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SUBJECT: LER 96-009-00:on 961220,miscalculation of instantaneous overcurrent relay settings resulting in inoperability of safety-related equipment occurred.Caused by utilization of inappropriate design.Testing was completed.W/970122 ltr.

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CATEGORY 1 DOCUMENT

WASHINGTON PUBLIC POWER SUPPLY SYSTEM
P.O. Box 968 • Richland, Washington 99352-0968

January 22, 1997
GO2-97-010

Docket No. 50-397

U. S. Nuclear Regulatory Commission
Attn: Document Control Desk
Washington, D. C. 20555

Gentlemen:

Subject: **NUCLEAR PLANT WNP-2, OPERATING LICENSE NPF-21**
LICENSEE EVENT REPORT NO. 96-009-00

Transmitted herewith is Licensee Event Report No. 96-009-00 for WNP-2. This report is submitted pursuant to 10 CFR 50.73(a)(2)(i)(B) and (a)(2)(ii)(B) and discusses the items of reportability, corrective action taken, and action to preclude recurrence.

Should you have any questions or desire additional information regarding this matter, please call me or Ms. L. C. Fernandez at (509) 377-4147.

Respectfully,

P. R. Bemis for P. R. Bemis
Vice President, Nuclear Operations
Mail Drop PE23

Enclosure

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IE22

LICENSEE EVENT REPORT (LER)

FACILITY NAME (1)	DOCKET NUMBER (2)	PAGE (3)
Washington Nuclear Plant - Unit 2	0 5 0 0 0 3 9 7	1 of 6

TITLE (4) MISCALCULATION OF INSTANTANEOUS OVERCURRENT RELAY SETTINGS RESULTING IN INOPERABILITY OF SAFETY-RELATED EQUIPMENT

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)
12	20	96	96	- 0 0 9 -	0 0	01	22	97	N/A	0 5 0 0 0 0 5 0 0 0

OPERATING MODE (9)	1
POWER LEVEL (10)	1 0 0

THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10 CFR: (11)

__ 20.402(b)	__ 20.405c	__ 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)	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 AREA CODE	TELEPHONE NUMBER
Bill Pfitzer, Licensing Engineer	509	377-2419

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	
A	B I	R L Y	W 1 2 0	Yes							

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

ABSTRACT (16)

At 08:01, on December 20, 1996, with the plant operating at 100% power, Service Water Pump 1A (SW-P-1A) immediately tripped during a pump start attempt from the control room. Local investigation at the pump feeder breaker revealed that the motor tripped due to actuation of the instantaneous overcurrent (IOC) unit of the feeder breaker's overcurrent (50/51) relay. The pump was declared inoperable and an investigation was initiated into the cause of actuation of the IOC relay. The investigation revealed that the SW-P-1A IOC relay had been reset on November 27, 1996 in accordance with a Plant Modification Request (PMR) and the relay setpoint had been reduced from 38 amps (relay current) to the as-left setting of 26.3 amps. The PMR also reduced the settings of the IOC relays for Residual Heat Removal pump 2A (RHR-P-2A) and Low Pressure Core Spray pump 1 (LPCS-P-1).

It was determined that the IOC setpoints were calculated using inaccurate locked rotor current (LRC) and a non-conservative selection of the LRC multiplication factor. The inaccuracies in the LRC should have been accounted for by using a higher multiplication factor. The IOC setpoints were recalculated using more appropriate design input. The SW-P-1A IOC relay setpoint was changed in the field, a post maintenance test (PMT) was conducted and SW-P-1A pump was declared operable. Additionally, the IOC relay setpoints for RHR-P-2A and LPCS-P-1 have been changed.

The root cause of this event is utilization of inappropriate design input for the derivation of IOC relay setpoints. This resulted in IOC trip setpoints which provided insufficient margin for possible variations in starting current for the three affected safety-related pumps.

A conservative risk assessment identified a Core Damage Frequency of 5.75E-5/yr and a Risk Achievement Worth (RAW) of 3.23. This value of RAW is in the low to moderate range of risk significance. Therefore the safety consequences of this event are considered low to moderate.

Event Description

At 08:01, on December 20, 1996, with the plant operating at 100% power, Service Water Pump 1A (SW-P-1A) [BI][P] breaker (E-CB-SW1A) [BKR] unexpectedly tripped during a pump start attempt from the control room. Local indication at the breaker revealed the pump breaker tripped due to operation of the instantaneous overcurrent (IOC) unit of the overcurrent protection relay SW-RLY-5051/P1A [RLY][50], accompanied by actuation of lockout relay SW-RLY-86/P/1A [RLY][86]. When the pump breaker tripped, SW-P-1A was declared inoperable and entry was made into Technical Specification Action Statements 3.7.1.1.a and 3.7.1.1.d. Emergency diesel generator DG-1 [DG] was also declared inoperable due to unavailability of engine cooling water and entry was made into Technical Specification Action Statements 3.8.1.1.a and 3.8.1.1.d.

Subsequent investigation revealed that on November 27, 1996 Plant Modification Request (PMR) 85-0528-0 was implemented to reduce the IOC trip setpoint of SW-RLY-5051/P1A from 38 amps to the as-left setpoint of 26.3 amps relay current. During the post maintenance testing (PMT) on November 28, 1996 the pump started successfully. The pump also started successfully six more times during subsequent operations between November 28, 1996 and December 20, 1996.

This event is being reported in accordance with 10CFR50.73(a)(2)(i)(B) and 10CFR50.73(a)(2)(ii)(B).

Immediate Corrective Action

After the trip, field testing was completed on December 20, 1996 that revealed the pump motor was electrically sound. All three phase to ground readings were greater than or equal to 5,000 meg ohms, and the impedance of each winding was found to be consistent with anticipated values. Based on the results of these tests and new information from the motor vendor, the IOC trip setpoint for SW-RLY-5051/P1A was recalculated and recalibrated at 35 amps relay current. After completion of PMT, SW-P-1A was declared operable on December 21, 1996.

A preliminary evaluation of design inputs for the IOC relay trip setpoint calculation was conducted for other Emergency Core Cooling System (ECCS) pumps to verify pump operability.

Further Evaluation

The original IOC setting of 38 amps relay current was derived in original Burns & Roe (B&R) calculations using the vendor's preliminary design data for the motor locked rotor current (LRC) and a "multiplication factor" of 1.92. (In IOC setpoint calculations, the multiplication factor is applied to the LRC to account for attributes such as system voltage variations, DC offset and relay tolerances.) The B&R calculation did not provide any basis for using a multiplication factor of 1.92.

PMR 85-0528-0 was initiated to address deficiencies in the original B&R overcurrent protection design. The overcurrent protection relay settings for medium voltage breakers were derived in calculation E/I-02-92-17. Based on the calculation, the IOC setpoints for the following safety-related motor protection relays were recalibrated:

- SW-RLY-5051/P1A
- LPCS-RLY-5051/P1
- RHR-RLY-5051/P2A

The IOC setting of 27 amps (as-left 26.3 amps) relay current provided in PMR 85-0528-0 was derived by calculation E/I-02-92-17 which utilized vendor motor test data for LRC, and a multiplication factor of 1.65, which is the minimum multiplication factor recommended in IEEE/ANSI Standard C37.96, 1988. The LRC was derived from motor test data at approximately 20% rated voltage using a linear ratio. This results in an abnormally low LRC value because of motor saturation factors. Most of the recent test reports for new motors provide test data taken at 80% rated voltage which provides a more accurate LRC when increased linearly to rated voltage.

The IOC setting equation is shown below:

$$\textit{IOC setting (relay current)} = \frac{\textit{multiplication factor x LRC}}{\textit{CT ratio}}$$

Following the SW-P-1A trip on December 20, 1996, calculation E/I-02-92-017 was reexamined and further discussions were held with General Electric - Nuclear Energy (GE-NE) concerning the application of routine motor test measurements of LRC. GE-NE recommended that, when calculating IOC settings, previous factory test results conducted at low voltages should not be applied at higher voltages using a simple linear extrapolation without accounting for the asymmetry in currents at rated voltage.

In other discussions, a power system analysis consulting firm validated the industry practice of using a linear ratio to derive LRC at rated voltage from the LRC test data at low voltage, but recommended using a factor of 1.7 to 1.8 times the motor LRC to account for variations in: (a) motor X/R ratio; (b) the prestarting voltages; and (c) motor saturation effects not accounted for in the low voltage LRC test data.

A survey of five other nuclear utilities was also conducted following the SW-P-1A trip. The survey found that these utilities use the LRC test data when available, otherwise the LRC design data is used in the calculation for the IOC settings. These utilities also indicated that a multiplication factor of 1.73 to >2.0 is applied to the motor LRC to derive the IOC settings for the motors.

Based on these findings, calculation E/I-02-92-17 has been revised to use higher multiplication factors than the minimum recommended value of 1.65. Based on the revised calculation, the IOC relays which had been calibrated under PMR 85-0528-0 have now been recalibrated. SW-RLY-5051/P1A was set to 2.145 times LRC at rated voltage, LPCS-RLY-5051/P1 was set at 2.159 times LRC at rated voltage, and RHR-RLY-5051/P2A was set at 2.356 times LRC at rated voltage. The new IOC settings optimize IOC relay operation by minimizing inadvertent trips while providing adequate coordination of the motor feeder breaker with the upstream source breaker in the event of an electrical fault.

Root Cause

The root cause of this event is utilization of inappropriate design input for the derivation of IOC relay setpoints. This includes using inaccurate LRC values and selection of a multiplication factor which resulted in a non-conservative setpoint from a system reliability standpoint. This resulted in the calculation and implementation of IOC settings which were inadequate to account for possible variations in starting currents.

Further Corrective Actions

Revised IOC setpoints have been implemented for the SW-P-1A, RHR-P-2A, and LPCS-P-2.

ECCS Division I pump motor starting currents and voltage were measured using high speed recording instruments. These test results will be evaluated against as left IOC settings to verify adequate margin. Based on this evaluation, a determination will be made regarding similar testing for other medium voltage motors.

The vendor's certified test report for SW-P-1A motor will be validated and the accuracy of factory LRC test data measured at low voltage will be evaluated.

An independent assessment of IOC relay setpoint methodology, including the use of LRC test data, will be conducted by an external organization.

The methodology used to derive the IOC settings for ECCS and BOP pump breakers, including the magnitude of the multiplication factors will be validated.

A review of other applicable electrical calculations and their output interface calculations which could be impacted by the use of LRC test data will be performed and calculations revised as necessary.

Formal guidance regarding vendor data validation used for design input will be provided to appropriate personnel.

A formal review of the initiating design change document will be conducted by a special Design Review Board to assess overall implementation adequacy, and as a programmatic corrective action to enhance quality in plant modifications the Design Review Board will be instituted to assess overall implementation adequacy of selected plant modifications with safety and/or commercial significance.

Design Engineering personnel have received training regarding lessons learned and conservative decision making. This training will also be included in the engineering support staff continuing training and will be tied to previous station events such as the Estimated Critical Position event.

Assessment of Safety Consequences

SW-P-1A started successfully during the PMT after the IOC settings were reduced and successfully started six more times prior to the trip on December 20, 1996. LPCS-P-1 and RHR-P-2A both started successfully during the PMT after the IOC settings were reduced. Consequently, a high probability exists that the pumps would have started on demand based on the several successful starts of these pumps during this period.

After the trip of SW-P-1A, the pump was declared inoperable. SW-P-1A cools the Division I equipment required for accident mitigation and safe shutdown. Loss of SW-P-1A would have affected Division I components. Even though the pump was technically inoperable, the IOC relay could have been reset at the breaker to support pump start to provide the necessary cooling.

Probabilistic Safety Assessment (PSA) techniques were used to assess risk significance. The quarterly assessment of PSA systems unavailability was conducted for the fourth quarter of 1996. This time period bounds the period of reduced IOC relay settings for SW-P-1A, RHR-P-2A, and LPCS-P-1 and includes safety-related or Technical Specification risk significant systems. This assessment verifies that these systems were operating within their PSA unavailability allowances, with the exception of the SW A system due to this event. This review verified that Division II system and component availabilities were within PSA assumptions.

The WNP-2 PSA models the failure of these pumps to start in calculating the plant's Core Damage Frequency (CDF). A range of failure to start probabilities can be inserted into the PSA to calculate the effect on CDF. The failure of SW-P-1A on the eighth attempt would indicate a failure to start probability of 0.125. No further attempts to start the pump were made at the problematic IOC relay setting, therefore the pump may be more or less reliable than this observed value. The RHR-P-2A and LPCS-P-1 pumps were each started once with revised IOC relay settings without failure. This condition represents a degraded, but functional, state for these pumps.

Failure to start probabilities of 0.2 and 0.1 were chosen to envelope the observed degradation for each of the three pumps. These probabilities represent a failure to start every five times and ten times, respectively. These start probabilities were picked based on a minimum of 17% margin to IOC trip setting based on measured amps.

For this degraded condition, a conservative risk assessment was performed using a 20% probability of failure to start for SW-P-1A, RHR-P-2A, and LPCS-P-1 simultaneously. This resulted in a CDF of 5.75E-5/yr and a Risk Achievement Worth (RAW) of 3.23. This value of RAW is in the low to moderate range of risk significance, which represents only a cautionary region for plant operation, wherein no contingency plans would be required. A more realistic estimate of only SW-P-1A failing to start at the observed frequency would not be considered risk significant by PSA guidance.

The safety consequences of this event are considered moderate to minimal. This condition did not threaten the health and safety of the public or plant personnel.

Previous Similar Events

LER 93-03 reported a similar deficiency involving mis-coordination of the incoming line overcurrent relay time delay and the primary undervoltage transfer logic time delay in the medium voltage AC Electrical Distribution System (EDS). This was discovered during initial preparation of calculation E/I 02-92-017, "Medium Voltage EDS Phase Overcurrent Relay Settings", which is the subject calculation in this current report. The root cause of the condition reported in LER 93-03 was inadequate original architect engineer design analysis which resulted in inadequate coordination of undervoltage transfer logic time delay with the overcurrent protective relay time delays. The original overcurrent relay calculation was later superceded by calculation E/I 02-92-017 which was being developed at the time. Although LER 93-03 reports a condition that is similar to the current event in that it involved the medium voltage EDS overcurrent protection system, it dealt with deficiencies in the bus incoming line overcurrent time delay setings and did not directly relate to motor branch feeder breaker IOC settings provided in E/I 02-92-017. The corrective action from LER 93-03 to revise the original calculations focused mainly on the settings of the bus incoming line overcurrent time delays and would not be expected to address possible deficiencies in motor branch feeder breaker IOC settings or the design inputs used to derive the settings.

Other than LER 93-03, there have been no other previous reportable events at WNP-2 involving miscalculation of IOC relay settings.