ENTERGY

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Grand Gulf Nuclear Station

October 12, 1994

U.S. Nuclear Regulatory Commission
Mail Station P1-37
Washington, D.C. 20555

Attention: Document Control Desk

Subject: Grand Gulf Nuclear Station
Docket No. 50-416
License No. NPF-29
Proposed Amendment to the Operating License Concerning
Closure and Deletion of License Condition 2.C.(26),
Turbine Disc Integrity (PCOL-94/01)

GNRO-94/00114

Gentlemen:

By this letter, Entergy Operations, Inc. requests a change to the Grand Gulf Nuclear Station (GGNS) Operating License. The change would close and delete the existing License Condition 2.C.(26) for Turbine Disc Integrity.

The license condition requires that the bores and key ways of the low pressure (LP) turbine discs be inspected for indications of cracking. The inspections are to continue on a 50,000 hours-of-operation interval until the potential for turbine disc cracking has been assessed and an acceptable alternate inspection schedule has been established. GGNS has performed this assessment and proposes an alternate inspection schedule.

We request the review of this submittal be completed by 2/95 and that it be considered a cost beneficial licensing action (CBLA). We are instituting a program to replace all turbine rotors with improved rotors to increase unit power output by increased turbine efficiency. Plans are to replace the high pressure turbine during Refueling Outage (RFO) 7 and the currently installed LP turbine rotors and discs starting in RFO8 and continuing through RFO10. If this request is approved, we plan to use the current failure probability methodology to increase the inspection interval of the turbines being replaced, as well as the improved turbines. The current license condition would require an LP-1 turbine disc inspection during RFO7 (scheduled for 4/95) because, by RFO8, the LP-1 turbine will have operated for more than 50,000 hours since its last ultrasonic (UT) disc inspection. This is the reason for the requested review completion time. Concerning CBLA, the savings which result from reduced inspections and maintenance are estimated at over $20,000,000 (in 1994 dollars) over the life of the plant with an immediate savings during RF07 of approximately $2,000,000.

1S0047

G9408301

AP01 Change NRC POR 4 Encl 1 w/att attch. 3

1/1

In accordance with the provisions of 10 CFR 50.4, the signed original of the requested amendment is enclosed. Attachment 1 is the affirmation for this proposed change as required by 10 CFR 50.30. Attachment 2 provides the background, technical justification, and the No Significant Hazards Consideration to support the requested amendment. Attachment 3 is supporting information that Siemens Power Corporation considers proprietary. In accordance with the requirements in 10CFR2.790(b), an affidavit is enclosed to support the withholding of this information from public disclosure. Attachment 4 is a copy of the affected Operating License page, marked up to show the requested change. This proposed amendment does not affect the improved technical specifications submitted on October 15, 1993 or any other pending request.

This proposed amendment has been reviewed and accepted by the Plant Safety Review Committee and the Safety Review Committee.

On the basis of the guidelines presented in 10CFR50.92, Entergy Operations, Inc. has concluded that this proposed amendment involves no significant hazards considerations.

If you have any questions concerning this proposed change, please contact Sheri Mahoney at (601) 437-6552.

Yours truly,

CRH/SBM/mtc
attachments:
1. Affirmation per 10CFR50.30
2. GGNS PCOL-94/01
3. Supporting Information for PCOL-94/01 (Proprietary)
4. Mark-up of Affected Operating License Page

cc: Mr. Jeff Tedrow (w/a)
Mr. H. W. Keiser (w/a)
Mr. R. B. McGehee (w/a)
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BEFORE THE

UNITED STATES NUCLEAR REGULATORY COMMISSION

LICENSE NO. NPF-29

DOCKET NO. 50-416

IN THE MATTER OF

MISSISSIPPI POWER & LIGHT COMPANY
and
SYSTEM ENERGY RESOURCES, INC.
and
SOUTH MISSISSIPPI ELECTRIC POWER ASSOCIATION
and
ENTERGY OPERATIONS, INC.

AFFIRMATION

I, C. R. Hutchinson, being duly sworn, state that I am Vice President, Operations GGNS of Entergy Operations, Inc.; that on behalf of Entergy Operations, Inc., System Energy Resources, Inc., and South Mississippi Electric Power Association I am authorized by Entergy Operations, Inc. to sign and file with the Nuclear Regulatory Commission, this application for amendment of the Operating License of the Grand Gulf Nuclear Station; that I signed this application as Vice President, Operations GGNS of Entergy Operations, Inc.; and that the statements made and the matters set forth therein are true and correct to the best of my knowledge, information and belief.

C. R. Hutchinson

STATE OF MISSISSIPPI
COUNTY OF CLAIBORNE

SUBSCRIBED AND SWORN TO before me, a Notary Public, in and for the County and State above named, this 12th day of October, 1994.

(SEAL)

Richard R. Moore III
Notary Public

My commission expires:
MISSISSIPPI STATEWIDE NOTARY PUBLIC
MY COMMISSION EXPIRES JUNE 5, 1998
BONDED THRU STEGALL NOTARY SERVICE

G9408301

PROPOSED CHANGE TO THE OPERATING LICENSE

CLOSURE AND DELETION OF LICENSE CONDITION 2.C.(26)

TURBINE DISC INTEGRITY

PCOL-94/01

A. SUBJECT

1. PCOL-94/01: Closure and Deletion of Operating License Condition 2.C.(26), Turbine Disc Integrity

2. Affected Operating License Page: 10

B. BACKGROUND

The Grand Gulf Nuclear Station (GGNS) turbines were supplied by Allis-Chalmers Power Systems (A-CPSI) and manufactured by A-CPSI and Kraftwerk Union (KWU)/Siemens Power Corporation (SPC). The turbine system consists of one high pressure (HP) turbine and three low pressure (LP) turbines in series.

During the review of the GGNS operating license application, the NRC identified concerns in regard to turbine disc integrity and requested additional information on the turbines in a letter dated November 17, 1981. The NRC stated that past experience with similar equipment in the United Kingdom and with Westinghouse turbines in the United States had revealed a propensity for stress corrosion cracking in discs that was not predictable. The NRC required additional information concerning operating temperatures, lubricants used during assembly and other information about the discs to complete their review.

The NRC's Supplemental Safety Evaluation Report (SSER) Number 1, Section 10.2.1, dated December 1981, addressed turbine disc integrity again. The NRC stated that, because GGNS could require substantially more time to gather the information necessary to justify long term operations, an interim conservative approach was taken by assuming that the propensity for disc cracking was the same as that of Westinghouse turbines. The NRC expected to impose a license condition that would require the inspection of the bores and key ways of all the LP turbine discs for ultrasonic (UT) indications of cracking during each refueling outage. Further, the inspection schedule could be adjusted after licensing if the responses to the NRC's requests were favorable.

GGNS provided the information requested in the November 17 NRC letter in GGNS letters dated January 7, 1982 and March 23, 1982.

On 6/16/82, the GGNS low power operating license was issued with License Condition 2.C.(34) which required the inspection of each of the LP turbine discs during each refueling outage. On 11/1/84, GGNS's full power operating license was issued with the same license condition, renumbered as License Condition 2.C.(26).

Before the end of the first cycle of operation, by a letter dated November 1, 1985, GGNS submitted a proposed amendment to the Operating License that would allow the inspection of each of the LP turbine discs on an inspection interval not to exceed 50,000 hours of operation. In a letter dated November 22, 1985, the NRC requested additional information concerning the proposed inspection interval, corrective actions if cracks were detected, and various calculation parameters. In a letter dated December 27, 1985, GGNS provided the requested information.

A meeting between GGNS and the NRC was held on January 9, 1986 to discuss various issues. As a result of the meeting, GGNS provided additional information by letters dated January 24 and February 26, 1986.

The NRC issued Amendment No. 12 on April 29, 1986 to modify License Condition 2.C.(26) to state:

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

The NRC approved the extension of the inspection interval based on four considerations:

1. The fracture toughness of disc materials was acceptable. Appendix 10A of the FSAR and a letter dated November 1,1985 contained information on the material properties of the discs' material specifications that the NRC found acceptable.

2. The consequences of turbine missiles in the event of disc failure were acceptably low. The NRC concluded that the total turbine missile risk from low and high trajectory missiles is acceptably low for GGNS so

that plant structures, systems, and components important to public safety are adequately protected against potential turbine missile damage.

3. The NRC accepted GGNS's commitment to shorten turbine disc inspection intervals if necessary based on inspection results as an indication of GGNS's intent to consider operating data in the inspection program.

4. The methodology used for turbine disc failure analysis and its similarity to the Westinghouse methodology, taking into account the unique features of the turbine disc design, was acceptable. The NRC found that GGNS followed the Westinghouse methodology in calculating critical crack size, crack growth rate, and probability of disc failure. However, insufficient information was provided to confirm three areas of the methodology regarding calculations of the probability of disc crack initiation. These were:

   a. The Factor of 15: The factor of 15 used in calculating crack initiation probability derived from a test that showed that, for tests with oxygen, cracks were not initiated for operating times up to 30,000 hours. Tests showed that under adverse environmental conditions, such as flow stagnation and crevices, it took about 2,000 hours to initiate cracks. The 30,000-hour variable was divided by 2,000 hours to obtain a factor of 15. GGNS stated that the different design of the KWU turbines might reduce the probability of disc crack initiation compared to Westinghouse designs. Insufficient information was provided to confirm the factor of 15, but the NRC believed that the omission of this factor would not significantly affect the inspection interval of 50,000 hours.

   b. Disc Materials and Water Chemistry: Because of the similarity of disc materials and water chemistry, GGNS did not expect intergranular stress corrosion cracking (IGSCC) to occur in this disc design. Sufficient information supporting the statement that the disc materials and water chemistry of GGNS and the German nuclear plants are similar was not provided. Therefore, an evaluation could not be made.

c. Susceptibility to IGSCC: Although the discs in each turbine were fabricated using the same material, manufacturing method, and method of assembly, the NRC believed that 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. Sufficient information supporting the statement that an inspection of any one turbine at any given number of operating hours is representative of all three turbines with respect to the initiation and growth of IGSCC was not provided.

Note: These three areas are discussed in greater detail in the following section.

Due to the approval of the license condition change, GGNS adopted a sectionalized maintenance schedule in which one turbine was inspected at approximately each outage. During Refueling Outage (RFO) 1, the HP turbine was inspected. The LP-3 turbine was inspected during RFO2 and the LP-1 turbine during RFO3. At the request of the NRC, GGNS provided information on the inspections of the LP-3 turbine and the LP-1 turbine. The NRC concluded the inspections were acceptable.

Since that time, two more LP turbine inspections have been performed. The LP-2 turbine was inspected during RFO4 and no reportable indications of cracking were found in the discs. The LP-3 turbine was inspected for the second time during RFO6 (fall of 1993). No unacceptable indications in the discs or key ways were found. However, several recordable indications were identified on the inlet side of Disc 4 generator end. None of the indications were located in the key way area or shrink-fit area of the disc bore. The detected indications were analyzed per the established methodology. The technical evaluation of these recordable indications determined that safety and operability were not adversely affected nor was the operation of the unit restricted. Although this information was not required to be provided to the NRC, GGNS submitted information on the recordable indications in a letter dated November 23, 1993 for consistency with past recording practices.

Several years ago, SPC and KWU began manufacturing turbines that improved thermal performance, while maintaining and enhancing the already high degree of reliability and availability of their turbines. Replacement of existing turbines with improved turbines results in a gain in power plant

output. Due to the potential for higher turbine efficiency, GGNS has been studying the possibility of upgrading the existing turbines. Although the turbine currently installed is highly reliable and efficient, GGNS has recently decided to move forward with the turbine upgrade project. The turbines (1 HP and 3 LP) will be upgraded in RFO7 through RFO10, at the rate of one turbine per outage.

The current schedule for installation of the upgraded turbine, combined with the current inspection schedule is:

Outage #	Replacement	Required Inspection
RFO7	HP	LP-1
RFO8	LP-1	LP-2
RFO9	LP-2	None
RFO10	LP-3	LP-3

The decision to upgrade the turbines prompted an evaluation of the current license condition, inspection intervals, and the methodology for calculating failure probability. Four main issues arose during this evaluation:

- NRC concerns during the issuance of Amendment No. 12
- Alternate inspection schedule and its effect on the currently installed rotors
- Future inspection intervals for the upgraded rotors
- Closure and deletion of the current license condition

The following justification addresses these issues. Based on this evaluation, GGNS requests that the license condition be closed and deleted and that future inspection intervals be determined for individual turbines, using the currently approved methodology.

C. JUSTIFICATION

Current License Condition 2.C.(26) requires inspection of the turbine discs

to be performed at intervals no greater than 50,000 operating hours. The license condition also states that the inspections will continue at that interval until the potential for turbine disc cracking has been assessed and an acceptable alternate inspection schedule has been established. GGNS has performed these requirements and this information is contained in the following sections.

GGNS proposes to replace the rigid inspection requirement of 50,000 hours with a more flexible requirement to determine the allowed inspection interval appropriate for each rotor. This results in variable inspection intervals for the three LP rotors. The original probabilistic methodology and original acceptable levels of disc failure will be maintained. Actual rotor disc test data and actual operating hours will be used to establish the appropriate operating hours between disc inspections. This will ensure that the interval is correct for each rotor by considering the hours of service since the last UT disc inspection of each rotor and the actual condition of the rotors themselves. GGNS believes that this approach is still conservative since the original probability of disc rupture and the acceptable level of failure remain the same.

SPC/KWU has developed this new approach using the current methodology and recommends its use to determine inspection intervals for the LP rotors.

Disc failure probability is expected to be significantly less than calculated because of favorable operational experience from the four inspections of the currently installed turbines and results of inspections of this type of turbine worldwide. These additional details that reduce failure probability are not included in analysis yet make the comfort level for lengthened inspections very high. Since the operating license was issued:

- Four inspections of the LP turbine discs at GGNS (the LP-3 twice and the LP-2 and the LP-1, once each) have been performed without significant findings.

- Favorable operating experience and inspection data at GGNS on the existing turbines are now available.

- A favorable inspection on a sister unit at Comanche Peak found no reportable indications.

- A favorable inspection on a sister unit at Connecticut Yankee found no reportable indications.

- Significantly more favorable information is now available on the KWU turbines from a worldwide perspective.

- The original methodology is being retained.

Inspections of Siemens Turbines Worldwide

In a technical report for presentation at the American Power Conference in April, 1991 entitled "Advanced LP Turbine Installation at 1300 MW Power Station Unterweser", Siemens discussed the reliability of the Siemens/Kraftwerk Union (KWU) turbine designs. In 1982, when EPRI reported about stress corrosion cracking in nuclear LP turbines, a program was initiated by Siemens/KWU to ultrasonically inspect all their disc-type rotors (as opposed to the mono-block rotors) in nuclear power plants. In 1987, indications on one rotor disc in the Unterweser (Germany) plant were found. This single event was the only one found out of 310 discs inspected in nuclear power plants.

After an additional cycle of operation, the Unterweser LP rotor was removed from service during a scheduled outage. The rotor was de-stacked and disc 1 was replaced. The rotor was re-stacked with one new disc and was returned to Unterweser for spare rotor service.

Many more rotor discs have been UT inspected since that time. There have been two other findings. Each case was carefully evaluated. Evaluation found the indications were not operation limiting and neither indication is thought to be IGSCC due to the location. All findings were on the inside diameter in lower stress areas and not in the key way area.

One of the two other findings was at GGNS during RFO6 and was discussed in Section B., Background. Attachment 3 gives further information on the other finding and is designated as proprietary.

There have been no other indications found to date in any rotors manufactured by Siemens/KWU/SPC.

NRC Concerns During the Issuance of Amendment No. 12

The NRC issued Amendment No. 12 on April 29,1986 to modify License Condition 2.C.(26) to allow an inspection interval of 50,000 hours for the LP turbine discs. The NRC found all aspects of the turbine inspection acceptable except for three areas of the methodology regarding calculations of the probability of disc crack initiation. These three areas are discussed below and additional information is provided.

1. The Factor of 15: The factor of 15 used in calculating crack initiation probability derived from a test that showed that, for tests with oxygen, cracks were not initiated for operating times up to 30,000 hours. Tests showed that under adverse environmental conditions, such as flow stagnation and crevices, it took about 2,000 hours to initiate cracks. The 30,000-hour variable was divided by 2,000 hours to obtain a factor of 15. GGNS stated that the different design of the KWU turbines might reduce the probability of disc crack initiation compared to Westinghouse designs. Insufficient information was provided to confirm the factor of 15, but the NRC believed that the omission of this factor would not significantly affect the inspection interval of 50,000 hours.

   The test data which the factor of 15 was derived from is discussed on page 4 of Engineering Report ER-8503, "Probability of Disk Cracking due to Stress Corrosion, " which was provided to the NRC by MP&L via AECM-85/0333, dated November 1, 1985. The report was submitted as Attachment IV to that letter. Except for additional confirming tests, there is no good way to further prove the factor of 15. GGNS believes that the use of test data is the most appropriate method for defining time to crack initiation. However, once a rotor has been in service, the time to crack initiation is no longer a factor since crack initiation is only valid for the first operating cycle of any rotor. After the first operating cycle, the methodology conservatively assumes a 0.1 inch undetectable crack in the discs. Since the currently installed rotors have been in service for more than one cycle and have seen more than 30,000 hours of service, a 0.1 inch undetectable crack is assumed for each and the time to crack initiation no longer applies.

   Given the planned schedule for installation of the upgraded rotors, this factor would only be valid for the first operating cycle of each

upgraded rotor; i.e., Cycle 9 for the upgraded LP-1, Cycle 10 for the upgraded LP-2 and Cycle 11 for the upgraded LP-3. The currently installed rotors and each upgraded rotor after its initial operating cycle would assume a 0.1 inch undetectable crack.

GGNS does not consider the factor of 15 limiting because it is used only one time for each upgraded rotor. GGNS considers the test data previously submitted as the best available information and justification. GGNS proposes to use the same one-time factor of 15 approved for the original rotors for the first cycle of each of the upgraded rotors. The factor would not be applicable for the currently installed rotors or for the upgraded rotors following the first operating cycle of each rotor.

2. Disc Materials and Water Chemistry: Because of the similarity of disc materials and water chemistry to those in German plants, GGNS did not expect intergranular stress corrosion cracking (IGSCC) to occur in their disc design. Sufficient information supporting the statement that the disc materials and water chemistry of GGNS and the German nuclear plants are similar was not provided.

Disc Materials

Attachment 3 gives information on the A-CPSI/Siemens/KWU/SPC disc materials and is designated as proprietary.

The disc materials of turbines in Germany and the disc materials of the GGNS turbines are similar.

Water Chemistry

SPC Recommended Limits

The majority of German plants with this type of turbine adhere to the water chemistry limits specified by SPC. These are:

Specified Values	Units	Continuous Operation	Startup Operation*
Continuous Monitoring of Conductivity at 25°C:			
Direct Conductivity	µmho/cm	<0.15	<0.50
Cation Conductivity	µmho/cm	<0.10	<0.50
Silica (SiO_2)	ppb	<10	<50
Total Iron (Fe)	ppb	< 5	<50
Total Copper (Cu)	ppb	< 1	<10
Sodium (Na)	ppb	< 5	<20

*Specified values have to show a decreasing trend and values for continuous operation have to be reached in 2 to 3 days during commissioning and in 2 to 3 hours after startup.

GGNS Reactor Water Chemistry Measurements

Due to the large amount of available data since initial operation, the time frame was limited to 1/9/92 to 8/23/94, which represents 5 recent startup and operational periods. The results are representative of normal reactor water chemistry at GGNS. The continuous operation result given below is an average of those measurements taken at reactor power greater than 80% and the startup operation result is an average of those taken with reactor power at 0 to 80%. 80% was selected to include the majority of the startup transient analytical results while excluding most of the analytical results from routine power operation. GGNS does not calculate cation conductivity on a routine frequency; therefore, no representative values are available for this parameter. Time-weighted averages of various GGNS reactor water measurements are given below.

Reactor water	Units	Continuous Operation	Startup
Conductivity	µmho/cm	0.147	0.196
Silica	ppb	102	43
Total Iron	ppb	7.2	21.4
Total Copper	ppb	0.5	1.0
Sodium	ppb	0.6	4.2

The average measurements for these parameters are in line with or much better than those that SPC recommends with the exception of total iron and silica for continuous operation. Concerning total iron, an average value of 7.2 ppb is greater than the recommended value of < 5 ppb. However, the direct conductivity for the time period as indicated above has been maintained within the SPC recommendation of < 0.15 μmho/cm; therefore, the higher iron level is considered acceptable. The GGNS average value of 102 ppb for silica exceeds the SPC recommended value of < 10 ppb. Silica is not a critical parameter for disc integrity. A silica limit is specified since this parameter affects the surface finish of the blading. Additionally, past inspections have not indicated a problem with reactor water iron and silica measurements at these levels. Based on the above tables, GGNS believes that the water chemistry at GGNS is similar to that of a typical German plant.

3. Susceptibility to IGSCC: Although the discs in each turbine are fabricated using the same material, manufacturing method, and method of assembly, the NRC believed 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. Sufficient information supporting the statement that an inspection of any one turbine at any given number of operating hours is representative of all three turbines with respect to the initiation and growth of IGSCC was not provided.

During review of the license condition change in 1985, GGNS stated that the inspection of one turbine is representative of all three turbines. GGNS stated in a letter dated December 27, 1985 that the disc failure probability of the LP-3 was calculated to be slightly higher than the probability for the other two. The LP-3 due to its outlet conditions operated at a slightly higher moisture content as compared to the other two.

UFSAR Section 10.2.3.8 refers to ER-8503. On pages 7 and 8 of this report, formulas required to calculate probability of disc rupture were defined. During rotor manufacture, the material properties of each disc were determined. The material properties were different for each LP disc as defined in Figures 1E85.090 (LP-1), 1E85.091 (LP-2), and 1E85.092 (LP-3). The values for the variables representing the

material properties were then used in the formulas for each disc. A probability of disc cracking was calculated for each rotor. The sum of the probabilities for each rotor was the total probability of disc rupture for the entire rotor. The disc materials, calculations and probability of disc cracking were summarized in the aforementioned figures included in ER-8503. The probabilities are summarized below.

LP-1 Rotor (Figure 1E85.090)	Probability P(t) = 2.28×10^{-5}
LP-2 Rotor (Figure 1E85.091)	Probability P(t) = 2.75×10^{-5}
LP-3 Rotor (Figure 1E85.092)	Probability P(t) = 5.21×10^{-5}

Sum of LP Rotors 1, 2, 3 Probability P(t) = 1.02×10^{-4}

From the above probabilities, it can be seen that LP-3 contributes half of the total probability. LP-1 and LP-2 each contribute only one-forth of the total probability due to better material properties for these rotors. In other words, based on this data, LP-3 would require shorter inspection periods than either LP-1 or LP-2 and the inspection intervals for LP-1 and LP-2 should be longer than the interval for LP-3.

Originally, before 1985, all rotors were to be inspected together. Given this condition, only the total probability of failure was valid for determining an inspection interval. Also, the current industry philosophy at that time considered only total probability when determining inspection intervals even if the rotors were to be inspected at different outages. Therefore, when GGNS proposed the license condition change in 1985, this philosophy was applied. The total probability of 1.02×10^{-4} was used to create Figure 1E85.093 attached to ER-8503 which graphically depicted the total probability for disc rupture.

This philosophy, along with a few other considerations, led to the set 50,000 operating hour inspection interval that GGNS requested. The NRC was concerned that an inspection of one LP turbine did not represent the condition of all three LP turbines but approved the requested change. This allowed GGNS to adopt a sectionalized maintenance schedule in which one rotor was inspected each outage, roughly.

Once GGNS decided to move forward with the turbine upgrade, it was appropriate to consider the actions required to close the license

condition. Since it was necessary to establish an alternate inspection schedule to accomplish this, the current philosophy for determining inspection intervals was reviewed.

During this review, GGNS confirmed the NRC's suspicions. A shift in industry philosophy has occurred due to the understanding that different rotors have different probabilities of failure and should have different inspection intervals. Therefore, GGNS agrees with the NRC and proposes to evaluate each rotor, original or upgraded, based on crack growth rate for the tested material properties. Following is an illustration of the proposed approach to be used when applying the "revised" philosophy to the current methodology.

Alternate Inspection Schedule and Its Effect on the Currently Installed Rotors

To close the current license condition, an alternate inspection schedule must be established. The "revised" philosophy discussed above makes it necessary to now define the best way to evaluate missile probability when doing sectionalized maintenance on rotors with different crack growth rates, leading then to an acceptable inspection interval. This is applicable for the currently installed and the upgraded rotors.

Based on License Condition 2.C.(26), the LP-1 rotor should be inspected during the next outage (RFO7) and then replaced during the following outage (RFO8). The LP-2 rotor should be inspected during RFO8 and then replaced during RFO9. With the LP-3, the inspection and replacement are due at the same outage (RFO10). This schedule is based on actual and estimated operating hours given in attached Figure 1.

To determine the effect of the "revised" philosophy on the inspection interval of the currently installed rotors, it is necessary to begin with a review of the initial probability calculations and determine which parts are still applicable to the currently installed rotors. Figure 1E85.093 of ER-8503 represents the initial disc rupture probability. The "No Initial Crack" curve shown on Figure 1E85.093 is no longer valid for the currently installed rotors. This curve applies only to the first operating cycle for any rotor because it is assumed that no cracks have initiated on the new rotors. Because all three currently installed rotors have been through at least one operating cycle, this curve no longer applies. After the first operating cycle,

the methodology conservatively assumes that a crack of 0.1 inch in length has initiated during the last cycle. Therefore, the "Minimum Detectable Indication of 0.1 in." curve is still valid for the currently installed rotors. Using the "revised" philosophy, the evaluation of one rotor alone is not adequate for determining an inspection interval for that rotor. The sum of all three rotors defines the total failure probability. Total failure probability must be less than the NRC acceptable failure probability which varies depending on service hours between inspections and the orientation of the turbine. Therefore, the total failure probability for the rotors is also valid.

On Figure 1E85.093, two curves are given for the NRC acceptable failure probability, one for favorable orientation and the other for unfavorable orientation. For GGNS, the unfavorable turbine orientation curve is valid since the turbine is parallel to the containment, making the possibility of a turbine missile in the direction of containment more likely.

It is also necessary to determine failure probability curves for each currently installed rotor. Using the original probabilities for disc cracking for each rotor from ER-8503 (and shown below for convenience), curves for each LP rotor were created, assuming that each rotor had a minimum detectable indication of 0.1 inch. The sum of the three new curves equals the original curve. These three new curves were then graphed on the original Figure 1E85.093 curve. This new graph is attached Figure 2.

The original probabilities for each LP rotor given on Figures 1E85.090, 1E85.091 and 1E85.092:

LP-1 Rotor (Figure 1E85.090)	Probability $P(t) = 2.28 \times 10^{-5}$
LP-2 Rotor (Figure 1E85.091)	Probability $P(t) = 2.75 \times 10^{-5}$
LP-3 Rotor (Figure 1E85.092)	Probability $P(t) = 5.21 \times 10^{-5}$
Sum of LP Rotors 1, 2, 3	Probability $P(t) = 1.02 \times 10^{-4}$

It is also necessary to determine expected operating hours for each rotor. Attached Figure 1 gives information on past and future inspections. An average operating hours per cycle is calculated to be 10,233. A conservative estimate of 12,000 hours for the operating cycle is also assumed to provide an additional 15% margin.

The probability of disc rupture up to the time of RFO7, RFO8, RFO9 and RFO10 is represented graphically on attached Figures 3 through 6,

respectively. The average and the conservative estimate for each rotor's operating hours were graphed on that rotor's individual curve. From each rotor's curve, a probability was determined. The probabilities were then summed to determine a total failure probability. The NRC acceptable failure probability is shown as "Allowable" on each figure.

Figures 3 through 6 show that the probability of disc rupture is less than the inspection criteria without UT disc inspection of the LP-1 and LP-2 rotors before planned replacement. Results were:

From Figure 3 for RFO7, the sum of the probabilities is 1.9 to 2.64 x 10^{-5}. This is well within the NRC limit.

From Figure 4 for RFO8, the sum of the probabilities is 6.4 to 8.7 x 10^{-5}. The NRC limit is approached; therefore, a limit must be placed on the number of operating hours allowed before inspection of LP-1 (which is the limiting rotor at this time) is required. This limit is discussed below. During RFO8, the LP-1 will be replaced. Below is the operating hour information for LP-1 for RFO7 and RFO8, extracted from Figure 1 for convenience.

STATUS OF LP-1 ORIGINAL ROTOR		
BASIS OF ESTIMATE	RFO7	RFO8
	OPERATING HOURS	OPERATING HOURS
PRESENT AVERAGE OF 10,233 HRS PER CYCLE	43,376	53,609
15% MARGIN OF 12,000 HRS PER CYCLE	45,146	57,146

From Figure 5 for RFO9, the sum of the probabilities is 5.6 to 8.9 x 10^{-5}. The NRC limit is approached; therefore, a limit must be placed on the number of operating hours allowed before inspection for the LP-2 (which is the limiting rotor at this time) is required. This limit is discussed below. During RFO9, the LP-2 rotor will be replaced. Below is the operating hour information for LP-2 for RFO8 and RFO9, extracted from Figure 1 for convenience.

STATUS OF LP-2 ORIGINAL ROTOR		
BASIS OF ESTIMATE	RFO8	RFO9
	OPERATING HOURS	OPERATING HOURS
PRESENT AVERAGE OF 10,233 HRS PER CYCLE	42,316	52,549
15% MARGIN OF 12,000 HRS PER CYCLE	45,853	57,853

From Figure 6 for RFO10, the sum of the probabilities is 2.8 to 6.3 x 10^{-5}. The NRC limit is approached; therefore, a limit must be placed on the allowed operating hours for LP-3 (which is the limiting rotor at this time) is required. This limit is discussed below. During RFO10, the LP-3 rotor will be replaced. Below is the operating hour information for LP-3 for RFO10, extracted from Figure 1 for convenience.

STATUS OF LP-3 ORIGINAL ROTOR	
BASIS OF ESTIMATE	RFO10
	OPERATING HOURS
PRESENT AVERAGE OF 10,233 HRS PER CYCLE	40,932
15% MARGIN OF 12,000 HRS PER CYCLE	48,003

As shown in ER-8503 Figures 1E85.090, 1E85.091 and 1E85.092, LP-1 and LP-2 have a slower crack growth rate than LP-3 due to better material properties. Evaluation of actual material properties yields the attached Figures 3 through 6 for RFO7, RFO8, RFO9 and RFO10. In summary, the risk of a rotor disc failure is as follows if the LP-1 and LP-2 UT disc inspections are delayed for one cycle until replaced:

PROBABILITY OF ROTOR DISC FAILURE IF LP-1 AND LP-2 ROTOR DISCS NOT UT INSPECTED BEFORE REPLACEMENT								
ROTOR ID	RFO7		RFO8		RFO9		RFO10	
	PROBABILITY		PROBABILITY		PROBABILITY		PROBABILITY	
	AVERAGE 10,233 HRS	15% MARGIN 12,000 HRS	AVERAGE 20,466 HRS	15% MARGIN 24,000 HRS	AVERAGE 30,699 HRS	15% MARGIN 36,000 HRS	AVERAGE 40,932 HRS	15% MARGIN 48,000 HRS
LP-1	1.5×10^{-5}	2.1×10^{-5}	4.7×10^{-5}	6.0×10^{-5}	$<1.0 \times 10^{-6}$	$<1.0 \times 10^{-6}$	$<1.0 \times 10^{-6}$	$<1.0 \times 10^{-6}$
LP-2	4.2×10^{-6}	5.4×10^{-6}	1.7×10^{-5}	2.7×10^{-5}	5.1×10^{-5}	7.5×10^{-5}	$<1.0 \times 10^{-6}$	$<1.0 \times 10^{-6}$
LP-3	$<1.0 \times 10^{-6}$	$<1.0 \times 10^{-6}$	$<1.0 \times 10^{-6}$	$<1.0 \times 10^{-6}$	5.3×10^{-6}	1.4×10^{-5}	2.8×10^{-5}	6.3×10^{-5}
TOTAL	1.9×10^{-5}	2.64×10^{-5}	6.4×10^{-5}	8.7×10^{-5}	5.6×10^{-5}	8.9×10^{-5}	2.8×10^{-5}	6.3×10^{-5}
ALLOWABLE	8.5×10^{-5}	8.5×10^{-5}	1.0×10^{-4}	1.0×10^{-4}	1.0×10^{-4}	1.0×10^{-4}	9.0×10^{-5}	9.0×10^{-5}

As discussed above, a limit must be placed on the number of operating hours allowed by the current methodology. This limit was set by determining the allowable NRC criteria and converting that to the allowed operating hours for that rotor. The limit for each currently installed rotor is given below.

MARGIN ALLOWABLE IF LP-1 AND LP-2 NOT UT INSPECTED BEFORE REPLACEMENT			
CONDITION	RFO8 LP-1 LIMITING AND REPLACED	RFO9 LP-2 LIMITING AND REPLACED	RFO10 LP-3 LIMITING AND REPLACED
	HOURS	HOURS	HOURS
AVERAGE CYCLE	53,609	52,549	40,932
CONSERVATIVE CYCLE (+15%)	57,146	57,853	48,003
MAXIMUM PERMITTED BY PROBABILITY	61,500	59,900	51,900

GGNS thus believes that in the unlikely case that reactor fuel would allow it, LP-1 could be operated to 61,500 hours since last inspection without violating acceptable risk limits. LP-2 rotor could be operated to 59,900 hours since last inspection without violating acceptable risk limits. LP-3 could be operated to 51,900 hours since last inspection without violating acceptable risk limits. The rotors will be replaced before these limits are exceeded.

The results show that the probability of failure is acceptable. Coupled with the reliability of the currently-installed turbines and the replacement of the turbine rotors, GGNS believes it is reasonable to eliminate the set 50,000-hour inspection of the turbine rotors and replace it with a variable schedule to be determined using the currently approved methodology.

Using the current methodology, material properties and operating hours are the important factors. It is assumed that there is a 0.1 inch undetectable crack in the discs at the last inspection. Time between inspections is based on the crack growth rate for the installed LP rotor discs. Thus, the probability of disc cracking for the original or upgrade rotors cannot be reduced or increased due to inspection findings. The currently installed LP rotors are evaluated assuming an undetectable crack exists at the time of the last inspection. Thus, there is no need to inspect the original LP rotors as inspection will not change future inspection intervals.

GGNS found that the most accurate way to meet reasonable inspection requirements in the future is to use the above graph approach to determine the limit of hours allowed before rotor inspections. This technique appropriately reduces operating hours between inspections for LP rotors with faster disc crack growth rate and increases operating hours between inspections for LP rotors with slower crack growth rate.

GGNS finds no gain from inspecting the rotors being removed from service and thus proposes not to perform inspection on the currently installed rotors.

Future Inspection Intervals for the Upgraded Turbines

GGNS does not propose to change the methodology for determining the inspection interval already approved by the NRC. GGNS proposes to use this methodology to determine the number of operating hours between disc

inspections for the upgraded turbines. Actual rotor and disc material properties will be determined during manufacture and used to determine crack growth rate under design stresses. The replacement LP rotors with improved turbine materials will likely result in an increased inspection interval proportional to the reduction in crack growth rate.

During manufacture of the new upgraded rotors, test samples will be used to collect material property data like that summarized on Figures 1E85.090, 1E85.091 and 1E85.092 for the original rotors. A new summary sheet for each upgraded rotor will be prepared and the probabilities of each disc and sum of the discs calculated and presented in a similar format as Figures 1E85.090, 1E85.091 and 1E85.092, using formulas as defined in ER-8503. Probability curves will be added to Figure 1E85.093 or similar figure for the probability of disc failure of each upgraded rotor, independently. Disc inspections will then be set to not exceed the limits as graphed on 1E85.093 for all three LP rotors.

As the rotor manufacture has not been completed, actual test samples have not been evaluated to determine the specific material properties for each upgraded rotor.

The inspection interval determined by this method will be controlled administratively. If, in the future, a change to the inspection interval is warranted, the current methodology for evaluating failures will be used and 10CFR50.59 will be applicable.

Design of the Upgraded Turbines

This section contains a detailed discussion of the upgraded turbines and is included for information.

The upgrade consists of replacing the HP turbine rotor, blades, and inner shell. The LP turbine upgrade consists of replacing the rotors, discs, blades, inner casing blading and the last three rows of stationary blading on the inner outer casing on all three LPs.

The improved design features that provide most of the power efficiencies are:

- Use of more efficient T4 profile integrally shrouded blades
- Improved HP and LP turbine inter stage labyrinth seal strip design
- Use of more twisted blading to better utilize steam flow velocity.
- Advanced free standing blade section contoured to suit flow profile.
- Improved diffuser design and profile.

The design improvements that provide maintenance and cost savings are:

- Erosion-corrosion resistant LP casing
- Advanced LP rotor disc manufacturing techniques
  - optimized water spray during forging heat treatment
  - shot-peening of discs one and two
  - rolling and honing of all key ways
  - manufacture of present disc 1 and 2 as one disc.

Built-in compressive surface stresses make the improved disc-type rotors virtually impervious to stress corrosion. The combined tensile rim stresses resulting from centrifugal forces acting at the blades and the discs are smaller than 29 Ksi. This tangential stress has been reduced from 44 Ksi by the residual compressive stresses of 15 Ksi built into the disc forging during the controlled heat treatment with the water-spraying process. The same low tensile stress level is reached for the overall bore stresses in the shrink fit and the key way area due to the residual compressive stresses from the heat treatment and shot-peening. However, the key way stresses themselves have been converted into compressive stresses. Since the rolling process is performed after the discs have been shrunk-on, only the additional portion of the stress from the centrifugal forces act against the high residual stresses; but they alone are not high enough to produce tensile stressing of the key way during speed operation. There is still a margin of 29 Ksi compressive stressing left to prevent any stress corrosion in the key way.

In addition to improved material properties such as low "deep seated FATT" of less than 32°F, low yield stress of less than 120 Ksi, and high fracture toughness of $K_{IC}min$ = 180 Ksi $\sqrt{in.}$ in the disc center at 68° ambient

temperature, act to virtually eliminate the potential of a crack developing .

A rigid inner casing is a feature which avoids potential exterr.al missiles at any catastrophic overspeed event of up to almost 150%. As a replacement rotor with the most reliable integrally shrouded and free-standing blading, it also offers improved performance. A short installation time is another advantage. Improved performance is achieved by providing design features, such as improved blade profiles, double strip seals for the integrally shrouded blading, free-standing blades without losses due to lashing or damping features, a large exhaust annulus area and an optimized diffuser contour, and the advanced, last stage blade and forward-curving stationary blades all contribute to the rotor's efficient and trouble-free life.

Northeast Utilities installed and is now operating two improved upgraded turbines at the Connecticut Yankee Nuclear Power Station.

The Closure and Deletion of the Current License Condition.

Rather than requesting interim changes for each of these issues separately, closure of the license condition is more appropriate to prevent unnecessary license amendment requests. GGNS has evaluated the potential for crack growth and has decided that the original approved methodology continues to be appropriate. Also, GGNS has proposed an alternate inspection schedule in which the inspection interval for each rotor is determined somewhat independently, based on the operating hours and the condition of each rotor. Therefore, GGNS has met the required actions for closure of the license condition and proposes to close and delete License Condition 2.C.(26).

D. NO SIGNIFICANT HAZARDS CONSIDERATIONS

Entergy Operations, Inc. proposes to revise the Operating License to delete License Condition 2.C.(26), Turbine Disc Integrity.

The Commission has provided standards for determining whether a no significant hazards consideration exists as stated in 10 CFR50.92(c). A proposed amendment to an operating license involves a no significant hazards consideration if operation of the facility in accordance with the proposed amendment would not: (1) involve a significant increase in the

probability or consequences of an accident previously evaluated; or (2) create the possibility of a new or different kind of accident from any previously evaluated; or (3) involve a significant reduction in a margin of safety.

Entergy Operations, Inc. has evaluated the no significant hazards consideration in its request for a license amendment. In accordance with 10CFR50.91(a), Entergy Operations, Inc. is providing the analysis of the proposed amendment against the three standards in 10CFR50.92:

1. No significant increase in the probability or consequences of an accident previously evaluated results from this change.

   The proposed change would close and delete License Condition 2.C.(26). The approved methodology currently used to evaluate the probability of rotor failure and the inspection interval will not be changed. The closure and deletion of the license condition is an administrative change and will not affect any accident previously evaluated .

   The bounding accident for the turbine-generator as analyzed in the Grand Gulf Nuclear Station (GGNS) Updated Final Safety Analysis Report (UFSAR) is the occurrence of an external missile resulting from the failure of a low pressure (LP) turbine disc. The probability of this incident occurring is less than 1×10^{-5} per year, which is the NRC acceptable failure criterion for probability. This change does not affect this probability.

   Any extension to the service interval in the future will be evaluated in accordance with the current methodology. The original acceptable levels of failure will be maintained. Therefore, no significant increase in the probability or consequences of a previously evaluated accident results from this change.

2. The change would not create the possibility of a new or different kind of accident from any previously evaluated.

   The proposed change does not involve a change to the control logic or operating procedures for the turbine but rather transfers the control of the LP turbine disc inspection interval from the Operating License to administrative control. The current approved methodology will

continue to be used when determining future inspection intervals.

Therefore, this change does not create the possibility of a new or different kind of accident from any previously evaluated.

3. The change would not involve a significant reduction in a margin of safety.

Closing and deleting the current license condition for LP turbine disc inspections and controlling the inspection interval administratively has no adverse effects to the margin of safety. The current approved methodology for failures will continue to be used and any changes to future inspection intervals will be evaluated by that methodology. This change does not affect any previous safety analysis presented in the UFSAR and does not affect the criteria used to establish safety limits, the basis for limiting safety system settings, the basis for limiting conditions of operation, a change to the technical specifications or a change in plant operations.

Therefore, this change does not involve a significant reduction in a margin of safety.

On the basis of the above evaluation in accordance with 10CFR50.92(c), Entergy Operations, Inc. has concluded that operation in accordance with the proposed amendment involves no significant hazards consideration.

E. BASIS THAT THE REQUEST DOES NOT INVOLVE IRREVERSIBLE ENVIRONMENTAL CONSEQUENCES

Entergy Operations, Inc. has evaluated the proposed amendment against the criteria for categorical exclusion specified in 10CFR51.22 and has concluded that the proposed amendment:

(i) involves no significant hazards consideration,

(ii) does not significantly change the types or increase the amounts of any effluents that may be released offsite, and

(iii) does not significantly increase individual or cumulative occupational radiation exposure.

Therefore, Entergy Operations, Inc. has concluded that the proposed amendment does not involve irreversible environmental consequences and meets the eligibility criteria for categorical exclusion set forth in 10CFR51.22(c)(9).

F. REFERENCES

1. NRC letter dated November 17,1982, Request for Additional Information - Turbine Disc Integrity; MAEC-81/246

2. NUREG-0831, Supplement No. 1, Safety Evaluation Report related to the operation of Grand Gulf Nuclear Station, Units 1 and 2, December 1981

3. Mississippi Power & Light Company (MP&L) letter dated January 7,1982, MTEB Concerns on Turbine Disc Integrity, SSER 1.11 (27); AECM-82/20

4. MP&L letter dated March 23,1982, MTEB Concerns on Turbine Disc Integrity, SSER 1.11 (27); AECM-82/103

5. NRC letter dated June 16, 1982, Grand Gulf Nuclear Station, Unit 1 - Issuance of Facility Operating License; MAEC-82/142

6. NRC letter dated November 1, 1984, Issuance of Facility Operating License NPF-29 - Grand Gulf Nuclear Station, Unit 1; MAEC-84/0387

7. MP&L letter dated November 1,1985, Proposed Amendment to the Operating License (PCOL-85/19); AECM-85/0333

8. NRC letter dated November 22,1985, Grand Gulf Unit 1 - Request for License Amendment to Defer Turbine Disc Inspection; MAEC-85/0390

9. MP&L letter dated December 10,1985, Utility Power Corporation Engineering Reports; AECM-85/0403

10. NRC letter dated December 24,1985, Forthcoming meeting with Mississippi Power & Light Company (MP&L) regarding Grand Gulf Unit 1; MAEC-85/0420

11. MP&L letter dated December 27,1985, Additional Information Supporting Deferral of Turbine Disc Inspection; AECM-85/0413

12. MP&L letter dated January 24,1986, Requested Information for the January 9,1986 Turbine Disc Meeting, AECM-86/0027

13. MP&L letter dated February 26,1986, Additional Information Requested at 1/9/86 Turbine Disc Meeting; AECM-86/0055

14. NRC letter dated April 29,1986, Issuance of Amendment No. 12 to Facility Operating License NPF-29, Grand Gulf Nuclear Station, Unit No. 1; MAEC-86/0134

15. System Energy Resources, Inc. letter dated July 11,1988, Low Pressure Turbine Inspection; AECM-88/0125

16. NRC letter dated April 10,1989, Safety Evaluation Concerning Low Pressure Turbine Disc Inspection - Grand Gulf Nuclear Station (GGNS), Unit 1 (TAC No. 56442); MAEC-89/0121

17. System Energy Resources, Inc. letter dated December 1,1989, Submittal of Summary Inspection Report on the No. 1 GGNS Low Pressure Turbine Disc; AECM-89/0214

18. NRC letter dated January 23,1990, Low Pressure Turbine Disc Inspection - Grand Gulf Nuclear Station (GGNS), Unit 1 (TAC No. 56442); MAEC-90/0013

19. Entergy Operations, Inc. letter dated November 23,1993, Recordable Indications Identified During Turbine Disc Inspection; GNRO-93/00143

20. Siemens letter to Entergy Operations, Inc. dated October 10, 1994, concerning concurrence with PCOL 94/01

FIGURE 1

REVIEW OF PAST AND PLANNED LP ROTOR INSPECTIONS					
RFO NO.	UNIT OPERATING HOURS		ACCUMULATED OPERATING HOURS SINCE LAST ROTOR DISC UT INSPECTION		
	TOTAL	SINCE LAST INSPECTION	LP-1	LP-2	LP-3
	HOURS	HOURS	HOURS	HOURS	HOURS
RFO1	11,093*	11,093	11,093	11,093	11,093
RFO2	18,178*	7,085	18,178	18,178	**18,178**
RFO3	28,254*	10,076	**28,254**	28,254	10,076
RFO4	39,547*	11,293	11,293	**39,547**	21,369
RFO5	50,417*	10,870	22,163	10,870	32,239
RFO6	61,397*	10,980	33,143	21,850	**43,219**
RFO7[AV]	71,630[AV]	10,233[AV]	43,376[AV]	32,083[AV]	10,233[AV]
RFO7**	73,400**	12,003**	45,146**	33,853**	12,003**
RFO8[AV]	81,863[AV]	10,233[AV]	53,609[AV]	42,316[AV]	20,466[AV]
RFO8**	85,400**	12,000**	57,146**	45,853**	24,003**
RFO9[AV]	92,096[AV]	10,233[AV]	10,233[AV]***	52,549[AV]	30,699[AV]
RFO9**	97,400**	12,000**	12,000***	57,853**	36,003**
RFO10[AV]	102,329[AV]	10,233[AV]	20,466[AV]***	10,233[AV]***	40,932[AV]
RFO10**	109,400**	12,000**	24,000***	12,000***	48,003**

* Actual operating hours for each rotor at time of outage

AV Using average hours through RFO6 of 10,233 hours per cycle

** Using estimated hours of 12,000 hours for conservative estimate (15% more than to date)

*** With upgraded rotor

BOLD Hours at time of LP rotor disc inspections

FIGURE 2

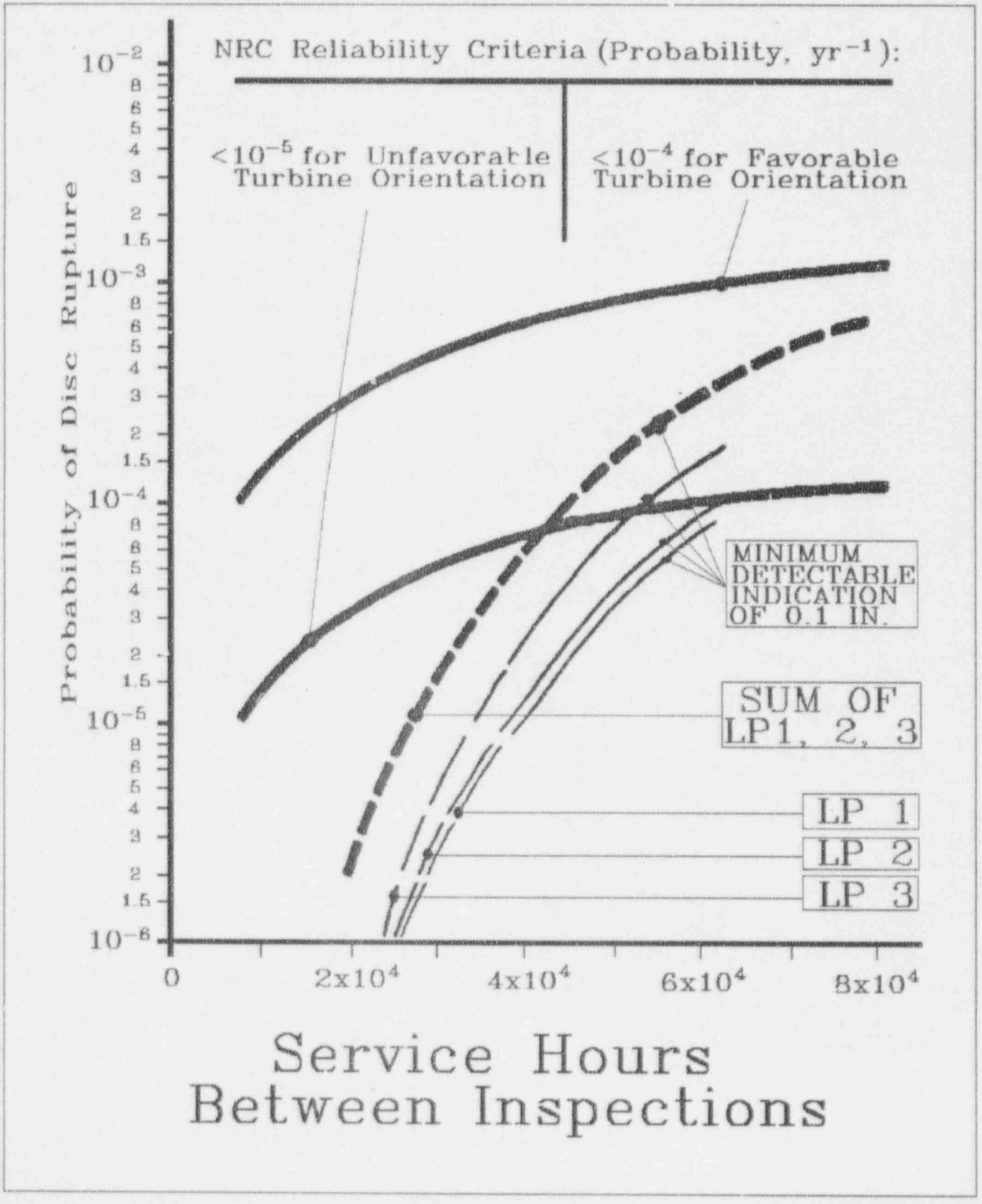
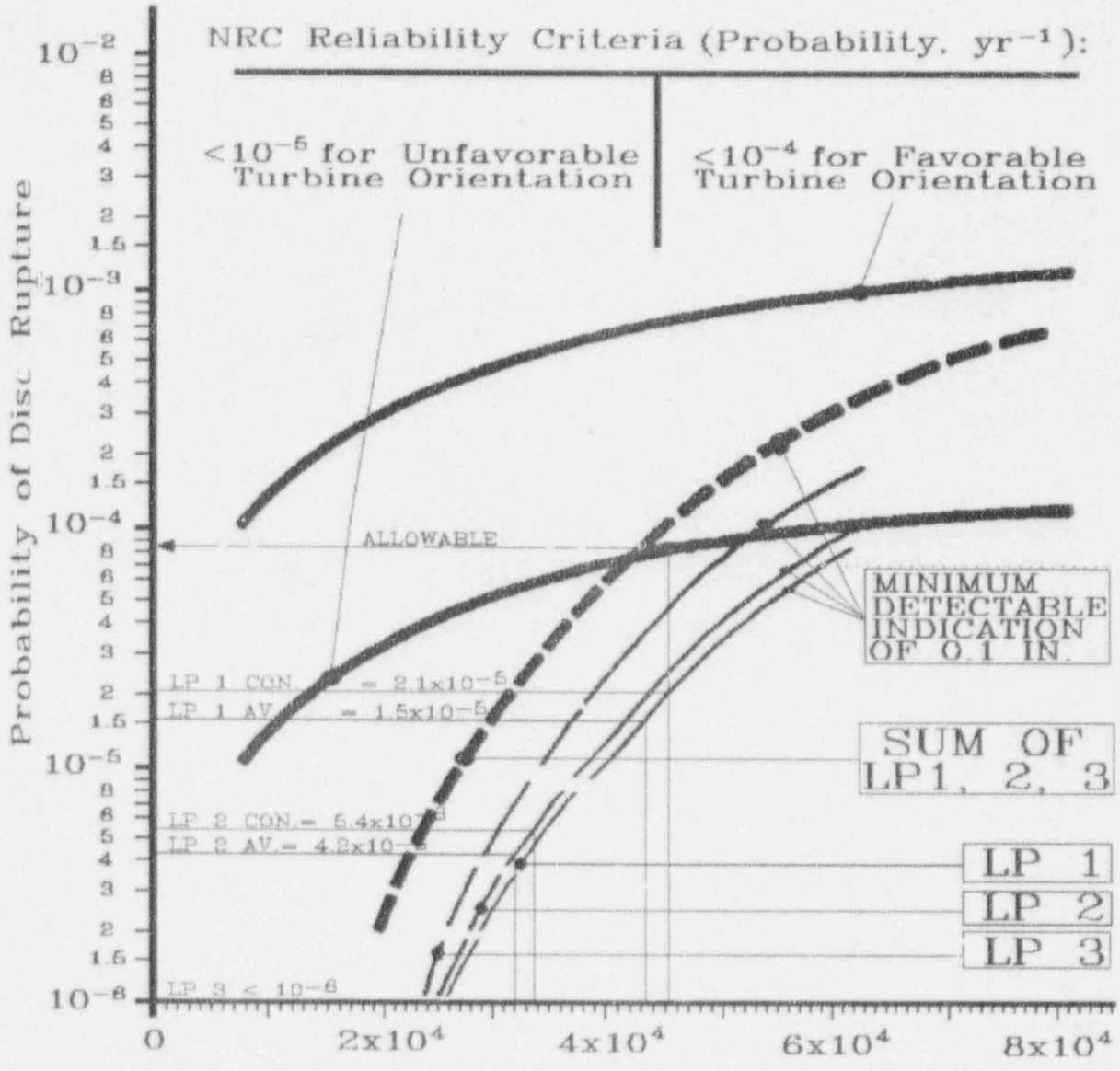

NRC Reliability Criteria (Probability, yr⁻¹):
<10⁻⁵ for Unfavorable Turbine Orientation
<10⁻⁴ for Favorable Turbine Orientation
Probability of Disc Rupture
10⁻²
10⁻³
10⁻⁴
10⁻⁵
10⁻⁶
MINIMUM DETECTABLE INDICATION OF 0.1 IN.
SUM OF LP1, 2, 3
LP 1
LP 2
LP 3
0
2x10⁴
4x10⁴
6x10⁴
8x10⁴
Service Hours Between Inspections

FIGURE 3

Example RF07

LP No. 1 =43,376 AV, 45,146 CON. Hrs
LP No. 2 =32,083 AV, 33,853 CON. Hrs
LP No. 3 =10,233 AV, 12,003 CON. Hrs



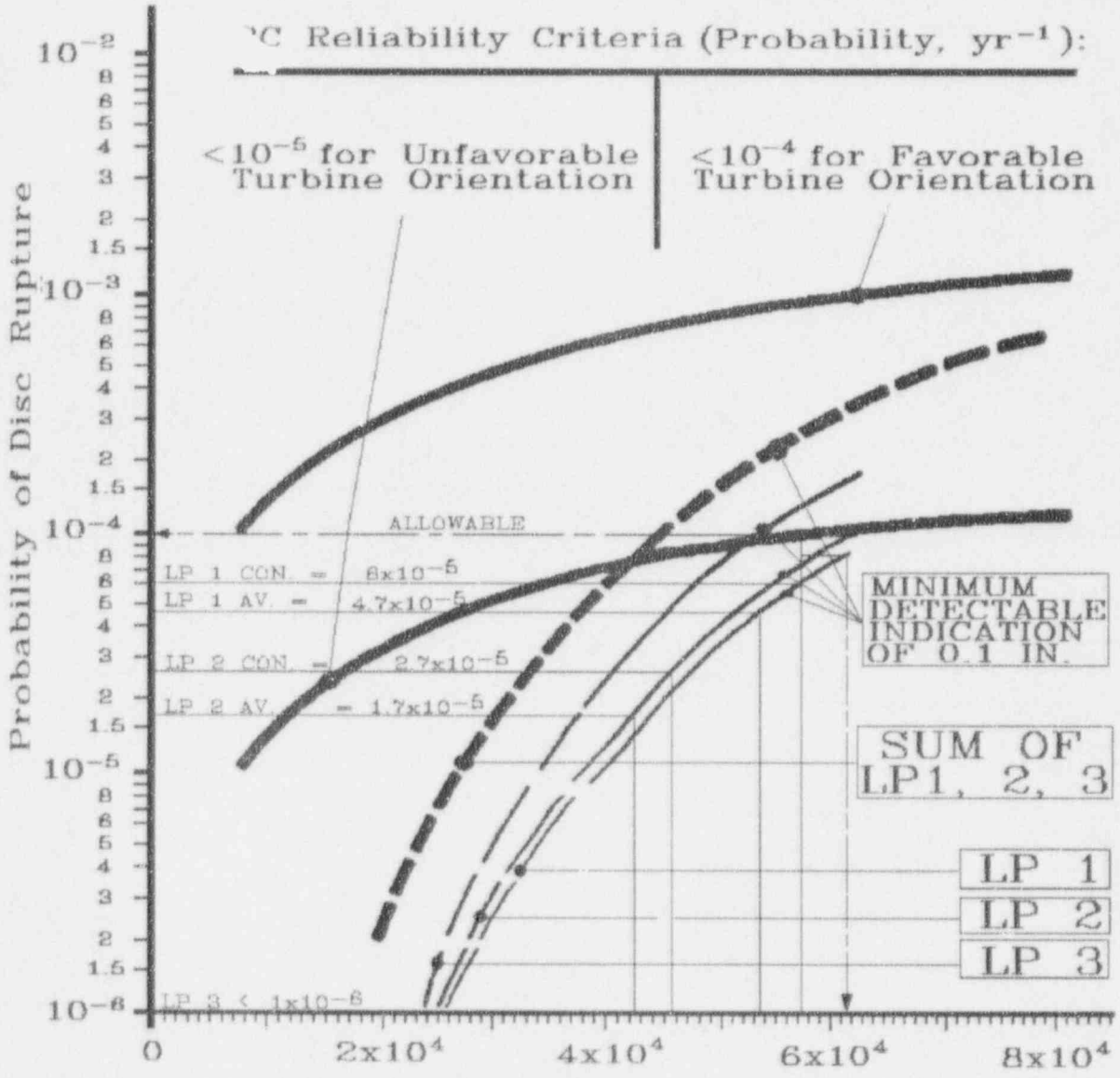
Service Hours Between Inspections

PROBABILITY AT RF07 = 1.9 TO 2.64 x 10^{-5}
NRC LIMITS NOT APPROACHED, SEE RF08

FIGURE 4

Example RF08

LP No. 1 = 53,609 AV, 57,146 CON. Hrs
LP No. 2 = 42,316 AV, 45,853 CON. Hrs
LP No. 3 = 20,466 AV, 24,003 CON. Hrs



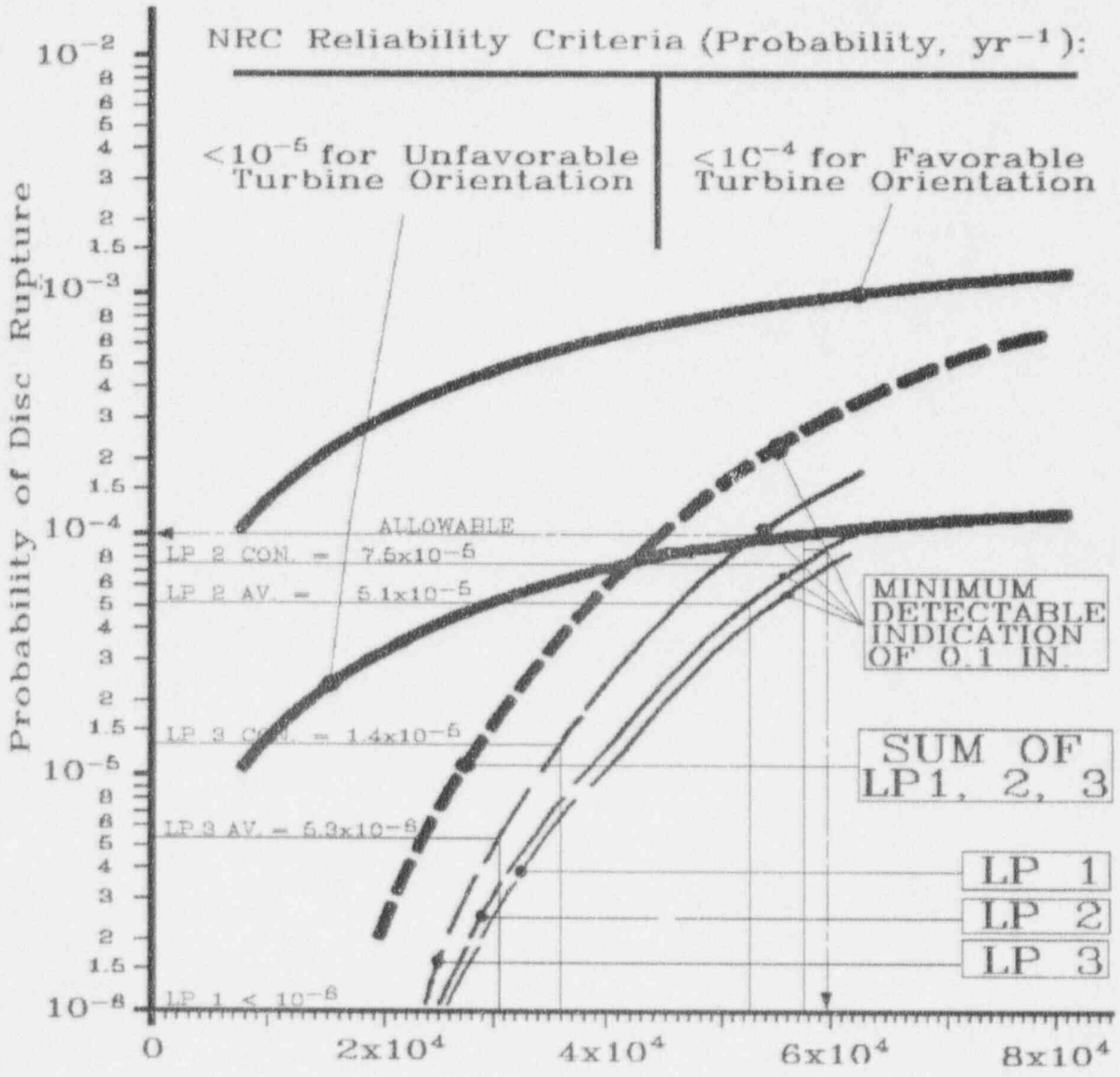
Service Hours Between Inspections

PROBABILITY AT RFO 8 = 6.4 TO 8.7 x 10^{-5}
NRC LIMIT AT LP 1 = 61,500 HRS (15% MARGIN)

FIGURE 5

Example RF09

LP No. 1 =10,233 AV, 12,000 CON.Hrs
LP No. 2 =52,549 AV, 57,853 CON.Hrs
LP No. 3 =30,699 AV, 36,003 CON.Hrs



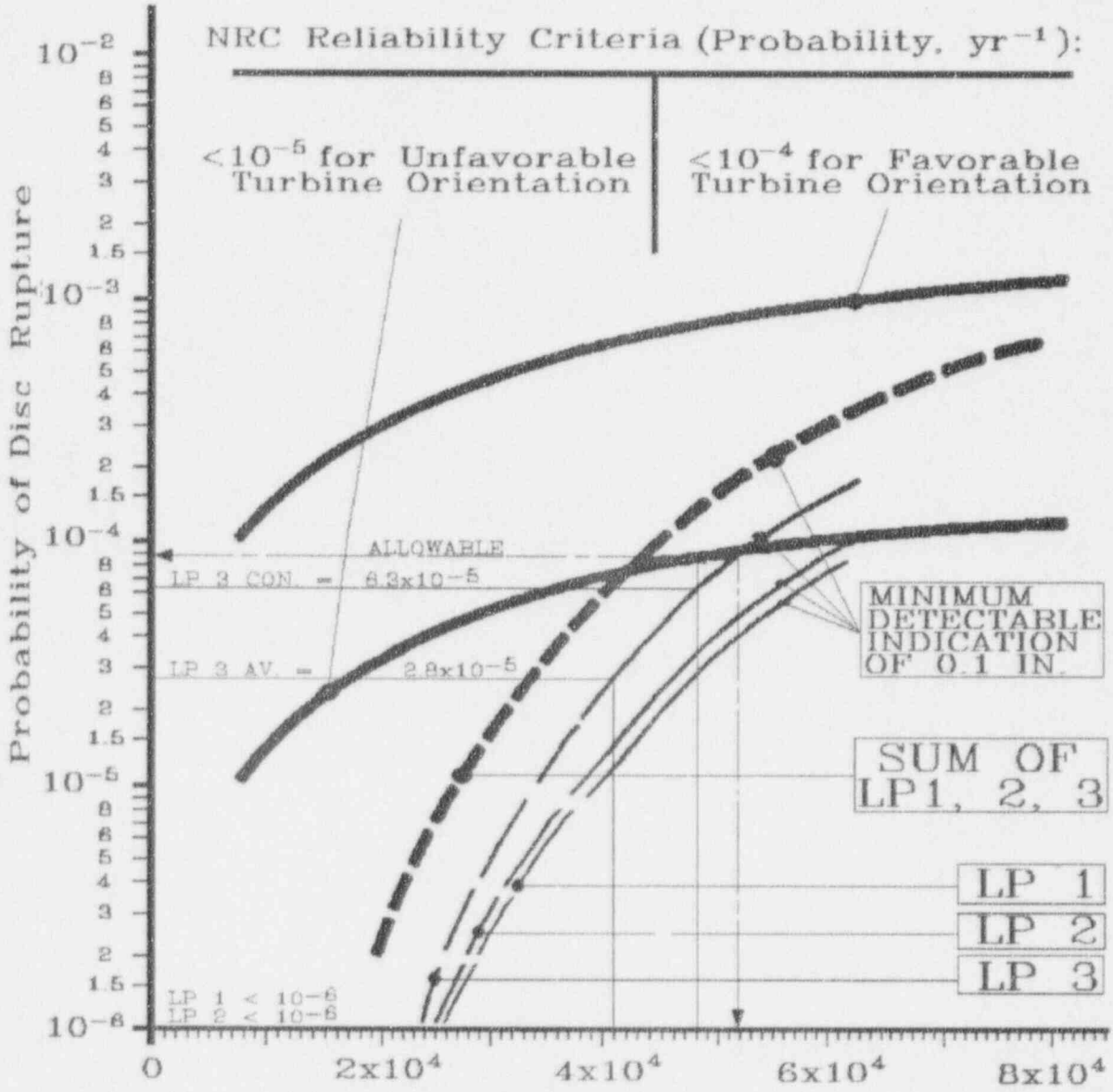
Service Hours Between Inspections

PROBABILITY AT RFO 9 = 5.6 TO 8.9 x 10^{-5}
NRC LIMIT AT LP 2 = 59,900 HRS (14% MARGIN)

FIGURE 6

Example RF010

LP No. 1 = 20,466 AV, 24,000 CON. Hrs
LP No. 2 = 10,233 AV, 12,000 CON. Hrs
LP No. 3 = 40,932 AV, 48,003 CON. Hrs



Service Hours Between Inspections

PROBABILITY AT RFO 10 = 2.8 TO 6.3 x 10^{-5}
NRC LIMIT AT LP 3 = 51,900 HRS (25% MARGIN)

MARK-UP OF AFFECTED OPERATING LICENSE PAGE

(24) Interplant Communication Systems (Section 9.6.1.2, SER, SSER #2, SSER #4, SSER #5)

Tests of the communication systems used to mitigate the consequences of an event and attain a safe plant shutdown shall be completed during preoperational and startup tests. An evaluation of the test results shall be provided for NRC review within 90 days after test completion. Any system modifications found necessary as a result of NRC review shall be completed prior to startup following the first refueling outage.

(25) Reliability of Diesel-Generators (Sections 8.3.1, 9.6.3 through 9.6.7, SER, SSER #2, SSER #4, SSER #6)

(a) Prior to startup following the first refueling outage, a heavy duty turbocharger gear drive assembly shall be installed on all EMD diesel-generators.

(b) EOI shall comply with TDI emergency diesel generator requirements specified in Attachment 2 to this license.

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

(Deleted)

~~EOI shall ultrasonically inspect the bores and keyways of the low pressure turbine discs for indications of cracking prior to exceeding 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.~~

(27) Circulating Water System (Section 10.4.5, SER)

EOI shall not fill the Unit 2 circulating water system (including the natural draft cooling tower basin) until Unit 1 flooding concerns related to this system are resolved to the satisfaction of the NRC staff.

(28) Advisor to the Vice President

MP&L shall have on its nuclear operations staff, one or more corporate management officials or advisors (who may be either permanent employees or contracted consultants) who have substantial commercial nuclear power plant operating management experience and who will advise on all decisions affecting safe operation of the plant. This requirement shall be in effect until the plant has accumulated at least 6 months at power levels above 90 percent of full power.