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DTE Energy

10CFR50.73

November 26, 2003
NRC-03-0085

U S Nuclear Regulatory Commission
Attention: Document Control Desk
Washington D C 20555

Reference: Fermi 2
NRC Docket No. 50-341
NRC License No. NPF-43

Subject: Licensee Event Report (LER) No. 03-003

Pursuant to 10 CFR 50.73(a)(2)(i)(B), Detroit Edison is submitting the enclosed LER No. 03-003. This LER documents the discovery of non-conservative setpoints for the thermal-hydraulic stability Option III Oscillation Power Range Monitor (OPRM).

No commitments are being made in this LER:

Should you have any questions or require additional information, please contact Mr. Norman K. Peterson of my staff at (734) 586-4258.

Sincerely,

William T. O'Connor Jr.

cc: M. A. Ring
H. K. Chernoff
M. V. Yudasz, Jr.
NRC Resident Office
Region III
Regional Administrator, Region III
Wayne County Emergency Management Division

IE22

NRC FORM 366 (7-2001) U.S. NUCLEAR REGULATORY COMMISSION

APPROVED BY OMB NO. 3150-0104 EXPIRES 7-31-2004

Estimated burden per response to comply with this mandatory information collection request: 50 hours. 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.

LICENSEE EVENT REPORT (LER)

(See reverse for required number of digits/characters for each block)

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4. TITLE

Non-Conservative Setpoints for Stability Option III (OPRM) Period Based Detection Algorithm, Period Confirmation Adjustable Variables

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
10	02	2003	2003	– 003	– 00	11	26	2003	FACILITY NAME	DOCKET NUMBER 05000

9. OPERATING MODE	1
10. POWER LEVEL	100

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)	50.73(a)(2)(v)(A)	73.71(a)(5)	
20.2203(a)(2)(ii)	50.36(c)(2)	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)	50.73(a)(2)(v)(C)		
20.2203(a)(2)(iv)	50.73(a)(2)(i)(A)	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)
Steve Cashell – Principal Licensing Engineer	(734) 586-1549

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)

General Electric Company submitted a 10 CFR 21 notification identifying that they had determined that the stability Option III period based detection algorithm (PBDA) period confirmation adjustable variables (period tolerance and conditioning filter cutoff frequency) may be non-conservative, and recommended that the Average Power Range Monitor (APRM) Operating Power Range Monitor (OPRM) Upscale trip (Technical Specification Limiting Condition for Operation (LCO) 3.3.1.1, function 2.f) be considered inoperable for plants with a PBDA period tolerance setpoint less than 100 msec, and with a cutoff frequency of greater than 1.0 Hz. All OPRM channels were declared inoperable (but were maintained in a functional and armed condition) on October 2, 2003, because the Fermi-2 OPRM period tolerance was set at 50 msec, and the conditioning filter cutoff frequency was set at 3.0 Hz. Alternate methods to detect and suppress thermal hydraulic instability oscillations were placed into effect in accordance with Technical Specification LCO 3.3.1.1, Action J. The apparent deficiency was identified by General Electric (the OPRM and reactor vendor) following a July 24, 2003 instability event at Nine Mile Point-2. The Fermi OPRM settings would have been sufficient to identify a wide range of stability transients. Additionally, the operators have been trained to recognize instabilities and to take appropriate actions should an instability occur. The period tolerance and conditioning filter cutoff frequency setpoints were changed and all OPRM channels were declared operable on November 18, 2003. This event has been documented in the Fermi 2 corrective action program.

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Initial Plant Conditions:

Mode	1
Reactor Power	100 percent

Description of the Event

During a conference call with the Boiling Water Reactor Owner's Group (BWROG) on October 2, 2003, the General Electric Company Nuclear Engineering group (GENE) stated that they intended to make a 10 CFR Part 21 notification to the NRC regarding the stability Option III period based detection algorithm (PBDA) period confirmation adjustable variables (period tolerance and conditioning filter cutoff frequency). GENE subsequently submitted the Part 21 notification on October 4, 2003 (SC03-20). GENE had concluded that performance of the OPRM with settings other than a period tolerance of 100 msec or higher, and a cutoff frequency of 1.0 Hz might allow the safety limit minimum critical power ratio (SLMCPR) to be exceeded for some anticipated instability events. GENE recommended that the Average Power Range Monitor (APRM) Oscillation Power Range Monitor (OPRM) Upscale trip (Technical Specification Limiting Condition for Operation (LCO) 3.3.1.1, function 2.f) be considered inoperable until these variable settings could be changed to satisfy the revised criteria. Following this phone conversation all Fermi 2 OPRM channels were declared inoperable because period tolerance was set at 50 msec, and conditioning filter cutoff frequency was set at 3.0 Hz. The Fermi-2 OPRM remained functional and armed, such that automatic trip capability was maintained for instability transients. Alternate methods to detect and suppress thermal hydraulic instability oscillations were placed into effect in accordance with Technical Specification LCO 3.3.1.1, Action J.

Detroit Edison reported this condition to the NRC in accordance with 10CFR50.72(b)(3)(v), an event that could have prevented fulfillment of a safety function on October 2, 2003 at 1500 hours (Event Number 40215), prior to the actual Part 21 report by GENE. It has since been determined that the safety function of detecting and suppressing thermal hydraulic instability oscillations had not been lost because there were other means, including procedures and training, that the control room staff has for detecting and suppressing thermal hydraulic instability oscillations should they occur. However, this event is still reportable under 10CFR50.73(a)(2)(i)(B), as a condition prohibited by the Technical Specifications, because the OPRM Upscale trip has been considered operable since installation and implementation of the trip function on April 24, 2000, with potentially non-conservative values for period tolerance and conditioning filter cutoff frequency.

Background

Stability solution Option III, also known as the OPRM, generates OPRM cell signals from local power range monitor (LPRM) signals. An OPRM Upscale trip is issued from an APRM channel when the period based detection algorithm (PBDA) in that channel detects oscillatory changes in the neutron flux,

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indicated by the combined signals of the LPRM detectors in a cell, with the period confirmation counts and relative cell amplitude exceeding specified setpoints. One or more cells in a channel exceeding the trip conditions will result in a channel trip. An OPRM Upscale trip is also issued from the channel if either the growth rate or the amplitude based algorithms detect growing oscillatory changes in the neutron flux for one or more cells in that channel. Three of the four channels are required to be operable. Each channel is capable of detecting thermal-hydraulic instabilities by detecting the related neutron flux oscillations, and issuing a trip signal.

The basic unit of the Option III hardware/software system is the OPRM cell. An OPRM cell typically consists of three or four closely spaced (LPRM) detectors. The signals from the individual LPRM detectors in a cell are averaged to produce the OPRM cell signal. The cell signal is filtered to remove noise components with frequencies above the range of stability related power oscillations. This is accomplished using a two-pole Butterworth filter with a variable cutoff frequency of between 1.0 to 2.5 Hz. The conditioned signal is filtered again using a relatively long time constant (typically about 6 seconds) to produce an additional time-averaged value. The conditioned and the conditioned/time-averaged signals are used to detect reactor instabilities.

GE Licensing Topical Report (LTR) NEDO-31960-A, Supplement 1, "BWR Owners' Group Long-Term Stability Solutions Licensing Methodology (Supplement 1)," November 1995, describes the Option III detection algorithms, and defines what constitutes expected oscillations indicative of thermal-hydraulic instability that are to be suppressed by the Option III algorithms. There are three algorithms associated with the detection of thermal-hydraulic instability related neutron flux oscillations: the period based detection algorithm, the amplitude based algorithm, and the growth rate based algorithm. All three are implemented in the OPRM Upscale function, but the safety analysis takes credit only for the period based detection algorithm. The other algorithms provide defense-in-depth protection.

The technical basis for the PBDA is provided in licensing topical report NEDO-32465-A, "Reactor Stability Detect and Suppress Solutions Licensing Basis Methodology for Reload Applications", August 1996. It defines the PBDA period confirmation adjustable variables for the Oscillation Power Range Monitor (OPRM) to be the period tolerance and the conditioning filter cutoff frequency. It states that the period tolerance may be adjusted in the range of 100 to 300 msec, and the conditioning filter cutoff frequency in the range of 1.0 to 2.5 Hz. Subsequent plant-specific submittals have extended the period tolerance range on the low end to 50 msec and the cutoff frequency on the high end to 3.0 Hz. These were the settings utilized by Fermi-2.

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On July 24, 2003, a slow growing core wide instability event occurred at Nine Mile Point - 2 (NMP-2). The OPRM installed at NMP-2 has 4 OPRM channels, each with 30 OPRM cells. Fermi-2 has a similar configuration. A plant-specific Critical Power Ratio (CPR) performance curve had been determined for NMP-2 and the OPRM was armed when the event occurred. For the current cycle, the NMP-2 PBDA confirmation count setpoint was 14 counts, and the normalized amplitude trip setpoint was 1.12. A plant specific CPR performance curve had been determined for Fermi-2 as well, and the Fermi 2 OPRM has been armed since the start-up from RF07. For the current cycle, the PBDA confirmation count setpoint is 14 counts, and the normalized amplitude trip setpoint is 1.11. For cycle 10, the Supplemental Reload Licensing Report justified changing the amplitude trip setpoint to 1.12. A conservative decision was made to keep the amplitude trip setpoint at 1.11.

The OPRM is designed such that any cell sensing an instability would reach the confirmation count criteria before the amplitude increased to its trip setpoint. Post event analysis indicates that the NMP-2 OPRM did not perform as expected. Only one of the 120 cells performed correctly in that it reached the confirmation count setpoint before the amplitude trip setpoint was reached. At the time of the scram, there were approximately 20 cells with an amplitude at or above the amplitude setpoint, but only 5 cells with confirmation counts at or above the confirmation count setpoint. This was attributed to a large number of confirmation count resets throughout the event. The adjustable period confirmation variables at NMP-2 were set at 50 msec for the period tolerance and 3.0 Hz for the cutoff frequency. Fermi-2 was operating with the same settings.

The evaluation by GENE concluded that the 3.0 Hz corner frequency does not adequately filter out high frequency noise from the LPRM signals provided to the OPRM cells. The signal using a 3.0 Hz setting contains false peaks and valleys that cause inappropriate confirmation count resets. The evaluation also concluded that the 50 msec period tolerance produces frequent confirmation count resets due to small variations in the oscillation period. GENE stated in their 10 CFR Part 21 report SC03-20, that expected confirmation count performance can be achieved with a cutoff frequency of 1.0 Hz and a period tolerance of 100 msec or larger.

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GENE issued another Safety Information Communication (SC03-22) on October 31, 2003 in which it stated:

> Stability solution Option III, also known as the Oscillation Power Range Monitor (OPRM), generates OPRM cell signals from Local Power Range Monitor (LPRM) signals. The OPRM cell signals are filtered and evaluated to determine when a reactor instability has occurred, and when the oscillation has grown to a sufficient magnitude that warrants generation of a reactor scram. A two-pole Butterworth filter is used with a variable cutoff frequency to filter high frequency noise out of the signals. GE Nuclear Energy (GENE) recently recommended that absent further justification, the cutoff frequency be set at 1.0 Hz (SC03-20, issued 10/4/03) to ensure acceptable performance of the OPRM.
>
> During evaluation of the filtering cutoff frequency issue, it was realized that the impact of signal attenuation associated with the filter had not been considered when the amplitude trip setpoint was determined. GENE has determined that it is non-conservative to calculate the setpoint without the attenuation effect. The reload licensing methodology defines a setpoint that provides Safety Limit Minimum Critical Power Ratio (SLMCPR) protection at a 95/95 probability/ confidence level for anticipated instability events. The evaluation of the attenuation effect determined that when the signal attenuation effect is included in the methodology, SLMCPR protection is provided at the best-estimate level and hence this is determined to not be a reportable condition. However, the licensing basis 95/95 protection level may not be provided and the setpoint should be re-evaluated including the attenuation effect.

Fermi-2's Cycle 10 amplitude trip setting per the Cycle 10 Supplemental Reload Licensing Report was calculated to be 1.12; however, the setting was conservatively maintained at 1.11. Due to the amplitude issue raised by GENE in SC03-22, Detroit Edison performed an in-house evaluation that demonstrates our existing PBDA amplitude setpoint remains adequate for providing SLMCPR protection given the amplitude signal attenuation problem associated with resetting the corner frequency to 1.0 Hz. Based on this evaluation, we believe that the licensing basis 95/95 protection level is provided. Therefore the corner frequency will be set to 1.0 Hz and the amplitude trip setting will remain at 1.11.

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Cause of the Event

The apparent deficiency regarding the stability Option III period based detection algorithm (PBDA) period confirmation adjustable variables (period tolerance and conditioning filter cutoff frequency) was identified by General Electric (the OPRM and reactor vendor) following the July 24, 2003 event at NMP-2, in which a slow growing core wide instability occurred.

Analysis of the Event

10 CFR 50, Appendix A, General Design Criteria (GDC) 10 "Reactor Design" requires, and safety limits (SL) ensure, that specified acceptable fuel design limits are not exceeded during normal operation, including the effects of anticipated operational occurrences (AOOs). The fuel cladding integrity SL is set such that no significant fuel damage is calculated to occur if the limit is not violated. Because fuel damage is not directly observable, a stepback approach is used to establish a safety limit, such that the MCPR is not less than the limit specified in Technical Specification 2.1.1.2. MCPR greater than the specified limit represents a conservative margin relative to the conditions required to maintain fuel cladding integrity.

The SLMCPR is set such that no significant fuel damage is calculated to occur if the limit is not violated. Since the parameters that result in fuel damage are not directly observable during reactor operation, the thermal and hydraulic conditions that result in the onset of transition boiling have been used to mark the beginning of the region in which fuel damage could occur. Although it is recognized that the onset of transition boiling would not result in damage to BWR fuel rods, the critical power at which boiling transition is calculated to occur has been adopted as a convenient limit. However, the uncertainties in monitoring the core operating state and in the procedures used to calculate the critical power result in an uncertainty in the value of the critical power. Therefore, the SLMCPR is defined as the critical power ratio in the limiting fuel assembly for which more than 99.9% of the fuel rods in the core are expected to avoid boiling transition, considering the power distribution within the core and all uncertainties.

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The OPRM settings in use at NMP-2, period tolerance of 50 msec and conditioning filter cutoff frequency of 3.0 Hz, provided SLMCPR protection at NMP-2 during the July 24, 2003 event. Due to the robust OPRM design, it is probable that these same settings (the ones that were in use at Fermi-2) would have provided SLMCPR protection for the same instability event had it occurred at Fermi-2. Additional analysis may show that values other than those specified by GENE in SC03-20 for the PBDA adjustable confirmation variables also provide acceptable performance. However, GENE cannot currently ensure that the SLMCPR would not be exceeded for all anticipated instability events with OPRM settings other than period tolerance of 100 msec or higher and corner frequency of 1.0 Hz.

NEDO-32465-A states that conservatism is introduced in the design philosophy by selecting the MCPR Safety Limit to demonstrate protection of fuel cladding integrity for anticipated stability events. The SLMCPR is a conservative limit for this application because the fuel and clad responses to stability related oscillations are relatively mild even if the critical power ratio falls below the SLMCPR. The Option III initiated rod insertion will assure that the hot bundle will only experience a few oscillations above the setpoint prior to scram. If a rod actually experienced boiling transition, the cyclic nature of the event would result in clad rewet approximately every two seconds. A few oscillations in which the clad rewets would result in a nearly negligible cladding temperature transient. This fact has been demonstrated in the assessment of NEDO-32047, "ATWS Rule Issues Related to BWR Core Thermal-Hydraulic Stability." This assessment shows that, provided the clad rewets between cycles, the clad temperature increase is typically less than 100°F for oscillations up to 200% of rated power.

Not only is the use of the SLMCPR as the acceptance criterion extremely conservative in protecting the fuel; but, the operators have been trained to recognize instabilities and the events that can lead to instability, and to take appropriate actions should an instability occur. For both slow and fast growing instabilities, the OPRM would have alarmed when the plant entered the "trip enabled region" (<60% flow and > 28% power), and it likely would have generated upscale alarms if an actual instability were to occur. Upscale alarms would have caused the operators to monitor the core for instabilities per the alarm response procedure (ARP) and if observed, place the mode switch in shutdown. For fast growing instabilities, it is highly likely that the defense in depth algorithms would generate a trip before fuel damage occurred, regardless of whether the PBDA algorithm was experiencing confirmation count resets. Finally, although allowed by Technical Specifications, the Fermi-2 operators are restricted from intentionally entering and operating in the "Scram" and "Exit" regions of the power to flow map, even with the OPRM system operable. This is done to prevent operation in an area of the power/flow map where there is a significantly increased risk of instability.

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Corrective Actions

Upon discovery of this event, all OPRM channels were declared inoperable, and alternate methods to detect and suppress thermal hydraulic instability oscillations were placed into effect in accordance with Technical Specification 3.3.1.1, Action J. This action was completed at 1500 hours on October 2, 2003. The Fermi-2 OPRM has remained functional and armed during this period in order to maintain automatic trip capability for the vast majority of instability transients.

Period tolerance was changed to 100 msec, and conditioning filter cutoff frequency was changed to 1.0 Hz, and all OPRM channels were declared operable on November 18, 2003.

This event has been documented in the Fermi 2 corrective action program, CARD 03-22220. Any further corrective actions will be tracked and implemented commensurate with the established processes and priorities of the program.

Additional Information

A. Failed Components: None

B. Previous LERs on Similar Problems:

LER 02-005, "Non-Conservative Setpoint for Stability Option III (OPRM) Period Based Algorithm – Tmin," dated January 20, 2003 describes another event in which the OPRM PBDA settings were found by the vendor (GE) to be incorrect. Corrective actions for the previous event could not have prevented the occurrence of this current event. The current problem was not discovered until the NMP-2 event of July 24, 2003, and involves different PBDA variables.