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NRC-94-0093

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

References: 1) Fermi 2
NRC Docket No. 50-341
NRC License No. NPF-43

2) NRC Letter, Martin to Gipson, dated
December 28, 1993

3) Detroit Edison letter, NRC-94-0075, dated
August 24, 1994

Subject: Supplementary Response to Confirmatory Action Letter on
December 25, 1993 Turbine Event

Detroit Edison submitted its response to the NRC Confirmatory Action Letter (CAL) on the December 25, 1993 turbine event (Reference 2) on August 24, 1994 in Reference 3. In the response, Detroit Edison committed to address three activities in a supplementary response prior to plant startup. This letter constitutes the supplementary response. The specific results are covered in the enclosures to this letter. Two formal commitments are being made in this response as follows:

- Monitoring of Main Turbine-Generator vibration will be performed during initial roll-up, synchronization and power ascension.

- The Main Turbine-Generator automatic trip on vibration will be activated for Cycle 5 after a planned period of about 60-90 days of near full power operation.

This letter concludes Detroit Edison's response to the CAL. Based on the evaluation results, Detroit Edison believes that safe operation of Fermi 2 as planned will be achieved.

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If there are any questions on the information provided in this letter, please contact Lynne S. Goodman, Director, Nuclear Licensing at (313) 586-4097. She will answer any questions, make information available to NRC technical reviewers and inspectors, or arrange a meeting.

Sincerely,

Enclosures

cc: T. G. Colburn
J. R. Padgett (Mich. Public Service Commission)
M. P. Phillips
A. Vegel
NRC Regional Administrator

ENCLOSURE 1

SUPPLEMENTARY CAL RESPONSE

I. INTRODUCTION

In Detroit Edison's response to the NRC Confirmatory Action Letter, the commitment was made to address the following activities in a supplementary response:

- Results of straightening and balancing of low pressure turbine rotors, discussion of plans to monitor turbine vibration during startup and actions planned if excessive vibration is experienced.

- Results of turbine missile analysis and safety evaluation review.

- Results from crud scrapings and destructive tests on the fuel bundle parts.

Each of these activities will be addressed in the following sections. Additionally, clarifications of two items contained in Reference 3 are included to preclude misunderstanding.

II. LOW PRESSURE TURBINE ROTORS AND MONITORING OF TURBINE VIBRATION

A. LP Rotor Bend Reduction

Following the December 25 incident and disassembly of the Low Pressure (LP) Turbines, the LP rotors were inspected and found to have slight bends. Each of the rotors had bends of different magnitude, but generally the bow or bend was most pronounced at the center plane, or mid-length between journals.

The reduction of the induced bow was undertaken at the Westinghouse facility in Charlotte. The Fermi LP rotors are of built-up construction, i.e., the rotor forging has discs or wheels shrunk onto it, which then carry the turbine blades. Couplings are then shrunk onto both ends to connect the rotor line together.

Normally, running the rotors to an overspeed condition will reduce shrink fit and allow discs to settle evenly, on run-down even loading will be obtained. Both LP1 and LP2 were taken to 120% nominal speed, i.e., 1800 x 1.2 or 2160 rpm, and disc settling was seen to take place as indicated by vibration amplitude and phase angle changes. The bow in both rotors was reduced.

LP3 had sustained a more significant bow, such that running to an overspeed condition presented some risk to the overspeed facility. It was, therefore, decided to reduce

the bow as much as possible by individual disc heating with the rotor in a vertical position. Discs 6, 5, and 2 on the front of LP3 were heated in turn, using induction heating units, so as to release their shrink fits and were then allowed to cool, establishing a more uniform fit on the rotor.

This effectively reduced the bow from .036" to .018", which then made it acceptable for overspeed runs. In the overspeed facility, the bend was further reduced to .0115" by relieving the uneven fits of the remaining discs.

Below are tabulated the rotor run-out readings before and after the Charlotte work. The remaining bow is not a problem with respect to clearances with the LP cylinders, at most it decreases top and bottom clearances by only .006" on LP2 and LP3. The out-of-balance load (which the rotor center of gravity rotating off true center induces) has been balanced out at Charlotte.

Rotor	1994 As Found	1994 After Overspeed
LP1	.016"	.010"
LP2	.018"	.012"
LP3	.033" -Disc heating .018"	.012"

The ability of the residual rotor bow to cause dynamic energy by rotation (vibration) was minimized by shop balancing each rotor and machining the coupling faces. After each LP Turbine rotor was run to 120% overspeed and the residual bow was determined stable, the 7th & 8th stage blades were removed from the rotors. The 7th & 8th stage root protection blocks were installed and the rotors were returned to the spin box for 110% overspeed testing and final balancing.

The final balancing was performed to reduce shaft vibration amplitude at the critical speeds and at 1800 rpm to acceptable values (values which Westinghouse accepts for shipment of new rotors). The final shaft vibration amplitudes at 30 Hz after balancing at 1800 rpm for each LP rotor are as follows:

LP1	1.4 mils peak-to-peak
LP2	1.3 mils peak-to-peak
LP3	1.7 mils peak-to-peak

The face of each coupling on each LP rotor was machined to result in a face total indicated run-out of 1 mil or less.

This assures that the bow of each rotor will have negligible effect on the adjacent rotor when coupled.

Calculations were performed to verify that existing coupling bolts could be re-used between couplings, after the face true-up. The resulting error between adjacent bolt holes was found to be less than 1 mil, which is well within the fit tolerance for the hydraulic coupling bolts used.

B. Planned Turbine Vibration Monitoring

See Enclosure 2 "Fermi 2 Main Turbine-Generator Vibration Monitoring and Balancing During Startup After RF04" for the guidance developed for turbine-generator monitoring during initial startup after the current turbine outage.

As discussed in Enclosure 2, Detroit Edison plans to activate the automatic Main Turbine-Generator trip on vibration after a planned period of about 60-90 days of near full power operation. J. Tsao, NRC, requested that the reason for this plan be addressed in the supplementary response. The reason for this 60-90 day period is to monitor and evaluate performance of the vibration monitoring equipment and the Main Turbine-Generator to minimize the possibility of reactor scrams due to invalid actuations of this automatic turbine trip. Turbine equipment has historically been a significant cause of reactor scrams in Boiling Water Reactors. One of the reasons Detroit Edison disarmed the automatic trip of its previous vibration monitoring equipment was to eliminate a source of spurious reactor transients. The previous vibration monitoring equipment triggered the automatic turbine trip due to false vibration signals caused by electrical noise within the system. A review of the industry operating experience indicated that some other BWR operating owners defeat the automatic turbine trips on vibration.

The vibration monitoring equipment is currently being replaced with equipment that has vibration signal circuit monitoring features that reduce the likelihood of processing any spurious signals to the automatic turbine trip. The new equipment and the delay feature of the automatic trip reduce the probability of unnecessary trips. The monitoring period will provide an opportunity to gain confidence that the new vibration monitoring system and the selected setpoints (for vibration level and time delay) would be unlikely to cause unnecessary turbine trips.

III. RESULTS OF TURBINE MISSILE ANALYSIS AND SAFETY EVALUATION

The missile analysis for the revised configuration of the turbine with the 7th and 8th stage blades removed has been completed. The original turbine missile analysis assumed failure of the 8th stage disc at 3000 rpm, well above the design overspeed. The analyzed worst case missile was a 120 degree segment of the 8th stage LP turbine disc, weighing 8650 lbs.

The analysis of the revised configuration concludes that the first disc to fail, assuming that speed increases beyond the design overspeed, would be the 6th stage disc at 3280 rpm. The analysis shows that the 8th stage disc, without the blades, has a bursting speed of 3600 rpm. The 6th stage failure speed is the upper limit of speed at which any disc could be released from the rotor because, after this first break, the speed of the turbine will not continue to increase due to the large unbalanced forces acting on the rotating members and their supports. The 6th stage disc failure at 3280 rpm has a much lower energy level than the present design basis missile. However, the revised analysis makes a conservative assumption that the disturbance from the 6th stage disc failure causes the consequential failure of the 8th stage disc. The 8th stage disc at 3280 rpm will contain more energy than the original design basis missile. The revised analysis design basis missile is, therefore, a 120 degree segment of the 8th stage disc weighing 8650 lbs. and fragmenting at 3280 rpm.

A missile barrier analysis was performed. The analysis concluded that previously credited missile barriers are structurally adequate to protect against the new design basis missile. The increased energy level of the missile would not have a significant impact on the integrity of the barriers, which would perform as originally designed.

A 10CFR50.59 safety evaluation has been performed for the revised turbine rotor configuration, incorporating the results of the new missile analysis. The safety evaluation concludes that the probability and consequences of an accident or malfunction of equipment important to safety are not increased and there is no unreviewed safety question.

IV. RESULTS FROM CRUD SAMPLING AND DESTRUCTIVE TESTS ON FUEL BUNDLE PARTS

Fuel deposit sampling was performed to assess the effects of the reactor water chemistry transient of December 25, 1993 on fuel cladding. While no significant impact was expected on the zircaloy cladding material, it was deemed prudent to perform fuel deposit sampling as the fuel rod cladding is the major

repository of waterborne crud. Three bundles were selected for deposit sampling, as discussed in Reference 3. Brush and scrape samples were obtained from the surface deposits (crud) on 2 fuel rods per bundle.

Samples were analyzed for elemental and isotopic loading concentrations. Crystallographic analysis was also performed on selected samples. The major constituent of the fuel deposit samples was iron - 85-96% of the brush samples and 80-89% of the scrape samples. The next predominant species were nickel and zinc. All other species comprised approximately 2% or less of the deposit material. Samples were analyzed for aluminum, calcium, magnesium, sodium, silicon and titanium. The majority of the samples did not contain these species above the background detection limit. Where these species were detected, the concentrations were very low and not considered significant.

The Fermi 2 fuel deposits were compared with data from other General Electric BWRs. Fuel deposits from Fermi 2 were well within the distribution band for BWRs.

The major fuel deposit activities detected were Co-60 and Zn-65. These activities were also within the experience band of other BWRs. No unusual activities were detected.

The crystal composition of the fuel deposits was determined by x-ray diffraction. Hematite was the predominant crystal structure observed. Mixed spinel structures, such as Fe_3O_4, $ZnFe_2O_4$ and $NiFe_2O_4$ were also observed in some samples. The selected Fermi 2 fuel deposit samples followed the crystal structure composition of previous BWR experience.

In summary, the fuel deposits from the Fermi 2 bundles were determined to be within the experience band of other BWRs. No unusual loading patterns, deposit species or crystal structures were observed.

Fuel components from four fuel bundles, as discussed in Reference 3, were sent to the GE hot cell for examination. The components included lock tab washers, hex nuts, springs, and one channel fastener. No evidence of degradation was observed by visual examination. Optical metallography was performed on representative specimens. No evidence of service-induced cracking or other anomalous conditions was observed.

The visual and optical metallographic examination found the materials to have surface conditions characteristic of exposure to the BWR environment. No evidence of service-induced degradation consistent with stress corrosion cracking or micro-biologically induced corrosion was found.

V. CLARIFICATIONS

Detroit Edison has identified two items in Reference 3 as needing clarification based on internal discussions. The first relates to the system walkdown teams. The description of the walkdown process remains correct, however, there were areas in the Turbine Building containing mainly turbine support equipment that were not covered by the walkdown scope described. These areas have since been walked down during a separate effort and corrective actions are being evaluated and implemented per the normal plant work control process.

The second item concerns the corrective action to review Extraction/Heater Drain Systems for conformance with ANSI/ASME Standard TDP-2-1985, "Recommended Practices for Prevention of Water Damage to Steam Turbines Used for Electric Power Generation," and to implement appropriate changes prior to restart from RF-05. The specific portion of the Extraction Steam/Heater Drain Systems that this action applies to are the feedwater heaters installed in the condenser neck. These are the Number 1 North, 1 Center, 1 South, 2 North, 2 Center, and 2 South Feedwater Heaters. Extraction for these heaters is from the 7th and 8th stage area of the Low Pressure turbines. The modification of the extraction steam line to Feedwater Heaters 1 and 2 low point drains mentioned in Reference 3 arose from this review. This modification has been physically completed.

ENCLOSURE 2

FERMI 2 MAIN TURBINE-GENERATOR
VIBRATION MONITORING AND BALANCING
DURING START-UP AFTER RFO4