

OAK RIDGE NATIONAL LABORATORY

OPERATED BY MARTIN MARIETTA ENERGY SYSTEMS, INC.
FOR THE U.S. DEPARTMENT OF ENERGY

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June 14, 1993

Mr. Ken Karwoski
Office of Nuclear Reactor Regulation
Materials and Chemical Engineering Branch
U.S. Nuclear Regulatory Commission
MS OWFN 7D4
Washington, DC 20555

Dear Ken:

At the request of Emmett Murphy, I have expanded on my conclusions and recommendations section in my letter report of June 4, 1993, to you about our inspection trip to Palo Verde. They are as follows:

1. Since the utility is performing tube pulls and metallography, any final conclusion about this problem should wait until all of the results are known. However, since I am under contract to NRC to furnish my report now, I have made these following conclusions based on the information available to me at the time.
2. The free span cracking is the most difficult and dangerous problem facing the industry today. This problem is more serious for instance, than the ODSCC at the tube supports, because it occurs in the free span where the tube will rupture, rather than have a leak controlled by the presence of the tube support. Because the ODSCC is confined to the tube supports, the defects are shorter and not as likely to burst. An unlikely combination of events would have to occur for the tube support ODSCC defects to cause multiple tube ruptures.

The main method for detecting defects in the free span tubing is the differential bobbin probe. This probe measures the difference between two absolute coils, about 0.060 in. apart. It is more sensitive to "fast changing" geometry variations, and not as sensitive to slowly changing signals such as these defects are. The

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slow-variation-along-the-length nature of these defects also favors to some extent a burst-before-leak scenario.

3. The eddy-current test as it is presently performed throughout the industry, is not adequate to detect this type of degradation before it grows through wall during one cycle, for the crack growth-rate taking place at Palo Verde. There was no observable differential bobbin signal at the prior (1991) outage for the ruptured tube and the next worst tube (these were the only two tubes that I examined in detail for the 1991 outage, and since they were the largest at this outage, I felt that they may have been the oldest, longest growing defects). The ruptured tube grew to through wall, and the other grew to be quite deep. However, it may be possible to improve the detectability of the eddy-current test for this type of defect.

4. The main way utilities have become sensitive to this type of defect is through a tube rupture or leakage, such as occurred at McGuire and Palo Verde. The rupture at Ginna was also caused by a long, slowly varying defect, although loose parts wear and not cracking was the cause of the Ginna defect. I believe that the metallographic results at Farley reported a free-span defect, but no special effort that I am aware of has been made to inspect Farley for this type of defect. After McGuire was alerted to this type of defect, they did successfully find other similar ones at a second plant without the benefit of a rupture or leakage.

5. Of the tubes reviewed at the time of my inspection trip, there were two others that had defect depths about 85% or greater as reported by the bobbin coil and verified by the RPC. At the time of my trip all of the tubes had been inspected by the bobbin but only a fraction of the tubes in the "affected region" had been inspected by the RPC. I believe that defects this deep and longer than 1 in. would be likely to rupture if a severe transient occurred. The potential for rupture of these flaws is being investigated on the pulled tubes with metallography and that should give a better picture.

6. In my conclusion I stated that this was the "most dangerous" problem facing the industry today. I was speaking about my knowledge of the degradation in the steam generators today. I consider the free-span degradation to be more dangerous (i.e., more safety significant) than other types of degradation that we now know to be occurring. The older forms of degradation are recognized and well known, methods have been developed to detect them, and they have usually been arrested. This is not presently the case for this free span cracking, although I am confident that this problem will also be solved with continued efforts by both the NRC and industry.

I hope that these comments are of use to you. If I can be of further help to you, please give me a call.

Sincerely yours,

Caius V. Dodd

Caius V. Dodd

Nondestructive Testing Group
Metals and Ceramics Division

Attachment

cc: D. J. McGuire
D. G. O'Connor
C. E. Pugh
G. M. Slaughter
C. V. Dodd/File

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