December 15, 1987 SIL No. 459

BYRON-JACKSON RECIRCULATION PUMP SHAFT & COVER CRACKING

Please note that this SIL is a follow-up to RICSIL No. 003 issued by GE on May 21, 1986.

Background

A number of PWR reactor coolant pumps and BWR reactor recirculation pumps manufactured by the Byron-Jackson Company (B-J) have been disassembled and inspected during the past few years because of the length of time the pumps have been in operation, ASME Section XI ISI requirements and some operational problems. Thermal fatigue cracking has been observed in several pumps.

GE Nuclear Energy issued RICSIL No. 003 on May 21, 1986, which, in part, addressed thermal fatigue cracking in pump shafts and covers. B-J issued a related advisory (Tech Note 8701-80-005) in January 1987. Both documents contained the conclusion that although the observed cracking was undesirable, it was considered to be relatively benign based on analyses and observations. Cracks were expected to exhibit virtual arrest or show very small growth for depths exceeding 0.2 inches (shafts are 5 to 8 inches in diameter). The January 1987 B-J Tech Note recommended that utilities disassemble and inspect the pumps at the first convenient opportunity. Recent findings, however, indicate that the cracks may represent a threat to pump reliability.

Discussion

Recent observations and measurements of the pumps in operating installations show that some cracks have penetrated to depths greater than 0.3 inches in both shafts and covers. These depths are greater than previously anticipated based on the expected frequency of thermal cycling. In the cover, cracks are axial and could be of sufficient depth to

penetrate the closed cooling water (CCW) circuit if cracks and flow passages are at corresponding azimuths. This represents a risk of contaminating a normally clean system and possibly subjecting it to higher pressures. No such occurrences have been reported.

In the shaft, some cracks change orientation from axial to circumferential. This represents an increased risk of shaft failure under normal operating conditions if the cracks propagate to sufficient depth or under abnormal conditions if the shaft is subjected to increased dynamic loading as could occur from cavitation or by a forcign object becoming lodged in the pump. No such failures have been reported in BWR pumps.

During the period in which these recent field observations were made, B-J performed an analysis of the crack initiation and growth mechan- isms. This work included analysis of recent test data from a full scale operating temperature pump shaft and cover mock-up. The data verified previous conclusions that mixing cold seal purge flow with hot system water initiates cracks. The data also showed that previously unknown low frequency fluctuations occur. Shaft and cover crack growth analyses considering these low frequency fluctuations support the field observations and indicate that such thermal cracks can penetrate to depths beyond the observed depth of approximately 0.3 inches, but at low propagation rates. Cracking in pumps without seal purge can occur but is expected to be less severe and to occur at a higher position on the shaft and cover.

Recommended Action

GE recommends that BWR owners consider these findings and develop contingency plans to prevent negative impact on power production and to minimize effects on outage maintenance activities. GE recommends that such contingency plans include the following.

1. Review pump and system design, period of operation and maintenance history. Correlate with other field experience to assess the potential impact on the pump or pumps in question. For pumps with a high potential for significant cracking, the following actions should be considered:

    - Install shaft probes to monitor shaft vibration response to protect against consequential damage in the event crack propagation changes from thermally driven to mechanically driven.

    - Monitor CCW effluent for contamination by reactor coolant to provide early warning and to minimize contamination of external CCW system and equipment in the event communication develops between these systems.

2. Review ASME Section XI ISI plans and commitments and establish plans which consider the recent findings described in this SIL. Schedule inspections of pumps

with greater than 80,000 hours of pump operation to detect cracks and implement corrective actions before excessive crack growth occurs.

3. Prepare an inspection plan and develop the following:
    - Methods for examining pump shafts and covers
    - Criteria for return to service
    - Repair methods and alternatives considering ALARA
    - Plans for replacement of existing parts or use of improved designs

BWR utilities are requested to inform GE of the results of pump examinations. This information will be used to characterize crack growth behavior and can be used to develop inspection and maintenance actions for other pumps.

If you would like additional information on this subject, please contact your local GE Nuclear Energy Service Representative.

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For further information, comments, questions, on these Web pages send an E-Mail to the Power Answer Center Administrator

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