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NOTE FOR: J. W. Craig, Acting Branch Chief, MEB/DE/RES

FROM: J. Muscara, MEB/DE/RES

SUBJECT: FIELD TESTS OF ADVANCED EDDY CURRENT INSPECTION METHODS

In mid-November ORNL Personnel, under RES FIN B0417, participated in an inservice inspection at the Prairie Island Unit 2 power plant to test advanced eddy current array probes, techniques and instrumentation. A summary of this activity is attached to this note. The tests were successful and demonstrated excellent sensitivity and speed for detection of flaws with the ORNL designed pancake probe arrays. Because of the limited amount of time that the probes and properly operating equipment were available before the field test, certain aspects of the advanced technology that have been developed at ORNL over the years were not evaluated during this field test. For example, the array probes and equipment were not trained and programmed to use the advanced, non-linear multi-frequency data analysis techniques for the automated characterization of flaws and conditions in the steam generator during the inservice inspection.

ORNL staff received outstanding cooperation and support from personnel of Northern States Power, Zetec and Conam prior to and during the field inspection which greatly contributed to the success of the test.

Some utility personnel and eddy current inservice inspection vendors have indicated interest in using the advanced pancake probes for other inspections and Zetec is already constructing several of these probes for commercial application.

Our activities through 1994 to complete the program include cooperation with the industry in order to transfer the technology, incorporating refinements and improvements to the probes and instruments, training and programming of the equipment for automated flaw characterization and conducting a final field validation test.

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Enclosure: As stated

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EDDY CURRENT INSPECTION TRIP TO PRAIRIE ISLAND

ORNL personnel under an RES program, recently (Nov. 8-16, 1993) participated in an inservice inspection at the Prairie Island nuclear power plant to test new array probes, techniques and instrumentation for the inservice inspection of steam generator tubes under actual field conditions. Current practice uses the bobbin coil probe for the survey inspections. If the probe detects particular types of degradation, the inspection is supplemented with the use of a rotating pancake coil (RPC). The bobbin coil inspection is fast, 24 inches per second, but this coil is not sensitive to circumferential cracks or to some axial cracks that produce low level signals. The RPC inspection is sensitive to circumferential cracks and is better able to characterize flaws, but it is slow at 0.2 inches per second. Therefore, the RPC inspection is usually only conducted in localized areas on short segments of the tube.

The new probes tested use pancake type coils for better sensitivity and incorporate several coils around the circumference of the tube so that rotation is not needed and the probes can be translated along the tube at high speeds. These new probes consisted of two 16-coil array probes. The first probe (the P60 pancake probe) was an improved version of the pancake probe used in normal inspections. By using computer optimization to make a number of improvements, the overall sensitivity of this probe was increased by about a factor of 5 to 10 over the normal pancake probe. This was confirmed by comparing inspection results for given tubes obtained by the new probes versus the commercial inspection. The second array probe consisted of 16 reflection coils also designed and developed by ORNL. This probe showed similar sensitivity during the field tests to the normal pancake probe and computations showed it will be 40% more sensitive than even the P60 probe with the proper driving instrumentation. The instrument used to drive the array probes was the MIZ-30, a new multi-channel, multi-frequency commercial instrument developed by Zetec. This instrument provided good driving performance for all the probes used except for the reflection probe array. The reflection probes require more gain than the instrument was able to provide to obtain the maximum performance that these probes can achieve. The new array probe inspections are designed to be more effective than both the rotating pancake coil inspections and the bobbin coil inspections of current practice. In the field tests, the new pancake array probes detected small-signal flaws that were not called by the standard bobbin coil inspection, was 75 times faster than the RPC inspection and nearly as fast (15 inches per second versus 24 inches per second) as the bobbin coil. The new method would allow the inspection of a plant that is experiencing considerable degradation and would need to perform RPC inspections (similar to the recent case at Palo Verde, unit 2) to be done in one week instead of several months. Further, the entire length of the tubing can be inspected instead of just short lengths. The array probes are sensitive to axial cracks, circumferential cracks, and volumetric defects; while the bobbin probe is not sensitive to circumferential cracks or to various axial cracks.

The utility personnel and their eddy current inspection vendors provided excellent support and cooperated with the ORNL staff which resulted in a successful field test of advanced technology. The ruggedness of the array probes, their high sensitivity and speed were demonstrated under field conditions. Plans for completing this program over the next year include incorporating final improvements to the probe designs, providing for more gain

capability in the driving instrument, training and programming the instrument using multi-frequency signal analysis procedures (methods already developed) for the accurate, automated, online characterization of flaws and conditions in the steam generator tubes, and conducting a final field validation inservice inspection test.