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**Detroit Edison**



*A DTE Energy Company*

10 CFR 50.73

October 24, 2001  
NRC-01-0076

U. S. Nuclear Regulatory Commission  
Attention: Document Control Desk  
Washington D C 20555-0001

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

Subject: Licensee Event Report 01-002, "Licensed Power Limit Exceeded  
Due to a Non-conservative Steam Moisture Carryover Fraction"

Pursuant to the requirement in Section 2.F. of the Fermi 2 Operating License, Detroit Edison is submitting the enclosed Licensee Event Report (LER) 01-002. This LER documents a non-conservative bias in the heat balance methodology for calculating core thermal power. The main steam moisture carryover fraction was found to overestimate the actual moisture content of the steam. As a result of this condition, it is possible that Fermi 2 exceeded its licensed power limits on one or more occasions during the first three operating cycles. However, due to the low order of magnitude of the calculation bias, there was no adverse effect on the health and safety of the public.

The following commitment is being made in this LER:

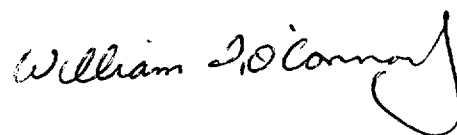
A validation of the reactor heat balance parameters will be performed to evaluate the process for potential similar errors.

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

Sincerely,

A handwritten signature in cursive script, reading "William J. O'Connor". The signature is written in dark ink and is positioned to the right of the word "Sincerely,".

cc: J. Dyer  
T. J. Kim  
M. A. Ring  
M. V. Yudas, Jr.  
NRC Resident Office  
Region III  
Wayne County Emergency Management Division

## LICENSEE EVENT REPORT (LER)

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

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 [bjsl@nrc.gov](mailto:bjsl@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.

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## 2. DOCKET NUMBER

05000341

## 3. PAGE

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## 4. TITLE

## Licensed Power Limit Exceeded Due to a Non-conservative Moisture Carryover Fraction

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
01	23	1988	2001	002	00	10	26	2001		05000
9. OPERATING MODE			11. THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10 CFR §: (Check all that apply)							
1			20.2201(b)			20.2203(a)(3)(ii)			50.73(a)(2)(ii)(B)	50.73(a)(2)(ix)(A)
10. POWER LEVEL			20.2201(d)			20.2203(a)(4)			50.73(a)(2)(iii)	50.73(a)(2)(x)
100			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)	X 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)			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)	License Section 2.F., "Violation of License Condition 2.C. (1)"
12. LICENSEE CONTACT FOR THIS LER										
NAME								TELEPHONE NUMBER (Include Area Code)		
Sam Hassoun – Principal Licensing Engineer								(734) 586-4287		
13. COMPLETE ONE LINE FOR EACH COMPONENT FAILURE DESCRIBED IN THIS REPORT										
CAUSE	SYSTEM	COMPONENT	MANU-FACTORER	REPORTABLE TO EPIX		CAUSE	SYSTEM	COMPONENT	MANU-FACTORER	REPORTABLE TO EPIX
14. SUPPLEMENTAL REPORT EXPECTED								15. EXPECTED SUBMISSION DATE		
YES (If yes, complete EXPECTED SUBMISSION DATE).				X	NO			MONTH	DAY	YEAR

## 16. ABSTRACT (Limit to 1400 spaces, i.e., approximately 15 single-spaced typewritten lines)

On September 28, 2001, Detroit Edison determined that a non-conservative bias existed in the reactor heat balance methodology for calculating core thermal power. Specifically, the main steam moisture carryover fraction used in the heat balance calculations was found to overestimate the actual moisture content of the steam. Due to this condition, it is possible that Fermi 2 exceeded its licensed power limits on one or more occasions; however, this bias represents an insignificant portion of the total thermal power (less than 0.1 percent) and is also small compared to the overall precision of the core thermal power evaluation. Exceeding the thermal power limit in Fermi 2 License Section 2.C.(1) is a reportable condition under Section 2.F. of the Fermi 2 Operating License.

Based on the low order of magnitude of the calculation bias and conservatism inherent in the power levels used for safety analyses, this condition did not result in any adverse impact on the health and safety of the public.

The moisture carryover fraction in the heat balance calculations will be revised to reflect the plant test data. As an interim measure, the maximum reactor power level was administratively reduced by three megawatt thermal.

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17. NARRATIVE (If more space is required, use additional copies of NRC Form 366A)

## **Initial Plant Conditions:**

Mode 1  
Reactor Power 100 percent

## **Description of the Event**

On September 28, 2001, Detroit Edison Company (DECo) determined that a non-conservative bias existed in the reactor heat balance methodology for calculating core thermal power at Fermi 2 nuclear power plant. Specifically, the main steam [SB] moisture carryover fraction used in the heat balance calculations was found to overestimate the actual moisture content of the steam. A General Electric (GE) report titled "Impact of Steam Carryover Fraction on Process Computer Heat Balance Calculations," dated September 2001, states that measurements made over the previous years have shown that the steam carryover is close to zero for Boiling Water Reactor (BWR) 4 and later designs. The 0.1 percent steam carryover fraction used at Fermi 2 since original plant operation is based on input from GE per the steam dryer specifications. Changing the steam carryover fraction from 0.1 percent to zero increases the calculated core thermal power by 0.082 percent or 2.81 megawatt thermal (MWth) for the current 3430 MWth licensed thermal limit at Fermi 2. The maximum power level was administratively reduced by 3 MWth upon discovery of this condition.

Section 2.C.(1) of the Fermi 2 Operating License states: "DECo is authorized to operate the facility at reactor core power levels not in excess of 3430 megawatts thermal (100 percent power) in accordance with the conditions specified herein and in Attachment 1 [Preoperational Test, Startup Tests and Other Items] to this license...." Prior to the third refueling outage, Fermi 2 was authorized to operate at 3292 MWth under the original operating license, and at 3293 MWth for the second and third reactor core cycles. The original 3292 MWth rating was a typographical error in the operating license.

Section 2.F. of the Fermi 2 Operating License states: "Except as otherwise provided in the Technical Specifications or Environmental Protection Plan, DECo shall report any violations of the requirements contained in Section 2.C. of this license in the following manner: initial notification shall be made within 24 hours to the NRC Operations Center via the Emergency Notification System with written follow-up within 30 days in accordance with the procedures described in 10 CFR 50.73(b), (c) and (e)."

## **Cause of the Event**

The cause of this event is the information provided by GE as input to the heat balance calculations used for evaluating the core thermal power. The steam dryer performance specification required less than 0.1 percent moisture carryover fraction in the steam leaving the pressure vessel. This requirement in the specification was also used in the core thermal power evaluation. A contributing factor to this event is the failure to analyze empirical test data obtained in 1988 and 1996 against input parameters for the reactor heat balance methodology.

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## Analysis of the Event

The Fermi 2 operating license was amended on September 14, 1992 to increase the maximum licensed reactor core thermal power from 3293 to 3430 MWth; however, power was administratively limited to between 3293 and 3327 MWth due to limitations with the main turbine generator and other turbine ancillary equipment. This administrative limit was applied since the startup from the third refueling outage in November 1992 until the startup from the seventh refuel outage in the Spring of year 2000. Therefore, for the period between the third and seventh refueling outages, plant operation at the lower than licensed power limits provide an adequate margin to absorb the effect of the difference in the moisture carryover fraction in addition to the other 4.6 MWth non-conservative errors previously discussed in Licensee Event Reports (LERs) 95-008, 96-013 and 97-001. The errors reported in these three LERs were corrected prior to the seventh refueling outage.

The design basis Loss of Coolant Accident (LOCA), design basis Containment, and Transient Analyses incorporate a two percent power level measurement uncertainty which equates to 68.6 MWth. Historically, the maximum heat balance calculation uncertainty due to instrument inaccuracies when using the Process Computer [ID] was 1.85 percent or approximately 63.5 MWth. This results in an approximately five MWth margin in the two percent uncertainty assumption. When using the manual heat balance calculation method, the historical maximum uncertainty due to instrument inaccuracies was 2.3 percent versus the 1.85 percent assumed for the Process Computer calculation. Since this exceeded the two percent power uncertainty requirement, operating procedures require reducing reactor power by at least 1 percent upon loss of the process computer. During the seventh refueling outage, a Feedwater Digital Control [JK] system was installed. As a result, the maximum heat balance calculation uncertainties for the Process Computer and manual calculation were reduced to 1.47 and 1.12 percent, respectively. Therefore, for the current cycle (Cycle 8), the margins available in the two percent assumption with the Process Computer or the manual heat balance method are more than adequate to absorb the non-conservative bias due to the moisture carryover fraction used in the heat balance calculations.

Because the maximum magnitude of the moisture carryover fraction bias is bounded by the available margin, the assumptions used for the safety analysis were not exceeded. As a result, previous operation with this error was within the bounds of the design basis LOCA, Containment, and Transient Analyses as described in the Updated Final Safety Analysis Report (UFSAR).

During original plant startup testing, a test was performed in November 1988 to measure the reactor moisture carryover fraction as part of a demonstration to verify the reactor vendor warranty. The test report documented a moisture fraction of 0.002 percent; however, no confidence level or uncertainty was identified in the report. The main purpose of the test was to demonstrate warranty compliance and was not set up to verify heat balance calculations input parameters.

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Another reactor moisture carryover test was performed in March 1996. The purpose of this test was to evaluate turbine cycle performance and ensure that the amount of moisture in turbine steam would not have adverse effects on turbine blade wear. The test report indicates that the average measured moisture carryover fraction is 0.0654 percent with a 95 percent confidence interval of plus or minus 0.0236 percent. The report further recommends using a nominal moisture carryover fraction of 0.07 percent. However, because analysis of plant test data was focused on compliance with turbine performance criteria, it was not recognized that the 0.1 percent moisture carryover fraction was not conservative and; therefore, it was not changed in the heat balance calculations. The difference between the recommended 0.07 percent fraction and the value of 0.1 percent used in the calculations translates into about 0.8 MWth non-conservative bias.

Before the third refueling outage, it is possible that Fermi 2 exceeded its licensed power limits on one or more occasions. The combination of the non-conservative errors resulting from this event and the other three LERs mentioned above could have exceeded the five MWth margin available when using the Process Computer heat balance method. Additionally, previous practices included lowering reactor power by about 0.4 percent power upon loss of Process Computer. Therefore, there may have been occasions where actual thermal power exceeded the licensed limits. However, it is unlikely that the reactor was maintained that close to the maximum power limits.

The change in core thermal power due to the moisture carryover fraction is an order of magnitude less than the precision of the Minimum Critical Power Ratio (MCPR) safety limit evaluation process. Furthermore, the 0.1 percent change in core thermal power is a factor of 18 less than the precision of the Process Computer core thermal power estimate. Therefore, the health and safety of the public were not adversely affected by this event.

**Corrective Actions**

Upon discovery of this event, the maximum power level was administratively reduced by 3 MWth. This administrative limit will remain in effect until the moisture carryover fraction in the heat balance calculations has been revised to reflect the plant test data.

Additionally, a validation of other heat balance parameters will be performed to evaluate the process for potential similar problems.

This event has been documented in the Fermi 2 corrective action program. The corrective actions will be tracked and implemented commensurate with the established processes and priorities of the program.

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**Additional Information**

A. Failed Components: None

B. Previous LERs on Similar Problems

LER 97-001

On February 6, 1997 during a review of the Reactor Water Cleanup (RWCU) system inputs to the reactor heat balance calculation, an error was discovered in the mass flow conversion algorithm used by the Process Computer for RWCU flow. It was determined that this resulted in a non-conservative error of approximately 0.6 MWth in the heat balance calculation. Based on the low order of magnitude of the error and conservatism inherent in power levels used for safety analyses, this condition did not result in any adverse impact on the health and safety of the public. The mass flow conversion algorithm was corrected and the procedure for the manual heat balance calculation and the software specification were revised to include the appropriate algorithm. This LER is similar in that the heat balance calculation was impacted in a non-conservative manner. However, in LER 97-001 the reason for this error was a wrong calculation of the RWCU flow. In the current LER it is due to a non-conservative input to the heat balance methodology.

LER 96-013

On October 4, 1996, Detroit Edison determined that a non-conservative bias existed in the heat balance methodology for calculating core thermal power. During performance of a preventative maintenance event, a discrepancy in the "as found" calibration data between the Recirculation Pump B Motor Power Wattmeter and the associated Process Computer Point was discovered. Initial investigation showed that the wattmeter was scaled for 0.0 to 8.0 megawatts full-scale and the Process Computer Point was effectively scaled for a 0.0 to 10.6 megawatt range full-scale. The impact on the heat balance calculation was that calculated core thermal power could have been up to approximately 3 MWth lower than actual power, at the highest Reactor Recirculation Pump speeds. Based on the low order of magnitude of the bias and conservatism inherent in power levels used for safety analyses, this condition did not result in any adverse impact on the health and safety of the public. The discrepancy between the Reactor Recirculation Pump Motor Power Wattmeters and the Process Computer Points was corrected. This LER is similar in that the heat balance calculation was impacted in a non-conservative manner. However, in LER 96-013 the reason for the event was a Process Computer input scaling error. In the current LER it is due to a non-conservative input to the heat balance methodology.

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LER 95-008

On December 13, 1995, Detroit Edison discovered a non-conservative omission in the heat balance methodology for calculating core thermal power. Control Rod Drive (CRD) flow that is directed to the Reactor Recirculation Pumps for seal flow contributes approximately four gallons per minute of cold water to the primary system. The impact on the heat balance calculation was that calculated core power was approximately one MWth lower than actual power. Detroit Edison incorporated the effects of CRD purge flow to the Reactor Recirculation Pump seals into reactor heat balance calculations by a modification to the Process Computer and manual heat balance calculation methodologies via a change to the Radiative Heat Loss Constant. This LER is similar in that the heat balance calculation was impacted in a non-conservative manner. However, in LER 95-008 the reason for this error was an omission in the heat balance methodology. In the current LER it is due to a non-conservative input to the heat balance methodology.