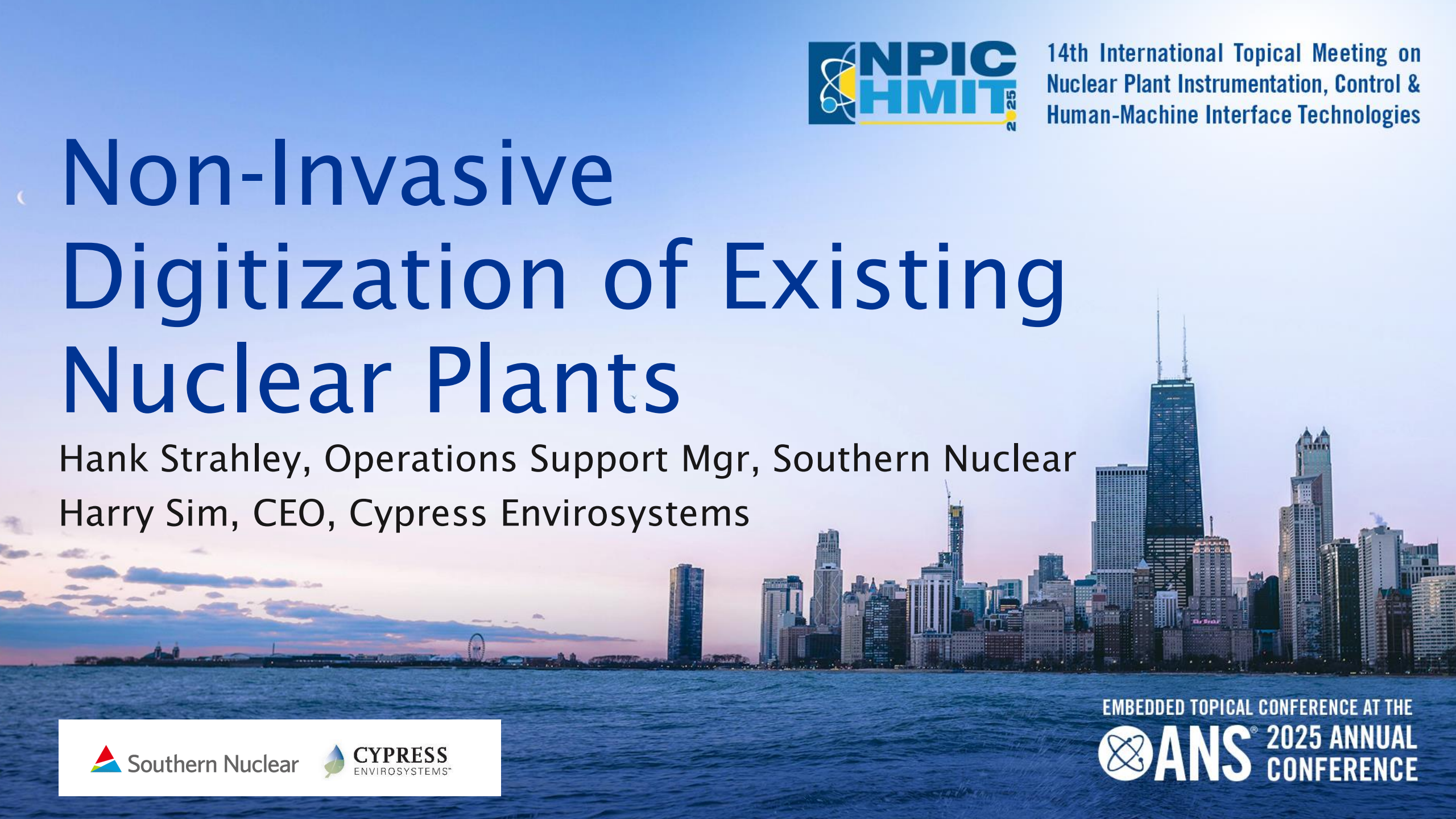

NPIC HMIT 2025
14th International Topical Meeting on Nuclear Plant Instrumentation, Control & Human-Machine Interface Technologies
Non-Invasive Digitization of Existing Nuclear Plants
Hank Strahley, Operations Support Mgr, Southern Nuclear
Harry Sim, CEO, Cypress Envirosystems
Southern Nuclear
CYPRESS ENVIROSYSTEMS
EMBEDDED TOPICAL CONFERENCE AT THE
ANS 2025 ANNUAL CONFERENCE

# Problem: Most Plant Data is NOT Digitized




**Use of AI, cost reduction: Requires more data, more frequently**

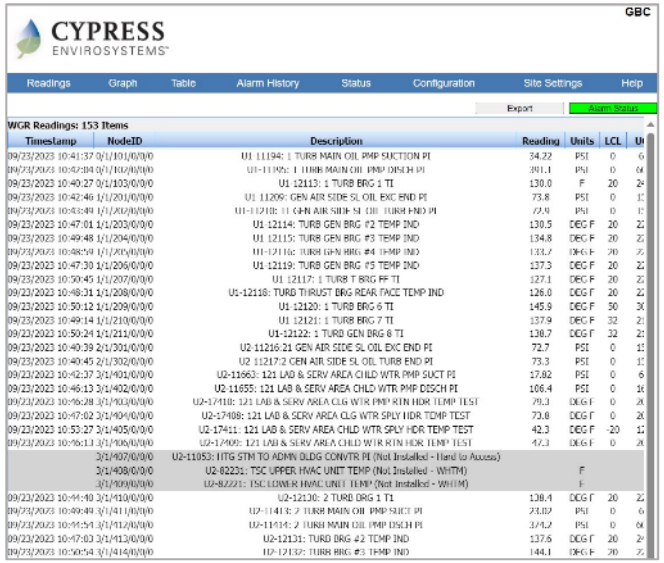
# Solution: Non-Invasive Sensors – 5 Minute Install



Connection via
RESTful API or OPC

**Historian**

**HMI**




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

Southern Nuclear

ENVIROSYSTEMS

ANS

# Typical Installation




**Outdoors, Radiologically Controlled Area, Safety Related, Seismic Related**

# Typical Installation-2



**Minimal disruption to existing operator rounds**

# Family of Non-Invasive Monitoring Solutions

Valve Cycle Isolation Monitor

Wireless Temperature and Humidity Monitor

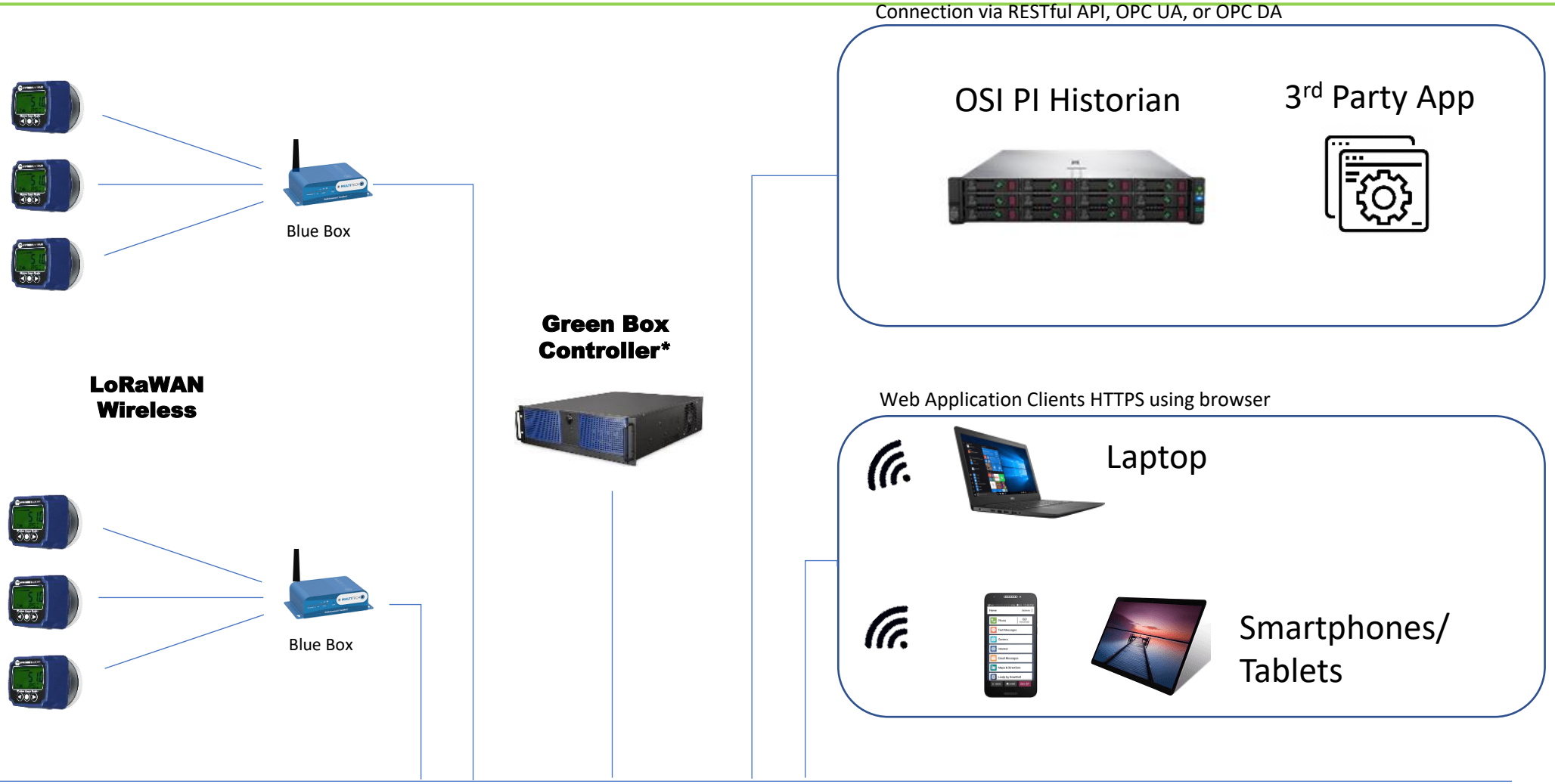
Steam Trap Monitor

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**

# Network Architecture – Cyber Approved

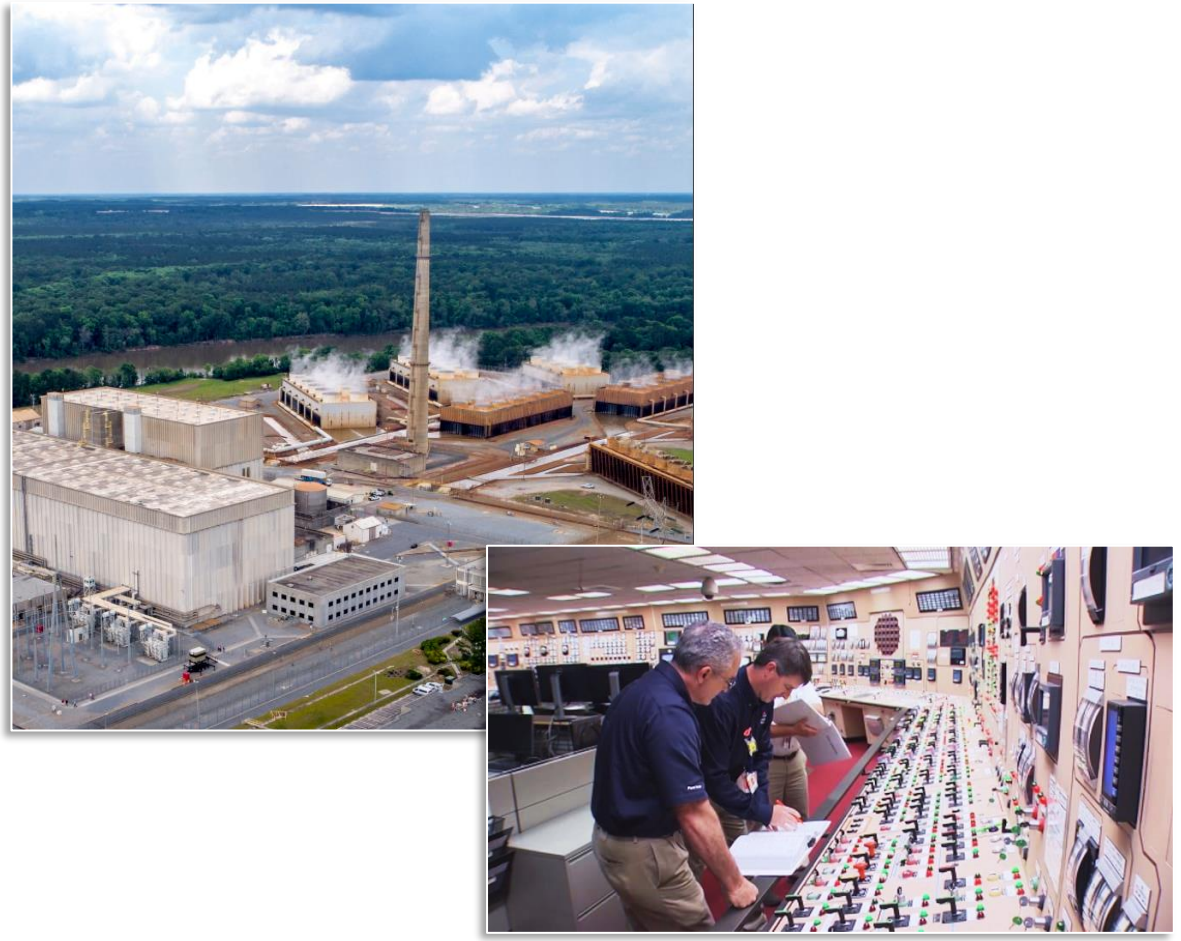



**Seamlessly integrates with existing plant IT infrastructure**

*Non-Invasive Digitization Deployment at:*

# Southern Nuclear Company Plant Hatch, Baxley, Georgia United States

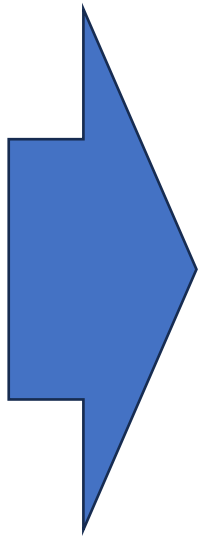
| | |
|---|---|
| Reactor Type: | GE BWR-4 |
| Units Operational: | 2 x 900 MW |
| Start Operations: | 1975 (Unit 1) |
| | 1979 (Unit 2) |



# 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 via crash cart, emergent needs

# Long Term Trending: Turbine Valve Actuator Temperatures

**Need:**

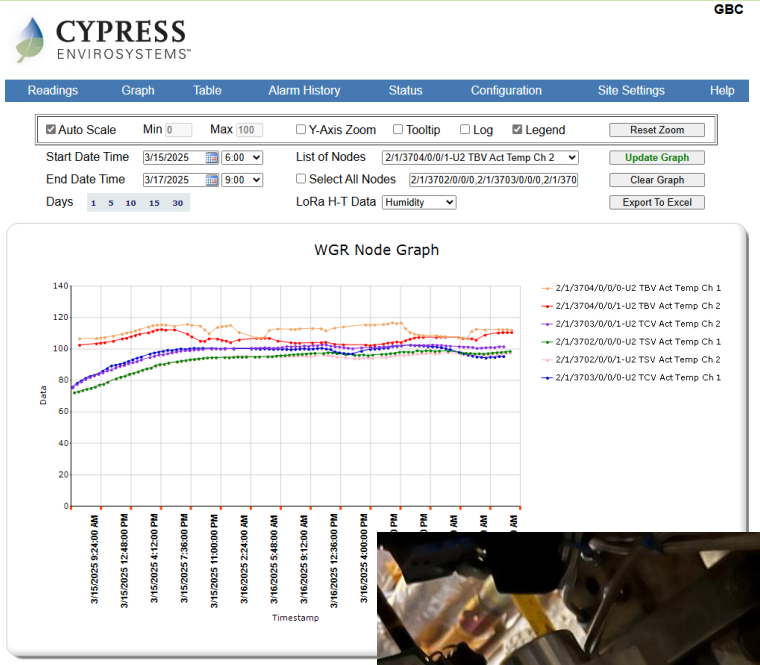
- Long term temperature trending to monitor for EHC fluid degradation due to temperature

**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



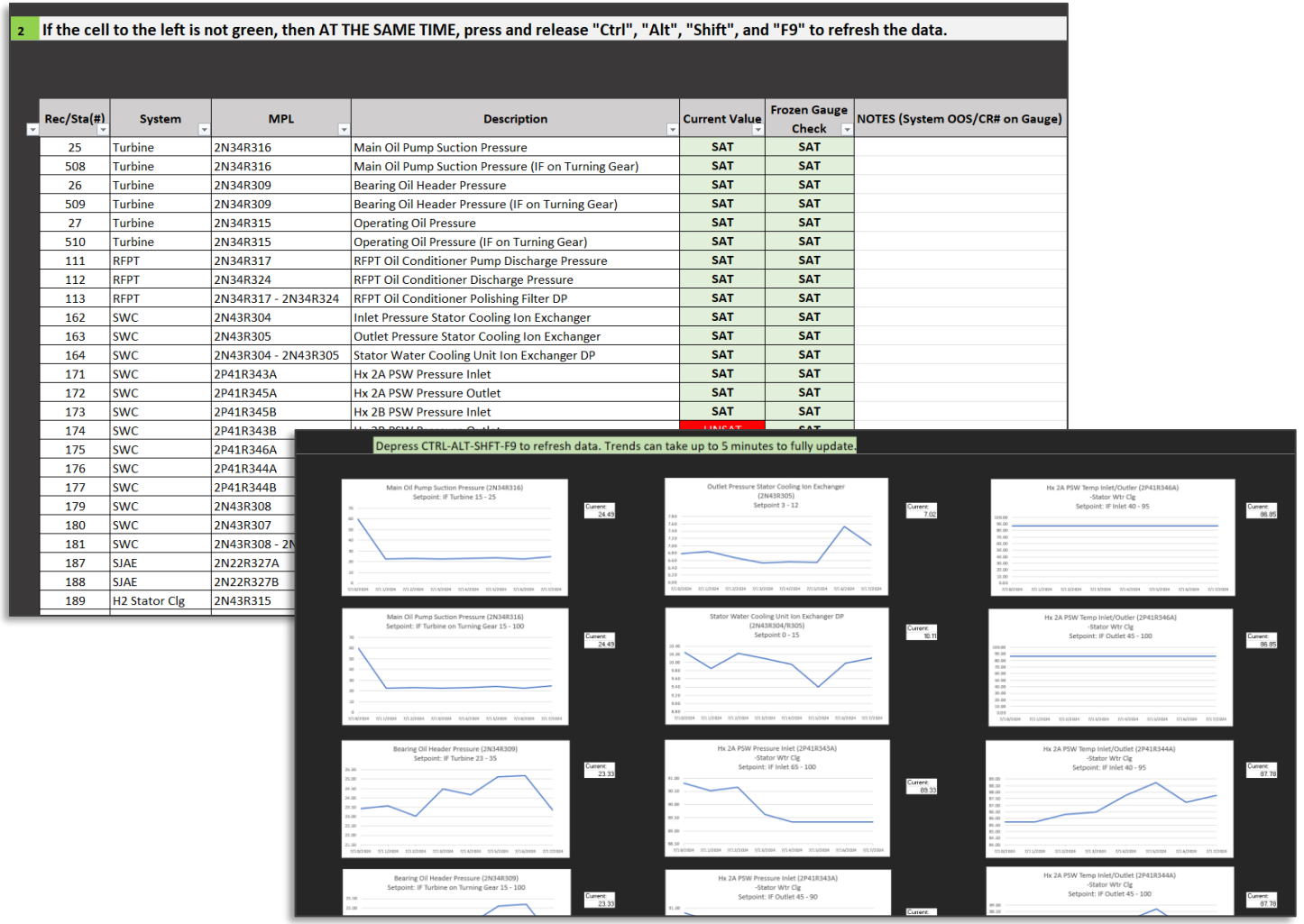

# Operator Rounds Dashboard

**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 | | UNSAT | | |
| 175 | SWC | 2P41R346A | | | | |
| 176 | SWC | 2P41R344A | | | | |
| 177 | SWC | 2P41R344B | | | | |
| 179 | SWC | 2N43R308 | | | | |
| 180 | SWC | 2N43R307 | | | | |
| 181 | SWC | 2N43R308 - 2N | | | | |
| 187 | SJAE | 2N22R327A | | | | |
| 188 | SJAE | 2N22R327B | | | | |
| 189 | H2 Stator Clg | 2N43R315 | | | | |

Depress CTRL-ALT-SHFT-F9 to refresh data. Trends can take up to 5 minutes to fully update.

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

# Dry Well Temp / Humidity Monitoring

**Need:**

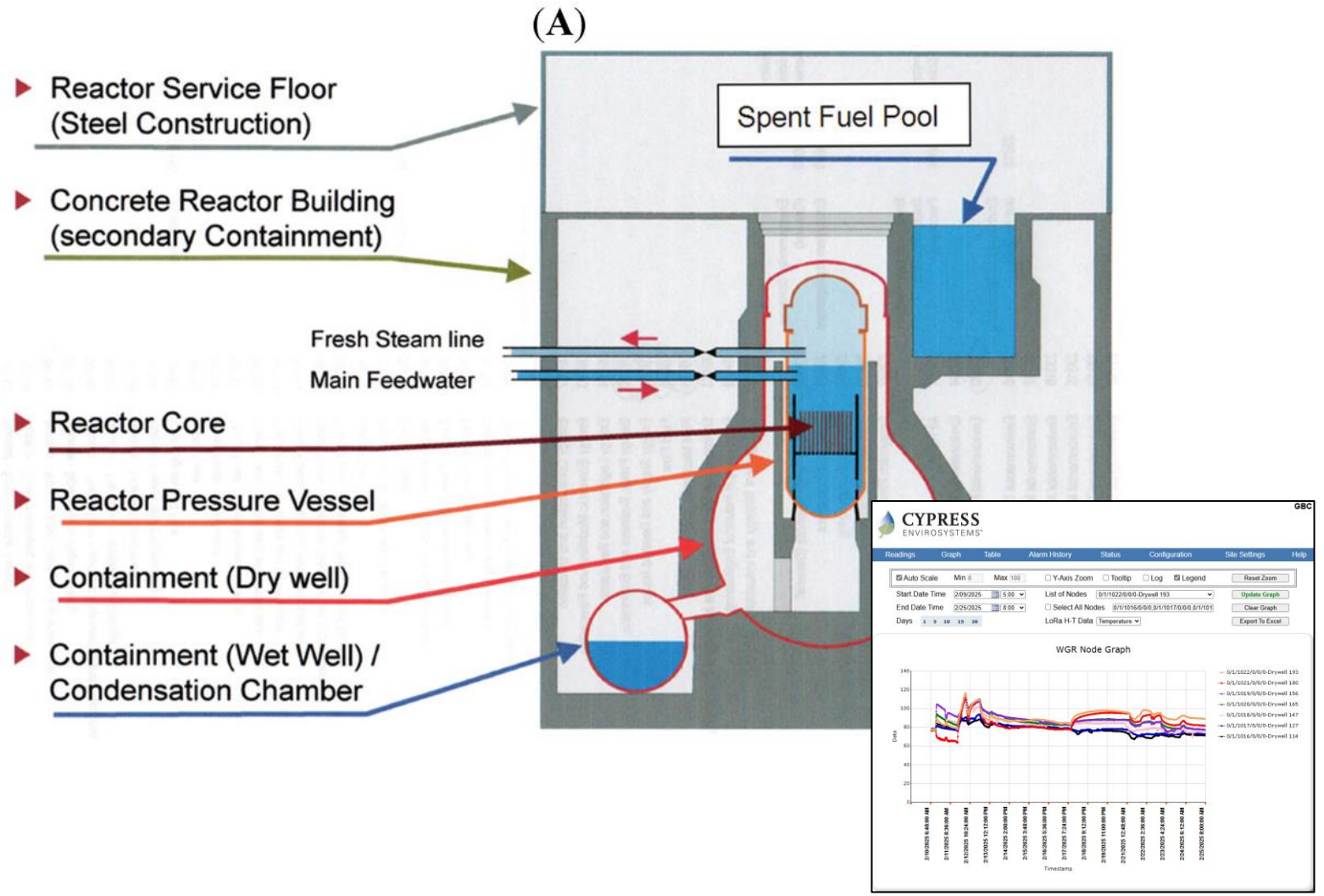
- During outage: Monitor temperature and humidity for worker safety (heat stress).
- Minimize time and dosage exposure for RP Tech to gather data each shift.

**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



# 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:**

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

# 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

# Enhance Design Modifications: Condensate Booster Pump Seal Continuous 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.

# Machine Vision Webcam Digitization

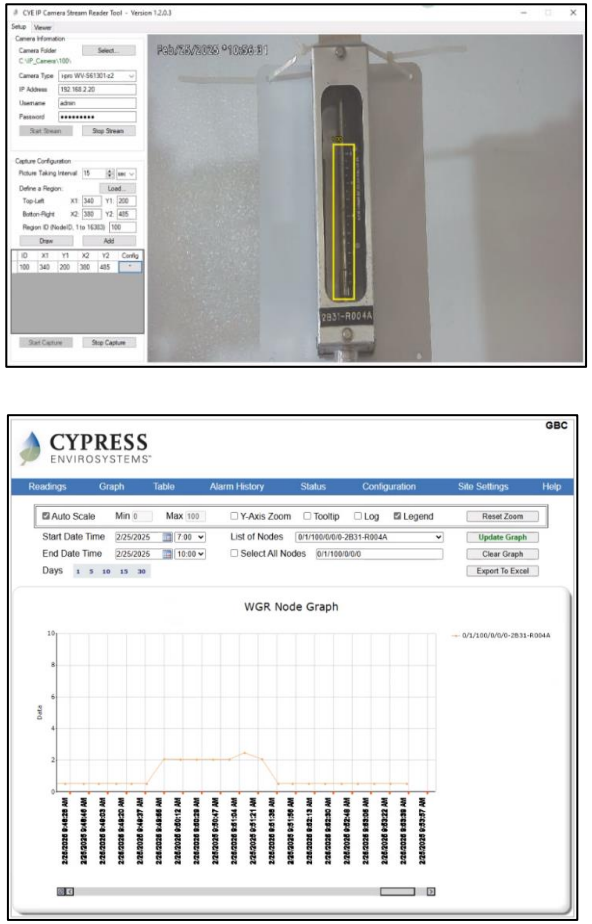
**Application:**

- Support design mod to reactor recirc pump seal purge filter.
- Monitor purge flow during post install testing.
- Normally requires operator watching webcam display.
- Replace with machine vision.

**Benefit:**

- Reduce operator time.
- Quickly detect excursions.
- Ability to collect, trend and analyze historical data.


**Webcam with Operator monitor**




**Automated Digitized Collection of Data**

# Valve Cycle Isolation Monitoring

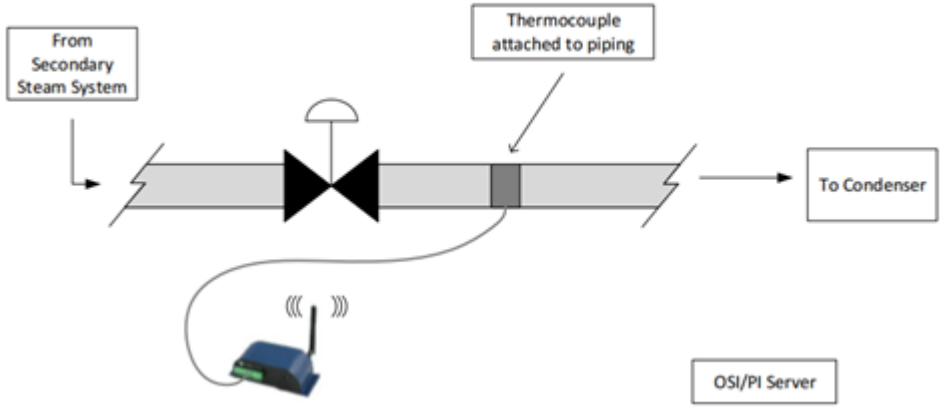
**Need:**

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

**Benefit:**

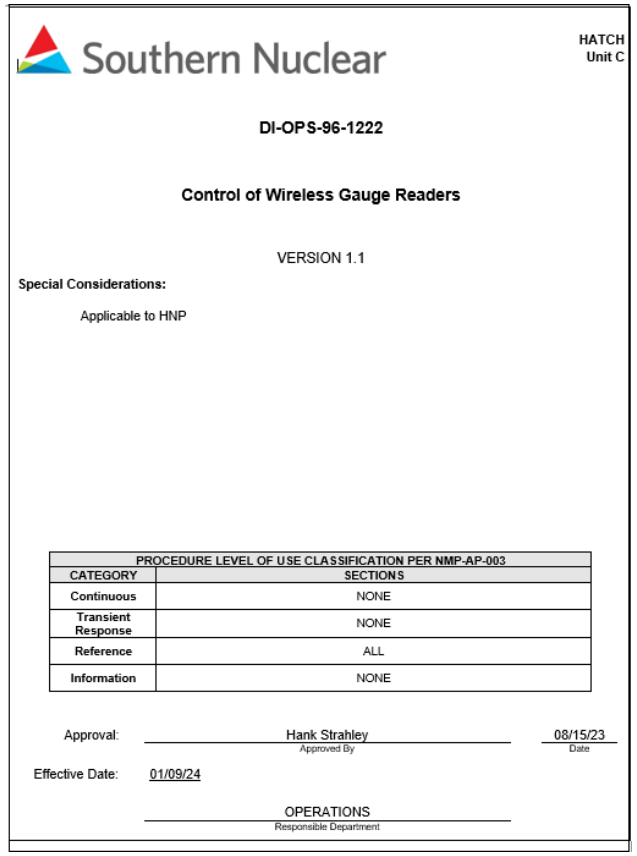
- Stop leaks, save MW's (est. up to 2MW per malfunctioning valve).
- Save operator time to monitor valves

Detect Leaking Valves



# 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 (Approved By) 08/15/23 (Date)

Effective Date: 01/09/24

OPERATIONS (Responsible Department)

# Deployments – N. America 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

# Q & A

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