



NITSL DC-Remote Monitoring Technologies and Predictive Analytics- Group Collaboration -I&A/Digital Controls

William Carelock, Randall Olson, Khody Sellers,
Eric Fleming, Sellers(SNC), Harry Sim
(Cypress)
7/16/25

Goals & Objectives



- Goal: How to enable remote monitoring in existing nuclear plants
- Objectives:
 - Understand hurdles to enable remote monitoring in existing plants
 - Review solutions for digitizing/capturing plant process data
 - How to integrate data with M&DC / predictive analytics
 - Sharing OE: Case studies, benefits and ROI, best practices

Hurdles to Remote Monitoring



Most Plant Data is Not Digitized – Collected Manually

Non-Invasive Digitization Solutions



Connection via
RESTful API or OPC

Historian



Five Minute Installation – No Downtime, No Impact to Plant Process

Typical Installation - 2



Used Outdoors, in RCA, Seismic Structures

Manual + Digital Data Collection



Minimize disruption to existing operator rounds

Capturing Data Beyond Gauges



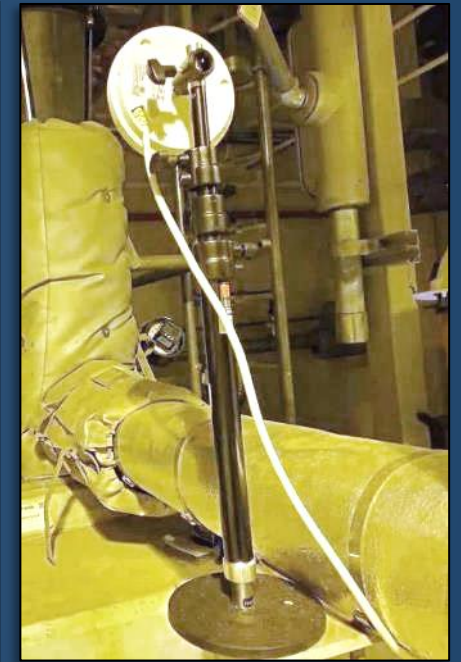
Valve Cycle
Isolation
Monitor



Wireless
Temperature and
Humidity Monitor



Wireless Transducer Reader
(thermocouples, 4-20mA, 0-5V, dry
contacts, RS-232 etc.)



Webcam Digitization
(machine vision)

Wireless, Battery Operated, Non-Invasive, Install in Minutes
10% Cost of Traditional Approaches

Deployments –Nuclear Fleet (34 plants)



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

* Pending Installation

Plant Engagement



DEPARTMENT:

- Operations
- Maintenance
- Engineering
- Chemistry
- Radiation Protection
- Monitoring & Diagnostics Center



BENEFITS:

- Improve operator efficiency
- Equipment fault detection/reduce unplanned downtime
- Reduce maintenance cost – enable condition-based maintenance
- Optimizing plant thermal performance
- Improve worker safety – ALARA, heat stress
- Troubleshooting via crash cart, emergent needs

Stakeholder Engagement & Sustainable Adoption



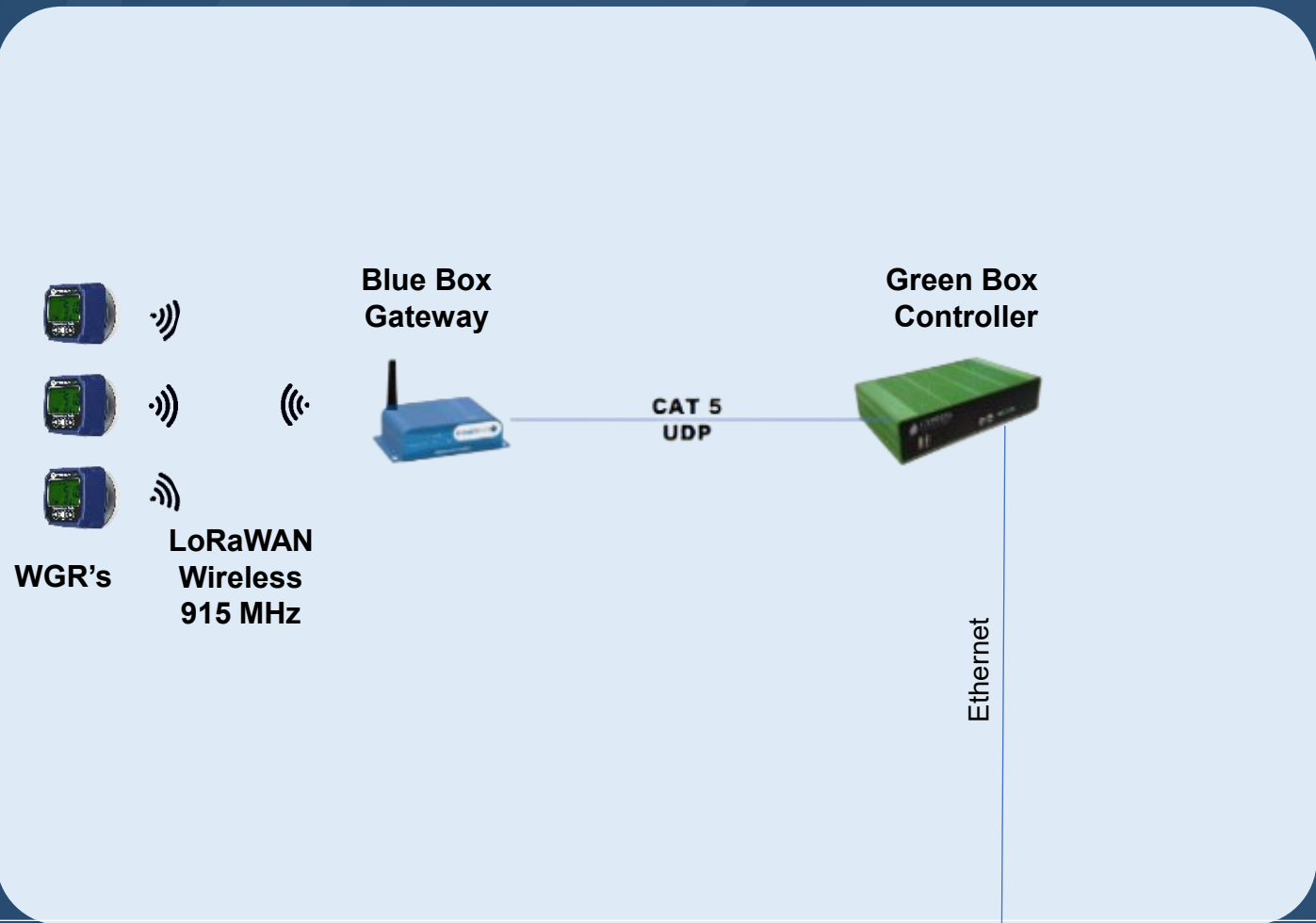
- Clear procedures for tasks, roles, and ownership.
- Lots of training.
- Users Group to share OE and best practices – Industry wide group plus Southern chapter.
- Create library of Use Cases with documented benefits.
- PROACTIVE - DO NOT TAKE ADOPTION FOR GRANTED.

 Southern Nuclear		HATCH Unit C												
DI-OPS-96-1222														
Control of Wireless Gauge Readers														
VERSION 1.1														
Special Considerations:														
Applicable to HNP														
<table border="1"><thead><tr><th colspan="2">PROCEDURE LEVEL OF USE CLASSIFICATION PER NMP-AP-003</th></tr><tr><th>CATEGORY</th><th>SECTIONS</th></tr></thead><tbody><tr><td>Continuous</td><td>NONE</td></tr><tr><td>Transient Response</td><td>NONE</td></tr><tr><td>Reference</td><td>ALL</td></tr><tr><td>Information</td><td>NONE</td></tr></tbody></table>			PROCEDURE LEVEL OF USE CLASSIFICATION PER NMP-AP-003		CATEGORY	SECTIONS	Continuous	NONE	Transient Response	NONE	Reference	ALL	Information	NONE
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Approval:	<u>Hank Strahley</u> Approved By	<u>08/15/23</u> Date												
Effective Date:	<u>01/09/24</u>													
	<u>OPERATIONS</u> Responsible Department													

Network Architecture – SNC Plant



SNC Plant



Monitoring & Diagnostics Ctr



Connection via RESTful API, OPC

Web Application Clients HTTPS using browser

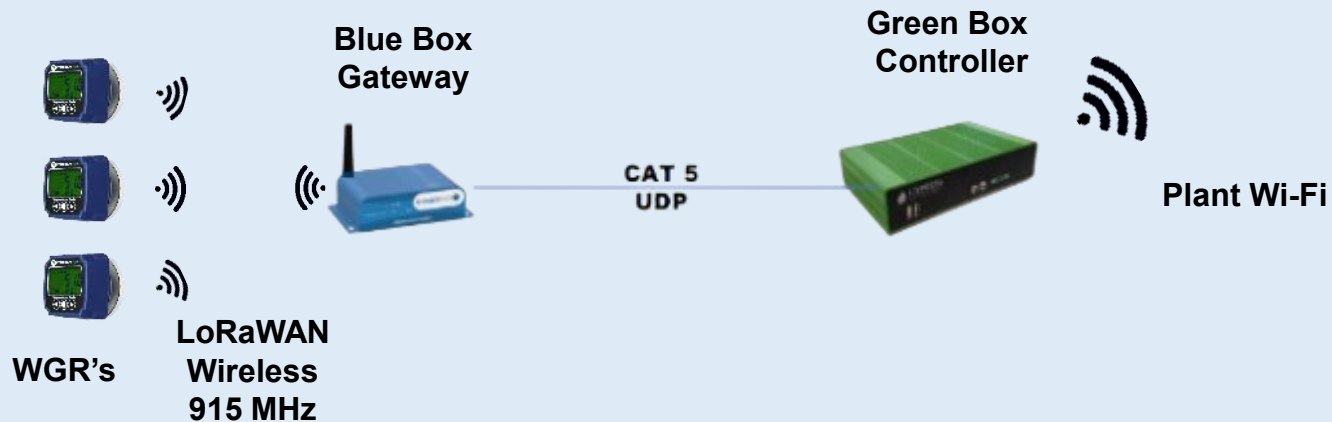


Southern Level 2 Business Network

Network Architecture – SNC Plant



SNC Plant



Monitoring & Diagnostics Ctr

OSI PI Historian

3rd Party App

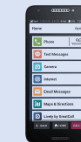


Connection via RESTful API, OPC

Web Application Clients HTTPS using browser



Laptops



Smartphones/
Tablets



Southern IoT Wireless Network

Network Architecture – SNC Plant



Plant Hatch

Atlanta Data Center

Monitoring & Diagnostics Ctr



Southern Level 2 Business IoT Network

Trending: Turbine Valve Actuator Temp



Need:

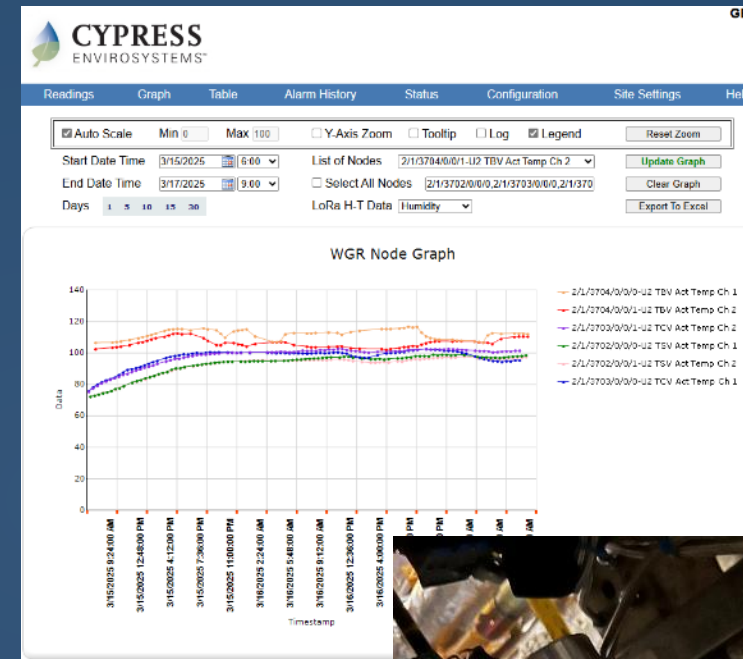
- Long term temperature trending to monitor for EHC fluid degradation due to temperature

Solution:

- Install magnetic thermocouples to each Turbine Valve Actuator

Benefit:

- Real time temperature monitoring without entry into Condenser Bay
- Eliminate Radiation dose and heat stress to personnel
- Avoid Turbine Valve failures due to EHC fluid degradation



Machine Vision Webcam Processing



Application:

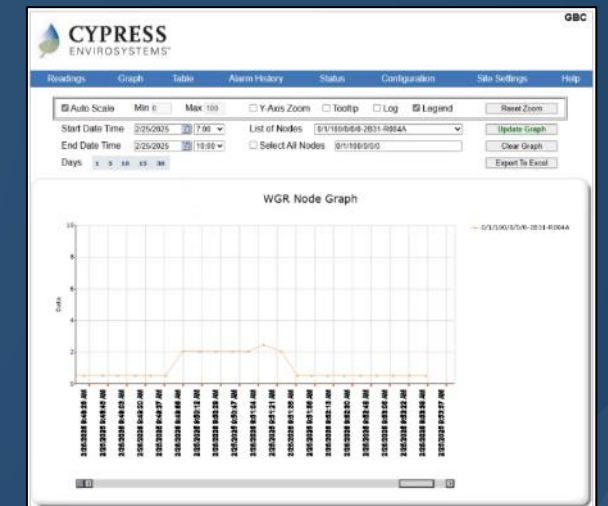
- Support design mod for Reactor Recirc Pump seal purge filter skid.
- Monitor purge flow during post mod testing.

Benefit:

- Quickly detect variations.
- Ability to collect, trend and analyze historical data.
- Able to assist in design testing of critical components.



**Webcam with
Operator monitor**



**Automated Digitized
Collection of Data**

Enhance Design Modifications: Condensate Booster Pump Seal Monitoring



Application:

- Design Mod to upgrade Unit 2 condensate booster pump seals
- Added six WGRs as low-cost method to digitize/enable continuous monitoring of seal pressures.

Benefit:

- Minimize design time and cost to allow continuous monitoring.
- Enable automated equipment health monitoring and fault-detection.



Valve Cycle Isolation Monitoring



Need:

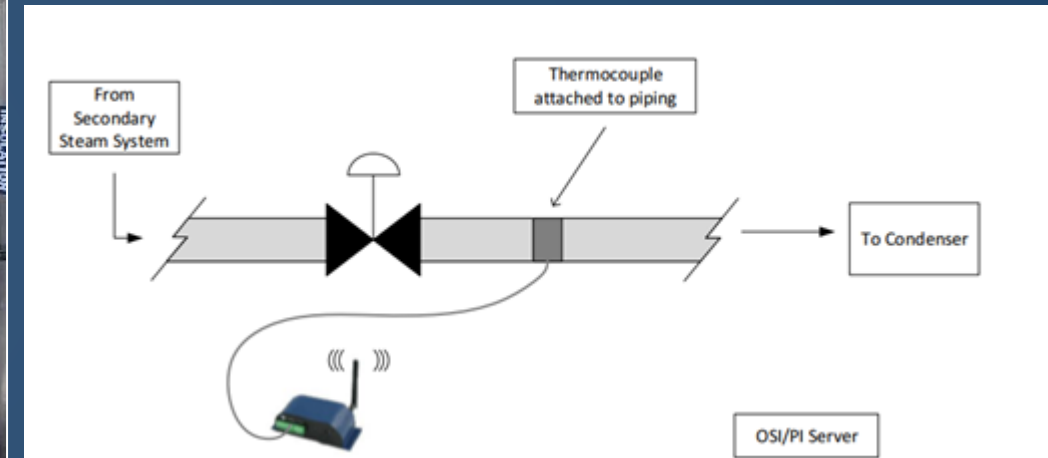
- Detect valve cycle isolation faults.
- Minimize cost and process disruption.

Benefit:

- Stop leaks, save MW's (est. up to 2MW per malfunctioning valve).
- Save operator time to monitor valves



Detect Leaking Valves



Early Fault Detection: Condenser Tube Leaks



Need:

- Remotely monitor Condenser Hotwell Sodium and Conductivity to detect tube leaks

Concept:

- Use Wireless Digit Readers to monitor installed Sodium and Conductivity instruments

Benefit:

- Early detection of tube leaks prior to impacting Reactor Chemistry
- Ability to trend chemistry data
- Remote monitoring versus having a technician gathering data



Operator Rounds Dashboard



Concept:

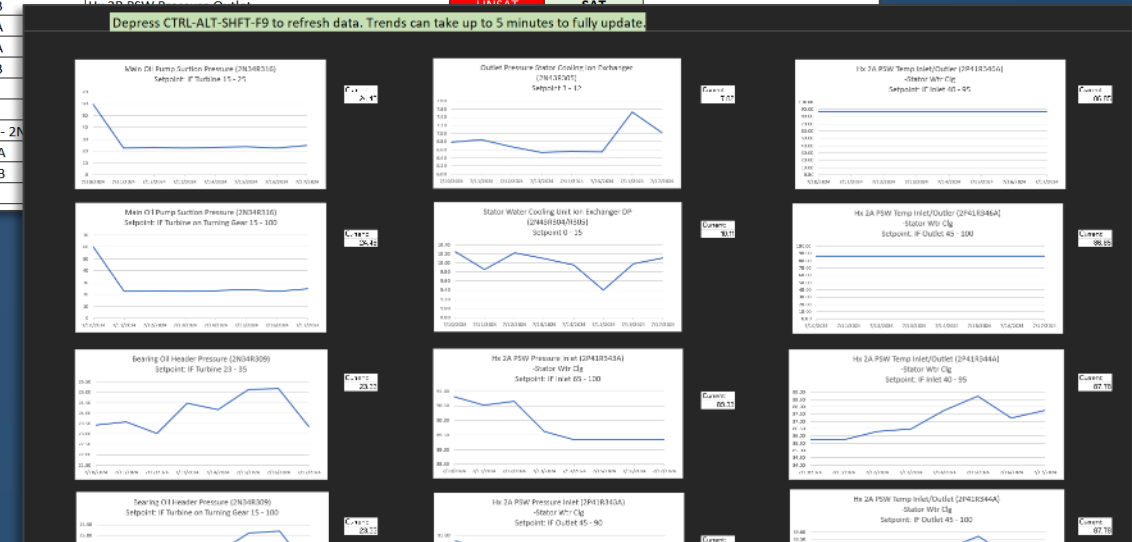
- Collect rounds data throughout day using WGRs
- Operators can review trends and identify abnormalities at start of shift
- Plan and prioritize work more efficiently

Benefit:

- Reduce operator time by 2 hours per shift
- Faster response to excursions / emergent issues

2 If the cell to the left is not green, then AT THE SAME TIME, press and release "Ctrl", "Alt", "Shift", and "F9" to refresh the data.

Rec/Sta(#)	System	MPL	Description	Current Value	Frozen Gauge Check	NOTES (System OOS/CR# on Gauge)
25	Turbine	2N34R316	Main Oil Pump Suction Pressure	SAT	SAT	
508	Turbine	2N34R316	Main Oil Pump Suction Pressure (IF on Turning Gear)	SAT	SAT	
26	Turbine	2N34R309	Bearing Oil Header Pressure	SAT	SAT	
509	Turbine	2N34R309	Bearing Oil Header Pressure (IF on Turning Gear)	SAT	SAT	
27	Turbine	2N34R315	Operating Oil Pressure	SAT	SAT	
510	Turbine	2N34R315	Operating Oil Pressure (IF on Turning Gear)	SAT	SAT	
111	RFPT	2N34R317	RFPT Oil Conditioner Pump Discharge Pressure	SAT	SAT	
112	RFPT	2N34R324	RFPT Oil Conditioner Discharge Pressure	SAT	SAT	
113	RFPT	2N34R317 - 2N34R324	RFPT Oil Conditioner Polishing Filter DP	SAT	SAT	
162	SWC	2N43R304	Inlet Pressure Stator Cooling Ion Exchanger	SAT	SAT	
163	SWC	2N43R305	Outlet Pressure Stator Cooling Ion Exchanger	SAT	SAT	
164	SWC	2N43R304 - 2N43R305	Stator Water Cooling Unit Ion Exchanger DP	SAT	SAT	
171	SWC	2P41R343A	Hx 2A PSW Pressure Inlet	SAT	SAT	
172	SWC	2P41R345A	Hx 2A PSW Pressure Outlet	SAT	SAT	
173	SWC	2P41R345B	Hx 2B PSW Pressure Inlet	SAT	SAT	
174	SWC	2P41R343B	Hx 2B PSW Pressure Outlet	SAT	SAT	
175	SWC	2P41R346A	Hx 2B PSW Temp Inlet/Outlet (2P41R346A)	SAT	SAT	
176	SWC	2P41R344A	Hx 2B PSW Temp Inlet/Outlet (2P41R344A)	SAT	SAT	
177	SWC	2P41R344B	Hx 2B PSW Temp Inlet/Outlet (2P41R344B)	SAT	SAT	
179	SWC	2N43R308	Stator Water Clg	SAT	SAT	
180	SWC	2N43R307	Stator Water Clg	SAT	SAT	
181	SWC	2N43R308 - 2N43R307	Stator Water Clg	SAT	SAT	
187	SJAE	2N22R327A	Stator Water Clg	SAT	SAT	
188	SJAE	2N22R327B	Stator Water Clg	SAT	SAT	
189	H2 Stator Clg	2N43R315	Stator Water Clg	SAT	SAT	



Credit: Operator Dashboard developed by J. Plumb, Operator at Duke Energy, Oconee Nuclear Plant

Crash Cart for Emergent Issues



Need:

- Plant needs data quickly to troubleshoot, diagnose and correct emergent issues.

Concept:

- Use Crash Cart with non-invasive sensors to collect data
- Pre-approved, ready to install in 30 minutes.

Benefit:

- Reduced time needed for engineering reviews and approvals to add sensors (or minimizes, efficiently, effectively, etc.)



Dry Well Temp / Humidity Monitoring



Need:

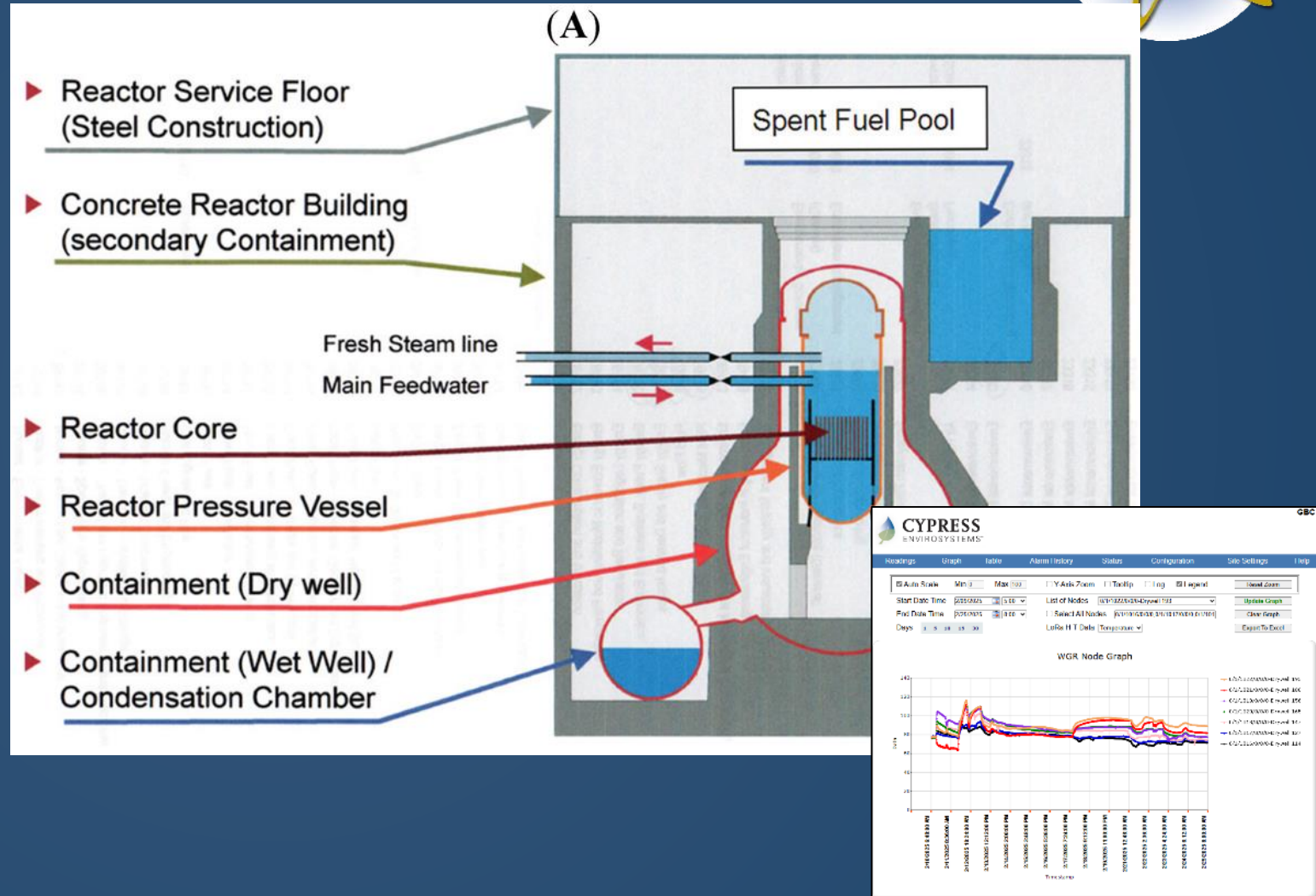
- During outage: Monitor temperature and humidity for worker heat stress.
- Minimize time and dosage exposure for RP Tech to gather data each shift.

Solution:

- Use magnetic mount temporary non-invasive Wireless Temperature and Humidity Monitors.

Benefit:

- Save 1.5 Man-hours/day, 45 Man-hours outage total
- Reduce 8 mrem/day, 240 mrem outage total radiation exposure
- Reduced Industrial Safety exposure



M&D Center Birmingham

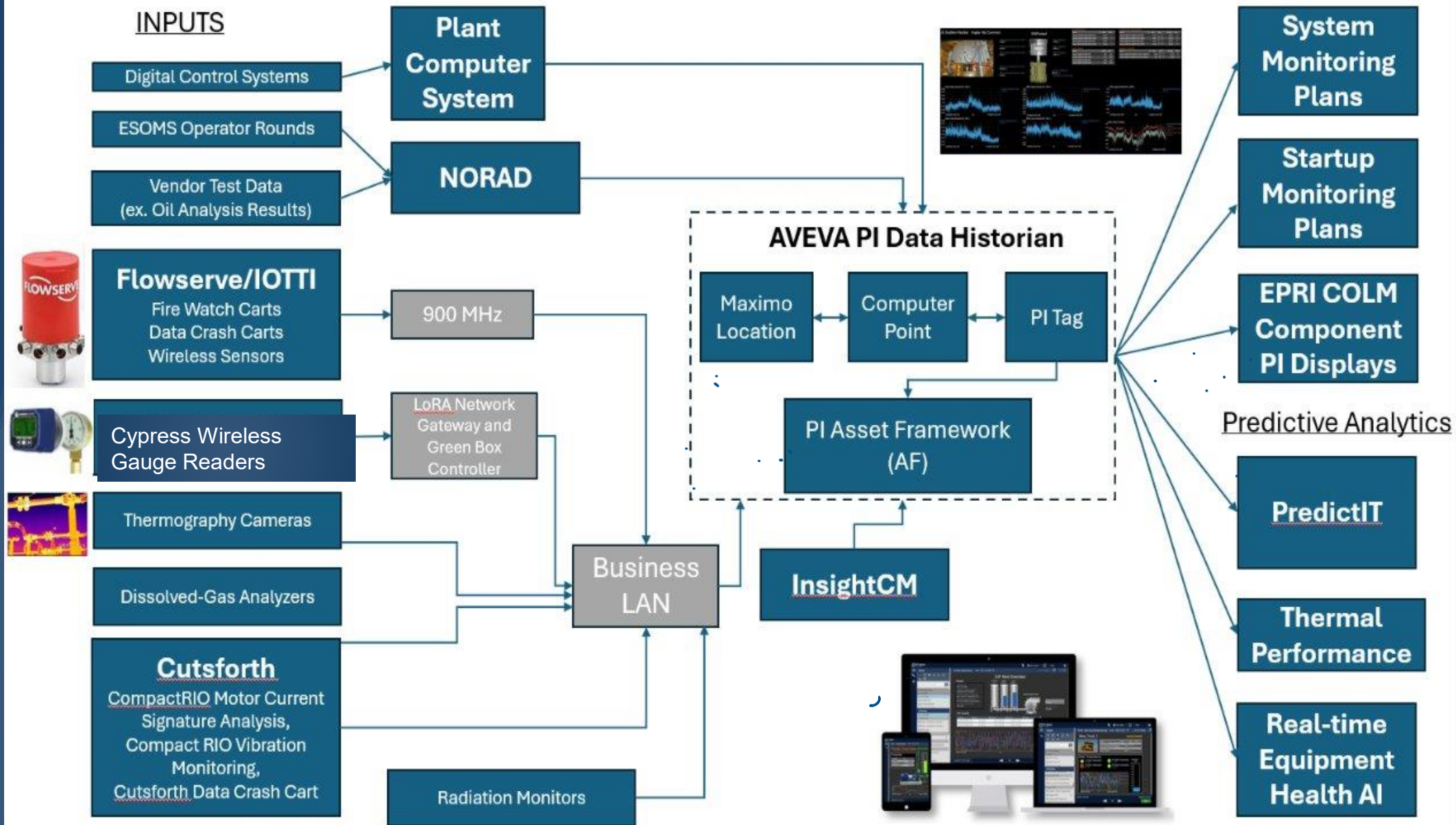


SNC Monitoring and Diagnostic Vision

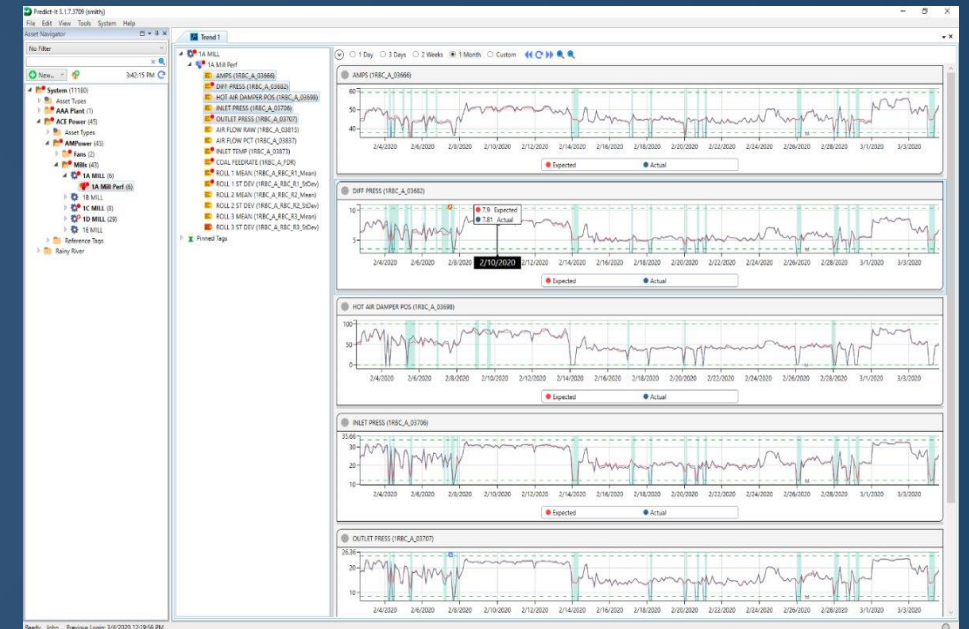
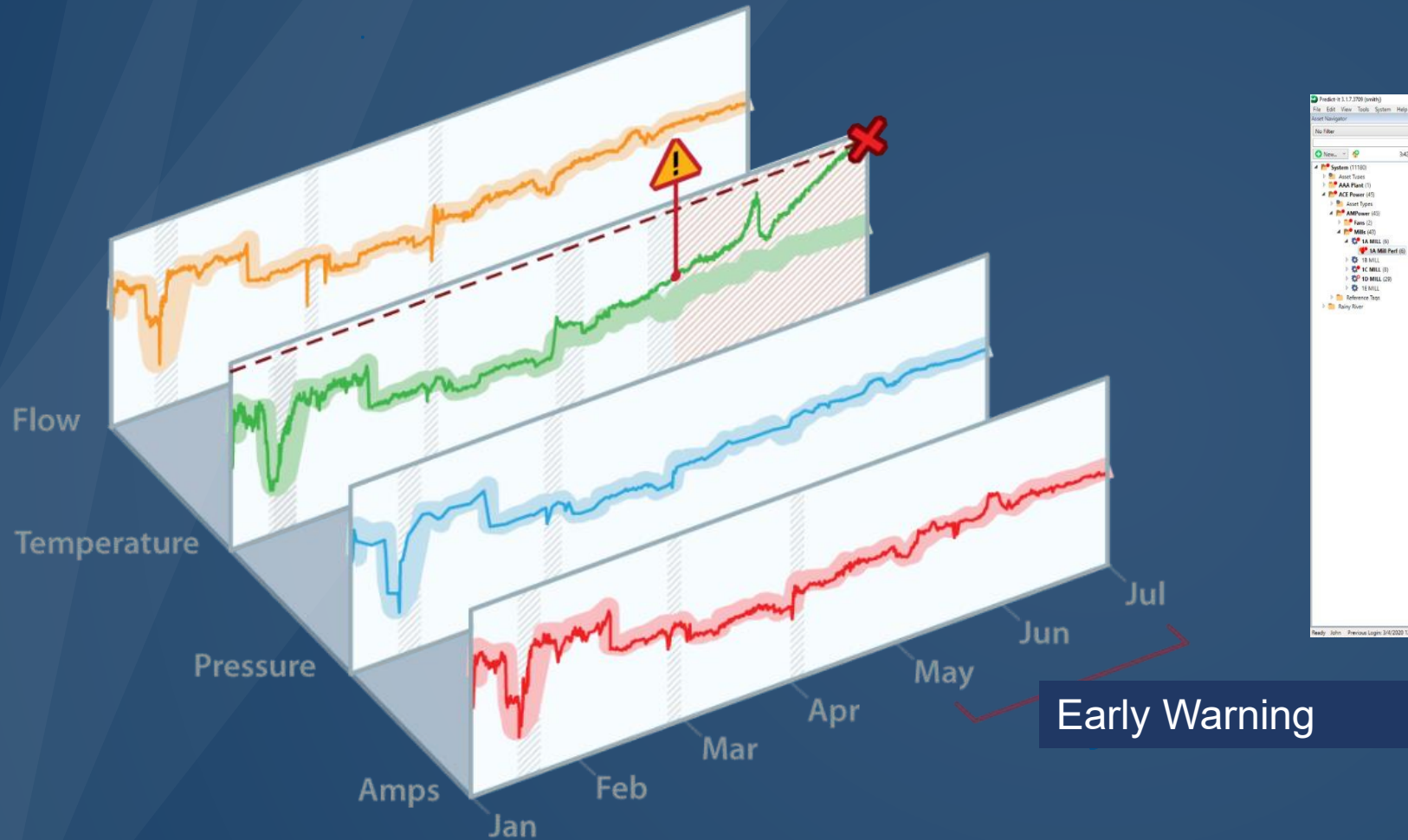


- The M&D Center uses **advanced Hardware and Software (AI, Machine Learning, Modeling, predictive analytics)** to detect and diagnose performance and reliability issues.
- The M&D Center not only improves equipment reliability but also optimizes **thermal performance (PEPSE RT)** to reduce O&M expenses by supporting the Transition to a **condition-based PM (OLM Transmitter Calibration Extension)**

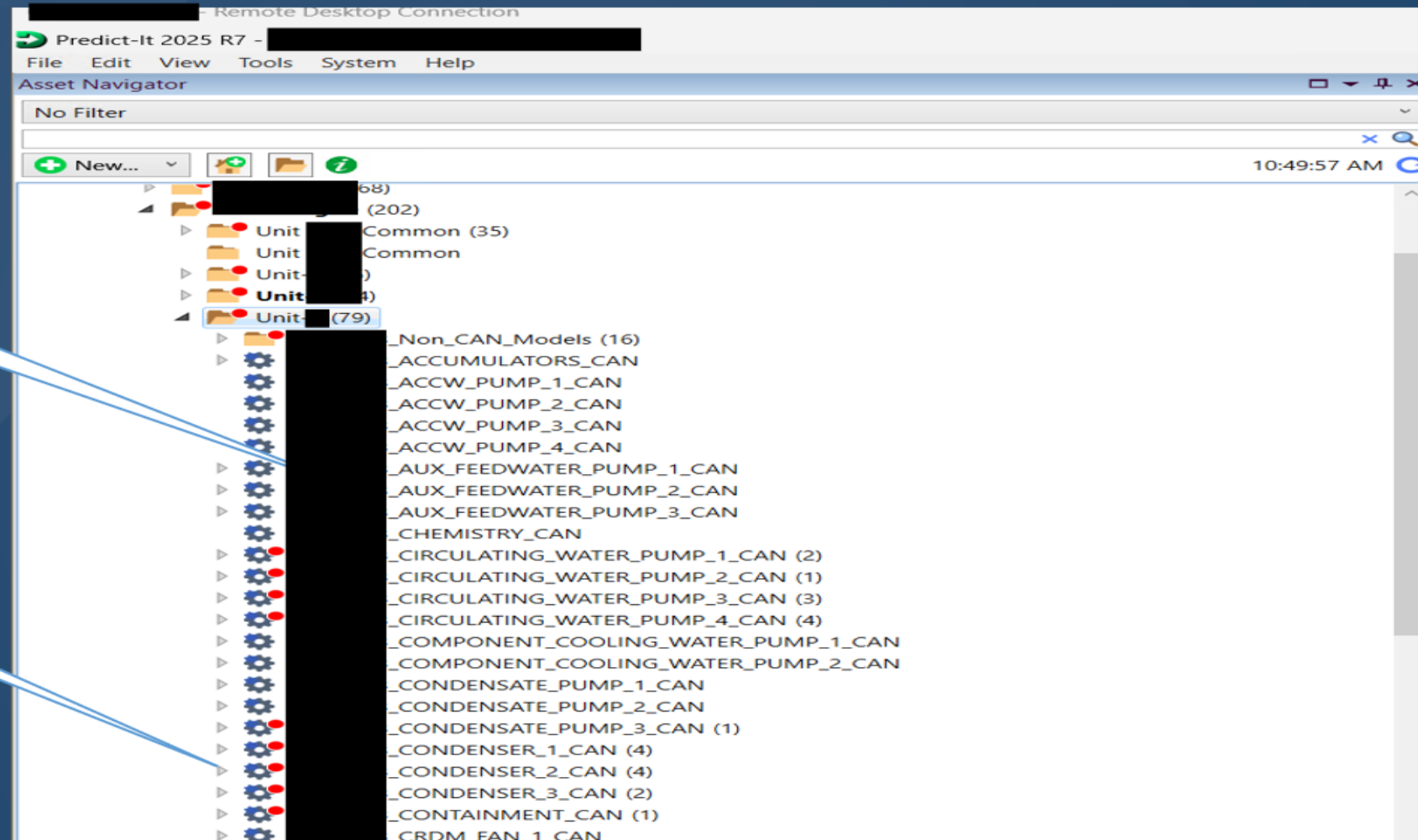
Data Flow



What is APR Modeling?



Model Types



Reliability CBM

Process

Predict-It APR Module Isophase

Normal Operation

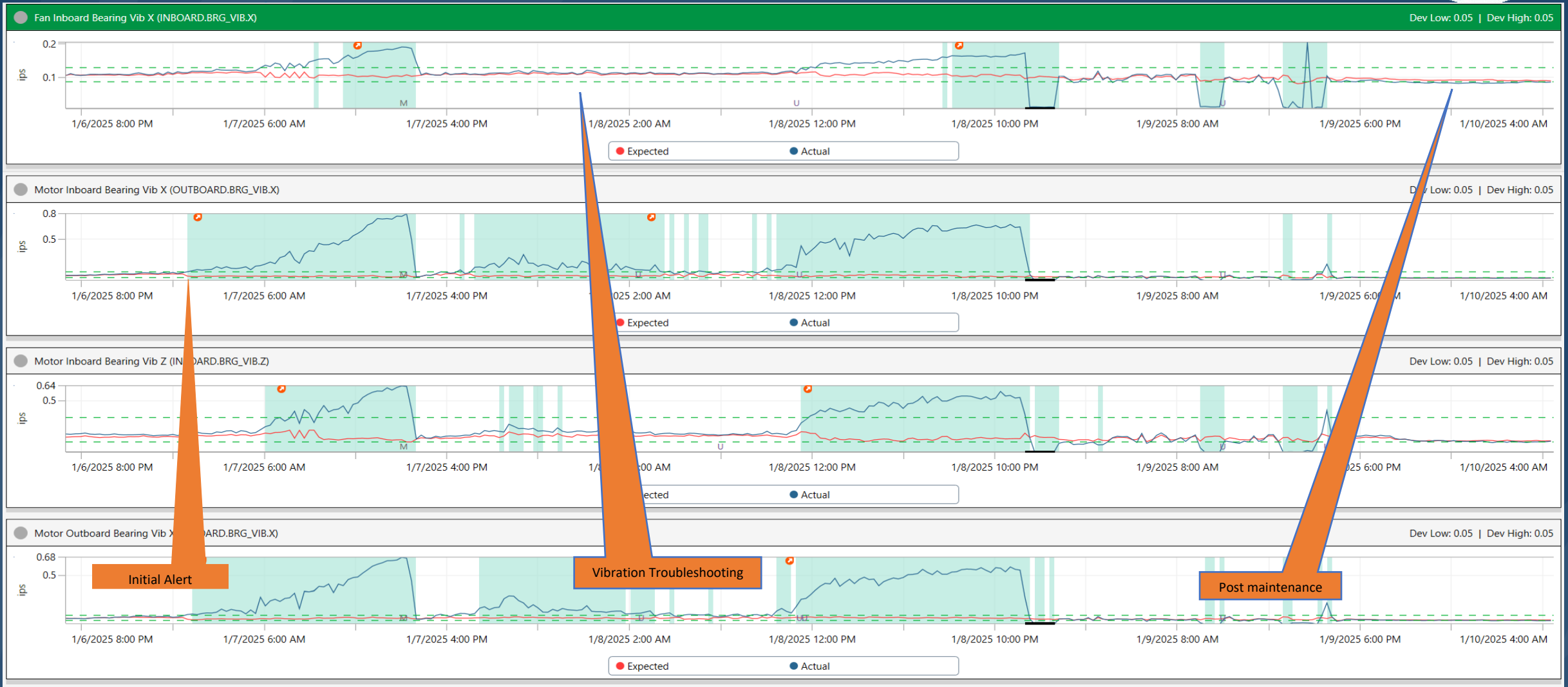
Actual Valve = 0.094
Expected Value = 0.091

Actual Valve = 0.2
Expected Value = 0.099

Abnormal Condition



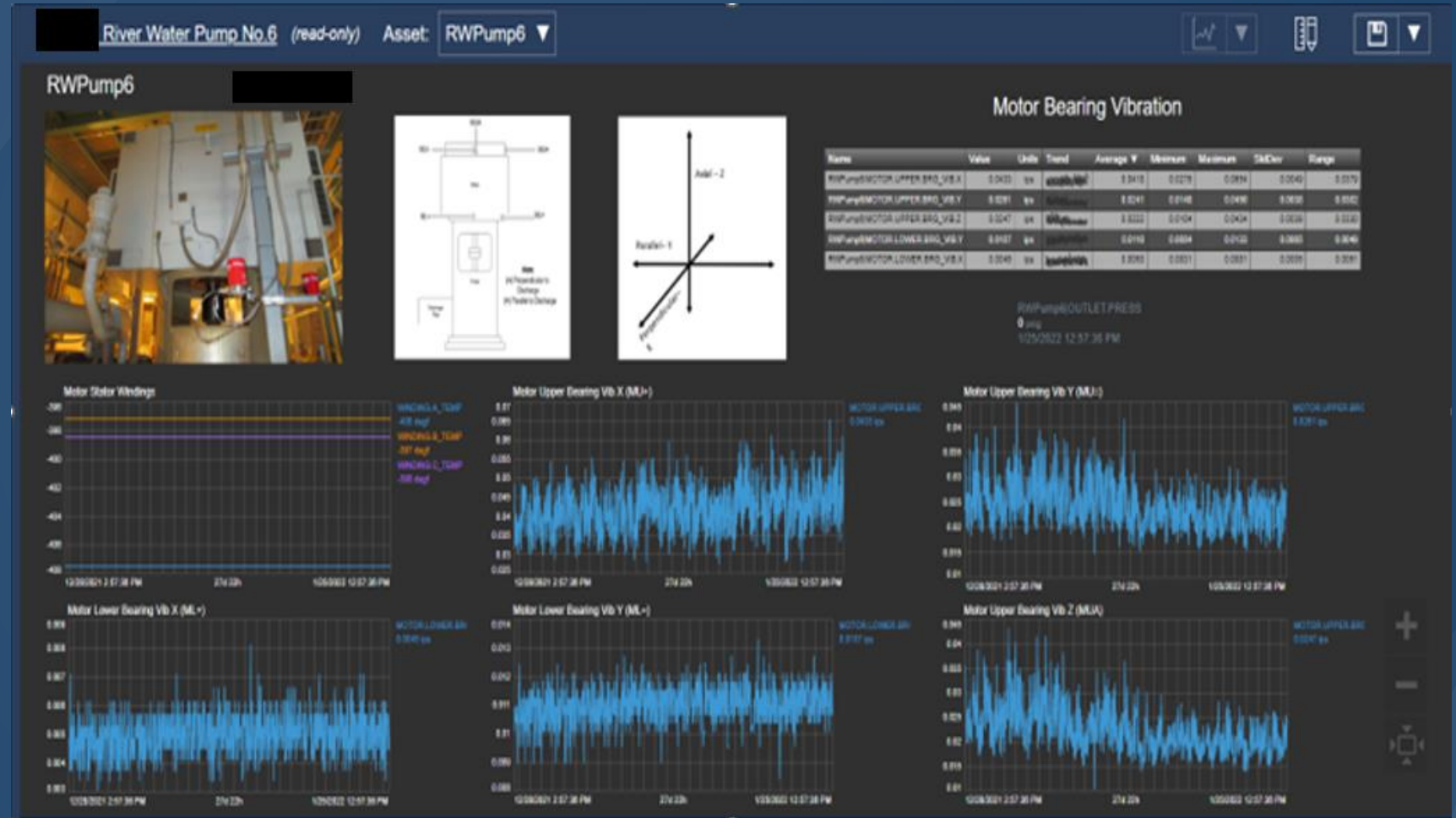
Critical Failure Avoidance



M&D Application of OLM Technology



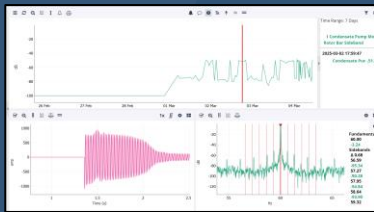
- *Wireless Sensors sending motor parameters from over a mile away*
- *M&D Center using this information for predictive modeling*



M&D Application of OLM Technology



CBM (Condition-Based Maintenance) Online Asset Health and Diagnostics



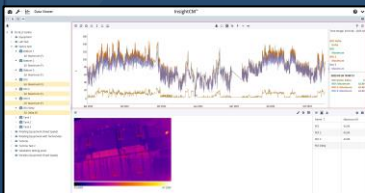
InsightCM MCSA

- Online Motor Current Signature Analysis
- Rotor health evaluation
- Start-up in-rush capture



Online Water in Oil Monitor

- Pilot at E.C. Gaston on Unit 4 where we have water issues from the steam seals.
- PPM of water in oil
- Mount inline with oil flow



Online InfraRed

- Transformer monitoring
- Small camera available for temporary monitoring

Bluetooth Sensors

- Will add “attributes” to the data
- Increased model accuracy and future machine learning capabilities



Critical Asset Vibration

- Currently using on Farley RCPs.
- Continuous online vibration monitoring connected to the vibration protection system.
- Web access for all SNC engineers



M&D Application of OLM Technology

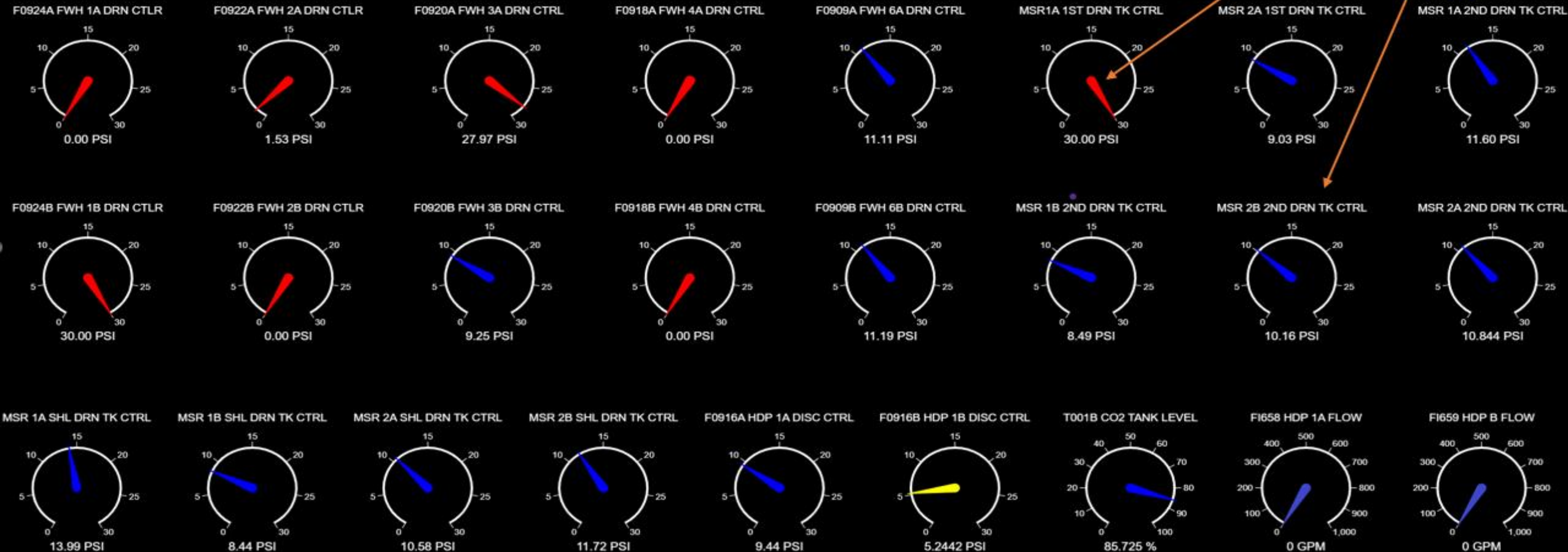


[To Tabular Display](#)

Wireless Gauge Readers

Multi State
configuration

Notification of
alert
conditions



Plant Notifications



Southern Nuclear

SRVA

Reactor Pressure
1,040.4

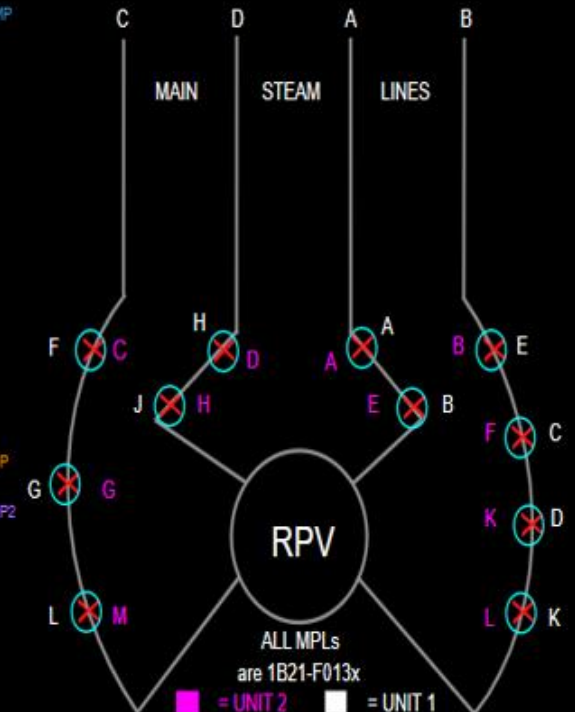
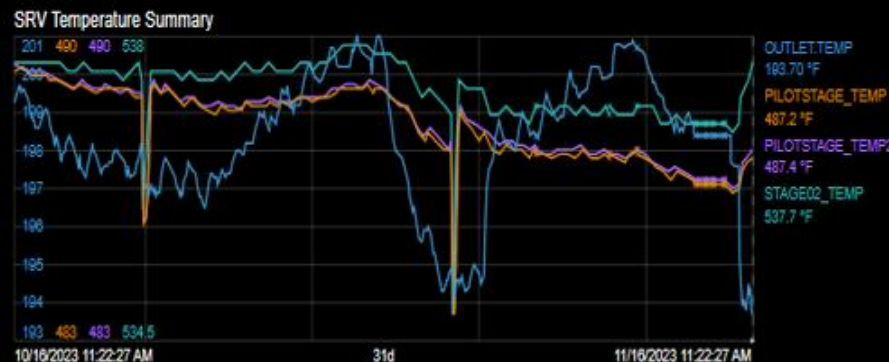
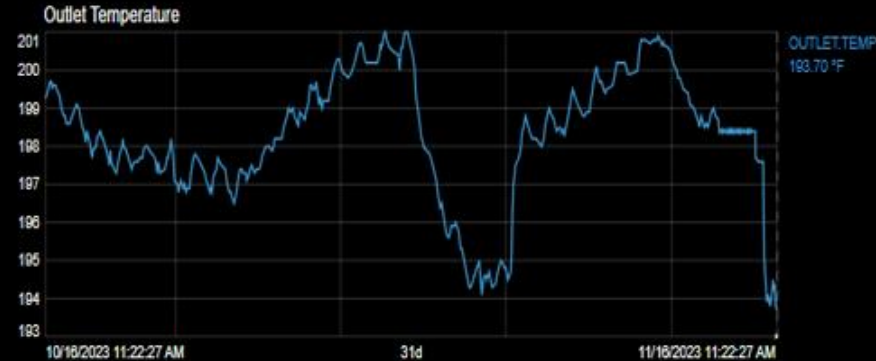
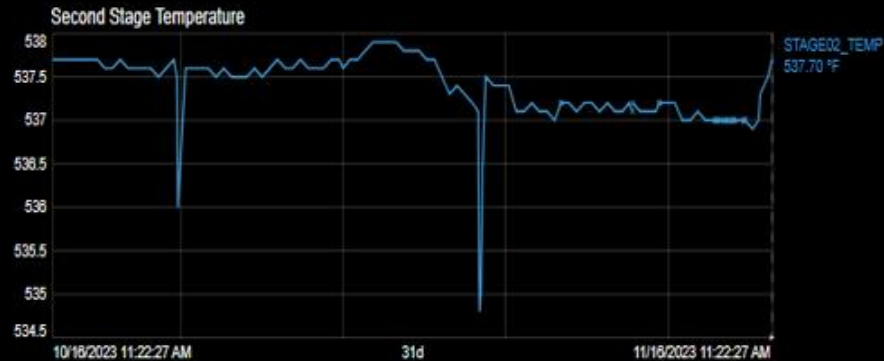
CORE POWER %
98.571

GROSS MW
912.5

Name	Description	Value	Units	Trend	Minimum	Maximum	StdDev	Range
SRVA/OUTLET_TEMP	Reactor Safety Relief Valve A Outlet Temperature	193.7	°F		193.7	201	1.66	7.3
SRVA/PILOTSTAGE_TEMP	Reactor Safety Relief Valve A Pilot Stage Temperature	487.2	°F		483.6	489.3	0.85732	5.7
SRVA/PILOTSTAGE_TEMP2	Reactor Safety Relief Valve A Pilot Stage Temperature 2	487.4	°F		483.7	489.36	0.83734	5.6608
SRVA/STAGE02_TEMP	Reactor Safety Relief Valve A Stage 02 Temperature	537.7	°F		534.8	537.9	0.3278	3.1

Pilot Stage leakage is identified by: Procedure 34AB-B21-003-1 [ProGo](#)

- A reduction of greater than a 30°F on either of the two Pilot Stage thermocouples AND
- A reduction of greater than a 5°F on the Second Stage thermocouple AND
- The Reactor is at steady state condition with pressure > 850 PSIG.



M&D Application of OLM Technology

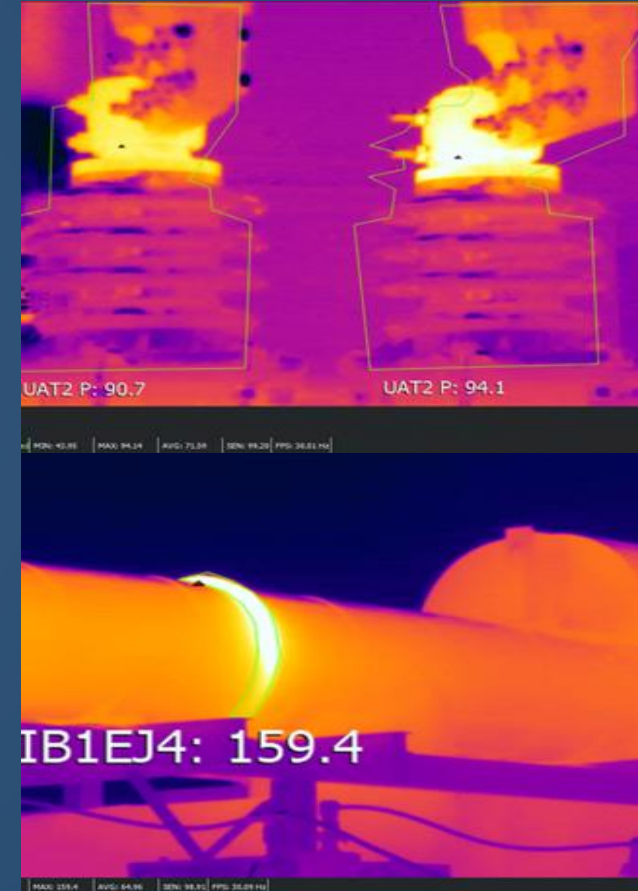


Low Voltage Switchyard Thermal Cameras

Installed thermal cameras to monitor large power transformers and component heat signatures to be proactive and identify anomalies. Each camera has full pan/tilt/zoom capability and monitors each region of interest (ROI) on GSU's, UAT's RAT's, SAT's at 3 - minute intervals.

Each ROI is assigned a Osi Pi data tag that is supplied to the Osi Pi data historian to provide trends with alert limits

The Technology Organization assisted in installing Osi Pi data historians locally at each site along with integrating the data and video feeds.



Wireless Fire Watch Carts



Wireless Vibration Crash Carts



M&D Center Innovation

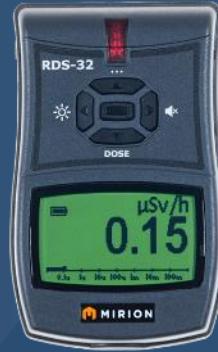
Flex Dome Wireless Equipment Monitoring





Future Developments

Wireless Remote Radiation Monitor



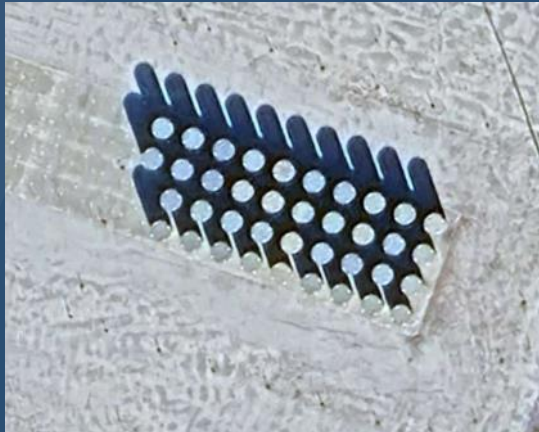
Commercially Available
Radiation Meter



Add-on
Wireless Digit Reader

- Real-time wireless mobile radiation dose rate monitor
- Battery operated: does not require power nor communications wires
- No need to install additional wireless network (uses Blue Box Gateway and GBC)
- Data via OPC or RESTful API available to PI Historian, 360 Plant Walkthru Software etc.

Drone Integration: Dry Cask Inspection



Skydio Drone

- May be piloted
- Or autonomous



Skydio Dock

- “Garage” protection
- Recharging
- Data download



Q & A