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NP-33-03-007-00

Docket No. 50-346

License No. NPF-3

August 5, 2003

United States Nuclear Regulatory Commission
Document Control Desk
Washington, D.C. 20555

Ladies and Gentlemen:

LER 2003-007
Davis-Besse Nuclear Power Station, Unit No. 1
Date of Occurrence – June 6, 2003

Enclosed please find Licensee Event Report (LER) 2003-007, which is being submitted to provide written notification of an issue discovered during analysis of the Electrical AC Distribution System involving a potential loss of offsite power following a design basis accident. This LER is being submitted in accordance with 10CFR50.73(a)(2)(v) and 10CFR50.73(a)(2)(i)(B). Commitments associated with this LER are listed in the Attachment.

The information contained in this LER is based upon a preliminary cause evaluation. If the final evaluation results in a significant change to the content of the LER (including significance, implications, or consequences of the event or substantial changes in planned corrective actions), the LER will be revised as directed by NUREG-1022.

Very truly yours,

Lew W. Myers

GMW/s

Attachments

cc: Regional Administrator, USNRC Region III
DB-1 NRC Senior Resident Inspector
Utility Radiological Safety Board

IE22

COMMITMENT LIST

The following list identifies those actions committed to by the Davis-Besse Nuclear Power Station in this document. Any other actions discussed in the submittal represent intended or planned actions by Davis-Besse. They are described only as information and are not regulatory commitments. Please notify the Manager - Regulatory Affairs (419-321-8450) at Davis-Besse of any questions regarding this document or associated regulatory commitments.

COMMITMENTS	DUE DATE
Change the tap settings on the 4160 V to 480 V essential substation transformers supplying power to essential buses E1 and F1 to increase the 480 V essential bus voltage during power operations.	Prior to entry into Mode 4.
Change the tap settings on the 480 V to 240 V transformers feeding essential buses YE2 and YF2 to increase the 240 V essential bus voltage.	Prior to entry into Mode 4.
Install Interposing relays on the motor starters for the Main Feedwater Steam Generator Isolation motor-operated valves FW 601 and FW612.	Prior to entry into Mode 4.
Install shorting bars for selected hydramotor circuits.	Prior to entry into Mode 4.
Revise the Trip Setpoint and Allowable Value for the 90% undervoltage essential bus feeder trip relays.	Prior to entry into Mode 4.
Submit a Technical Specification Amendment to incorporate the new values for the Trip Setpoint and Allowable Value for the 90% undervoltage essential bus feeder trip relays into the DBNPS Technical Specifications.	December, 2005
Until the change to the Technical Specifications for the 90% undervoltage essential bus feeder trip relays is implemented, maintain administrative controls in accordance with NRC Administrative Letter 98-10.	Implement prior to entry into Mode 4

NRC FORM 366 (7-2001) U.S. NUCLEAR REGULATORY COMMISSION	APPROVED BY OMB NO. 3150-0104 EXPIRES 7-31-2004
LICENSEE EVENT REPORT (LER) (See reverse for required number of digits/characters for each block)	Estimated burden per response to comply with this mandatory information collection request: 50 hrs. Reported lessons learned are incorporated into the licensing process and fed back to industry. Send comments regarding burden estimate to the Records Management Branch (T-6 E6), U.S. Nuclear Regulatory Commission, Washington, DC 20555-0001, or by internet e-mail to bjs1@nrc.gov, and to the Desk Officer, Office of Information and Regulatory Affairs, NEOB-10202 (3150-0104), Office of Management and Budget, Washington, DC 20503. If a means used to impose information collection does not display a currently valid OMB control number, the NRC may not conduct or sponsor, and a person is not required to respond to, the information collection.

1. FACILITY NAME	2. DOCKET NUMBER	3. PAGE
Davis-Besse Unit Number 1	05000346	1 OF 9

4. TITLE

AC System Analysis Shows Potential Loss of Offsite Power Following Design Basis Accident

5. EVENT DATE			6. LER NUMBER			7. REPORT DATE			8. OTHER FACILITIES INVOLVED	
MO	DAY	YEAR	YEAR	SEQUENTIAL NUMBER	REV NO	MO	DAY	YEAR	FACILITY NAME	DOCKET NUMBER
										05000
06	06	2003	2003	— 007 —	00	08	05	2003	FACILITY NAME	DOCKET NUMBER 05000

9. OPERATING MODE	5
10. POWER LEVEL	000

11. THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10 CFR §: (Check all that apply)

	20.2201(b)		20.2203(a)(3)(ii)		50.73(a)(2)(ii)(B)		50.73(a)(2)(ix)(A)
	20.2201(d)		20.2203(a)(4)		50.73(a)(2)(iii)		50.73(a)(2)(x)
	20.2203(a)(1)		50.36(c)(1)(i)(A)		50.73(a)(2)(iv)(A)		73.71(a)(4)
	20.2203(a)(2)(i)		50.36(c)(1)(ii)(A)	X	50.73(a)(2)(v)(A)		73.71(a)(5)
	20.2203(a)(2)(ii)		50.36(c)(2)	X	50.73(a)(2)(v)(B)		OTHER Specify in Abstract below or in NRC Form 366A
	20.2203(a)(2)(iii)		50.46(a)(3)(ii)	X	50.73(a)(2)(v)(C)		
	20.2203(a)(2)(iv)		50.73(a)(2)(i)(A)	X	50.73(a)(2)(v)(D)		
	20.2203(a)(2)(v)	X	50.73(a)(2)(i)(B)		50.73(a)(2)(vii)		
	20.2203(a)(2)(vi)		50.73(a)(2)(i)(C)		50.73(a)(2)(viii)(A)		
	20.2203(a)(3)(i)		50.73(a)(2)(ii)(A)		50.73(a)(2)(viii)(B)		

12. LICENSEE CONTACT FOR THIS LER

NAME	TELEPHONE NUMBER (Include Area Code)
Gerald M. Wolf, Staff Engineer - Licensing	(419) 321-8001

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

CAUSE	SYSTEM	COMPONENT	MANU-FACTURER	REPORTABLE TO EPIX	CAUSE	SYSTEM	COMPONENT	MANU-FACTURER	REPORTABLE TO EPIX

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

16. ABSTRACT (Limit to 1400 spaces, i.e., approximately 15 single-spaced typewritten lines)

On June 6, 2003, while performing an upgrade of the analysis of the electrical distribution system, a deficiency was identified for the low probability limiting analysis design case involving a loss of coolant accident (LOCA) with the plant operating in Mode 1 with degraded voltage conditions. The in-rush current from starting all essential loads to mitigate a large break LOCA in conjunction with the degraded grid voltage may result in insufficient voltage for some essential 480 V equipment to operate satisfactorily during the degraded voltage condition. Furthermore, if a startup transformer and/or bus tie transformer is out of service in this condition, undervoltage relays may actuate causing a loss of preferred power to the 4160 V essential buses, resulting in loading of the Emergency Diesel Generators. This undervoltage condition is an original design deficiency that has a very low probability of occurrence because of the limited use of a single startup and/or single bus tie transformer and highly reliable grid voltages in the Midwest. This issue is being reported in accordance with 10CFR50.73(a)(2)(v) as a condition that could have prevented fulfillment of a safety function, and 10CFR50.73(a)(2)(i)(B) as a condition prohibited by the Technical Specifications.

FACILITY NAME (1)	DOCKET (2)	LER NUMBER (6)			PAGE (3)
		YEAR	SEQUENTIAL NUMBER	REVISION NUMBER	
Davis-Besse Unit Number 1	05000346	2003	– 007 –	00	2 OF 9

NARRATIVE *(If more space is required, use additional copies of NRC Form 366A)* (17)

DESCRIPTION OF OCCURRENCE:

As part of the Return to Service Plan, the Davis-Besse Nuclear Power Station (DBNPS) staff completed a Safety Function Validation Project review of the 4160 Volt electrical distribution system. This review revealed a number of unverified assumptions in previous analyses of the electrical distribution system. To address this, analysis of the electrical distribution system is being performed utilizing the Electrical Transients Analysis Program (ETAP) computer modeling software. This analysis includes load flow and voltage drop calculations for various plant operating conditions and design basis accident conditions. On June 6, 2003, with the plant in Mode 5, this analysis identified deficiencies with the low probability limiting analysis cases involving a loss of coolant accident (LOCA) with the plant operating in Mode 1 with degraded grid voltage conditions, either with only one startup transformer and/or one bus-tie transformer in service, or with both startup and both bus tie transformers in service.

The DBNPS onsite electrical systems include the 13.8 kV [EB], the 4160 V [EA, EB], and the 480 V [EC, ED] AC distribution systems, two 4160 V emergency diesel generator units [EK-DG] and one non-essential 4160 V diesel generator which serves as the alternate AC source for station blackout concerns (All voltages listed are nominal voltage). Refer to Figure 1 for a diagram of the DBNPS 4160 V and above electrical system. With the turbine-generator [EL-TG] operating, the normal source of station power is from the unit auxiliary transformer [EA-XFMR] to the 13.8 kV buses [EA-BU]. There are two 345 kV to 13.8 kV startup transformers that provide reserve and startup power from the offsite distribution network. Isolation of the turbine-generator from the 345 kV grid system [FK] results in de-energization of the unit auxiliary transformer and fast transfer of the 13.8 kV buses A and B to their respective startup transformer. The specific startup transformer used to power each 13.8 kV bus is pre-determined by the position of a reserve source selector switch. These switches can align either startup transformer to each 13.8 kV bus, but are typically selected so that each 13.8 kV bus is aligned to a different startup transformer. Each startup transformer was originally designed to have sufficient capacity to be operated as a complete reserve source for both 13.8 kV buses if either startup transformer is out of service. This design feature allows for flexible alignment of the offsite to onsite power supply while maintaining power available to non-essential plant equipment if the auxiliary transformer becomes unavailable.

Power to the 4160 V distribution system is from two bus tie transformers that step down the voltage from 13.8 kV to 4160 V. Each bus tie transformer normally supplies one essential and one non-essential 4160 V bus and is available as a reserve source for the redundant set of essential and non-essential 4160 V buses. The capacities of the bus tie transformers and the associated circuit breakers are designed to permit station operation with one bus tie transformer out of service. Transfer schemes are provided to switch each set of 4160 V buses from its normal bus tie transformer to its reserve. The transfer between the two sources is done automatically by protective relay

FACILITY NAME (1)	DOCKET (2)	LER NUMBER (6)			PAGE (3)
		YEAR	SEQUENTIAL NUMBER	REVISION NUMBER	
Davis-Besse Unit Number 1	05000346	2003	– 007 –	00	3 OF 9

NARRATIVE *(If more space is required, use additional copies of NRC Form 366A)* (17)

DESCRIPTION OF OCCURRENCE: (Continued)

action, or manually by the operator. Two redundant Emergency Diesel Generators (EDGs) provide onsite standby sources to supply their respective essential buses. If the essential bus voltage is not maintained, the undervoltage relays [EB-27] set at approximately 90 percent of nominal bus voltage automatically initiate isolation of the essential bus following a time delay of approximately 7.5 seconds. The loss of voltage relays set at approximately 59 percent of nominal bus voltage automatically initiate load shedding and EDG starting after a time delay of approximately 0.5 seconds. If a Safety Features Actuation System (SFAS) [JB] actuation occurs in conjunction with the loss of voltage, the sequencer will automatically load the bus. A Station Blackout Diesel Generator (SBODG) [EA-DG] provides an alternate source of emergency power in addition to the EDGs. The SBODG has no automatic start or load feature. However, it can be manually started and loaded from either the Control Room or the SBODG electrical equipment room.

Utilizing the ETAP software, an analysis was performed for the low probability event of the plant operating in Mode 1 at 100 percent power with degraded grid voltage (98.3 percent of nominal), the electrical distribution systems aligned to a single startup transformer and a single bus tie transformer bus when a SFAS Level 4 actuation occurs. A SFAS Level 4 actuation is indicative of a large-break LOCA, and so all Emergency Core Cooling Pumps (High Pressure Injection Pumps [BQ-P] and Low Pressure Injection Pumps [BP-P]), as well as the Containment Spray Pumps [BE-P] are started along with closing Containment Isolation Valves [ISV] and initiating a trip of the Reactor and Main Turbine. Since power is available from the offsite transmission network, all electrical loads are started upon receipt of the SFAS Level 4 actuation signal (These loads would be started sequentially if the EDGs were supplying power to the essential electrical buses). The in-rush current from the starting of these essential loads in conjunction with the existing loads associated with normal 100 percent power operation compounded by degraded grid voltage results in voltages at the essential 4160 V buses that drop below the setpoint of the 90 percent undervoltage relays. The analysis shows that the 4160 V bus voltages do not recover above the reset value for the undervoltage relays for this limiting system configuration. Therefore, given these conditions, the undervoltage relays would trip the supply breakers to the essential 4160 V buses. The loss of voltage relays would then load the essential buses onto the EDGs, and the SFAS Level 4 loads would sequence onto the essential buses.

DBNPS Technical Specification 3.8.1.1 requires a minimum of two qualified circuits between the offsite transmission network and the onsite Class 1E (essential) A.C. electrical power distribution system be operable while in Modes 1 through 4. A qualified circuit is defined by Technical Specification 3/4.8.1.1 Bases, as well as the Updated Safety Analysis Report, as one that meets the requirements of 10CFR50 Appendix A, General Design Criterion (GDC) 17. With one of these circuits out of service because of a startup transformer and/or a bus tie transformer out of service, power operation would be allowed to continue for up to 72 hours as allowed by Technical Specification 3.8.1.1 Action "a" provided the correct breaker alignments and

FACILITY NAME (1)	DOCKET (2)	LER NUMBER (6)			PAGE (3)
		YEAR	SEQUENTIAL NUMBER	REVISION NUMBER	
Davis-Besse Unit Number 1	05000346	2003	– 007 –	00	4 OF 9

NARRATIVE *(If more space is required, use additional copies of NRC Form 366A)* (17)

DESCRIPTION OF OCCURRENCE: (Continued)

indicated power availability are verified for the other circuit within one hour and every 8 hours thereafter, and the ability of the EDG to start and accelerate up to 900 RPM is verified within 24 hours. With both of these circuits out of service, power operation may only continue for up to 24 hours per Action "d" provided the ability of the two EDGs to start and accelerate up to 900 RPM is verified within 8 hours.

Therefore, when one startup and/or bus tie transformer is out of service coincident with a LOCA and degraded grid voltage, the remaining circuit would not meet the qualification requirements of Technical Specification 3.8.1.1. In reviewing past operating history, it was found that on January 5, 2002, when the Main Generator was removed from service to support repairs to a hydrogen cooler, 13.8 kV bus "B" transferred from startup transformer X01 to startup transformer X02 unexpectedly due to a shorted relay contact. The appropriate Technical Specification actions were taken for one startup transformer out of service, but because of the condition recently discovered utilizing the ETAP software, neither offsite to onsite circuit remained operable. GDC 17 defines the safety function of both the offsite electrical power system and the onsite emergency power system as providing sufficient electrical power capacity and capability in the event of a design basis accident assuming that the other system is not available. Therefore, this past configuration condition represents an event that could have prevented fulfillment of a safety function, which is reportable in accordance with 10CFR50.73(a)(2)(v). Similar configuration conditions included (but are not limited to) August 7, 2001, when bus tie transformer AC was removed from service to conduct testing of its fire protection deluge system, and August 13-14, 2001, when startup transformer X01 was removed from service for maintenance. Furthermore, because of this unknown condition, on August 13-14, 2001, the EDGs were not tested within 8 hours, nor was the plant shutdown to hot standby (Mode 3) conditions in the subsequent 6 hours with both offsite circuits inoperable, which is reportable per 10CFR50.73(a)(2)(i)(B) as a condition prohibited by the Technical Specifications.

Utilizing the ETAP software, an analysis was also performed for the low probability event of both startup transformers and both bus tie transformers available with the plant operating in Mode 1 at 100 percent power with degraded grid voltage (98.3 percent), when a SFAS Level 4 actuation occurs. Similar to the case above, all SFAS Level 4 electrical loads start immediately upon receipt of the SFAS actuation signal. While the motor starting in-rush current also results in the voltage at the essential 4160 V buses dropping below the setpoint of the 90 percent undervoltage relays, analysis shows that the bus voltage recovers above the reset value of the undervoltage relays before the relay time delay expires. For this postulated case, the undervoltage relays would not likely trip the supply breakers to the essential 4160 V buses, and the 4160 V essential buses remain connected to the offsite power sources as required by GDC 17. However, the voltages on the 480 V essential buses may not recover to the level necessary for the satisfactory operation of some essential loads such as motor-operated valves and

FACILITY NAME (1)	DOCKET (2)	LER NUMBER (6)			PAGE (3)
		YEAR	SEQUENTIAL NUMBER	REVISION NUMBER	
Davis-Besse Unit Number 1	05000346	2003	— 007 —	00	5 OF 9

NARRATIVE *(If more space is required, use additional copies of NRC Form 366A)* (17)

DESCRIPTION OF OCCURRENCE: (Continued)

ventilation damper operators (hydramotors). Therefore, during this postulated condition, even with both startup transformers and both bus tie transformers available, the electrical distribution system would not meet the requirements of GDC 17. This design deficiency represents a condition that could have prevented fulfillment of a safety function, which is reportable in accordance with 10CFR50.73(a)(2)(v).

APPARENT CAUSE OF OCCURRENCE:

As a result of the Millstone Unit 2 event in July 1976 caused by a reduction in grid voltage, undervoltage relays were installed at the DBNPS to protect the 4160 V essential buses from degraded voltage conditions. As a result of the Arkansas Nuclear One (ANO) Unit 1 event in September 1978 involving degraded voltage on the safety buses, the DBNPS Architect/Engineer analyzed the DBNPS electrical power distribution system using a computer model to ensure adequate voltage existed on the DBNPS safety buses. In 1989, the DBNPS engineering staff selected the Electrical Load Management System (ELMS) computer program to model the electrical distribution system and to perform a more detailed review of the distribution system for calculating short circuit currents and for comparison against equipment ratings, determining bus and terminal voltage throughout the system depending on source voltage and alignment, and calculating load flow within the system. However, the ELMS modeling did not include the most limiting postulated scenario of one startup transformer and one bus-tie transformer in service as had been originally modeled by the DBNPS Architect/Engineer. Although this condition appears to be an original design bases deficiency, no specific cause could be found for why the ELMS modeling did not include the most limiting scenario, which may be due in part to the fact that the ELMS modeling was completed over ten years ago. This was a missed opportunity to identify this design deficiency and is attributed to inadequacy in engineering rigor as well as inadequate management oversight in preparing the ELMS modeling and in preparing the undervoltage relay setpoint calculation, which resulted in incomplete analysis and unverified assumptions in the calculations. The issues of engineering rigor and management oversight are being addressed as part of the DBNPS Return to Service Plan.

In 2001, the DBNPS purchased the ETAP software to replace the now outdated ELMS software. This was due to the fact that the ELMS software is no longer supported by the developer, and the ETAP software, which is widely used at commercial nuclear power plants in the United States, has expanded capability and is designed to run on the current generation of desktop computers. Because of the increased capability of the ETAP software over previous analysis tools, more detailed models can be made instead of utilizing simplified lumped loading modeling. The ELMS software had specific limitations on the number of buses and loads that it could handle, whereas the ETAP software supports a greater number of buses and loads. Increased rigor when modeling the electrical distribution system led to the discovery that at

APPARENT CAUSE OF OCCURRENCE: (Continued)

the degraded voltage limit of 98.3 percent, some components at the 480 V level may receive insufficient voltage to ensure they remained capable of performing their designated safety functions in the limiting scenario described above.

ANALYSIS OF OCCURRENCE:

During the low probability period of susceptibility, if grid voltage degraded, voltage on essential buses may be inadequate to assure that essential loads would remain capable of performing their intended safety functions. The low voltage condition on the 480 V essential buses may reduce the control power and voltage within the control circuits to a level insufficient to actuate the main line contactors. As a result, the control power fuses may open when the loads (i.e. motors) are signaled to start. The low voltage could also cause motors to run below synchronous speed and draw current that could damage motor windings or cause the supply breaker to trip on overcurrent.

One particular set of control circuits affected by degraded voltage is the circuits for the Main Feedwater Steam Generator Isolation Valves [SJ-ISV]. These valves receive a close signal from the Steam and Feedwater Rupture Control System (SFRCS) to isolate feedwater flow to the steam generators, but do not receive a signal from the SFAS to close in the event of a LOCA. There is no significant in-rush current associated with actuation of the SFRCS; therefore, these valves would not be affected by the limiting design condition of degraded grid voltage coincident with a SFAS Level 4 actuation as described above. However, these valves may not have operated during other degraded grid voltage events due to insufficient voltage on the 480 V essential buses. Other valves in the Main Feedwater piping to the Steam Generators remained capable of closing on an SFRCS signal.

Other control circuits affected by the degraded voltage include ventilation damper actuators (hydramotors) for one train of the Component Cooling Water Room ventilation [VF-DMP] and one train of the Emergency Ventilation Systems [VC-DMP]. The other train of Component Cooling Water Room ventilation was not affected by the degraded voltage, and operators could have taken additional actions to keep the Component Cooling Water Room temperature within equipment operating limits. The other train of the Emergency Ventilation System was also not affected by the degraded voltage condition, and remained available to perform its intended function.

In the recent past, when a startup transformer and/or a bus tie transformer was unavailable, the two Emergency Diesel Generators as well as the Station Blackout Diesel Generator were maintained available in accordance with the requirements of 10CFR50.65(a)(4) to manage the increase in risk. Therefore, during these isolated configuration conditions there was little safety significance because of this defense-in-depth practice.

FACILITY NAME (1)	DOCKET (2)	LER NUMBER (6)			PAGE (3)
		YEAR	SEQUENTIAL NUMBER	REVISION NUMBER	
Davis-Besse Unit Number 1	05000346	2003	– 007 –	00	7 OF 9

NARRATIVE *(If more space is required, use additional copies of NRC Form 366A)* (17)

ANALYSIS OF OCCURRENCE: (Continued)

An analysis of the FirstEnergy transmission system was performed by the transmission system operator. The purpose of this analysis was to evaluate the impact of various transmission system contingencies, including the loss of generation from the DBNPS, on the 345 kV system voltage at the DBNPS 345 kV switchyard. The analysis also determined the probabilities associated with potential low voltage at the DBNPS 345 kV switchyard. The conclusion of this analysis was that with the DBNPS not producing power, the probability of experiencing grid voltage at or below 98.3 percent was less than one day in 1000 years, or an annual frequency of 2.7E-06. Per NUREG/CR-5750, Rates of Initiating Events at U.S. Nuclear Power Plants: 1987-1995, the annual frequency of a large-break LOCA that would result in a SFAS Level 4 actuation is 5.0E-6. Therefore, the combined annual frequency of a Large-Break LOCA coincident with degraded grid voltage conditions is 1.4E-11, which per Regulatory Guide 1.174 guidelines results in a very small increase in core damage frequency. Overall, this condition is considered to have minimal safety significance.

CORRECTIVE ACTIONS:

The Trip Setpoint and Allowable Value for the 90% undervoltage essential bus feeder trip relays will be revised to assure voltage to essential equipment is sufficient to support operation. The trip setpoint will be revised prior to entry into Mode 4. The new values will be incorporated into the DBNPS Technical Specifications, and until this change to the Technical Specifications is implemented, administrative controls implemented in accordance with NRC Administrative Letter 98-10 will remain in place.

The tap settings on the 4160 V to 480 V essential substation transformers [ED-XFMR] supplying power to essential buses E1 and F1 will be changed to increase the 480 V essential bus voltage during power operations. The tap settings on the 480 V to 240 V transformers feeding essential buses YE2 and YF2 [ED-BU] will also be changed to increase the 240 V essential bus voltage. These tap setting revisions will be completed prior to entry into Mode 4.

Interposing relays will be installed on the NEMA size 3 motor starters [SJ-MSTR] for the Main Feedwater Steam Generator Isolation motor-operated valves FW 601 and FW612. The interposing relays confine the motor starting current to the MCC, creating only a minimal voltage drop in the circuitry; thereby assuring adequate voltage is available during design basis conditions. Shorting bars will be installed for selected Hydramotor [DMP] circuits to reduce the voltage drop seen at the Hydramotor to ensure it remains capable of positioning its associated ventilation damper in the event of a design basis accident. These modifications will be completed prior to entry into Mode 4.

FACILITY NAME (1)	DOCKET (2)	LER NUMBER (6)			PAGE (3)
		YEAR	SEQUENTIAL NUMBER	REVISION NUMBER	
Davis-Besse Unit Number 1	05000346	2003	– 007 –	00	8 OF 9

NARRATIVE *(If more space is required, use additional copies of NRC Form 366A)* (17)

CORRECTIVE ACTIONS: (Continued)

Based on the final results of the ETAP analysis and continued evaluation, other actions may be performed to ensure compliance with applicable standards to ensure the offsite to onsite circuits are qualified as described in the DBNPS Licensing Basis. These actions may include such items as permanently defeating the auto-transfer circuitry between startup transformers and/or bus tie transformers, or modifying station procedures to prohibit undesired lineups of the offsite circuits. These actions will be completed as necessary to ensure operability of the offsite to onsite circuits.

FAILURE DATA:

LER 2000-004 documented an event that occurred on April 22, 2000, where all offsite power was lost during bus transfer testing during a refueling outage. The corrective actions from this 2000 event, which was a result of personnel error, would not have prevented this current event, which is a result of a latent design issue.

Energy Industry Identification System (EIIS) codes are identified in the text as [XX].

NP-33-03-007-00 CRs 02-07646, 03-04435, 03-05347

LICENSEE EVENT REPORT (LER)

FACILITY NAME (1)	DOCKET (2)	LER NUMBER (6)			PAGE (3)
		YEAR	SEQUENTIAL NUMBER	REVISION NUMBER	
Davis-Besse Unit Number 1	05000346	2003	– 007 –	00	9 OF 9

NARRATIVE *(If more space is required, use additional copies of NRC Form 366A)* (17)

FIGURE 1-DAVIS-BESSE ELECTRICAL DISTRIBUTION SYSTEM