Hope Creek Replacement of SRMs and IRMs with Digital NUMAC Wide Range Neutron Monitor System

Application of RIS 2002-22 Supplement 1 Qualitative Assessment Approach to Install Digital WRNMS Upgrade Under 10CFR50.59

NRC Public Meeting

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PSEG Nuclear LLC

Agenda

- Introduction
- Purpose of meeting
- Scope of Project
- Rationale for use of RIS-2002-22 Supplement-1 for WRNM
- RWE During Startup
- Startup of Idle Recirc Pump at Low Power
- Plant / System Attributes Supporting Qualitative Assessment
- Elements Supporting Qualitative Assessment
- Proposed Scope of LAR
- Next Steps
- Adjourn

Purpose of Meeting

- **Hope Creek is pursuing replacement of the Source and Intermediate Range Neutron Monitors (SRMs/IRMs) with the GE NUMAC Wide Range Neutron Monitor System (WRNMS)**
  - Pursue implementation of digital upgrade under 10 CFR 50.59
  - 50.59 supported by a Qualitative Assessment prepared using the criteria and guidance described in Regulatory Information Summary (RIS) 2002-22 Supplement 1
    - QA to support conclusion that Likelihood of Failure of digital SSC sufficiently low
  - Standard LAR to address required Tech Spec changes
  - Licensing approach informs project costs and schedule
- **This meeting seeks to gather staff feedback on this approach**
  - Assessment of SRM / IRM / WRNM replacement falling within the scope of 50.59 and the RIS in lieu of submittal under ISG-06 review process
  - Use of Qualitative Assessment via RIS guidance to address 50.59 questions

Scope of Project

- **Project replaces the 4 SRM channels and 8 IRM channels with 8 WRNM channels**
  - Improved reliability and dose reduction over SRMs / IRMs
  - Installed at Peach Bottom and international plants
- **Hope Creek Source Range Monitors**
  - Four non-safety related SRM channels
    - Flux monitoring during refueling and startup through critical
    - Detectors withdrawn below core once IRMs on scale
    - Provides alarm on short reactor period and rod block on count rate
    - Not credited for mitigating any UFSAR Chapter 15 event
    - Non-coincident scram function on high count rate used during initial fuel load and startup and if shutdown margin test performed in lieu of SDM calculation
    - WRNMS doubles number of channels for refuel monitoring

Scope of Project cont.

Hope Creek Intermediate Range Monitors

- Eight safety related IRM channels
  - Flux monitoring during startup up to the low power range (~10%)
  - Channel manually ranged up through 10 ranges during startup to maintain indication on scale as reactor flux increases
  - Detectors withdrawn below core once APRMs on scale and Mode-1 entered
  - Provides rod block on HI setpoint (<108% of scale) and scram on HI-HI setpoint (<120% of scale)
    - Provides protection against prompt reactivity additions
    - Rod block and scram logic bypassed when mode switch in Run
  - Identified as redundant mitigation for the Rod Withdrawal Error – Startup transient in UFSAR Section 15.4.1 and Appendix 15B
  - Described to mitigate startup of idle recirc pump at low power in UFSAR Section 15.9

Scope of Project cont.

NUMAC Wide Range Neutron Monitor System

- **Eight safety related WRNM channels**
  - Covers flux monitoring from shutdown through full power operation
  - No manual range switching
    - Automatically ranges from Range 0 (S/D Refuel) through Range 6 (Power Ops)
  - Breeder detectors fixed in core at similar elevation as SRM/IRM
  - Provides rod block and scram trip outputs based on reactor period in lieu of percent of scale
    - RPS input logic 1-out-of-4 twice – Same as IRM logic
    - Rod block and scram logic bypassed with mode switch in Run
    - Provides indication only during power ops – no trip function
- **Fulfills same role as IRM trip for Chapter 15 AOOs**
- **Change to period-based rod block & scram function and conversion of SRM to WRNM requires TS changes**

Applicability RIS-2002-22 Supplement-1 for WRNM

- **NRC/Industry guidance on digital upgrades via 50.59**
  - RIS 2002-22 Supplement-1
  - Reg Guide 1.187 Rev. 2 / NEI 96-07 Appendix D
  - Qualitatively assess likelihood of failure for safety related digital SSCs
- **Draft BTP 7-19 Rev. 8 acknowledges qualitative assessment and plant diversity can be used to address software CCF**
- **SRM / IRM can be considered within the scope of the RIS**
  - WRNMS is a replacement of an RPS input (IRMs) and not a wholesale replacement of the RPS logic system
  - WRNM design attributes align with the guidance in the RIS
  - IRM / WRNM only used for brief period in the operating cycle (startup) and is bypassed during power ops
  - IRM trip is only protective function from SRM/IRM in Chapter 15 events
    - Two Anticipated Operational Transients

Continuous Rod Withdrawal Error During Startup

- **Non-limiting event in UFSAR Sec 15.4 – Reactivity and Power Distribution Anomalies**
  - Not required to be re-analyzed as part of reload licensing
- **Continuous withdrawal of out of sequence, high worth rod**
  - Event is precluded by Rod Worth Minimizer
  - Contingent upon failure of RWM and failure of rod blocks and operational procedures and verifications for rod withdrawal
  - No radiological release or consequences from event
- **Transient analysis performed to demonstrate large margin to licensing basis criterion for fuel failure (<< 170 cal/g-UO_2)**
  - Described in UFSAR Appendix 15B
  - Evaluated using conservative point kinetics model

RWE During Startup cont.

- **Event is terminated by either IRM scram or by APRM 15% power Setdown scram in startup**
  - Appendix 15B analysis assumes IRM system in worst case bypass condition
  - APRM 15% scram assumed in analysis for event termination
  - Analysis shows APRM scram likely to be reached as soon as (worst case bypassed) IRM scram
- **IRM trip backed by diversity of protection against RWE**
  - Operational procedures and peer check verifications
  - Rod block from RWM
  - APRM setdown rod block and scram

Startup of Idle Recirc Pump at Low Power

- **Anticipated Operational Transient in UFSAR 15.9 - Nuclear Safety Operational Analysis**
  - Non-limiting event
  - NSOA intended to ensure limiting transients analyzed in UFSAR Secs.15.1 - 15.8 remain bounding for all possible transients
  - Evaluates event at a reactor power between 5% and 10%
  - Resulting flux transient **may** produce a high flux trip from IRM
  - Although not specifically stated, the APRM 15% setdown scram provides a diverse backup to the IRM scram during this transient
    - NUREG-1433 Bases identifies that at IRM Range 9 or 10, it is possible that the APRM 15% power setdown scram will possibly provide the primary trip signal for a core wide increase in power
    - Startup of an idle recirc pump would produce a core wide increase in power

Plant /System Attributes that Support a Qualitative Assessment

- **IRM / WRNM system falls outside the scope of an ISG-06 / BTP 7-19 based License Application**
  - System provides redundant & diverse protection for impacted transients
  - Impacted transients are non-limiting and do not result in any release of radioactive material
  - RWE contingent on failure of multiple barriers
    - Operational Procedures and Peer Checks
    - Rod Worth Minimizer
    - IRM / APRM Control Rod Blocks
  - Limited reliance on IRM protection for idle recirc pump start in startup
  - Both Chap 15 events terminated by either IRM or APRM scram
  - IRMs are not relied upon to initiate and complete control actions essential to maintain plant parameters within acceptable limits established for a DBE
  - Minimal window of time in operating cycle when IRM trip is relied upon for transient protection

Design Elements Supporting Qualitative Assessment

- **WRNM based on NUMAC digital platform**
  - Long operational history of Class 1E platform
  - WRNM processor/design updates to be performed via GEH Appendix-B development program
    - Same process as NUMAC PRNM – recently evaluated by NRC (ML17216A022)
- **Continuous self diagnostics built into the channel with trip on critical faults**
- **No cross-divisional or cross-channel communication or shared resources**
  - Each WRNM channel self-contained
- **No change to active RPS logic**
- **Dedicated, simple routine program resides on internal firmware**
- **Independent SW and HW watchdog timers that generate a trip on timeout**
- **Even in event of worst case software CCF, RWE & idle recirc pump start events terminated by diverse APRM trip**
- **Diversity among NUMAC WRNM, PRNM and RWM designs can be established**
- **These and other design attributes will support a qualitative assessment via the RIS**

Proposed Scope of LAR

- **LAR would describe required TS changes to reflect the design of the WRNM system**
  - Conventional (Non ISG-06) License Change per 10 CFR 50.92
    - Licensing action limited to required TS changes
    - Similar to LAR for Salem analog wide range NI replacement of SR/IR channels (Amendment Nos. 313 / 294, ML16096A419)
  - Replace references to SRM / IRM with WRNM
    - Replace RPS TS percent of scale IRM trip with WRNM period based trip
    - Eliminate SRM and drive related rod blocks and replace TS percent of scale IRM rod block with period based rod block

Next Steps