MISSISSIPPI POWER & LIGHT COMPANY
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P. O. BOX 1640, JACKSON, MISSISSIPPI 39205

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JAMES P. McGAUGHY, JR.
ASSISTANT VICE PRESIDENT

April 16, 1982

Office of Inspection & Enforcement
U. S. Nuclear Regulatory Commission
Region II
101 Marietta Street, N.W.
Suite 3100
Atlanta, Georgia 30303

Attention: Mr. J. P. O'Reilly, Regional Administrator

Dear Mr. O'Reilly:

SUBJECT: Grand Gulf Nuclear Station
Units 1 and 2
Docket Nos. 50-416/417
File 0260/15525/15526
PRD-81/49, Final Report, Thermal
Cycling of Reactor Vessel Head
During Hot Operations
AECM-82/162

On December 1, 1981, Mississippi Power & Light Company notified Mr. F. S. Cantrell, of your office, of a Potentially Reportable Deficiency (PRD) at the Grand Gulf Nuclear Station (GGNS) construction site. The deficiency concerns thermal cycling of the reactor vessel head during Hot Operations

We had evaluated the deficiency and concluded that it was not reportable under the provisions of 10CFR50.55(e). The deficiency and the rationale for considering it not reportable were discussed with Mr. Cantrell when the commission was first notified of the deficiency on December 1, 1981. Mr. Cantrell understood our rationale but considered the event to be of such significance that he requested MP&L to submit a detailed written report in the 10CFR50.55(e) format.

MP&L requested General Electric to make a formal review of the incident. GE has reviewed and analyzed this occurrence and has determined that the fatigue usage factor for the ten (10) temperature transients is acceptable and that the deficiency is not reportable under 10CFR50.55(e).

All details are included in our attached Final Report.

Yours truly,

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For J. P. McGaughy, Jr.

KDS:scb
ATTACHMENT

cc: See page 2

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cc: Mr. N. L. Stampley
Mr. R. B. McGehee
Mr. T. B. Conner

Mr. Richard C. DeYoung, Director
Office of Inspection & Enforcement
U. S. Nuclear Regulatory Commission
Washington, D.C. 20555

Mr. G. B. Taylor
South Miss. Electric Power Association
P. O. Box 1589
Hattiesburg, MS 39401

FINAL REPORT FOR PRD-81/49

I. Description of the Deficiency

During Hot Operations testing, November 5-10, 1981, the reactor vessel bottom head experienced a number of thermal transients. The transients occurred as a result of actions taken to reduce the amount of temperature stratification in the reactor vessel bottom head region. Several of these exceeded the Grand Gulf FSAR and Technical Specification limits of 100^{o} F/hr. average rate of change of coolant temperature during normal heatup and cooldown. The maximum change in one hour period was 148^{o} F.

This deficiency affected System B21, the Nuclear Boiler System for Unit 1 only. Unit 2 was not affected.

Preop testing was being performed on the reactor recirculation system (B33) and the vessel internals vibration system (F41) as part of Hot Operations testing. This required the recirculation pumps to be run at high flow conditions for long periods of time. The operation of the pumps generated a large heat input to the reactor water which had a high temperature limit of 530^{o} F. Higher than normal control rod drive (CRD) cooling water (125^{o} F. maximum temperature) flow was maintained to try to counteract this heating effect. This resulted in higher than normal input of cold water through the vessel CRD nozzles into the bottom head region.

The testing plan provided that when the temperature limit was reached, testing would be suspended to allow the system to cool down. This would be done by shifting the recirculation pumps to slow speed which would reduce the heat input from the pumps. The system temperature losses to the ambient plus the cooling effect of the CRD cooling water flow into the vessel would exceed the input from the recirculation pumps, thereby bringing the system temperature gradually down to where the testing could be continued and the pumps shifted back into high speed.

At the time of the occurrence of the thermal transients several other contributing conditions existed. First, the flow control valve (FCV) was left at the minimum flow position during the slow speed operation which still allowed flow through the loop but less than the flow if the FCV was at the maximum flow position. This resulted in reducing the sweep of the flow through the bottom head region allowing the cold CRD cooling water to accumulate in the bottom head region.

Second, the reactor water clean up (RWCU) system was shut down due to a leaking valve which was being repaired. Normally, the RWCU system is continuously removing water from the reactor vessel through the bottom head drain which reduces the accumulation of cold water in the bottom head. The temperature of the water in the bottom head is indicated by a temperature element in the drain line. With no flow through the drain, the temperature indicated is not a true indication of the water temperature in the bottom head.

Third, there was no fuel in the core, resulting in a low pressure drop across the core. This possibly contributed to reducing the sweep of the flow through the bottom head, especially at low flow conditions.

The net effect of the high flow of cold CRD cooling water into the bottom head, the lack of RWCU water flow out of the bottom head, and the reduction of the sweep of the flow from the jet pumps across the bottom head region was the accumulation of cold CRD cooling water in the bottom head.

When the recirculation pump flow was increased by either opening the FCV or shifting the pumps to fast speed, the jet pump flow would sweep away the cold CRD cooling water in the bottom head region and replace it with the hot recirculation loop water. The bottom head metal temperature would rapidly rise due to the temperature differential between the metal and the hotter water next to it.

A contributing factor to the cause of the transients was that the differential temperature interlocks for the recirculation pumps were not operational because their preop testing had not been completed. These are designed to minimize thermal gradients in the vessel by preventing the starting or shifting of the recirculation pumps when differential temperatures between the top and bottom of the vessel or between the vessel water and the recirculation loop water exceed specified limits.

II. Analysis of Safety Implications

The potential existed that the large rate of change of the vessel bottom head metal temperatures may have caused stresses in excess of those for which the bottom head was designed.

The thermal transients were analyzed by General Electric. Nine (9) of the ten (10) transients were within the ASME Code requirement for simplified elastic-plastic analysis. The tenth transient, when combined with the most critical normal and upset event which can occur in the future, exceeded the ASME Code requirement for simplified

elastic-plastic analysis. A plastic analysis including provisions of ASME Code Case N-196-1 was performed using an axis-symmetric finite element model of the most critically affected component for this transient range.

Summing the partial usages of the ten (10) transients with the maximum usage of all normal and upset events expected for forty (40) years of operation, independent of the location in the RPV bottom head region, gives a usage factor which is less than the acceptable ASME Code limit.

Therefore, the fatigue usage factor is acceptable for the ten temperature transients and the deficiency is not reportable under the provisions of 10CFR50.55(e).

III. Corrective Actions Taken

Since the final analysis has shown that no detrimental effect occurred to the design life of the reactor vessel no remedial actions are required.

To prevent recurrence of the temperature stratification during the remainder of the testing, the following guidelines were issued.

1. A minimum of one recirculation pump running on the low frequency motor generator (LFMG) with the FCV at the maximum flow position should be operating at all times.

2. While on the LFMG as above, the CRD flow to the cooling water header should be limited as follows:

   a. If there is flow through the bottom head drain to give a representative temperature reading of the water in the bottom head and the recirculation flow is at least equal to one recirculation pump on slow speed with the FCV at maximum flow position, then the CRD flow can be up to a maximum of 100 gpm.

   b. If there is no flow through the bottom head drain, or if the recirculation flow is less than with one recirculation pump on slow speed with the FCV at maximum flow position, then the CRD flow is limited to a maximum of 40 gpm.

3. The RWCU system should be kept in service at all times if possible. If the recirculation flow is less than with one recirculation pump on slow speed with the FCV at maximum flow position, then the RWCU suction flow from the recirculation pump suction legs should be throttled to increase the flow through the bottom head drain.

4. When only one recirculation pump is running, the FCV for the idle pump should be open to maximum flow position after insuring that the pump is stopped.

Prior to increasing recirculation flow either by starting a pump, or by increasing flow from a pump, the vessel metal and upper water temperatures and the bottom head drain water temperature were to be monitored for any indication that stratification may have occurred. If stratification existed, the recirculation flow could not be increased.

Prior to restarting the recirculation pumps, if they are off for more than 10 minutes, and if the RWCU system is not operational, the CRD pumps are to be turned off and the bottom head metal temperature monitored. If the differential between the bottom head metal temperature and the flange temperatures increased by more than 50° F. above the differential that existed while the pumps were running, the recirculation pumps could not be restarted.

The existence of temperature stratification would be indicated by the bottom head drain to upper vessel water temperature differential exceeding 100° F. as long as the RWCU system is operating. If the RWCU is not operating, the existence of stratification could be indicated by the bottom head metal temperature having dropped sharply while the upper vessel water temperature was constant or slowly changing.

If stratification existed, it may be possible to slowly eliminate it without having to shutdown by increasing the bottom head drain flow slowly by throttling the RWCU suction flow from the recirculation pump suction legs if the Reactor Water Clean Up system is operating.

If the Reactor Water Clean Up system is not operating, it may be possible to eliminate the temperature stratification by blowing down through the Reactor Water Clean Up system to the condenser hotwell.

After fuel load, in normal operations there will not be the high CRD cooling water flow into the bottom head, the RWCU system would need to be operational to meet the reactor water quality limits or for level control during heatup and hot standby, and the core would be installed. System Operating Instruction (SOI) No. 04-1-01-B33-1 will be revised to include a requirement to have the FCV at the maximum flow position when running one recirculation pump on the LFMG. This combined with the core being loaded will counteract the reduction in the sweep of the flow through the bottom head, especially at low flow condition. Most importantly, the temperature interlocks have to be operational and the temperature differentials met in order for there to be a change in pump speed or to start a pump. The plant has been designed and system operating instructions written to prevent what happened during the Hot ops testing, which is an abnormal situation, from happening during normal operation.