Consumers Power
POWERING MICHIGAN'S PROGRESS
Palisades Nuclear Plant: 27780 Blue Star Memorial Highway, Covert, MI 49043

G B Slade
General Manager

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DOCKET 50-255 - LICENSE DPR-20 - PALISADES PLANT -
LICENSEE EVENT REPORT 92-038 - REACTOR TRIP CAUSED BY A LOSS OF THE PREFERRED AC BUS Y-20 COINCIDENT WITH A BLOWN FUSE IN A SECOND CHANNEL OF THE REACTOR PROTECTIVE SYSTEM

Licensee Event Report (LER) 92-038 is attached. This event is reportable in accordance with 10CFR50.73(a)(2)(iv) as an event that resulted in the automatic actuation of the reactor protective system (RPS).

Gerald B Slade
General Manager

CC Administrator, Region III, USNRC
NRC Resident Inspector - Palisades

Attachment

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PALISADES
NUCLEAR PLANT

28017

NRC Form 366
(9-83)

U.S. NUCLEAR REGULATORY COMMISSION
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LICENSEE EVENT REPORT (LER)

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TITLE (4) REACTOR TRIP CAUSED BY A LOSS OF THE PREFERRED AC BUS Y-20 COINCIDENT WITH A BLOWN FUSE IN A SECOND CHANNEL OF THE REACTOR PROTECTIVE SYSTEM

EVENT DATE (5)			LER NUMBER (6)					REPORT DATE (8)			OTHER FACILITIES INVOLVED (8)	
MONTH	DAY	YEAR	YEAR		SEQUENTIAL NUMBER		REVISION NUMBER	MONTH	DAY	YEAR	FACILITY NAMES	
											N/A	0 5 0 0 0
0 8	2 5	9 2	9 2	-	0 3 8	-	0 0	0 9	2 4	9 2	N/A	0 5 0 0 0

OPERATING MODE (9)	N	THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10 CFR §: (Check one or more of the following) (11)			
POWER LEVEL (10)	1 0 0	20.402(b)	20.405(c)	X 50.73(a)(2)(iv)	73.71(b)
		20.405(a)(1)(i)	50.36(c)(1)	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)	50.73(a)(2)(i)	50.73(a)(2)(viii)(A)	
		20.405(a)(1)(iv)	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
Cris T. Hillman, Staff Licensing Engineer	AREA CODE 6 1 6 7 6 4 - 8 9 1 3

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
X YES (If yes, complete EXPECTED SUBMISSION DATE)	NO		1 1	2 0	9 2

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

On August 25, 1992 at 0129 hours, with the plant operating at 100% power, and all systems in a normal full power alignment, the reactor tripped. The reactor trip resulted from a loss of the preferred ac bus Y-20, coincident with a blown fuse in another portion of the reactor protective system (RPS). The automatic reactor trip was successfully completed with no major plant equipment problems identified. The plant was maintained in hot shutdown for evaluation of the trip.

The cause of this event was the loss of preferred ac bus Y-20 that resulted in the loss of one channel of the reactor protective system (RPS), coincident with a blown fuse in a second channel of the RPS, which resulted in the initiation of an RPS trip signal. Preferred ac bus Y-20 was lost due to the failure of inverter ED-07. It was later determined that improper internal wiring connecting the transformers within ED-07 caused accelerated aging of the transformer coils and resulted in the failure of two transformers.

Corrective action for this event included checking all the fuses in the RPS system for proper sizing, completing a Procurement Engineering Checklist for the SOLA transformers to identify critical characteristics to be used during the procurement process, updating plant drawings and vendor manuals of the inverters to properly show the use of functionally equivalent SOLA transformers, and reviewing this event with electrical maintenance department personnel to reinforce the importance of requiring attention to the proper connection of components that have multiple windings. Additional corrective action regarding the pressurizer level control circuitry is being developed and will be reported in a supplemental licensee event report.

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EVENT DESCRIPTION

On August 25, 1992 at 0129 hours, with the plant operating at 100% power and all systems in a normal full power alignment, the reactor tripped. The reactor trip resulted from a loss of the preferred ac bus Y-20 [ED;PL], coincident with a blown fuse in a second channel of the reactor protective system (RPS). Preferred ac bus Y-20 provides ac power to the Engineered Safeguards System electrical loads including the reactor protective system (RPS) [JC]. The automatic reactor trip was successfully completed with no major plant equipment problems identified. The control room immediately initiated emergency operating procedures (EOPs) EOP-1, "Standard Post Trip Actions," and EOP-2, "Reactor Trip Recovery." The required actions for the EOPs were successfully completed and the procedures were exited.

During the actions taken for the reactor trip, it was noted that the "B" channel of the RPS was de-energized indicating a loss of Y-20. Pressurizer level control was operating in the "B" channel which is powered from Y-20, therefore, the control room operators immediately swapped pressurizer level control to the redundant "A" channel, in accordance with the Off-Normal Procedure (ONP) 24.2, "Loss of Preferred AC Bus Y-20," and expected additional automatic charging pump starts of the standby charging pumps to be initiated based on pressurizer level. After a short period of time with no additional charging pump starts, the control room operators manually started an additional charging pump in accordance with the EOPs to regain pressurizer level. At the time the control room operators manually started a charging pump, pressurizer level was approximately 32% with the pressurizer level control setpoint at 42%.

The plant was maintained in hot shutdown for evaluation of the trip. Preferred ac bus Y-20 was re-energized through the bypass regulator at approximately 0330 hours on August 25, 1992. On August 26, 1992, at 0925 hours preferred ac bus Y-20 was returned to its normal power supply and the limiting condition of operation (LCO) action statement was exited.

This event is reportable to the NRC in accordance with 10CFR50.73(a)(2)(iv) as an event that resulted in the automatic actuation of the reactor protective system (RPS).

CAUSE OF THE EVENT

The cause of this event was the loss of preferred ac bus Y-20 that resulted in the loss of one channel of the reactor protective system (RPS), coincident with a blown fuse in a second channel of the RPS, which resulted in the initiation of an RPS trip signal. Preferred ac bus Y-20 was lost due to the failure of inverter ED-07. It was later determined that improper internal wiring connecting the transformers within ED-07 caused accelerated aging of the transformer coils and resulted in the failure of two transformers.

This event involved the failure of equipment important to safety.

ANALYSIS OF THE EVENT

Failed Preferred ac Bus Y-20

Preferred ac bus Y-20 is a 120V ac electrical distribution panel that provides ac power to the Engineered Safeguards electrical loads. Y-20 is normally powered from the station batteries through an inverter. The inverters in use at Palisades employ output transformers to filter and regulate the output of the inverter. The inverter uses three, one-third capacity, constant voltage transformers made by SOLA Electric Co. to perform this task. These SOLA transformers are a static magnetic voltage regulator that include capacitors as part of a ferro-resonant circuit. SOLA supplies their units as a complete package; transformer, terminal block, and several capacitors.

Equipment History of SOLA Transformers

The original SOLA transformers were supplied with a single primary winding for input connections. Current plant drawings and controlled vendor manuals reflect this wiring configuration.

In 1980, SOLA informed the inverter manufacturer that the original SOLA transformers with a single primary winding were no longer available. SOLA recommended a substitute with two primary windings. For the substitute to be used at Palisaed jumpers would be used to properly connect the transformers. The plant drawings or vendor manuals were not changed to reflect the installation of jumpers.

In 1981 another substitution was made by SOLA. The 1981 substitute included multiple primary windings and capacitors. Again, the use of jumpers to properly connect the transformers was required; however, the plant drawings and vendor manuals were not changed.

In 1984 transformer T-21 was replaced in ED-07. The replacement SOLA transformer that was removed from stock was equipped with multiple input connections. Jumpers were properly attached; however, the source of the information to install the jumpers was not documented in the maintenance order package, and was also not reflected in plant drawings or the vendor manual.

In 1985, SOLA suggested that all three transformer/capacitor pairs be replaced as a group. This would ensure that each of the three paralleled SOLAs equally share load.

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In July 1986, contrary to the information provided by SOLA, only two transformers (T-20 and T-22), but all three sets of capacitors were replaced in ED-07. The work order summary for the replacement did not indicate that transformers T-20 and T-22 had the required jumpers installed.

Current Status

Following the reactor trip on August 25, 1992, troubleshooting revealed that the output voltage from preferred ac bus Y-20 had dropped to 24 volts. Further troubleshooting indicated that inverter ED-07 had failed and that transformers T-20 and T-22 within inverter ED-07 had shorted windings and required replacement. Based on equipment history information obtained in 1985 concerning replacement of SOLA transformers, all three SOLA transformers (T-20, T-21 and T-22) and their "matching" capacitors would need to be replaced. Three SOLA transformers were in stock and were used as replacements for the failed transformer components.

Post maintenance testing of the replacement transformers found the output voltage of inverter ED-07 to be unsatisfactorily low at ≈100 volts. Troubleshooting identified that the replacement transformers had four primary windings with different connection options. The plant drawings and the controlled vendor manual had not been updated for correct placement of jumpers to provide the required output voltage, therefore, no jumpers were installed during the replacement of the damaged transformers. Jumpers were subsequently installed following engineering direction and review of the vendor manual that was shipped with the replacement SOLA transformers. The output voltage was fully acceptable after the installation of the necessary jumpers.

Since the SOLA transformers that failed (T-20 and T-22) on August 25, 1992 had been in service since 1986, a question was raised as to whether or not inverter ED-07 was capable of providing power output to meet both normal and emergency loads. An analysis was performed to determine both normal operating and emergency power demands on ED-07. The analysis concluded that the normal continuous load on ED-07 is 4,390 volt-amps while the emergency load on ED-07 adds an additional 1,082 volt-amps for a total of 5,472 volt-amps. During the 1992 refueling outage, technical specifications surveillance procedure (TSSP) RT-8D, "Engineered Safeguards System - Right Channel" was performed. This TSSP tested inverter ED-07 with both normal loads and emergency loads. The results of TSSP RT-8D demonstrated that the inverter ED-07 was fully capable of serving both normal and emergency loads. Furthermore, preventive maintenance is performed on the inverters using the periodic and predetermined activity control system (PPACS). PPAC SPS019, which measures the output voltage of the transformers in inverter ED-07 and was last performed on March 17, 1992, was reviewed. This review determined that the measured output voltage of the transformers in inverter ED-07 were acceptable.

In addition, all three transformers were removed from inverter ED-07 and were sent to CPCo's Equipment and Services laboratory for testing. Of the three transformers, T-21 had been properly connected since 1984 therefore, it was available for testing and evaluation. Transformers T-20 and T-22 were examined to determine the cause of their failures. Preliminary test results indicate that the transformers operate at a higher

temperature with only one primary winding connected which could cause accelerated aging. Furthermore, the preliminary test results indicate that even with only one primary winding connected, the transformers are able to provide output power of the proper voltage, frequency and wave form. A formal report is being developed. The final results of this report will be provided in a supplement to this LER.

Incorrectly Sized Fuse in the "C" Channel RPS Trip Logic

Troubleshooting performed on the RPS system following the August 25, 1992 revealed a blown fuse in the "C" channel of the logic circuits for the RPS.

The RPS contains six logic ladders representing the 2 out of 4 logic combinations; AB, AC, AD, BC, BD, & CD. Each logic ladder is powered by two auctioneered 28 volt power supplies. The power supply and ac feed to the power supply correspond to the particular matrix ladder. For example, the B-C matrix is powered on one side by a "B" channel 28 volt supply which is fed from preferred ac bus Y-20. The other side is powered by a "C" channel 28 volt power supply fed from preferred ac bus Y-30.

When the Y-20 bus was lost (due to the failure of ED-07), three of the six logic ladders that involve the "B" channel (AB, BC, & BD) lost one (the B supply) of their auctioneered 28 volt power supplies. For matrix logic ladders AB and BD, the remaining redundant 28 volt power supplies picked up the load and kept the matrix trip relays energized. For the BC logic ladder, the remaining redundant 28 volt power supply suffered a blown fuse. Although the power supply was capable of carrying the load, the blown fuse prevented the "C" channel power supply from picking up the matrix trip relays for the BC logic ladder, therefore, the BC matrix trip relays de-energized and a full RPS trip was generated. A review of the vendor supplied wiring diagrams indicated that the required fuse size was 1.0 amp; however, the blown fuse removed from the circuit was a 0.5 amp fuse. It could not be determined whether the fuse had blown prior to the August 25, 1992 event or blew as a result of the failure of preferred ac bus Y-20.

A majority of the RPS system was replaced during the 1992 refueling outage. The existence of the 0.5 amp fuse was not determined during post-modification testing. The instrument and control (I&C) technicians assigned to the RPS upgrade project were interviewed and responded that they had not replaced any of the 28 volt dc power supply fuses. The RPS hardware vendor performed an internal investigation regarding their QA practices employed during the assembly, inspection and testing of the RPS hardware. From this investigation the vendor could not conclude whether the incorrect size fuse was or was not installed prior to shipment to CPCo.

Failure of Charging Pump Auto-start

Pressurizer level control was operating in the "B" channel which is powered from Y-20, therefore, the control room operators immediately swapped pressurizer level control to the redundant "A" channel, in accordance with the Off-Normal Procedure (ONP) and expected additional automatic charging pump starts initiated by the pressurizer level controller. After a short period of time with no additional charging pump starts, the

control room operators manually started an additional charging pump to regain pressurizer level in accordance with the EOPs. At the time the control room operators initiated a manual charging pump start pressurizer level was approximately 32% with the pressurizer level control setpoint at 42%.

System Engineering, Operations and I&C reviewed the electrical prints depicting the pressurizer level control system design. This review concluded that the charging pumps would not start for the plant conditions which existed following the reactor trip on August 25, 1992. The normal level control signal was configured such that no additional charging pumps would start while the back-up level control signal was configured to start additional charging pumps. Testing was performed to verify that the pressurizer level controllers were operating as designed.

During the event pressurizer level control was swapped to the "A" channel following the loss of Y-20 in accordance with the ONPs. The redundant controller (in this case the "A" channel) is normally in the manual mode with a 50% normal level control signal that calls for the additional charging pumps to be tripped. As a result of the trip and the loss of Y-20, with the pressurizer level decreased to the point where the back-up level control signal would have initiated additional charging pump starts. Since the normal pressurizer level control signal was still not requiring additional charging pump starts, a standing trip signal was present while the back-up pressurizer level control signal was configured for additional charging pump starts; however, the breakers for the charging pumps are equipped with an anti-pump relay. With both a start signal and a trip signal being fed to the charging pump breaker, the anti-pump relay activated and would not allow the additional charging pumps to start. The control room operators correctly identified the failure of the charging pumps to start and placed the charging pumps in manual control, thereby allowing a charging pump to start. It is important to note that both the manual charging pump start signal and the safety injection system (SIS) charging pump start signal will defeat the anti-pump relay allowing the charging pumps to be started.

Further investigation revealed that the design discrepancy regarding the inability to start a charging pump with a standing trip signal energized had been previously identified in D-PAL-90-053 and has not been corrected. Proposed corrective action for D-PAL-90-053 included modifying the charging pump circuitry so that the back-up level controls could start the charging pumps without relying on the normal level controls to clear the standing trip signal. The modification to the control circuitry has been delayed to the 1994 refueling outage.

CORRECTIVE ACTION

Prior to plant start-up the fuses in the remaining eleven 28V dc power supplies located in RPS Channels A, B, C, & D were checked and found satisfactory. In addition, fuses are in other locations in the RPS circuitry were checked and found satisfactory.

Inverter ED-07

Further investigation into the reasons why the plant wiring diagrams did not adequately reflect the correct jumper installation for the transformers within inverter ED-07 and why vendor supplied information was not previously incorporated into plant design documents was deemed necessary. This information is documented in corrective action document D-PAL-92-227. The incorrect connection of the two SOLA transformers in 1986 was caused by:

1. Failure to identify during the procurement process that substitute SOLA transformers, although thought to be functional equivalents, had physical size and electrical connection differences.

2. Failure to perform detailed design engineering during the justification of functionally equivalent replacement parts.

3. Failure to identify on plant drawings and vendor manuals that replacement transformers in stock would require both physical and electrical modifications before their use.

4. Inattention to detail during the installation process.

Corrective action for the events pertaining to the failure of inverter ED-07 are documented in D-PAL-92-227 and include the following actions.

1. Complete a Procurement Engineering Checklist for the SOLA transformers to identify critical characteristics to be used during the procurement process. This will help justify any changes in model and part numbers.

2. Update plant drawings of the inverters to properly show the use of functionally equivalent SOLA transformers.

3. Update plant vendor manuals for the inverters to properly show the use of functionally equivalent SOLA transformers.

4. Review this event with electrical maintenance department personnel to reinforce the importance of requiring attention to the proper connection of components that have multiple windings.

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Incorrectly Sized Fuse in the "C" Channel RPS Trip Logic

The results of investigation as to the existence of the 0.5 amp fuse in the RPS circuit as opposed to the required 1.0 amp fuse are documented in corrective action document D-PAL-92-230 and include the following actions.

1. Check the fuses in the remaining eleven 28V dc power supplies located in RPS channels A, B, C, & D. Also, other fuses in the logic circuits were verified to be properly sized. This action was completed prior to plant re-start and all fuses were found to be correctly sized.

2. Review response from the vendor of the RPS hardware concerning this event and determine if additional corrective action is warranted. The vendor investigation could not confirm that the incorrectly sized fuse was installed by the vendor.

Failure of Charging Pump Auto-start

The failure of the charging pump auto-start circuit is being evaluated.

ADDITIONAL INFORMATION

None