Digitization of Nuclear Plants

Wireless Gauge Reader Overview for Operators

Version 7.0

3/7/2024

CYPRESS ENVIROSYSTEMS™

WGR Deployments – Nuclear Generation

- Duke Energy (Fleetwide: Oconee, Robinson, Brunswick, Harris, Catawba, McGuire)
- Southern (Fleetwide: Farley, Hatch, Vogtle)
- Xcel Energy (Fleetwide: Prairie Island, Monticello)
- Constellation Energy (Calvert, Braidwood, Clinton, JAF, Nine Mile Point, Limerick, Ginna, Peach Bottom)
- NextEra (Fleetwide: Turkey Point, St. Lucie, Point Beach, Seabrook)
- Vistra Luminant (Comanche Peak, Davis Besse)
- STP Nuclear (South Texas)
- Nebraska Public Power District (Cooper)
- PSEG (Fleetwide: Salem, Hope Creek)*
- Bruce Power (Canada)
- Arizona Public Service (Palo Verde*)
- Entergy Vermont Yankee (1 unit – decommissioned)
- EPRI Charlotte - Nuclear Applications Center (installed)
- France EDF (pilot deployment)

* Pending Installation

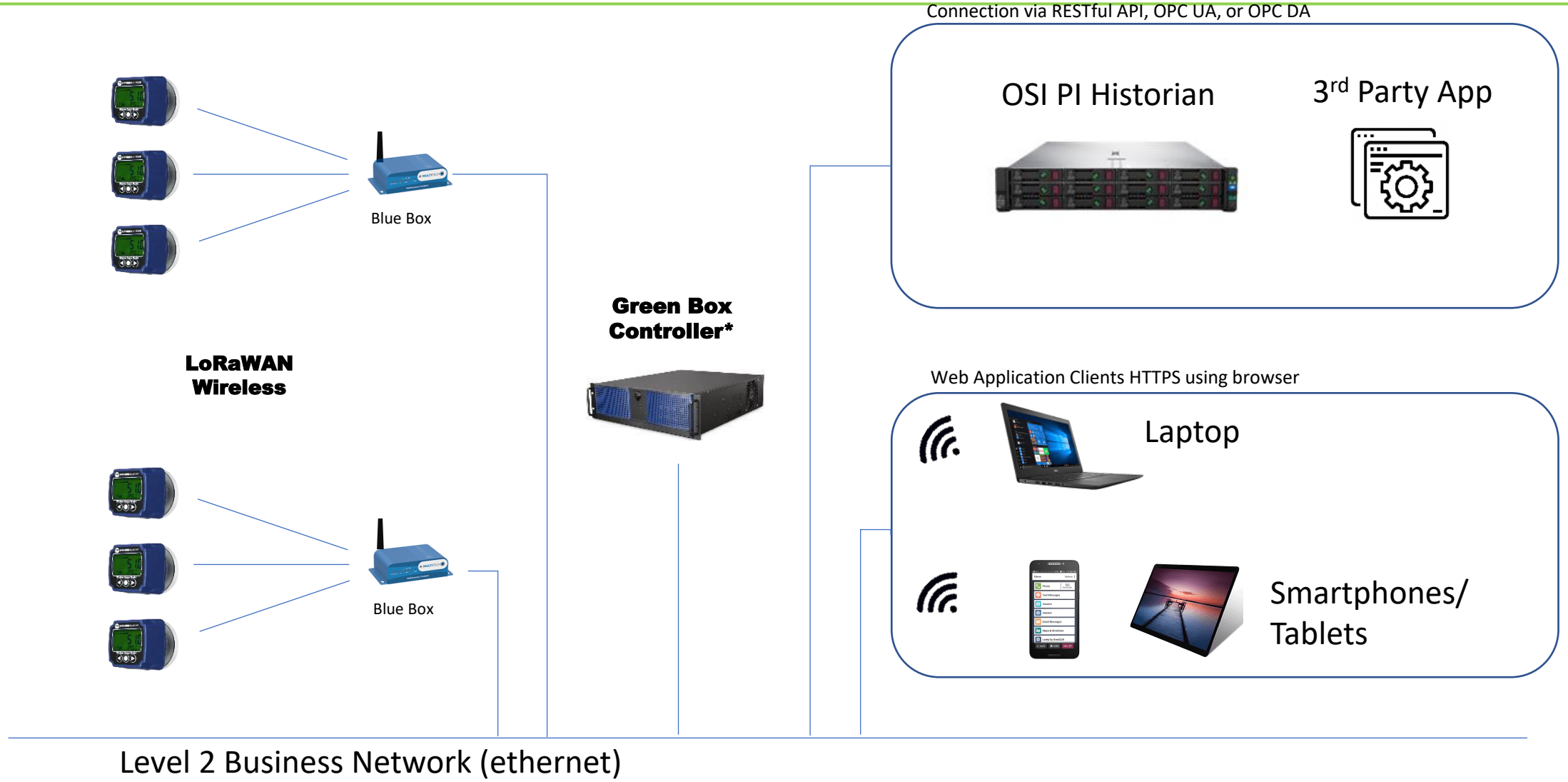
Problem: Most Plant Data is NOT Digitized

Solution: Non-invasive sensors – 5 minute install

- "Electronic Eyeball" reads gauges and numeric indicators and transmits readings wirelessly
- Already approved and installed in over 30 nuclear power plants
- Non-invasive, clamp-on to existing gauges in minutes
- No downtime, no leak check, no wiring, no drawings
- Battery life of 3+ years at 15 minute sample rate
- IP56/NEMA 4 rated for outdoor use
- Various size and types of mounting adapters to fit most existing gauges

Typical Installation

Deployment Architecture – Salem Nuclear Plant



Data Visibility on Tablets or PI Historian

GBC

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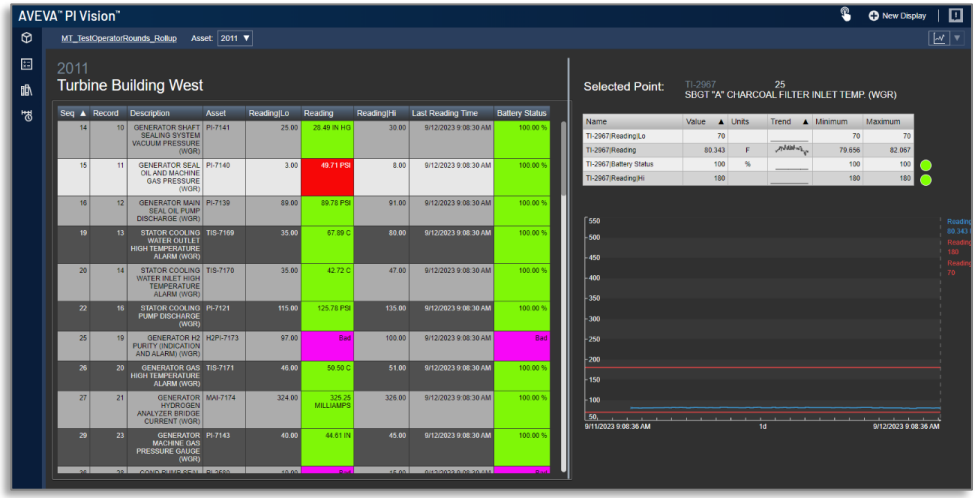
Readings | Graph | Table | Alarm History | Status | Configuration | Site Settings | Help

Export | Alarm Status

WGR Readings: 153 Items

Timestamp	NodeID	Description	Reading	Units	LCL	UC
09/23/2023 10:41:37	0/1/101/0/0/0	U1-11194: 1 TURB MAIN OIL PMP SUCTION PI	34.22	PSI	0	6
09/23/2023 10:42:04	0/1/102/0/0/0	U1-11195: 1 TURB MAIN OIL PMP DISCH PI	391.1	PSI	0	60
09/23/2023 10:40:27	0/1/103/0/0/0	U1-12113: 1 TURB BRG 1 TI	130.0	F	20	24
09/23/2023 10:42:46	1/1/201/0/0/0	U1-11209: GEN AIR SIDE SL OIL EXC END PI	73.8	PSI	0	15
09/23/2023 10:43:49	1/1/202/0/0/0	U1-11210: 11 GEN AIR SIDE SL OIL TURB END PI	72.9	PSI	0	15
09/23/2023 10:47:01	1/1/203/0/0/0	U1-12114: TURB GEN BRG #2 TEMP IND	130.5	DEG F	20	22
09/23/2023 10:49:48	1/1/204/0/0/0	U1-12115: TURB GEN BRG #3 TEMP IND	134.8	DEG F	20	22
09/23/2023 10:48:59	1/1/205/0/0/0	U1-12116: TURB GEN BRG #4 TEMP IND	133.7	DEG F	20	22
09/23/2023 10:47:30	1/1/206/0/0/0	U1-12119: TURB GEN BRG #5 TEMP IND	137.3	DEG F	20	22
09/23/2023 10:50:45	1/1/207/0/0/0	U1-12117: 1 TURB T-BRG FF TI	127.1	DEG F	20	22
09/23/2023 10:48:31	1/1/208/0/0/0	U1-12118: TURB THRUST BRG REAR FACE TEMP IND	126.0	DEG F	20	22
09/23/2023 10:50:12	1/1/209/0/0/0	U1-12120: 1 TURB BRG 6 TI	145.9	DEG F	50	30
09/23/2023 10:49:14	1/1/210/0/0/0	U1-12121: 1 TURB BRG 7 TI	137.9	DEG F	32	21
09/23/2023 10:50:24	1/1/211/0/0/0	U1-12122: 1 TURB GEN BRG 8 TI	138.7	DEG F	32	21
09/23/2023 10:40:39	2/1/301/0/0/0	U2-11216:21 GEN AIR SIDE SL OIL EXC END PI	72.7	PSI	0	15
09/23/2023 10:40:45	2/1/302/0/0/0	U2-11217:2 GEN AIR SIDE SL OIL TURB END PI	73.3	PSI	0	15
09/23/2023 10:42:37	3/1/401/0/0/0	U2-11663: 121 LAB & SERV AREA CHLD WTR PMP SUCT PI	17.82	PSI	0	6
09/23/2023 10:46:13	3/1/402/0/0/0	U2-11655: 121 LAB & SERV AREA CHLD WTR PMP DISCH PI	106.4	PSI	0	16
09/23/2023 10:46:28	3/1/403/0/0/0	U2-17410: 121 LAB & SERV AREA CLG WTR PMP RTN HDR TEMP TEST	79.3	DEG F	0	20
09/23/2023 10:47:02	3/1/404/0/0/0	U2-17408: 121 LAB & SERV AREA CLG WTR SPLY HDR TEMP TEST	73.8	DEG F	0	20
09/23/2023 10:53:27	3/1/405/0/0/0	U2-17411: 121 LAB & SERV AREA CHLD WTR SPLY HDR TEMP TEST	42.3	DEG F	-20	12
09/23/2023 10:46:13	3/1/406/0/0/0	U2-17409: 121 LAB & SERV AREA CHLD WTR RTN HDR TEMP TEST	47.3	DEG F	0	20
	3/1/407/0/0/0	U2-11053: HTG STM TO ADMN BLDG CONVTR PI (Not Installed - Hard to Access)				
	3/1/408/0/0/0	U2-82231: TSC UPPER HVAC UNIT TEMP (Not Installed - WHTM)		F		
	3/1/409/0/0/0	U2-82221: TSC LOWER HVAC UNIT TEMP (Not Installed - WHTM)		F		
09/23/2023 10:44:40	3/1/410/0/0/0	U2-12130: 2 TURB BRG 1 T1	138.4	DEG F	20	22
09/23/2023 10:49:49	3/1/411/0/0/0	U2-11413: 2 TURB MAIN OIL PMP SUCT PI	23.02	PSI	0	6
09/23/2023 10:44:54	3/1/412/0/0/0	U2-11414: 2 TURB MAIN OIL PMP DSCH PI	374.2	PSI	0	60
09/23/2023 10:47:03	3/1/413/0/0/0	U2-12131: TURB BRG #2 TEMP IND	137.6	DEG F	20	24
09/23/2023 10:50:54	3/1/414/0/0/0	U2-12132: TURB BRG #3 TEMP IND	144.1	DEG F	20	22

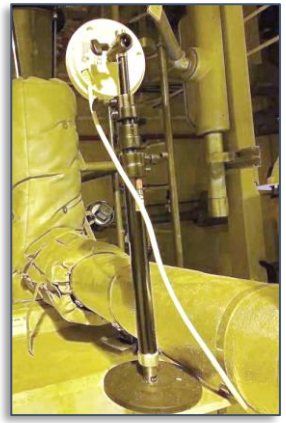


- Current Readings
- Historical Trending
- Download to Excel (.csv)
- Configurable Alarm Limits
- Configurable Notifications

Operator Efficiency Use Case: Webcam Monitoring Automation

Webcam Monitoring – current practice

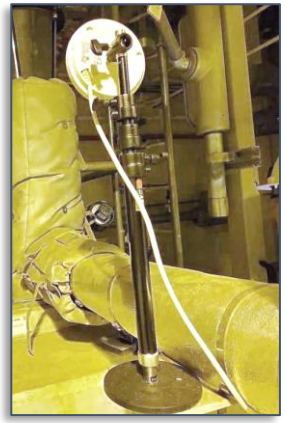
Webcams in the field



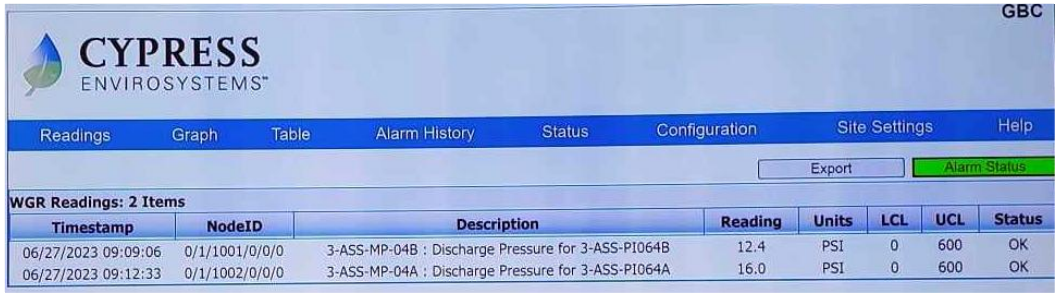
Operator watching video feed

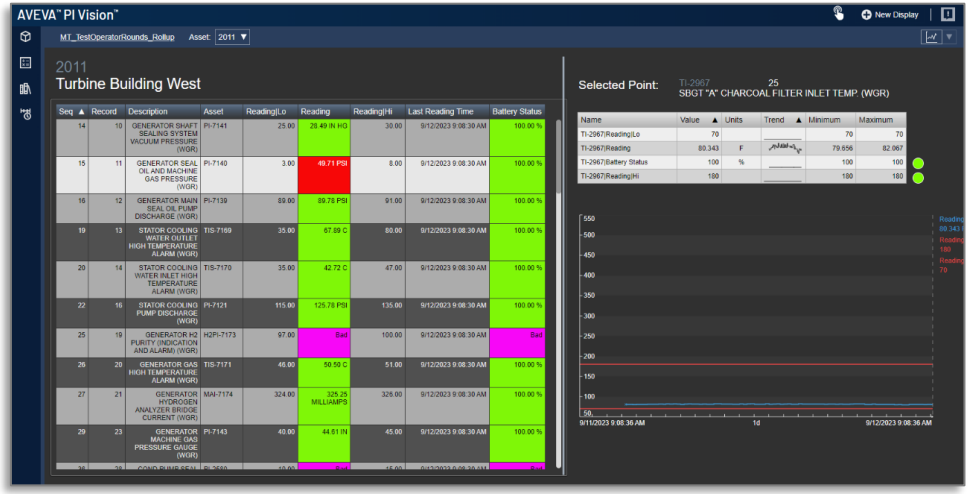
Webcam Monitoring – with Machine Learning

Webcams in the field



Data stored for trending / alarming / reporting
(accessible via operator tablets or PI Historian)

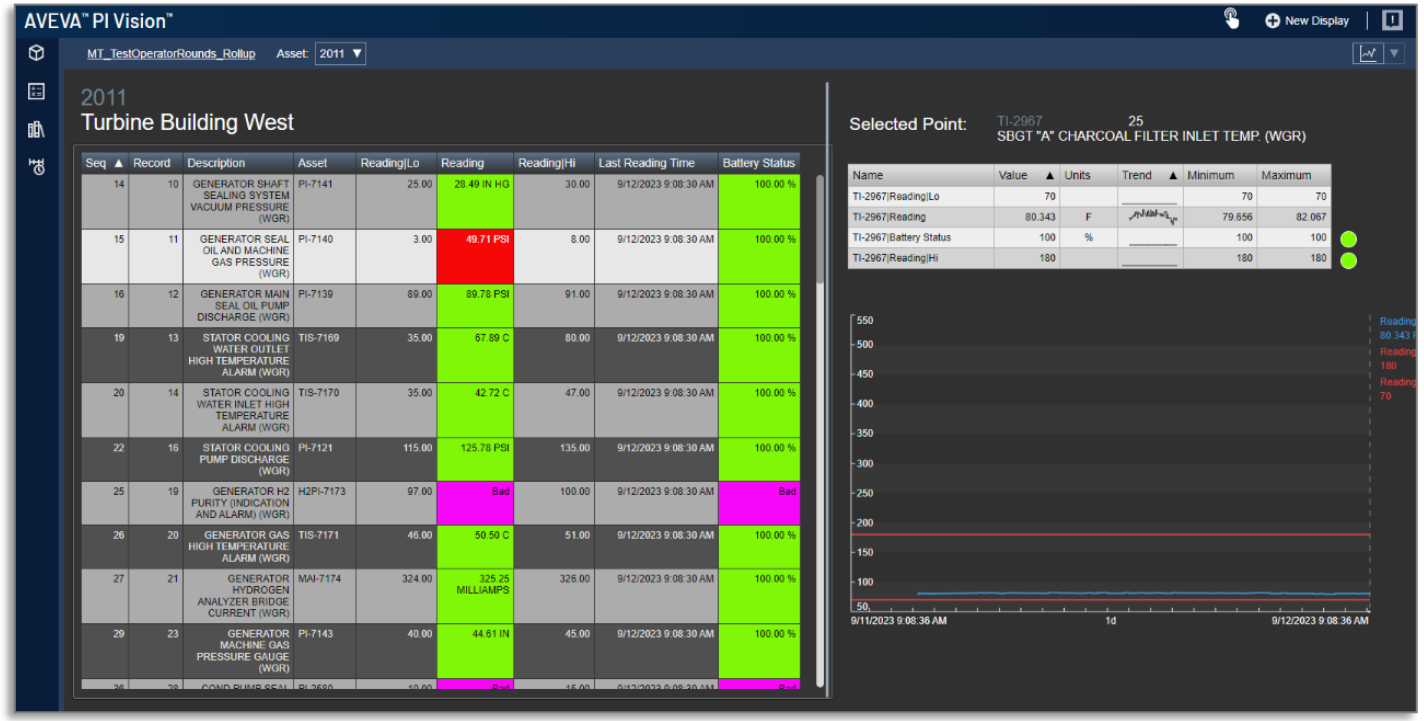




Operator Efficiency Use Case: Shift Dashboard

Operator Shift Dashboard

- Developed by Xcel Energy and Duke Energy
- Dashboard tool used by operators at start of shift
- Shows status of readings in Red, Yellow, or Green representing status of equipment monitored on rounds
- Operators can review history trend, set alarms, or compare to other points for analysis
- Helps to identify and focus on potential issues, before taking rounds

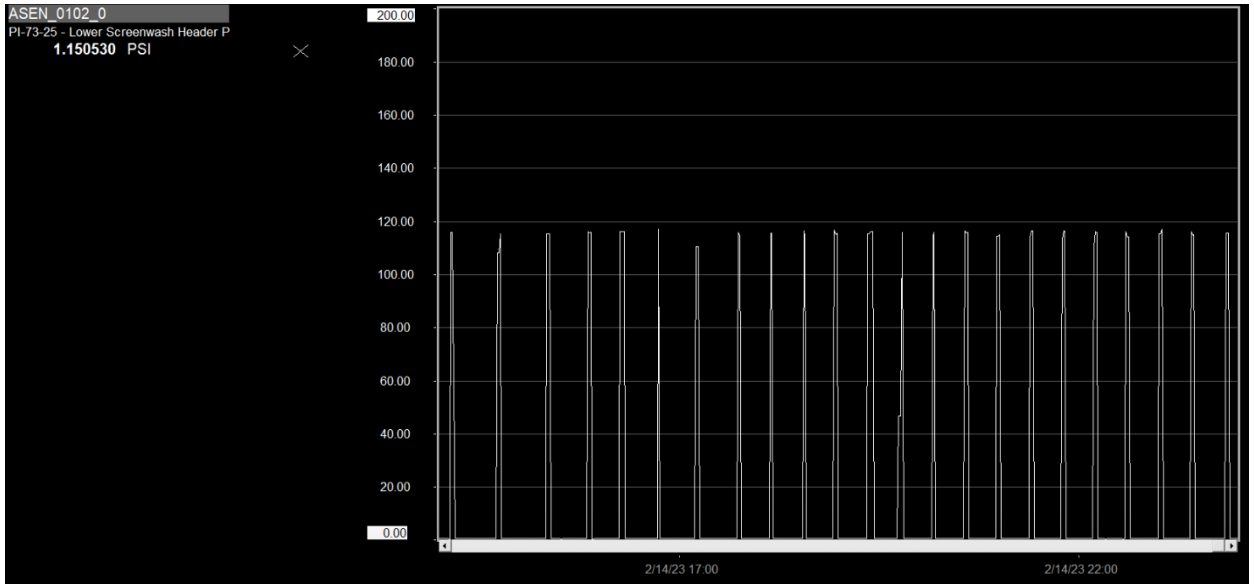


PI Vision Dashboard, implemented by Tim Tvrdik, I.T, Xcel Energy

Operator Efficiency Use Case: Minimizing Operator Wait Time for Equipment Response

Minimize Operator Wait Time for Equipment Response

- Certain rounds tasks require operators to wait and watch equipment to confirm functionality.
- Example: Constellation (Nine Mile Point) operators must confirm intake screen pump action each shift. Pump typically actuates once every 20 minutes, and operators may wait idle for response.
- Non-invasive monitoring and trending of pump head pressure allows operators to be freed up from non-productive waiting.



Silas Hoffstaetter – Constellation Nine Mile Point

Operator Efficiency Use Case: Enabling Condition Based Maintenance and ALARA

Condition Based Maintenance + ALARA

- Automated monitoring of filter delta-pressure for condensate polisher filters – minimize time and dosage exposure (BWR)
- Clinton observed problems with their condensate polisher – suspect that filters are clogging up.
- Short term fix to replace filters more often, but expensive and time intensive.
- Need to monitor filter delta pressure more often to detect when a change is needed – condition based maintenance.
- Only way to do this is sending operators to read pressure gauges. This is a BWR. Dose rates in CP area about 25 mrem/hr.
- WGR used to remotely monitor and trend filter pressures.

Use Case Library – Available to WGR Users Group

jotform | Tables

Use Case Library - Non-Invasive Nuclear Plant Digitization

Last updated at 18 Apr 2023 8:08 AM

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Case Library - Non-Invasive Nuclear Plant Digitization | WGR Case Studies - Reports | + Add Tab

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Title of Use Case	Utility	Plant	T...	Depart...	Plant Location	Plant System or Sub-System	What improvements/benefits come from the data?
Enable condition Based Maintenance for condensate polisher filters	Constellation	Clinton	BWR	Maintenance	Turbine Building	Condensate Polishing System	Operator Efficiency; ALARA reducing dosage exposure; Maintenance
Fault detection for Air Operated Valves for Feedwater Heaters	Constellation	Calvert Cliffs	PWR	Engineering	Turbine Building	Feedwater Tanks Air Operated Valves	Operator Efficiency; Fault Detection; Maintenance Effort/Consumable
Fault Detection for Stator Cooling Water Control Valves	Southern Company	Hatch	BWR	Operations	Turbine Building	Generator Stator	Operator Efficiency; Fault Detection; Maintenance Effort/Consumable
Improve efficiency of Operator rounds	Duke Energy	Oconee	PWR	Operations	Multiple		Operator Efficiency; ALARA reducing dosage exposure
Fault Detection for Reactor Recirculation Pump Seals	Duke Energy	Brunswick	BWR	Engineering	Reactor Building	Reactor cooling	Fault Detection
DRAFT - Enhance operator efficiency for thermal performance monitoring	PSEG	Hope Creek	BWR	Operations	Turbine Building	Feedwater Heaters	Operator Efficiency; Fault Detection
Fault Detection for Transformers	Constellation	Calvert Cliffs	PWR	Engineering	Other	Transformers	Operator Efficiency; Fault Detection
Ensure personnel safety - Temperature and Humidity Monitoring View	Constellation	Calvert Cliffs	PWR	Operations	Turbine Building	Work and storage environment	Operator Efficiency; Safety (e.g. Heat Stress, Confined Space etc.)
Improve groundwater management monitoring	Duke Energy	Brunswick	BWR	Chemistry	Other	Sump Pumps	Operator Efficiency; Fault Detection; Compliance (e.g. Environmental
Implement Condition Based Maintenance of Condensate Polisher Demin	Energy Harbor	Davis Besse	PWR	Chemistry	Turbine Building	Condensate Polishing System	Operator Efficiency; Maintenance Effort/Consumables
Enhance Operator Efficiency for Monitoring Intake Screen	Constellation	Nine Mile Pt	BWR	Operations	Intake	Intake screens	Operator Efficiency
Improve personnel safety for negative pressure compliance monitoring	Constellation	Nine Mile Pt	BWR	Other	Multiple	Negative pressure locations	Operator Efficiency; Safety (e.g. Heat Stress, Confined Space etc.)
DRAFT - Condition based monitoring of lube oil filters	Constellation	Nine Mile Pt	BWR	Engineering	Turbine Building	Lubricating oil system	Fault Detection
Fault Detection - Cycle Isolation Valve Temperature Monitoring	Duke Energy	Harris	PWR	Engineering	Turbine Building	Cycle isolation valves	Thermal Performance; Improves efficiency of the Thermal Performance
Feedwater Heater Temperature Monitoring	Duke Energy	Robinson	PWR	Engineering	Turbine Building	Heater Drain	Troubleshooting/Emergent Issues
DRAFT - Fault detection for condensate vacuum pumps and valves	PSEG	Salem	PWR	Engineering	Turbine Building	Condensate pumps and valves	Operator Efficiency; Fault Detection; Maintenance Effort/Consumable
DRAFT - Fault detection & troubleshooting for containment moisture rem...	Bruce Power	Bruce A	CANDU	Engineering	Other	Dryer system for containment moist...	Operator Efficiency; Fault Detection; Maintenance Effort/Consumable
DRAFT - Safety Surveillance Monitoring remote monitoring	Luminant	Comanche Peak	PWR	Operations	Multiple	Safety related systems	Operator Efficiency; Fault Detection
Operator Efficiency - Automating Webcam Monitoring	Southern Company	Vogtle	PWR	Operations	Turbine Building		Operator Efficiency; Fault Detection; Maintenance Effort/Consumable