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Palisades Nuclear Plant: 27780 Blue Star Memorial Highway, Covert, MI 49043

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Nuclear Regulatory Commission
Document Control Desk
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DOCKET 50-255 - LICENSE DPR-20 - PALISADES PLANT
LICENSEE EVENT REPORT 94-012-01 - THERMAL MARGIN MONITOR INTERNAL GROUND - REACTOR PROTECTIVE SYSTEM (RPS) DESIGN BASIS - SUPPLEMENTAL REPORT

Licensee Event Report (LER) 94-012, Supplement 1, is attached. This supplement includes a revised analysis of the event section, as well as an extension of our estimated completion date for upgrading the Thermal Margin Monitor to the end of the refueling outage following the 1995 refueling outage.

This event was originally reported to the NRC as a condition outside the design basis of the plant, per 10CFR50.73(a)(2)(ii)(B).

COMMITMENT SUMMARY

The following commitments were part of the original LER and are still active:

The Failure modes and affects analysis for the RPS will be updated to reflect the modifications performed to the RPS and the TMM as a result of this event report.

The schedule for completing the modifications to the Thermal Margin Monitors to remove the internal ground resistance from the TMM, has been changed from the 1995 refueling outage to the end of the refueling following the 1995 refueling.

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After the grounds are removed the need for the circuit isolation devices added as a result of this event to the inputs and outputs of the TMM will be reevaluated.

The following are new commitments from the supplement:

A procedure will be developed to test RPS and TMM signal circuits for grounds.

A memo will be issued to all department heads, members of the PRC and Management Review Board emphasizing the need to recognize situations where the plant is not in compliance with design basis.

Kurt M Haas
Plant Safety and Licensing Manager

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

Attachment

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)
Palisades Plant	0 5 0 0 0 2 5 5	1 OF 0 8

TITLE (4) Thermal Margin Monitor Internal Ground - Reactor Protective System (RPS) Design Basis - Supplemental Report

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 4	2 7	9 4	9 4 -	0 1 2 -	0 1	0 1	1 7	9 5	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)	0 0 0	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)(2)	50.73(a)(2)(vii)	OTHER (Specify in Abstract
		20.405(a)(1)(iii)	50.73(a)(2)(i)	50.73(a)(2)(viii)(A)	below and in Text,
		20.405(a)(1)(iv)	X 50.73(a)(2)(ii)	50.73(a)(2)(viii)(B)	NRC Form 366A)
		20.405(a)(1)(v)	50.73(a)(2)(iii)	50.73(a)(2)(x)	

LICENSEE CONTACT FOR THIS LER (12)

NAME	TELEPHONE NUMBER
William L Roberts, 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
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 27, 1994, with the plant in cold shutdown, it was determined that an internal ground in the Thermal Margin Monitor (TMM) causes a non-conformance with the Reactor Protective System (RPS) design basis. The TMM is part of the RPS and the RPS is designed to operate as an ungrounded system. The ground path in the TMM was connected to the pressurizer pressure measurement loop, the Nuclear Instrumentation (NI) System and the Primary Coolant System (PCS) temperature inputs. A second ground in the pressurizer pressure loop or in the PCS temperature transmitter loop could adversely affect the RPS accuracy and reliability.

The cause of this event is an internal ground in the TMM design which was not identified at the time of installation and the failure to recognize that this internal ground put the RPS outside of the FSAR design basis in that the RPS is designed to be ungrounded.

Modifications to effectively isolate the internal ground in the TMM from the pressurizer pressure circuitry and PCS temperature circuits were completed prior to plant heat-up.

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EVENT DESCRIPTION:

On April 27, 1994, the plant was in cold shutdown. During a re-evaluation of the Thermal Margin Monitor (TMM), PY-0102A (B, C & D), and its effects on the operability of the Reactor Protective System (RPS), it was determined that a resistance path to ground internal to the TMM, caused a non-conformance with the design basis as stated in the Palisades FSAR section 7.2.7, "Effects of Failures". FSAR section 7.2.7, Analog Portion, item 2 states that "Shorting the [signal] leads to an ungrounded voltage source, has no effect since the signal circuit is ungrounded." Section 3, states "Single grounds on the signal circuit have no effect. Double grounds would tend to cause the channel to fail in the safe direction". Similar statements are found in the FSAR section 7.2.7, "Logic Portion," items 7 and 11.

The FSAR section 7.2.7 item 2 statement indicates the RPS analog signal circuits are designed to operate ungrounded. Despite this design requirement, the TMM had an internal ground path from the 24 volt dc power supply through a 10K ohm resistor to ground. This ground path was initially found connected from the TMM through the Thermal Margin/Low Pressure (TM/LP) bi-stable trip unit to the pressurizer pressure measurement loop, where an additional ground in the pressurizer pressure loop could establish a ground loop which may have a non-conservative influence on the pressurizer pressure signals of the RPS.

After finding the internal (as-designed) TMM ground and realizing the potential impact on the pressurizer pressure measurement loop, all four channels of the pressurizer pressure related equipment were conservatively declared inoperable pending further investigation. Although monthly surveillance by the I&C department would discover a second (unintentional) ground on the pressurizer pressure loop, the Operations department does not have a means to readily detect the second ground. The results of I&C testing, in response to this event, by inducing actual grounds in the pressurizer pressure loop identified the potential for causing non-conservative shifts in some loop signals or setpoints.

Subsequent circuit analysis and testing performed on May 16, 1994 on the TMM inputs and outputs revealed that the TMM 10K ohm ground is also connected from the TMM to the PCS instrumentation and the Nuclear Instrumentation (NI) systems. In the PCS instrumentation system, the ground is connected to the cold leg and the hot leg average temperature instruments, where an additional (unintentional) ground could establish a ground loop which may have a non-conservative influence on the temperature inputs to the TMM. The temperature inputs are used in the TM/LP trip setpoint calculation and in the variable high power trip calculation.

In the Nuclear Instrumentation (NI) System, the TMM internal ground is connected to the upper, lower, and upper-plus-lower power range detector signals. Testing performed on the NI signals indicates that an additional ground in these circuits has no effect on the NI system or on the

RPS. This is due to the presence of buffer isolators located in the NI system in each of the NI signals. Operations does not have a method to detect a second ground on the temperature loops or on the NI systems.

CAUSE OF THE EVENT:

The cause of this event is a signal common to earth ground in the Thermal Margin Monitor design which was not identified at the time the TMM's were installed. The cause of the event is also a failure to recognize that the presence of the internal grounds in the TMM placed the RPS outside of the FSAR design basis in that the RPS is designed to be ungrounded.

ANALYSIS OF THE EVENT:

One of the RPS trip parameters is the Thermal Margin/Low Pressure (TM/LP) calculated signal. In 1988, the original analog TM/LP calculators were replaced by digital Thermal Margin Monitors. The TMM function is to prevent reactor conditions from violating a minimum departure from nucleate boiling ratio (DNBR) by a continuously computed function of core power, reactor coolant maximum inlet temperature, core coolant system pressure and axial shape index. The TMM provides a signal to the TM/LP bi-stable trip unit which also receives an input signal from the pressurizer pressure measurement loop. The TM/LP bi-stable trip unit will generate alarm and trip signals based on the comparison of the trip setpoint input from the TMM and the pressure signal from the pressurizer pressure measurement loop.

In the course of troubleshooting a July 3, 1991 RPS trip (LER 91-012, dated 8/2/91), it was concluded that the source of power which energized the test portion of the bi-stable dual coil relays and contributed to the event, came from the TMM 24 volt dc power supply. As a corrective action for the July 3, 1991 reactor trip event, the TMM vendor was contacted regarding a potential signal common to earth ground in the TMM. The vendor indicated there was none. Because of a continuing indication of a ground path, investigation by Palisades plant continued and eventually revealed the existence of a 10K ohm resistor which provided an internal ground path through the resistor to the power supply in the TMM, through setpoint indicator PIA-0102A (for Channel A), and to the signal common for the setpoint voltage transmitted to the TM/LP bi-stable trip unit. This signal propagated through the TM/LP bi-stable to the signal common of the pressurizer pressure measurement loop. Thus, if a short develops in the pressurizer pressure loop, the ground loop would be fed by the 24 volt dc power supply in the TMM. It was determined that all four RPS channels were similarly affected.

The vendor was contacted regarding the removal of the 10K ohm resistor which provided the ground path. The vendor did not support its removal because its removal would present the potential for a shock hazard to personnel near the chassis and the possibility of degradation of the equipment.

An engineering evaluation of the acceptability of the signal common to ground connection in the TMM and the ability of the RPS to satisfy FSAR 7.2.7, "Effects of Failures" was performed in response to Palisades plant corrective action E-PAL-91-014K and was completed July 23, 1993. The evaluation considered the ability of the RPS to perform its safety function given the TMM short to ground and the verification that an unintentional short to ground (single failure) would not cause an unnecessary RPS actuation or safety function. The evaluation concluded that for single shorts to ground in the pressurizer pressure loop, the short would only affect one channel out of four and that the short would be detectable on the setpoint indicator of the TMM. Monthly surveillance by the I&C department compare the displayed signal value to the TMM calculated signal and would detect a short on the pressurizer pressure loop by a deviation in the two values. At that time, it was concluded the RPS did not violate its Technical Specification requirements and was therefore considered operable.

In April 1994, during reviews of equipment for operability in consideration for heat-up from cold shutdown following an outage, the ability of the RPS to satisfy the design requirements in FSAR section 7.2.7, given the TMM internal ground and the potential for additional grounds on the pressurizer pressure measurement loop, was re-evaluated. On April 27, 1994, it was decided that all four channels of the RPS pressurizer pressure measurement loops including the TMM-s should conservatively be declared inoperable pending further investigation because unintentional grounds on the pressurizer pressure loops were not readily detectible by the Operations department. This was deemed the prudent and conservative course of action considering the enhanced sensitivity to issues as part of the overall plant performance improvement plan. Additional evaluation and testing confirmed that for certain postulated grounds in the pressurizer pressure signal loops, the ground path established through the TMM grounding resistor could adversely affect some pressurizer pressure trip signals.

There were three opportunities where the non-conformance with the RPS design requirements for an ungrounded system could have been recognized. First, it could have been recognized and tested for during the initial installation of the TMM modification (FC-628). Second, during replacement of the RPS trip relay coils in FC-888 following a July 3, 1991 RPS trip, a thorough design review of FC-888 could have identified the non-conformance. Third, an opportunity was missed during resolution of the corrective action for the July 3, 1991 RPS trip where removal of the TMM ground was considered.

During the TMM installation, the vendor's statement that the TMMs were ungrounded was accepted at face value and no additional testing or investigation was initiated to verify this design criteria. Had this been identified as a critical design characteristic, as required by the current modification procedures, verification of the ungrounded criteria would have been required at the time of installation.

During the design review of FC-888, the resolution focused on the design of the trip relay coils and on preventive maintenance to monitor the relay coil performance and not on the entire TMM design. The review relied heavily on a vendor letter discussing the design and construction of the replacement relays and concluded that the design was acceptable.

When removal of the TMM ground connection was not supported by the vendor, an analysis was submitted which documented a justification to use the TMMs with the grounds in place. The analysis concluded that a second ground in the TM/LP pressure trip circuits of the RPS would be a single failure. It also concluded that the single failure would only affect one of the four channels and, therefore, since it would neither initiate a false protective action (reactor trip) nor prevent a proper protective action, it was deemed an acceptable configuration. It was not concluded at this time that the existing configuration did not comply with the associated licensing design basis. This conclusion was not reviewed by the corrective action review board prior to closeout of the activity.

SAFETY SIGNIFICANCE:

With the internal ground in the TMM, testing has demonstrated the potential for an additional single ground on the pressurizer pressure loop to cause a non-conservative shift in the pressure signal or setpoint in that loop. All postulated ground paths establish current flow through the setpoint indicator of the TMM and are therefore detectable. Testing has also demonstrated the potential for an additional ground to cause a non-conservative shift in the temperature input signals to the TMM which affect the thermal power calculation.

For clarification, the following interpretation of the FSAR section 7.2.7 items 2, 3, 7 and 11 regarding the terms "grounds" and "no effect" is provided.

> An "ungrounded" circuit is interpreted to mean a circuit in which the impedance of the circuit as measured to ground, is at a sufficiently high level such that with a addition of a single ground on the circuit there will be no significant effect on the instrument loop. ". . .no significant effect. . ." is interpreted to mean that a single ground (in addition to the circuit impedance of the circuit-to-ground) results in either no change in the circuit signal level, a change in the signal level in a conservative direction or a change in the signal level that is within the tolerances of the loop accuracy analyses.
>
> Conversely, a "significant effect" is one where the change to the signal circuit is in a non-conservative direction and is outside the tolerances of the instrument loop accuracy analysis which could then impact the FSAR chapter 14 Safety Analyses.

CORRECTIVE ACTION:

The corrective action process has been substantially upgraded in several respects. All conditions affecting installed plant equipment are now reviewed for the effect on equipment operability and a reportability review is conducted for all conditions identified. A new screening group has been established to identify those conditions which are significant and need plant management attention and detailed root cause analysis. There is increased management involvement in the corrective action process.

A modification has been implemented to effectively isolate the grounded TMM from the ungrounded pressurizer pressure loop of the RPS through the installation of an isolation device located external to the TMM.

On May 16, 1994, during the engineering of the modification to install isolation between the TMM signal and the TM/LP trip unit, an analysis revealed an additional ground path from the internal TMM 10K ohm ground to the Nuclear Instrument inputs and the Primary Coolant System temperature inputs to the TMM. Testing performed on May 19, 1994 revealed that an additional ground inserted in the temperature transmitter loop could adversely affect the temperature signals but that an additional ground inserted in the NI input circuits had no effects on the TMM nor on the NI circuits.

A second modification was initiated which increases the impedance between the internal ground connection from the TMM to the temperature signal instrument loops. This was accomplished by installing three operational amplifier input devices internal to the TMM in place of jumpers in the NI input circuits. Identical input devices are currently in use in the TMM temperature input circuits; however, jumpers in the NI input circuits provide the ground path back to the temperature circuits. The input devices will increase signal common-to-ground resistance to an acceptable value. Analysis and testing of the temperature instrument circuits reveals that with the input devices installed on the NI inputs and an additional ground on the temperature circuits, there is no effect on the operation of the TMM or on the temperature instruments.

The modifications to: (1) provide electrical isolation between the TMM signal and the TM/LP trip unit to effectively separate the ground in the TMM pressurizer pressure circuitry and, (2) provide increased electrical resistance between the TMM temperature inputs and the TMM unit to effectively separate the grounded TMM from the ungrounded temperature circuits; were completed before plant heat-up.

A future modification will be pursued which will remove the internal resistance ground from the TMM, thus restoring the RPS and the TMM to an ungrounded state. This modification is currently scheduled for installation during the refueling outage following the 1995 refueling

outage. The TMM vendor has indicated that this is a complex modification and the engineering and design changes needed to remove the internal ground cannot be completed in time for the 1995 refueling outage.

The modifications installed prior to commencing plant heat-up effectively isolate the grounded TMM from the ungrounded RPS. Raising the impedance of the ground in the TMM effectively restores the deficient condition to the design and licensing bases.

I. PRIOR TO PLANT HEAT-UP:

Actions A-D were accomplished prior to plant heat-up.

A. Isolate the TM/LP Pressure trip signal circuits from the internal TMM impedance.

B. Isolate the Primary Coolant System temperature and Nuclear Instrumentation System Power Range input signals to the TMMs by isolating those circuits from the internal TMM ground or raising the impedance level of the ground to an acceptable level.

C. Verify that all of the TMM inputs and outputs are effectively ungrounded after the completion of modifications and perform testing to verify the modified loops, the TMMs and the affected portions of the RPS function properly.

D. Test each TMM to validate that circuit isolation modifications do not effect the TMMs safety function.

II. TO PREVENT RECURRENCE:

A. Update the RPS' Failure Modes Effects Analysis to reflect the modifications performed to the RPS and the TMM as a result of this Event Report.

B. Electrical and I&C engineering personnel have been provided with a summary of this event report.

C. The RPS Design Basis Document has been updated to include the work completed on the system and to clarify what an "ungrounded" signal is.

D. This event report has been incorporated into the appropriate accredited training programs.

E. The original commitment was to change the Nuclear Engineering and Construction Organization (NECO) Guidelines to ensure that all modifications are designed and tested appropriately to ensure that isolation and separation requirements are maintained. This action was not taken as described, as it is not reasonable to test for separation and isolation. Separation is a factor of cable and device location. Engineering design and review are adequate to determine correct device location. Isolation is also a design function. Testing of the isolator is done at the time of procurement if adequate design documentation does not exist. The existing design procedures reference the appropriate design documents which specify the requirements for adequate electrical circuit separation and isolation.

F. Change the FSAR to clarify the definition of "ungrounded" and the "effects of a ground" in section 7.2.7.

G. Modify the TMMs to remove the internal ground and then reevaluate the need for circuit isolation devices added by this event report to the inputs and outputs of the TMM.

H. It has been determined that additional surveillance procedures on the added TMM isolation devices will not be written, as an existing Technical Specification Surveillance procedure (MI-2A) tests the isolators as part of the signal loop test.

I. It was determined that the need exists to periodically monitor unisolated TMM and RPS circuits for the presence of grounds. A new action has been initiated to develop a procedure to test RPS and TMM signal circuits for grounds.

J. A memo has been provided to all I&C technicians on the importance of, and methods to detect, grounds on floating systems.

K. Provide a memo summarizing the event to all department heads, members of the PRC and Management Review Board, emphasizing the need to recognize situations where the plant is not in compliance with design basis.