Arizona Nuclear Power Project
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Docket Nos. STN 50-528/529/530

Corrected Copy.
October 8, 1987
161-00562-JGH/JRP

U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

ATTN: Document Control Desk

Dear Sirs:

Subject: Palo Verde Nuclear Generating Station (PVNGS)
Units 1, 2 and 3
Reactor Coolant Pump Shafts
File: 87-A-056-026

This letter is provided to inform you of information which ANPP has received from Combustion Engineering (CE) and KSB Pump Co. (W. Germany) concerning the KSB reactor coolant pump shaft cracks experienced in European Power Facilities. Since receiving this information, ANPP has been gathering and analyzing the information available relating to the RCP shaft concern. We acknowledge that the events in Europe are significant and merit our continued attention, however, our efforts to date indicate that the situation is not a safety concern based on our accident analysis. In addition to the formation of an in-house review group, ANPP has met with CE, KSB and KWU of W. Germany to solicit input from the PVNGS RCP designer, manufacturers and builders to ensure that the continued operation of PVNGS will not be harmful to the health and safety of the public. Based on the most recent information obtained regarding ongoing tests at CE and inspections by KSB and KWU in Europe, it is apparent that many questions are yet to be answered before a definitive root cause for RCP shaft cracking and/or failure can be established. KSB continues to assess the shaft related problems at all power facilities using KSB designed pumps or pumps which were based on the KSB reference design.

The following information reflects our most current level of knowledge and understanding of the situation as presented by CE and KSB.

Findings of KSB RCP Shafts in Europe

KSB has found crack indications at the end of the impeller keyway and also at the end of the impeller hub. Nineteen out of twenty-four shafts inspected had cracks of 1.0mm to 8.0mm in depth and two shafts reportedly have failed. The two shaft failures experienced in Europe occurred after 37,000 and 47,000 hours of operations respectively at Grafenrheimfeld and Gosgen Nuclear Power Facilities. Both of these failures involved extenuating circumstances not present for the other inspected shafts.

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Cause of the Cracking

The cracking that occurs near the upper region of the keyway is believed to be due to corrosion assisted fatigue. Although KSB has not identified a root cause for the crack initiation, it is apparent that the operating stresses exceed the shafts' material endurance limits. KSB reports this could be caused by such factors as high thermal stresses induced during loss and recovery of seal injection, the reduction in fatigue strength caused by chrome plating the shaft, stress concentration at the keyway, and corrosion induced by the aqueous environment. After initiation, the cracks then appear to propagate very slowly over millions of stress cycles.

Applicability to PVNGS

The above mentioned information indicates that there is an increased risk of reduced pump availability when operating the RCPs with pump shafts of the kind presently installed in Nuclear Power Facilities in W. Germany. The RCPs supplied to PVNGS by CE are similar design as the European pumps, hence PVNGS may be considered susceptible to a similar type problem. In the two shafts which failed, Grafenrheimfeld had 37,000 hours of operation and Gosgen had 47,000 hours of operation. PVNGS Unit 1 will have less than 17,000 hours by the end of cycle 1 and approximately 25,000 hours by the end of cycle 2.

The two shaft failures in Europe had extenuating circumstances which are not present at PVNGS. The shaft failure at Grafenrheimfeld (37,000 hrs) is believed to have been significantly aggravated by a previous shaft repair which caused a crack to initiate at a location different from other identified crack locations. The shaft failure at Gosgen (47,000 hrs) was aggravated by misalignment of the impeller key in the shaft keyway.

PVNGS Plan of Action

Based on the information received from CE, KSB and KWU, ANPP has determined that a detailed stress and fracture mechanics analysis is needed to understand the problems as they relate to PVNGS. The existing vibration monitoring system at PVNGS can be used to monitor the amplitude of shaft vibration to provide an alert to impending shaft failure. This can be accomplished by adjusting the set points to the existing monitors and adding phase deviation monitoring capability. These modifications are currently planned to be implemented during the first refueling outage of each unit. Vibration data from European plants indicates impending shaft failure can be identified by an increase in shaft orbit with sufficient time to perform a plant shutdown prior to shaft failure. The Unit 1 RCP shafts will be inspected via ultrasonic techniques during the first refueling outage to determine the extent of cracking, if any, that may have occurred to the shafts.

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Safety Consequence

Again, we want to reiterate the fact that RCP shaft cracks and/or failure at European facilities is not a safety concern for PVNGS. This situation, however slight, is covered by an accident analysis in chapter 15. In addition, the plant operators are well informed about the event and have been provided specific instructions as how to mitigate the event should it occur.

The conclusion from the RCP sheared shaft event is that the event would be no more adverse than the rotor seizure event. For both events, the total number of fuel pins calculated in DNB, and which are conservatively assumed to fail, is less than 3.79%. The resultant radiological consequences are within the guidelines of 10CFR100. Based on this information, the continued operation of PVNGS Units 1, 2 and 3 will not be harmful to the health and safety of the public.

Should you have any questions, please call.

Very truly yours,

J. G. Haynes
Vice President
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JGH/JRP/ls

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