

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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Current I&C Overview



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

Review of PUR1 Tech Specs

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 ± 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

Description of Proposed System

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

Project Item	Date of Completion
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
License Amendment Request Sent to NRC	March 18
Software Ready for Integration	May 1
Factory Acceptance Testing Complete	June 30
Delivery of all Hardware and Software (excluding detectors)	July 30
License Amendment Request Approved by NRC	September
Startup and Acceptance Testing	September/October



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