Request for Partial Exemption from 10 CFR 50.62(c)(1) Risk-Informed Process for Evaluations (RIPE) 2nd Pre-Submittal Meeting

Palo Verde Nuclear Generating Station (PVNGS)

November 17, 2021

Agenda

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Issue Description

- 10 CFR 50.12 partial exemption from 10 CFR 50.62(c)(1) using RIPE process to remove the Diverse Auxiliary Feedwater Actuation System (DAFAS) from the PVNGS licensing basis
  - … must have equipment *from sensor output to final actuation device, that is diverse from the reactor trip system,* **to automatically initiate the auxiliary (or emergency) feedwater system** *and initiate a turbine trip under conditions indicative of an ATWS…*
- Diverse turbine trip and diverse scram system are unaffected by this request

Path to Submittal

- Identified low-risk application of new RIPE process
  - Exemption from 10 CFR 50.62(c)(1) to remove DAFAS from the PVNGS licensing basis
- Reviewed newly issued NRC guidance for RIPE exemptions
- Challenge board with NEI held on June 24, 2021
  - Favorable feedback to proceed with submittal
- 1st Pre-submittal meeting w/ NRC held on September 1, 2021
- Integrated Decision-making Panel (IDP) held on September 30, 2021
  - NRC observed IDP
  - APS provided comments during IDP that will be addressed prior to submittal
- NRC provided APS three comments on October 18, 2021 (ML21306A188), and requested 2nd pre-submittal meeting
- 2nd Pre-submittal meeting w/NRC on November 17, 2021
- Plan to submit mid-December 2021

Item #1

NRC Review of Special Circumstances

NRC Comment

During the Integrated Decision-Making Panel (IDP), Palo Verde alluded that it plans to seek an exemption from 50.62(c)(1) by relying on the special circumstance that the application of the rule is not necessary to achieve the underlying purpose of the rule (10 CFR 50.12(a)(2)(ii)).

However, the preliminary IDP technical justification appears to rely on undue hardship 50.12(a)(2)(iii).

The defense-in-depth/safety margin (DID/SM) justification basis could differ under special circumstance.

An exemption request will need to explain the basis for the special circumstance being claimed with respect to the DID/SM justification provided.

Item #1

NRC Review of Special Circumstances

- Special circumstances are present:
  - 10 CFR 50.12(a)(2)(iii), states that special circumstances are present whenever compliance would result in undue hardship or other costs that are significantly in excess of those contemplated when the regulation was adopted, or that are significantly in excess of those incurred by others similarly situated.

Item #1
NRC Review of Special Circumstances

10 CFR 50.12(a)(2)(iii), Undue Hardship

- Significant resources associated with maintaining DAFAS
  - Obsolete system and not supported by the vendor
  - Spare parts are not readily available
  - Maintenance requires significant engineering resources to reverse engineer components
  - Frequent fiber optic communication problems affecting system availability
- DAFAS design using Modicon programmable logic controllers is unique to PVNGS
- Calculated risk for removing DAFAS is not risk-significant and has a minimal impact on safety
  - Delta risk for CDF and LERF is orders of magnitude lower than the acceptance criteria in NEI 21-01 and RG 1.174
- The Final Rule Statements of Consideration (49 FR 26038, dated June 26, 1984) regarding the value of DAFAS:

  Diverse and Independent Auxiliary Feedwater Initiation and Turbine Trip for PWRs: § 50.62(c)(1)

  This was proposed by the Utility Group on ATWS. It consists of equipment to trip the turbine and initiate auxiliary feedwater independent of the reactor trip system. It has the acronym AMSAC, which stands for Auxiliary (or ATWS) Mitigating Systems Actuation Circuitry. It has a highly favorable value/impact for Westinghouse plants and ***a marginally favorable value/impact for Combustion Engineering and Babcock and Wilcox plants.*** *Since it has the potential for a spurious trip of the reactor which reduces its value/impact, it should be designed to minimize these trips.*
- Therefore, the resources associated with maintaining or replacing DAFAS is not commensurate to its safety significance, which represents an undue hardship for compliance with 10 CFR 50.62(c)(1).

Item #2

NRC Review of Crediting Manual Actuation of AFS in Lieu of DAFAS

NRC Comment

The licensee plans to rely on manual actuation of Auxiliary Feedwater System (AFS) as the only alternative to the diverse automatic actuation of AFS by Diverse Auxiliary Feedwater Actuation System (DAFAS).

Essentially, the licensee appears to credit procedures that provide for manual actuation of AFS within 10 minutes is being credited as an element of DID in lieu of DAFAS. However, other elements of the licensee's preliminary DID justification indicate no increase in human error associated with the removal of DAFAS.

NRC review guidance in the Standard Review Plan Chapter 18, Attachment A, directs additional NRC staff review of operator manual actions required in less than 30 minutes.

For example, the submittal of information such as the basis for the action time margin, uncertainties associated with operator's ability to perform the actions, details regarding how AFS will be controlled once manually actuated, and details of crew validation runs could support a determination that operator actions are feasible and reliable without the need for a detailed, in-depth review if the licensee's exemption request demonstrates low safety significance.

In addition, because the IDP technical justification appears to indicate that human error uncertainties associated with manual actuation of AFS may already be incorporated into the PRA model, the NRC staff will need to understand how this uncertainty information is integrated into the exemption justification.

Item #2

NRC Review of Crediting Manual Actuation of AFS in Lieu of DAFAS

- PVNGS intent is to rely on the high reliability and single failure proof design of the Plant Protection System (PPS) and Engineered Safety Features Actuation System (ESFAS) to provide for automatic actuation of Auxiliary Feedwater (AF) via the Auxiliary Feedwater Actuation Signal (AFAS)
  - Risk-Insights demonstrate the adequacy of relying on PPS/ESFAS and maintains alignment with Defense-in-Depth philosophy (minimal risk impact well below NRC guidelines for RIPE)
  - Historical evidence of reliability will be included in the submittal
- Manual action has been demonstrated to provide Auxiliary Feedwater in an appropriate time-frame, but is not the primary basis for supporting the DID
  - Manual actuation of AF is not credited in the PRA model for ATWS events

Item #2

NRC Review of Crediting Manual Actuation of AFS in Lieu of DAFAS

- DAFAS is not included in Chapter 15 Accident Analysis of the UFSAR
- Beyond design basis analysis performed:
  - Loss of Normal Feedwater Flow Accident
  - ATWS Scenario [Trip from Supplementary Protection System (SPS) on High Pressurizer Pressure]
  - Automatic Auxiliary Feedwater Actuation disabled
- Simulator runs to demonstrate operator response to the above scenario
- Analysis performed to demonstrate the plant specific response and support the RIPE evaluation

Item #3

NRC Review of DID Strategy

NRC Comment

An exemption request should provide clarity and details regarding the elements of the planned DID strategy including the logic path through each DID element that is relied upon to maintain adequate safety margins.

Information provided should be well-reasoned, support critical elements of DID, and provide a complete explanation of the DID/SM justification, including by addressing matters such as RG 1.174, "An Approach for Using Probabilistic Risk Assessment in Risk-Informed Decisions on Plant-Specific Changes to the Licensing Basis," Item C.2.1.1.2).

While the preliminary IDP contains DID information, a RIPE exemption request will need to reformulate this DID information and augment it as needed to demonstrate that auxiliary feedwater is initiated (with elimination of DAFAS) such that sufficient DID is maintained, commensurate with the risk associated with loss of feedwater accidents.

Item #3

NRC Review of DID Strategy

Defense-in-Depth (DID)

- Rich history on perspectives of DID related to reactors covering a time period of roughly 60 years.
- For about the first 30 years, DID was viewed strictly from a deterministic or a structuralist perspective
- Protections relying on multiple barriers and multiple layers of defense (Diversity/Redundancy)
- Mid-1990's use of risk results and insights became part of DID
- Risk results and insights used to identify where defense protections could be enhanced or relaxed or used to determine the adequacy of such protections

Item #3

NRC Review of DID Strategy

Defense in Depth Design Features (post exemption)

- Reactor Protection System (RPS)
  - 4 Channels with 15 Trip parameters
  - Core Protection Calculator, Steam Generator (SG) Low Level, and High Pressurizer Pressure Trips provide prevention of an ATWS event
- Engineered Safety Features Actuation System (ESFAS)
  - PPS provides 2/4 logic for ESFAS actuations
  - Provides AFAS-1 and AFAS-2 on receipt of Low SG level signal
- Supplementary Protection System (SPS)
  - 4-Channel safety related Diverse Scram System
  - Trips on high pressurizer pressure
  - Opens Reactor Trip Circuit Breakers and Motor Generator set load output contactors
  - Exceeds 10 CFR 50.62 requirements
- Diverse Turbine Trip
  - Trip on control element drive mechanism power bus undervoltage (SPS trip interrupts power to this bus)

Item #3
NRC Review of DID Strategy

Single Failure Proof Design (PPS/ESFAS) – Post Exemption

- PPS sends 2/4 trip logic to ESFAS for initiation of Auxiliary Feedwater
  - Parameter 18 (AFAS-1) monitoring for Steam Generator 1 Low Level Conditions
  - Parameter 19 (AFAS-2) monitoring for Steam Generator 2 Low Level Conditions
- PPS 2/4 logic accomplished six trip matrices (AB, AC, AD, BC, BD, CD)
  - PPS channels independent and isolated from each other per safety related design criterion
  - Relay contacts are fail safe (actuation on loss of power or open circuit condition)
  - Single relay contact failure only affects one of the six matrices in the associated channel
  - Entire relay card failure would only affect three of the six matrices in associated channel
  - PPS trouble annunciation associated with all trip relays to promptly identify failures
- PPS provides AFAS signal to both ESFAS A and ESFAS B
  - Actuation circuitry is also 2/4 logic and is designed to be fail safe
  - Two trains of AF actuated when signal is received (AF-A, AF-B)
- Any single failure is incapable of defeating both PPS and ESFAS

Item #3

NRC Review of DID Strategy

Seven Defense-in-Depth Considerations

1. **Preserve a reasonable balance among the layers of defense.**
   - PPS/ESFAS design provides prevention of an ATWS event
   - Auxiliary Feedwater provides layers of defense by:
     - Minimizing challenges to the Plant
     - Preventing any events from progressing to core damage
     - Containing the radioactive source term
   - DAFAS does not impact the likelihood of an initiating event
   - ESFAS is a highly reliable two-out-of-four channel logic system which actuates two trains of Auxiliary Feedwater
   - Non-Class 'N' Train Auxiliary Feedwater pump also available to provide feedwater
   - Removal of the DAFAS from the licensing basis does not significantly reduce the reliability of the Auxiliary Feedwater System

Item #3

NRC Review of DID Strategy

Seven Defense-in-Depth Considerations

2. **Preserve adequate capability of design features without an overreliance on programmatic activities as compensatory measures.**
   - PPS/ESFAS design provides adequate capability for reactor trips and automatic actuation of Auxiliary Feedwater
   - Since Auxiliary Feedwater actuation is automatic, no operator action or compensatory measures are required for this exemption request
   - Emergency Operating Procedures for Standard Post Trip Actions and Loss of All Feedwater remain unaffected by this exemption request

3. **Preserve system redundancy, independence, and diversity commensurate with the expected frequency and consequences of challenges to the system, including consideration of uncertainty.**
   - The change does reduce the diversity, redundancy, and independence of an additional means of automatically actuating the AF
   - The remaining redundant, independent, and diverse features within the ESFAS are preserved and sufficient given the expected frequency and challenges to the system
   - PRA insights with conservative inputs find delta in risk is orders of magnitude lower than the acceptance criteria

Item #3

NRC Review of DID Strategy

Seven Defense-in-Depth Considerations

4. **Preserve adequate defense against potential Common Cause Failures (CCFs).**
   - PPS/ESFAS/SPS are designed to provide adequate defense against potential CCFs
   - Common cause modeling in the PRA model includes both AF and ESFAS AFAS components
   - PRA modeling for AF actuation only credits automatic ESFAS actuation in an ATWS
   - ESFAS and AF components are monitored under Maintenance Rule with no maintenance rule functional failures (MRFFs) or 10 CFR 50.65 (a)(1) performance criteria issues over their respective monitoring periods
     - DAFAS has historically been in/out of Maintenance Rule category (a)(1) enhanced performance monitoring, and is currently in (a)(1) in all three units

Item #3

NRC Review of DID Strategy

Seven Defense-in-Depth Considerations

5. Maintain multiple fission product barriers.

- PVNGS multiple fission product barriers are fuel cladding, RCS pressure boundary, and containment
- Peak RCS pressure occurs before the initiation of Auxiliary Feedwater in ATWS scenarios
- The exemption request does not remove, reduce, or otherwise impact the existing PVNGS designed multiple fission product barrier

6. Preserve sufficient defense against human errors.

- The design of PPS/ESFAS/SPS provides a redundant and automatic means for reactor trips and actuation of AFAS to provide Auxiliary Feedwater
- AFAS is initiated automatically based on low Steam Generator level and does not require operator action to support initiation. Since human action is not required, the exemption request does not reduce any defense against human errors

Item #3

NRC Review of DID Strategy

Seven Defense-in-Depth Considerations

7. Continue to meet the intent of the plant's design criteria.

- By nature of the exemption request, the design criteria associated with DAFAS will not be met (it is to be removed from the licensing basis)
- Based on the design of PPS/ESFAS/SPS, DAFAS is not required to mitigate an ATWS event
- PPS/ESFAS/SPS and AF designs are unaffected by the exemption request and continue to meet associated design criteria

Closing Comments

- Scope of PV RIPE Change Well Defined
  - Exemption to 10 CFR 50.62
  - Eliminate DAFAS Requirement
  - No Change to Diverse Scram System or Diverse Turbine Trip
- PV IDP Review Provided Value and Good Challenges
- RIPE Screening Questions
  - Defense-in-Depth Provided by Robust Design Bases
- PRA Results for DAFAS Change are Orders of Magnitude Less than RIPE Acceptance Criteria
- Benefits of Second Pre-Submittal Call
- An Exemption Using RIPE Process is Appropriate for Removal of the DAFAS Requirement at Palo Verde