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AUTH.NAME AUTHOR AFFILIATION
WEBB,T.J. Wisconsin Public Service Corp.
EVERS,K.H. Wisconsin Public Service Corp.
RECIP.NAME RECIPIENT AFFILIATION

SUBJECT: LER 91-002-00:on 910220,determined that second level undervoltage trips of safeguard buses did not meet design basis.Caused by inadequate design evaluation.Time delay shortened to 6 s.W/910320 ltr.

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March 20, 1991

10 CFR 50.73

U. S. Nuclear Regulatory Commission
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Washington, D.C. 20555

Gentlemen:

Docket 50-305
Operating License DPR-43
Kewaunee Nuclear Power Plant
Reportable Occurrence 91-002-00

The attached Licensee Event Report for reportable occurrence 91-002-00 is being submitted in accordance with the requirements of 10 CFR 50.73, "Licensee Event Report System."

Sincerely,

K. H. Evers
Manager-Nuclear Power

TJW/jms

Attach.

cc - INPO Records Center
Mr. Patrick Castleman, US NRC
US NRC, Region III

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NRC Form 366 (9-83)

U.S. NUCLEAR REGULATORY COMMISSION
APPROVED OMB NO 3150-0104
EXPIRES 8/31/85

LICENSEE EVENT REPORT (LER)

FACILITY NAME (1)	DOCKET NUMBER (2)	PAGE (3)
Kewaunee Nuclear Power Plant	0 5 0 0 0 3 0 5	1 OF 0 6

TITLE (4) Safety System Functional Inspection Discovers That the Safeguards Bus Undervoltage Protection is Outside of its Design Basis as a Result of an Inadequate Design Evaluation

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 NUMBER(S)
0 2	2 0	9 1	9 1	0 0 2	0 0	0 3	2 2	9 1	N/A	0 5 0 0 0
										0 5 0 0 0

OPERATING MODE (9): N

POWER LEVEL (10): 1 0 0

THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10 CFR § (Check one or more of the following) (11)

20.402(b)	20.405(c)	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)(3)	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)	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 (AREA CODE)
Thomas J. Webb - Plant Nuclear Engineer	4 1 4 3 8 8 - 2 5 6 0

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

CAUSE	SYSTEM	COMPONENT	MANUFACTURER	REPORTABLE TO NPRDS	CAUSE	SYSTEM	COMPONENT	MANUFACTURER	REPORTABLE TO NPRDS

SUPPLEMENTAL REPORT EXPECTED (14)

		EXPECTED SUBMISSION DATE (15)	MONTH	DAY	YEAR
YES (If yes, complete EXPECTED SUBMISSION DATE)	X NO	N/A			

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

At 1520 on February 20, 1991, with the plant at 100% power, it was determined that the second level undervoltage trips of the safeguard buses did not meet their design basis. The second level undervoltage trip isolates the 4160 volt safeguard buses from offsite power if bus voltage drops below 92.5% of nominal voltage for more than 5 minutes. Once isolated, the buses would be loaded onto their respective diesel generator.

The deficiency was identified during a self-initiated safety system functional inspection of the 480 volt and 4160 volt supply and distribution systems. The inspection identified a concern if a safety injection signal were to occur concurrent with an undervoltage condition. Under these circumstances there may have been insufficient voltage to actuate the contactors in the control circuitry for the safety related loads on the 480 volt motor control center.

This event is a result of an inadequate design evaluation. Personnel involved in the design process did address this issue during the design of the undervoltage trip in 1981. However, due to a misinterpretation of pre-operational test results, they did not believe Kewaunee was susceptible to this type of failure.

In the short term, the second level undervoltage time delay was shortened to six seconds. In the long term, the review of the undervoltage trip is continuing. Modifications resulting from this review will be completed prior to the end of the current refueling outage.

Description of Event

This report describes the discovery of a condition that placed the plant outside of its design basis. At 1520 on February 20, 1991, with the plant at 100% power, it was determined that the second level undervoltage protection for the two safeguard buses at the plant was not in compliance with its design basis. Specifically, if a degraded grid condition were to occur coincident with a safety injection (SI) signal [JE], the undervoltage setpoint could have prevented the operation of some SI components. The condition was discovered during a self initiated safety system function inspection (SSFI) of the 480 volt (V) [ED] and 4160V [EB] supply and distribution systems.

The undervoltage protection system is designed to isolate the two safeguard 4160V buses [BU] from their normal offsite power supplies during degraded grid conditions. Once isolated the buses would be loaded onto their respective diesel generator [DG]. The undervoltage trips of the bus are designed to prevent operation of safeguard equipment at voltages and currents that could adversely affect the operability of the equipment. The two settings for isolating a safeguard bus are:

1. Bus voltage $\leq$ 85% of nominal voltage with a time delay of $\leq$ 2.5 seconds.

2. Bus voltage $\leq$ 92.5% of nominal voltage with a time delay of $\leq$ 5 minutes.

The primary undervoltage trip at 85% of nominal voltage is designed to protect against a loss of voltage to the 4160V safeguard buses. The setpoint accounts for line losses and ensures that equipment connected to the bus will not be operated below 80% of its rated voltage. The associated time delay prevents unnecessary actuations due to temporary bus disruption while ensuring protective actions proceed as described in the Updated Safety Analysis Report (USAR).

The second level undervoltage trip at 92.5% of nominal voltage is designed to protect against long term operation of safeguard equipment during degraded grid condition. The setpoint accounts for line losses preventing operation of equipment below 90% of its rated voltage for more than five minutes. This ensures long term operability of the safeguard equipment connected to the bus. The five minute time delay allows operation of safeguard equipment at voltages between 80% and 90% of rated voltage for short periods of time. It was determined that this was acceptable for safety related motors due to the motors' service factors and the conservative insulation design of the motors.

However, the SSFI identified a concern with the contactors for the motors [MO] fed by the 480 volt motor control centers (MCCs), e.g., fans [FAN] and motor operated valves [V]. To protect against motor damage during degraded grid conditions, 460V motors are connected to the 480V MCCs. Attachment 1 provides a simplified diagram of a typical 460 volt motor connected to a 480 volt MCC. Initiation of a safety injection signal closes contact 1, energizing the start coil (contactor) [MSTR]. The start coil or contactor in turn closes contacts 2, 3, and 4, which starts the motor. A concern arose when it was discovered that the manufacturer's minimum recommended voltage for reliable operation of the contactors is 85% of rated voltage. The second level undervoltage trip could allow operation at 80% of the motor's rated voltage for up to five minutes. Therefore if a safety injection signal had occurred during degraded grid conditions, there may have been insufficient voltage to actuate the 460V safeguard motor contactors.

A secondary concern arises if a safety injection signal occurs closing contact 1 and the contactor fails to actuate due to undervoltage conditions. If the contactor fails to actuate, the fuse [FU] in the circuit will be exposed to the actuation (in-rush) current for up to five minutes. The in-rush current is approximately 5 times higher than the operating current. It is doubtful that the fuse could survive for 5 minutes while exposed to the in-rush current.

Cause of Event

The event is the result of an inadequate design evaluation. The original design of the undervoltage trips addressed the operability of the control circuitry for the 460V motors. At the time (November 1981), it was believed that the annual test of the safety injection actuation system verified the ability of the contactors to pickup under degraded bus voltage conditions.

During this test, a safety injection signal is generated coincident with a blackout signal. As a result, the buses are isolated from offsite power and are loaded onto their respective diesel generator. Safety injection loads are then automatically loaded onto the buses. Pre-operational testing demonstrated that during this test the voltage at the bus momentarily drops below the voltage expected during a prolonged degraded grid condition. The personnel involved in the design of the undervoltage trip believed that this demonstrated the ability of the contactors to operate during undervoltage conditions.

A re-analysis of the pre-operational test results identified the following misinterpretations made during original design:

1. Although the voltage at the safeguards buses drops below the voltage expected during a degraded condition, contactor operation does not coincide with low voltage points. Therefore operation of contactors during under-voltage conditions is not verified during this test.

2. The undervoltage condition only exists momentarily during the test (approximately ½ second). Therefore the fuses in the controlling circuitry are only exposed to high currents for this brief period. If a safety injection signal were to occur coincident with an undervoltage condition and the contactors failed to actuate, the fuses in the control circuitry could be exposed to the high in-rush current for five minutes. It is doubtful that the fuses in the circuit could survive for five minutes without opening the circuit.

Analysis of Event

This event is reportable in accordance with 10 CFR 50.73(a)(2)(ii)(B) as an event that placed the plant outside of its design basis. This event was also reported at 1600 on February 20, 1991 in accordance with 10 CFR 50.72(ii)(B).

Although the event placed the plant in a condition outside of its design basis, its affect on safety was minimal. The event would have presented safety implications only if a safety injection signal had been initiated to respond to an actual event coincident with a degraded grid condition. The electrical grid supplying Kewaunee is highly reliable. Since installation of the second level undervoltage trip in 1982, there has only been one low voltage event which resulted in actuation of the second level undervoltage timer. The event occurred in May of 1983 during the 1983 refueling outage. A transformer supplying offsite power to the plant was intentionally isolated for maintenance. Since 1983, several modifications have been implemented to increase the reliability of the offsite power supply to Kewaunee. This includes installation of four capacitor banks on the 138 Kilovolt distribution system in Kewaunee's substation.

Although the manufacturer of the contactors recommended minimum voltage is 85%, we have performed limited in-house testing of the contactors used at Kewaunee. The testing has shown that the contactors will actuate at voltages ranging from 62.5% to 78.3% of nominal voltage. Therefore, in the unlikely event that a safety injection signal were to occur coincident with a degraded grid, there is reason to believe that the contactors would have operated satisfactorily.

Corrective Actions

On February 23, 1991 a temporary design change to the second level undervoltage trip was completed. The design change removed the five minute time delay from the second level undervoltage trip and set a new time limit of 6 seconds. The 6 second time limit ensures that the fuses will not open the circuit during degraded grid conditions.

In the long term, the evaluation of the undervoltage protection system is continuing and will determine a setpoint and time delay that will minimize inadvertent actuations while ensuring that protective actions proceed as described in the Updated Safety Analysis Report. Modification resulting from this evaluation will be completed prior to the end of the current refueling outage.

Additional Information

Similar Events: None

Equipment Failures: None

TYPICAL 480 VOLT MOTOR STARTING CIRCUIT

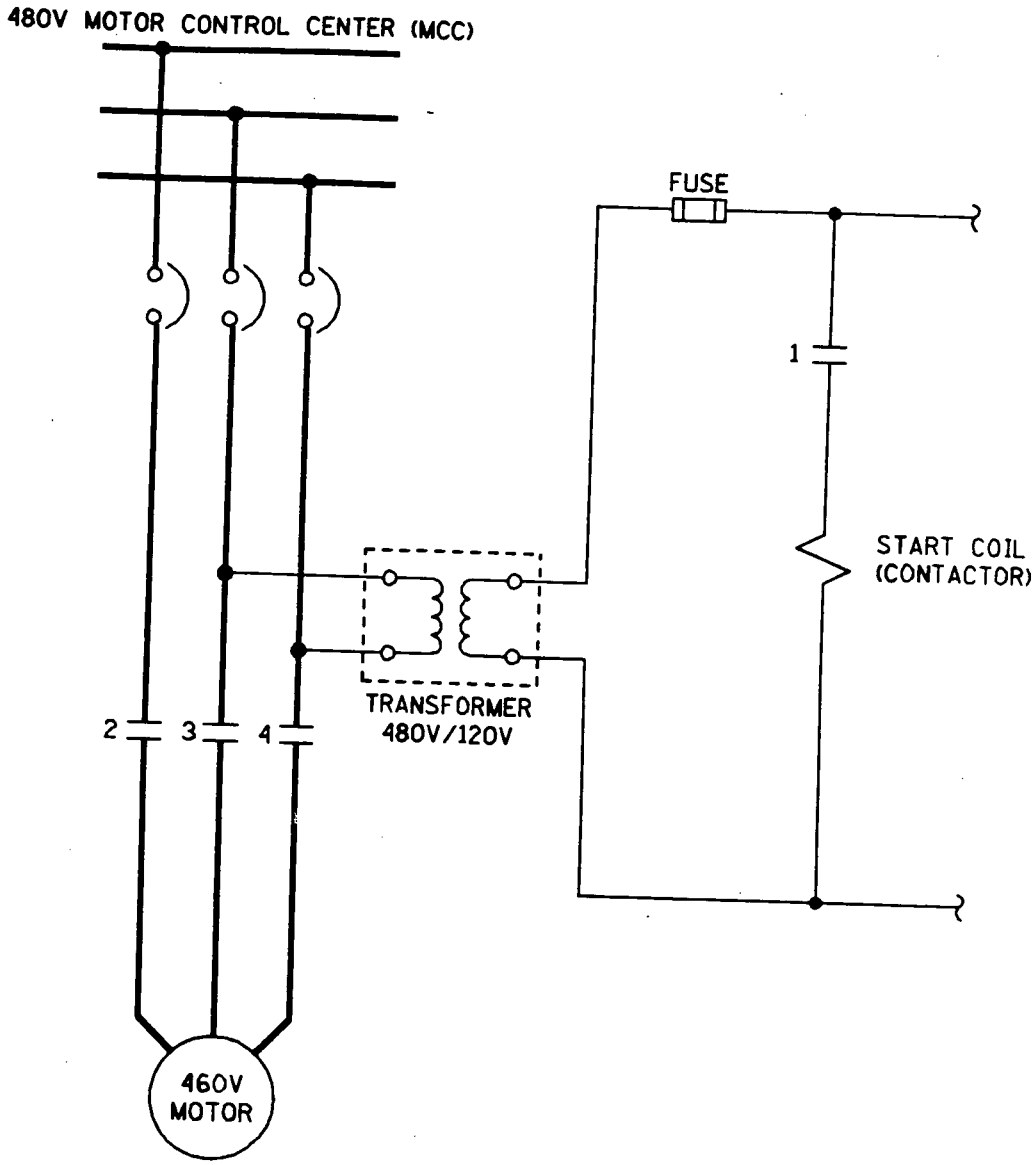

FIGURE 1