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July 13, 1994

A. L. Hiser, Jr.
Mail Stop T-10E10
Nuclear Regulatory Commission
Washington, DC 20555

Subject: Review of Core Shroud Cracking in Dresden Nuclear Power Station Unit 3 and Quad Cities Nuclear Power Station Unit 1

Dear Allen:

For this review, I obtained copies of two letters from Commonwealth Edison addressed to Mr. William T. Russel, Director of NRR with the first one dated June 14, 1994 and the second one dated June 24, 1994. Both of these letters covered the ultrasonic examination results and a limited amount of destructive results from boat samples removed from the two core shrouds. In addition, I attended a meeting at White Flint on Monday, June 27, 1994 with Commonwealth Edison staff and NRR staff. In the following comments, I will present my views on the ultrasonic examination results that have been reported.

1. The visual examination discovered intergranular stress corrosion cracking (IGSCC) at all locations that were accessible on the H5 welds of the two shrouds. The ultrasonic inspection that was performed was designed to try to obtain sizing information and not to confirm the presence of IGSCC (IGSCC was confirmed by the results of the metallographic examination of the boat samples). For example, the 60°RL dual transducers are designed to zone focus and not to be effective in the near-surface zone. The lack of confirmation of some of the IGSCC by UT should not be viewed as a negative. The presence of IGSCC was a given based on the visual examination, and the UT techniques used were selected for trying to obtain information about crack depth.

2. The destructive metallographic examination results from the boat samples show that the cracks were in some cases isolated and in others there were a number of circumferential cracks running basically parallel to one another. In all cases, as the cracks grew deeper, the ends of the cracks became "cloud-like" in

nature. This effect can result when there is a small growing stress. This deeper area is also quite tight in that the crack opening dimension (COD) in this vicinity is small. This effect will create problems from the standpoint of detection and sizing. In the PISC I, II, and most recently in PISC III, it has been found that complex cracks (multiple cracks, "clouds" of defects, irregular cracks, etc.) are much more difficult from the standpoint of reliable detection and accurate sizing than single vertical planar cracks. These complex cracks do not provide good strong coherent tip diffracted signals for detection and sizing.

Studies performed by PNL and EPRI have shown that there is a tendency to undersize IGSCC in BWR piping because the deepest portion of the crack is very tight and does not produce strong tip diffracted signals. Generally, this undersizing is on the order of 2 to 3 mm. However, it does illustrate the difficulty of sizing the true depth of IGSCC. The results of the IGSCC performance demonstration testing conducted at the EPRI NDE Center has shown that the tendency of many inspectors is to oversize the smaller IGSCC and to undersize the deeper IGSCC.

Therefore, the expectation is that deeper cracks will be undersized by the ultrasonic measurements.

From the June 24 letter, the IGSCC (see Figure 7) from Dresden Unit 3 at 153 degrees azimuth was sized at 0.3" and the boat sample was found to have a IGSCC of 0.61" while at 324 degrees azimuth (see Figure 8) there were 4 cracks with the deepest one being oriented away from the insonification direction have a depth of 0.64" and was UT sized as 0.52". This later case is consistent with prior experience and is undersized the 2 to 3 mm that have been previously found. The undersizing of the first case is the more difficult one to understand because the UT estimate is 1/2 the real depth and from the micrograph, there is no apparent feature at this depth to explain this amount of undersizing.

3. It was proposed that one of the ways that the performance could be improved would be to use a 45° shear wave and look for the potential shadowing that a deep crack might produce on the signal backscattered from the inside fillet weld. For this technique to work, there are two things that must happen. The first is that the crack must scatter the insonifying energy and prevent the energy from being transmitted through the crack. The second is that the fillet weld must provide a fairly consistent backscattered signal to use to determine when

obscuration has occurred due to the presence of a crack. This later case can be handled in a conservative fashion in that if there is a reduction in the backscattered signal regardless of cause, it can be attributed to the presence of a crack. The more difficult issue is the transmission properties of a tight IGSCC. As indicated in the previous item, the trend will be to undersize these, but this is based on cracking in coolant piping of BWRs. How IGSCC in piping relate to the cracking in the core shroud is a question that needs to be answered. The important thing that needs to be answered is what are the ultrasonic transmission properties of IGSCC in a core shroud (specifically, weld H5)? Currently, there is no data to answer this question. However, there are the boat samples. These boat samples are from the right area and they contain IGSCC that is representative of the conditions in this weldment. If the remaining boat samples are sufficiently large, perhaps it would be possible to make ultrasonic measurements on them that would provide some useful information for addressing this question. It needs to be noted that the boat samples have been obviously removed from the shroud and the tightness of the IGSCC may not be representative of the conditions that exist in situ. Therefore, these ultrasonic measurements may not provide the information needed to understand what the ultrasonic properties are like in situ.

4. It is recommended that the use of focused probes or the use of the synthetic aperture focusing technique (which uses computer processing to simulate the performance of focused probes) be evaluated for performing an inspection from the underside of the core support ledge. This is the surface that is adjacent to weld H6. The potential attractiveness of this is that the sound field would be striking the crack at a 90° angle and the reflected signal would be a strongly scattered signal versus the weak tip diffracted signal that is currently used for sizing. The potential problems concern the ability to position a transducer in this area with a scanner that would permit the needed scanning pattern and the already-mentioned issue of the scattering properties of the IGSCC with regard to the crack being tight.

In conclusion, there needs to be some additional work performed to provide answers to the questions and concerns that have been presented. This is the only way to bring this issue of UT undersizing to closure and to place bounds on the extent of the UT undersizing. Until further data is made available, it must be assumed from a conservative position that all of the UT estimates are undersizing by the largest discrepancy that was found. In the data presented, this turned out to be 0.3". Until further data is provided for the effects of the crack tightness on the 45° shear shadowing, these measurements must be questioned as to their accuracy.

Very truly yours,

Steven R Doctor
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Enclosures

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