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LEVINE,J.M. Arizona Public Service Co. (formerly Arizona Nuclear Power
RECIP.NAME RECIPIENT AFFILIATION

SUBJECT: LER 95-005-00:on 950407,determined that tubesheet blockage found in EDG B jacket water cooler would have reduced min required heat rejection through cooler.Caused by failure of epoxy coating.Reassessment of cleaning times.W/950502 ltr.

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Arizona Public Service Company
PALO VERDE NUCLEAR GENERATING STATION
P.O. BOX 52034 • PHOENIX, ARIZONA 85072-2034

192-00929-JML/BAG/KR
May 2, 1995

JAMES M. LEVINE
VICE PRESIDENT
NUCLEAR PRODUCTION

U. S. Nuclear Regulatory Commission
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Dear Sirs:

Subject: Palo Verde Nuclear Generating Station (PVNGS)
Unit 1
Docket No. STN 50-528 (License No. NPF-51)
Licensee Event Report 95-005-00

Attached please find Licensee Event Report (LER) 95-005-00 prepared and submitted pursuant to 10CFR50.73. This LER reports a condition that was determined to have rendered the Emergency Diesel Generator (EDG) B inoperable when debris was found blocking the tubesheets in the EDG-B jacket water cooler. In accordance with 10CFR50.73(d), a copy of this LER is being forwarded to the Regional Administrator, NRC Region IV. If you have any questions, please contact Burton A. Grabo, Section Leader, Nuclear Regulatory Affairs, at (602) 393-6492.

Sincerely,

James M. Levine

JML/BAG/KR/pv

Attachment

cc: L. J. Callan (all with attachment)
K. E. Perkins
K. E. Johnston
INPO Records Center

IE22

LICENSEE EVENT REPORT (LER)

FACILITY NAME (1)	DOCKET NUMBER (2)	PAGE (3)
Palo Verde Unit 1	0 5 0 0 0 5 2 8	1 OF 1 2

TITLE (4)

Emergency Diesel Generator Inoperable Due to Debris in Cooling Water Heat Exchanger

EVENT DATE (5)			LER NUMBER (6)			REPORT DATE (7)			OTHER FACILITIES INVOLVED (8)	
MONTH	DAY	YEAR	YEAR	SEQUENTIAL NUMBER	REVISION NUMBER	MONTH	DAY	YEAR	FACILITY NAMES	DOCKET NUMBERS
									N/A	0 5 0 0 0
0 4	0 7	9 5	9 5	- 0 0 5	- 0 0	0 5	0 2	9 5	N/A	0 5 0 0 0

OPERATING MODE (9)	6	THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10 CFR §: (Check one or more of the following) (11)					
POWER LEVEL(10)	0	20.402(b)	20.405(c)	50.73(a)(2)(iv)	73.71(b)		
		20.405(a)(1)(i)	50.36(c)(1)	X 50.73(a)(2)(v)	73.71(c)		
		20.405(a)(1)(ii)	50.36(c)(2)	50.73(a)(2)(vii)	OTHER (Specify in Abstract below and in Text, NRC Form 366A)		
		20.405(a)(1)(iii)	X 50.73(a)(2)(i)	50.73(a)(2)(viii)(A)			
		20.405(a)(1)(iv)	X 50.73(a)(2)(ii)	50.73(a)(2)(viii)(B)			
		20.405(a)(1)(v)	50.73(a)(2)(iii)	50.73(a)(2)(x)			

LICENSEE CONTACT FOR THIS LER (12)

NAME	TELEPHONE NUMBER
Burton A. Grabo, Section Leader, Nuclear Regulatory Affairs	AREA CODE 6 0 2 3 9 3 - 6 4 9 2

COMPLETE ONE LINE FOR EACH COMPONENT FAILURE DESCRIBED IN THIS REPORT (13)

CAUSE	SYSTEM	COMPONENT	MANUFAC-TURER	REPORTABLE TO NPRDS	CAUSE	SYSTEM	COMPONENT	MANUFAC-TURER	REPORTABLE TO NPRDS

SUPPLEMENTAL REPORT EXPECTED (14)		EXPECTED SUBMISSION DATE (15)	MONTH	DAY	YEAR
YES (If yes, complete EXPECTED SUBMISSION DATE)	X NO				

ABSTRACT (Limit to 1400 spaces, i.e., approximately fifteen single-space typewritten lines) (16)

On April 7, 1995, at approximately 1300 MST, Palo Verde Unit 1 was in Mode 6 (REFUELING) during a scheduled refueling outage, when APS Engineering personnel determined that tubesheet blockage (primarily corrosion nodules) found in the Emergency Diesel Generator (EDG) B jacket water cooler would have reduced minimum required heat rejection through the cooler. This condition potentially could have affected EDG B's performance under design basis accident conditions. At the time, EDG B was removed from service for 18 month surveillance testing and preventive maintenance. Because Unit 1 EDG B was considered to have been inoperable for an indeterminate period, this condition constitutes a violation of Technical Specifications 3.8.1, AC Sources. Because the potential for tubesheet blockage in the EDG A jacket water cooler (redundant train) could have adversely affected EDG A's performance under design basis accident conditions, this condition also constitutes a condition that alone could have prevented the fulfillment of the safety function of a system. However, the condition did not adversely affect EDG A's performance.

A preliminary evaluation has determined that the formation of the corrosion nodules is due to the failure of the epoxy coating that lines the carbon steel spray pond supply piping. Unit 1's EDGs (A and B), Unit 2's EDGs (A and B), and Unit 3's EDG A heat exchangers have been inspected and cleaned. The tubesheet blockage found in the other EDG heat exchangers would not have adversely affected their respective EDG's performance. Unit 3 EDG B heat exchangers will be scheduled for inspection and cleaning. There have been no previous similar events reported pursuant to 10CFR50.73.

TEXT

1. REPORTING REQUIREMENT:

This LER 528/95-005-00 is being written to report

1. any condition prohibited by the plant's Technical Specifications (TS) as specified in 10 CFR 50.73(a)(2)(i)(B);

2. a condition that alone could have prevented the fulfillment of the safety function of a system that is needed to: (A) shut down the reactor and maintain it in a safe shutdown condition; (B) remove residual heat; or (D) mitigate the consequences of an accident as specified in 10 CFR 50.73(a)(2)(v); and

3. a condition that resulted in the nuclear power plant being in an unanalyzed condition that significantly compromised plant safety as specified in 10 CFR 50.73(a)(2)(ii).

Specifically, at approximately 1300 MST on April 7, 1995, Palo Verde Unit 1 was in Mode 6 (REFUELING) during its fifth refueling outage (1R5) with the Reactor Coolant System (RCS) (AB) at approximately 98 degrees Fahrenheit (F) and at atmospheric pressure, when APS Engineering personnel (utility, nonlicensed) determined that tubesheet blockage (primarily corrosion nodules) found in the Unit 1 Emergency Diesel Generator (EDG) B jacket water cooler (LB) would have reduced minimum required heat rejection through the cooler. This condition potentially could have affected EDG B's (EK) performance under design basis accident conditions (a design basis tornado event assuming worst case spray pond (BS) temperature of 110 degrees F). At the time, EDG B was removed from service for 18 month surveillance testing and preventive maintenance. Because Unit 1 EDG B was considered to have been inoperable for an indeterminate period, this condition constitutes a violation of TS 3.8.1, AC Sources.

Because the potential for tubesheet blockage in the Unit 1 EDG A jacket water cooler (redundant train) could have adversely affected EDG A's performance under design basis accident conditions, this condition constitutes a condition that alone could have prevented the fulfillment of the safety function of a system. However, based on subsequent inspection of the Unit 1 EDG A heat exchangers on April 18, 1995, APS Engineering personnel determined that the as-found condition of the EDG A heat exchangers would not have prevented EDG A from performing its design basis safety function.

Existing calculations establish the minimum required spray pond coolant flowrates to the EDG heat exchangers as a function of inlet spray pond temperature and assume no tubesheet blockage. Therefore, this constitutes a condition that resulted in the nuclear power plant,

specifically Unit 1, being in an unanalyzed condition that significantly compromised plant safety.

2. EVENT DESCRIPTION:

NOTE: Information pertinent to this discussion on the cooling water subsystems (LB) for the EDG is available in Section 8, ADDITIONAL INFORMATION.

A condition similar to the one reported in this LER 528/95-005-00 was discovered on February 21, 1995 when the Unit 2 EDG A heat exchangers were opened for scheduled PM inspection and cleaning during the fifth refueling outage (2R5). Unit 2 was defueled at the time. The PM tasks are intended to identify areas of coating failure and subsequent corrosion problems on the spray pond piping of these heat exchangers and to ensure that coating material is reapplied, if necessary. During the PM inspection, an unexpected amount of debris consisting of plastic pieces and corrosion nodules (i.e., pieces of corrosion product) was identified in the tubesheets of the jacket water cooler and the lube oil cooler. The inlet side of the lube oil cooler was assessed to have tubesheet blockage of approximately forty-nine (49) percent. The inlet side of the jacket water cooler was assessed to have tubesheet blockage of approximately twenty-one (21) percent. The turbocharger intercoolers were found to have only slight tubesheet blockage.

An investigation was initiated in accordance with the APS Corrective Action Program to evaluate the potential impact of this condition and the transportability to the other cooling water subsystems for the EDGs in the three units. An operability assessment was also performed, and based on minimum acceptable flow rates (measured) from the ESPS to the EDG heat exchangers, APS Engineering personnel determined that the as-found condition of Unit 2's EDG A heat exchangers would not have prevented EDG A from performing its design basis safety function during a design basis tornado event assuming worst case spray pond temperature of 110 degrees F.

Previously, the EDG heat exchangers had been inspected on a single refueling cycle interval. With the application of different coating material to the EDG heat exchangers and adjacent pipe spools, the coating failures and corrosion problems appeared resolved and the inspection/cleaning PM task was extended to every other refueling outage. The Unit 2 EDG A heat exchangers had the longest in-service time (approximately 39 months) and were the first heat exchangers to be inspected on the two refueling cycle interval. The Unit 2 EDG B heat exchangers had been in-service for approximately 23 months.

APPROXIMATE IN-SERVICE TIME (in months) SINCE LAST EDG HEAT EXCHANGER INSPECTION (as of late February, 1995):

Unit 1:		Unit 2:		Unit 3:	
EDG A	EDG B	EDG A	EDG B	EDG A	EDG B
17	34	39	23	29	10

As part of the investigation, while the unit was in the current refueling outage (2R5), plans were made to inspect Unit 2's EDG B heat exchangers prior to their normally scheduled PM interval. On March 7, 1995, Unit 2 was in Mode 6 during 2R5 when the Unit 2 EDG B heat exchangers (the redundant train) were opened for inspection. APS Engineering personnel discovered similar type of debris in the tubesheets of the jacket water cooler and the lube oil cooler. The inlet side of the lube oil cooler was assessed to have tubesheet blockage of approximately thirty (30) percent. The inlet side of the jacket water cooler was assessed to have tubesheet blockage of approximately seventeen (17) percent. The turbocharger intercooler B was assessed to have tubesheet blockage of approximately fourteen (14) percent. The turbocharger intercooler A was visually inspected and no excessive blockage was detected. Again, APS Engineering personnel determined that the as-found condition of Unit 2's EDG B heat exchangers would not have prevented EDG B from performing its design basis safety function during a design basis tornado event assuming worst case spray pond temperature of 110 degrees F.

Based on the inspections of the Unit 2 EDG heat exchangers, APS Engineering personnel determined that the debris buildup on the tubesheets was at least partially time dependent. With the Unit 2 EDG A heat exchangers having been the longest in-service (39 months), the potential for tubesheet blockage appeared to be bounded by the Unit 2 EDG A heat exchangers. Although Unit 1 EDG B heat exchangers had the next longest in-service time (34 months), immediate action was not considered necessary for the other two units (Units 1 and 3), partially because of the forthcoming Unit 1 refueling outage. However, work orders were generated to inspect both trains of Unit 1's EDG heat exchangers during the Unit 1 fifth refueling outage (1R5) scheduled on April 1, 1995.

Since the worst case conditions (a design basis tornado event assuming worst case spray pond temperature of 110 degrees F) were bounded by hot weather conditions (i.e., temperature and humidity), there were no immediate concerns that the Unit 1 and Unit 3 EDGs would not have been able to perform their safety function if called upon during the following months of March and April. The Unit 3 heat exchanger inspection time frame was to be based on the completed results of the Unit 1 EDG heat exchanger inspections.

At approximately 1146 MST on April 5, 1995, Unit 1 was in Mode 5 (COLD SHUTDOWN) during 1R5 when the Unit 1 EDG B was declared inoperable by Control Room personnel for scheduled maintenance. On April 6, 1995, the Unit 1 EDG B heat exchangers were opened for inspection. APS Engineering personnel discovered similar type of debris (primarily corrosion nodules) in the tubesheets of the jacket water cooler and the lube oil cooler. The inlet side of the lube oil cooler was assessed to have tubesheet blockage of approximately forty-eight (48) percent. The inlet side of the jacket water cooler was assessed to have tubesheet blockage of approximately fifty-five (55) percent. The turbocharger intercooler B was assessed to have tubesheet blockage of approximately eighteen (18) percent. The turbocharger intercooler A was visually inspected and no excessive blockage was detected. On April 7, 1995 at approximately 1300 MST, following an evaluation of the excessive tubesheet blockage in the jacket water cooler, APS Engineering personnel determined that the as-found condition of Unit 1's EDG B jacket water cooler may have prevented the EDG B from performing its design basis safety function during a design basis tornado event assuming worst case spray pond temperature of 110 degrees F. Unit 1 EDG B was considered to have been inoperable for an indeterminate period.

An immediate operability assessment was performed by APS Engineering personnel for Unit 1 EDG A and Unit 3 EDGs. The assessment determined that after seven (7) days into the refueling outage (1R5), the amount of core decay heat would be substantially less than that considered in the design basis tornado event. In addition, the loads on the EDG would be less than the design analysis. There were no immediate operability concerns for the remaining train EDG A based on expected weather conditions and the EDG heat exchangers' in-service hours (18 months). Reasonable assurance exists that the Unit 1 EDG A cooling water requirements would be met under current refueling outage conditions. In addition, since the worst case conditions are bounded by hot weather conditions, there were no immediate concerns that the Unit 3 EDGs would be able to perform their safety function if called upon during the month of April. In addition, Unit 3 EDG heat exchangers had less in-service time and previous inspections of the Unit 3 spray pond piping show that the coating conditions are significantly better than Units 1 or 2, and measured flowrates through the Unit 3 EDG heat exchangers are significantly higher than the other units' heat exchanger measured flowrates. The Unit 3 heat exchanger inspection time frame was to be based on the completed results of Unit 1 EDG heat exchanger inspections.

On April 18, 1995, Unit 1 was defueled during 1R5 when the Unit 1 EDG A heat exchangers (the redundant train) were opened for inspection. APS Engineering personnel discovered similar type of debris in the tubesheets of the jacket water cooler and the lube oil cooler. The inlet side of the lube oil cooler was assessed to have tubesheet blockage of approximately thirty-four (34) percent. The inlet side of

the jacket water cooler was assessed to have tubesheet blockage of approximately fourteen (14) percent. The turbocharger intercooler B was assessed to have tubesheet blockage of approximately eight (8) percent. The turbocharger intercooler A was visually inspected and no excessive blockage was detected. Again, APS Engineering personnel determined that the as-found condition of Unit 1's EDG A heat exchangers would not have prevented EDG A from performing its design basis safety function during a design basis tornado event assuming worst case spray pond temperature of 110 degrees F.

At approximately 0700 MST on April 26, 1995, Unit 3 was in Mode 1 (POWER OPERATION) at approximately 100 percent power when Unit 3 EDG A was declared inoperable by Control Room personnel to perform the inspection/ cleaning PM for the EDG heat exchangers. The heat exchangers had been in-service for approximately 31 months. APS Engineering personnel discovered similar type of debris (primarily corrosion nodules) in the tubesheets of the jacket water cooler and the lube oil cooler. The inlet side of the lube oil cooler was assessed to have tubesheet blockage of approximately thirty-four (34) percent. The inlet side of the jacket water cooler was assessed to have tubesheet blockage of approximately six (6) percent. The turbocharger intercoolers were visually inspected and no excessive blockage was detected. Again, APS Engineering personnel determined that the as-found condition of Unit 3's EDG A heat exchangers would not have prevented EDG A from performing its design basis safety function during a design basis tornado event assuming worst case spray pond temperature of 110 degrees F.

The Unit 3 EDG B heat exchangers have been in-service approximately 12 months. The next scheduled EDG B outage window is May 30, 1995. Since no immediate operability concerns exist, a decision may be made to delay the inspection until 3R5 scheduled in October 1995.

The jacket water coolers and the lube oil coolers that have been inspected in Units 1, 2, and 3 (with the exception of Unit 3 EDG B heat exchangers) were cleaned to remove the blockage. The turbocharger intercoolers were cleaned or verified clean.

Based on the inspections made on the essential cooling water (BI) heat exchangers during 1R5 and 2R5, APS Engineering personnel have determined that the Essential Cooling Water System was not impacted by this condition (no tubesheet blockage was found) and therefore, would have performed its intended safety function.

3. ASSESSMENT OF THE SAFETY CONSEQUENCES AND IMPLICATIONS OF THIS EVENT:

APS Engineering evaluated the impact of the tubesheet blockage on the ability of the Unit 1 EDG B to perform its safety function. As previously discussed, the as-found condition of the Unit 1 EDG B jacket

water cooler may have prevented EDG B from performing its design basis safety function during a design basis tornado event assuming worst case spray pond temperature of 110 degrees F. This includes tornado damage to 12 spray pond nozzles. The design basis accident assumes worst case loads on the EDG. Actual loads would be less than the EDG rated load of 5500 kW and therefore, less heat rejection would actually occur.

Since the worst case conditions (a design basis tornado event assuming worst case spray pond temperature of 110 degrees F) were bounded by hot weather conditions (i.e., temperature and humidity), and since the debris buildup on the tubesheets was at least partially time dependent, there is reason to believe that since October 1994 (previous six months) the actual outside temperatures would have mitigated the consequences of the Unit 1 EDG B tubesheet blockage. Prior to October 1994, based on actual weather conditions, EDG B's performance would only potentially have been adversely affected during the hotter summer months

Considering overall plant safety with one potentially inoperable EDG, it is probable that preferred (offsite power) (FK) would be restored prior to peak temperatures being reached 30 hours into the design basis event. In addition, the redundant train (EDG A) was available and the gas turbine (station blackout) was available for train A equipment.

The event did not result in any challenges to the fission product barriers or result in any releases of radioactive materials. Therefore, there were no adverse safety consequences as a result of this event. This event did not adversely affect the safe operation of the plant or health and safety of the public.

4. CAUSE OF THE EVENT:

An independent investigation of this event is being conducted in accordance with the APS Corrective Action Program. As part of the investigation, a root cause of failure analysis of the EDG heat exchanger tubesheet blockage is to be performed by APS Engineering personnel.

The plastic debris found in the EDG heat exchanger tubesheets consisted mainly of small pieces of sheet plastic which most probably originated from multicolored pennants (construction barrier flagging) or from wrappers and packaging. In some cases, small pieces of duct tape were found blocking the tubesheet. In addition, a single tapered rubber stopper and one piece of paper debris was found. Most of the debris found on the EDG heat exchanger tubesheets consisted mainly of corrosion nodules. Based on visual comparison, the larger corrosion nodules closely matched the curvature of a 10-inch pipe inside dimension. There is a 10-inch supply to the EDG heat exchangers which branches off of the 24-inch spray pond supply. The most probable source for most of this

debris appears to be intake through the spray pond pump suction during system operation. Most floating debris is expected to be caught on a spray pond pump screen and remain intact until a biennial PM to inspect and clean the spray pond pumphouse intake structure.

A preliminary evaluation, based on available data, has determined that the apparent failure mechanism is the failure of the epoxy coating that lines the carbon steel spray pond piping (SALP Cause Code B: Design, Manufacturing, Installation Error). Over the years, failures of the epoxy lining have been discovered throughout the piping. Repairs and recoatings have been implemented in many accessible areas. Remote visual inspections have been used to monitor the underground (inaccessible) piping. The inspections have detected localized corrosion sites where the original epoxy coating has failed and corrosion nodules have formed on the piping.

To mitigate the corrosion of the exposed carbon steel, numerous EPRI guidelines have been implemented. The spray pond systems are operated at least three times a week to prevent stagnate water conditions. In addition, biocides and corrosion inhibitors (including the introduction of zinc phosphate in late 1994) have been added, and carbon steel coupons in the spray pond system are monitored for carbon steel corrosion rates. Until the recent tubesheet blockage events, the primary concern with the epoxy coating failures was maintaining the integrity of the spray pond piping. The adverse affect of the corrosion nodules on the heat exchangers was not a consideration.

The spray pond system supply piping is configured as follows: 24-inch piping carries the total discharge flow [nominal 17,000 gallons per minute (gpm)] from the spray pond pump. The 24-inch line branches into a 10-inch line to the EDG heat exchangers (nominal 1,500 gpm) and a 20-inch line to the essential cooling water heat exchangers (nominal 15,500 gpm). Based on the pipe size and flow rates, the flow velocity through the 24-inch line is approximately 13 feet per second (fps). The flow velocity through the 20-inch line is also approximately 13 fps and flow velocity through the 10-inch line is approximately 6 fps.

Although the release mechanism is not fully understood, the preliminary evaluation has postulated that a corrosion nodule grows in volume until it achieves sufficient cross-sectional area such that the force of the spray pond flow eventually causes it to break loose from the pipe wall. Based on the flow velocities through the different sized piping, the corrosion nodules grow the largest in the 10-inch lines supplying the EDG heat exchangers before breaking loose, and the corrosion nodules are large enough to block the EDG heat exchanger tubesheets. In the 24-inch and 20-inch lines, due to the higher flow velocities, the corrosion nodules would break loose at a smaller size and apparently pass through the tubes of the essential cooling water heat exchangers. It has also

been postulated that the introduction of zinc phosphate into the spray pond may have contributed to the release of the corrosion nodules. As stated previously, inspections of the essential cooling water heat exchangers during 1R5 and 2R5 refueling outages have found no corrosion nodules in the tubesheets.

If the final root cause of failure analysis of the EDG heat exchanger tubesheet blockage differs from this determination, a supplement to this report will be submitted to describe the final root cause of failure. The root cause of failure analysis is expected to be completed by June 30, 1995.

Contributing to the buildup of the corrosion nodules in the tubesheets was the reduction in the PM task frequency. The PM tasks are intended to identify areas of coating failure and subsequent corrosion problems on the supply side (ESPS) piping of these heat exchangers and to ensure that coating material is reapplied, if necessary. Previously, the EDG heat exchangers had been inspected on a single refueling cycle interval. With the application of different coating material to the EDG heat exchangers and adjacent pipe spools, the coating failure and corrosion problems appeared resolved and the inspection/cleaning PM task was extended to every other refueling outage. Since APS Engineering personnel determined that the debris buildup on the tubesheets was at least partially time dependent, the change in the PM frequency inadvertently had an adverse affect on the EDG heat exchangers.

No unusual characteristics of the work location (e.g., noise, heat, poor lighting) directly contributed to this event. There were no procedural errors or personnel errors which contributed to this event.

5. STRUCTURES, SYSTEMS, OR COMPONENTS INFORMATION:

There are no indications that any structures, systems, or components were inoperable at the start of the event which contributed to this event. No failures of components with multiple functions were involved. No failures that rendered a train of a safety system inoperable were involved. There were no safety system responses and none were necessary.

6. CORRECTIVE ACTIONS TO PREVENT RECURRENCE:

An independent investigation of this event is being conducted in accordance with the APS Corrective Action Program. Actions to prevent recurrence are being developed based upon the results of the investigation and are being tracked to completion under the PVNGS Commitment Action Tracking System. These actions include the reassessment of the inspection/cleaning PM task frequency, and the development and implementation of a method to minimize the formation of

corrosion nodules, to remove the existing corrosion nodules in a controlled environment, and to detect tubesheet blockage while at power operation.

The calculation to determine the minimum required spray pond coolant flowrates to the EDG heat exchangers is being revised to establish the required flowrate as a function of inlet spray pond temperature and a percentage of tubesheet blockage.

7. PREVIOUS SIMILAR EVENTS:

No other previous events have been reported pursuant to 10CFR50.73 where corrosion nodules have affected the EDG heat exchangers ability to perform their minimum required heat rejection function.

8. ADDITIONAL INFORMATION:

The purpose of the EDG is to supply AC electrical power to Class 1E safety-related equipment when offsite (preferred) power is not available.

The EDG heat exchangers function to remove waste heat, maintain lubricating oil temperature and viscosity, and assist in maintaining overall EDG performance. There are four heat exchangers per EDG train that use spray pond water for cooling purposes.

1. Jacket Water Coolers (DG-E05): The primary function of this cooler is to remove heat from combustion. Jacket water is circulated through the cylinder liners and cylinder heads in the engine and the waste heat of combustion in reject in the coolers. A small portion of the jacket water flow is used to cool the engine speed regulating governor actuator and turbocharger.

2. Lube Oil Coolers (DG-E04): The primary function of this cooler is to maintain the lube oil temperature. Lubricating oil cools bearing surfaces that are heated by friction. Lubricating oil is also heated by blow-by gases and conduction from metal parts. Regulation of lubricating oil temperature is important to ensuring proper viscosity to minimize friction at the bearings.

3. Turbocharger Intercoolers (DG-E01): There are two intercoolers on each EDG which function to improve EDG performance. Supply air to the engine is compressed and heated by the turbocharger. An intercooler on each of the two engine air intake headers cools the intake air. The intake air is made more dense by this arrangement to improve engine performance by providing additional air for combustion.

4. Fuel Oil Coolers (DG-E03): The fuel oil coolers function to cool by-passed fuel oil which is returned to the fuel oil day tank to prevent the fuel oil in the day tank from becoming too hot.

The Essential Spray Pond System (ESPS) consists of two independent, redundant safety-related flow trains that remove heat from ESF and safety-related components (i.e., EDG heat exchangers and the Essential Cooling Water heat exchanger). Each train takes suction from and returns water to its spray pond. The heat from these systems is rejected to the essential spray pond which provides the plant with the ultimate heat sink (see Figure 1: Spray Pond single train flow diagram). The two ESPS flow trains are fully redundant with one exception: the combined volume from both spray ponds is required for long term operation (e.g., post-LOCA) without makeup water. The ESPS normally operates during a plant shutdown, or when an EDG is running. The ESPS will start and run in response to emergency start signals. In addition, the ESPS is started and run approximately three times a week for water chemistry control. The Essential Cooling Water System (ECWS), which is the intermediate cooling system between shutdown cooling and the ESPS, in turn provides cooling for the reactor core (via the shutdown cooling system heat exchangers) and the Essential Chilled Water System.

DESIGN BASIS ACCIDENT INFORMATION:

In order to demonstrate compliance with General Design Criteria (GDC) 2 and 4 for the ultimate heat sink (UHS), Calculation 13-NC-SP-206, "Ultimate Heat Sink Design Reverification" was prepared to assess the capability (thermal performance) of one spray pond, with several nozzles damaged (12 of 320), to act as the UHS for the plant during a design basis tornado induced forced shutdown event with a coincident loss of offsite power. A single failure of the EDG in the other train is assumed and therefore, only one degraded spray pond is available.

The governing criteria for the analysis is that the maximum limiting temperatures (1) of the ECWS of 132 degree F based on the performance requirements of the essential chiller, and (2) of the ESPS of 110 degrees F based on EDG cooling water requirements are not exceeded. In other words, the calculation determined that the maximum water temperature at the exit of the spray pond pump shall not exceed 110 degrees F during a loss of offsite power event requiring the use of the EDGs. The weather data used in the calculation was the worst 29 consecutive days for thermal design (temperature and humidity) for the essential spray pond. Other than tornado damage to the spray pond nozzles, the hydraulic evaluation assumes an ESPS piping network with new, clean pipe conditions.

LICENSEE EVENT REPORT (LER) TEXT CONTINUATION

FACILITY NAME	DOCKET NUMBER	LER NUMBER			PAGE
		YEAR	SEQUENCIAL NUMBER	REVISION NUMBER	
Palo Verde Unit 1	0 5 0 0 0 5 2 8	9 5	- 0 0 5	- 0 0	1 2 OF 1 2

TEXT

Spray Pond System Single Train Flow Diagram: