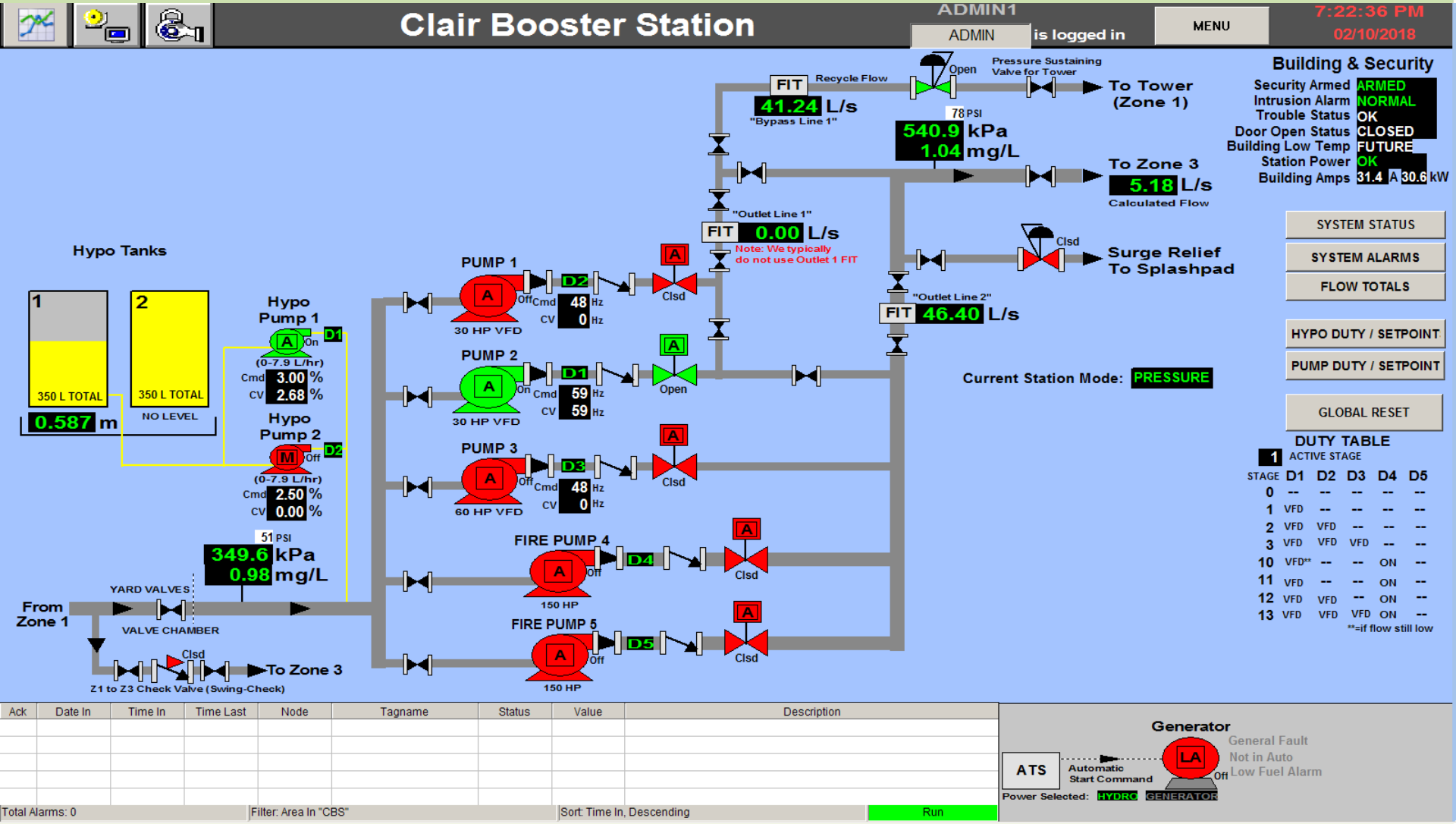
Dash Board Displays – Pressures Across City



Ack	Date In	Time In	Time Last	Node	Tagname	Status	Value	Description
✓	02/10/2018	10:55:14.273	10:55:14.273	WDSCADA	DOBG00100EPF	CFN	ALARM	Downey Well Pump Power Monitor
✓	29/09/2018	12:54:05.987	12:54:05.987	WDSCADA	MEBG00100EPF	CFN	ALARM	Membro Well Pump Disconnect Off
✓	29/09/2018	12:54:05.921	12:54:05.921	WDSCADA	MEBG00100EOL	CFN	ALARM	Membro Well Pump Overload Alarm
✓	29/09/2018	12:54:05.921	12:54:05.921	WDSCADA	MEBG00100EGA	CFN	ALARM	Membro Well Pump General Alarm
✓	29/09/2018	12:54:01.935	12:54:01.935	WDSCADA	MEBGB0100EPF	CFN	ALARM	Membro Booster Pump Disconnect Off

Total Alarms: 46 | Filter: Off | Sort: Time In, Descending | Run

A More Complex Site: VFDs, Duty Numbers, etc.



Build on What you Have

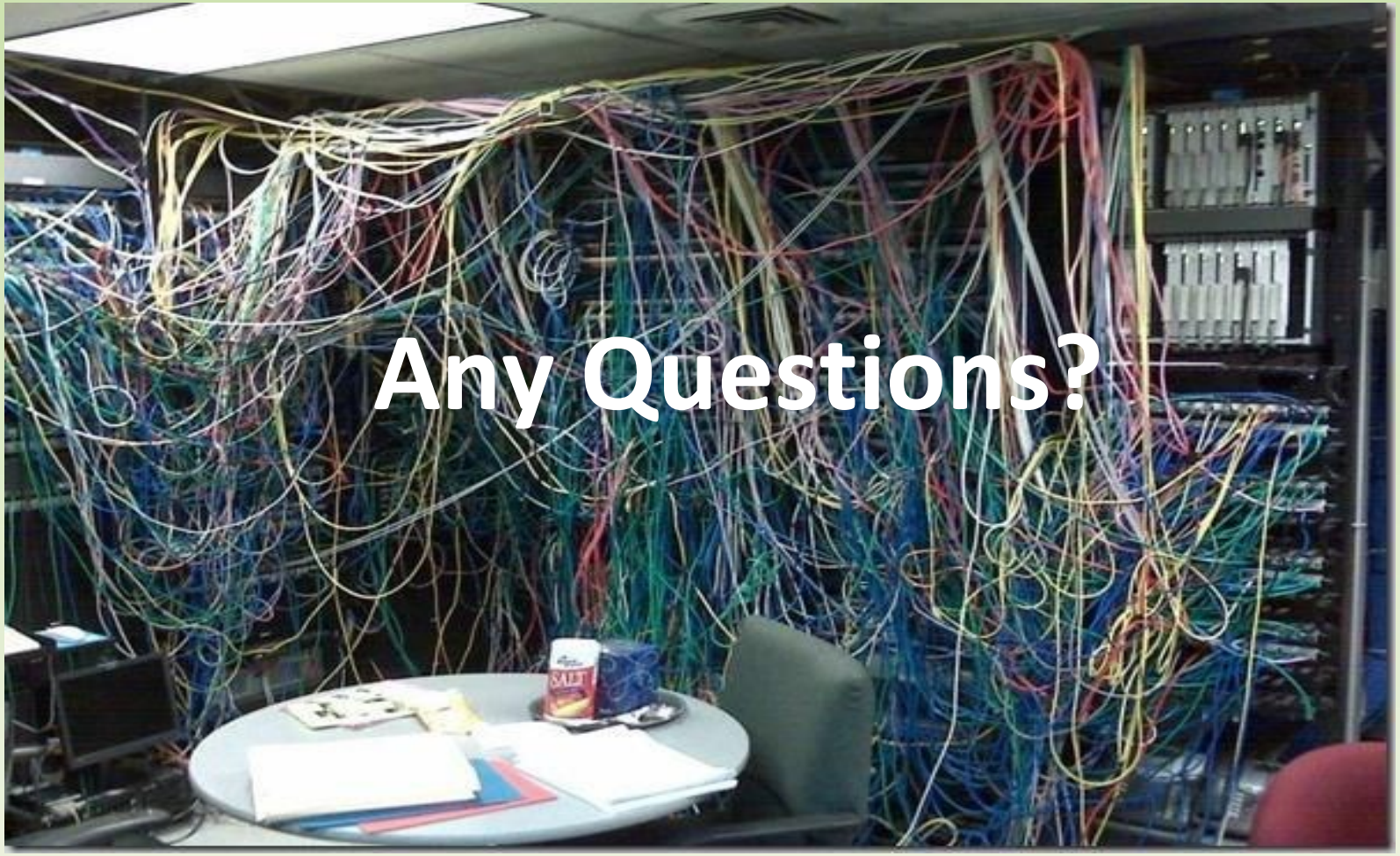
- SCADA is essential for both Operations and Compliance

- Operators Need Situational Awareness to Operate Effectively
- Use the SCADA HMI to show the whole picture to operators
- SCADA Alarms systems must be rationalized/documented

- Pay attention to data integrity by investing in data redundancy
- SCADA networks are key to robust SCADA systems
- Cyber Security is requires a multi-pronged approach

- When upgraded SCADA systems, leverage what you have
- Take advantage of new technology and ideas

Wrap-Up



* Not a high performance SCADA System