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EPRI Low Power and Shutdown Probabilistic Risk Assessment Standard Pilot: Palo Verde Self-Assessment

2015 TECHNICAL REPORT

EPRI Low Power and Shutdown Probabilistic Risk Assessment Standard Pilot: Palo Verde Self-Assessment

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All or a portion of the requirements of the EPRI Nuclear Quality Assurance Program apply to this product.

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PRODUCT DESCRIPTION

An objective of the Electric Power Research Institute (EPRI) low power and shutdown (LPSD) probabilistic risk assessment (PRA) roadmap is to improve LPSD PRA methods. This report documents the results of a pilot effort of the American Nuclear Society/American Society for Mechanical Engineers (ANS/ASME) LPSD PRA standard based on a self-assessment of the Palo Verde model. EPRI and Palo Verde collaborated in this effort so that the Palo Verde LPSD PRA model development can benefit from the review and EPRI members can benefit from the feedback that the assessment provides concerning the LPSD PRA standard as well as insights about research opportunities for LPSD PRA methods.

Background

Experience with the development of consensus PRA standards has shown that pilots provide the industry knowledge necessary to truly understand the breadth and depth of the requirements and to ensure that a given standard can be practically applied. Piloting of standards enables practical application to full-scale PRA models and can help to ensure that a standard in development will represent the industry's consensus methods when published.

Due to the uncertainties of scheduling from outage to outage and the variety of plant configurations that can be encountered in outage schedules, the results from a shutdown PRA can vary widely, depending on out-of-service equipment and plant operating states. The LPSD PRA standard has been under development since the late 1990s and represents an ambitious scope of PRA elements. These considerations make sufficient piloting of the LPSD PRA standard for trial use and pilot application important to EPRI and its members.

Objectives

The objectives of the effort described in this report were as follows:

- Review the Palo Verde LPSD draft model against the ANS/ASME standard using the peer review process in order to identify areas for improvement and strengths.
- Identify any issues in the draft LPSD standard, such as inconsistencies, errors, and gaps.
- Identify research needs in the area of LPSD PRA, such as where analysis methods might require development or improvement.

Approach

The self-assessment was performed using an approach based on the industry PRA peer review process. Six risk professionals reviewed the Palo Verde LPSD PRA model. Through their review, the team made conclusions relevant to the model and standard, and they recommended opportunities for future research.

Results

The self-assessment team found that the Palo Verde LPSD PRA development has progressed toward a first-of-kind LPSD PRA using the draft standard in the areas of plant operating states, initiating events, accident sequences, data analysis, and systems analysis. However, the absence of detailed success criteria analysis with applicable thermal-hydraulic inputs limited the development of human reliability analysis and other model elements. The team reviewed 103 supporting requirements and compiled a total of 76 facts and observations.

Twenty-one recommendations to improve the LPSD PRA standard were identified. Among them, the Palo Verde team found that the outage procedures provided a more inclusive basis for identifying plant operating states than did the concept of plant evolutions as provided in the LPSD PRA standard. It is also suggested that an LPSD-specific definition of *core damage* be considered because the definitions typically used for at-power conditions might not be applicable to LPSD conditions.

Finally, potential future research topics were identified as follows:

- Development of guidance to support conversion of at-power PRA elements to LPSD PRA elements
- Research into the need to model at-initiator human failure events and methods for their systematic identification and development
- Investigation of the thermal-hydraulics for shutdown conditions, including the definition of *core damage*

Applications, Value, and Use

For EPRI members interested in developing LPSD PRA models, this report is a valuable source of user experience and insights. Documented herein are the practical application and review of the ANS/ASME standard for low power and shutdown probabilistic risk assessment, with recommendations for consideration by the standard development team and the ASME/ANS Joint Committee on Nuclear Risk Management included.

Keywords

Configuration risk management
Low power and shutdown (LPSD)
Peer review
Probabilistic risk assessment (PRA)

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1
INTRODUCTION

This report documents the 2014 EPRI Low Power Shutdown (LPSD) PRA Standard Pilot. The pilot consisted of a self-assessment of a draft LPSD PRA, using the draft ANS/ASME LPSD PRA Standard for trial use in pilot applications (TUPA) [1]. The self-assessment was performed on the Palo Verde Nuclear Generating Station (PVNGS) draft LPSD PRA by a team of industry experts, at the PVNGS site in October, 2014.

1.1 Purpose

This purpose of this pilot self-assessment was three-fold:

- Review the LPSD draft model and associated documents against the ANS/ASME LPSD PRA Standard [1], in order to identify areas for improvement and strengths in the model and documentation.
- Identify any issues in the draft LPSD Standard, such as recommended improvements, inconsistencies, errors and gaps.
- Identify research needs in the area of LPSD PRA, such as where analysis methods may require development or improvement.

1.2 Approach

The self-assessment was performed using a peer review structure, in a manner similar to an at-power peer review as outlined in NEI 05-04 [2]. A team of 6 risk professionals with experience in shutdown PRA and risk assessments was used to review the available model and documentation on site, with support from the utility LPSD PRA project and modeling personnel. High Level Requirements (HLR) from the standard were assessed, and Supporting Requirements (SR) were graded in a manner identical to the peer review process outlined in NEI 05-04.

The LPSD PRA model was developed and is maintained using EPRI Risk & Reliability (R&R) User Group software tools.

1.3 Guidance and Standards Used

Revision 12 of the draft ANS/ASME LPSD PRA Standard [1], which had recently been submitted for a recirculation ballot by the Joint Committee on Nuclear Risk Management (JCNRM), was used. Although the standard had not yet been issued at the time of the self-assessment, the Standard was not expected to change substantially between the draft used and the final issued for TUPA. Therefore, it was determined that performing the review using the available draft standard would benefit the utility and the standard.

1.4 Scope of Technical Elements Reviewed

For the purposes of this assessment, only LPSD internal events associated with CDF were reviewed. This is based on the progress of the model at the time of the self-assessment; LERF and external hazards were not part of the draft model. Additionally, only Modes 3 – 6 (hot standby to refueling modes) were included in the draft model.

The specific technical elements from the standard that were to be reviewed by this assessment were:

- Plant Operating State Analysis (LPOS)
- Initiating Events Analysis (LIE)
- Accident Sequence Analysis (LAS)
- Success Criteria (LSC)
- Systems Analysis (LSY)
- Human Reliability Analysis (LHR)
- Data Analysis (LDA)
- Quantification (LQU)

The self-assessment did not address PRA configuration control (commonly referred to as Maintenance and Update (MU)), since the purpose and scope were focused on technical elements of the SD PRA model and documents.

The human reliability analysis (LHR), success criteria (LSC) and quantification (LQU) tasks were still under development and were not completed or documented. Accordingly, these elements did not receive a thorough review. However, feedback was provided by the review team in the form of limited reviews and spot checks in these areas, with comments and recommendations provided (in the form of Findings and Observations) for specific topics. Assessed capabilities for some of the LHR, LSC and LQU high level requirements (HLR) were documented (see Tables 5-6, 5-9 and 5-10); however, individual Supporting Requirements were not evaluated.

1.5 General Process

Prior to the onsite review, the review team was selected and the team members were approved by the utility as being independent of PRA development and qualified. Responsibilities and the schedule were defined by the Review Team Lead. The review team exchanged information regarding the scope of the upcoming review, on-site logistics, the LPSD PRA Standard and the NEI 05-04 review process.

The review team members reviewed the PRA model material provided by the utility prior to their arrival onsite. Prior to travelling to the site for the review, the review team held a web meeting to receive instruction on using the database tool for documenting the review, to review schedule and logistics, and discuss any specific topics of interest to the reviewers.

Utility personnel presented an overview of the plant and PRA model during the first morning of the onsite visit. The review team then began its comprehensive and concentrated review of the PRA documentation and electronic models against the LPSD PRA Standard Supporting Requirements criteria. Different technical elements were the focus of individual days of the onsite visit (refer to schedule in Section 5.1). The review team members performed independent studies of the PRA against the criteria and consulted with utility PRA personnel and other review members in order to come to an understanding of the PRA capabilities with respect to the PRA standard criteria. The review team convened daily for a consensus meeting on the capability category assessments for the Supporting Requirements on the schedule for that day.

The review team held a daily debrief with the PVNGS LPSD PRA lead and support staff, and an exit meeting at the end of the week with PVNGS staff and management to summarize the findings documented in this report.

Following the site visit, the review report was developed. A draft of the report was submitted to the PVNGS staff for review and comment.

1.6 Capability Categories

The PRA Peer Review process uses capability categories to assess the relative technical merits and capabilities of each technical supporting requirement reviewed. The capability categories and criteria were developed as part of the original PRA Standard development, considering attributes of a PRA necessary to ensure quality, elements of a PRA that are critical to its technical adequacy, and elements needed to support PRA applications. The capability categories and criteria, which are used in the LPSD PRA Standard and have been adopted for this program, provide guidance on appropriate use of the information covered by the supporting requirements for risk-informed applications, and convey the ability of the PRA supporting requirements to support particular types of applications. Three capability category levels are used to indicate the relative technical adequacy of each supporting requirement, based on the criteria at hand.

The three capability categories are termed Capability Category I, Capability Category II, and Capability Category III. The Capability Categories apply to individual Supporting Requirements. Capability Categories are not assigned to Technical Elements, High Level Requirements (HLR), or to the PRA as a whole. The criteria of individual Supporting Requirements can span various levels of capability, as shown in Table 1-1.

Table 1-1
Supporting Requirement Capability Category Ranges

Type of Supporting Requirements Formats	PRA Standard Capability Category Supporting Requirements			Characterization Choices Recommended(1)
	I	II	III	
1	■			I
2	■	■		I/II
3		■		II
4		■	■	II/III
5			■	III
6	■	■	■	ALL

(1) These characterizations apply if the PRA meets the intent of the Capability Requirements that span the respective shaded categories.

Categories that apply to meeting at least Capability Category II (as requested by PVNGS) include: I/II, II, II/III, III, and ALL.

The interpretation (per the PRA Standard) of each Supporting Requirement capability is provided in Table 1-2. Capability category assignments are made based on the judgment of the Review Team after reviewing both the PRA and the associated documentation. PVNGS LPSD PRA personnel were also consulted throughout the week of the onsite visit, and were a valuable input into understanding the characteristics of the PRA.

Per guidance in RG 1.200 (refer to excerpt below), identification of an omission or an error does not necessarily mean that the associated Supporting Requirement is not met:

> "As a general rule, compliance with a requirement of the Standard is demonstrated if there is clear evidence of an intent to meet the requirements. Many of the requirements apply to several parts of the PRA model. For example, the requirements for systems analysis apply to all systems modeled, and certain of the data requirements apply to all parameters for which estimates are provided. If among these systems or parameter estimates there are a few examples of non-compliance, this does not mean that the requirement has not been met, if for the majority, the requirement has been met, and the few examples can be put down to mistakes or oversight. If, however, there is a systematic failure to address the requirement, e.g., component boundaries have not been defined at all, then the requirement has not been complied with. In either case, (1) the examples of non-compliance are to be rectified, or demonstrated not to be relevant to the application, and (2) documented." [3]

If an identified omission or an error represents a systematic problem in that area, then the review team assesses the Supporting Requirement as Not Met.

Table 1-2
Interpretation of Supporting Requirement Capability Categories[1]

Span of SR	Finding from Peer Review	Interpretation
Capability Categories I, II, and III (all)	SR met	Can support applications in all Capability Categories
	SR not met	Minimum standard is not met
One Capability Category (I, II, or III)	SR met for specific capability category	Can support applications requiring that Capability Category or below
	SR not met	Minimum standard (Capability Category I) is not met
Capability Categories I and II only	SR met for CC I/II	Can support applications that require Capability Category I or II
	SR met for CC III	Can support applications in all Capability Categories
	SR not met	Minimum standard is not met
Capability Categories II and III only	SR met for CC II/III	Can support applications in all Capability Categories
	SR met for CC I	Can support applications requiring Capability Category I
	SR not met	Minimum standard is not met

1.7 Facts and Observations (F&O)

Facts and Observations (F&Os), often referred to as Findings and Suggestions, are provided to augment the Supporting Requirement assessments. The F&Os provide a method to transmit details of the PRA model to the model owner. These details may represent either strengths of the PRA or enhancements for consideration.

The significance of the F&Os is determined with regard to whether the issue may adversely impact the effective use of the PRA in Risk-Informed applications. In general, this is consistent with areas that prevent a Supporting Requirement from being fulfilled.

For the PVNGS LPSD PRA, the Supporting Requirements were assessed against Capability Category II, in accordance with the guidance provided by the PVNGS staff. Thus, for an SR where Category I was determined to be Met, an F&O has been written with respect to not meeting Category II, and assigned an importance based on the potential that the issue adversely

[1] See RA-Sb-2013 [6] Table 1-1.3-3

impacts the ability of the PRA model to be usefully applied for intended risk informed applications.

The F&Os are prioritized according to Table 1-3, as discussed in the NEI peer review guideline NEI-05-04 [2]:

Table 1-3
Types of Findings and Observations

Importance Level	Definition
Finding	An issue or discrepancy (observation) that needs to be addressed to ensure: • Technical adequacy of the PRA (relative to a Capability Category), • The PRA update process has sufficient capability/robustness, or • The process to evaluate the capability of the PRA technical elements that is necessary (to support applications)
Suggestion	An observation considered desirable for maintaining maximum flexibility for PRA applications and to be consistent with industry practices. No significant impact on the PRA results or the integrity of the PRA should follow from failing to resolve a suggestion. Examples of a suggestion include: • Minor technical and editorial items • Recommendations to be consistent with industry practices (e.g., replacement of a given consensus model with a more widely used model) • Recommendations to enhance PRA technical capability as permitted by time and resources
Best Practice	Indicates a PRA strength, reserved for a best practice in the industry.

Supporting Requirements that are assessed not to meet Capability Category II are supported with at least one Finding level Fact & Observation to support the assessment and provide recommendations from the review team.

The PRA may meet the intent of a particular SR, but the review team may identify a non-systematic error related to that SR that needs to be corrected (e.g., significant contribution to the risk profile). In the PVNGS LPSD PRA self-assessment, the definition of “significant” with respect to the risk profile was not precisely defined (no explicit numerical guidance is provided in NEI 05-04), and the review team used judgment regarding how much of a change in CDF determined whether an issue was significant. This significance assessment was then balanced with the assessment as to whether the issue needs to be included in the PRA or whether it should be considered for inclusion because of industry trends on the issue.

The review team was ultimately in agreement and reached consensus in all cases as to the priority level of an F&O. If there had been any cases where there was not agreement, consistent with the guidance in NEI 05-04, the majority view of the review team would be used to assess the significance of an F&O, and the dissenting reviewer(s) would have had the opportunity to document their views (Note: the same approach applies to the assessment of SR capabilities where there may have been reviewer differences of opinion).

The F&Os for the PVNGS PRA self-assessment are provided in Appendix B.

1.8 Comments on LPSD PRA Standard

The final version of the ANS/ASME LPSD PRA Standard (TUPA) was published in March 2015 [4]. At the time of the PVNGS LPSD PRA self-assessment, the LPSD PRA Standard was in the ballot process by the Joint Committee on Nuclear Risk Management (American Nuclear Society and American Society of Mechanical Engineers) as a TUPA standard. Accordingly, another purpose of the PVNGS LPSD PRA self-assessment was to gather comments on the LPSD PRA Standard. The intent was for the reviewers and PVNGS personnel to provide feedback on specific HLR, SR, notes, or commentary, as well as any information that was not included in the Standard.

The method for collecting comments was for the individual reviewer of a given SR to make a comment in the F&O database regarding the Standard. This was typically done after consulting with other reviewers to determine their input on and understanding of the particular part of the Standard. Additionally, some comments were made on behalf of the PVNGS PRA staff, which were brought to light either during investigation of a particular issue between reviewer and staff member, or during a daily debrief.

The final list of comments on the LPSD PRA Standard was reviewed by the review team. The list of comments on the standard is provided in Section 3.

1.9 Proposed Topics in LPSD PRA Research

Potential areas of LPSD PRA research were solicited from both the review team and the PVNGS staff during the self-assessment. The intent was to identify potential research in areas of LPSD PRA technology having broad industry benefit. One example is the general lack of shutdown core damage definitions, which may be different from the at-power definition(s). The list of research areas was reviewed by the peer review team at the end of the peer review, and presented as part of the final debrief with PVNGS staff and management. The final list of research areas is provided in Section 4.

1.10 Peer Review Team

One of the most important aspects of the Peer Review process is the make-up and selection of the review team that carries out the review process. The review team is composed of experienced PRA personnel knowledgeable in LPSD PRA issues and experienced in the performance and application of PRAs. The LPSD PRA review team includes peers who are knowledgeable in PRAs for plants similar to the plant being reviewed. The team members are also independent from the analyses done in support of the PVNGS LPSD PRA model and documents. Overall, the review team had over 100 years of experience in risk analyses and PRA.

2
SELF-ASSESSMENT RESULTS SUMMARY

This section provides a brief overview of the plant design and the LPSD PRA components and features, as well as a high level review of the results of the self-assessment. Details of the self-assessment results (i.e., HLR assessments, SR ratings, and F&Os) are provided in Section 5 and Appendices B and C.

2.1 Important Plant Design and Procedural Features

PVNGS is a 3-unit site, composed of Combustion Engineering System 80 Pressurized Water Reactors (PWR). All 3 units operate separately from each other, without cross-ties and with very few shared systems. Some relevant features of the design are:

- 3990 MWth, ~1400 MWe
- 2-loop RCS, with no Power Operated Relief Valve (PORV)
- Large dry containment, non-class 1E containment fan coolers that are not sized for post-accident heat removal; containment heat removal via containment spray
- 2 trains of High Pressure Safety Injection (HPSI), Low Pressure Safety Injection (LPSI) and Containment Spray (CS). CS pumps can be aligned for shutdown cooling (SDC) use.
- 2 emergency diesel generators (EDG) per unit, and 2 station blackout (SBO) generators shared between the 3 units
- 1 motor-driven and 1 turbine-driven Auxiliary Feedwater (AFW) pumps, and one non-class 1E motor-driven pump
- Spray ponds provide ultimate heat sink; they cool the EDGs directly and also removes heat from the Essential Cooling Water (ECW) system

2.2 LPSD PRA Attributes

The PVNGS LPSD PRA was still in development at the time of the self-assessment. However, performing the self-assessment on the model and documenting it provided an opportunity for both the utility and EPRI to gain experience and knowledge from the process.

The LPSD PRA is a single unit Level 1 model for internal events during Modes 3 – 6 (Hot Standby to Refueling); it is based on the at-power internal events model. It was developed and is maintained using the EPRI Risk & Reliability suite of software (e.g., CAFTA, PRAQuant). At the time of the self-assessment, the Success Criteria, HRA and Quantification elements and their documentation were in progress. The Data Analysis task had been completed, but was still being documented.

2.2.1 Plant Operating States (LPOS)

The Plant Operating States (POS) for the PVNGS LPSD PRA were developed using the LPSD Standard LPOS requirements. Shutdown evolutions, as described in the LPSD PRA Standard requirements were a major element of this effort. The shutdown evolutions were determined through operational procedure reviews and plant operating history. Five representative evolutions were chosen to develop the model:

- Forced Outage to Hot Standby – Heat removal maintained with Auxiliary Feed & Steam Bypass
- Controlled Shutdown to Cold Shutdown (e.g., Tech Spec mandated shutdown) – Final configuration included RCS loops filled and a bubble in the pressurizer.
- Refueling Outage – no midloop operations
- Refueling Outage – cold (post-reload) midloop
- Forced Outage to Cold Shutdown – Included a hot (front-end) midloop period

The POSs were determined using these five evolutions, Westinghouse WCAP report guidance, plant procedures and historical information. 15 POSs were initially defined, and were further subdivided into a total of 49 POSs.

2.2.2 Initiating Events (LIE)

Initiating events for the shutdown modes were identified by reviewing the PVNGS at-power initiators for applicability, industry operating experience, and PVNGS operational history. There were 23 of 28 at-power initiators determined to be applicable to LPSD. 16 additional LPSD initiators were identified, including Loss of Shutdown Cooling (SDC) and Maintenance-induced LOCA.

2.2.3 Accident Sequences (LAS) and Success Criteria (LSC)

There were 37 event trees developed for the LPSD PRA; this included a mixture of at-power PRA event trees, modified at-power event trees and new LPSD event trees. The PVNGS emergency operating procedures used in Modes 3 – 6 provided the basis for the event trees. At this stage of the LPSD PRA development, the LPSD event trees were based on limited success criteria development using the at-power success criteria and RCS time-to-boil data tables. A 24-hour mission time was used. The limited development of the success criteria impacted several other areas for review, including HRA and quantification.

2.2.4 Systems Analysis (LSY)

As mentioned previously, the system modeling was performed in CAFTA. For many systems, the at-power system fault trees were used as the starting point, although significant modifications were required due to assumptions and dependencies that did not apply to LPSD conditions based on plant operating states and/or plant mode.

2.2.5 Data Analysis (LDA)

The reliability data analysis was based on at-power data (e.g., NUREG/CR-6928). No distinction was made between at-power and LPSD failure data. For unavailability (i.e., maintenance and test), a 3-year window was reviewed. A longer window was not used due to recent significant changes in outage management protocols and performance.

2.2.6 Human Reliability Analysis (LHR)

The HRA was incomplete, although 70 human failure events (HFE) had been identified and were loaded into the EPRI HRA Calculator. The total number of HFEs includes different permutations of the same action, due to changes required for a different POS. At this stage of development, operator interviews had not been conducted. The need to develop shutdown-specific success criteria also impacted the HRA, since timing is dependent on that success criteria.

2.2.7 Quantification (LQU)

Since there were still elements of the LPSD PRA to be completed, quantification could only reflect the incomplete state of the model. However, it was useful to have developed the quantification tools and processes to allow for logic and process checks. For the PVNGS LPSD PRA, each POS was calculated to determine the POS CDF, per hour. A POS duration factor (in hours) was multiplied by the CDF to obtain a POS core damage probability (CDP). The POS CDPs for a given LPSD evolution (e.g., Refueling Outage) are summed, and an evolution frequency factor (number of that specific evolution performed per year) was applied to determine the CDF (per year) for each evolution.

2.3 Self-Assessment Summary

Section 5 and Appendices B and C provide detailed tables of HLR assessments, SR ratings, and F&Os. A brief overview is provided here.

Although not complete, solid progress has been made developing the PVNGS LPSD PRA using the draft LPSD PRA standard, especially in the areas of POS, initiating events, accident sequences, and systems and data analyses. As discussed previously, LPSD-specific success criteria is needed in order to complete the model, as this impacts accident sequences, system analyses, HRA, and quantification.

The PVNGS experience in developing the LPSD PRA and the self-assessment performed by the review team highlighted a potential problem area, i.e., the use of evolutions to define POS (per the LPOS requirements). The POS concept is well-understood as an outage management process and in qualitative Configuration Risk Management (e.g., defense in depth). However, it appears that the intent of the SRs associated with evolutions, which is to help provide a comprehensive definition of outage work scope, had the effect of complicating the POS analysis without a demonstrable benefit. Specific issues are documented in Table 3-1.

Due to the limited development of some elements of the PVNGS LPSD PRA, the self-assessment results and statistics are also limited. For example, of the 268 supporting requirements (SR) for LPSD Level 1 internal events, 103 SRs (about 40%) could be reviewed. As stated previously, some elements were not reviewed in any detail (LSC, LHR, and LQU). Nearly half (50) of the SRs were evaluated as Met for Capability Category II or above; an

additional 6 SRs were evaluated as Met for Capability Category I. The remaining SRs reviewed were evaluated as Not Met. Tables 5-11 and 5-12 provide a breakdown of the number of SRs in each Capability Category for each element reviewed. Appendix C provides the individual assessments of each SR.

A total of 76 Facts and Observations (F&O) were written; any SR that was evaluated as Capability Category I or Not Met has at least one Finding (F) level F&O assigned to it. There were 57 Finding level F&Os and the remaining 19 were Suggestions (S). Table 5-13 provides the number and type of F&Os per element, and Appendix B provides the individual F&Os.

Further development of the PVNGS LPSD PRA model is necessary to fully evaluate it against the draft LPSD PRA Standard. Specifically, applicable success criteria, based upon relevant thermal-hydraulic analyses, are essential to development of a credible PRA for use in applications. Nonetheless, the model review exercised portions of the Standard and exposed issues for consideration by the standard development project team.

3
RECOMMENDATIONS FOR THE LPSD PRA STANDARD

One of the purposes for performing this self-assessment was to use the LPSD PRA Standard in a peer review setting, in order to identify areas for improvement or gaps in which the Standard could benefit from additional detail. Both the reviewers and the PVNGS PRA staff were encouraged to take note of any requirements that were not clear or whose purpose was not understood, typographical or editorial errors, and any other comments to improve the standard. Table 3-1 provides a listing of the comments received on the standard during the self-assessment.

Table 3-1
Comments on the LPSD Standard

SR	Comment
LPOS-A1	There seems to be a disconnect between sections A and B of the LPOS element. The intent of Section A appears to be the full identification of evolutions and subsequent POSs while the intent of Section B appears to be the grouping of the evolutions and POSs identified in Section A. Review the SRs IE-A1 and IE-B1 for example wording to consider for LPOS-A1 and LPOS-B1. For example, LPOS-A1 currently requires identification and analysis of a representative set of LPSD evolutions that encompasses refueling outages, forced outages, controlled shutdowns, drained-down and non-drained maintenance outages, and hot shutdowns. It is unclear what the intent of this SR is asking for, routine outages, infrequent configurations or all potential plant states. Also, the definition of "*evolution*" as a "*series of connected or related activities*" is too vague. This is important as it forms the basis of the POS development. For PVNGS, the use of outage procedures provided a more comprehensive set of POS than review of the evolutions.
LPOS-A4	Second word in SR should be "existing"
LPOS-A7	Recommend that SRs in each of the other hazards verify that POSs are adequate for the hazard.

Table 3-1 (continued)
Comments on the LPSD Standard

SR	Comment
LPOS-B1	CC II and CC III say "[See Note (1)]" but there is no Note (1) in the Standard for LPOS. Item (b) states "*bounded by worst case impact*"; it is not clear what this means (i.e., what is an example of worst case "impact"). Additionally, there is a concern that one could screen POSs by grouping evolutions (and thus subsuming one type of evolution that has different POSs, which are similar). The terms "*LPSD Evolution*" and "*representative evolution*" are not well defined. They could refer from anything as simple as shutting down the reactor to as complicated as an entire refueling outage. It is difficult to review the various grouping SRs due to this issue. It is unclear what the intent of this SR is asking for, routine outages, infrequent configurations or all potential plant states.
LPOS-B6	The intent of this is unclear. It is not clear whether it adds anything to the normal POS development and grouping process. The metrics identified for grouping (CDF and LERF) imply a later level of model quantification than may be possible at the POS development stage.
LPOS-C1	Part of this SR "*as appropriate, the frequency of forced outages assigned to each identified safe, stable state from the plant specific full power PRA*" should be addressed in LPOS-A1. Clarification of the intent of "*each identified safe, stable state from the plant specific full power PRA*" is also desired. What is the purpose of determining the LPSD evolution frequency and durations? The guidance contained in this SR appears to border on the identification of a specific method.
LPOS-C4	The purpose of this SR is not clear and is not tied to other technical elements, e.g., SC and HR, which may use the decay heat level information. Furthermore, there is no requirement to justify that consideration of decay heat levels would or would not impact POS definition. A reference should be provided to other SRs, e.g., LSC-B4 or LHR-4, to use the decay heat information developed to meet this SR. A requirement should be added to justify that decay heat values, when considered in the context of SC or HR, do not affect the definition of POS.
LPOS-C5	Clarify the intent of this SR with the regards to "*future plans or upcoming LPSD evolution schedules*"
LIE-A2	Note (2) should say "5 - 9" instead of "5 ~ 9" (2 instances) It is not clear whether there are really any other categories of IEs caused by at-initiator HFEs that can be imagined. It might be difficult to prove that there are no such IEs, and this is listed as a category that must be INCLUDED in the spectrum of IEs considered.
LIE-A6	Note (6) should be applied to LIE-A5. Note (7) should be applied to LIE-A6.
LIE-A7	The inclusion of Note (6) in part (b) implies a requirement to evaluate at-initiator HFEs. There is another issue, regarding the accounting of manual scrams and manual shutdowns, and whether they should be in at-power or shutdown models.

Table 3-1 (continued)
Comments on the LPSD Standard

SR	Comment
LIE-A9	It seems that the point of this review is to ensure a comprehensive review within each POS to ensure that all IEs are captured. However, the term "*initiating event precursor*" is undefined. An example is provided in the CCII requirement and Note 6 ties in "*at-initiator HFEs*."
LIE-C3	The intent of the Standard, regarding credit for recovery actions should be clarified. A potential change would be for it to say: "If you CREDIT recovery actions [those implied in LIE-C6(c), and those implied and discussed in LIE-C8 as appropriate], JUSTIFY each such credit (as evidenced such as through procedures or training) [see Note (8)]."
LIE-C5	The SR should not bold the sentence starting with the action verb, “ACCOUNT”. Also, it should be noted that historical information can only be estimated for planned outages, not forced outages. There should be some limits prescribed to this SR regarding predicting future POS and durations and frequencies of evolutions.
LIE-C6	Is item (c) pertinent to LPSD conditions? This also brings up the issue noted in LIE-A7 regarding manual shutdowns and their inclusion in at-power vs. LPSD models.
LAS-A8	A requirement from the internal events portion of the standard (IE-A8) is modified by NOTE 3. Refer to the discussion in Section 1.1.2, which should be included in one or more SRs.
LAS-B3	This SR should include a set of examples that are more likely to occur during shutdown (e.g., not enough decay heat following reload to run a steam-driven pump).
LSC-A2	The definition of core damage provided for at-power events is probably not applicable to shutdown events. Several industry documents suggest that 1300 °F is appropriate. The LPSD standard should specify that use of the definitions for core damage in the at-power standard must be justified if used for shutdown conditions. Consideration of reactivity events is unique to shutdown. Definition of core damage for reactivity events should be provided.
LSY-B2	The LPSD PRA should identify the possibility of intra-system CCF groups based on safety functions, because POS other than at-power operation allow a system to perform same safety function as another system. For example, containment spray pumps are able to perform a shutdown cooling function in certain plant designs.
LDA-C8	The Standard should refer to temporary and maintenance alignments.
LDA-C13	The SR is not clear, in that no requirements are presented to use the data evaluated in the PRA model.

4
PROPOSED FUTURE LPSD PRA RESEARCH TOPICS

One of the purposes of the self-assessment was to determine whether any generic issues exist in the LPSD PRA area that could benefit from EPRI research. The review team and utility LPSD PRA staff collaborated to identify three areas for potential research:

1. Use of at-power data for LPSD (e.g., NUREG/CR-6928)

   Currently, NUREG/CR-6928 [5] provides reliability information for nuclear power plant components. Since it is likely that a majority of the data is from at-power conditions, there may be a need to develop separate reliability data for shutdown operations, or provide justification that at-power data is appropriate to shutdown conditions. This is also true for common cause factors. EPRI research in this area could help determine whether at-power reliability data is appropriate to use in LPSD PRAs, and sources of data specific to LPSD PRAs.

2. At-initiator HFE – Establishing the need and methods

   One addition to the LPSD PRA Standard, that does not exist in the at-power standard, is a subset of HRA for at-initiator human failure events (HFE). An at-initiator HFE essentially causes or significantly contributes to an initiating event.

   As discussed in Section 3.2.5 of the LPSD standard, at-initiator HFEs need to be included for LPSD evolutions because they can cause significant initiating events (e.g., over draining) and the dependencies between the at-initiator and post-initiating event actions may be significant. Therefore, high level and supporting requirements are identified in the LPSD standard for such events. However, during the self-assessment, it was unclear both to the review team and the utility staff how to bound the scope of the task of identifying at-initiator HFEs and how to quantify them. Accordingly, a research effort that investigates the need to model at-initiator HFEs and provides methods for systematic identification and development would address this issue.

3. Development of appropriate T-H methods for LPSD.

   There is a significant experience base in the PRA community for evaluating reactor transients and accidents that start from full power. However, the thermal-hydraulics of shutdown reactor operations are different and should be investigated. One topic that is specifically noted in Table 3-1 is the definition of core damage from a shutdown perspective (see comment on SR LSC-A2). Additionally, reactivity accidents are very different at shutdown than at-power, and should be researched for their implications as initiating events.

5
LPSD PRA REVIEW RESULTS

5.1 Plant Specific Review Information

This section provides a brief overview of the schedule and review assignments for the review team. The schedule for the week is included as Appendix A.

5.1.1 Review Schedule and Assignments

The six PRA engineers that comprised the review team were assigned as element leads and to support reviews of different elements, based on their experience and preference. The review team leader also led one or more elements. The elements reviewed on each day were scheduled such that one or more element was completed each day of the review. This spread out the consensus sessions (held at the end of each day) over the week. The initial assignment of reviewers and time slots for each of the elements is shown in Table 5-1. These assignments were modified as necessary throughout the week as the time needed to complete the reviews changed (e.g., based on reducing the scope of the review).

Table 5-1
Overview of Reviewer Assignments and Review Week Schedule

Time Slot	Reviewer 1	Reviewer 2 (Lead)	Reviewer 3	Reviewer 4	Reviewer 5	Reviewer 6
Mon AM	POS	POS	POS	POS	POS	POS
Mon PM	IE	IE	IE	IE	AS	SC
Tues AM	SC	AS	SC	DA	AS	SC
Tues PM	AS	QU	HR	DA	SY	HR
Wed AM	DA	SY	HR	HR	SY	HR
Wed PM	SY	SY	HR	HR	SY	DA
Thurs AM*	QU *	QU	QU *	QU	QU	QU
Thurs PM	QU	QU	QU	QU	QU	QU
Fri AM	Summary	Summary	Summary	Summary	Summary	Summary

* The Thursday morning shaded sessions allow for review of the designated elements if needed; otherwise support review of results and insights, address any issues remaining from prior element reviews.

Table 5-2 provides the breakdown of each element by the number of reviewer slots (a reviewer slot is essentially a half day). Since QU and HR were not reviewed to the extent initially intended when the schedule was developed, more effort was put on some of the other tasks, such as POS, IE, and DA.

Table 5-2
Reviewer Slots per Element

Element	Reviewer-Slots*
POS	6
IE	4
AS	4
SC	4
SY	6
DA	4
HR	7
QU	11
Total	46

* Each Reviewer-Slot is 1 reviewer for ½ day (AM or PM), not including Monday AM or Friday AM

5.2 Technical Element High Level Requirement Summaries

Assessments for each HLR of each element are provided in Table 5-3 through Table 5-10. As noted previously, the HLRs are not graded or evaluated using capability categories.

After the first day of the review, the review team concluded that the current level of documentation available for the PRA, with some exceptions, would result in F&Os written for the documentation SRs in nearly every element. The review team and utility PRA personnel agreed to forgo the specific assessment of documentation SRs; areas that had documentation deficiencies were noted in the F&Os associated with the applicable SR. Therefore, the last HLR for each element (e.g., HLR-LPOS-D) was not assessed, and is so noted in Tables 5-3 through 5-10.

Table 5-3
High Level Requirement Capability Assessment – LPOS

Technical Element	HLR	Assessed Capability
LPOS	HLR-LPOS-A	A thorough, systematic and structured analysis was performed to identify actual and potential evolutions and their associated plant operating states. A set of representative evolutions was selected to represent the average shutdown risk. The correct POSs are associated with the modeled evolutions; all potential POSs are maintained.
LPOS	HLR-LPOS-B	In general, the POS analysis did not group or screen POSs. Therefore, many of the requirements were not applicable. Once the model has adequate detail, it is expected that grouping and screening POSs will be feasible and taken under evaluation. Evolutions were grouped to provide a reasonable set of evolutions for quantification. One shortcoming was the definition and delineation of POS associated with demand-based initiators.
LPOS	HLR-LPOS-C	POS frequencies and durations were determined, based on the last 3 years' outages. It is recommended that additional historical records be reviewed to account for POSs or evolutions that are not within the last 3 years, but may be applicable in the future. Decay heat levels are determined, but the calculations may not have the detail necessary to be considered best estimate. Decay heat levels are generally applied in a conservative manner to POSs.
LPOS	HLR-LPOS-D	Documentation is outside the scope of review.

Table 5-4
High Level Requirement Capability Assessment - LIE

Technical Element	HLR	Assessed Capability
LIE	HLR-LIE-A	A comprehensive set of initiating events (IEs) was identified for various POSs defined in the LPSD model. However, no systematic evaluation of potential IEs caused by support system failures, human errors, or temporary alignments was conducted.
LIE	HLR-LIE-B	Some grouping of the identified IEs for various POSs was conducted. However, no structured and systematic process to group IEs to facilitate the accident sequence development and CDF quantification was performed. A separate event tree was developed for each of the about 40 IEs that were identified in the model.
LIE	HLR-LIE-C	A group of about 40 initiating events for various POSs were quantified using mainly at-power model data and some generic databases. No recent generic LPSD data sources (e.g., EPRI reports, NUREGs) and plant-specific data were used to estimate IE frequencies. Additionally, the uncertainty in the IE frequencies was not characterized.
LIE	HLR-LIE-D	This aspect of the LIE technical element was not in-scope for this assessment.

Table 5-5
High Level Requirement Capability Assessment - LAS

Technical Element	HLR	Assessed Capability
LAS	HLR-LAS-A	The modeling and documentation provide the expected framework for the accident sequence analysis. There are gaps in the full development in the AS product associated with documentation of key safety functions and the interface with site-specific TH analyses and HFE development.
LAS	HLR-LAS-B	The current level of the accident sequence development is consistent with the guidance in the standard. One gap was identified in that it could not be determined if phenomenological conditions created by the accident progression or plant conditions within a POS are identified and/or modeled.
LAS	HLR-LAS-C	This aspect of the LAS technical element was not in-scope for this assessment.

Table 5-6
High Level Requirement Capability Assessment - LSC

Technical Element	HLR	Assessed Capability
LSC	HLR-LSC-A	PVNGS LPSD PRA uses currently same success criteria in the at-power PRA and the PVNGS LPSD team plans to define LPSD success criteria or timing for accident sequence analysis based on LPSD thermal-hydraulic analysis. It makes review of success criteria requirement is out of scope.
LSC	HLR-LSC-B	The PVNGS LPSD PRA does not perform thermal-hydraulic analysis for success criteria or timing for accident sequence analysis. However, PVNGS plans to perform thermal-hydraulic analyses in the future. Review of this requirement on success criteria is out of scope.
LSC	HLR-LSC-C	While Section 3 of Event Trees and Success Criteria notebook contains a table which lists and briefly describes the success criteria for the event tree functions, the notebook does not have any further description regarding the event tree functions. System Model Development notebook describes the event tree functions in system modeling standpoints, not success criteria standpoint. Event Trees and Success Criteria notebook should describe the definition of success criteria and timing information, in addition to a comprehensive thermal-hydraulic analysis notebook.

Table 5-7
High Level Requirement Capability Assessment - LSY

Technical Element	HLR	Assessed Capability
LSY	HLR-LSY-A	The system modeling development and documentation provides for evaluation of system and component failures as an input into the calculation of risk metrics. Gaps were identified in the areas of system walkdowns, engineer and operator interviews, incorporation of HRA, success criteria, data analysis and phenomenological considerations.
LSY	HLR-LSY-B	It appears that no systematic approach to common cause modelling was used for LPSD-specific system models. Also, no evaluation of the applicability of the at-power analysis is provided. Several SR-specific comments are provided where specific problems have been identified. However, overall, this HLR is not reviewable.
LSY	HLR-LSY-C	This aspect of the LSY technical element was not in-scope for this assessment.

Table 5-8
High Level Requirement Capability Assessment - LDA

Technical Element	HLR	Assessed Capability
LDA	HLR-LDA-A	The basic events used in the LPSD model were mainly based on the at-power model. A group of new basic events was identified for the LPSD systems (LPSI/SDC and CS systems) for various POSs. In general, the new basic events were clearly defined. However, the component boundaries and success criteria were not defined. Additionally, CCF basic events for the LPSD systems were not defined and documented. The applicability of the at-power basic events (e.g., component boundary, success criteria, mission time) to the LPSD model needs to be also discussed and documented.
LDA	HLR-LDA-B	The grouping of the components for the LPSD systems was adequately performed.
LDA	HLR-LDA-C	The basic event estimates used in the LPSD model were mainly based on the at-power model. For the new basic events, plant-specific unavailability data (e.g., maintenance frequency and duration, POS duration) was collected for Modes 3 and 4 POSs and unavailability basic event estimates were generated. Similar plant-specific data was collected for Modes 5 and 6 POSs, however, no unavailability basic events were generated. No plant-specific unreliability data has been collected for the new basic events.
LDA	HLR-LDA-D	The basic event estimates used in the LPSD model were mainly based on the at-power model. However, the applicability of the at-power basic event estimates to the LPSD model needs to be discussed and documented (e.g., component boundary, success criteria, mission time). Generic unreliability estimates were used for the new basic events. No CCF estimates were documented in the data analysis notebook for the new basic events. Plant-specific unreliability estimates accompanied by a characterization of the uncertainty have to be developed for risk significant components. Plant-specific maintenance basic event values were developed for selected components in Modes 3 and 4. For Modes 5 and 6, house events were used to model component unavailabilities, but it is not evident how this was applied to various POSs and how the raw data was used.
LDA	HLR-LDA-E	This aspect of the LDA technical element was not in-scope for this assessment.

Table 5-9
High Level Requirement Capability Assessment - LHR

Technical Element	HLR	Assessed Capability
LHR	HLR-LHR-A	This HLR was not able to be reviewed at this time based on the current status of the HRA.
LHR	HLR-LHR-B	This HLR was not able to be reviewed at this time based on the current status of the HRA.
LHR	HLR-LHR-C	This HLR was not able to be reviewed at this time based on the current status of the HRA.
LHR	HLR-LHR-D	This HLR was not able to be reviewed at this time based on the current status of the HRA.
LHR	HLR-LHR-E	A limited review of this HLR was performed. The following items were identified. LHR-E1: Procedures are identified in the HRA calculator summary sheets output, however, no review of how the procedures are impacted by POS changes is evident. Operational events are not reviewed. LHR-E2: Actions modelled for specific HFEs are listed in the HRA calculator output. However, the entire procedural path for each modelled action is not given. Without the complete description of the scenario progression, this SR is not reviewable. LHR-E3: Not done and, therefore, not reviewable. There are operator interview documents, but it appears that the interview information related to the use and interpretation of procedures is not formally incorporated in the HFE analyses. LRH-E4: Not done and, therefore, not reviewable.
LHR	HLR-LHR-F	This HLR was not able to be reviewed at this time based on the current status of the HRA.

Table 5-9 (continued)
High Level Requirement Capability Assessment - LHR

Technical Element	HLR	Assessed Capability
LHR	HLR-LHR-G	A limited review of this HLR was performed. The following items were identified. LHR-G1: Quantification has not been performed therefore, significant HFEs cannot be identified. Also, this SR is not reviewable because HLRs E and F are not reviewable. It has been stated that there are no screening HFEs in the LPSD model. LHR-G2: Met. LHR-G3: Not documented in a manner that facilitates review. LHR-G3a: Not addressed in the documentation and, therefore, not reviewable. LHR-G4: No T/H analyses performed, therefore, not reviewable. LHR-G5: Not done and, therefore, not reviewable. There are operator interview documents, but it appears that the interview information related to the task completion times is not formally incorporated in the HFE analyses. LHR-G6: Not done and, therefore, not reviewable. LHR-G7: Not done and, therefore, not reviewable. LHR-G8: Not done and, therefore, not reviewable.
LHR	HLR-LHR-H	A limited review of this HLR was performed. The following items were identified. LHR-H1: Quantification has not been performed therefore, significant sequences cannot be identified to credit potential recovery actions. Also, this SR is not reviewable because HLRs E and F are not reviewable. LHR-H2: Cues are not clearly specified. Timing is not provided. LHR-H3: Not done.
LHR	HLR-LHR-I	This HLR was not able to be reviewed at this time based on the current status of the HRA.
LHR	HLR-LHR-J	This HLR was not able to be reviewed at this time based on the current status of the HRA.
LHR	HLR-LHR-K	This HLR was not able to be reviewed at this time based on the current status of the HRA.
LHR	HLR-LHR-L	This HLR was not able to be reviewed at this time based on the current status of the HRA.
LHR	HLR-LHR-M	The documentation portion was out of scope for this assessment.

Table 5-10
High Level Requirement Capability Assessment - LQU

Technical Element	HLR	Assessed Capability
LQU	HLR-LQU-A	An initial effort has been made to quantify the model. The overall approach is to quantify on a per hour basis, generate POS results as CDPs (accounting for average hours in each POS), and using the frequency of evolutions to meet the LPSD PRA standard requirements to develop a model that can calculate average annual core damage frequency. Although some spot-checking of cutsets were performed as part of the review, the results are limited and not at a stage facilitating determination of significant sequences that include all of the appropriate inputs, such as HFEs.
LQU	HLR-LQU-B	The quantification generally uses appropriate models and codes. While the modeling appears to use an appropriate approach, sequences are grouped in the fault tree on a POS level, which is somewhat unconventional compared to a model that is quantified on a sequence basis, and may be challenging to review. At this stage the quantification is not mature enough to identify method-specific limitations and features. Some important elements are included in the modeling, such as the use of logic flags. Mutually exclusive event screening is in progress. Establishing truncation limits and convergence has not been addressed.
LQU	HLR-LQU-C	HFE dependencies have not been identified or evaluated.
LQU	HLR-LQU-D	Quantification results are not mature enough to identify significant contributors to CDF in a meaningful way A spot-check of cutsets was performed; no illogical cutsets were found.
LQU	HLR-LQU-E	The inputs, such as success criteria and human reliability analysis, are not mature enough to support analysis of model uncertainty and assumptions. Parametric uncertainty has not been performed.
LQU	HLR-LQU-F	Documentation is outside the review scope.

5.3 Supporting Requirements Results Summary and Statistics

Supporting requirement assessments (and capability category ratings) are provided in Tables C-1 through C-8 (one for each element). This section provides statistics and summaries of the various SR capability categories.

Table 5-11
Number and Percentage of SRs in Each Capability Category

Capability Category	# of SRs	%
Met	39	15%
I	6	2%
I/II	4	1%
II	5	2%
II/III	2	1%
III	0	0%
Not Met	47	17%
NR/NA[2]	165	62%
Total	268	100%

Table 5-12
Number of SRs in Each Capability Category by Element

Element	Met	I	I/II	II	II/III	III	Not Met	NR/NA	Total
LPOS	5	1	0	1	2	0	3	10	22
LIE	7	3	2	0	0	0	13	12	37
LAS	8	2	1	0	0	0	5	5	21
LSC	0	0	0	0	0	0	0	15	15
LSY	14	0	1	1	0	0	4	22	42
LHR	0	0	0	0	0	0	0	60	60
LDA	5	0	0	3	0	0	22	6	36
LQU	0	0	0	0	0	0	0	35	35
Total	**39**	**6**	**4**	**5**	**2**	**0**	**47**	**165**	**268**

[2] NR is ‘not reviewed’ and NA is ‘not applicable’

Table 5-13
F&Os per Element

Element	Findings	Suggestions	Total
LPOS	7	4	11
LIE	20	5	25
LAS	8	5	13
LSC	1	3	4
LSY	5	2	7
LHR	NA	NA	NA
LDA	16	0	16
LQU	NA	NA	NA
Total	57	19	76

6
REFERENCES

1. ANS/ASME-58.22, “Requirements for Low Power and Shutdown Probabilistic Risk Assessment,” Revision 12 for Balloting, October 2014.
2. NEI 05-04, “Process for Performing Follow-on PRA Peer Reviews Using the ASME PRA Standard,” January 2005.
3. NRC Regulatory Guide 1.200, “An Approach for Determining the Technical Adequacy of Probabilistic Risk Assessment Results for Risk-Informed Activities”, Rev. 2, March, 2009.
4. ANS/ASME-58.22-2014, Requirements for Low Power and Shutdown Probabilistic Risk Assessment. Trial-Use Standard. March 2015.
5. NUREG/CR-6928, “Industry-Average Performance for Components and Initiating Events at U.S. Commercial Nuclear Power Plants,” 2007.
6. ASME/ANS RA-Sb–2013, Addenda to ASME/ANS RA-S–2008, Standard for Level 1/Large Early Release Frequency Probabilistic Risk Assessment for Nuclear Power Plant Applications, 2013.

A
DAILY AGENDA AND SCHEDULE

Palo Verde LPSD PRA Self-Assessment Schedule and Agenda [3]

AGENDA ITEM	REVIEWER	TIME
MONDAY		
Review Team Setup, Introductions, Logistics, etc.	(All)	7:00 am - 7:30 am
Orientation & PRA Overview by utility	(All)	7:30 am - 8:30 am
Plant Operating States Review	(All)	8:30 am – 12:00 pm
LUNCH		12:00 pm - 12:30 pm
Initiating Events (IE) Review	(1, 2, 3, 4)	12:30 pm – 3:00 pm
Success Criteria (SC) Review	(6)	12:30 pm – 3:00 pm
Accident Sequence (AS) Review	(5)	12:30 pm – 3:00 pm
Consensus Mtg. on Elements: (POS) and (IE)	(All)	3:00 pm – 5:30 pm
Summary of Days Findings: • Discussion of F&Os • Group Discussion on Standard Feedback and Research Needs and Documentation of Issues • Open Questions • Prepare Debrief Info for Tuesday AM		

[3] Agenda and assignments shown per the plan; during the review, adjustments were made to accommodate reviewer availability for various elements, interactions with utility personnel, and consensus discussions.

Palo Verde LPSD PRA Self-Assessment Schedule and Agenda

AGENDA ITEM	REVIEWER	TIME
TUESDAY		
Debrief with utility on previous day's review	(All)	7:00 am - 7:30 am
Accident Sequence (AS) Review	(2, 5)	7:30 am – 12:00 pm
Success Criteria (SC) Review	(1,3 & 6)	7:30 am – 12:00 pm
Data (DA) Review	(4)	7:30 am – 12:00 pm
LUNCH		12:00 pm – 12:30 pm
Accident Sequence (AS) Review	(1)	12:30 pm – 3:00 pm
Systems (SY) Review	(5)	12:30 pm – 3:00 pm
Human Reliability Analysis (HR) Review	(3, 6)	12:30 pm – 3:00 pm
Data (DA) Review	(4)	12:30 pm – 4:00 pm
Quantification Review (QU)	(2)	12:30 pm – 3:00 pm
Sub-Consensus Mtgs. on Elements AS and SC - Reviewer 1 to coordinate with AS and SC leads	(AS:1,2,5) (SC:1,3,6)	3:00 pm – 4:00 pm
Summary of Days Findings: • Group Consensus on SRs: (AS), (SC) • Discussion of F&Os • Group Consensus on Standard Feedback, Research Needs and Documentation of Issues • Open Questions • Prepare Debrief Info for Wednesday AM	(All)	4:00 pm – 6:00 pm

Palo Verde LPSD PRA Self-Assessment Schedule and Agenda

AGENDA ITEM	REVIEWER	TIME
WEDNESDAY		
Debrief with utility on previous day's review	(All)	7:00 am – 7:30 am
Human Reliability Analysis (HR) Review	(3, 4, 6)	7:30 am – 12:00 pm
Data (DA) Review	(1)	7:30 am – 12:00 pm
Systems (SY) Review	(2 & 5)	7:30 am – 12:00 pm
LUNCH		12:00 pm – 12:30 pm
Human Reliability Analysis (HR) Review	(3 & 4)	12:30 pm – 3:00 pm
Systems (SY) Review	(1, 2 & 5)	12:30 pm – 3:00 pm
Data (DA) Review	(6)	12:30 pm – 3:00 pm
Summary of Days Findings: • Group Consensus on SRs: (HR), (SY) • Group Consensus on Standard Feedback, Research Needs, and Documentation of Issues • Discussion of F&Os • Open Questions • Prepare Debrief Info for Thursday AM	(All)	3:00 pm -6:00 pm

Palo Verde LPSD PRA Self-Assessment Schedule and Agenda

AGENDA ITEM	REVIEWER	TIME
THURSDAY		
Debrief with utility on previous day's review	(All)	7:00 am – 7:30 am
Quantification (QU) Review	(1*, 2, 3*, 4, 5, 6)	7:30 am – 12:00 pm
Consensus Mtg. on DA	(All)	10:30 am – 12:00 pm
LUNCH		12:00 pm – 12:30 pm
Quantification (QU) Review	(All)	12:30 pm – 2:00 pm
Summary of Days Findings • Group Consensus Session (QU, MU) • Discussion of F&Os • Consensus on Standard Feedback, Research Needs, and Documentation of Issues • Open Questions • Leads Begin Element Summaries	(All)	2:00 pm – 5:30 pm
FRIDAY		
Debrief with utility on previous day's review	(All)	7:00 am – 7:30 am
Individual Wrap-up/Review/Leads Finish Summaries and All SR and F&O Input, Standard Feedback and Research Opportunities	(All)	7:30 am – 10:30 am
Compile Summaries and Exit Material	(All)	10:30 am – 11:30 am
Exit Meeting with utility	(All)	11:30 am – 12:30 pm

B
FACTS AND OBSERVATIONS

Table B-1 provides a list of all Facts and Observations (F&O), the level (Suggestion or Finding), the affected supporting requirement (SR) and any other SRs to which the F&O may be applicable. Table B-2 provides the details for every F&O.

Table B-1
Supporting Requirements to F&O Cross-Reference

F&O ID	Level	Supporting Requirement	Other Applicable Supporting Requirements
LPOS-A1-01	S	LPOS-A1	
LPOS-A2-01	F	LPOS-A2	
LPOS-A4-01	S	LPOS-A4	
LPOS-A5-01	S	LPOS-A5	
LPOS-B1-01	S	LPOS-B1	
LPOS-B1-02	F	LPOS-B1	
LPOS-B5-01	F	LPOS-B5	
LPOS-C1-01	F	LPOS-C1	
LPOS-C4-01	F	LPOS-C4	
LPOS-C4-02	F	LPOS-C4	
LPOS-C5-01	F	LPOS-C5	
LIE-A1-01	S	LIE-A1	
LIE-A1-02	F	LIE-A1	
LIE-A2-01	F	LIE-A2	
LIE-A4-01	F	LIE-A4	
LIE-A5-01	F	LIE-A5	LIE-A6
LIE-A7-01	F	LIE-A7	
LIE-A7-02	F	LIE-A7	
LIE-A8-01	F	LIE-A8	
LIE-A9-01	F	LIE-A9	
LIE-A9A-01	F	LIE-A9a	LAS-B6, LDA-C8

Table B-1 (continued)
Supporting Requirements to F&O Cross-Reference

F&O ID	Level	Supporting Requirement	Other Applicable Supporting Requirements
LIE-B2-01	F	LIE-B2	
LIE-B3-01	F	LIE-B3	
LIE-B3-02	S	LIE-B3	
LIE-B6-01	F	LIE-B6	
LIE-C1-01	F	LIE-C1	
LIE-C1-02	F	LIE-C1	
LIE-C1-03	S	LIE-C1	
LIE-C1-04	F	LIE-C1	
LIE-C2-01	F	LIE-C2	
LIE-C4-01	F	LIE-C4	
LIE-C5-01	S	LIE-C5	
LIE-C8-01	F	LIE-C8	
LIE-C12-01	S	LIE-C12	
LIE-C14-01	F	LIE-C14	
LIE-C15-01	F	LIE-C15	
LAS-A1-01	S	LAS-A1	
LAS-A1-02	S	LAS-A1	
LAS-A2-01	F	LAS-A2	LAS-A3
LAS-A4-01	S	LAS-A4	
LAS-A5-01	F	LAS-A5	
LAS-A9-01	F	LAS-A9	
LAS-A10-01	F	LAS-A10	
LAS-A11-01	F	LAS-A11	
LAS-B1-01	F	LAS-B1	LAS-B2
LAS-B3-01	F	LAS-B3	
LAS-B3-02	F	LAS-B3	
LAS-B5-01	S	LAS-B5	
LAS-B6-01	S	LAS-B6	
LSC-A2-01	S	LSC-A2	

Table B-1 (continued)
Supporting Requirements to F&O Cross-Reference

F&O ID	Level	Supporting Requirement	Other Applicable Supporting Requirements
LSC-A4-01	F	LSC-A4	
LSC-B1-01	S	LSC-B1	
LSC-C1-01	S	LSC-C1	
LSY-A2-01	S	LSY-A2	
LSY-A3-01	S	LSY-A3	
LSY-A4-01	F	LSY-A4	
LSY-B1-01	F	LSY-B1	LSY-B3
LSY-B1-02	F	LSY-B1	
LSY-B3-01	F	LSY-B3	
LSY-B3-02	F	LSY-B3	
LDA-A1-01	F	LDA-A1	LDA-D6
LDA-A1-02	F	LDA-A1	
LDA-A2-01	F	LDA-A2	LSY-A8
LDA-C1-01	F	LDA-C1	
LDA-C2-01	F	LDA-C2	LDA-C7, LDA-C8,LDA-C9, LDA-D1, LDA-D2, LDA-D3, LDA-D4
LDA-C2-02	F	LDA-C2	LDA-C7, LDA-C8, LDA-C11, LDA-C14
LDA-C2-03	F	LDA-C2	LDA-C7, LDA-C8, LDA-C11
LDA-C3-01	F	LDA-C3	
LDA-C3-02	F	LDA-C3	
LDA-C4-01	F	LDA-C4	
LDA-C5-01	F	LDA-C5	
LDA-C6-01	F	LDA-C6	
LDA-C10-01	F	LDA-C10	
LDA-C13-01	F	LDA-C13	
LDA-C16-01	F	LDA-C16	
LDA-D8-01	F	LDA-D8	

Table B-2
Findings and Observations

SR	F & O	Description	F&O Level	Comments	Resolution
LPOS-A1	LPOS-A1-01	The use of a three prior year period for the identification of potential evolutions may be insufficient for the incorporation of plant-specific operating experience.	S	During the consensus discussion, this topic was discussed extensively to identify where the intent of the standard was driving technical rigor and the application of the SR by Palo Verde. Additionally, clarification among LPOS sections A and B is warranted to provide guidance for the identification of evolutions (LPOS section A) and guidance for the development of representative groupings of the evolutions (LPOS section B).	The conclusion during the discussion was that additional review by the utility for plant-specific operating experience beyond the three-year period is recommended.
LPOS-A2	LPOS-A2-01	The LPOS task documentation can be enhanced to provide a discussion of the sources and methods used to gather site specific information. This would include items such as keywords used, date ranges, databases searched and so forth.	F		One potential resolution would be to include an appendix that provides the methods information for repeatability in future model updates.
LPOS-A4	LPOS-A4-01	The LPOS task documentation can be enhanced to provide a discussion of the sources and methods used to gather site specific information on potential future LPSD conditions.	S		One potential resolution would be to include an appendix that provides the method used, such as an interview sheet, to collect the information for the potential future LPSD conditions.
LPOS-A5	LPOS-A5-01	The results of interviews with operators have been incorporated into the LPSD evolutions and POSs, but the interviews are not formally documented. The Palo Verde LPSD PRA model document, "Tasks 1 - 3, Evolutions And Plant Operating States," refers to Sections 2 and 3, but these sections formally do not document the interviews.	S		Suggestion: Document interviews with operators and other plant personnel.

Table B-2 (continued)
Findings and Observations

SR	F & O	Description	F&O Level	Comments	Resolution
LPOS-B1	LPOS-B1-01	Grouping Hot Standby based on evolution #9 may not be bounding, when compared to evolution #10.	S	There is a non-negligible probability that hot standby during a forced outage may be driven by secondary system unavailability. Using evolution #9 to represent the hot standby group assumes that steam bypass and atmospheric dump valves (ADVs) could be used for heat removal, which should have a lower failure probability than just ADVs alone.	Additional documentation of the grouping bases would be beneficial.
LPOS-B1	LPOS-B1-02	There is no evidence that items (b) and (c) were used to define the groups of evolutions.	F	The difference between CCI and CCII are the requirements to ENSURE that certain issues are accounted for in grouping.	Add documentation to provide the basis for grouping.
LPOS-B5	LPOS-B5-01	POS involving demand-based initiators have not been grouped, evaluated, or delineated. This SR is not met for any CC.	F	Disposition of this SR does not address the development of POS involving demand-based initiators. Disposition was as follows: It was determined that there was insufficient need to create separate POSs to address potential "demand-based" initiating events. The only "demand-based" initiator was found to be miscalibration of reactor water level instrumentation system (RWLIS), and this was considered inappropriate to limit to a single demand-based POS. Otherwise all initiators were as "time-based". This disposition focuses on the development of demand-based IEs. The CCII requirement uses the verbs "Evaluate" and "Delineate" and CCI uses "GROUP" or "DELINEATE" as applied to the development of POS involving demand-based initiators.	While a comprehensive IEF data development is not available in the industry, there are data sources (e.g., EPRI report 1021176) available that can be used to support this effort.

Table B-2 (continued)
Findings and Observations

SR	F & O	Description	F&O Level	Comments	Resolution
LPOS-C1	LPOS-C1-01	Three years of operating experience is not sufficient to take into account the contribution of infrequent LPSD evolutions such as Evolution #25 from the Palo Verde LPSD PRA model document, "Tasks 1 - 3, Evolutions And Plant Operating States,", Table 2-4.	F		Perform more operating experience analysis or use the frequency of forced outages assigned to each identified safe, stable state from the plant specific full power PRA.
LPOS-C4	LPOS-C4-01	The decay heat data used is provided in half-day increments. There is no justification that the coarseness of the decay heat data is acceptable for use in later analyses.	F	Because an evaluation is performed, this SR is considered met.	Provide justification that the coarseness of the data is acceptable for use in the PRA.
LPOS-C4	LPOS-C4-02	There is no evaluation that the referenced decay calculation is acceptable for use in the LPSD PRA. For example, if the referenced calculation uses upper-bound decay heat curves, then the decay heat levels may be overly conservative.	F	Because an evaluation is performed, this SR is considered met.	Justify that the calculation is appropriate for use in the PRA.
LPOS-C5	LPOS-C5-01	There is one statement in Section 2.1 of the Palo Verde LPSD PRA model document, "Tasks 1 - 3, Evolutions And Plant Operating States,", that states "Additional Evolutions were added based on possible future activities that were provided during interviews." No documentation or summary of the interviews was available. No evidence that plans were reviewed was provided.	F	Although there is a minimal amount of evidence that some review was performed, this review does not appear to be extensive. Therefore, this SR is considered not met.	List all documents reviewed and document all interviews performed.
LIE-A1	LIE-A1-01	Additional methods and documents could be used for identification of initiating events.	S	A system-by-system review of the plant systems for initiating events (e.g., as discussed in LIE-A5) could be provided. Additionally, there is no reference to EPRI 1021176, "An Analysis of Loss of Decay Heat Removal and Loss of Inventory Event Trends (1990-2009)."	Review and document EPRI 1021176 and perform system-by-system review of plant systems.

Table B-2 (continued)
Findings and Observations

SR	F & O	Description	F&O Level	Comments	Resolution
LIE-A1	LIE-A1-02	There may be ISLOCA paths that exist during shutdown that are not considered or analyzed at power.	F	There should be a review of potential ISLOCA paths to ensure that there are no new paths for an ISLOCA during shutdown POSs.	Review and document potential ISLOCA paths.
LIE-A2	LIE-A2-01	It is not clear whether there are any additional categories of initiating events caused by at-initiator HFEs (item (g) in LIE-A2).	F	LIE-A2 requires that the spectrum of initiating events includes additional categories of initiating events caused by at-initiator HFEs (item (g) in LIE-A2). If there were none, it is not clear that they were considered.	Review for additional categories of initiating events caused by at-initiator HFEs (item (g) in LIE-A2) and document.
LIE-A4	LIE-A4-01	There was no indication that any review attempted to identify how at-initiator operator actions could impact later mitigation strategies was evident.	F	This SR requires that the review be performed to identify both items. Since only one of the two factors was identified, this SR is considered not met.	Delineate actions expected at each event to identify any actions that may impact later recovery actions.
LIE-A5	LIE-A5-01	No evidence was available that a systematic evaluation of each system was performed to assess the possibility of causing an initiating event. This Finding is also applicable to SR LIE-A6.	F	This analysis is required by the SR. Therefore, this SR is considered not met.	Perform and document a systematic review of all systems for their potential to cause an initiating event in LPSD modes.
LIE-A7	LIE-A7-01	Section 2.3 the Palo Verde LPSD PRA model document, "Tasks 4 - 6, Initiating Events and Frequencies," states that the PVNGS operating experience database was reviewed. However, no reference to the specific database was provided. Also, the date of the review and extent or basis of the review was not documented.	F	Because the analysis cannot be reproduced without recourse to the author, this is considered a finding-level observation.	Document the specific database, date of review, and keywords searched.
LIE-A7	LIE-A7-02	A review of initiating events is documented in Section 2.2.5 of the initiating events analysis. However, this review does not correlate observed initiating events by POS and no assessment of the applicability of events observed as occurring in one POS to other POS is documented.	F	Because this review is required by the SR, this is considered not met.	Document the POS in which each event identified during operating experience review occurred. Document the applicability of each event to other POS.

Table B-2 (continued)
Findings and Observations

SR	F & O	Description	F&O Level	Comments	Resolution
LIE-A8	LIE-A8-01	Specified interviews have not been conducted. CCII/III SR not met.	F	Interviews are required by the SR, so this SR only meets a CC I category.	Conduct interviews as planned.
LIE-A9	LIE-A9-01	CCII is not met. Resolution does not identify that precursors were identified or that the review included at-initiator HFEs.	F	Reviews are required by the SR, so this SR only meets a CC I category.	A review for potential precursor events, including at-initiator HFEs, would appear to strictly meet the intent of the SR. See comments on the SR in the Standard review.
LIE-A9a	LIE-A9A-01	SR CCII is not met because review of this SR did not include temporary alignments, such as temporary equipment, freeze seals, and other temporary changes to the plant during an outage.	F	Reviews are required by the SR, so this SR only meets a CC I category.	Expand the review to include temporary alignments.
LIE-B2	LIE-B2-01	Table 5-1 in the Palo Verde LPSD PRA model document, "Tasks 4-6, “Initiating Events and Frequencies," places the 40 LPSD initiators into four groups in order to facilitate accident sequence and quantification development. In some cases the initiator affects both decay heat removal and RCS inventory. In those cases the initiator would be selected for loss of inventory since it leads more quickly to core uncovery. There is no structured and systematic process to group IEs.	F	Use of a structured and systematic approach for grouping IEs is not evident in the documentation. Furthermore, as documented in SR LIE-B1, grouping is inconsistent. Since the SR requires that a systematic approach be used, this SR is considered not met.	Provide a structured and systematic process to group IEs.
LIE-B3	LIE-B3-01	Justification for a valid IE grouping is not evident in the report.	F	Justification for valid IE grouping is required by SR. There is no evidence of such justification in the LIE analysis document.	Group and document IE grouping consistent with the SR requirements.

Table B-2 (continued)
Findings and Observations

SR	F & O	Description	F&O Level	Comments	Resolution
LIE-B3	LIE-B3-02	From the Palo Verde LPSD PRA model document, "Tasks 4-6, “Initiating Events and Frequencies," "Table 2-2 below lists the LPSD initiators and their respective POSs. The Initiating Events are grouped by POSs that have the same initiators." The second sentence is not clear with respect to IE grouping and appears to provide circular logic to the first sentence.	S		Edit the second sentence related to Table 2-2 with respect to IE grouping and clarify what this table means.
LIE-B6	LIE-B6-01	It is not evident from the IE notebook if the grouping of the time-based and demand-based IEs was done properly.	F		Document the proper justification of the grouping of the time-based and demand-based IEs according to the SR requirements.
LIE-C1	LIE-C1-01	The use of at-power initiating event frequencies for events at shutdown may not be appropriate.	F	Many IE frequencies from the at-power model are used without modification for shutdown POSs. However, there are not adequate justifications that the data can be used directly, especially for events involving loss of support systems (instrument air, cooling water, ESF buses) which are typically worked on during outages, and may include abnormal or temporary lineups. There are no justifications for the IE frequency modifications made to at-power IE frequencies.	Provide justification for using at-power IE frequencies directly, or make appropriate changes to at-power frequencies for use in the shutdown model.

Table B-2 (continued)
Findings and Observations

SR	F & O	Description	F&O Level	Comments	Resolution
LIE-C1	LIE-C1-02	Loss of Offsite Power (LOOP) initiating event frequencies are not consistent with industry data for shutdown LOOP experience.	F	LOOP frequencies are not based on the most recent EPRI and NRC studies. Specifically, the NRC/INL data shows plant-centered and switchyard related LOOPs are higher during shutdown as compared to at-power.	Consider incorporating experience and data from EPRI and NRC sources for LOOP: *Losses of Offsite Power at U.S. Nuclear Power Plants: Summary of Experience Through 2013.* EPRI, Palo Alto, CA: 2014. 3002003115. *Losses of Offsite Power at U.S. Nuclear Power Plants - 2011:* EPRI, Palo Alto, CA: 2012. 1023147. NRC/INL: http://nrcoe.inel.gov/resultsdb/LOSP/
LIE-C1	LIE-C1-03	Data used for initiating events that are unique to shutdown conditions (e.g., Loss of RHR) are dated; newer data could be used.	S	More recent data is available than the data used in the IE frequency calculations (primarily from WCAP-16560-P, which is based primarily on NUREG/CR-6144). For example, EPRI 1021176 provides the events (without hours for denominators) for shutdown events through 2009.	Consider use of more recent data for calculating IE frequencies.

Table B-2 (continued)
Findings and Observations

SR	F & O	Description	F&O Level	Comments	Resolution
LIE-C1	LIE-C1-04	There is no evidence that plant-specific data was reviewed or used in the development of initiating event frequencies, with the exception of reactor vessel failures during LTOP events.	F	LIE-C1 requires that IE frequencies account for relevant plant-specific data. There is no evidence that plant-specific experience was reviewed for shutdown initiating events. There does not appear to be any Bayesian updating of shutdown events, even with 0 events, if that is the case.	Review plant history for relevant shutdown initiating events, and incorporate the information (if appropriate) into the shutdown IE frequencies. If no events exist, consider performing a Bayesian update with 0 events.
LIE-C2	LIE-C2-01	The applicability of the plant specific data which was used has not been demonstrated as applicable to LPSD conditions.	F	It appears that plant-specific data from the at-power model has been used. However, the intent of the SR is the use of plant-specific data appropriate to LPSD conditions.	Justify applicability for the plant-specific data used in the LPSD IE analysis.
LIE-C4	LIE-C4-01	The Task 4-6 notebook states that this will be conducted as part of the DA tasks. Based on review of the DA notebook, Task 16-17, this SR is not met.	F	There was no plant-specific data collection for IEs or the unreliability data analysis. SR is not met.	Develop plant-specific data for IEs and perform Bayesian updating.
LIE-C5	LIE-C5-01	The SR requires accounting for differences between the historical data regarding POS durations and frequencies and POS durations and frequencies that are planned in the future.	S		Document the potential differences between historical POS durations and frequencies over the period of POS occurrences in the historical records and those POS durations and frequencies in planned future plant operation that could be different from historical values.

Table B-2 (continued)
Findings and Observations

SR	F & O	Description	F&O Level	Comments	Resolution
LIE-C8	LIE-C8-01	One initiating event, loss of atmospheric dump valves (ADVs), uses a fault tree to quantify the initiating event frequency. The PVNGS LPSD PRA documentation does not include any description of this fault tree. When system fault trees are developed for initiating events, the supporting requirements of the SY technical element are invoked. None of these appear to have been considered, for example, LSY-B8, LSY-A18, LSY-A19, etc. Furthermore, it is not clear that support systems that could affect the initiating event as well as other systems used for accident mitigation were considered and are properly addressed in the modelling.	F	Because no documentation of the fault tree is provided and none of the SY technical element supporting requirements appear to have been addressed, this SR is considered not met.	Develop and document of support system fault trees in accordance with all applicable SRs.
LIE-C12	LIE-C12-01	Comparison with generic data sources and reasonableness of the IE frequencies are documented throughout the IE report. It would be useful to summarize the reasonableness of results and comparison with generic data sources in one place (e.g., one single table).	S		It would be useful to summarize the reasonableness of results and comparison with generic data sources in one place (e.g., one single table).
LIE-C14	LIE-C14-01	There is no evidence that the ISLOCA frequency for LPSD model has been quantified properly to address the LPSD conditions.	F		Perform and document the ISLOCA frequency assessment for LPSD.
LIE-C15	LIE-C15-01	The uncertainty in the IE frequencies was not characterized.	F	The SR requires to characterize IE frequency uncertainties and there is no evidence that this was done.	Document the IE frequencies in terms of their mean values and uncertainties (e., error factor, percentiles, variance).

Table B-2 (continued)
Findings and Observations

SR	F & O	Description	F&O Level	Comments	Resolution
LAS-A1	LAS-A1-01	Correlation of accident sequence to key safety function could be enhanced. See LAS-A2 for additional discussion.	S		One possible resolution would be the development of a table or other method for each accident sequence that identifies the key safety functions and associated success criteria.
LAS-A1	LAS-A1-02	Consider an enhancement to the Palo Verde LPSD PRA model document, "Tasks 7 - 10, Event Trees and Success Criteria" to discuss if there is an impact from having an undeveloped Containment Event tree on the key safety functions.	S		Provide a discussion of the impact on CDF results from the undeveloped Containment Event tree.
LAS-A2	LAS-A2-01	There is no explicit identification of key safety function "necessary to reach a safe, stable state and prevent core damage" for the individual initiating event discussion.	F	Identification of the key safety function is required for each initiating event by this SR; therefore, this is not met.	One possible resolution would be the development of a table or other method for each initiating event that identifies the key safety functions and associated success criteria.
LAS-A4	LAS-A4-01	Considering a link to either the Operator action basic event or HRA Calculator identifier would be an enhancement that would aid in the use and update of the LPSD model.	S		Include the specific identifier (such as Basic Event ID) with the Operator Action text name in the Accident Sequence notebook.

Table B-2 (continued)
Findings and Observations

SR	F & O	Description	F&O Level	Comments	Resolution
LAS-A5	LAS-A5-01	There is limited discussion of the development of the accident sequences with respect to the associated station procedures.	F	The reference to plant specific information is limited in the level of detail contained in the Accident Sequence task notebook.	An enhancement would be to provide a discussion of those plant-specific sources that were used in the development of the initiating event accident sequences. A section that provides details of the differences between the Full-Power and LPSD conditions could be created to capture this information consistently in a similar fashion to that used in identifying differences between the individual units.
LAS-A9	LAS-A9-01	The SR requires determination of accident progression parameters using realistic and applicable thermal-hydraulic analysis. There is no discussion on the use of similar (or plant-specific) TH analyses to support the identified progression or success criteria.	F	No plant specific TH analysis is available to support this, therefore this SR is not met.	Plant-specific TH analyses need to be developed to support accident sequence development, HRA timing, success criteria and so forth.
LAS-A10	LAS-A10-01	This SR was graded as Capability Category 1. This assessment was based on the lack of discussion of the differences between the full power initiating event (FPIE) and LPSD conditions.	F		Provide a discussion of the differences in system operation and success criteria between the FPIE and LPSD modeling in the accident sequence modeling description.
LAS-A11	LAS-A11-01	SR AS-11 provides guidance in the development of event tree transfers. While the transfers are identified in the individual sequence descriptions there is no overall description of the transfers and their purpose.	F		Consider enhancing the discussion of transfers developed to support event tree modeling to include list of transfers, where they are used and applicable dependencies.

Table B-2 (continued)
Findings and Observations

SR	F & O	Description	F&O Level	Comments	Resolution
LAS-A11	LAS-A11-01	SR AS-11 provides guidance in the development of event tree transfers. While the transfers are identified in the individual sequence descriptions there is no overall description of the transfers and their purpose.	F		Consider enhancing the discussion of transfers developed to support event tree modeling to include list of transfers, where they are used and applicable dependencies.
LAS-B1	LAS-B1-01	The system models were reviewed to determine if the appropriate equipment were considered failed due to initiating events. Although it appeared that the correct impacts are modeled, there is no documentation of which initiators affect which components or systems.	F	Identification of initiating event impacts was obviously performed, but there is no documentation of this task.	Document initiating event impacts on systems, trains, and/or components.
LAS-B3	LAS-B3-01	Phenomenological conditions created by the accident progression are not identified, nor do they appear to be included in the model. An example is the turbine-driven AFW pump is credited following core reload, when adequate decay heat may not be available. It is not clear whether there is adequate steam pressure and flow to run the turbine-driven AFW pump during periods of low decay heat. Aux steam may need to be considered as the source. At a minimum, documentation should discuss this issue.	F	Identification and evaluation of the impact of phenomenological conditions is required for this SR.	Document the identification and incorporation of phenomenological conditions and their impact, or lack thereof, on the accident sequence or system models.

Table B-2 (continued)
Findings and Observations

SR	F & O	Description	F&O Level	Comments	Resolution
LAS-B3	LAS-B3-02	The location and size of postulated inventory losses are not explicitly identified as part of the accident sequence. Except for the fact that SDC is considered to be failed and SI is required during an unisolated loss of inventory event (i.e., H, J or K LOCA), no other impacts are considered.	F	The SR requires location and size of inventory losses to be identified in order to accurately develop the accident sequences. The only information regarding the size of the inventory losses for H, J and K LOCAs is in the fault trees, where it appears that they are all considered as Small LOCAs. However, the basis for this (and a definition of Small LOCA with respect to shutdown conditions) is not provided.	Identify the location and size of inventory losses as needed to accurately develop accident sequences. Identify and incorporate any impacts from unisolated loss of inventory other than loss of SDC and requirement for SI.
LAS-B5	LAS-B5-01	The Palo Verde LPSD PRA model document, "Tasks 7 - 10, Event Trees and Success Criteria" simply references the system analysis in the "Tasks 11-12, System Model Development" document.	S	Review of the sequences and underlying fault trees shows that this requirement is met.	Improve the documentation in the Task 7-10, Event Tree and Success Criteria document to include some specific references to the event trees and fault trees demonstrating that this SR is met.
LAS-B6	LAS-B6-01	While this element is met, the documentation supporting it in the roadmap needs improvement.	S		Provide specific examples of dependencies created by plant configurations and maintenance practices. Show that these configurations are DEFINED and MODELED.
LSC-A2	LSC-A2-01	The core damage definition is not clearly defined in SC or AS documentation.	S	The undesirable state of LPSD accident sequence analysis may vary such as core damage or core boiling depend on differences in POS conditions and purposes of analysis.	The undesirable end sates are needed to define clearly with consideration of the plant condition in each POS.
LSC-A4	LSC-A4-01	Credit is taken for the gas turbine generator (GTG) to recover power in the event of a LOOP and failure of both EDGs. However, the fact that the other units may require the GTGs if their EDGs fail.	F	The SR requires that mitigating systems that are shared between units are evaluated for the case in which multiple units experience a common initiating event (e.g., LOOP).	Some accounting must be made for the other units' need of the GTGs in the event of a LOOP affecting multiple units.

Table B-2 (continued)
Findings and Observations

SR	F & O	Description	F&O Level	Comments	Resolution
LSC-B1	LSC-B1-01	Section 3 of the Palo Verde LPSD PRA model document, "Tasks 7 - 10, Event Trees and Success Criteria,"indicates that system success criteria are based on the success criteria of the at-power PRA. Limited consideration was taken regarding difference in POSs such as decay heat level. For instance DPSR11 "Depressurize the Reactor Coolant System (SLOCA)" has same system success criteria for POS 2 and 14 (Table 2.1.2-4 of the Palo Verde LPSD PRA model document, "Tasks 11-12, System Model Development").	S	As is, this could result in conservatism in the LPSD PRA result.	More POS-specific success criteria analysis is needed to meet category II.
LSC-C1	LSC-C1-01	While Section 3 of the Palo Verde LPSD PRA model document, "Tasks 7 - 10, Event Trees and Success Criteria," notebook contains a table list and briefly includes the system success criteria as event tree functions, the notebook does not have further description regarding bases of the success criteria and plant response on an initiating event. Although the System Model Development notebook describes the event tree functions from a system modeling standpoint, it does not from the success criteria standpoint.	S	As is, this is not sufficient to facilitate risk-informed applications, upgrades, and peer review.	Event Trees and Success Criteria notebook should describe the definition of success criteria and timing information, in addition to a comprehensive thermal-hydraulic analysis notebook.
LSY-A2	LSY-A2-01	No evidence of system engineer interviews was found. The SR identifies the conduct of interviews with System Engineers as an example of the collection of pertinent information for systems analysis.	S		Conduct interviews with System Engineers to collect pertinent information to validate the systems analysis.

Table B-2 (continued)
Findings and Observations

SR	F & O	Description	F&O Level	Comments	Resolution
LSY-A3	LSY-A3-01	Existing system notebook documentation could be enhanced to incorporate LPSD information as a consistent repository of system related information used by the PRA modeling.	S		Consider the enhancement of the existing FPIE system notebook to include a section on LPSD limitations, capabilities, temporary configurations and OE reviews.
LSY-A4	LSY-A4-01	This SR is considered as Not Met due to the need to perform walkdowns for the CS injection and gravity feed additions. Refer to assumption 11 in the Palo Verde LPSD PRA model document, "Tasks 11-12, System Model Development."	F		Perform the walkdowns for the CS injection and gravity feed additions.
LSY-B1	LSY-B1-01	A spot check of system models developed specifically for the LPSD model was performed and it was noted that common-cause failures of the ADVs was not included based on an unjustified assumption. Also, it does not appear that common-cause failures were included for SDC valves, for example, HV-683 and HV-692.	F	Because both randomly-selected spot checks of the model indicated errors, this SR is considered not met.	Develop and model common cause failures in a systematic and traceable manner.
LSY-B1	LSY-B1-02	Common cause failures are modelled using the methods and data applied in the at-power PRA model. No review or justification of the applicability of the at-power common-cause modelling to the LPSD model was evident.	F	Because no justification of the at-power modelling was performed, this SR is considered not met.	Develop and model common cause failures in a systematic and traceable manner.
LSY-B3	LSY-B3-01	No documentation of the common cause grouping of components for LPSD-specific components was provided.	F	Because no documentation of common cause groups was provided, this SR is considered not met.	LPSD specific CCF analysis is needed to establish LPSD specific CCF groups using a logical, systematic traceable process.

Table B-2 (continued)
Findings and Observations

SR	F & O	Description	F&O Level	Comments	Resolution
LSY-B3	LSY-B3-02	The PVNGS LPSD PRA model does not have LPSD-specific CCF analysis. LPSD specific CCF analysis is needed to take into account the different operating condition during applicable POSs. For instance, containment spray pumps are modeled as backup SDC pumps and those pumps have the same service conditions, similar maintenance practices, and other conditions that can result in CCF.	F	CCF modeling is required for components modeled for a safety function.	LPSD-specific CCF analysis is needed to establish LPSD-specific CCF groups using a logical, systematic process.
LDA-A1	LDA-A1-01	There were no CCF basic events were identified for new components identified in the LPSD model (LPSI and CS).	F	There was no justification for excluding CCF basic events for LPSD systems (LPSI and CS). Therefore, this SR is not met.	Add CCF basic events for LPSI and CS components to the LPSD model.
LDA-A1	LDA-A1-02	An assumption in the model documentation states that: "Charging pump maintenance occurs during the flooded POSs where the boron concentration is at least doubled and SI boration is available as a backup. During these POSs two of the three charging pumps are out of service, but with the extra RCS inventory (operator response time increase) and the backup SI systems the unavailability of the two pumps is considered negligible. Therefore the charging unavailability during RFOs is not modeled."	F	The screening of charging pump unavailability basic event is not consistent with the standard SR requirement.	A basic event for a component may be screened out if it is shown that its contribution to the total failure probability is less than 1% (See LSY-A15 and SY-A15). Provide justification consistent with the standard requirements.

Table B-2 (continued)
Findings and Observations

SR	F & O	Description	F&O Level	Comments	Resolution
LDA-A2	LDA-A2-01	New basic events have been identified, but the component boundaries and success criteria have not been defined and documented in the data analysis report. Also, there are no justifications provided for using the same SSC boundaries and success criteria for at-power basic events in the LPSD model.	F	No evidence of component boundaries and success criteria have been defined and documented in the data analysis report for the new basic events identified in the LPSD model.	Define and document component boundaries and success criteria associated with the new basic events identified for components in the LPSD model. Provide justification for using the same SSC boundaries and success criteria for at-power basic events in the LPSD model.
LDA-C1	LDA-C1-01	The at-power model used two old generic component failure rates databases that will be updated in the near future. No Bayesian update has been performed for the new basic events identified in the LPSD model so no generic data bases have been identified for these new basic events either.	F	At the time of the self-assessment, this task is in progress. So the SR is not met.	Identify/create a new generic database for SSC failure probabilities for LPSD model.
LDA-C2	LDA-C2-01	There is no evidence of plant-specific unreliability data collection effort in the report.	F	There is no evidence of plant-specific unreliability data collection effort in the model documentation for the new basic events identified for LPSI and CS systems. This is why this SR is not met.	Collect and document plant-specific unreliability data.
LDA-C2	LDA-C2-02	Plant-specific unavailability data was collected for Mode 5 and 6 but it was not analyzed. For plant-specific maintenance unavailabilities for Modes 5 and 6, house events were used, but it is not clear what POSs would apply and how it was determined from the data.	F	There is no basis for how the maintenance unavailabilities are evaluated and applied for specific POSs in Modes 5 and 6.	Provide a list of POSs in Modes 5 and 6 where a house event approach is used for maintenance unavailabilities and link the data collected to the house events.

Table B-2 (continued)
Findings and Observations

SR	F & O	Description	F&O Level	Comments	Resolution
LDA-C2	LDA-C2-03	Section 2.2 the Palo Verde LPSD PRA model document, "Tasks 16-17, Data Analysis," shows that unavailability for some components identified in Section 2.1 in Modes 3 and 4 of non-RFO shutdowns were not evaluated.	F		Provide justification for screening out unavailabilities for components for Modes 3 and 4.
LDA-C3	LDA-C3-01	The following components required Bayesian updating for the LPSD model: 1. Motor-operated valves 2. Essential Safeguards Bus 3. K202 Relay 4. K204 Relay No plant-specific unreliability data was collected for these components.	F	No plant-specific unreliability data was collected for the new basic events identified in the LPSD model.	Collect plant-specific unreliability data for the new components identified in the LPSD model.
LDA-C3	LDA-C3-02	The Palo Verde LPSD PRA model document, "Tasks 16-17, Data Analysis," states that the LPSD analysis uses the at-power PRA BE data base in LPSD. CAFTA database (.RR) files indicate that part of at-power basic event data use various test intervals and mission times to calculate probabilities of basic events.	F	Use of applicable parameters is required by the SR, hence this SR is not met.	Applicability of these parameters in the at-power data should be checked and properly adjusted in accordance with characteristics of POSs.
LDA-C4	LDA-C4-01	There is no evidence that a clear basis for the identification of events as failures has been developed for the new LPSD components. No plant-specific unreliability failure data has been collected yet.	F	There is no evidence of a basis for the identification of events as failures for new components in the LPSD model and justification of the use of failure definitions for other components in the at-power model as applied to the LPSD model.	Develop a clear basis for the identification of events as failures for new components in the LPSD model and justify the use of failure definitions for other components in the at-power model as applied to the LPSD model.

Table B-2 (continued)
Findings and Observations

SR	F & O	Description	F&O Level	Comments	Resolution
LDA-C5	LDA-C5-01	No plant-specific unreliability failure data has been collected yet. Therefore there is no evidence that this SR is met.	F	No plant-specific unreliability data collection has been performed.	When collecting plant-specific data for new components in the LPSD model, count repeated plant-specific component failures occurring within a short time interval as a single failure if there is a single, repetitive problem that causes the failures. In addition, count only one demand.
LDA-C6	LDA-C6-01	The Palo Verde LPSD PRA model document, "Tasks 16-17, Data Analysis," states that: "The number of POS-based plant-specific demands for components was considered, but no applicable additional demands were noted." and references Sections 2.0 and 3.1 in Table D-1. However, there is no evidence of such evaluations in the report.	F	The SR requires that the number of plant-specific demands on standby components applicable to a specific POS be estimated. However, there is no evidence of such evaluations in the report.	Document the evaluation of estimation of plant-specific demands on standby components applicable to a specific POS.
LDA-C10	LDA-C10-01	This SR requires reviewing and identifying those surveillance tests that can be credited as demands for a considered component failure mode in the LPSD model. This is part of the plant-specific unreliability data collection effort. This task has not been performed.	F	The review and identification of the surveillance tests that can be credited for specific failure modes have not been performed. Therefore, this SR is not met.	Review and identify those surveillance tests that can be credited as demands for a considered component failure mode in the LPSD model.

Table B-2 (continued)
Findings and Observations

SR	F & O	Description	F&O Level	Comments	Resolution
LDA-C13	LDA-C13-01	Raw data for maintenance unavailability during outage periods is presented in Appendix A of the Palo Verde LPSD PRA model document, "Tasks 16-17, Data Analysis". Unavailability time is evaluated for selected components for each of the last three refueling outages for each of the three units. The data is not aggregated to obtain an average, expected value. Use of the data is not addressed.	F	Because the analysis does not aggregate the data and address how it is used in the model, this SR is considered not met.	Aggregate the unavailability data and address how it is included in the model.
LDA-C16	LDA-C16-01	There is no analysis of offsite power recovery that was credited in the analysis.	F	This is required by SR, so this SR is not met.	Perform recovery analysis for loss of offsite power.
LDA-D8	LDA-D8-01	Actions to address the requirements to address modifications in this SR were not performed.	F	Actions to address the requirements in this SR were not performed. Therefore, this SR is not met.	Evaluate data to address modifications.

C
SR CAPABILITY CATEGORY AND REVIEW RESULTS

Tables C-1 through C-8 provide the assessment details of each SR for the eight technical elements reviewed. This includes the SR Capability Category Rating (described in Tables 1-1 and 1-2) and the basis for the rating.

In these tables, NA means ‘not applicable’ and NR means ‘not reviewed.’ An SR may be not applicable due to the methods used in meeting the standard. For example, if POSs are not grouped, than any SR addressing the grouping of POSs would be assessed as NA. On the other hand, some SRs (primarily in LSC, LHR and LQU) were not reviewed during the self-assessment, because they were deemed to be incomplete and not reviewable.

Table C-1
Supporting Requirements Assessment for LPOS

Supporting Requirement	Capability Category	Assessment
LPOS-A1	II	Palo Verde established a set of representative LPSD evolutions as described in the LPSD PRA model document, "Tasks 1 - 3, Evolutions And Plant Operating States" that includes Refueling outages, Controlled or unplanned shutdowns to either Hot Standby (Mode 3) or Cold Shutdown (Mode 5) conditions, and Shutdowns/outages that include RCS draindown (midloop). However, the use of a three-year look-back period for the identification of potential evolutions may be insufficient for the incorporation of plant-specific operating experience.
LPOS-A2	I/II/III	The Palo Verde LPSD PRA model document, "Tasks 1 - 3, Evolutions and Plant Operating States" document provides a detailed methodology of progressing through the development of evolutions from a broad perspective to a more refined specific event. Sections 2 and 3 of this document provide the results of the grouping of evolutions and the associated POSs.
LPOS-A3	I/II/III	The Palo Verde LPSD PRA model document, "Tasks 1 - 3, Evolutions and Plant Operating States" document provides a detailed methodology of progressing through the development of evolutions from a broad perspective to a representative evolution and more refined POS. Section 3 of this document provides the summary of the attributes associated with the this SR.
LPOS-A4	I/II/III	Palo Verde LPSD PRA model document, "Tasks 1 - 3, Evolutions and Plant Operating States" provides a discussion of identified potential future evolutions. For example, section 3.5 identifies the potential for a POS associated with a draindown occurring with the pressurizer manway remaining intact. Appendix B provides the associated POSs for these potential future evolutions.
LPOS-A5	II/III	The results of interviews with operators have been incorporated into the LPSD evolutions and POSs, but the interviews are not formally documented. The documentation roadmap refers to Sections 2 and 3 of the Palo Verde LPSD PRA model document, "Tasks 1 - 3, Evolutions And Plant Operating States," but these sections formally do not document the interviews. Suggestion: Document interviews with operators and other plant personnel.

Table C-1 (continued)
Supporting Requirements Assessment for LPOS

Supporting Requirement	Capability Category	Assessment
LPOS-A6	II/III	As documented in Section 3.0 of the Palo Verde LPSD PRA model document, "Tasks 1 - 3, Evolutions And Plant Operating States," fifteen (15) standard POSs were used in this analysis. Each POS was characterized by certain plant parameters: core decay heat level, reactor coolant system (RCS) level, RCS temperature, RCS vent status, containment status, decay heat removal mechanisms (i.e., FW, AFW), and initiating events. The availability of automatic and manual systems and the need for operator actions during each POS were also considered by the analysts. This is documented in Section 3.0, Appendix A, Appendix C, and Appendix D. Consideration of plant conditions and heat removal capabilities, initiating events, and time to boil estimates needed for HRA were the basis for why the 15 representative POSs were sub-divided into about 40 POSs to address the differences.
LPOS-A7	NA	NA - Only internal events performed.
LPOS-B1	I	LPSD Evolutions were grouped by the type of unplanned maintenance evolution or planned outage. Section 2.3 of the Palo Verde LPSD PRA model document, "Tasks 1 - 3, Evolutions And Plant Operating States," describes the selection process, which is based primarily on previous operations, plus an additional potential future evolution (hot midloop) identified from plant staff reviews. The evolution selected for Hot Standby (#9) may not be bounding (assumes condenser is available for steam bypass). Documentation of the grouping with respect to meeting items (b) and (c) is needed to meet CC II.
LPOS-B2	NA	NA - POSs were not screened.
LPOS-B3	NA	NA - POSs were not grouped.
LPOS-B4	NA	NA - POSs were not grouped.
LPOS-B5	Not Met	Disposition of this SR does not address the development of POS involving demand-based initiators. Disposition was as follows: It was determined that there was insufficient need to create separate POSs to address potential "demand-based" initiating events. The only "demand-based" initiator was found to be miscalibration of RWLIS, and this was considered inappropriate to limit to a single demand-based POS. Otherwise all initiators were as "time-based".
LPOS-B6	NA	SR Not Applicable - Did not group POSs.
LPOS-B7	NA	NA - POS not grouped

Table C-1 (continued)
Supporting Requirements Assessment for LPOS

Supporting Requirement	Capability Category	Assessment
LPOS-C1	Not Met	The average frequency and average duration of LPSD evolutions were calculated in Section 4.2 using 3 years' experience. More operating experience review could capture information regarding infrequent plant evolutions, such as Evolution #25.
LPOS-C2	I/II/III	Section 4 of Tasks 1 - 3 notebook shows calculation of the average duration and average time after shutdown for each POS.
LPOS-C3	NA	N/A - No POS grouping
LPOS-C4	I/II/III	Decay heat levels for each POS are listed in Appendix D of "Palo Verde Nuclear Generating Station Low Power Shutdown Model Tasks 1-3 Evolutions and Plant Operating States." That document uses time-to-boil data specific to PVNGS. However, the data used provided decay heat data in half-day increments and there is no justification that the coarseness of the decay heat data is acceptable for use in later analyses. In addition, there is no evaluation that the referenced decay calculation is acceptable for use in the LPSD PRA. For example, if the referenced calculation uses upper-bound decay heat curves, then the decay heat levels may be overly conservative.
LPOS-C5	Not Met	There is one statement in Section 2.1 of the Palo Verde LPSD PRA model document, "Tasks 1 - 3, Evolutions And Plant Operating States," that states "Additional Evolutions were added based on possible future activities that were provided during interviews." No documentation or summary of the interviews was available. Additionally, there is no evidence that the result of the reviews validated the assumed decay heat levels and POS durations.
LPOS-D1	NR	Documentation SRs not reviewed
LPOS-D2	NR	Documentation SRs not reviewed
LPOS-D3	NR	Documentation SRs not reviewed

Table C-2
Supporting Requirements Assessment for LIE

Supporting Requirement	Capability Category	Assessment
LIE-A1	I/II/III	The identification of initiating events was based on industry documents (e.g., WCAPs and NUREGs), PVNGS at-power initiating events, and recent operating experience. Two F&Os apply. This SR is Met.
LIE-A2	I/II/III	All of the initiating event categories listed in LIE-A2 are included in the spectrum of initiating events. However, it is not clear whether there are any additional categories caused by at-initiator HFEs (LIE-A2, item (g)) [see F&O LIE-A2-01]. This SR is Met.
LIE-A3	I/II/III	Section 2.2.5 of the Palo Verde LPSD PRA model document, "Tasks 4-6, Initiating Events and Frequencies," describes the review of plant-specific initiating events, as well as other industry events. The SR is Met.
LIE-A4	Not Met	Generic analyses reviewed are identified in Section 2.2 of "Palo Verde Nuclear Generating Station Low Power Shutdown Model Tasks 4- 6 Initiating Events and Frequencies." This section identifies that several initiating events were identified as part of that review. However, there was no indication that the review attempted to identify how at-initiator operator actions could impact later mitigation strategies. This SR requires that the review be performed to identify both items. Since only one of the two factors was identified, this SR is considered not met.
LIE-A5	Not Met	No evidence was available that a systematic evaluation of each system was performed to assess the possibility of causing an initiating event. No evidence was available that a review by POS was performed. Because this review is a requirement of the SR, this is considered not met. Finding LIE-A5-01 documents this issue.
LIE-A6	Not Met	No evidence was available that a systematic evaluation of each system was performed to assess the possibility of causing an initiating event. No evidence was available that a review by POS was performed. Because this review is a requirement of the SR, this is considered not met. Finding LIE-A5-01 documents this issue.
LIE-A7	Not Met	A review of initiating events is documented in Section 2.2.5 of the initiating events analysis. However, this review does not correlate observed initiating events by POS and no assessment of the applicability of events observed as occurring in one POS to other POS is documented. Review of the PVNGS-specific events could not be reproduced without recourse to the author.
LIE-A8	I	This item has not been completed by the developer. Interviews are planned in the future.

Table C-2 (continued)
Supporting Requirements Assessment for LIE

Supporting Requirement	Capability Category	Assessment
LIE-A9	I	CCII is not met. Resolution does not identify that precursors were identified or that the review included at-initiator HFEs.
LIE-A9a	I	Temporary alignments were not addressed for this SR. The intent of temporary alignments is different from configuration alignments.
LIE-A10	NA	Not Applicable - Not in Scope of Review
LIE-B1	I/II/III	An event tree was developed for each IE and then IEs with similar event trees were grouped together. This is a backward approach to the one suggested in the standard. Table 5-1 of the Palo Verde LPSD PRA model document, "Tasks 4-6, Initiating Events and Frequencies," places the 40 LPSD initiators into four groups in order to facilitate accident sequence and quantification development. There was some grouping of IEs performed (e.g., KLOCA, HLOCA and JLOCA) but There is no structured and systematic process to group IEs (see LIE-B2). For example, HLOCA and JLOCA can be grouped together and IEAFP-TD and IEAFP-MD can be grouped together as well.
LIE-B2	Not Met	Table 5-1 of the Palo Verde LPSD PRA model document, "Tasks 4-6, Initiating Events and Frequencies," places the 40 LPSD initiators into four groups in order to facilitate accident sequence and quantification development. In some cases the initiator affects both decay heat removal and RCS inventory. In those cases the initiator would be selected for loss of inventory since it leads more quickly to core uncovery. There is no structured and systematic process to group IEs.
LIE-B3	Not Met	Justification for a valid IE grouping is not evident in the Palo Verde LPSD PRA model document, "Tasks 4-6, Initiating Events and Frequencies.".
LIE-B4	I/II/III	These separate IEs were considered by reviewing those for the at-power model and modifying them for LPSD, if needed. A separate table showing these IEs would be useful in support of a future peer review.
LIE-B5	NA	N/A. Not Performed.

Table C-2 (continued)
Supporting Requirements Assessment for LIE

Supporting Requirement	Capability Category	Assessment
LIE-B6	Not Met	It is not evident from the IE notebook (Palo Verde LPSD PRA model document, "Tasks 4-6, Initiating Events and Frequencies") that the grouping of the time-based and demand-based IEs was done properly.
LIE-C1	Not Met	Initiating Event Frequencies are calculated for each applicable POS, based on generic data. The data source for many of the IEs is taken from the at-power PRA, with some modifications. For new initiating events only applicable to shutdown conditions, industry data is taken primarily from WCAP-16560-P (which relied on NUREG/CR-6144 for much of its data). There is a concern that the use of at-power data requires more justification or analysis. Additionally, there are some assumptions that are not valid (e.g., LOOP frequencies for shutdown are in some cases higher than at-power). Some newer data sources exist (e.g., EPRI 1021176) that aren't accounted for. There is no discussion or mention of plant-specific data, except for reactor vessel failure during low temperature overpressure (LTOP) events. There is no indication that a search for PS data was undertaken.
LIE-C2	Not Met	The use of plant specific data may be implicit in the development, primarily based on the adaptation of the at-power IE modeling, but it is not explicit.
LIE-C3	NA	NA - No credit is taken for recovery actions.
LIE-C4	Not Met	The Palo Verde LPSD PRA model document, "Tasks 4-6, Initiating Events and Frequencies," states that this will be conducted as part of the DA tasks. Based on review of the Palo Verde LPSD PRA model document, "Tasks 16-17, Data Analysis (DA) Notebook," this SR is not met.
LIE-C5	I/II/III	The IE frequency calculation per year was performed and documented in Tables 5-2 and 5-3 of the Palo Verde LPSD PRA model document, "Tasks 4-6, Initiating Events and Frequencies."
LIE-C6	NA	N/A. Not performed.
LIE-C6a	NA	N/A. Not performed.
LIE-C7	I/II	No time trend analysis was performed and time trend analysis is not required to meet CC II.

Table C-2 (continued)
Supporting Requirements Assessment for LIE

Supporting Requirement	Capability Category	Assessment
LIE-C8	Not Met	One initiating event, loss of ADVs, uses a fault tree to quantify the initiating event frequency. The PVNGS LPSD PRA documentation does not include any description of this fault tree. When system fault trees are developed for initiating events, the supporting requirements of the SY technical element are invoked. None of these appear to have been considered, for example, LSY-B8, LSY-A18, LSY-A19, etc. Furthermore, it is not clear that support systems that could affect the initiating event as well as other systems used for accident mitigation were considered and are properly addressed in the modelling. Because no documentation of the fault tree is provided and none of the SY technical element supporting requirements appear to have been addressed, this SR is considered not met.
LIE-C9	NA	N/A. Not performed.
LIE-C9a	NA	N/A. Not performed.
LIE-C10	NA	N/A. Not performed.
LIE-C11	NA	N/A. Not performed.
LIE-C12	I/II/III	Comparison with generic data sources and reasonableness of the IE frequencies are documented throughout the Palo Verde LPSD PRA model document, "Tasks 4-6, Initiating Events and Frequencies." It would be useful to summarize the reasonableness of results and comparison with generic data sources in one place (e.g., one single table).
LIE-C13	I/II	The unique LPSD IEs were analyzed using generic and plant-specific OE and information is documented in Section 2.2 of the Palo Verde LPSD PRA model document, "Tasks 4-6, Initiating Events and Frequencies."
LIE-C14	Not Met	There is no evidence that the ISLOCA frequency for the LPSD model has been quantified properly to address the LPSD conditions.
LIE-C15	Not Met	The uncertainty in the IE frequencies was not characterized.
LIE-D1	NR	Documentation SRs not reviewed
LIE-D2	NR	Documentation SRs not reviewed
LIE-D3	NR	Documentation SRs not reviewed

Table C-3
Supporting Requirements Assessment for LAS

Supporting Requirement	Capability Category	Assessment
LAS-A1	I/II/III	The review of this Technical Element was limited based on the incomplete development of the Success Criteria, TH and HRA analysis as discussed in the HLRs for LAS. This Technical Element and associated SRs should be re-validated following completion of the Success Criteria. Event trees documented in the Palo Verde LPSD PRA model document, "Tasks 7-10, Event Trees and Success Criteria," provide a systematic development of the initiating event and mitigating systems and operator actions, a graphical representation in an "event tree structure" which provides a framework to support sequence quantification. As noted in "Tasks 7 - 10, Event Trees and Success Criteria", event flags are used to allow a given event tree to support multiple POSs.
LAS-A2	Not Met	Individual initiating event descriptions do not include a discussion of the key safety functions. Identification of the key safety function is required for each initiating event by this SR; therefore, this is not met.
LAS-A3	Not Met	In the Palo Verde LPSD PRA model document, "Tasks 7-10, Event Trees and Success Criteria," Table 3-1 provides a listing of the success criteria that is defined for each node in the event trees. Refer to F&O LAS-A2-01.
LAS-A4	I/II/III	Table 3-1 provides an identification of operator actions for the applicable nodes in the event trees. In addition, the description of each individual initiating event also includes a discussion of any applicable operator actions.
LAS-A5	I/II/III	The reference to plant specific information is limited in the level of detail. Reference to the full-power internal events PRA documentation is listed which may ultimately fulfil this SR.
LAS-A6	Not Met	In "Tasks 7 - 10, Event Trees and Success Criteria", the description of the accident sequences are provided in a sequential order that represents the response of systems and operator actions as they are expected to occur in the accident progression.
LAS-A7	I/II/III	Accident sequences are developed for each initiating event. As discussed in "Tasks 7 - 10, Event Trees and Success Criteria", several POS's may be contained within the same event tree.
LAS-A8	I/II	The event trees identify those sequences that end in either a safe state, core damage or a transfer to another fault tree.

Table C-3 (continued)
Supporting Requirements Assessment for LAS

Supporting Requirement	Capability Category	Assessment
LAS-A9	Not Met	This SR requires determination of accident progression parameters using realistic and applicable thermal-hydraulic analysis. No plant specific TH calculations are available at this time. Event trees were developed based on, where applicable, at power event trees supplemented with discussions with station personnel. Therefore, this SR is not met (see Finding LAS-A9-01).
LAS-A10	I	There is a concern that for the modeling brought over from the internal events model, there is no discussion of an evaluation of the applicability of the FPIE system operation and operator actions to the LPSD conditions. For example, Assumption 14 under Task 10 of Section 1 identifies a pre-existing model error that is felt to be slightly non-conservative and negligible. However, with no assessment of the applicability of FPIE to LPSD conditions, the uncertainty of the insignificance becomes larger and may need to be addressed in a more timely fashion. While RWLIS miscalibration is identified as an initiating event in section 2.2.5.3 of IE notebook, it is handled as a sub initiator of initiator of Shutdown Cooling (SDC) initiating event by assumption 15 in AS and SC notebook. (See F&O LAS-A10-01)
LAS-A11	I	Transfers are included in the event tree structure. However, there is no discussion of how the transfers are defined and established for use in the event tree development.
LAS-B1	I/II/III	For each initiating event, mitigating systems impacted by the occurrence of the initiator are identified and incorporated in the accident progression via the system models.
LAS-B2	I/II/III	Event trees and system fault trees adequately account for dependence on success or failure of preceding systems, functions and/or human actions. (See F&O LAS-B1-01).
LAS-B3	Not Met	There is no evidence that phenomenological conditions created by the accident progression or plant conditions within a POS are identified and/or modeled. One example of a possible condition is credit for turbine-driven pump with low decay heat levels (see F&O LAS-B3-01). Although the loss of primary coolant inventory (unisolated) causes loss of SDC, there are no other discussions on these events, including the location and size of postulated losses. (See F&O LAS-B3-02).

Table C-3 (continued)
Supporting Requirements Assessment for LAS

Supporting Requirement	Capability Category	Assessment
LAS-B4	NA	N/A per notebook
LAS-B5	I/II/III	Cursory review of the accident sequences and fault trees reveals a high level of detail that includes intersystem and train level interfaces. Examples include LOSDC, LLOCA, and loss of FW.
LAS-B6	I/II/III	This SR is considered met. However, resolution of LIE-A9a-01 may invalidate this conclusion. The conclusion that this SR is met is based on the following. As an example, the steam generator heat removal (SGHR) development in the Palo Verde LPSD PRA model document, "Tasks 11-12, System Model development," provides dependency examples for both configuration and maintenance practices. Section 2.1.1 provides details of the definition and modeling of SGHR including which steam generator is taken OOS using flags and the various configurations of running equipment (e.g., AFW or SDC), plant modes and other equipment.
LAS-B7	NR	Not Reviewed.
LAS-C1	NR	Documentation SRs not reviewed
LAS-C2	NR	Documentation SRs not reviewed
LAS-C3	NR	Documentation SRs not reviewed

Table C-4
Supporting Requirements Assessment for LSC

Supporting Requirement	Capability Category	Assessment
LSC-A1	NR	Not reviewed
LSC-A2	NR	See LSC-A2-01 (S)
LSC-A2a	NR	Not reviewed
LSC-A3	NR	Not reviewed
LSC-A4	NR	See LSC-A4-01 (F)
LSC-A5	NR	Not reviewed
LSC-A6	NR	Not reviewed
LSC-B1	NR	See LSC-B1-01 (S)
LSC-B2	NR	Not reviewed
LSC-B3	NR	Not reviewed
LSC-B4	NR	Not reviewed
LSC-B5	NR	Not reviewed
LSC-C1	NR	See LSC-C1-01 (S)
LSC-C2	NR	Not reviewed
LSC-C3	NR	Not reviewed

Table C-5
Supporting Requirements Assessment for LSY

Supporting Requirement	Capability Category	Assessment
LSY-A1	I/II/III	There is considerable discussion of the modifications made to the At-Power model logic and of LPSD-specific additions to the fault tree.
LSY-A2	I/II/III	Applicable station procedures for LPSD conditions were reviewed and included as references in the development of the modifications to the At-Power model logic and of LPSD-specific additions to the fault tree. No evidence that system engineer interviews were performed.
LSY-A3	I/II/III	This SR is met primarily through the existing At-Power system modeling development. As noted in the Palo Verde LPSD PRA model document, "Tasks 11 - 12, System Model Development," modifications to the system modeling to address the POS conditions were performed as described.
LSY-A4	Not Met	This SR is considered as Not Met due to the need to perform walkdowns for the CS injection and gravity feed additions. Refer to assumption 11 of "Tasks 11 - 12, System Model Development". Refer to LSY-A4-01.
LSY-A5	I/II/III	This is met through the development of separate modeling for the specific POS including capabilities of the system for the given LPSD condition. A description of the modeling changes is included in the Palo Verde LPSD PRA model document, "Tasks 11 - 12, System Model Development."
LSY-A6	I/II/III	The system modeling boundary was initially established using the At-Power modeling and then subsequently modified to address the specific POS conditions. For the LPSD-specific system modeling, the inclusion of systems and associated components was appropriate.
LSY-A7	I/II	Detailed system modeling was developed starting with the At-Power model and was modified as needed to reflect the POS conditions. In addition, LPSD-specific modeling was developed as needed (e.g., for shutdown cooling and gravity feed).
LSY-A8	Not Met	There were no definitions of component boundaries included in Data Analysis so it was not possible to validate a match between the system modeling component boundaries to the Data Analysis component failure analysis. Refer to LDA-A2-01.

Table C-5 (continued)
Supporting Requirements Assessment for LSY

Supporting Requirement	Capability Category	Assessment
LSY-A9	NA	NA - This SR is NA as the model does not include super components.
LSY-A10	NR	NA - This SR was not completely evaluated based on the lack of full development of Success Criteria and Thermal-Hydraulic (TH) analysis. System modeling is adjusted based on the specific POS. However, further adjustment may be required based on the completion of the Success Criteria and TH development discussed above.
LSY-A11	NR	NA - This SR was not completely evaluated based on the need to fully develop the Success Criteria and TH analysis. The Success Criteria initially used the At-Power criteria and was adjusted based on the specific POS. Further adjustment may be required following completion of the Success Criteria and TH analysis.
LSY-A12	I/II/III	This SR is Met. No evidence of the inclusion of beneficial failures was found.
LSY-A13	I/II/III	Existing At-Power flow diversion modeling was retained. For the LPSD-specific modeling that was added, flow diversion was included as a potential failure mode.
LSY-A14	I/II/III	This SR is met with the exception of the inclusion of pre-initiator human actions.
LSY-A15	NA	NA - This SR is Not Applicable.
LSY-A16	NR	NR - This SR is not reviewable at this time. The HRA Pre-initiator development has not been completed at this time. Future evaluation of this SR is recommended in conjunction with review of the LHR requirements.
LSY-A17	I/II/III	NA - HFEs associated with the At-Power model have been retained and Operator Actions associated with LPSD conditions have been identified. These operator actions are aligned with the different POS conditions. However, the full development of the HRA has not been completed at this time. This SR is considered met based on the information available at this time. However, a validation of the Operator actions should be performed after completion of the HRA task.

Table C-5 (continued)
Supporting Requirements Assessment for LSY

Supporting Requirement	Capability Category	Assessment
LSY-A18	I/II/III	System failures were retained from the At-Power model. Functions added to address the LPSD conditions were evaluated for failure mechanisms and were included in the initiating event attribute, where applicable for those systems such as for SDC with the Loss of SDC initiating event.
LSY-A19	I/II/III	Maintenance unavailability was incorporated into the model at a train level and through house events for individual components to allow for future configuration risk application. System actuations were removed from applicable POSs and replaced with operator action events to initiate the system.
LSY-A20	I/II/III	The outage maintenance philosophy in use by the utility focuses on train maintenance such that redundant equipment is not removed simultaneously.
LSY-A21	I/II/III	These attributes were retained from the At-Power model and verified to remain valid for LPSD. The LPSD specific attributes were incorporated into the model through the POS specific modeling.
LSY-A22	II	The At-Power analyses was used. LPSD specific limitations were identified by station procedure and incorporated into the POS system modeling.
LSY-A23	I/II/III	Model nomenclature was retained from the At-Power model for consistency including the new events developed for the LPSD conditions.
LSY-A24	NA	NA - No credit was taken for mean time to repair.

Table C-5 (continued)
Supporting Requirements Assessment for LSY

Supporting Requirement	Capability Category	Assessment
LSY-B1	Not Met	It appears that no systematic approach to common cause modelling was used for LPSD-specific system models. Also, no evaluation of the applicability of the at-power analysis is provided. Several SR-specific comments are provided where specific problems have been identified. However, overall, HLR-SY-B is not reviewable. Common cause failures are modelled using the methods and data applied in the at-power PRA model. No review or justification of the applicability of the at-power common-cause modelling to the LPSD model was evident. A spot check of system models developed specifically for the LPSD model was performed and it was noted that common-cause failures of the atmospheric dump valves (ADVs) was not included based on an unjustified assumption. Also, it does not appear that common-cause failures were included for shutdown cooling (SDC) valves, e.g., HV-683 and HV-692. Because both randomly-selected spot checks of the model indicated errors, and no justification of the at-power modelling was performed, this SR is considered not met.
LSY-B2	NA	Not applicable, since there is no inter-system CCF modeling.
LSY-B3	Not Met	Common cause failures are modelled using the methods and data applied in the at-power PRA model. No review or justification of the applicability of the at-power common-cause modelling to the LPSD model was evident. No documentation of the common cause grouping of components for LPSD-specific components was provided. Refer to F&O LSY-B1-01. Because no documentation of common cause groups was provided and no justification of the at-power modelling was performed, this SR is considered not met.
LSY-B4	NR	Not reviewed
LSY-B5	NR	Not reviewed
LSY-B6	NR	Not reviewed

Table C-5 (continued)
Supporting Requirements Assessment for LSY

Supporting Requirement	Capability Category	Assessment
LSY-B7	NR	Not reviewed
LSY-B8	NR	Not reviewed
LSY-B9	NR	Not reviewed
LSY-B10	NR	Not reviewed
LSY-B11	NR	Not reviewed
LSY-B12	NR	Not reviewed
LSY-B13	NR	Not reviewed
LSY-B14	NR	Not reviewed
LSY-B15	NR	Not reviewed
LSY-C1	NR	Documentation SRs not reviewed
LSY-C2	NR	Documentation SRs not reviewed
LSY-C3	NR	Documentation SRs not reviewed

Table C-6
Supporting Requirements Assessment for LDA

Supporting Requirement	Capability Category	Assessment
LDA-A1	Not Met	Reliability data analysis was mainly based on at-power data analysis and components reliability estimates. Some new reliability basic events were defined for the LPSD model. New maintenance unavailability basic events and estimates were developed for the LPSD model. Correct the definition of the basic event: 4SIAPSV189-RV-FO = LTOP Train B Relief Valve Fails to Close (should be Fail to Open).
LDA-A2	Not Met	New basic events have been identified, but the component boundaries and success criteria have not been defined and documented in the data analysis report. Also, there are no justifications provided for using the same SSC boundaries and success criteria for at-power basic events in the LPSD model.
LDA-A3	I/II/III	The same data analysis methodology was used for the LPSD PRA model as in the at-power PRA model. Similar failure probability models (e.g., failure on demand, hourly failure rates, unavailabilities) were used.
LDA-A4	I/II/III	The LPSD PRA model used the methodology from the at-power PRA for demand, operating failures, and standby failures. Test and maintenance unavailability was developed based upon maintenance rule and/or shutdown outage operation history of PVNGS, as were POS durations and frequencies. The LPOS durations and frequencies are documented in the Palo Verde LPSD PRA model document, "Tasks 1 – 3, Evolutions and Plant Operating States."
LDA-B1	II	The grouping of components for parameter estimation relies on the at-power PRA model and methodology. No grouping was needed or done for LPSI and CS components modeled in the LPSD model.
LDA-B2	II	No outlier components were identified for LPSD model.
LDA-C1	Not Met	Not performed. This portion of the model was under development at the time of the self-assessment. The at-power model used two old generic component failure rate databases that are planned to be updated in the future. No Bayesian update has been performed for the new basic events identified in the LPSD model so no generic data bases have been identified for these new basic events.
LDA-C2	Not Met	Plant-specific unavailability data has been collected and documented in the Palo Verde LPSD PRA model document, "Tasks 16-17, Data Analysis." However, there is no evidence of plant-specific unreliability data collection effort in the report. See Findings LDA-C2-01, LDA-C2-02, and LDA-C2-03.

Table C-6 (continued)
Supporting Requirements Assessment for LDA

Supporting Requirement	Capability Category	Assessment
LDA-C3	Not Met	The following components required Bayesian updating for the LPSD model: 1. Motor-operated valves 2. Essential Safeguards Bus 3. K202 Relay 4. K204 Relay No plant-specific unreliability data was collected for these components.
LDA-C4	Not Met	There is no evidence that a clear basis for the identification of events as failures has been developed for the new LPSD components. No plant-specific unreliability failure data has been collected.
LDA-C5	Not Met	No plant-specific unreliability failure data has been collected. Therefore there is no evidence to see that this SR is met.
LDA-C6	Not Met	The Palo Verde LPSD PRA model document, "Tasks 16-17, Data Analysis," states that: "The number of POS-based plant-specific demands for components was considered, but no applicable additional demands were noted" in Sections 2.0 and 3.1. However, there is no evidence of such evaluations in the report.
LDA-C7	Not Met	The Palo Verde LPSD PRA model document, "Tasks 16-17, Data Analysis," states that "Unavailability data was collected based on plant operating experience and assigned to the appropriate POS" as documented in Sections 2.0 and 3.1 and Appendix A and Appendix B. Plant-specific unavailability data was collected for Mode 5 and 6 but it was not analyzed. For plant-specific maintenance unavailabilities for Modes 5 and 6, house events were used, but it is not clear what POSs would apply and how it was determined from the data. Refer to Findings LDA-C2-01, LDA-C2-02, and LDA-C2-03.
LDA-C8	Not Met	The Palo Verde LPSD PRA model document, "Tasks 16-17, Data Analysis," states that "Unavailability data and standby alignments were collected and reviewed based on plant operating experience and assigned to the appropriate POS." in Sections 2.0 and 3.1 and Appendix A and Appendix B. Refer to Findings LDA-C2-01, LDA-C2-02, and LDA-C2-03 and LIE-A9a-01 (with regard to temporary alignments).
LDA-C9	Not Met	There is no evidence of collecting plant-specific run times for LPSD components. Refer to Finding LDA-C2-01.

Table C-6 (continued)
Supporting Requirements Assessment for LDA

Supporting Requirement	Capability Category	Assessment
LDA-C10	Not Met	This SR requires reviewing and identifying those surveillance tests that can be credited as demands for a considered component failure mode in the LPSD model. This is part of the plant-specific unreliability data collection effort. This task has not been performed.
LDA-C11	Not Met	The Maintenance Rule (MR) data was used to determine the OOS duration times to estimate component unavailabilities. Refer to Findings LDA-C2-02 and LDA-C2-03.
LDA-C12	I/II/III	As described in Section 2.2 of the data notebook, unavailability for POS in Modes 3 and 4 is modelled using same methodology as was used for the at-power PRA model. The at-power modelling of maintenance unavailable is acceptable for the LPSD PRA model in Mode 3 and 4. Modelling of maintenance unavailability for Mode 5 and Mode 6 is described in Section 2.1. The modelling appears to be appropriate for the LPSD PRA.
LDA-C13	Not Met	Raw data for maintenance unavailability during outage periods is presented in Appendix A of the Palo Verde LPSD PRA model document, "Tasks 16-17, Data Analysis." Unavailability time is evaluated for selected components for each of the last three refueling outages for each of the three units. The data is not aggregated to obtain an average, expected value. Use of the data is not addressed. Since the analysis does not aggregate the data and address how it is used in the model, this SR is considered not met.
LDA-C14	Not Met	As described in Section 2.2 of the Palo Verde LPSD PRA model document, "Tasks 16-17, Data Analysis ," unavailability for POS in Modes 3 and 4 is modelled using the same methodology as was used for the at-power PRA model. The at-power modelling of maintenance unavailability is acceptable for the LPSD PRA model in Mode 3 and 4. Modelling of maintenance unavailability for Mode 5 and Mode 6 is described in Section 2.1. The modelling appears to be appropriate for the LPSD PRA. Refer to Finding LDA-C2-02.
LDA-C15	NA	N/A. No repair modeling performed in LPSD.
LDA-C16	Not Met	Offsite power recovery is credited, but there is no documentation of the basis. Shutdown specific non-recovery data should be used.

Table C-6 (continued)
Supporting Requirements Assessment for LDA

Supporting Requirement	Capability Category	Assessment
LDA-C17	I/II/III	Calculation of POS and evolution times are documented in Section 4 of the Palo Verde LPSD PRA model document, "Tasks 1 – 3, Evolutions and Plant Operating States." Evaluation of test and maintenance durations is documented in Section 2.1 of the Palo Verde LPSD PRA model document, "Tasks 16-17, Data Analysis."
LDA-C18	NA	No generic estimates were used. Therefore, this SR is not applicable.
LDA-C19	I/II/III	Calculation of POS and evolution times are documented in Section 4 of the Palo Verde LPSD PRA model document, "Tasks 1 – 3, Evolutions and Plant Operating States."
LDA-D1	Not Met	This analysis uses data from the at-power PRA and identified new basic events for LPSD specific components, but no new reliability data was evaluated. Refer to Finding LDA-C2-01.
LDA-D2	Not Met	This analysis uses data from the at-power PRA and identified new basic events, but no new reliability data was evaluated. Refer to Finding LDA-C2-01.
LDA-D3	Not Met	Data from at-power PRA was used to develop the LPSD PRA data. The at-power PRA data was evaluated using the Bayesian approach with uncertainty information. However no analysis was performed for LPSD data. Refer to Finding LDA-C2-01.
LDA-D4	Not Met	Data from at-power PRA was used to develop the LPSD PRA data. The prior distribution data for the at-power model is based on NUREG/CR-6928. However no analysis was performed for LPSD data. Refer to Finding LDA-C2-01.
LDA-D5	II	The LPSD PRA data analysis uses the Alpha Factor method based on the at-power PRA.
LDA-D6	Not Met	There is no documentation of CCF analysis in the data analysis notebook. Refer to Finding LDA-A1-01.
LDA-D7	NA	No screening of data was performed. Therefore, this SR is not applicable.
LDA-D8	Not Met	Actions to address the plant modification requirements in this SR were not performed. Therefore, this SR is not met.

Table C-6 (continued)
Supporting Requirements Assessment for LDA

Supporting Requirement	Capability Category	Assessment
LDA-E1	NR	Documentation SRs not reviewed
LDA-E2	NR	Documentation SRs not reviewed
LDA-E3	NR	Documentation SRs not reviewed

Table C-7
Supporting Requirements Assessment for LHR

Supporting Requirement	Capability Category	Assessment
LHR-A1	NR	Not Reviewed
LHR-A2	NR	Not Reviewed
LHR-A2a	NR	Not Reviewed
LHR-A3	NR	Not Reviewed
LHR-B1	NR	Not Reviewed
LHR-B2	NR	Not Reviewed
LHR-B3	NR	Not Reviewed
LHR-C1	NR	Not Reviewed
LHR-C1a	NR	Not Reviewed
LHR-C2	NR	Not Reviewed
LHR-C3	NR	Not Reviewed
LHR-D1	NR	Not Reviewed
LHR-D2	NR	Not Reviewed
LHR-D3	NR	Not Reviewed
LHR-D4	NR	Not Reviewed
LHR-D5	NR	Not Reviewed
LHR-D6	NR	Not Reviewed
LHR-D7	NR	Not Reviewed
LHR-E1	NR	Not Reviewed

Table C-7 (continued)
Supporting Requirements Assessment for LHR

Supporting Requirement	Capability Category	Assessment
LHR-E2	NR	Not Reviewed
LHR-E3	NR	Not Reviewed
LHR-E4	NR	Not Reviewed
LHR-F1	NR	Not Reviewed
LHR-F2	NR	Not Reviewed
LHR-F3	NR	Not Reviewed
LHR-G1	NR	Not Reviewed
LHR-G2	NR	Not Reviewed
LHR-G3	NR	Not Reviewed
LHR-G3a	NR	Not Reviewed
LHR-G4	NR	Not Reviewed
LHR-G5	NR	Not Reviewed
LHR-G6	NR	Not Reviewed
LHR-G7	NR	Not Reviewed
LHR-G8	NR	Not Reviewed
LHR-H1	NR	Not Reviewed
LHR-H2	NR	Not Reviewed
LHR-H3	NR	Not Reviewed
LHR-I1	NR	Not Reviewed

Table C-7 (continued)
Supporting Requirements Assessment for LHR

Supporting Requirement	Capability Category	Assessment
LHR-I2	NR	Not Reviewed
LHR-I3	NR	Not Reviewed
LHR-J1	NR	Not Reviewed
LHR-J2	NR	Not Reviewed
LHR-J3	NR	Not Reviewed
LHR-J4	NR	Not Reviewed
LHR-J5	NR	Not Reviewed
LHR-K1	NR	Not Reviewed
LHR-K1a	NR	Not Reviewed
LHR-K2	NR	Not Reviewed
LHR-K3	NR	Not Reviewed
LHR-K4	NR	Not Reviewed
LHR-K5	NR	Not Reviewed
LHR-K6	NR	Not Reviewed
LHR-K7	NR	Not Reviewed
LHR-K8	NR	Not Reviewed
LHR-L1	NR	Not Reviewed
LHR-L2	NR	Not Reviewed

Table C-7 (continued)
Supporting Requirements Assessment for LHR

Supporting Requirement	Capability Category	Assessment
LHR-L3	NR	Not Reviewed
LHR-M1	NR	Not Reviewed
LHR-M2	NR	Not Reviewed
LHR-M3	NR	Not Reviewed

Table C-8
Supporting Requirements Assessment for LQU

Supporting Requirement	Capability Category	Assessment
LQU-A1	NR	Not Reviewed
LQU-A2	NR	Not Reviewed
LQU-A3	NR	Not Reviewed
LQU-A4	NR	Not Reviewed
LQU-A5	NR	Not Reviewed
LQU-B1	NR	Not Reviewed
LQU-B2	NR	Not Reviewed
LQU-B3	NR	Not Reviewed
LQU-B4	NR	Not Reviewed
LQU-B5	NR	Not Reviewed
LQU-B6	NR	Not Reviewed
LQU-B7	NR	Not Reviewed
LQU-B8	NR	Not Reviewed
LQU-B9	NR	Not Reviewed
LQU-B10	NR	Not Reviewed
LQU-C1	NR	Not Reviewed
LQU-C2	NR	Not Reviewed
LQU-C3	NR	Not Reviewed
LQU-D1	NR	Not Reviewed

Table C-8 (continued)
Supporting Requirements Assessment for LQU

Supporting Requirement	Capability Category	Assessment
LQU-D2	NR	Not Reviewed
LQU-D3	NR	Not Reviewed
LQU-D4	NR	Not Reviewed
LQU-D5	NR	Not Reviewed
LQU-D6	NR	Not Reviewed
LQU-D7	NR	Not Reviewed
LQU-E1	NR	Not Reviewed
LQU-E2	NR	Not Reviewed
LQU-E3	NR	Not Reviewed
LQU-E4	NR	Not Reviewed
LQU-F1	NR	Not Reviewed
LQU-F2	NR	Not Reviewed
LQU-F3	NR	Not Reviewed
LQU-F4	NR	Not Reviewed
LQU-F5	NR	Not Reviewed
LQU-F6	NR	Not Reviewed

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