SUBMITTAL-ONLY SCREENING REVIEW OF THE PALO VERDE NUCLEAR GENERATING STATION UNITS INDIVIDUAL PLANT EXAMINATION FOR EXTERNAL EVENTS

(Seismic Portion)

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1.0 INTRODUCTION

1.1 Purpose

In response to the NRC issued Supplement 4 to Generic Letter (GL) 88-20, "Individual Plant Examination of External Events (IPEEE) for Severe Accident Vulnerabilities - 10 CFR 50.54(f)", the Arizona Public Service Company (APS) performed an IPEEE for the Palo Verde Nuclear Generating Station (PVNGS) Unit 1,2, and 3, and submitted the IPEEE results to NRC [1]. Brookhaven National Laboratory (BNL), as requested by NRC, performed the submittal-only screening review to verify the technical adequacy of the seismic portion of the APS's IPEEE submittal. This Submittal-only Screening Review presents the results and conclusions of the BNL review and evaluation.

BNL's methodology utilized for the review followed the guidelines provided in the document titled "Guidance for the Performance of Screening Reviews of Submittals in response to USNRC Generic Letter 88-20, Supplement 4" (Draft, Oct. 24, 1996).

1.2 Background

PVNGS is comprised of three virtually identical nuclear units, each a Combustion Engineering System 80™ (C-E System 80™) Pressurized Water Reactor (PWR) Nuclear Steam Supply System (NSSS) design. The rated core thermal power level is 3800 MWt plus 17 MWt net of heat from nonreactor sources. APS was granted construction permits on May 25, 1976, and commercial operation began on January 28, 1986, September 19, 1986, and January 8, 1988 for Units 1, 2, and 3, respectively. The engineering and construction of PVNGS were contracted to Bechtel Power Corporation.

1.3 Licensee's IPEEE Process and Licensee's Insights

The plant licensing seismic design basis is a 0.2g Safe Shutdown Earthquake (SSE) using ground motion design spectra defined by Regulatory Guide 1.60. However, the plant was designed for 0.25g peak ground acceleration (PGA). The Review Level Earthquake (RLE) established for the Palo Verde site was represented by a 5% damped NUREG/CR-0098 median spectrum with a PGA of 0.5g. After a series of negotiations and PVNGS seismic hazard evaluation, NRC subsequently approved the 0.3g full-scope assignment for PVNGS by letter dated September 27, 1993. The chronology of IPEEE correspondence is listed in Table 2-1 of the submittal.

In response to the NRC issued Supplement 4 to Generic Letter (GL) 88-20, APS performed an IPEEE for the PVNGS Unit 1,2, and 3. The seismic portion of the IPEEE was developed based on the EPRI methodology for Seismic Margins Assessment (SMA) and carried out by a team consisting of APS , EQE International and Robert Kennedy of RPK Structural Mechanics Consulting. The results of the SMA were enclosed in the IPEEE report which was submitted to NRC with a letter, dated June 30, 1995.

The PVNGS SMA included an identification of the systems required to operate following a seismic event. Two success paths, for both a reactor trip transient with the RCS intact and a small-break LOCA (SBLOCA) transient, were selected. A seismic walkdown was performed and it was confirmed that there is a High Confidence of a Low Probability of Failure (HCLPF) for those components required to achieve at least one

success path on each Success Path Logic Diagram. It is concluded in the submittal that the PVNGS power plants are adequately designed and constructed to withstand credible seismic events and that the IPEEE has demonstrated that no seismic vulnerabilities exist at PVNGS.

2.0 REVIEW FINDINGS

2.1 IPEEE Format and Methodology Documentation

The submittal was organized in a format consistent with the guidelines provided in NUREG-1407, and the method and associated assumptions used in the seismic IPEEE were described in sufficient depth. All major seismic IPEEE related issues were addressed, including plant walkdowns, system analysis, relay chatter, soil liquefaction, nonseismic failures, human actions and containment performance. Discussions were also provided with respect to certain generic issues identified in NUREG-1407. Therefore, it seems that the IPEEE format and methodology documentation are adequate.

2.2 Seismic Review Team Selection

A single Seismic Review Team (SRT) was formed with the participation of individuals who have knowledge and experience with the plant walkdown process. The SRT selection was in full compliance with requirements of EPRI NP-6041.

2.3 Seismic Input

The Design Basis Earthquake (DBE) is 0.2g, however, the plant soil-structure interaction (SSI) analyses were performed for a seismic input of 0.25g peak ground acceleration (PGA). A 0.25g PGA was utilized in the design of Category I equipment.

The Review Level Earthquake (RLE) assigned to the plant by NRC is 0.3g and the plant is binned in the full-scope category.

2.4 Success Path Selection and Safe Shutdown Equipment List (SSEL)

The selection of the systems and the equipment required for the system operations in an accident mitigation process is based on the EPRI methodology. The submittal states that the development of plant-specific Success Path Logic Diagrams (SPLD) with the RCS intact and under SBLOCA conditions was aided by a plant-specific PRA (apparently this is the PVNGS IPE). The paths are discussed in some detail and outlined in Figures 3-1 and 3-2 of the Submittal. The SPLD with an intact RCS uses the Reactor Protection System, Auxiliary Feedwater, the Atmospheric Dump Valves, the Auxiliary Pressurizer Spray System, and the Shutdown Cooling System. The Small Break LOCA SPLD uses the Reactor Protection System, Auxiliary Feedwater, the Atmospheric Dump Valves, High Pressure Injection, and High Pressure Recirculation. Both the RCS intact and the SBLOCA paths require secondary cooling as this plant does not have a feed and bleed capability. Because of the lack of the PORVs for feed and bleed operation, the Palo Verde analysis considered an additional system, called the N Train AFW system, in both success paths, in addition to the seismically qualified regular AFW system. However, this N Train AFW is not seismically qualified. It was originally considered for a possible seismic capacity upgrade, but it appears that system interactions of this system with other non-safety equipment were identified, which precluded a cost effective seismic capacity upgrade. Therefore, PVNGS has a single seismically qualified success path for an intact RCS case, plus a single qualified path for the SBLOCA case.

The compilation of the SSELs provides a complete list of all active and passive components associated with operation of required support and frontline systems as documented in the submittal. The procedure for the SSEL development appears to be adequate.

2.5 Plant Walkdown Approach

Based on the results of the new SSI analysis, it was concluded that all seismic category I equipment including relays have a HCLPF greater than the RLE demand. Therefore, the plant walkdown focused on verifying acceptable equipment anchorage and a lack of system interaction concerns. The walkdown approach and procedure were described in sufficient detail including: selection of the Seismic Review Team (SRT); modification to the SMA suggested by EPRI for task consolidation; format of walkdown documentation sheets; and resolutions of all walkdown concerns. The description of the walkdown process appears to be adequate, and it is stated in the submittal that all concerns identified in the walkdown affecting the primary mitigation paths, listed in Table 3-4 of the submittal, were satisfactorily resolved. The plant level HCLPF was therefore determined to be higher than the RLE demand.

It seems that the seismic/fire and seismic/flood interactions issues were considered in the walkdowns. There is no discussion of any issues resulting from such interactions and how such issues were resolved in the success path HCLPF calculations.

2.6 Structural Analysis and HCLPF Calculation

In Section 3.1.3 of the submittal, it is stated that a new set of soil-structure interaction (SSI) analyses were performed at PVNGS for the 0.3g RLE by ABB Impell Corporation and new in-floor response spectra (IFRS) for the IPEEE for a 0.3g RLE were generated. It is further stated that comparisons of these spectra to the plant design basis spectra indicate that for all locations in the plant where equipment on the IPEEE safe shutdown equipment list (SSEL) is located, the design spectra envelop the IPEEE spectra. Therefore, it is concluded in the submittal that all SSEL equipment, including relays and equipment associated with containment performance, have been seismically qualified for an earthquake level exceeding the RLE. Since this conclusion plays a crucial role in decisions made for walkdowns, alternative shutdown path selection, relay chatter evaluations, and HCLPF calculation for systems, components and equipment in success paths, the results of the Impell SSI analysis summarized in the submittal were examined for this submittal-only review to determine the adequacy and validity of the analysis.

The Impell SSI analyses were performed using the computer code SASSI for five buildings at PVNGS. The N-S, E-W, and vertical components of the RLE IFRS with 5% damping were generated for all locations where the equipment on the SSEL is located. A sampling of comparisons of the IFRS and the design basis spectra for the Control, Auxiliary, Diesel Generator and Containment buildings is provided in Appendix 3B of the submittal. By visual inspection of these spectra comparisons three noticeable effects of the Impell SSI models were observed:

1) Significant spectral amplitude reductions in the RLE IFRS by as much as 80 percent compared to the design basis spectra.

2) Peak frequency shifts of the RLE IFRS by as much as 20 percent relative to the corresponding design basis spectra, which implies that the new SSI models differ from the SSI models used for generating the plant design basis spectra,

3) The ZPAs of the RLE IFRS for floor levels above grade are in some cases close to or below the RLE PGA, which is uncommon for structures situated on competent soils.

In light of the above observation, evaluation of the new Impell SASSI analysis may be worthwhile to determine its usefulness for assessing structural response at PVNGS. However, as discussed in Section 3.0, such an evaluation will not significantly impact the determination of whether the licensee has met the objectives of GL 88-20.

2.7 Soil Evaluation

The original site soil evaluation was reviewed by Geomatrix for the IPEEE. The potential for liquefaction of cohesion-less soils that underlie the site was discussed and evaluated. The submittal stated that the results of the analysis showed factors of safety against liquefaction of approximately 2.5 and higher for a peak ground acceleration of 0.3g. Earthquake induced settlements were also addressed and found to be negligible.

2.8 Relay Chatter Evaluation

A discussion on the relay chatter evaluation was provided and the procedure for verifying relay capacity was described. The relay capacities were examined using two sources: (1) GERS in EPRI-NP-7147-SL, and (2) the plant seismic qualification test records. The relay evaluation was documented in accordance with EPRI-NP-7148. The submittal states that " the control circuit diagrams of the SSEL components were examined to identify those relays for which relay chatter would prevent the associated SSEL component from performing its needed safety function. Once these relays were identified relay manufacturer and model information was obtained from plant computerized data bases and it was verified that these relays had a capacity in excess of the RLE demand."

While the relay analysis appears appropriate, concerns remain because the relay evaluation was performed using the new Impell SASSI analysis questioned in Section 2.6 above.

2.9 Containment Performance

Issues related to containment performance were addressed. Important equipment essential to containment performance was included in the SSEL and reviewed by the SRT during the walkdown. Discussions were included with respect to various concerns identified by the SRT. A summary of the identified concerns and resolutions were presented in Table 3-4 of the submittal.

However, issues related to containment bypass were not discussed in the submittal.

2.10 Nonseismic Failures and Human Actions

Nonseismic failures were discussed and the systems requiring manual actuation were identified and examined. It was concluded in the IPEEE that the operators are trained and can be relied upon to achieve cold shutdown following a loss of offsite power event, and there is high confidence that these actions would be performed within the available time. While the submittal does state that "the emergency procedures were examined to identify steps of the procedures that require the operators to verify or monitor certain plant parameters," there is no detailed discussion of operator actions, timing, location, access limitations, or other aspects of the HRA modeling within the success paths chosen.

2.11 Seismically-Induced Fires/Floods

Seismically-induced fires/floods were addressed in the plant walkdown. The submittal states that seismic/fire interaction issues addressed in the walkdown were (a) potential failure of SSEL components due to seismically induced fires and (b) the failure of SSEL components due to the inadvertent actuation of the fire protection system. Regarding flooding interaction concerns the submittal states that the typical concerns were covered in the PVGNS design to satisfy the requirements of Reg Guide 1.29 and therefore the walkdown concentrated on issues that may have been overlooked or appeared marginal. No detailed information is provided. Table 3-4 of the submittal which summarizes the walkdown findings only lists one flooding concern and this was judged not to be a problem by the seismic review team. The submittal states that all walkdown concerns affecting the primary mitigation path on either SPLD were satisfactorily resolved. The evaluations of seismically-induced fires/floods were documented in the Seismic Evaluation Worksheets with the fourth column used for seismic/fire interaction concerns and the fifth column for flooding system interaction concerns.

2.12 Unresolved Safety Issues (USIs) and Generic Safety Issues (GSIs)

<u>GSI-131</u> <u>Potential Seismic Interaction Involving the Movable In-Core Flux Mapping System Used in Westinghouse Plants</u>

GSI-131 is not applicable to this plant.

<u>USI A-45</u> <u>Shutdown Decay Heat Removal Requirements</u>

USI A-45, the decay heat removal issue, was addressed in the course of performing the IPEEE.

<u>GSI-156</u> <u>Systematic Evaluation Program (SEP)</u>

GSI-156 is not applicable to this plant.

<u>GSI-172</u> <u>Multiple System Response Program (MSRP)</u>

GSI-172 issues were addressed in the IPEEE submittal as follows:

- The effect of fire protection system actuation on safety-related equipment was addressed in Section 3.1.1 of the submittal.
- Seismic/fire interactions were addressed in Section 3.1.1 of the submittal.
- Hydrogen line ruptures were addressed in Section 3.1.1 of the submittal.
- Seismic-induced flooding was addressed in Section 3.1.1 of the submittal.
- Seismic-induced spatial and functional interactions were addressed in Sections 3.1.2 of the submittal.
- Seismic-induced relay chatter evaluation was addressed in Section 3.1.2 of the submittal.
- Failures related to human errors were discussed in Section 3.1.2 of the submittal.

2.13 Vulnerabilities/Plant Improvements

The submittal states that "for purposes of the PVNGS Seismic Margins Analysis a vulnerability would have been determined to exist if the seismic capacity of components on the highest capacity branch of either SPLD was determined to have a HCLPF of less than the RLE level." The plant seismic IPEEE has identified no such seismic related vulnerabilities and has determined that both of the success paths (i.e., the one for an intact RCS and the one for an SBLOCA) have a HCLPF in excess of the RLE level. As a result, no significant changes were made to plant design. However, the submittal notes that the walkdown identified a limited number of actions which need be taken to improve plant seismic capacity. The submittal provides no listing of these actions but cites as an example the improvement of the anchorage on the bookshelves located behind the control cabinets in Unit 3 to reduce the possibility that the cabinets would be impacted during a seismic event.

3.0 OVERALL EVALUATION AND CONCLUSIONS

The overall process, methods, documentation and organization of the submittal are consistent with NUREG-1407. The study has addressed issues relevant to the IPEEE program requested for the 0.3g full-scope plants. The strengths of the IPEEE, as documented in the submittal, are the well planned walkdown procedure and detailed description and documentation of systems, component and equipment in the success paths.

The EPRI seismic margins methodology with enhancements was used. Seismic/fire and seismic/flooding interactions were considered. The success paths and the SSEL appear reasonable. Non-seismic failure and operator actions were considered in the analysis, although only limited discussion is provided.

A major weakness of the submittal is that the seismic evaluation of SSEL components in the IPEEE relied heavily on the new plant soil structure interaction analyses. This new SSI analysis, which showed a significant spectral amplitude reduction when compared with the original design response, may be flawed. Therefore, a concern exists regarding this new Impell SASSI analysis and its usefulness for assessing structural response at PVNGS.

However, since the review level earthquake for the Palo Verde site was set at 0.3g and the PVNGS units were designed against an SSE of 0.25g, further detailed review of the new SSI analysis is unlikely to have a significant impact on the conclusion that the licensee's IPEEE submittal has fulfilled the objectives for the seismic area as outlined in GL 88-20. Nevertheless, the usefulness of new SSI analysis appears limited without a further detailed review.

Minor weaknesses were identified in some parts of the documentation of the submittal where only a very brief discussion of issues was provided. Examples are consideration of important operator actions and fire and flood interactions.

4.0 REFERENCE

[1] Palo Verde Nuclear Generating Station, Individual Plant Examination of External Events, Rev. 0 6/1/95, Attachment to Letter dated June 30, 1995 from James L. Levine (for William L. Stuart) of Arizona Public Service Company to USNRC.