

Non-Invasive Digitization of Nuclear Plants

September 3, 2025 - Vienna



Technical Meeting on
Operating Experience on the Use of Digital Technologies
for Instrumentation and Control Systems
EVT2402789

Presenters



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Product Manager, Duke Energy

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Website: www.duke-energy.com

- Innovation leader, Duke nuclear fleet
- Prior experience – Catawba Nuclear Station:
 - Operations Manager
 - Safety Assurance Manager
 - Engineering Manager
- BS Mechanical Engineering, N. Carolina State Univ



Hank Strahley

Operations Support Supervisor,
Southern Nuclear

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- Operations leader, Plant Hatch
- Prior experience:
 - System Operations Manager, Plant Hatch
 - Licensed Senior Reactor Operator
Nine Mile Point Nuclear Plant, Exelon
 - Nuclear submarine service, US Navy
- US Navy Nuclear Power Program



Harry Sim

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- Founder, inventor & patent holder
- Prior experience:
 - VP Honeywell Automation Control
 - Payload Director, NASA STS-40 Mission
- MBA Insead, France
- MS+BS Electrical & Mech Engineering,
Control Systems, Stanford University

Problem: Most Plant Data is NOT Digitized



Solution: Non-Invasive Sensors – 5 Minute Install



Wireless, battery operated, does not touch plant process:
~10% the cost of traditional instrumentation, 5 minute install

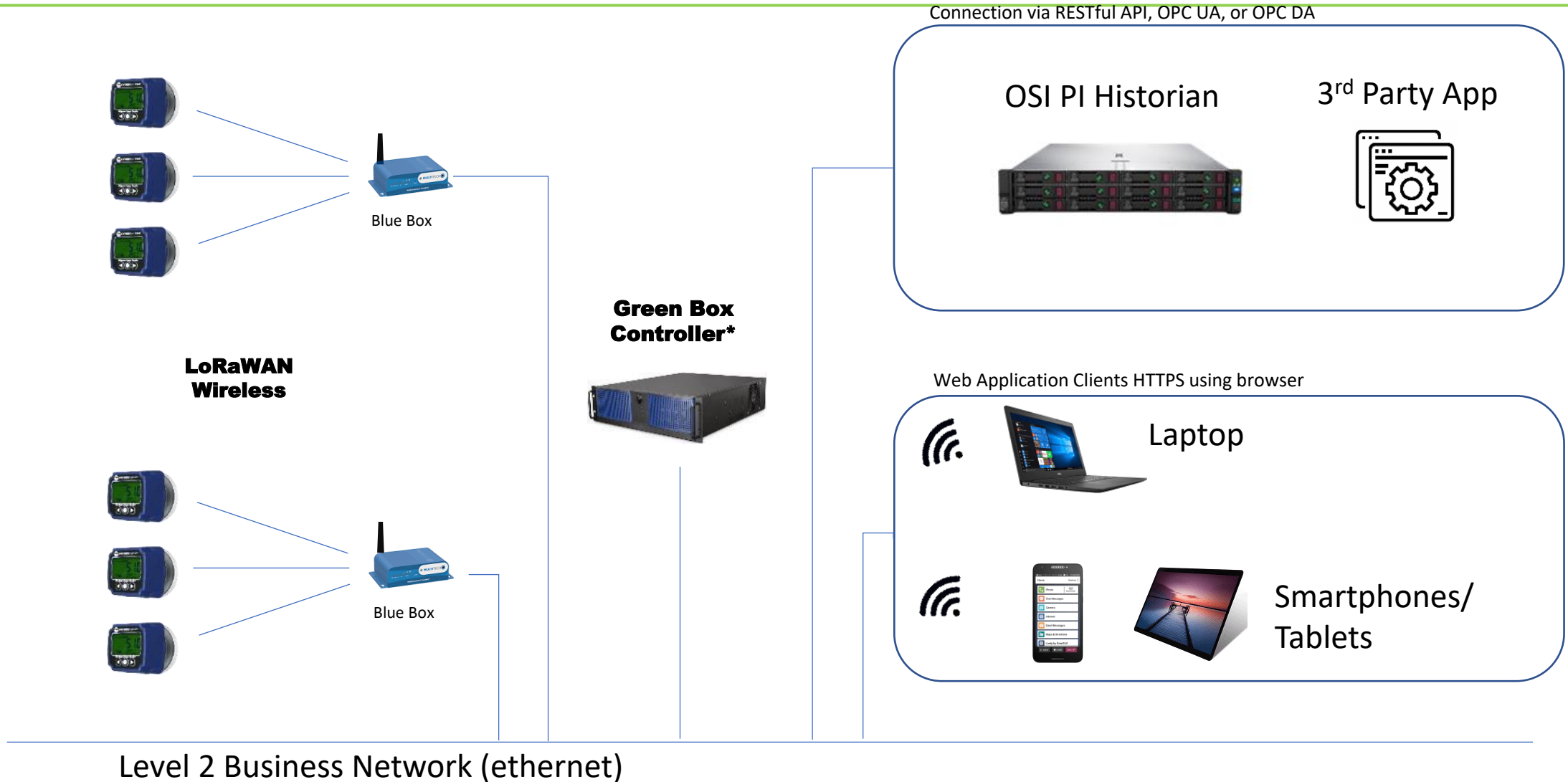
Installation Example



Outdoors, RCA, Seismic, Safety Related Areas



Integration with Plant Data Network – Cyber Approved



Non-Invasive Sensors



Wireless Gauge Reader



Cycle Isolation Valve Monitor



Wireless Temperature and Humidity Monitor



Wireless Rad Monitor



Webcam Digitization
(machine vision)



Vibration Sensors



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



Magnetic Mount Thermocouple



Void Detection



Drone Integration
(machine vision)

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

Operational Experience and Use Cases



Nuclear Fleet:

- Hatch, 2 reactors, BWR, Georgia, USA
- Vogtle, 4 reactors, PWR, Georgia, USA
- Farley, 2 reactors, PWR, Alabama, USA



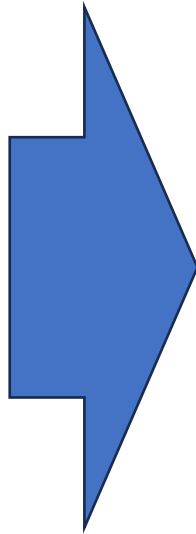
Nuclear Fleet:

- Harris, 1 reactor, PWR, N. Carolina, USA
- McGuire, 2 reactors, PWR, N. Carolina, USA
- Catawba, 2 reactors, PWR, S. Carolina, USA
- Robinson, 1 reactor, PWR, S. Carolina, USA
- Brunswick, 2 reactors, BWR, N. Carolina, USA
- Oconee, 3 reactors, PWR, S. Carolina, USA

Plant-wide Engagement – Broad benefits

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 crash cart, emergent needs

Operator Efficiency: Operator Rounds Dashboard

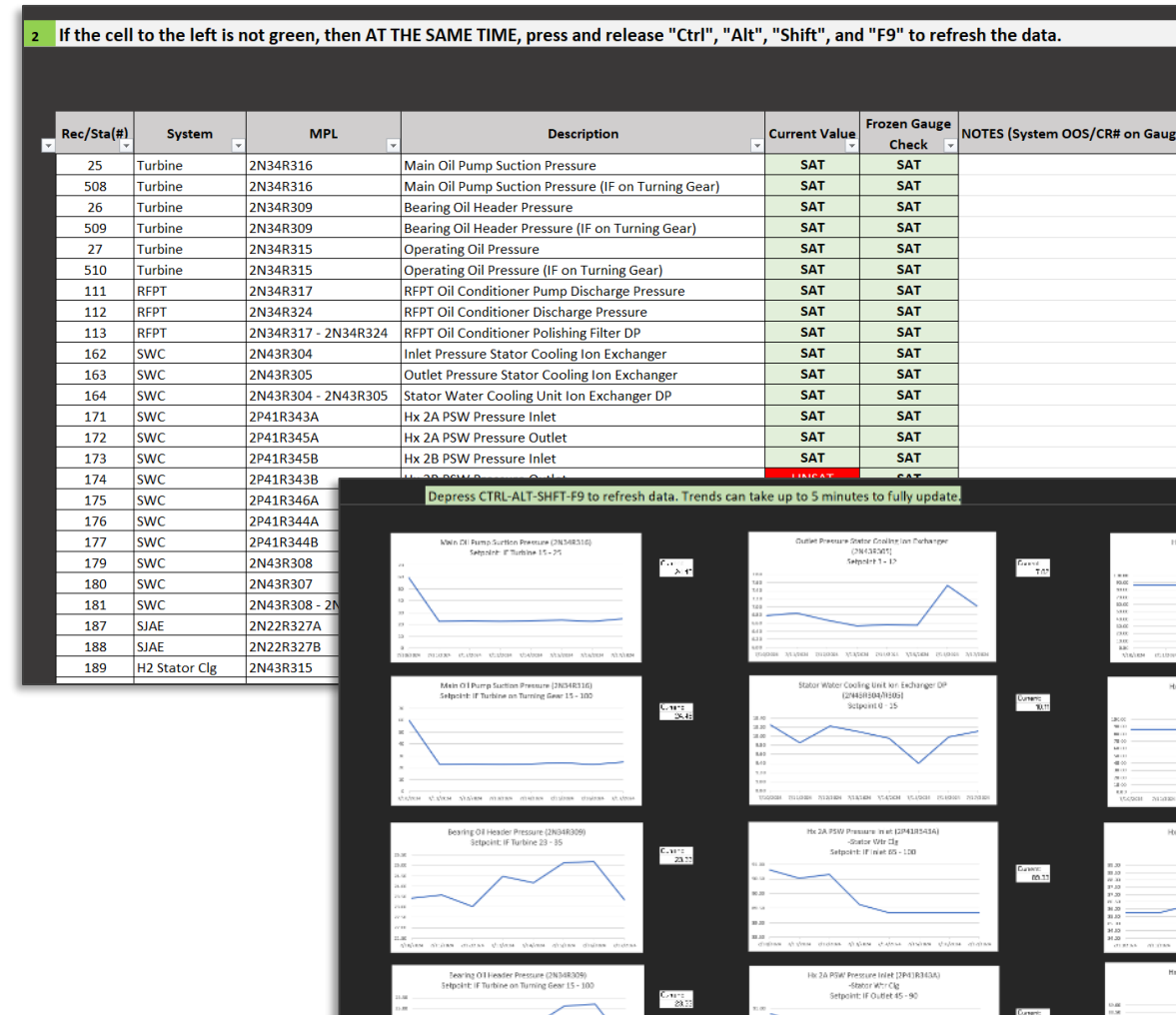


Concept:

- 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



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

Condition Based Maintenance: Pump Seals

- Automated remote monitoring of reactor recirculation pump seals
- WGR used to collect analog gauge readings for upper and lower seal pressures to assist in fault detection
- Benefits:
 - Reduce operator time to necessary to read gauges
 - Faster identification and troubleshooting of problems
 - Minimize down-time
 - Reduce dose exposure (in BWR)



Operator Efficiency: Feedwater Level – Machine Vision



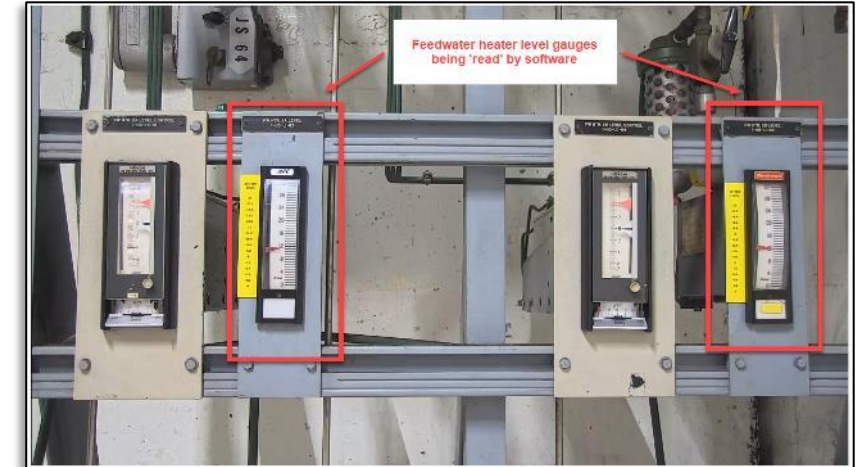
Duke Brunswick

Need:

- Automate data collection from feedwater heater including heater level.
- Prior issue resulted in heater taken offline for repairs.
- Must rely on vertical gauge local indicator.

Solution:

- Install Panasonic IP camera, use GBC machine vision capability to digitize image.
- Data can be stored in PI Historian.
- Operator can look at digitized trend data on PI Vision instead of just watching webcam video.



**Data collected and displayed
via PI Historian**

Environmental Monitoring: Sump Pump Hour Meters

- As part of a Groundwater Protection Plan, Cypress installed wireless gauge readers on sump pump hour meters to track electrical manhole sump pump run-time.
- No current method to monitor sump levels automatically.
- If tritium is detected the sump pump runtime data may be useful to determine where it came from.
- Catch two types of faults:
 - Pumps not running when they should (sump level too high)
 - Pumps running too much (must be a leak)



Thermal Performance: Valve Cycle Isolation Monitoring

Need:

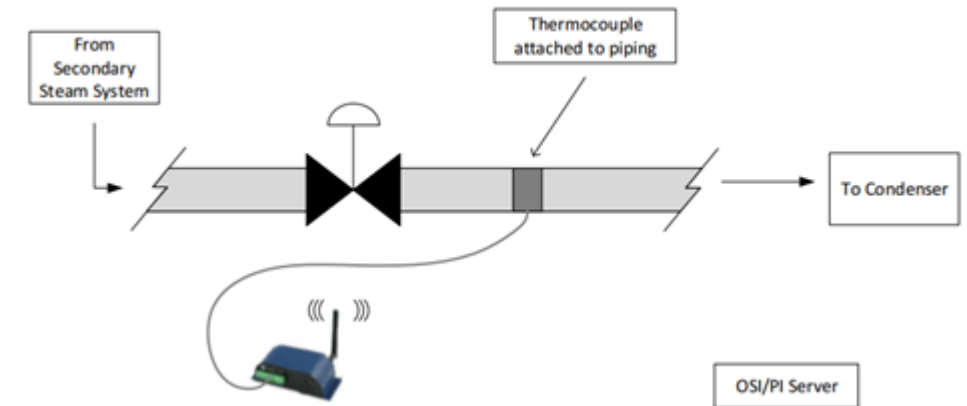
- Detect valve cycle isolation faults.
- Minimize cost and process disruption.

Benefit:

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



Detect Leaking Valves



Minimize Downtime: Crash Cart for Emergent Issues

Southern Hatch

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:

- Avoid lengthy engineering reviews and approvals to add sensors
- Minimize operator man-hours
- Reduce plant downtime



ALARA/Safety: Dry Well Temp & Humidity Monitoring

Need:

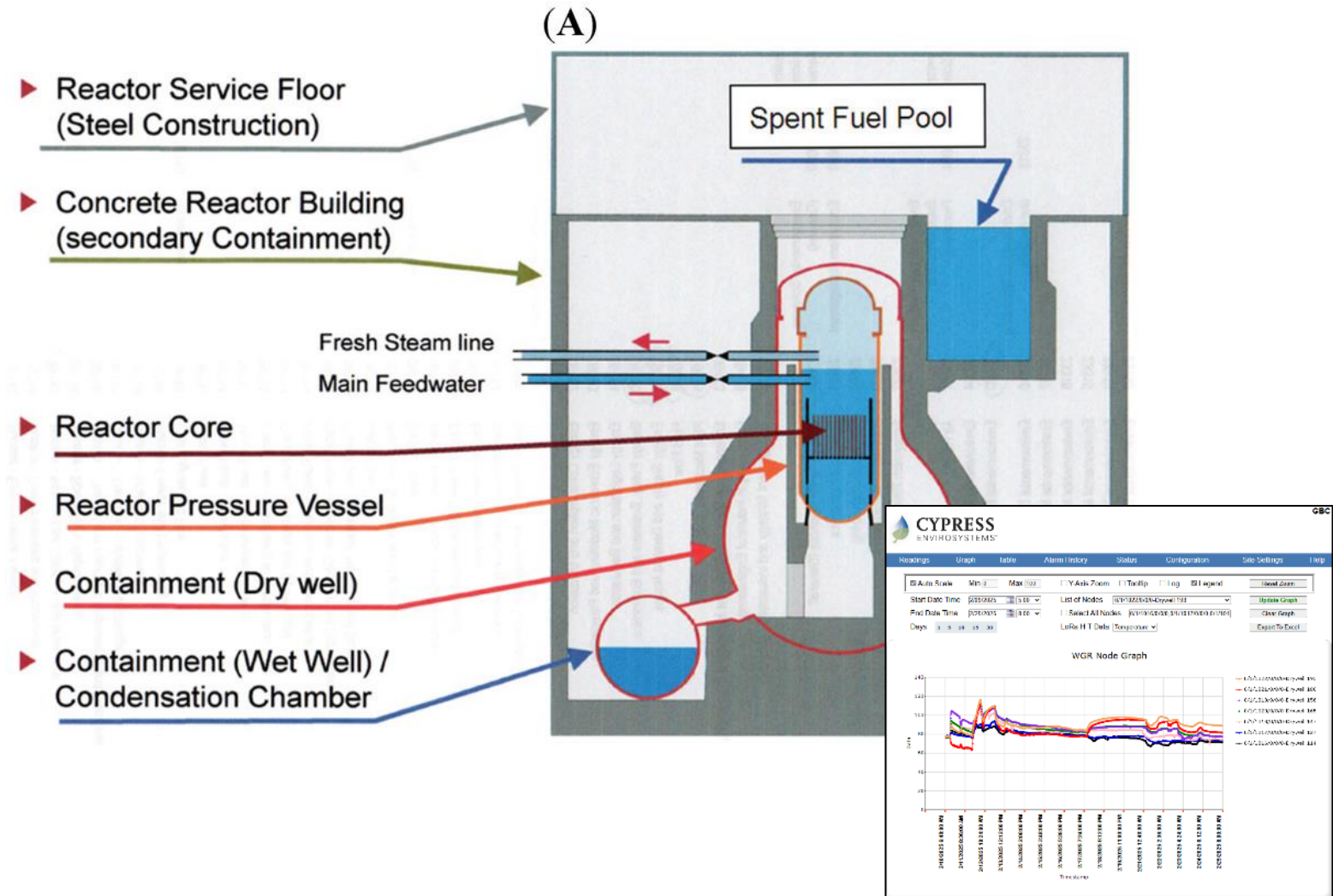
- During outage: Monitor temperature and humidity for worker safety (heat stress).
- Minimize time and dosage exposure for RP Tech to gather data each shift.

Solution:

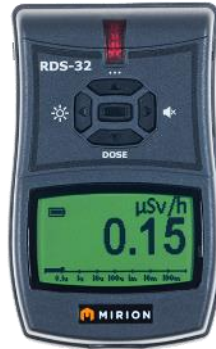
- Use magnetic mount temporary non-invasive Wireless Temperature and Humidity Monitors.

Benefit:

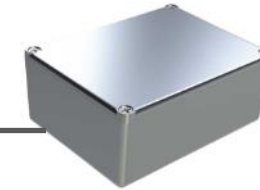
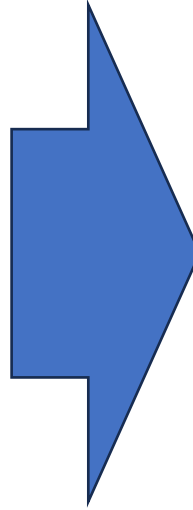
- Save 1.5 Man-hours/day, 45 Man-hours outage total
- Reduce 8 mrem/day, 240 mrem outage total radiation exposure
- Reduced Industrial Safety exposure



Enhancement - Wireless Remote Radiation Monitor



Commercially Available
Radiation Meter



External
Battery Pack

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.

Design Modifications: Condensate Booster Pump Seal Continuous Monitoring

Southern Hatch

Application:

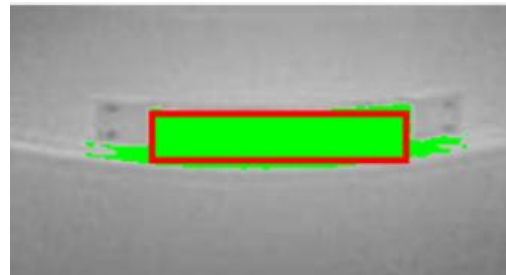
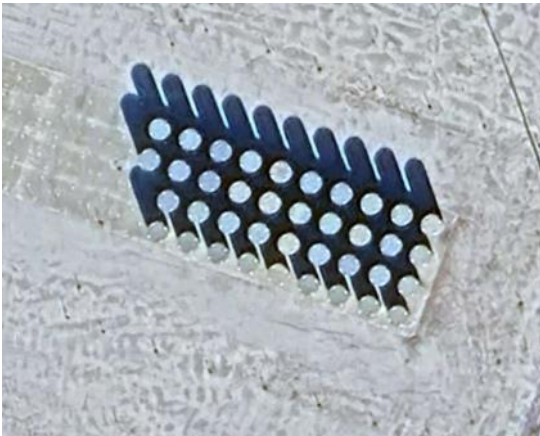
- Design Mod to upgrade Unit 2 condensate booster pump seals
- Added six WGRs as low-cost method to digitize/enable continuous monitoring of seal pressures.

Benefit:

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



In-Progress: Drone + Machine Vision Dry Cask Inspection



Skydio Drone

- May be piloted
- Or autonomous



Skydio Dock

- “Garage” protection
- Recharging
- Data download

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

PROCEDURE LEVEL OF USE CLASSIFICATION PER NMP-AP-003	
CATEGORY	SECTIONS
Continuous	NONE
Transient Response	NONE
Reference	ALL
Information	NONE

Approval: Hank Strahley 08/15/23
Approved By Date

Effective Date: 01/09/24

OPERATIONS
Responsible Department

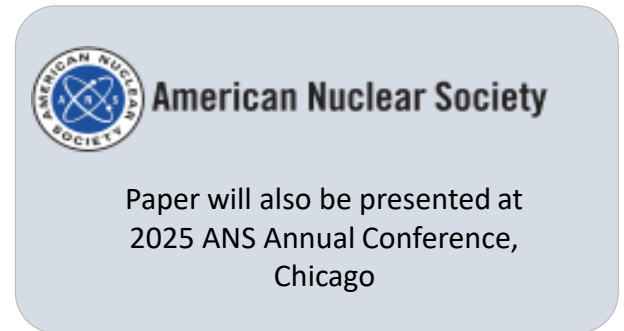
WGR Deployments – 33 Nuclear Plants

- 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, Ginna, Peach Bottom)
- NextEra (Fleetwide: Turkey Point, St. Lucie, Point Beach, Seabrook)
- Vistra (Comanche Peak, Davis Besse, Beaver Valley)
- 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

International Atomic Energy Agency Innovation Award 2024

“The ISOP Innovation Awards aim to highlight and recognize innovative use cases within the nuclear power industry. This programme showcases practical applications of cutting-edge technologies and solutions that have been successfully implemented in operating nuclear power plants.”



Q & A