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DTE Energy

10 CFR 50.73

March 23, 2005
NRC-05-0015

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 No. 2005-001, "Manual Reactor Shutdown Due to Containment Cooler Leak"

Pursuant to 10 CFR 50.73(a)(2)(i)(A) and 10 CFR 50.73(a)(2)(iv)(A), Detroit Edison is hereby submitting the enclosed Licensee Event Report (LER) No. 2005-001. This LER documents a January 24, 2005 event where the drywell leakage increased rapidly and exceeded technical specification limits for unidentified reactor coolant system leakage, and a plant manual shutdown was initiated as required by Technical Specification 3.4.4. The plant was then manually tripped in response to increasing drywell leakage rates. It was subsequently determined that drywell leak source was from the closed cooling water system supplying a drywell cooling unit, not from the reactor coolant system.

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: E. R. Duncan
N. K. Ray
NRC Resident Office
Regional Administrator, Region III
Supervisor, Electric Operators,
Michigan Public Service Commission

IE22

NRC FORM 366 (6-2004) U.S. NUCLEAR REGULATORY COMMISSION

APPROVED BY OMB: No. 3150-0104 Expires 6/30/2007

Estimated burden per response to comply with this mandatory 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 and FOIA/Privacy Service Branch (T-5 F52), U.S. Nuclear Regulatory Commission, Washington, DC 20555-0001, or by internet e-mail to infocollects@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 an 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

Manual Reactor Shutdown Due to Containment Cooler Leak

5. EVENT DATE			6. LER NUMBER			7. REPORT DATE			8. OTHER FACILITIES INVOLVED	
MONTH	DAY	YEAR	YEAR	SEQUENTIAL NUMBER	REV NO	MONTH	DAY	YEAR	FACILITY NAME	DOCKET NUMBER
01	24	2005	2005	- 001 -	00	03	23	2005		05000
									FACILITY NAME	DOCKET NUMBER
										05000

9. OPERATING MODE

1

10. POWER LEVEL

100%

11. THIS REPORT SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10 CFR§: *(Check all that apply)*

- ☐ 20.2201(b)
- ☐ 20.2201(d)
- ☐ 20.2203(a)(1)
- ☐ 20.2203(a)(2)(i)
- ☐ 20.2203(a)(2)(ii)
- ☐ 20.2203(a)(2)(iii)
- ☐ 20.2203(a)(2)(iv)
- ☐ 20.2203(a)(2)(v)
- ☐ 20.2203(a)(2)(vi)
- ☐ 20.2203(a)(3)(i)
- ☐ 20.2203(a)(3)(ii)
- ☐ 20.2203(a)(4)
- ☐ 50.36(c)(1)(i)(A)
- ☐ 50.36(c)(1)(ii)(A)
- ☐ 50.36(c)(2)
- ☐ 50.46(a)(3)(ii)
- ☒ 50.73(a)(2)(i)(A)
- ☐ 50.73(a)(2)(i)(B)
- ☐ 50.73(a)(2)(i)(C)
- ☐ 50.73(a)(2)(ii)(A)
- ☐ 50.73(a)(2)(ii)(B)
- ☐ 50.73(a)(2)(iii)
- ☒ 50.73(a)(2)(iv)(A)
- ☐ 50.73(a)(2)(v)(A)
- ☐ 50.73(a)(2)(v)(B)
- ☐ 50.73(a)(2)(v)(C)
- ☐ 50.73(a)(2)(v)(D)
- ☐ 50.73(a)(2)(vii)
- ☐ 50.73(a)(2)(viii)(A)
- ☐ 50.73(a)(2)(viii)(B)
- ☐ 50.73(a)(2)(ix)(A)
- ☐ 50.73(a)(2)(x)
- ☐ 73.71(a)(4)
- ☐ 73.71(a)(5)
- ☐ OTHER

Specify in abstract below or in NRC Form 366A

12. LICENSEE CONTACT FOR THS LER

FACILITY NAME	TELEPHONE NUMBER (Include Area Code)
Robert J. Salmon – Principal Licensing Engineer	(734) 586-4273

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
B	CC	AHU	C733	Y					

14. SUPPLEMENTAL REPORT EXPECTED

☐ YES *(If yes, complete 15. EXPECTED SUBMISSION DATE)* ☒ NO

15. EXPECTED SUBMISSION DATE

MONTH	DAY	YEAR

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

On January 24, 2005 at 1619 hours, the Fermi 2 power plant was manually shutdown (tripped) from 100% power due to unidentified drywell leakage that exceeded the technical specification requirements. The reactor protection system (RPS) performed as expected, and all rods were fully inserted into the core. The reactor water level decreased from a normal level of 197 inches to a level of 123 inches above the top of active fuel, and recovered to normal without operator intervention. The main steam isolation valves (MSIVs) remained open and reactor water level was maintained in the normal band. Reactor water was supplied by the condensate and reactor feedwater systems. Pressure control was maintained by the turbine bypass valves. There was no increase in reactor dome pressure as a result of this event, and none of the Safety Relief Valves (SRVs) lifted. Reactor water low level (Level 3) isolations occurred as expected. These included isolation Group 4 (Residual Heat Removal Shutdown Cooling and Head Spray), Group 13 (Drywell Sumps), and Group 15 (Traversing In-core Probe System) isolations. The operation of all of these systems was as expected in response to this event. At 1321 hours on January 25, 2005, the plant entered cold shutdown (Mode 4).

The source of the leak was determined to be from a failed end bell gasket on drywell cooler number 4. After appropriate repairs, plant restart commenced at 1710 hours on February 2, 2005.

Initial Plant Conditions:

Mode	1
Reactor Power	100 percent

Description of the Event

On January 24, 2005 at 1549 hours, the Fermi 2 power plant was operating at 100% power when an alarm was received in the main control room indicating that the rate of change of the drywell floor drain sump level was high. The drywell floor drain sump level [IJ] was determined to be increasing at approximately one inch per minute. Plant personnel determined the operational leakage rate as directed by the alarm response procedure, and determined that it exceeded the Technical Specification limit of 5 gpm at the time of the alarm. At approximately 1610 hours, the leak was determined to be approximately 30 gpm, based on the drywell sump level increase and drywell sump pump out rate. The Shift Manager declared that the plant was in an Unusual Event (Emergency Action Level SU5). The emergency plan requires entry into an Unusual Event due to unidentified or pressure boundary leakage greater than 10 gpm. With the sharply increased leakage rates and little prospect of reducing the leakage rate to within limits in the required time, it was decided to shut the reactor down consistent with Technical Specification 3.4.4 Action C. The Detroit Edison central system supervisor was notified of an impending plant shutdown due to unidentified drywell leakage at 1615 hours.

The reactor was manually shutdown (scrammed) by placing the mode switch in shutdown at 1619 hours in response to increasing drywell leakage rates. The reactor protection system (RPS) [JD] performed as expected, and all rods were fully inserted into the core. The reactor water level decreased from a normal level of 197 inches to a level of 123 inches above the top of active fuel, and recovered to normal without operator intervention. Subsequent to the event, the main steam isolation valves (MSIVs) remained open and reactor water level was maintained in the normal band of 173 to 214 inches. Reactor water was supplied by the condensate [SD] and reactor feedwater [SJ] systems. As designed, the turbine / generator [TA/TB] tripped on reverse power relaying. Pressure control was maintained by the turbine bypass valves [JI]. There was no transient increase in reactor dome pressure, and no safety relief valve (SRV) lifted as a result of this event. Reactor water low level (Level 3) isolations [JM] occurred as expected. These included isolation Group 4 (Residual Heat Removal Shutdown Cooling and Head Spray), Group 13 (Drywell Sumps), and Group 15 (Traversing In-core Probe System) isolations. These isolation signals were reset at 1629 hours, and the drywell sump pumps were returned to service at that time. The operation of all of these systems was as expected in response to this event.

At 1640 hours, additional calculations were performed that indicated the unidentified leak rate was in excess of 60 gpm. Based on that information, the Emergency Director declared that the plant was in an Alert (Emergency Action Level FA1). The emergency plan requires entry into an Alert if unidentified drywell leakage is greater than 50 gpm.

Required immediate notifications were made to the NRC in accordance with 10 CFR 50.72 on January 24, 2005 (EN 41354). This event is being reported in accordance with 10 CFR 50.73(a)(2)(i)(A) as the completion of a

shutdown required by the Technical Specifications, and in accordance with 10 CFR 50.73(a)(2)(iv)(A) as a manually initiated reactor scram.

The rate of increase in drywell sump level is used to calculate the leak rate from the reactor or from any other component or system located in the drywell portion of the primary containment. The drywell is inerted with nitrogen gas during power operation, and is not immediately accessible by plant personnel. Thus, any leakage indicated by an increase in the drywell floor drain sump level is initially assumed, as a worst case, to be unidentified reactor coolant system leakage until shown to originate from another source. Technical Specification Limiting Condition for Operation (LCO) 3.4.4 requires that there be no pressure boundary leakage, that unidentified drywell leakage be maintained at $\leq$ 5 gpm, that total drywell leakage be maintained at $\leq$ 25 gpm averaged over the previous 24 hour period, and that the increase in unidentified leakage within the previous 24 hour period be $\leq$ 2 gpm when in Mode 1. Plant operators determined that the unidentified drywell leakage exceeded the technical specification limit of 5 gallons per minute (gpm) at 1549 hours. When that limit is exceeded, the plant is required by Technical Specification 3.4.4 Action A.1 to reduce the unidentified leakage to less than 5 gpm within 4 hours. Action A.1 also requires that total drywell leakage in excess of 25 gpm be reduced to within 25 gpm within 4 hours. Technical Specification 3.4.4 Action B.2 applies when the increase in unidentified leakage in the last 24 hours is $\geq$ 2 gpm. It allows continued operation, if the source of the leakage can be determined not to involve service sensitive type 304 or type 316 stainless steel, however, the total leakage still must be maintained $\leq$ 25 gpm as required by Action A. If the leakage cannot be reduced within limits within the 4 hour time period, Technical Specification 3.4.4 Condition C requires the plant to be in hot shutdown within 12 hours, and in cold shutdown within 36 hours.

Drywell sump water samples were obtained and sent to the chemistry laboratory for analysis to determine the source of the unidentified leakage. The results of that analysis indicated that the sump water radiation levels were less than would be expected if the leak was from the reactor coolant system. Further chemical analysis was performed, and corrosion inhibitors were determined to be present in the sump water. Corrosion inhibitors are not used in the reactor coolant system, but are used in the closed cooling water systems. The Reactor Building Closed Cooling Water (RBCCW) system supplies cooling to the drywell through 14 drywell coolers. Two separate piping loops are routed through the drywell each supplying 7 drywell coolers. During abnormal conditions, these coolers receive their cooling water from the Emergency Equipment Cooling Water (EECW) system.

To determine which loop of the drywell cooling had the leak, the EECW System divisions were run one at a time, and the leak was determined to be in the EECW Division 2 system in the drywell. That portion of the system was removed from service at 2054 hours, and the leakage was observed to have immediately lowered. Once it was determined that the leakage was not reactor coolant leakage, and total leakage was reduced within limits, Technical Specification LCO 3.4.4 was met. There were no increases in airborne radioactivity in the containment and no release of radioactivity to the environment as a result of this event. The emergency plan Alert classification was terminated at 2228 hours.

At 1321 hours on January 25, 2005, the plant entered cold shutdown (Mode 4) and began a forced outage to determine the exact location of the leak, the extent of the equipment affected, and to perform any equipment repair and refurbishment needed as a result of the event. A plan was developed to identify and to properly sequence the activities required to determine the extent of the problem and to properly sequence the recovery activities.

The leak was determined to be the result of a failed drywell cooler number 4 end bell gasket. All 14 drywell coolers were inspected, and five coolers were reworked as a result of this event. The extent of the condition was determined to include those drywell coolers that had been repaired by Detroit Edison personnel using techniques and materials similar to that used on drywell cooler number 4. All four end bell gaskets on coolers number 3, 4, and 10, and two of four end bell gaskets on coolers number 1 and 2 were replaced prior to resuming operation. The two gaskets not replaced on each of cooler number 1 and 2 had not been disturbed since original installation and, hence, were determined to not require replacement.

Drywell coolers number 6 and 7 were rebuilt with wider gaskets using RTV as a gasket adhesive by construction craft in 1983, prior to initial plant startup. Although those coolers were reworked with a wide gasket and RTV, they were assembled by different personnel and tested at the design pressure of 150 psig. This pressure is 50% higher than the normal operating pressure of 100 psig and demonstrated the adequacy of the initial joint. Those coolers have not since been disturbed and exhibited no signs of leakage throughout the 21 years since they were rebuilt. Based on those considerations, it was determined that the integrity of those joints had been demonstrated to be acceptable, and those coolers did not require repair.

Unit restart commenced at 1710 hours on February 2, 2005.

Cause of the Event

The leak was caused by a failure of an end bell gasket on the number 4 drywell cooler. One part of the gasket extruded out from the end bell and cooling water was sprayed on adjacent equipment. The gasket failure was attributed to inadequate gasket compression that existed as a result of original equipment manufacturer (OEM) design information employing a thin flexible tube sheet and full face (wide) gasket. The OEM delivered coolers with narrow gaskets and a drawing showing the gasket was a full face gasket. Replacement gaskets were of the full face type. Significant cooler end cover bolt torque was required (and did not exist) to provide the required level of sealing performance for EECW/RBCCW system service requirements. Contributing causes included: 1) Insufficient initial bolt torque to establish adequate gasket compression, 2) Insufficient bolt torque to maintain adequate gasket compression, 3) Wrong gasket width, 4) Flatness of tube sheet surfaces, 5) Improper gasket adhesive, 6) Bolt spacing too wide, 7) Inadequate reassembly instructions, 8) Inadequate testing, and 9) tube plug weld interference with end bell fit.

Onsite cooler rebuilds used silicone sealant (RTV) as a gasket adhesive to ensure the gasket is held in place while assembling the cooler. The failed cooler was last assembled in November 1996 using amounts of RTV placed mostly in beads on each side of the gasket inside the bolt pattern. The RTV had in effect, become another gasket material in the joint. RTV is not recommended for use as a gasket in applications where pressure exceeds 100 psi due to low tensile shear strength. Bolts were tightened using 'skill of the craft' rather than a specified torque value, which resulted in a wide variance in bolt preload. The assembly was leak checked at operating pressure and the RTV helped prevent leakage in areas of reduced gasket compression since it seals by adhesion rather than compression.

The gasket blowout occurred because the pressure force acting on the thickness of the gasket exceeded the joint compressive friction force holding the gasket in place. Operating pressure was steady at the time of failure and

no significant fluctuations in pressure had occurred. The joint was subjected to a pressure test during the November 2004 refueling outage that was between normal operating pressure and design pressure. This higher pressure test could have degraded the joint, especially considering that RTV was functioning as a gasket. However, low bolt torque is the primary cause of failure.

Analysis of the Event

Plant operators manually tripped (scrammed) the plant in response to increasing drywell leakage rates well in excess of the Technical Specification LCO 3.4.4 limit for unidentified drywell leakage of 5 gpm in accordance with Technical Specification 3.4.4, Action C. It was subsequently determined that the event involved leakage from the closed cooling water system supplying drywell cooling unit number 4, and did not involve any leakage from the reactor coolant pressure boundary.

The Division 2 EECW cooling water to the drywell coolers was isolated and the leak was terminated. The drywell coolers do not provide a post-accident safety function. Plant Technical Specifications allow a complete division of EECW to be out of service for up to 72 hours before the plant must be shutdown. Division 2 of EECW was declared inoperable at 2054 hours on January 24, 2005. The plant entered Mode 4 (Cold Shutdown) on January 25 at 1321 hours which easily met those requirements. Furthermore, all of the essential functions of EECW Division 2 could be performed by that subsystem after the non-essential drywell equipment loads were removed from service.

Given the size and the initially unknown origin of the leak, the prompt plant shutdown was prudent. It also afforded the opportunity to determine whether any adjacent essential equipment had been affected by spray from the leak. Since the plant technical specifications were complied with at all times and since plant response to the unit trip was as expected, there was no undue risk to plant personnel or the general public as a result of this event.

Corrective Actions

All four end bell gaskets on coolers number 3, 4, and 10, and two of four end bell gaskets on coolers number 1 and 2 were replaced prior to resuming operation. The cooler end bells that were rebuilt used a narrower gasket which increased the loading on the gasket surface and improved the gasket compression at the specified bolting torque. To ensure proper gasket adhesion to the joint surfaces, RTV was replaced with a gasket adhesive with instructions provided on how to properly apply the new adhesive material. Tube plug welds were ground down as required to eliminate end bell fit-up interferences. In order to ensure sufficient initial bolt torque to establish and maintain adequate gasket compression, specific bolt torque requirements and bolt torque patterns were developed and included in the work packages. A sample of bolts were checked after 24 hours to ensure sufficient torque remained after relaxation and gasket compression.

Equipment components in the spray pattern of the leak were inspected to determine whether their function had been impacted by the water spraying from the number 4 drywell cooler. Three snubbers were identified as having been sprayed, and they were replaced, as a conservative measure, to ensure proper long-term function.

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All 14 drywell coolers were pressure tested at normal system operating pressure utilizing EECW pumps with the drywell return line isolated. This pressure represents the highest expected service condition. All 14 drywell coolers passed this pressure test.

This event has been documented in the Fermi 2 corrective action program, CARD 05-20426. Any further corrective actions identified as a result of these evaluations will be tracked and implemented commensurate with the established processes and priorities of the corrective action program.

Additional Information

A. Failed Components:
Component: Drywell Cooler
Function: Cools drywell atmosphere during normal operation
Manufacturer: CTI Nuclear (out of business)
Model Number: D27763
Failure Cause: Failed end bell gasket

B. Previous LERs on Similar Problems: None.