



# PUR1 – Instrumentation and Control Upgrade

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# Current I&C Overview

- Four channels make up the reactor monitoring equipment
  - Fission Chamber
  - Compensated Ionization Chamber
  - Uncompensated Ionization Chamber
- Two channels excluding the safety channel must be on-scale at all times
  - Low Power – Startup Channel, Linear Channel
  - High Power – Log-N, Linear Channel

# Current I&C Overview



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# General Outline

## Console Upgrade

- **Desire to go to a digital system**
  - **Reactor Reliability**
  - Implementation time
  - Improved data acquisition
  - Interface with future applications
- Currently exploring vendors
- Expected final contract on an hour-by-hour basis



# Approach to Regulatory Implementation



# 10 CFR 50.90 vs 10 CFR 50.59

- A licensee should obtain a license amendment pursuant to 10 CFR 50.90 ... if the change ... would result in an *increase in the likelihood or consequence of an accident or introduce a previously unanalyzed accident.*” – ISG for NUREG 1537 Part I
- “Result in more than a minimal increase in the frequency of occurrence of an accident previously evaluated in the final safety analysis report (as updated)” – 10 CFR 50.59 (c)(2)(i)
- “Result in a departure from a method of evaluation described in the FSAR (as updated) used in establishing the design bases or in the safety analyses.” – 10 CFR 50.59 (c)(2)(viii)



# Review of PUR1 Tech Specs

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## Safety Limits – Fuel Temperature

- The fuel and cladding temperatures shall not exceed 530 °C
- Change of Instrumentation and control will not affect this tech spec
- With 12 kW power uprate, expected maximum fuel temperature is around 45 °C

# Review of PUR1 Tech Specs

## Limiting Safety System Setting

- Measured value of the power level scram shall be no higher than 12.0 kW
- **Onset of Nucleate Boiling** is calculated to be ~95 kW
- Change of I&C will not affect this tech spec

# Review of PUR1 Tech Specs

Limiting Condition for Operation – Reactivity Limits

- Shutdown margin of at least  $0.01 \Delta k/k$
- No experiments with worth greater than  $0.004\% \Delta k/k$
- No moveable experiments with worth greater than  $0.003\% \Delta k/k$
- Change of I&C will not affect this tech spec

# Review of PUR1 Tech Specs

## Reactor Safety System

- The time from the initiation of a scram condition in the scram circuit until the shim-safety rod reaches the rod lower limit switch shall not exceed one second.
- Must be met by new control system



# Review of PUR1 Tech Specs

## Reactor Safety System

- Scram and Setback Setpoints
- New system must be shown to perform at an acceptable frequency of success

# Review of PUR1 Tech Specs

## Primary Coolant Conditions

- Primary coolant pH shall be maintained at an average over one year of  $5.5 \pm 1.0$
- Primary coolant resistivity shall be maintained at a value greater than  $330 \text{ k}\Omega\text{-cm}$
- Primary Coolant shall be at least 13 feet above core
- New I&C will support this surveillance through digital interface

# Review of PUR1 Tech Specs

## Confinement

- Negative Pressure of at least 0.05 in of water
- All doors shall remain closed except as needed for access
- All inlet and exhaust ducts shall contain a HEPA filter
- Dampers in ventilation capable of being closed
- New I&C will support this through digital interface

# Review of PUR1 Tech Specs

## Experimental Reactivity Limits

- Various requirements on experimental reactivity limits and temperatures
- Experiments will not be affected by new I&C

# Review of PUR1 Tech Specs

## Surveillance Requirements

- Rod worth to be measured every 2.5 years
- Calibration of reactor safety channels at least every 15 months
- Calibration of radiation monitoring every 15 months
- Verification of Rod Drop Times
- Will not be affected by new I&C

# Safety Analysis Report (SAR) Update

- 12 kW Power Uprate Submitted
- Expect to have several months of operation at this level before completion of digital upgrade
- All License Amendment Requests will be submitted off of this SAR





# Description of Proposed System

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## Overview

- Digital Neutron Flux Monitoring System covering all ranges of operation, Startup, Intermediate, Power and Wide Range
- New detectors included in upgrade
- RTP 3000 TAS Platform
- R\*TIME Server and Viewer Software

# Description of Proposed System

## Overview

- Startup and Intermediate Range Monitoring Using CIC
- Power Range Monitoring Using UIC
- Wide Range Monitoring Using FC
- RTP 3000 TAS System

# Description of Proposed System

## Overview

- Drive Assembly Interface Electronics
- RMS Systems Interface
- HVAC System Interface
- Makeup Water Interface
- Water Chemistry Sensors

# Description of Proposed System

## Reused Items


- Reused Equipment Racks
- Console and Hallway Scram Buttons
- Operator Console Keylock Switch

# Description of Proposed System

## System Interface

- Main Interface between system and operator will be a digital screen using R\*TIME
- Layout and Final Design to be determined following vendor decision
- Design lockdown early 2016 for LAR submission





# Functional and Safety Analysis

# Functional and Safety Analysis

## Failure Modes of New System

- Old reactor control system allowed for a Scram on any of the active channels
- Same to be true for new design
- No requirement for 2/3 or 2/4 logic

# Functional and Safety Analysis


## Time Dependencies

- Current requirement is for full rod insertion in less than one second
- Design, analysis, and testing will ensure this requirement is met

# Functional and Safety Analysis

## Operator Emergency Shutdown

- Identical circuitry with console and hallway scrams to be used
- Loss of power in any system also will initiate scram
- Removal of operator key to remove magnet power



# Schedule For Submitting License Amendment Request (LAR)

# Schedule for Submitting LAR

## Proposed Vendor Timeline

<b>Project Item</b>	<b>Date of Completion</b>
Phase 0 Meeting NRC	November 6
Final Contract In Place	November 9
Chosen Vendor Visit	November 16
System Functional Requirements Document Finalized	December 23
Hardware Design Finalized	January 30
Final hardware and software design package complete	February 28
<b>License Amendment Request Sent to NRC</b>	<b>March 18</b>
Software Ready for Integration	May 1
Factory Acceptance Testing Complete	June 30
Delivery of all Hardware and Software (excluding detectors)	July 30
<b>License Amendment Request Approved by NRC</b>	September
Startup and Acceptance Testing	September/October





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