



UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

April 29, 1986

Docket No. 50-416

Mr. Oliver D. Kingsley, Jr.
Vice President, Nuclear Operations
Mississippi Power & Light Company
P.O. Box 23054
Jackson, Mississippi 39205

Dear Mr. Kingsley:

SUBJECT: ISSUANCE OF AMENDMENT NO. 12 TO FACILITY OPERATING LICENSE
NPF-29 GRAND GULF NUCLEAR STATION, UNIT NO. 1

The Nuclear Regulatory Commission has issued the enclosed Amendment No.12 to Facility Operating License NPF-29 for the Grand Gulf Nuclear Station, Unit No. 1, located in Claiborne County, Mississippi. This amendment is in response to your letter dated November 1, 1985, and supplemented December 10 and 27, 1985, and January 24 and February 26, 1986.

The amendment changes License Condition 2.C.(26) by increasing the interval for inspection of the low pressure turbine discs. The amendment is effective as of its date of issuance.

A copy of the related safety evaluation supporting Amendment No.12 to Facility Operating License NPF-29 is enclosed.

Notice of issuance will be included in the Commission's next bi-weekly Federal Register notice.

Sincerely,

Walter R. Butler
Walter R. Butler, Director
BWR Project Directorate No. 4
Division of BWR Licensing

Enclosures:

1. Amendment No. 12
2. Safety Evaluation

cc w/enclosures:

See next page

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Mr. Oliver D. Kingsley, Jr.
Mississippi Power & Light Company

Grand Gulf Nuclear Station

cc:

Robert B. McGehee, Esquire
Wise, Carter, Child, Steen and Caraway
P.O. Box 651
Jackson, Mississippi 39205

The Honorable William J. Guste, Jr.
Attorney General
Department of Justice
State of Louisiana
Baton Rouge, Louisiana 70804

Nicholas S. Reynolds, Esquire
Bishop, Liberman, Cook, Purcell
and Reynolds
1200 17th Street, N.W.
Washington, D. C. 20036

Office of the Governor
State of Mississippi
Jackson, Mississippi 39201

Mr. Ralph T. Lally
Manager of Quality Assurance
Middle South Services, Inc.
P.O. Box 61000
New Orleans, Louisiana 70161

Attorney General
Gartin Building
Jackson, Mississippi 39205

Mr. Larry F. Dale, Director
Nuclear Licensing and Safety
Mississippi Power & Light Company
P.O. Box 23054
Jackson, Mississippi 39205

Mr. Jack McMillan, Director
Division of Solid Waste Management
Mississippi Department of Natural
Resources
Bureau of Pollution Control
Post Office Box 10385
Jackson, Mississippi 39209

Mr. R. W. Jackson, Project Engineer
Bechtel Power Corporation
15740 Shady Grove Road
Gaithersburg, Maryland 20877-1454

Alton B. Cobb, M.D.
State Health Officer
State Board of Health
P.O. Box 1700
Jackson, Mississippi 39205

Mr. Ross C. Butcher
Senior Resident Inspector
U.S. Nuclear Regulatory Commission
Route 2, Box 399
Port Gibson, Mississippi 39150

President
Claiborne County Board of Supervisors
Port Gibson, Mississippi 39150

Regional Administrator, Region II
U.S. Nuclear Regulatory Commission,
101 Marietta Street, N.W., Suite 2900
Atlanta, Georgia 30323

Mr. Ted H. Cloninger
Vice President, Nuclear Engineering
and Support
Mississippi Power & Light Company
Post Office Box 23054
Jackson, Mississippi 39205

Mr. J. E. Cross
Grand Gulf Nuclear Station Site Director
Mississippi Power & Light Company
P.O. Box 756
Port Gibson, Mississippi 39150

Mr. C. R. Hutchinson
GGNS General Manager
Mississippi Power & Light Company
Post Office Box 756
Port Gibson, Mississippi 39150

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The amendment changes License Condition 2.C.(26) by increasing the interval for inspection of the low pressure turbine discs. The amendment is effective as of its date of issuance.

A copy of the related safety evaluation supporting Amendment No. 12 to Facility Operating License NPF-29 is enclosed.

Notice of issuance will be included in the Commission's next bi-weekly Federal Register notice.

Sincerely,

Original signed by

Walter R. Butler, Director
BWR Project Directorate No. 4
Division of BWR Licensing

Enclosures:

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2. Safety Evaluation

cc w/enclosures:
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DISTRIBUTION
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MO'Brien
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PD#4/PM
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PD#4/D
WButler *WB*
04/19/86

50,000 hours of operation. All unacceptable indications and their dispositions shall be reported prior to startup for the next cycle of operation. These inspections shall continue on a 50,000 hour interval until the potential for turbine disc cracking has been assessed and an acceptable alternate inspection schedule has been established.

3. This license amendment is effective as of its date of issuance.

FOR THE NUCLEAR REGULATORY COMMISSION

Original signed by

Walter R. Butler, Director
BWR Project Directorate No. 4
Division of BWR Licensing

Date of Issuance: April 29, 1986

PD#4/LA
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add state & SECY before issuance

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April 29, 1986

Amendment No. 12 to Facility Operating License No. NPF-29-Grand Gulf, Unit 1

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UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

MISSISSIPPI POWER & LIGHT COMPANY

MIDDLE SOUTH ENERGY, INC.

SOUTH MISSISSIPPI ELECTRIC POWER ASSOCIATION

DOCKET NO. 50-416

GRAND GULF NUCLEAR STATION, UNIT 1

AMENDMENT TO FACILITY OPERATING LICENSE

Amendment No. 12
License No. NPF-29

1. The Nuclear Regulatory Commission (the Commission) has found that:
 - A. The application for amendment to the Grand Gulf Nuclear Station, Unit 1 (the facility) Facility Operating License No. NPF-29 filed by the Mississippi Power & Light Company acting for itself, Middle South Energy, Inc., and South Mississippi Electric Power Association (the licensees), dated November 1, 1985, and supplemented December 10 and 27, 1985, and January 24 and February 26, 1986, complies with the standards and requirements of the Atomic Energy Act of 1954, as amended (the Act) and the Commission's regulations as set forth in 10 CFR Chapter I;
 - B. The facility will operate in conformity with the application, as amended, the provisions of the Act, and the regulations of the Commission;
 - C. There is reasonable assurance (i) that the activities authorized by this amendment can be conducted without endangering the health and safety of the public, and (ii) that such activities will be conducted in compliance with the Commission's regulations set forth in 10 CFR Chapter I;
 - D. The issuance of this license amendment will not be inimical to the common defense and security or to the health and safety of the public;
 - E. The issuance of this license amendment is in accordance with 10 CFR Part 51 of the Commission's regulations and all applicable requirements have been satisfied.
2. Accordingly, Facility Operating License No. NPF-29 is changed as follows:

Change paragraph 2.C.(26) to read:

(26) Turbine Disc Integrity (Section 10.2.1, SER, SSER #1)

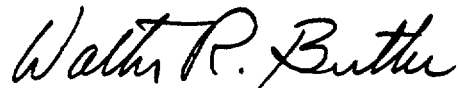
MP&L shall ultrasonically inspect the bores and keyways of the low pressure turbine discs for indications of cracking prior to exceeding

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50,000 hours of operation. All unacceptable indications and their dispositions shall be reported prior to startup for the next cycle of operation. These inspections shall continue on a 50,000 hour interval until the potential for turbine disc cracking has been assessed and an acceptable alternate inspection schedule has been established.

3. This license amendment is effective as of its date of issuance.

FOR THE NUCLEAR REGULATORY COMMISSION



Walter R. Butler, Director
BWR Project Directorate No. 4
Division of BWR Licensing

Date of Issuance: April 29, 1986



UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION
RELATED TO AMENDMENT NO. 12 TO FACILITY OPERATING LICENSE NPF-29

GRAND GULF NUCLEAR STATION, UNIT 1

MISSISSIPPI POWER & LIGHT COMPANY

MIDDLE SOUTH ENERGY, INC.

SOUTH MISSISSIPPI ELECTRIC POWER ASSOCIATION

1.0 INTRODUCTION

By letter dated November 1, 1985, as supplemented by letters dated December 10 and 27, 1985, and January 24 and February 26, 1986, Mississippi Power & Light Company (the licensee) requested a change to License Condition 2.C.(26) "Turbine Disc Integrity" to make the inspection interval for the low pressure turbine discs 50,000 hours of operation instead of one fuel cycle.

The Grand Gulf Nuclear Station (GGNS) Unit 1 main steam turbines consist of one high pressure turbine and 3 low pressure (LP) turbines. The turbines are manufactured by Kraftwerk Union (KWU) of Germany. Because of the massive size of the LP rotors, the rotors were not made from a single forging. Instead, individually forged discs were shrunk fit to a rotor and keyed in place to prevent discs moving independently of the rotor if the shrink fits were lost due to stress relaxation during operation. Because of the unique design of the LP turbines compared to older turbines, the licensee believes that turbine inspection at each refueling outage is overly conservative and would impose a handship by extending the refueling outage time beyond that otherwise required for refueling, surveillance tests, and maintenance.

License Condition 2.C.(26) states:

"During each refueling outage MP&L shall ultrasonically inspect the bores and keyways of the low pressure turbine discs for indications of cracking. All unacceptable indications and their dispositions shall be reported prior to startup for the next cycle operation. These inspections shall continue until the potential for turbine disc cracking has been assessed and an acceptable alternate inspection schedule has been established."

The license condition resulted from the NRC staff's review of the GGNS Final Safety Analysis Report (FSAR) Section 10.2.3 "Turbine Disc Integrity" and the generic concern with intergranular stress corrosion cracking (IGSCC) in keyway and bore areas in LP turbine discs. (Supplement No. 1 to the GGNS Safety Evaluation Report (SER), Section 10.2.1, December 1981). At the time of the 1981 review, the staff did not have sufficient information from the licensee on turbine disc material properties, operating temperatures in the bore area, steam moisture level, methodology of crack calculation, and operating temperature and lubricants used during assembly to justify a longer inspection interval. The staff was also concerned about several reported cases of cracking in KWU LP discs in

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fossil fuel plants. The staff took a conservative, interim position by assuming the propensity for disc cracking is the same as that of Westinghouse turbines. Hence, the staff required the ultrasonic inspection during the first and every refueling outage.

In the present submittals, the licensee has provided additional information to support its request for a longer inspection interval. The licensee proposes to inspect the high pressure turbine during the first refueling outage, one LP turbine during the second outage, the second LP turbine during the third outage, and the third LP turbine during the fourth outage. At the fifth refueling outage, the inspection cycle repeats itself. This schedule would provide a 50,000 hour inspection interval for each of the turbines, which is four to five times longer than the inspection interval required by the license condition.

2.0 EVALUATION

The staff evaluated the licensee's submittals based on four considerations: the methodology used for turbine disc analysis and its similarity to the Westinghouse methodology taking into account the unique features of the turbine disc design; the fracture toughness of disc materials; consequences of turbine disc failure in the event of disc failure; and, the licensee's commitment to shorten turbine disc inspection intervals if necessary based on inspection results.

2.1 Methodology for turbine disc failure analysis

In 1979, Westinghouse observed radial cracks in the bores and keyways of certain LP discs of a nuclear turbine. Since then, Westinghouse has published numerous studies on the methodology of estimating the probability of turbine disc rupture, calculating disc crack growth, and developing criteria for inspection intervals.* The staff has reviewed Westinghouse's studies and approved their methodology. As a part of the present review the staff determined whether the licensee used the same methodology as that of the Westinghouse turbine disc failure analysis. Four aspects of the turbine disc failure analysis are considered significant: critical crack size; crack growth rate; probability of disc crack initiation; and probability of disc failure, given the crack initiation. The licensee's proposed disc inspection interval was obtained from evaluating these four aspects of the disc crack analysis. The staff found that the licensee followed the Westinghouse methodology in calculating critical crack size, crack growth rate, and probability of disc failure. However, insufficient information was provided in the submittals for staff to confirm three areas of the licensee's methodology regarding calculations of the probability of disc crack initiation.

- (1) The staff questions the factor of 15 that the licensee used in calculating crack initiation probability. This factor was derived from a KWU test which showed that for tests with oxygen cracks were not initiated for operating times up to 30,000 hours. Tests showed that under adverse environmental

*W.G. Clark, B.B. Seth, D.H. Shafter, "Procedures for Estimating the Probability of Steam Turbine Disc Rupture from Stress Corrosion Cracking", 81-JPGC-Pwr-31, American Society of Mechanical Engineers

conditions, such as flow stagnation and crevices, it took about 2,000 hours to initiate cracks. The licensee divided 30,000 hours by 2,000 hours to obtain the factor of 15. The licensee stated that their keyway design precludes the effects of adverse environmental conditions because of unique design features of the KWU turbine. The KWU LP turbine disc design is somewhat different than Westinghouse designs in that the keyway area is not included in the shrink-fit area of the disc-rotor interface. This condition will lower the shrink-fit stresses in the keyway area. Another unique feature in the KWU LP turbine is the radial relief grooves which were premachined into the disc hub area and the rotor, which eliminates the high stress concentrations at the bottom ends of these keyway bores. This groove is designed to prevent flow stagnation. The different design of the KWU turbines may reduce the probability of disc crack initiation compared to Westinghouse designs but insufficient information was provided for the staff to confirm the factor of 15 used by the licensee. However, the staff believes the omission of this factor would not significantly affect the calculated inspection interval of 50,000 hours.

(2) In KWU's inspection of four LP turbines in the German nuclear plants, no cracks were found after 83,000 service hours. From these inspection results, the licensee states that they do not expect intergranular stress corrosion cracking (IGSCC) in their disc design because the disc materials, assembly, and water chemistry in the German power plants are the same as those at GGNS. The licensee did not supply sufficient supporting information to the staff to ascertain if the disc materials and water chemistry of German nuclear plants are similar to those of GGNS.

(3) The licensee stated that an inspection of any one turbine at any given number of operating hours will be representative of all three turbines with respect to the initiation and growth of IGSCC. Although the discs in each turbine are fabricated using the same material, manufacturing method, and method of assembly, the possible variations in material properties and operating conditions could cause the disc in one turbine to be more susceptible to IGSCC than the discs in the other turbines.

2.2 Disc materials

Criteria for evaluation of turbine disc integrity are contained in Standard Review Plan (SRP) 10.2.3, "Turbine Disc Integrity." During the licensing review in 1981, the staff raised questions about the materials properties of the discs. Specifically, the staff requested information from the licensee on disc material specifications and strength levels, operating temperatures in the bore area of the discs, lubricant used in the hub area of the discs for assembly, moisture level at the discs, and critical crack size calculation. The licensee's response to the staff questions was documented in Appendix 10A of FSAR and in the November 1, 1985 submittal. The staff considers the licensee's response acceptable.

2.3 Consequences of turbine disc failure

Although the licensee stated that the KWU disc design will not crack for operating times up to 50,000 hours, the staff nevertheless reviewed the consequence of turbine missile generation at GGNS. The probability of unacceptable damage resulting from turbine missiles may be expressed as the product of: the probability of turbine failure resulting in the ejection of turbine disc (or internal structure) fragments through the turbine casing; the probability of ejected missiles perforating intervening barriers and striking safety-related structures, systems, or components; and, the probability of struck structures, systems, or components failing to perform their safety function. The GGNS turbines have a massive and strong casing which should be able to contain turbine missiles caused by disc failures. In a previous disc failure of a Westinghouse turbine, turbine disc fragments were contained inside of the turbine casing. The GGNS Unit 1 turbine generator has an unfavorable orientation relative to the reactor building. The orientation places the containment building, auxiliary buildings, diesel generator building, standby service water cooling tower and basin, and control building, within the low and high trajectory missile strike zones of the turbine-generator train. During the operating license review, the licensee performed an analysis which indicated that the missile shield around the turbine would stop the postulated worst-case low trajectory missile and the probability of significant damage by the postulated worst-case high trajectory missile is within acceptable limits as defined in the Standard Review Plan, Section 2.2.3 (NUREG-0800). The staff had reviewed the consequence of turbine missiles and concluded that the total turbine missile risk from low and high trajectory missiles is acceptably low for GGNS Unit 1 so that the plant structures, systems, and components important to public safety are adequately protected against potential turbine missile damage (GGNS Safety Evaluation Report, Section 3.5.3, September 1981). The staff reviewed its previous evaluation of the consequence of turbine missiles using the information from this submittal and in the FSAR and re-affirms its previous finding.

2.4 Use of disc inspection results

Results from previous inspections of turbines show that cracks may occur randomly among discs. The staff believes that the licensee should not plan their inspection intervals solely from analyses but also should consider operating data and engineering judgment. The licensee has stated that future inspection schedules may be altered depending on results from prior inspections, input from KWU, or unexpected problems with continued operation of any of the GGNS steam conversion units. If the detection of cracks in one turbine unit is determined to affect the unit's operability, the licensee has committed to inspect the remaining two units for similar conditions during the same outage (December 27, 1985 submittal). The staff accepts this commitment as an indication of the licensee's intent to consider operating data in their inspection program.

2.5 Summary

Despite the staff's reservations on the methodology and input data used in calculating the probability of disc failure as noted in Section 2.1 above, the staff considers the 50,000 hour inspection interval and the associated inspection program for three low pressure turbines to be acceptable because: (1) the overall probability of turbine missile damage to safety related structures systems and components is small and the consequence of turbine failure affecting public safety is acceptably low, and (2) the licensee has committed to (a) alter the future inspection schedules depending on results from prior (GGNS) inspections, inputs from KWU, or unexpected problems arising from turbine operation, and, (b) inspect the remaining two LP turbines before restarting the unit if cracks are detected in one LP turbine.

Accordingly, the staff concludes that the licensee's requested change in License Condition 2.C.(26) is acceptable. The staff notes that the proposed license condition retains the requirement to report to the NRC any unacceptable indications of cracking identified in low pressure turbine disc inspections.

3.0 ENVIRONMENTAL CONSIDERATION

The amendment involves a change of requirements of facility components located within the restricted area as defined in 10 CFR 20 and a change in surveillance requirements. The Commission made a proposed determination that the amendment involves no significant hazards consideration, and there have been no comments on that proposal. Based on its evaluation, the staff concludes that there is no significant change in types or significant increase in the amounts of any effluents that may be released offsite. There is no significant increase in individual or cumulative occupational radiation exposure because the changes do not affect personnel exposure. Accordingly, the amendment meets the eligibility criteria for categorical exclusion set forth in 10 CFR Section 51.22(c)(9). Pursuant to 10 CFR 51.22(b), no environmental impact statement or environmental assessment need be prepared in connection with the issuance of the amendment.

4.0 CONCLUSION

The Commission made a proposed determination that the amendment involves no significant hazards consideration which was published in the Federal Register (51 FR 6826) on February 26, 1986, and consulted with the state of Mississippi. No public comments were received, and the state of Mississippi did not have any comments.

We have concluded, based on the considerations discussed above, that: (1) there is reasonable assurance that the health and safety of the public will not be endangered by operation in the proposed manner, and (2) such activities will be conducted in compliance with the Commission's regulations, and issuance of this amendment will not be inimical to the common defense and security or to the health and safety of the public.

Principal Contributors: J. Tsao, Engineering Branch, DBL
L. Kintner, BWR Project Directorate No. 4, DBL

Dated: April 29, 1986