

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

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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













2B31-R004B

Most Plant Data is Not Digitized – Collected Manually

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Non-Invasive Digitization Solutions



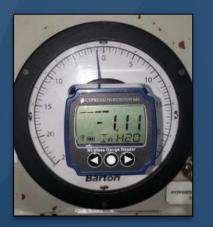


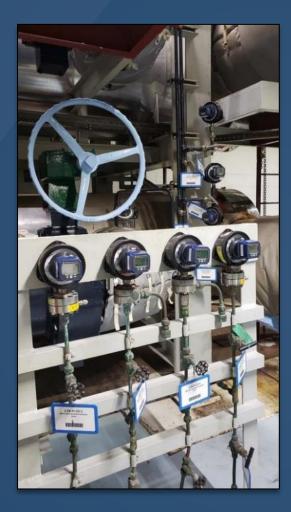
Five Minute Installation – No Downtime, No Impact to Plant Process

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Typical Installation - 2











Used Outdoors, in RCA, Safety Related, Seismic Structures

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Manual + Digital Data Collection



Minimize disruption to existing operator rounds

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Capturing Data Beyond Gauges







Wireless Temperature and Humidity Monitor



Valve Cycle Isolation 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

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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

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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 conditionbased maintenance
- Optimizing plant thermal performance
- Improve worker safety ALARA, heat stress
- Troubleshooting via crash cart, emergent needs

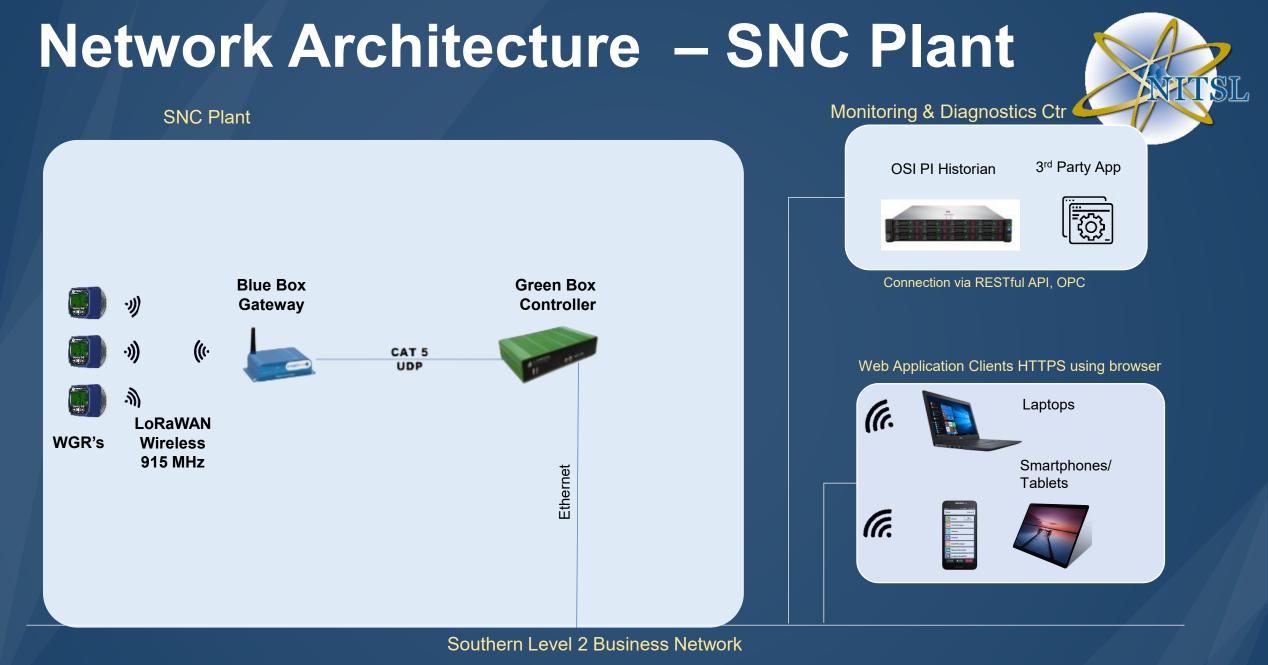


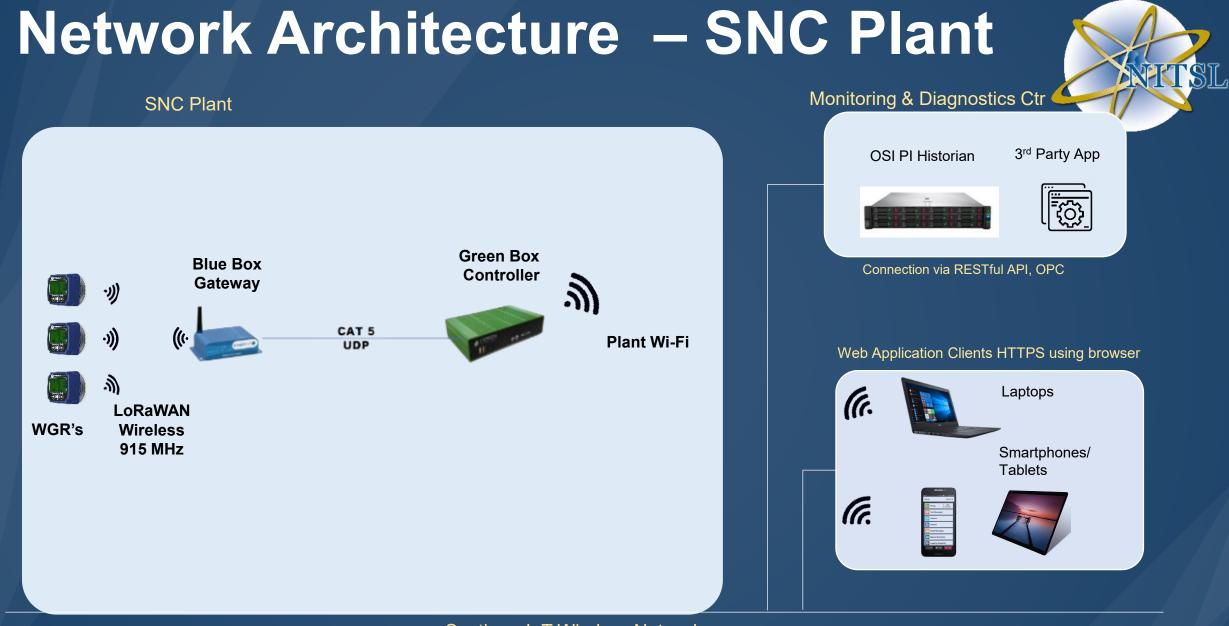
Stakeholder Engagement & Sustainable Adoption

- 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.

📥 Sou	thern Nuclear	HATCH Unit C	
	DI-OPS-96-1222		
Control of Wireless Gauge Readers			
VERSION 1.1			
Special Considerations:			
Applicable to HNP			
PR CATEGORY	OCEDURE LEVEL OF USE CLASSIFICATION PER NMP-AP-003 SECTION S		
Continuous	NONE		
Transient Response	NONE		
Reference	ALL		
Information	NONE		
	·		
Approval:		3/15/23	
	Approved By	Date	
Effective Date: 01/09/24			
_	OPERATIONS		
	Responsible Department		



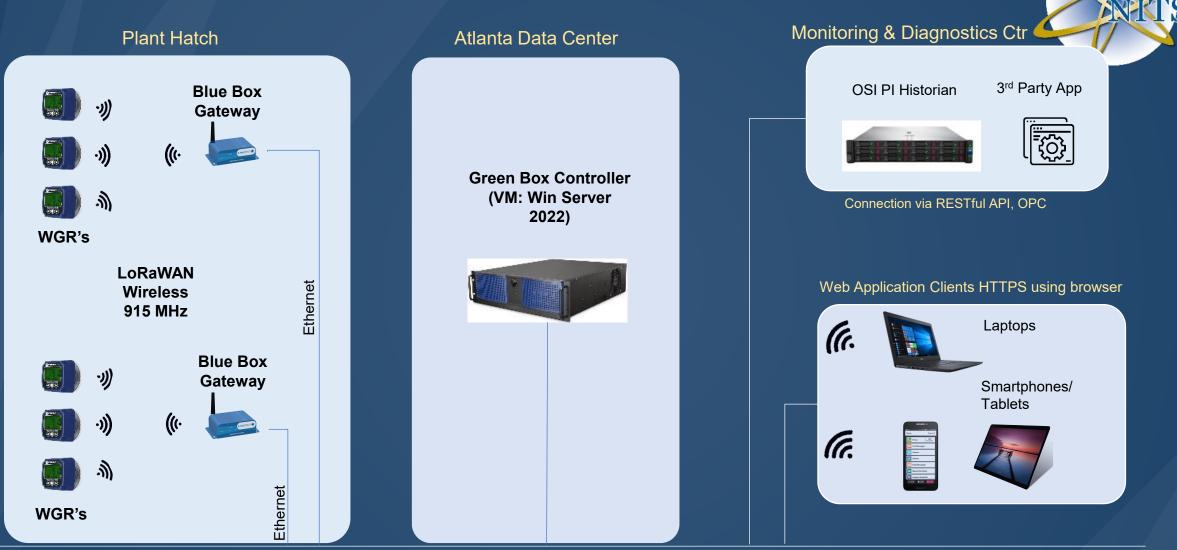




Southern IoT Wireless Network

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Network Architecture – SNC Plant



Southern Level 2 Business IoT Network

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Trending: Turbine Valve Actuator Temp

Need:

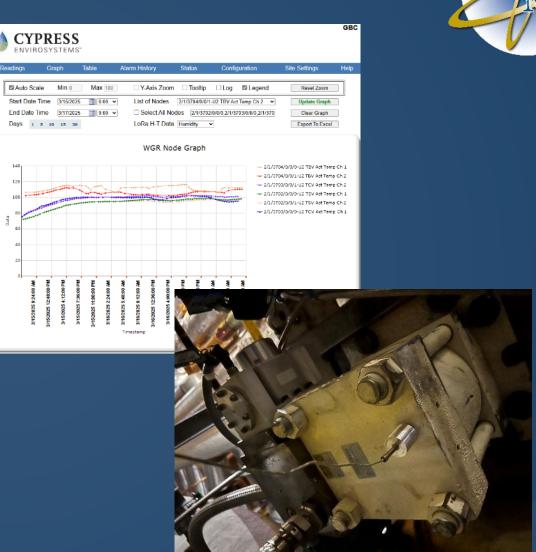
 Long term temperature trending to monitor for EHC fluid degradation due to temperature

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.

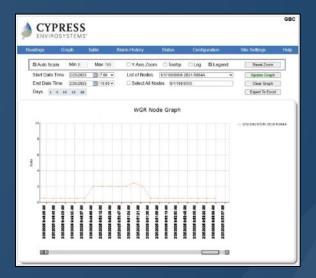
Benefit:

- 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:

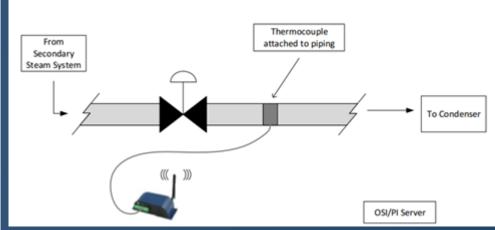
- Detect valve cycle isolation faults.
- Minimize cost and process disruption.

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

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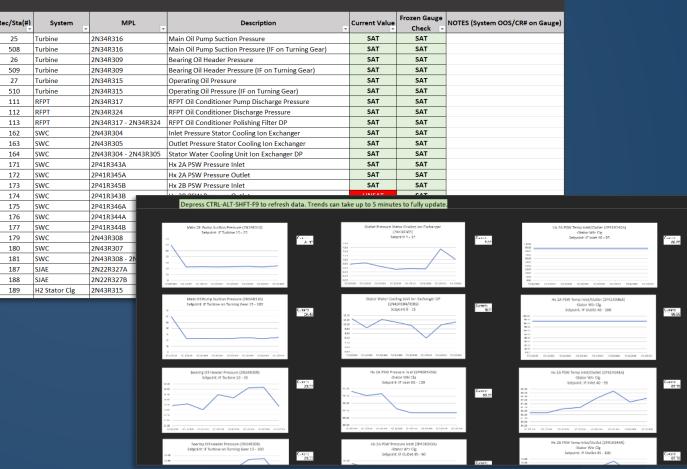
Concept:

- 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

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



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.)





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Dry Well Temp / Humidity Monitoring

Need:

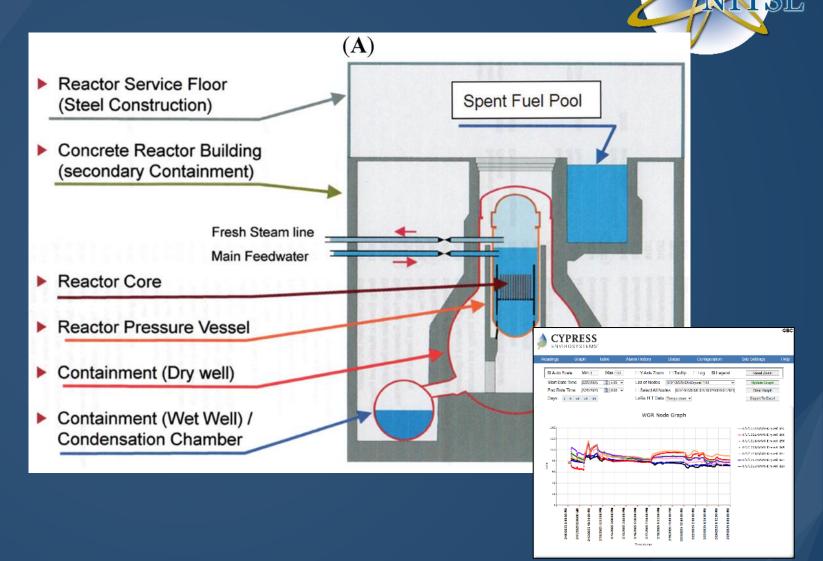
- During outage: Monitor temperature and humidity for worker heat stress.
- Minimize time and dosage exposure for RP Tech to gather data each shift.

Solution:

 Use magnetic mount temporary noninvasive Wireless Temperature and Humidity Monitors.

Benefit:

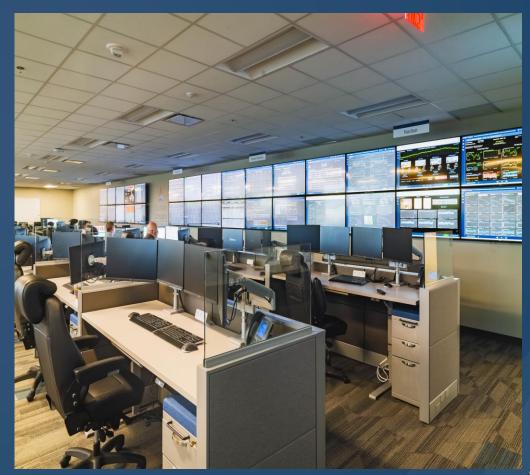
- Save 1.5 Man-hours/day, 45 Manhours outage total
- Reduce 8 mrem/day, 240 mrem outage total radiation exposure
- Reduced Industrial Safety exposure





M&D Center Birmingham

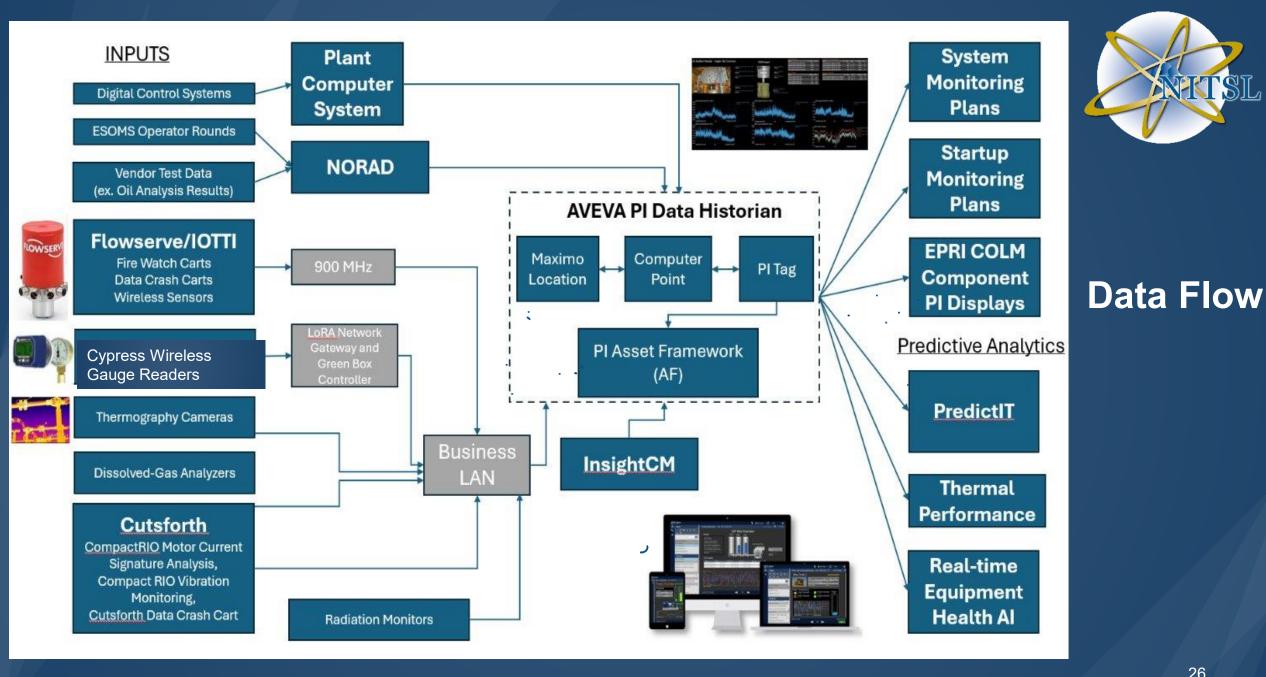




SNC Monitoring and Diagnostic Vision



- 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)**



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What is APR Modeling?

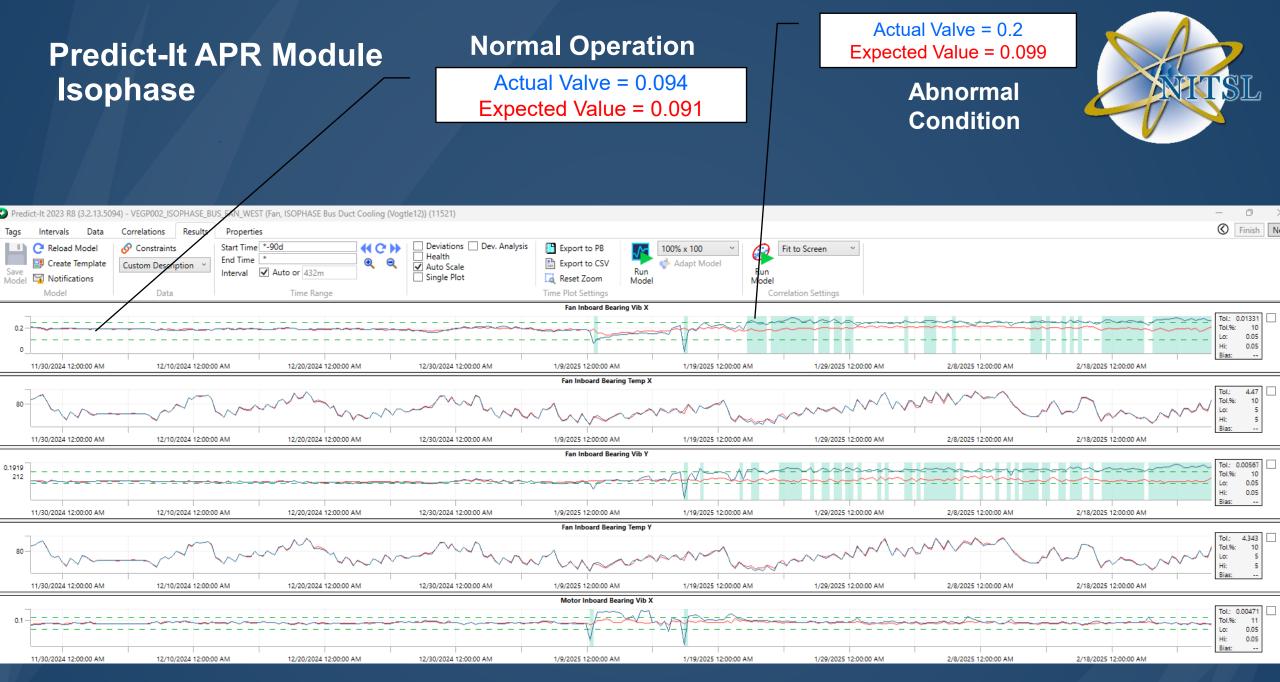




Model Types

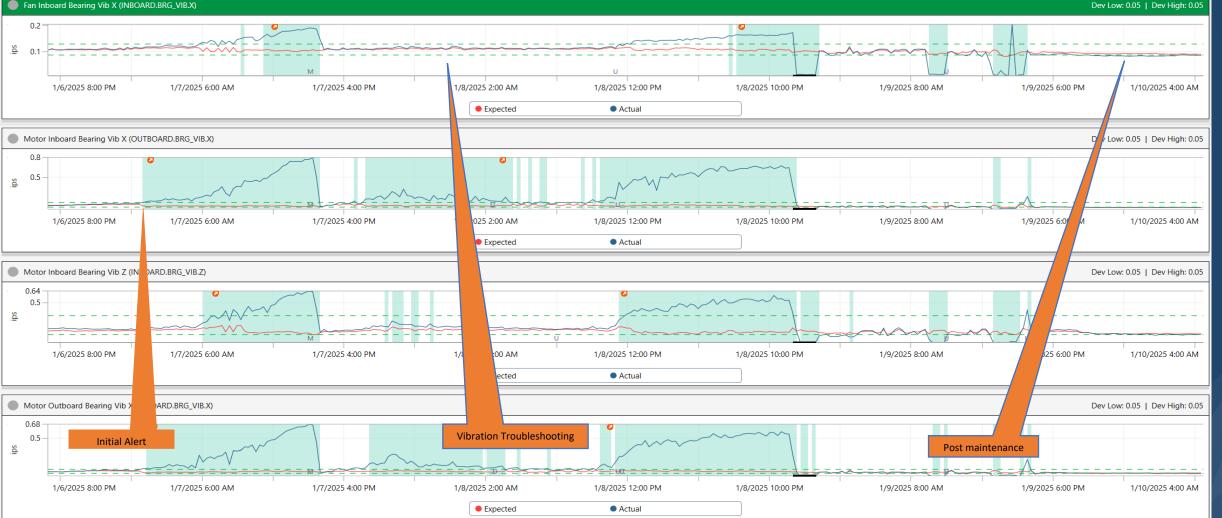
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	Unit Common (35)	
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	_ACCW_PUMP_3_CAN	
	_ACCW_PUMP_4_CAN	
	AUX_FEEDWATER_PUMP_1_CAN	
	AUX_FEEDWATER_PUMP_2_CAN	
	AUX_FEEDWATER_PUMP_3_CAN	
	CHEMISTRY_CAN	
	CIRCULATING_WATER_PUMP_1_CAN (2)	
Process	▷ See	
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	▷ SPCIRCULATING_WATER_PUMP_4_CAN (4)	
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	COMPONENT_COOLING_WATER_PUMP_2_CAN	
	CONDENSATE_PUMP_1_CAN	
	CONDENSATE_PUMP_2_CAN	
	CONDENSATE_PUMP_3_CAN (1)	
	CONDENSER_1_CAN (4)	
	CONDENSER_2_CAN (4)	
	CONDENSER_3_CAN (2)	
	CONTAINMENT_CAN (1)	
	CRDM FAN 1 CAN	

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Critical Failure Avoidance



Fan Inboard Bearing Vib X (INBOARD.BRG_VIB.X)

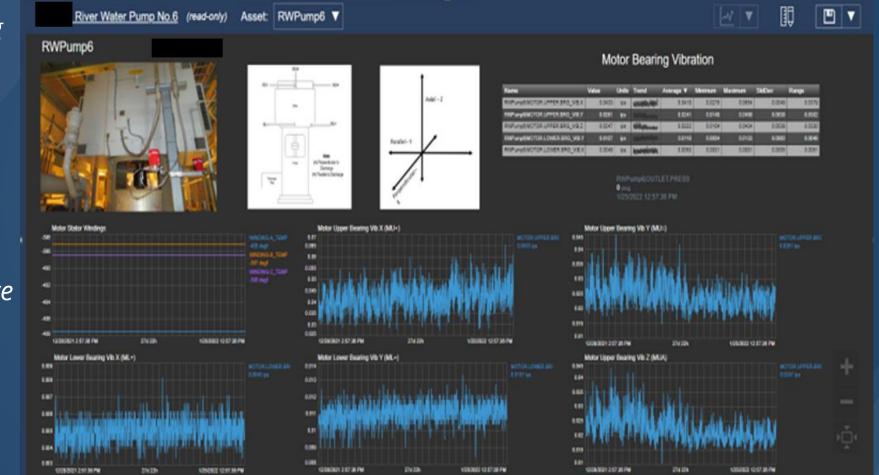
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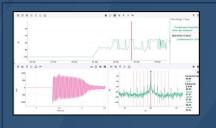
• Wireless Sensors sending motor parameters from over a mile away

 M&D Center using this information for predictive modeling





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



InsightCM MCSA

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

Bluetooth Sensors

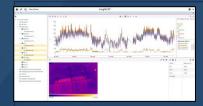
- Will add "attributes" to the data
- Increased model accuracy and futur machine learning capabilities





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

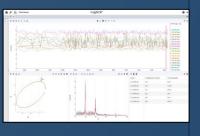


Online InfraRed

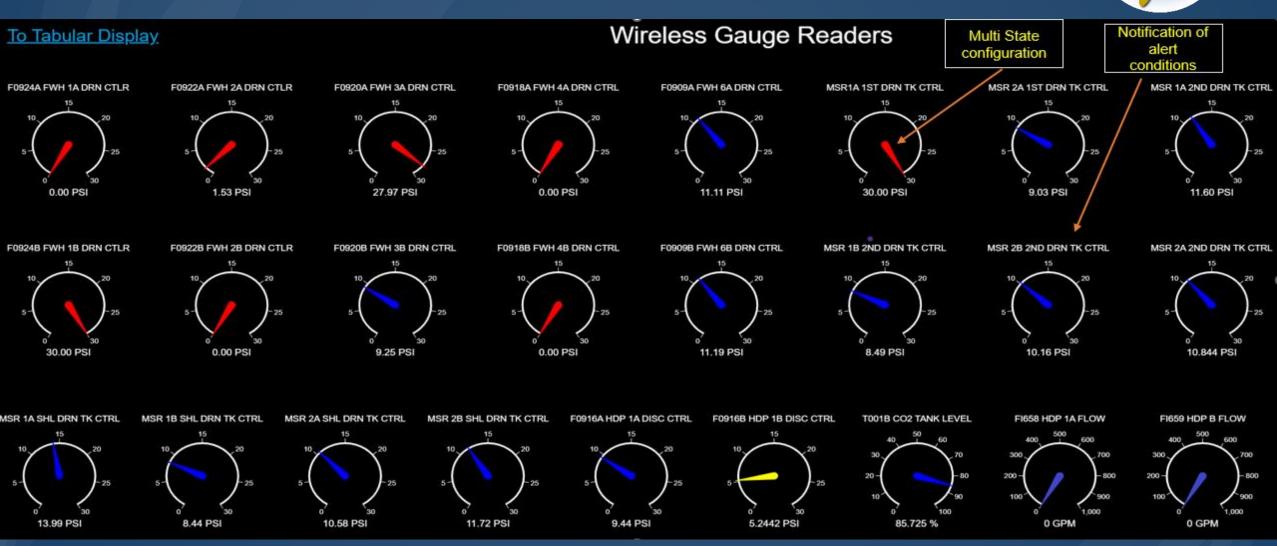
- <u>Online Infraced</u>
 <u>Transformer monitoring</u>
- Small camera available for temporary monitoring

Critical Asset Vibration

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



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Plant Notifications



ProGo



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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.



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Wireless Fire Watch Carts





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Wireless Vibration Crash Carts

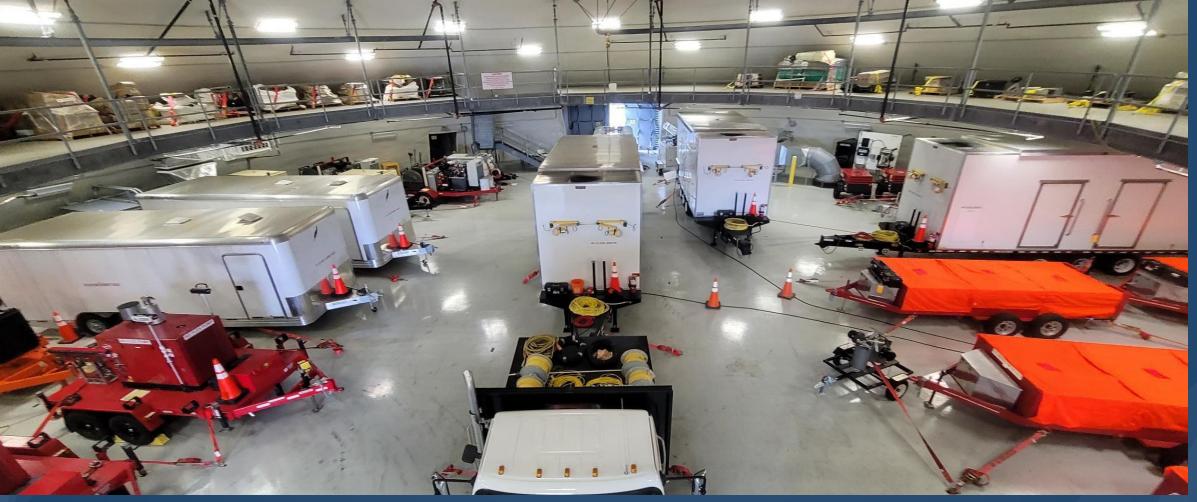




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M&D Center Innovation Flex Dome Wireless Equipment Monitoring





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Future Developments

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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 DroneMay be pilotedOr autonomous



Skydio Dock

- "Garage" protection
- Recharging
- Data download



Q & A