



**Xcel Energy**<sup>®</sup>

**PRAIRIE ISLAND  
CZT PROGRAM**

January 9<sup>th</sup> 2018

# OVERVIEW



Prairie Island uses Cadmium Zinc Telluride (CZT) instrumentation as an important tool in managing refueling outage risk and to support the Nuclear Promise.

This presentation covers:

- CZT Introduction
- Process Monitoring Program
  - Reactor Coolant System
  - Risk Mitigation
- Questions & Answers



# CZT TECHNOLOGY



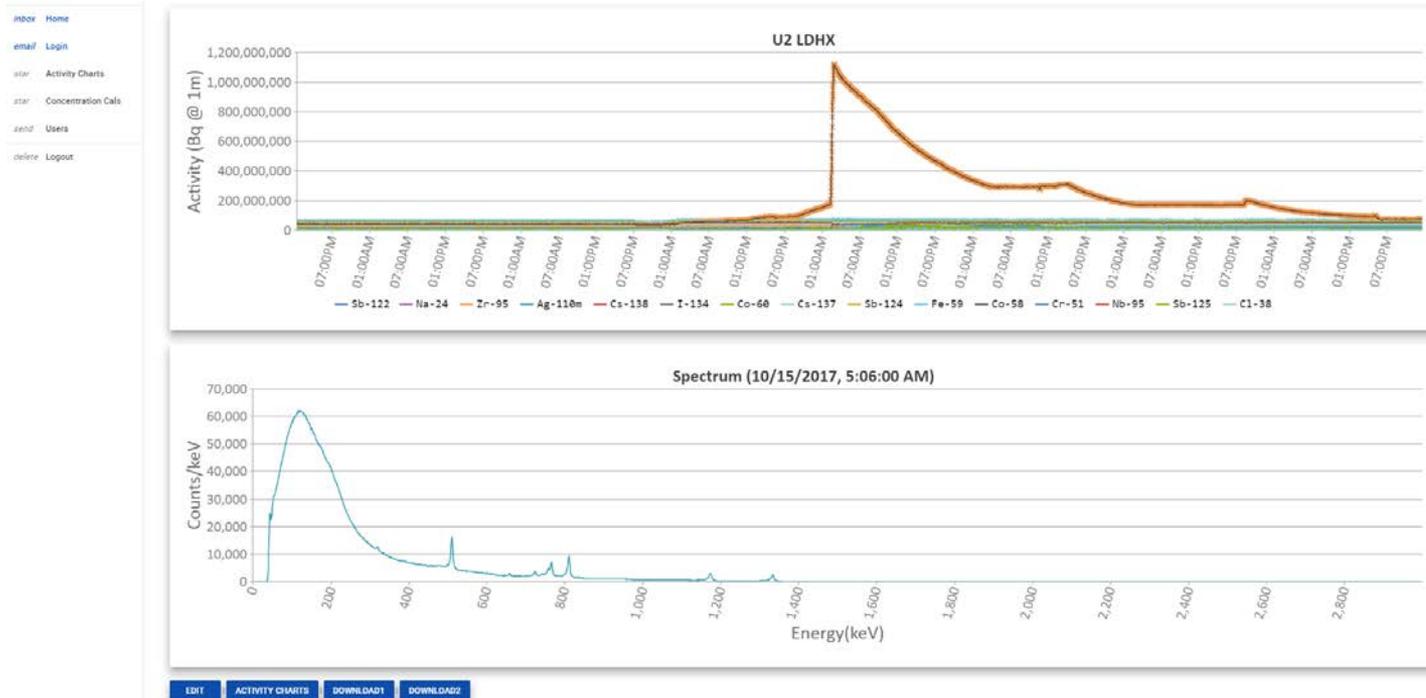
Prairie Island's CZT instruments are solid-state detectors used for gamma spectroscopy. These instruments use a 3-D position sensitive crystal and have energy resolution of less than 1.1% at 662 keV. The principle advantages of these detectors is their portability because cryogenic cooling is not required. PI uses two types of CZT instruments: process monitors and a spectroscopic imager.



# PROCESS MONITORING INSTRUMENTS



Monitors continuously integrate spectrographic data in 1 minute intervals and upload it into a centralized database. The data is combined with efficiency curves and can be viewed in real-time. The result is a quantitative assessment of various radionuclide concentrations in process piping.

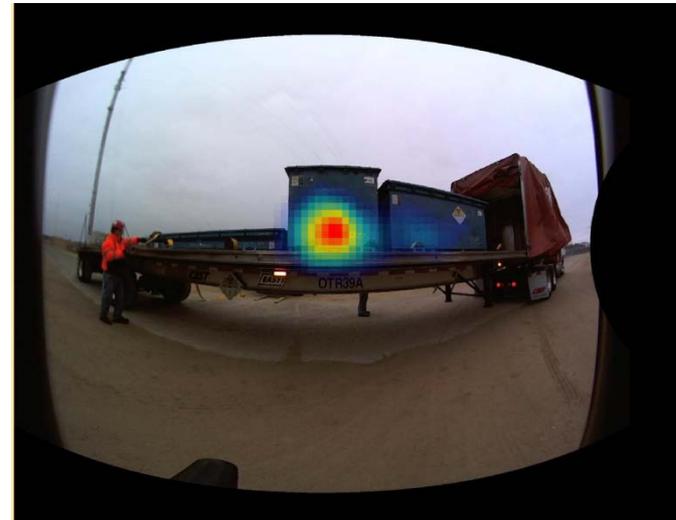
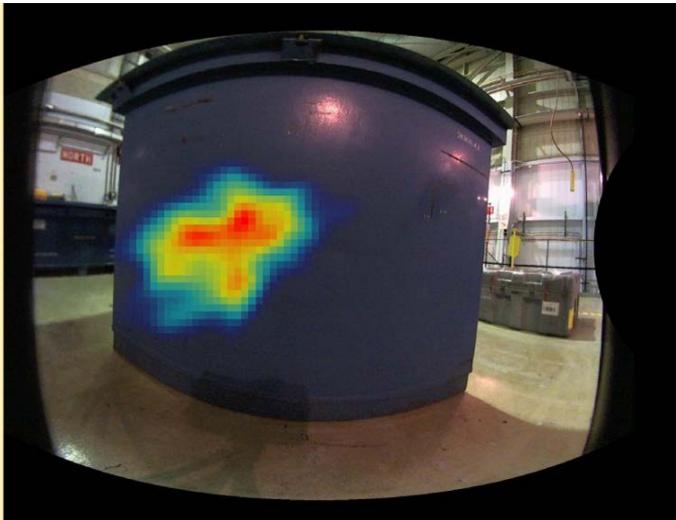


# SPECTROSCOPIC IMAGER



The instrument takes a visual image and overlays it with radionuclide specific heat maps to provide a visual means of communicating radiation fields. It is used for hot particle identification, temporary shielding validation, and shipping survey verification.

## Co-60 Images of Westinghouse Refueling Equipment

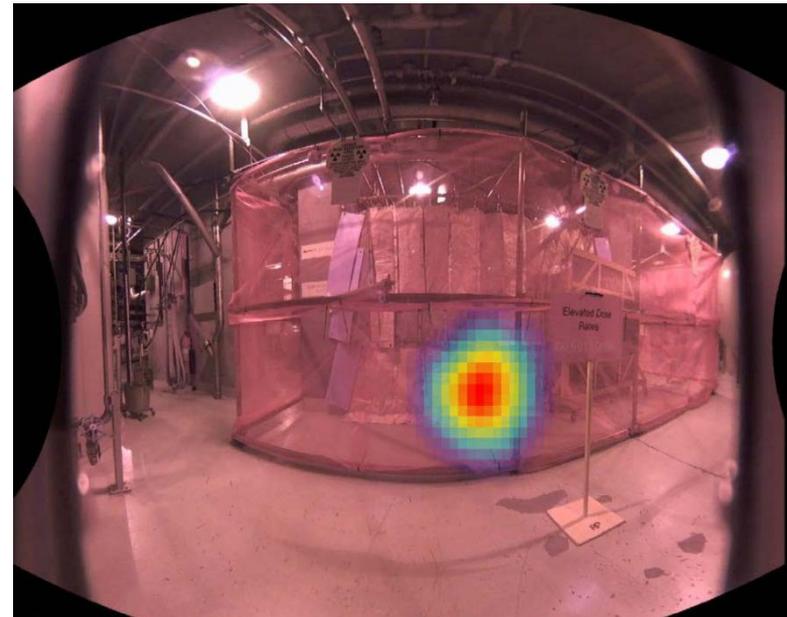
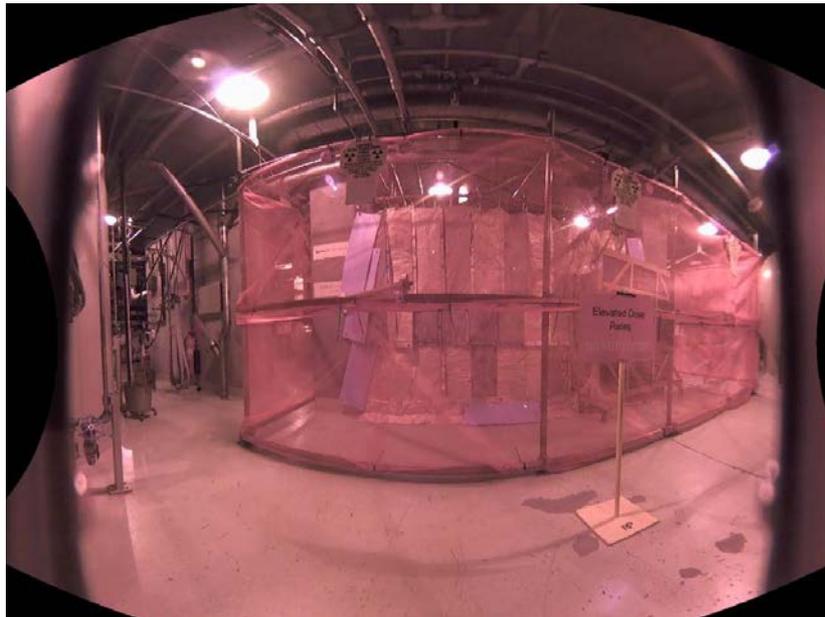


# SPECTROSCOPIC IMAGER



The instrument can be used to optimize temporary shielding installation by identifying either radiation streaming or areas where additional shielding should be placed.

## Co-60 Images of Sump-C Shielding Package Co-60



# CZT WORKING GROUP



In January 2015 a CZT Working Group was established through the North American Technical Center (NATC). The group meets on periodic conference calls to discuss site experiences with CZT monitoring, mapping of in-plant radiation fields, and the future of CZT technology.

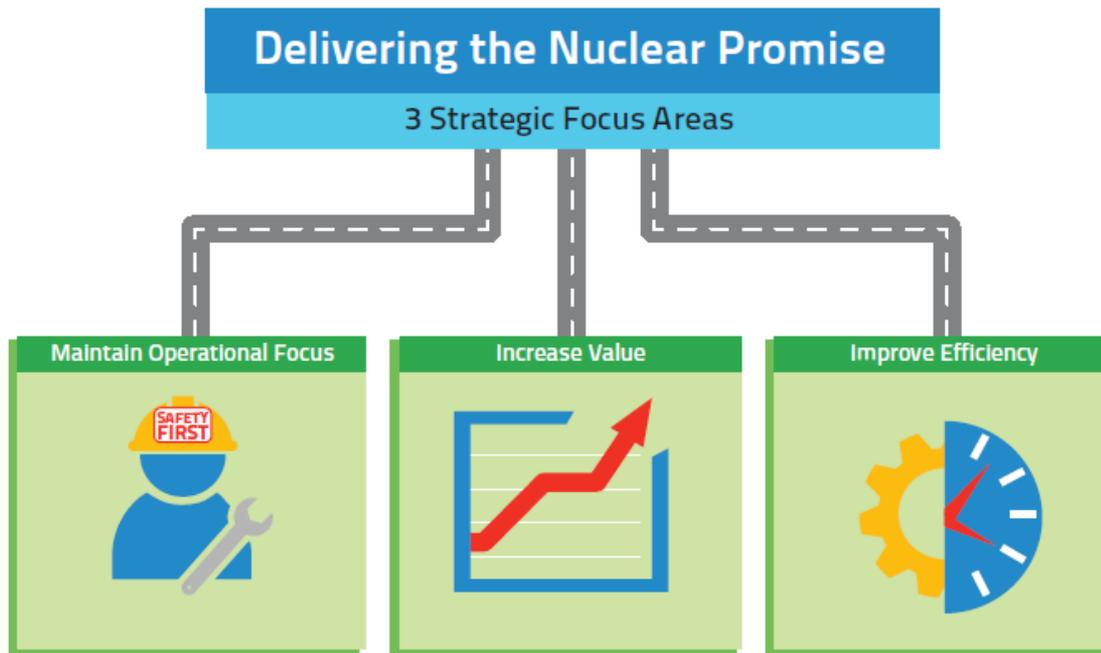
The group has also established a set of guidelines for utilization of spectroscopic imaging detectors to assist in the setup of new monitoring programs.



# PROCESS MONITORING PROGRAM



Real time radionuclide monitoring of the Reactor Coolant System (RCS) supports the Nuclear Promise by providing station leadership with a clear picture of plant conditions during transients and forced oxidation. The program at Prairie Island leverages this information to reduce nuclear and radiological risk.



# PROCESS MONITORING PROGRAM



Monitors are stationed year round at near the Unit 1 and Unit 2 Letdown heat exchangers and continuously analyze plant conditions. During refueling outages, additional monitors are placed throughout the station:

- RCS Letdown
- Residual Heat Removal (RHR)
- Mixed Bed Ion Exchanger
- High Traffic Step-Off Pads

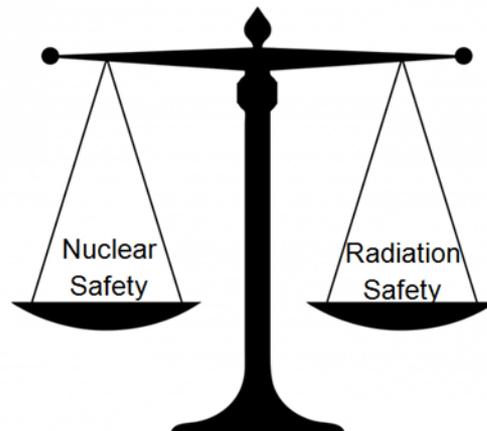
The system was piloted in 2016 and demonstrated excellent correlation between it and chemistry sampling. The system was upgraded and deployed prior to the 2017 2R30 refueling outage.

# PROCESS MONITORING PROGRAM



The monitoring system provided key radiological information that allowed the station to balance nuclear and radiological risk during the 2R30 refueling outage.

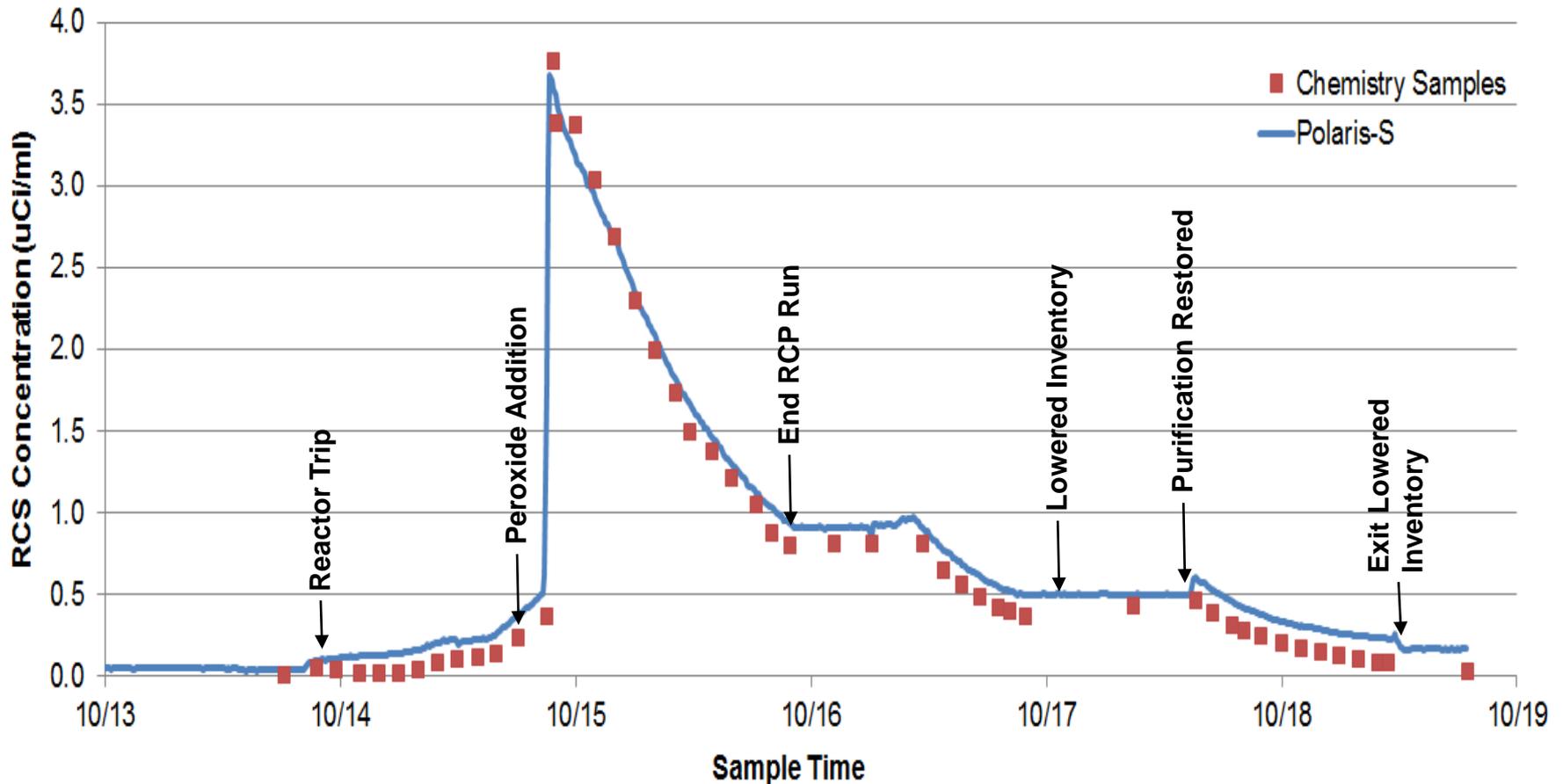
The planned window for the RCS to be in lowered inventory was 32 hours; however real-time purification forecasting showed that the RCS hard gamma emitter concentration target of 0.05 uCi/ml would require 40 hours.



# PROCESS MONITORING PROGRAM



## 2R30 Refueling Outage - Letdown Heat Exchanger Co-58



# PROCESS MONITORING PROGRAM

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Monitoring data was used to support CRE projections and the decision to allow cavity flooding at an RCS maximum concentration 0.10 uCi/ml. Flood up occurred at 0.078 uCi/ml.

The lowered inventory window was completed in 33.5 hours, which was 1.5 hours longer than the original window, but 6.5 hours were saved.

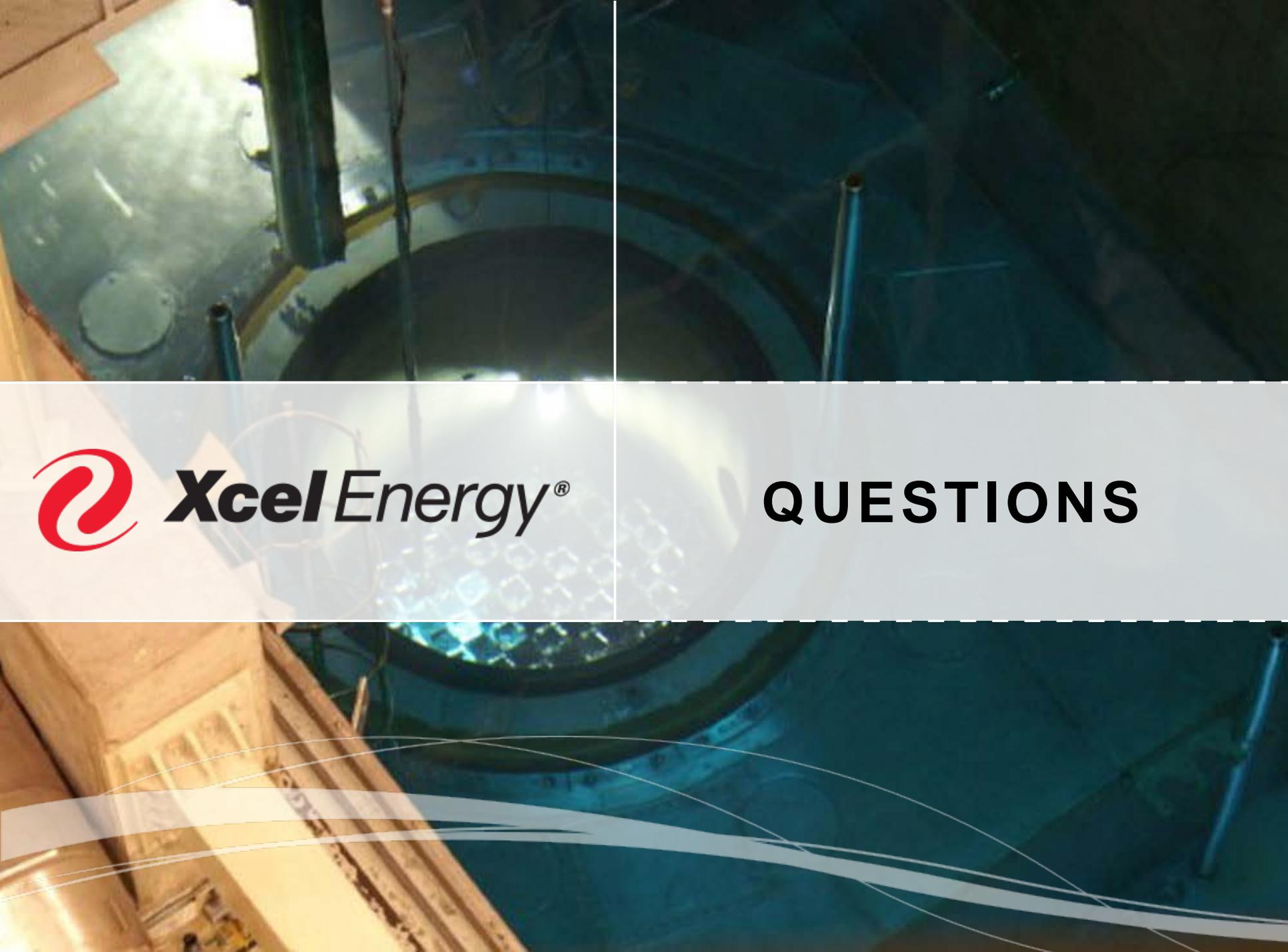
Station leadership balanced the nuclear risk associated with lowered inventory against the radiological risks. This resulted in a CRE of 31.346 on goal of 34 person-REM, and an estimated cost savings of \$270,000.

# SUMMARY



Prairie Island uses CZT instrumentation as an important tool in managing refueling outage risk and to support the Nuclear Promise. The process monitoring program uses real-time radionuclide characterization data to picture of plant conditions for enhanced decision making.

- RCS Monitoring
  - Characterize Multiple Process Systems
  - Correlation with Operating Conditions
  - Purification and CRE Projections
- Survey Verifications
  - Temporary Shielding
  - High Risk Shipping



**QUESTIONS**