# NRC-Industry MP4 ISG-06 R2 Tabletop

## Hope Creek Power Range Neutron Monitor NUMAC Digital Upgrade Pre-Application Coordination Meeting

June 13-14, 2018

Industry MP4 Team

NUCLEAR ENERGY INSTITUTE

# MP4 Tabletop Presentation Purpose



The purpose of this presentation is to exercise the draft DI&C-ISG-06 Revision 2 process for the Pre-Application Coordination Meeting. This presentation is based loosely on the Hope Creek PRNMS Phase 0 meeting presentation dated September 11, 2013 but is not associated with Hope Creek Generating Station (HCGS).

HCGS kindly gave their permission for use of this file.

# Agenda - Nonproprietary



- Meeting Purpose and Introductions
- ISG-06 Rev. 2 Alternate Review process alignment
- Project Information and PRNM Design Concept/Architecture
- Plant Impacts
- GEH Topical Report and Development Program
- Additional NRC Topics of Interest
- Plant Specific Action Items (PSAIs)
- Vendor Oversight Plan (VOP)
- Tool for file sharing
- PRNM Project Schedule/Milestones
- Summary
- Questions, Discussion and Feedback (Public Presentation)
- Conclusion (Public Presentation)

# Pre-Application Coordination Meeting Purpose



- To engage with NRC Staff prior to LAR submittal and describe the HCGS PRNMS NUMAC digital upgrade.
- To present the design concept and demonstrate how it addresses NRC requirements and policy regarding key issues.
- To gain alignment on use of ISG-06 Alternate Review process and submittal/review process.
- To solicit Staff feedback prior to LAR submittal to facilitate a more efficient NRC review.

# Introductions



## Utility / Vendor Team

- Kenneth Knaide – PSEG Director of Engineering – (Not) Hope Creek
- Robert Gallaher – PSEG PRNM Project Manager
- Chuck Lukacsy – PSEG Operations
- Keith Swing – PSEG System Engineer
- Ron Veideman – PSEG Lead Engineer
- Dave Heinig – PSEG Design Engineer
- Brian Thomas – PSEG Principal Licensing Engineer
- Robert Hoffman – PSEG Licensing Engineer

Participants listed here

- Kahlim Miller – GEH Project Manager
- Larry Chi – GEH Chief Engineer
- Frank Novak – GEH PRNM Technical Lead
- Sara Rudy – GEH Licensing Engineer

# ISG-06 Alignment – Use of AR Process



- LAR to be submitted for review under Alternate Review (AR) process
- AR process licensee prerequisites
  - LAR will describe licensee's Vendor Oversight Plan. GEH development process is consistent with (and conforms to) the 2015 version of NQA-1, Part II, Subpart 2.7.
  - GEH PRNMS topical report (TR)
    - TR was reviewed/approved by the NRC October 1995
    - Proposed modification scope is within the scope of the TR's applicability
    - TR vendor (i.e., GEH) will perform detailed software design, implementation, and testing
  - Licensee Commitments in Consideration of Early License Amendment Issuance
    - LAR will include commitment to complete any plant specific actions included in TR
    - LAR will include commitment to complete life cycle activities under the licensee's QA program
- Precedent LAR
  - Similar to Columbia PRNM upgrade; incorporating RAIs and NRC feedback
  - Review of Columbia SE as precedent

# ISG-06 Alignment – Fundamental Design Principles 7

The platform and system architecture discussion will address the ISG-06 Rev. 2 Section 2.6, Fundamental Design Principles:

- Redundancy
- Independence
- Deterministic Behavior
- Defense in Depth and Diversity

# PRNM LAR Needs and Benefits



- **Needs….**
  - Upgrade existing analog system to provide increased reliability,
  - Reduce maintenance work on existing system,
  - Address long-term obsolescence issues, and
  - Increase operational flexibility.

Needs and Benefits included

- **Benefits….The GEH NUMAC PRNM Implementation at Hope Creek will provide:**
  - Enhanced APRM features to improve system operation – use of Operator Display Assemblies
  - Automated system surveillance testing - built-in auto-calibration and self-test functions – ½ scram reduction; managing risk, eliminate use of extender card and INOP inhibit button
  - Highly reliable and accurate system functions
  - Familiarity w/ NUMAC chassis (operation & troubleshooting– leak detection, MSL rad monitors)
  - Reduced number of components

# GEH NUMAC Configuration



- 2-out-of-4 Logic Chassis
- Average Power Range Monitor (APRM) Chassis with Option III a[illegible] CD Stability functions
- Rod Block Monitor (RBM) Chassis
- Control Room Operator Display Assem[illegible])
- NUMAC Interface Computer ([illegible])
- Quad Low Voltage P[illegible]es (QLVPS)
- Similar to NU[illegible] Systems at:
  - Nine Mile U[illegible]2
  - Susquehanna Units 1 and 2
  - Peach Bottom Unit 1 and 2
  - Limerick Unit 1 and 2
  - Brown's Ferry Unit 1, 2, 3
  - Monticello
  - Grand Gulf
  - Columbia (LAR submitted for approval)
  - Etc…(more than 30 installed systems)

Similar Architecture information included

Main Display

LPRM Display

# Existing System Comparison

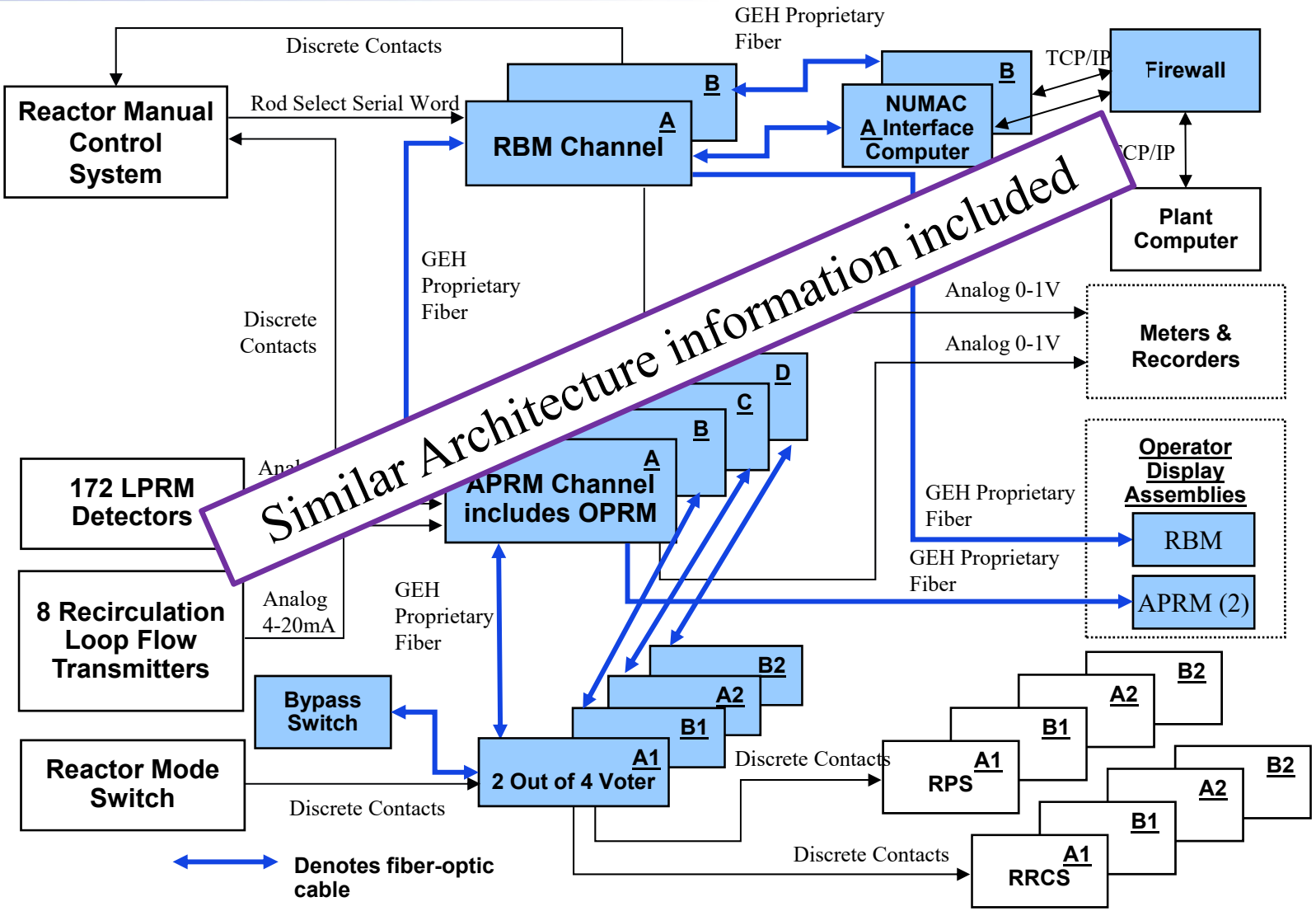


| Subsystem | Existing PRNM System | NUMAC PRNM System |
|---|---|---|
| Safety Function | Upscale Flux Trip<br>Simulated Thermal Power Trip<br>Setdown Flux Trip<br>OPRM trip provided by ABB OPRM system | Upscale Flux Trip<br>Simulated Thermal Power Trip<br>Setdown Flux Trip<br>OPRM trip |
| LPRM | - 43 LPRM strings, 172 LPRM detector Signals | No Ch[illegible] |
| Flow | - Four Flow channels, 8 Flow Transmitters<br>- Flow channels A&C provide input to APRM [illegible]<br>Each APRM selects the low input<br>- Flow channels B&D provide [illegible]<br>Each APRM selects [illegible] | [illegible]hannels, 8 Flow Transmitters<br>[illegible] flow channel provides input to 1 APRM channel |
| APRM | - 6 APRM [illegible]<br>- 21 [illegible] signals to each APRM channel<br>[illegible] A & B are not used by APRMs<br>- [illegible]utputs to RPS<br>- APRM A – RPS Channel A1<br>- APRM B – RPS Channel B1<br>- APRM C – RPS Channel A2<br>- APRM D – RPS Channel B2<br>- APRM E – RPS Channel A1, A2<br>- APRM F – RPS Channel B1, B2<br>- Two bypass switches | - 4 APRM Channels<br>- 4 LPRM NUMACs coupled with associated APRM channel to process all LPRM input signals<br>- 43 LPRM inputs signals to each APRM channel<br>- All LPRM detectors used by the APRMs<br>- Eight outputs to RPS<br>- Voter A1 – RPS Channel A1<br>- Voter B1 – RPS Channel B1<br>- Voter A2 – RPS Channel A2<br>- Voter B2 – RPS Channel B2<br>- One bypass switch |
| OPRM | - ABB BWROG Option III stability solution | - GE BWROG Option III and GEH DSS-CD stability solutions |
| RBM | - 2 RBMs, Flow-biased setpoints | - 2 RBMs, Power-biased setpoints (Full ARTS implementation) |

The Safety Function Summary Table is provided

# PRNM Architecture & Interface Systems





# PRNM Preparation and Issue Identification



- Industry Lessons-Learned applied
- Critical Digital Review completed
- HCGS Digital Program assessment completed
- TS Amendment removing APRM OPCON 5 operability requirement implemented
- Procedure Development Plan
  - To support FAT
  - To enhance Digital Program/Processes
- Potential future projects assessed for PRNM upgrade implications
  - To identify / mitigate / resolve issues early

# PRNM Upgrade Plant Impacts



- TS impacts
- FSAR impacts
- Calibration and surveillance testing impacts
- Plant staff impacts
- Setpoint Calculations
- PSEG Digital Lifecycle Program
- Procedure impact: NMS and RBM operating procedures, system operating and abnormal operating procedures, maintenance procedures, surveillance procedures, and alarm response procedures.

# Use of GEH PRNMS TR



- GEH PRNMS TR SE Report approved both the platform and application development process
- GEH Digital Lifecycle Process - current platform deviates from the approved PRNMS TR:
  - APRM Upscale/OPRM Upscale, APRM INOP Function Logic
  - Time to Calculate Flow-biased Trip Setpoint
  - Abnormal Conditions Leading to Inoperative Status
  - OPRM Pre-Trip Alarms
  - Increased Instrument Security
  - PRNM System Input Power Source
  - Minor software changes below level of detail of LTR
    - Lower level product enhancements (e.g., software change to support more efficient SR testing) and
    - Error corrections in software

# Application Development Process



Case 1: If an NRC approved application development process exists:

- NRC has already approved the application development process in the topical report and the underlying regulations have not changed since topical report approval, then ISG-6 Section D.4 has been addressed

Case 2: If no NRC approved application development process exists:

- The licensee has evaluated the vendor's application development process and determined that the process is consistent with ISG-6 Section D.4
- The LAR will describe the application development process consistent with ISG-6 Section D.4

At the Pre-application Coordination Meeting, one of these two cases will be discussed to address Section D.4. For GE PRNMS, it is Case 1. Note that this is a unique example in that it was NRC reviewed as part of a LAR for Hope Creek PRNM.

# Additional NRC Topics of Interest



- Data Communication (DI&C-ISG-04)
- Diversity and Defense in Depth (BTP 7-19)
- EMC Compliance (RG 1.180)
- Secure Development & Operational Environment (RG 1.152)
- Human Factors Considerations
- Application or Plant Specific Application Items
- Vendor (Technical) Oversight Plan

The example Digital System Topic slides following are included to demonstrate level of detail

# Data Communication (DI&C-ISG-04)



- Interdivisional Communications
  - PRNM design includes no channel-to-channel communications
  - Supports the safety function of the system (voting)
  - PRNM includes NSR-to-SR communications
  - Analysis will evaluate PRNM vs. 20 points in ISG-04
- Command Prioritization
  - Not applicable – the priority module (RPS) is not digital
  - No diverse actuation signals are combined in PRNM
- Multidivisional Control & Display Stations
  - ODAs are NSR, and utilize one-way communication from APRM/RBM NUMACs
  - No control functions

# Diversity and Defense in Depth (BTP 7-19)



- Schedule for D3 Analysis submittal
  - Prior to or with the LAR
- Preliminary review of HCGS UFSAR Chapter 15 shows significant overlap with CGS analysis
- Only minor Chapter 15 deltas were identified
- Will address all 9 criteria in BTP 7-19 Rev 6
- Will rely on built-in diversity with other plant systems
  - No requirement for a diverse actuation system is anticipated

# EMC Compliance (RG 1.180)



- PSEG procedures require EMC compliance for emissions and susceptibility
- Per PSEG procedure, EPRI TR-102323 and RG 1.180 contain acceptable testing standards
- PRNM is qualified to RG 1.180 limits
- HCGS environment is bounded by EPRI TR-102323
  - PRNM is located in a radio exclusion zone
- Comparison of equipment qualification to the plant specific envelope requirements
  - Pre-qualified equipment, equipment to be qualified

# Secure Development and Operational Environment (RG 1.152)



- GEH PSEG SDOE report is expected to be very similar to CGS report
  - Report details GEH SDOE program from Concept through Test phases
- SOE after turnover of system to PSEG covered by PSEG Cyber Security Program (CSP)
- HCGS is compliant with NRC approved cyber security plan
  - License Amendments No. 189 and 192
- SDOE Considerations
  - PRNM will be at cyber security Level 4
  - CRIDS and 3DM remain at Level 3 - Application Firewall between Levels 3 & 4
  - Data Diodes installed between Level 3 and 2 - eliminating outside attacks from impacting Level 3 & 4 systems.
  - Gain Adjustment Factor (GAF) uploads performed through the Application Firewall

# Human Factors Considerations



- For PRNMS, there are no safety critical or accident mitigating operator actions
- Important operator tasks remain unchanged; therefore, there is no impact to task dynamics, complexity, or workload for the operations staff
- Two new actions related to the Simulated Thermal Power (STP) setpoint of the NUMAC APRMS and each has sufficient time to complete them
- Upgrade does not impact reactor operating parameters or the functional requirements of the APRM system
- System will continue to provide information, enforce control rod blocks, and initiate reactor scrams under appropriate specified conditions as before

# Human Factors Considerations



- The PRNM back panel equipment and NUMAC ODA has been designed to meet NUREG-0700 to the extent practicable
- Integrated system validation is not warranted, since no change in important human actions for the replacement hardware.

# Plant Specific Action Items (PSAIs)



All PSAIs included as part of the generic approval of the GE Licensing Topical Report, NEDO-31439-A (October 1990), will be addressed as part of the LAR.

# Vendor Oversight Plan (VOP)



- LAR will include a project-specific VOP description per ISG-06 R2 Section C.2.2.1
- VOP includes participation by project stakeholders to ensure vendor compliance with their processes, including V&V, requirements traceability, configuration management, testing, software quality assurance, etc.
- Vendor Oversight activities include the following:
  - Initial audit and review
  - Periodic audits (which includes witness of critical testing or V&V activities)
  - Routine design reviews for technical and process compliance

# Sharepoint Site for file sharing



HCGS and GEH have established an electronic reading room for use in file sharing with NRC.

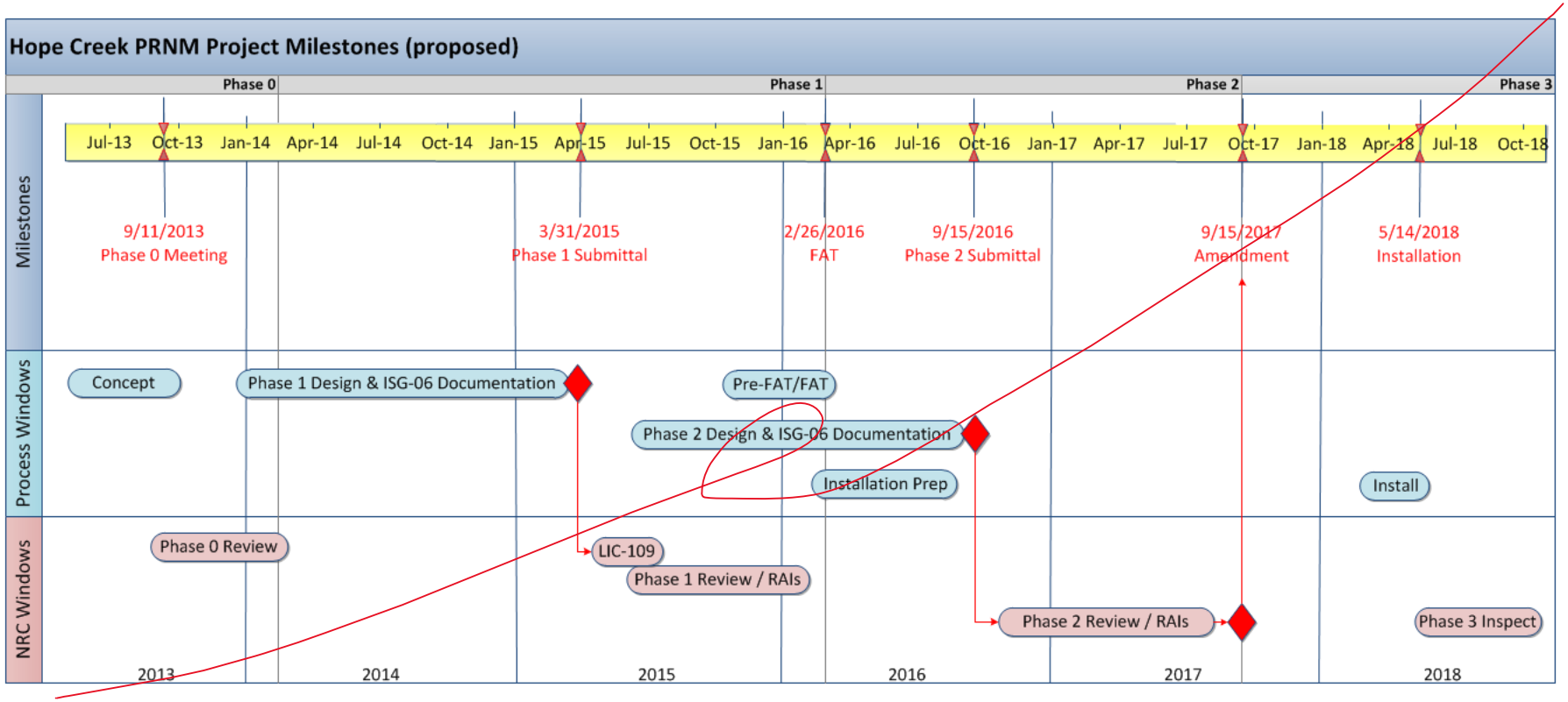
# PRNM Project Schedule / Milestones



- Pre-Application Coordination Meeting September 2013
- LAR Submittal 2nd Qtr 2015
- Amendment / SE June 2016
- Install Spring 2017

# Project Milestones/Timeline






Schedule will be provided – above just a placeholder

# Acronym List



**3DM –** 3DMONICORE™ (core monitoring system)
**ABB** - ASEA Brown Boveri
**AFT** – As Found Tolerance
**ALT** – As Left Tolerance
**APRM** - Average Power Range Monitor
**BTP** - Branch Technical Position
**CAP** – Corrective Action Program
**CCF** - Common Cause Failure
**CGS** – Columbia Generating Station
**CRIDS** - Control Room Integrated Display System (Hope Creek Process Plant Computer System)
**DSS-CD** - Detect and Suppress Solution – Confirmation Density
**D3** - Diversity, Defense in Depth
**ESFAS** - Engineered Safety Feature Actuation System
**FAT** - Factory Acceptance Testing
**GAF** – Gain Adjustment Factor
**GEH** - General Electric Hitachi Nuclear Energy
**HW** - Hardware
**INPO** - Institute of Nuclear Power Operations
**IRM** - Intermediate Range Monitor
**ISG** - Interim Staff Guidance
**LAR** - License Amendment Request
**LPRM** - Local Power Range Monitor
**LTR** - Licensing Topical Report
**NIC** - NUMAC Interface Computer
**NRC** - U. S. Nuclear Regulatory Commission
**NUMAC** - Nuclear Measurement Analysis and Control
**NSR** – Non Safety Related
**ODAs** - Operator Display Assemblies
**OPRM** - Oscillation Power Range Monitor
**PRNM** - Power Range Neutron Monitor
**PSEG** – Public Service Electric and Gas
**QLVPS** - Quad Low Voltage Power Supplies
**RAI** - Request for Additional Information
**RBM** - Rod Block Monitor
**RG** - Regulatory Guide
**RMCS** - Reactor Manual Control System
**RPS** – Reactor Protection System
**RRCS** - Redundant Reactivity Control System
**RTS** - Reactor Trip System
**Rx** - Reactor
**SE** - Safety Evaluation
**SDOE** – Secure Development and Operational Environmental
**SRM** - Source Range Monitor
**SW** - Software
**TSTF** - Technical Specification Task Force