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January 17, 1995
NRC-95-0002

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

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

Subject: Submittal of Memo Related to Fermi 2 Turbine Generator Event

The purpose of this letter is to submit the attached internal Detroit Edison memo which is related to the Fermi 2 Turbine Generator event of December 25, 1993. Submittal of this memo is being made at the request of the Fermi 2 Project Manager, Mr. Tim Colburn.

The memo is dated July 7, 1994 and contains information available at that time. The memo provided input from one member of the Root Cause Analysis Team to the team leader on several of the possible causes he was evaluating. Please note that this memo was not intended for submittal or to be used on its own, so a clarification is appropriate on the first paragraph and some names have been blacked out.

The first paragraph discusses that metallurgical examination of the crack surfaces indicate tangential blade vibration which is characteristic of torsional rotor vibration. Torsional rotor vibration is just one of the possible causes for tangential blade vibration, not the only cause. Names blocked out include names of personnel and names of other power plants.

It is Detroit Edison's understanding that the reason this memo was requested by the NRC Project Manager was because it discussed the information about shaft bow which had previously been communicated to the NRC but only verbally. No names were included in that section of the memo nor are they relevant. Additional and more up-to-date information related to the root cause investigation has already been submitted to the NRC.

If you have any questions regarding this memo, please contact Ms. Lynne S. Goodman, at (313) 586-4097.

Sincerely,

Attachment

cc: T. G. Colburn
J. B. Martin
M. P. Phillips
A. Vegel

Date: July 7, 1994

To: [redacted]

From: [redacted]

Subject: Blade Failures from Shaft Vibration

TORSIONAL LOADING-NEGATIVE SEQUENCE CURRENT

Turbine blade failures due to torsional resonance and negative sequence current have been reported at [redacted] and other locations. The pattern of the failure of Blade No. 9 on the L-0 row of the front flow of LP-3, combined with the root cracks of the L-1 stage rotating blades of LP-2 and LP-3 are indicative of a potential torsional resonance at 60 or 120 Hertz. Metallurgical examination of all of the crack surfaces indicate tangential blade vibration, characteristic of torsional rotor vibration. GEC analysis of the assembled rotor train does not clearly reveal a resonance at 60 or 120 Hertz, however the analysis is not verified by test. Unfortunately, there is no available record of negative sequence current at Fermi 2. Incidents of blade failures due to torsional resonance usually have involved more than one blade, however due to the unique thin trailing edge of blade no. 9, it may be an "outlier", or a premature failure. Therefore torsional resonance is a possible cause of the failure of blade no. 9.

TORSIONAL LOADING-THERMODYNAMICALLY INDUCED

Thermodynamically induced torsional loading would be indicative of an unsteady flow through the steam turbine, e. g. a pulsing flow. This is not an observed or reported cause of turbine blade failures.

LATERAL SHAFT VIBRATION

Unbalance

Lateral Shaft Vibration caused by rotor unbalance is a theoretical cause of blade failures. However the magnitude of shaft vibration required to cause blade vibration and failure is many times more than experienced by Fermi 2. Fermi 2 experienced higher than expected turbine shaft vibration in the 1988 to 1990 period, but within established limits for safe operation. Shaft vibration limits are specified to limit the potential of bearing damage, which is much more sensitive than the potential for blade vibration. Excessive shaft vibration has the potential to initiate rubs of turbine blades which could lead to blade failure, however all rubs observed after the event were judged to be a consequence of the large unbalance due to the failure of five l-0 blades. Computerized records of turbine shaft vibration are available for essentially the entire commercial history of the MTG, as

analyzed by [redacted]. Consequently, lateral shaft vibration due to unbalance is not a cause of the December 25, 1993 blade failure.

Bearing Whip

Oil Whip and Oil Whirl are vibration phenomena associated with journal bearings, resulting in shaft vibration at one-half or less of running speed. None of these frequency components were recorded on the LP-3 bearings since RF0-3; therefore they are not a cause of the December 25, 1993 blade failure.

Shaft Bow

A shaft bow has the potential to initiate a blade failure due to a rub. However no high shaft vibration was recorded prior to the event, nor was any significant rubs observed on the L-0 rotating blades or diaphragm ring. Therefore a shaft bow is not a possible cause of the failure of blade no. 9.

External Lateral Shaft Vibration

Lateral shaft vibration from an external source, such as an earthquake or an explosion is not a possible cause of the failure of blade no. 9 since there was no such event.

Misalignment

Lateral shaft vibration from misalignment is not a possible cause of the failure of blade no. 9 since there was no excessive vibration recorded prior to the event and no significant misalignment observed during disassembly.