TOLEDO EDISON
A Centenior Energy Company

DONALD C. SHELTON
Vice President—Nuclear
(419) 249-2300

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Subject: HPI/Makeup Nozzle Enhanced Ultrasonic Testing Development Program Report for Davis-Besse Nuclear Power Station Unit 1

Gentlemen:

Enclosed for your information is a report describing the development of enhanced ultrasonic testing (UT) for the High Pressure Injection (HPI)/Makeup nozzle during the sixth refueling outage (6RFO) at the Davis-Besse Nuclear Power Station Unit 1 (DBNPS). Enhanced UT of the HPI/Makeup nozzle is one of the follow-up activities resulting from discovery of the failed thermal sleeve during the fifth refueling outage (5RFO). Toledo Edison's letter to the NRC dated June 19, 1989 (Serial Number 1664) discussed its plans for enhanced UT development. Enhanced UT will be used as the basis for assessing the structural integrity of the HPI/Makeup nozzle and in determining the need for repair of the nozzle.

Toledo Edison contracted with the Babcock and Wilcox Nuclear Service Company to develop an enhanced UT system for examination of the DBNPS HPI/Makeup nozzle. Additionally, Toledo Edison contracted with the Electric Power Research Institute (EPRI) Non-Destructive Examination (NDE) Center to provide assistance with examination planning, mockup fabrication (including crack implantation), overview of examination design, and performance demonstration to the Nuclear Regulatory Commission (NRC).

The overall objective of the program was to develop an ultrasonic examination system capable of detecting, locating and sizing thermal fatigue type flaws penetrating the inner surface of the nozzle, the blend radius at the nozzle mouth, and the adjacent reactor coolant (RC) pipe inner surface. The features of the system include automated scanning and a computer-enhanced data acquisition and analysis system.

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During the development program, two meetings to review program status and demonstrate system capabilities were held with the NRC Staff and the NRC consultant, Battelle Pacific Northwest Laboratory (PNL). Toledo Edison's letter to the NRC dated February 20, 1990 (Serial Number 1768) documents the most recent meeting held on January 18, 1990.

Overall, the development program objectives were achieved. The system can reliably detect flaws penetrating into the base metal within the region of the nozzle and adjacent reactor coolant piping potentially affected by cold water exposure following the failure of the makeup thermal sleeve discovered in 1988. The detection threshold is well below the depth where structural integrity of the nozzle would be compromised.

The system can reliably size flaws in most of the examination region using tip-diffraction (time-based) sizing techniques. However, for a small zone inside the mouth of the nozzle, tip-diffraction sizing of axially-oriented flaws proved to be impractical with the selected scanning plan, leaving only amplitude-based and geometric shape techniques. Should axial flaws be detected in this zone, locally augmented sizing techniques will be employed.

Although not required for demonstration of structural integrity, efforts were made in the development program to detect flaws contained entirely within the cladding. The selected scanning strategy using shear wave techniques alone did not achieve the desired result. Therefore, longitudinal wave scanning is being used during the 6RFO examination of the HPI/Makeup nozzle in an effort to observe flaws in the cladding.

Based upon the results of the development program, Toledo Edison concludes that the enhanced ultrasonic examination techniques developed in this program can be used to provide a reliable assessment of the structural integrity of the HPI/Makeup nozzle.

Toledo Edison's letter to the NRC dated December 7, 1989 (Serial Number 1740) proposed the use of the B&W Automated Reactor Inspection System (ARIS) as an alternative to the volumetric and magnetic particle inspections of reactor vessel nozzle welds required by Section XI of the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code. The ARIS tool is essentially the same system as the enhanced UT system developed for examination of the HPI/Makeup nozzle. In August 1989, the ARIS tool was demonstrated using mockups with machined notches to demonstrate detection capabilities. The NRC representative present at the demonstration indicated that it may be necessary to demonstrate the ability to detect real flaws using samples with induced flaws before this alternative could be approved.

The enhanced UT development program demonstrated the ability to detect induced thermal fatigue flaws in blind sample blocks provided by the Electric Power Research Institute (EPRI) NDE Center and PNL. Because ARIS is essentially the same as the enhanced UT system developed for the HPI/Makeup nozzle, as discussed with the NRC staff an additional demonstration of ARIS is no longer necessary.

The results of the HPI nozzle inspections and justification for plant operation in Cycle 7 and beyond is currently being prepared and will be submitted with a separate letter.

Should you have any questions regarding this information, please contact Mr. R.W. Schrauder, Manager-Nuclear Licensing, at (419) 249-2366.

Very truly yours,

Enclosure

cc: P.M. Byron, DB-1 NRC Senior Resident Inspector
A.B. Davis, Regional Administrator, NRC Region III
T.V. Wambach, DB-1 NRC Senior Project Manager
State of Ohio