10 CFR 50.73

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102-07971-MLL/SPD
October 11, 2019

ATTN: Document Control Desk
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

Dear Sirs:

Subject: **Palo Verde Nuclear Generating Station (PVNGS) Unit 2**
**Docket No. STN 50-529 / License No. NPF 51**
**Licensee Event Report 2019-001-00**

Enclosed please find Licensee Event Report (LER) 50-529/2019-001-00 that has been prepared and submitted pursuant to 10 CFR 50.73. This LER reports an automatic actuation of the PVNGS Unit 2 reactor protection system.

In accordance with 10 CFR 50.4, copies of this LER are being forwarded to the Nuclear Regulatory Commission (NRC) Regional Office, NRC Region IV, and the Senior Resident Inspector.

Arizona Public Service Company makes no commitments in this letter. If you have questions regarding this submittal, please contact Matthew Kura, Department Leader, Nuclear Regulatory Affairs, at (623) 393-5379.

Sincerely,

Maria Lacal

MLL/SPD

Enclosure

cc: S. A. Morris NRC Region IV Regional Administrator
S. P. Lingam NRC NRR Project Manager for PVNGS
C. A. Peabody NRC Senior Resident Inspector PVNGS

NRC FORM 366 (04-2018) U.S. NUCLEAR REGULATORY COMMISSION

APPROVED BY OMB: NO. 3150-0104 EXPIRES: 03/31/2020

# LICENSEE EVENT REPORT (LER)

(See Page 2 for required number of digits/characters for each block)

(See NUREG-1022, R.3 for instruction and guidance for completing this form http://www.nrc.gov/reading-rm/doc-collections/nuregs/staff/sr1022/r3/)



| 1. Facility Name | 2. Docket Number | 3. Page |
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| Palo Verde Nuclear Generating Station (PVNGS) Unit 2 | 05000529 | 1 OF 6 |

**4. Title**

Automatic Actuation of the Reactor Protection System Resulting from a Loss of Reactor Coolant Pumps

| 5. Event Date | | | 6. LER Number | | | 7. Report Date | | | 8. Other Facilities Involved | |
|---|---|---|---|---|---|---|---|---|---|---|
| Month | Day | Year | Year | Sequential Number | Rev No. | Month | Day | Year | Facility Name | Docket Number |
| | | | | | | | | | | 05000 |
| 08 | 16 | 2019 | 2019 | 001 | 00 | 10 | 11 | 2019 | Facility Name | Docket Number |
| | | | | | | | | | | 05000 |

| 9. Operating Mode | 11. This Report is Submitted Pursuant to the Requirements of 10 CFR §: *(Check all that apply)* | | | |
|---|---|---|---|---|
| 1 | ☐ 20.2201(b) | ☐ 20.2203(a)(3)(i) | ☐ 50.73(a)(2)(ii)(A) | ☐ 50.73(a)(2)(viii)(A) |
| | ☐ 20.2201(d) | ☐ 20.2203(a)(3)(ii) | ☐ 50.73(a)(2)(ii)(B) | ☐ 50.73(a)(2)(viii)(B) |
| | ☐ 20.2203(a)(1) | ☐ 20.2203(a)(4) | ☐ 50.73(a)(2)(iii) | ☐ 50.73(a)(2)(ix)(A) |
| | ☐ 20.2203(a)(2)(i) | ☐ 50.36(c)(1)(i)(A) | ☒ 50.73(a)(2)(iv)(A) | ☐ 50.73(a)(2)(x) |
| **10. Power Level** | ☐ 20.2203(a)(2)(ii) | ☐ 50.36(c)(1)(ii)(A) | ☐ 50.73(a)(2)(v)(A) | ☐ 73.71(a)(4) |
| 100 | ☐ 20.2203(a)(2)(iii) | ☐ 50.36(c)(2) | ☐ 50.73(a)(2)(v)(B) | ☐ 73.71(a)(5) |
| | ☐ 20.2203(a)(2)(iv) | ☐ 50.46(a)(3)(ii) | ☐ 50.73(a)(2)(v)(C) | ☐ 73.77(a)(1) |
| | ☐ 20.2203(a)(2)(v) | ☐ 50.73(a)(2)(i)(A) | ☐ 50.73(a)(2)(v)(D) | ☐ 73.77(a)(2)(ii) |
| | ☐ 20.2203(a)(2)(vi) | ☐ 50.73(a)(2)(i)(B) | ☐ 50.73(a)(2)(vii) | ☐ 73.77(a)(2)(iii) |
| | | ☐ 50.73(a)(2)(i)(C) | ☐ Other (Specify in Abstract below or in NRC Form 366A | |

**12. Licensee Contact for this LER**

| Licensee Contact | Telephone Number (Include Area Code) |
|---|---|
| Matt Kura, Department Leader, Nuclear Regulatory Affairs | 623-393-5379 |

**13. Complete One Line for each Component Failure Described in this Report**

| Cause | System | Component | Manufacturer | Reportable To ICES | Cause | System | Component | Manufacturer | Reportable To ICES |
|---|---|---|---|---|---|---|---|---|---|
| X | JC | RLY | SEL | Y | | | | | |

| 14. Supplemental Report Expected | 15. Expected Submission Date | Month | Day | Year |
|---|---|---|---|---|
| ☐ Yes (If yes, complete 15. Expected Submission Date) ☒ No | | | | |

Abstract (Limit to 1400 spaces, i.e., approximately 14 single-spaced typewritten lines)

On August 16, 2019, at approximately 0821 Mountain Standard Time, an automatic reactor trip of PVNGS Unit 2 occurred when the Reactor Protection System generated trips on all four channels for low departure from nucleate boiling ratio and high local power density due to the loss of power to all four Reactor Coolant Pumps. All control element assemblies fully inserted into the reactor core. A Main Steam Isolation Signal was manually actuated due to the loss of main condenser cooling water. This required manual actuation of the auxiliary feedwater and essential spray pond systems.

When the main generator is connected to the switchyard grid, a generator under frequency condition is the only electrical fault that opens the output breakers without tripping the turbine and providing the electrical circuit logic needed to initiate a fast bus transfer of PVNGS non-class 1E 13.8 kilovolt (kV) loads.

The direct cause of the reactor trip was attributed to the opening of main generator output breakers inside the Salt River Project (SRP) switchyard. The output breakers opened due to an invalid trip output signal initiated from a Schweitzer Engineering Laboratory relay (SEL-387) within the SRP switchyard protection system. The SEL-387 and cable running from the Unit 2 main generator protection cabinet to the SRP interface cabinet at the switchyard boundary were replaced. Subsequent testing was unable to identify a failure mode. SRP will be implementing a modification to the relay tripping scheme to provide redundancy that will provide required protection to the switchyard while eliminating a plant trip vulnerability.

No previous similar events have been reported by PVNGS in the last 3 years.

| 1. FACILITY NAME | 2. DOCKET NUMBER | 3. LER NUMBER | | |
|---|---|---|---|---|
| | | YEAR | SEQUENTIAL NUMBER | REV NO. |
| Palo Verde Nuclear Generating Station (PVNGS) Unit 2 | 05000-529 | 2019 | - 001 | - 00 |

NARRATIVE

All times are Mountain Standard Time (MST) and approximate unless otherwise indicated.

1. REPORTING REQUIREMENT(S):

This Licensee Event Report (LER) is being submitted pursuant to 10 CFR 50.73 (a)(2)(iv)(A) to report an automatic actuation of the PVNGS Unit 2 reactor protection system (RPS) (EIIS: JC) due to an automatic reactor trip when all four reactor coolant pumps (RCPs) (EIIS: AB) lost power and the RPS generated trips on all four channels for low departure from nucleate boiling ratio (DNBR) and high local power density (LPD). This LER also reports the manual actuation of a Main Steam Isolation Signal (MSIS) due to the loss of main condenser cooling water, as one of the other specified system actuations listed under 10 CFR 50.73 (a)(2)(iv)(B)(2). The actuation of the MSIS required manual actuation of the auxiliary feedwater and essential spray pond systems.

This event was initially reported pursuant to 10 CFR 50.72 (b)(2)(iv)(B) at 12:05 on August 16, 2019, via the event notification system (EN # 54224).

2. DESCRIPTION OF STRUCTURE(S), SYSTEM(S), AND COMPONENT(S):

**SRP Switchyard Overview**

The switchyard (EIIS: FK), which is owned and operated by the Salt River Project (SRP), is configured in a ring bus arrangement with redundant east and west buses. There are multiple distribution transmission line connections and unit generator output and startup transformer connections. Each PVNGS unit main generator connects to the SRP switchyard via two generator output breakers and one motor operated disconnect that allow the unit to remain connected to the grid in the event of a loss of one of the two switchyard buses (either east or west). Unit 2 output breakers are designated as PL935 and PL938.

**PVNGS Electrical Distribution System Overview**

Three 525 kV tie lines supply power from the SRP switchyard to three startup transformers (SUTs) located within the PVNGS switchyard, which supply power to six 13.8 kV intermediate buses. Two physically independent circuits supply offsite (preferred) power to the onsite power system of each unit.

The PVNGS electrical distribution system provides electrical power to all non-safety related equipment via two non-class 1E alternating current (AC) 13.8 kV buses (NAN-S01 or NAN-S02). During normal plant operations the 13.8 kV non-class 1E buses are powered via the unit auxiliary transformer (MAN-X02), which is powered directly from the output of the main generator but may be powered from the offsite power supply.

The major loads supplied from these non-class 1E buses include the RCPs, circulating water pumps (EIIS: KE), support systems for the main feedwater pumps (EIIS: SJ), cooling water, and heating, ventilation, and cooling systems. The plant is designed such that the 13.8 kV non-class 1E buses can be powered from offsite power via the unit startup transformers (NAN-X01, NAN-X02 or NAN-X03) through intermediate 13.8kV buses (NAN-S05 and NAN-S06) normally only used during startup, shutdown, and when the main generator (EIIS: TB) is offline. A fast bus transfer feature provides the ability to transfer power supply from the main turbine generator to offsite power via the SUT in the event of a main turbine generator trip to maintain power to all four RCPs.

Each startup transformer secondary winding is sized to start and carry one-half of the non-class 1E loads of one unit and two trains of ESF loads, one of which is from another unit, during unit trips or during startup/shutdown operation. Class 1E buses (PBA-S03 and PBB-S04) are normally supplied through ESF transformers via the startup transformers and intermediate 13.8 kV buses.

The main generator protection is provided by two 525 kV generator output breakers located in the PVNGS switchyard that function both as the generator output breakers and as a part of the SRP switchyard ring bus arrangement. A motor operated disconnect is an additional circuit interrupting device located between the main generator and the SRP output breakers.

**SRP Main Generator Output Breaker Operation**

The main generator output breakers are in the SRP switchyard and form a portion of the ring bus arrangement on the line side. They serve as circuit interrupting protective devices for both generator/plant side failures as well as SRP switchyard failures. For reliability and operating flexibility, the SRP 525 kV switchyard design includes a breaker and a half arrangement for each circuit along with breaker failure backup protection. Each breaker has two trip coils on separate, isolated direct current (DC) control circuits.

Two redundant plant trip signals to the generator output breakers are provided as protection for the main generator and are generated within the PVNGS power block. The plant trip signals are transmitted to the SRP switchyard along dedicated cabling to an SRP interface cabinet (2EMANIF) located in the SRP switchyard. This cabling connects to a high-speed electromechanical auxiliary relay (AR) that sends the trip signal to a Schweitzer Engineering Laboratory (SEL) 387 solid-state differential and overcurrent protection relay input point (IN201).

The two independent plant trip signals are sent to two independent SEL-387 relays designated as SRP Protection System (SPS) A and SPS B. The A and B protection systems are independent and redundant, where either of the two signals will trip open both generator output breakers. The SRP interface cabinet serves as the point of separation between the PVNGS powerblock and SRP switchyard for operation and maintenance of components.

**Fast Bus Transfer**

The Loss of Offsite Power following turbine trip and fast bus transfer function is described in the Accident Analysis section of the PVNGS Updated Final Safety Analysis Report, Section 15.0.2.4.

With the plant in normal plant operations, during a turbine trip or loss of supply from the unit auxiliary transformer, (not involving an electrical fault or under frequency) the sequence of events includes a fast bus transfer. A fast bus transfer would be initiated upon tripping of the unit auxiliary transformer output breakers, and the alternate supply breakers would close within a few cycles to connect the 13.8 kV buses NAN-S01 and NAN-S02 to the startup transformers. Typically, the startup transformers supply NAN-S01 and NAN-S02 buses during plant startup or at other times when the turbine generator or unit auxiliary transformer is out of service. Transfers of these buses can also be initiated by the plant operator from the control room.

In the event of a turbine trip during normal plant operations, not involving an electrical fault or under frequency, the turbine generator will remain synchronized to the extra high voltage transmission network until residual energy in the turbine is dissipated. The generator will motorize for a short period of time, and will not trip until a sustained reverse power condition exists and the reverse power relay actuates. The reverse power relay actuation will initiate a sequential trip as described below, which results in a fast bus transfer initiation.

The reverse power relay actuation will simultaneously trip the generator exciter, the 525 kV breakers and the unit auxiliary transformer output breakers, thereby initiating a fast bus transfer.

There is one design electrical fault that opens the main generator switchyard output breakers without tripping the turbine and providing the electrical circuit logic needed to initiate a fast bus transfer of PVNGS non-class 1E 13.8 kilovolt (kV) loads, and that is a generator under frequency condition when the main generator is connected to the switchyard grid.

**Reactor Coolant System**

The reactor coolant system (RCS) (EIIS: AB) is comprised of two main flow loops each of which includes two RCPs and one steam generator (EIIS: AB). The primary function of the RCPs is to provide the necessary head to maintain forced circulation of reactor coolant through the RCS during normal operations. Critical operation of the reactor requires all four RCPs to be in operation to ensure adequate RCS flow. The RCPs are powered from non-class 1E 13.8 kV buses with 2 RCPs per bus. The fast bus transfer feature provides the ability to transfer power supply from the unit auxiliary transformer to offsite power via the SUT in the event of a main turbine generator trip (not involving an electrical fault or under frequency) to maintain power to all four RCPs.

**Reactor Protection System**

The RPS consists of four independent, redundant channels and includes a number of sensors, calculators (including the core protection calculators (CPCs)(EIIS: JC), logic circuits, and supporting equipment that monitor nuclear steam supply system (EIIS: AB) parameters. The RPS ensures the reactor is rapidly and reliably shut down to protect the fission product barriers and assist the engineered safety features systems in accident mitigation. When all four channels of RPS are in service, a reactor trip is actuated when two of four channels generate trip signals.

The CPCs monitor the operation of the RCPs as inputs to the calculations of DNBR and LPD and send trip signals to the RPS when setpoints are exceeded. The RPS actuation then causes simultaneous trips of the four reactor trip switchgear breakers (EIIS: AA) which are aligned in a selective two of four configuration to de-energize the control element drive mechanisms (EIIS: AA) so that all control element assemblies (CEAs) (EIIS: AA) are released to insert into the reactor core (EIIS: AC) and shut down the reactor.

3. INITIAL PLANT CONDITIONS:

On August 16, 2019, PVNGS Unit 2 was in Mode 1 (Power Operation) at 100 percent power with the RCS at normal operating temperature and normal operating pressure. There were no other structures, systems, or components out of service that contributed to this event.

4. EVENT DESCRIPTION:

On August 16, 2019, at approximately 0821 Mountain Standard Time, a Unit 2 main turbine trip occurred followed by an automatic reactor trip of PVNGS Unit 2 when the RPS generated trips on all four channels for low DNBR and high LPD due to the loss of power to all four RCPs. All CEAs fully inserted into the reactor core.

The main turbine trip was due to the opening of SRP main generator output switchyard breakers PL935 and PL938. The breakers received an invalid generator trip output signal from within the SRP SPS. The opening of the main generator output breakers does not provide the electrical circuit logic needed to initiate a fast bus transfer of the non-class 1E 13.8 kV loads. The transfer of these loads is needed to supply and maintain power to the RCPs and other secondary systems powered by non-class 1E buses.

The loss of the non-class 1E busses resulted in a loss of reactor coolant flow, main feedwater, plant cooling water, turbine cooling water, nuclear cooling water, normal chill water, instrument air, circulating water, and condenser vacuum. The control room entered emergency operating procedure 40EP-9EO07, Loss of Offsite Power / Loss of Forced Circulation, and manually actuated an MSIS in response to the loss of circulating water flow to the main condenser. The control room verified natural circulation with steam generator level control being provided by manually starting class 1E powered Auxiliary Feedwater Pump "B" and Spray Pond Pump "B". Heat removal was provided via Atmospheric Dump Valves. All class buses remained powered from the offsite power supply.

PVNGS Units 1 and Unit 3 were operating at 100 percent power at the time of the event and were not impacted by the Unit 2 reactor trip.

5. ASSESSMENT OF SAFETY CONSEQUENCES:

This event did not result in a challenge to the fission product barriers or result in the release of radioactive materials to the environment. There were no actual safety consequences as a result of this event and it did not adversely affect the health and safety of the public.

The RPS functioned as designed and initiated an automatic reactor trip that placed the plant in a safe condition. All CEAs fully inserted into the reactor core. Control room staff entered the standard post trip actions and diagnosed a reactor trip due to the loss of offsite power and a loss of forced circulation. Class 1E on-site power systems remained energized from the respective off-site power sources via the SUTs.

The Unit 2 reactor trip did not result in a transient more severe than those already analyzed. The primary system and secondary pressure boundary limits were not approached.

6. CAUSE OF THE EVENT:

The direct cause of the Unit 2 main turbine generator and reactor trip has been attributed to an unrepeatable IN201 false signal initiated within the SRP SPS "A" SEL-387 relay.

7. CORRECTIVE ACTIONS:

Immediate actions were taken by SRP to replace the SPS "A" SEL-387 and AR involved with the opening of the Unit 2 output breakers. PVNGS Electrical Maintenance replaced the cable running from the Unit 2 main generator protection cabinet to the SRP interface cabinet. Inspections and testing of the original SEL-387 and AR were conducted by SRP along with testing of the direct current power supply system for grounds and induced AC voltages from the SRP interface cabinet to the SRP blockhouse.

The testing was unable to identify a failure mode. SRP will be implementing a modification to the relay tripping scheme to provide redundancy that will provide required protection to the switchyard while eliminating a plant trip vulnerability.

PVNGS has requested SEL perform additional analysis on the relay to test for failure modes that could assert a false IN201 value in the relay logic.

In the event additional information is received that results in substantial changes in the corrective actions planned, PVNGS will submit a supplement to this LER.

# LICENSEE EVENT REPORT (LER)
## CONTINUATION SHEET

(See NUREG-1022, R.3 for instruction and guidance for completing this form http://www.nrc.gov/reading-rm/doc-collections/nuregs/staff/sr1022/r3/)



| 1. FACILITY NAME | 2. DOCKET NUMBER | 3. LER NUMBER | | |
|---|---|---|---|---|
| | | YEAR | SEQUENTIAL NUMBER | REV NO. |
| Palo Verde Nuclear Generating Station (PVNGS) Unit 2 | 05000-529 | 2019 | - 001 | - 00 |

8. PREVIOUS OCCURRENCES:

No previous similar events have been reported by PVNGS.