



**UNITED STATES  
NUCLEAR REGULATORY COMMISSION  
REGION IV  
611 RYAN PLAZA DRIVE, SUITE 400  
ARLINGTON, TEXAS 76011-8064**

June 15, 2000

EA-00-081

Craig G. Anderson, Vice President,  
Operations  
Arkansas Nuclear One  
Entergy Operations, Inc.  
1448 S.R. 333  
Russellville, Arkansas 72801-0967

**SUBJECT: NOTICE OF VIOLATION (NRC SPECIAL INSPECTION REPORT NO. 50-313/00-04; 50-368/00-04)**

Dear Mr. Anderson:

This is in reference to the predecisional enforcement conference conducted May 8, 2000, in Arlington, Texas. The conference was held to discuss two apparent violations of NRC requirements related to the low pressure injection/decay heat removal pumps at your Arkansas Nuclear One (ANO), Unit 1, nuclear power plant near Russellville, Arkansas. The apparent violations were described in the subject inspection report issued on April 26, 2000, and involved: (1) inadequate design control over changes made to the pump bearing housing material and the viscosity of the bearing lubricating oil; and (2) the above changes resulting in the pumps being inoperable from January 28 to February 5, 2000, when service water cooling temperatures were below 42°F.

On February 5, 2000, both low pressure injection/decay heat removal pumps at ANO Unit 1 were declared inoperable due to high temperatures on the pumps' inboard bearings. They were being used at the time to cool down the reactor coolant system by removing decay heat following a plant shutdown for maintenance. This is one of three primary functions these pumps perform. One of the remaining functions, which is a critical safety function, includes pumping water from the reactor building sump and through coolers to achieve long-term reactor cooling following a loss-of-coolant accident. The design assumption is that the pumps will function for at least 30 days following an accident. The apparent violations focused on the possible loss of this function due to a 1992 modification which replaced the original carbon steel bearing housings with stainless steel, and a September 1999 modification which replaced the pump bearing oil with a higher viscosity oil. These changes altered the thermal expansion characteristics of the bearing components which resulted in reduced internal clearances when bearing cooling water (i.e., service water) was at low temperatures, as was the case from January 28 to February 5, 2000.

At the conference, Entergy Operations, Inc. (Entergy) acknowledged that engineering evaluations associated with the bearing housing and oil viscosity modifications were not adequate in that they had not considered all of the possible engineering implications. Entergy also made the following points: (1) that the pumps' original manufacturing specifications permitted clearances that could have resulted in bearing overheating at low service water

temperatures; (2) that the change to stainless steel housings degraded the existing condition; (3) that the as-found pump clearances could have resulted in bearing overheating with either bearing housing material; and (4) that the change in oil viscosity caused additional bearing heating at low service water temperatures. However, Entergy disagreed that the pumps had been inoperable, contending that the pumps would have been capable of performing their intended safety function, including 30 days of operation following a loss-of-coolant accident, even if the pumps' inboard bearings failed due to high temperatures. Entergy based its position on its 1996 experience with a pump bearing failure, and the results of a detailed analysis of the pumps' capabilities performed by an expert panel convened by Entergy. Entergy acknowledged that the pumps were degraded, but concluded that the risk significance of this condition was low based on its expectation that the pumps would perform their intended safety function. In a May 15, 2000 letter, Entergy provided additional information to support its position based on specific questions that were raised at the conference.

The NRC does not find Entergy's conclusion that these pumps were capable of operating with failed inboard bearings for 30 days following a loss-of-coolant accident sufficiently convincing. We note that the pumps would be operating with a failed bearing -- a mode for which they were neither designed nor tested -- and would be pumping hot liquids containing entrained debris from the reactor building sump. While we concede that the pumps may have remained functional for some limited period of time in this condition, we are not convinced by the analysis or Entergy's 1996 experience that the pumps are likely to have operated for 30 days. The 1996 event, while indicative of the pumps' capability to operate sporadically over a two-week period with a failed bearing, is not conclusive evidence that the pumps would operate for a much longer period in the more challenging operating environment of post-accident conditions. The environment under which the pump operated in 1996 was not representative of post-accident conditions. With regard to the expert panel analysis and Entergy's risk estimates, the NRC believes there are too many uncertainties to confidently predict how long the pump would have remained functional in this degraded condition. The sensitivity study provided by Entergy in its letter dated May 15, 2000, demonstrated that the results of the expert panel's analysis are highly influenced by analysis uncertainties. Statements made during the conference indicated that the analysis uncertainties were not specifically addressed by the expert panel. Therefore, the NRC staff concludes that the analysis was subjective in nature and did not provide an adequate basis to demonstrate that the low pressure injection/decay heat removal pumps were functional while in this degraded condition.

In the NRC's view, functionality in this situation can be definitively proven only through testing. However, we do not believe further expenditure of either NRC or Entergy resources to prove or disprove operability would be productive. For that reason, we do not intend to pursue the concern that these pumps were inoperable and are not including such a violation in this enforcement action. We believe the more important issue is Entergy's lack of thoroughness in making design changes to these pumps, and its general lack of a detailed understanding of the relationship between pump components, oil viscosity and service water temperatures, which resulted in a degraded condition that seriously challenged the assumption that these pumps would remain capable of performing a critical safety function.

The risk significance of this degraded condition is highly dependent on the assumed pump failure probability. We believe that the probability of pump failure was higher than the 3-percent value assumed by Entergy, and believe this degraded condition to be more risk significant than Entergy estimated. We note that even a small increase in the assumed failure probability, such as a 5-percent pump failure probability, increases the risk estimate from very low to moderate.

From a purely deterministic standpoint, this degraded condition had the potential to affect both low pressure injection/decay heat removal pumps, leaving little remaining core cooling capability (i.e., reactor building spray) if these pumps failed to perform their post-accident function. This represents a serious degradation of the design of the emergency core cooling system. Thus, the NRC considers the potential safety implications of this degraded condition to be relatively significant and believes that the design control violation that contributed to this degraded condition is most appropriately classified at Severity Level III, in accordance with the November 9, 1999 version of the General Statement of Policy and Procedure for NRC Enforcement Actions, NUREG-1600 (Enforcement Policy).

At the conference, Entergy described numerous corrective actions, beginning with those necessary to determine and correct the causes of the overheating of the pump inboard bearings on February 5, 2000. Entergy took a number of actions to restore acceptable clearances and to ensure that the pumps would operate under any expected service water temperatures. The pumps were subjected to extensive functional testing before ANO Unit 1 was restarted. Entergy also plans to modify its bearing change-out procedures to assure critical tolerances on pump components are maintained, and to develop a long-term solution to provide added margin for critical tolerances. Entergy also described numerous corrective actions aimed at improving engineering evaluations associated with modifications and post-modification testing.

Because your facility has not been the subject of escalated enforcement action within the last 2 years, the NRC considered whether credit was warranted for *Corrective Action* in accordance with the civil penalty assessment process in Section VI.B.2 of the Enforcement Policy. Based on your actions to determine and correct the causes of these degraded pumps, as well as your actions to address the inadequate engineering analyses that contributed to the causes, the NRC has concluded that credit is warranted for your corrective actions. This results in no civil penalty being assessed.

Therefore, to encourage prompt and comprehensive correction of violations, and in recognition of the absence of previous escalated enforcement action, I have been authorized, after consultation with the Director, Office of Enforcement, not to propose a civil penalty in this case. However, significant violations in the future could result in a more significant regulatory response.

You are required to respond to this letter and should follow the instructions specified in the enclosed Notice when preparing your response. The NRC will use your response, in part, to determine whether further enforcement action is necessary to ensure compliance with regulatory requirements.

In accordance with 10 CFR 2.790 of the NRC's "Rules of Practice," a copy of this letter and its enclosure will be available electronically for public inspection in the NRC Public Document Room or from the Publicly Available Records (PARS) component of NRC's document system (ADAMS). ADAMS is accessible from the NRC Web site at <http://www.nrc.gov/NRC/ADAMS/index.html> (the Public Electronic Reading Room).

Sincerely,

/RA/

Ellis W. Merschoff  
Regional Administrator

Entergy Operations, Inc.

-4-

Docket Nos. 50-313; 50-368  
License Nos. DPR-51; NPF-6

Enclosure: Notice of Violation

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## NOTICE OF VIOLATION

Entergy Operations, Inc.  
Arkansas Nuclear One, Unit 1

Docket No. 50-313  
License No. DPR-51  
EA-00-081

During an NRC inspection completed March 30, 2000, a violation of NRC requirements was identified. In accordance with the "General Statement of Policy and Procedure for NRC Enforcement Actions," NUREG-1600, the violation is listed below:

10 CFR Part 50, Appendix B, Criterion III states, in part, that measures shall be established for the selection and review for suitability of application of materials, parts, equipment and processes that are essential to the safety-related functions of the structures, systems, and components.

Contrary to the above, as evidenced by the examples described below, the measures that were established for the selection and review for suitability of application of materials, parts, equipment and processes essential to the safety-related functions of the Unit 1 low pressure injection/decay heat removal pumps were not adequate.

1. In 1992, stainless steel bearing housings were installed to replace the original carbon steel housings. The housings had a greater coefficient of thermal expansion and a lower heat transfer coefficient than the original cast iron housings. The engineering evaluation completed for this design change failed to consider the greater thermal expansion of the new material and, as a result, did not identify the potential effect the change to the new material would have on pump internal clearances.
2. In September 1999, the bearing oil in the pumps was changed from ISO 22 to a higher viscosity oil, ISO 46. The engineering evaluation for this change in oil type failed to identify that the higher viscosity oil would increase the heat generation in the bearing and cause greater thermal expansion of the bearing race. As a result of this change, internal clearances became critical to the performance of the pumps. The engineering evaluation for the change in oil viscosity was not thorough and did not adequately consider the thermal characteristics of the lubricant and the resultant impact on the inboard bearing performance. (01013)

This is a Severity Level III violation (Supplement I).

Pursuant to the provisions of 10 CFR 2.201, Entergy Operations, Inc., is hereby required to submit a written statement or explanation to the U.S. Nuclear Regulatory Commission, ATTN: Document Control Desk, Washington, DC 20555 with a copy to the Regional Administrator, U.S. Nuclear Regulatory Commission, Region IV, 611 Ryan Plaza Drive, Suite 400, Arlington, Texas 76011, and a copy to the NRC Resident Inspector at the facility that is the subject of this Notice, within 30 days of the date of the letter transmitting this Notice of Violation (Notice). This reply should be clearly marked as a "Reply to a Notice of Violation" and should include for each violation: (1) the reason for the violation, or, if contested, the basis for disputing the violation or severity level, (2) the corrective steps that have been taken and the results achieved, (3) the corrective steps that will be taken to avoid further violations, and (4) the date when full compliance will be achieved. Your response may reference or include previous docketed correspondence, if the correspondence adequately addresses the required response. If an adequate reply is not received within the time specified in this Notice, an order or a Demand for

Information may be issued as to why the license should not be modified, suspended, or revoked, or why such other action as may be proper should not be taken. Where good cause is shown, consideration will be given to extending the response time.

If you contest this enforcement action, you should also provide a copy of your response, with the basis for your denial, to the Director, Office of Enforcement, United States Nuclear Regulatory Commission, Washington, DC 20555-0001.

Because your response will be placed in the NRC Public Document Room (PDR), to the extent possible, it should not include any personal privacy, proprietary, or safeguards information so that it can be placed in the PDR without redaction. If personal privacy or proprietary information is necessary to provide an acceptable response, then please provide a bracketed copy of your response that identifies the information that should be protected and a redacted copy of your response that deletes such information. If you request withholding of such material, you must specifically identify the portions of your response that you seek to have withheld and provide in detail the bases for your claim of withholding (e.g., explain why the disclosure of information will create an unwarranted invasion of personal privacy or provide the information required by 10 CFR 2.790(b) to support a request for withholding confidential commercial or financial information). If safeguards information is necessary to provide an acceptable response, please provide the level of protection described in 10 CFR 73.21.

Dated this 15th day of June 2000