Exemption Request Utilizing the Risk-Informed Process for Evaluations (RIPE) to Address Independence of Turbine Control System and Reactor Protection System Circuitry

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Exemption Request Utilizing the Risk-Informed Process for Evaluations (RIPE) to Address Independence of Turbine Control System and Reactor Protection System Circuitry

Shearon Harris Nuclear Power Plant (HNP)

2

Agenda

- Issue Description
- System Design and Operation
- Electrical Anomaly Evaluation
- Application of the RIPE Process
- PRA Results
- Schedule

Issue Description

- Received a green non-cited violation of 10 CFR 50 Appendix B, Criterion III, “Design Control” for “Treatment of Class 1E Interfaces and Interlocks with the Turbine Trip System (TTS) Design.”
  - Cited performance deficiency – The failure to ensure independence between Turbine Control System (TCS) circuits and the trains of Reactor Protection System (RPS) circuits in accordance with IEEE 279-1971, Section 4.6, “Independence,” and the UFSAR Section 7.0, “Instrumentation and Controls.”
  - Postulated an impact to the following functions:
    - The ability of the turbine to trip upon a reactor trip.
    - The ability of the reactor to trip upon a valid RPS signal.
    - The ability of the ESFAS to actuate upon a valid actuation.
  - Very low safety significance.
- Configuration in question is related to original HNP design for TTS and RPS interface and is in accordance with the Westinghouse NSSS standard design.

Issue Description

- Pursuing a limited exemption in accordance with 10 CFR 50.12, *Specific exemptions*, from the requirements of 10 CFR 50.55a(h)(2), *Protection systems*, requiring protection systems meet the requirements of IEEE 279-1971, “Criteria for Protection Systems for Nuclear Power Generating Stations,” utilizing the Risk-Informed Process for Evaluation (RIPE).
- § 50.55a Codes and standards
  - (h) Protection and safety systems. Protection systems of nuclear power reactors of all types must meet the requirements specified in this paragraph. Each combined license for a utilization facility is subject to the following conditions.
    - (2) Protection systems. For nuclear power plants with construction permits issued after January 1, 1971, but before May 13, 1999, protection systems must meet the requirements in IEEE Std 279–1968, "Proposed IEEE Criteria for Nuclear Power Plant Protection Systems," or the requirements in IEEE Std 279–1971, "Criteria for Protection Systems for Nuclear Power Generating Stations," or the requirements in IEEE Std 603–1991, "Criteria for Safety Systems for Nuclear Power Generating Stations, and the correction sheet dated January 30, 1995. For nuclear power plants with construction permits issued before January 1, 1971, protection systems must be consistent with their licensing basis or may meet the requirements of IEEE Std. 603–1991 and the correction sheet dated January 30, 1995.

Issue Description

- Specifically, the exemption request would remove the requirement for the RPS cables that terminate within the Turbine Control System (TCS) cabinet G (1TCS-CAB-G) meet the IEEE 279-1971 Section 4.6, *Channel Independence*, requirement that they be independent and physically separated.
- IEEE 279-1971, Section 4.6

  Channel Independence – Channels that provide signals for the same protective function shall be independent and physically separated to accomplish decoupling of the effects of unsafe environmental factors, electric transients, and physical accident consequences documented in the design basis, and to reduce the likelihood of interactions between channels during maintenance operations or in the event of channel malfunction.

Issue Description

- 10 CFR 50.12(a)(2) - “The Commission will not consider granting an exemption unless special circumstances are present. Special circumstances are present whenever –
  - (ii) Application of the regulation in the particular circumstance would not serve the underlying purpose of the rule or is not necessary to achieve the underlying purpose of the rule…
- Application of the regulation in this circumstance would not serve the underlying purpose of the rule and is not necessary to achieve the underlying purpose of the rule
  - Underlying purpose: Decouple the effects of unsafe environmental factors, electric transients, and physical accident consequences documented in the design basis.

System Design and Operation

- Protection Systems – include the electrical and mechanical devices and circuitry involved in generating the signals associated with the two protective functions of the Solid State Protection System (SSPS).
  - Reactor Protection System (RPS)
    - Function: generates signals that actuate reactor trip.
    - Part of the Reactor Trip System.
    - Automatic reactor trips based upon neutron flux, reactor coolant loop temperature, pressurizer pressure and level, and reactor coolant pump underfrequency and undervoltage, and a safety injection signal.
      - The sets of signals are redundant, physically separated, and meet the requirements of IEEE Standard 279-1971, “Criteria for Protection Systems for Nuclear Power Generating Stations.”
  - Engineered Safety Features Actuation System (ESFAS)
    - Function: generates signals that actuate engineered safety features.
    - Part of the Engineered Safety Features System.

System Design and Operation

- Turbine Control System (TCS)
  - Non-safety related.
  - Non-seismically designed.
  - Controls valve position, speed, and/or load depending on reference parameter selected.
  - If turbine parameter is exceeded, protection system will trip the turbine by closing all steam admission valves.
  - RPS provides redundant signals of reactor trip to TCS.

Electrical Anomaly Evaluation

- An evaluation was performed that focused on the potential for an electrical anomaly to occur at a common point within the TCS cabinet G and cause both trains of SSPS to become inoperable. It was postulated that the electrical anomaly could couple to other cables and impact other circuits by either Electromagnetic Interference (EMI), electrical noise which causes a disturbance or undesired response in electrical circuits, equipment, or systems, or radio frequency interference (RFI), which occurs from electrical disturbance within the radio frequency spectrum. EMI and RFI affect electrical components by induction, coupling or conduction.
- Results of evaluation determined that no credible events would impact either train of safety-related equipment from fulfilling its design basis function.

10

Application of the RIPE Process

- Applicable Guidance Documents:
  - Guidelines for Characterizing the Safety Impact of Issues, Revision 2, May 2022 (ADAMS Accession No. ML22088A135)
  - TSG-DORL-2021-01, Revision 3 – NRR Temporary Staff Guidance, Risk-Informed Process for Evaluations, September 2023 (ADAMS Accession No. ML23122A014)
  - NEI 21-01, Revision 1, Industry Guidance to Support Implementation of NRC's Risk-Informed Process for Evaluations, June 2022
- HNP meets the criteria to utilize the RIPE Process
  - Technically acceptable PRA
    - ✓ TSTF-505, "Provide Risk Informed Extended Completion Times – RITSTF Initiative 4b"
      - – Approved per License Amendment 184 (ADAMS Accession No. ML21047A314)
    - ✓ Robust Integrated Decision-Making Panel (IDP)
      - – Implementation of 10 CFR 50.69 (ADAMS Accession Nos. ML19192A012 and ML21316A248)

Application of the RIPE Process

- In order to characterize as minimal safety impact:
  - Contribute less than 1 x 10^{-7}/year to core damage frequency (CDF)
  - Contribute less than 1 x 10^{-8}/year to large early release frequency (LERF)
  - Cumulative risk is acceptable
    - If baseline risk remains less than 1 x 10^{-4}/year for CDF and less than 1 x 10^{-5}/year for LERF once the impact of the proposed change is incorporated into baseline risk.

12

PRA Results

- Quantitative Risk Characterization
  - Configuration assessed was the compromised “requirements for single failure and interactions between control and protection systems affecting reliability of the RPS” that would be present by not meeting RPS independence.

Metric	Working Model Base	With Assessed Adjustment	NRC RIPE Criteria for Minimal Safety Impact	Quantitative Risk Assessed to Current Configuration
CDF	4.1459E-5	4.1475E-5	< 1.0E-7	1.6E-8 ✓
LERF	3.5142E-6	3.5142E-6	< 1.0E-8	< 1.0E-10 ✓

  - Conclusion: Not risk-significant and has minimal impact on safety.

PRA Results

- Quantitative Risk Characterization
  - Once the impact of the cited deficiency is captured in the HNP PRA baseline risk model, the threshold for cumulative risk is still maintained acceptable in accordance with RIPE guidance.

Metric	With Assessed Adjustment	NRC RIPE Criteria for Acceptable Cumulative Risk
CDF	4.1475E-5	< 1.0E-4 ✓
LERF	3.5142E-6	< 1.0E-5 ✓

Schedule

- Integrated Decision-making Panel (IDP) - November 29, 2023.
- Post-IDP Pre-submittal Meeting with NRC – December 11, 2023.
- Submit RIPE Exemption Request - January 2024.
- Implementation within 120 days of receipt of safety evaluation.

15


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