Sandia National Laboratories

Albuquerque, New Mexico 87185

April 26, 1991

TAC·80168

50-263

Mr. Martin Hum
MS 7-D-4
U. S. Nuclear Regulatory Commission
Materials Engineering Branch
Washington, DC 20555

Subject: TRC Tool Performance for UT Scanning of Beltline Vessel Welds at Monticello Nuclear Power Plant

Dear Mr. Hum:

INTRODUCTION

A visit was made at Monticello Nuclear Power Plant on April 24 and 25, 1991 to review the design and scanning capabilities of the ABB Tekniska Rontgencentralen (TRC) manipulator for ultrasonic examination of BWR vessel shell welds. Of particular, interest was the ability of the manipulator to scan the vessel shell welds in the restricted area of the jet pumps and the core shroud. The clearances in this area for the transducer scanning head may only be several inches. Design of the transducer head must allow the transducer face to stay in contact with the ID vessel surface as the transducer head is moved over the rough clad surface of the vessel during normal scanning speeds for data acquisition.

TRC TOOL DESIGN

On April 24, the manipulator was inspected at close range as it laid on the refueling floor of the reactor building while it was being prepared to be inserted into the vessel. The manipulator consists of a large mast which is mounted on the flange of the vessel and extends down adjacent to the vessel inner wall to the core shroud. A motorized extension arm is attached to the mast between it and the vessel wall. A motorized slide and transducer holder is attached to the end of the extension arm. A TV camera is also mounted on the end of the extension arm which allows some visual inspection of the clad surface and the movement of the transducer holder over the clad surface.

A001
1/0

The design of the transducer holder, slide, and extension arm were examined closely. The transducer holder contained four independent transducers for a straight beam, a 45 degree shear beam, a 60 degree shear beam, and a dual 70 degree beam inspection. Each of these transducers was in a spring loaded gimbal device which allowed independent movement of the transducer in all directions perpendicular to the plane of the transducer holder face. Therefore, as the transducer holder passes over a rough clad area of various heights, each transducer is able to rotate freely and stay in contact with the clad surface.

The design of the extension arm is such that the transducer plate is also spring loaded against the vessel wall. Only the presence of a very sharp step in the clad surface of greater than 1/8 inch in height may cause a transducer to hang up on the step. The transducer holder is connected to a shaft that can be rotated through 360 degrees so that opposing transverse and longitudinal scans of the weld can be made consecutively.

The rotation shaft is mounted on a rigid compound transverse slide which is attached perpendicular to the extension arm of the mast. The slide has a curvature equal to the vessel wall curvature. As the slide extends the transducer holder circumferentially by approximately 2 feet, it maintains an equal distance of the transducer holder from the vessel wall and a constant force against the wall. The compound slide and transducer holder with transducers attached is approximately 3 to 4 inches in thickness. Therefore, when the transducers are scanning behind the restricted area of the jet pumps, a constant clearance distance of about 2 inches is maintained between the jet pumps and the transducer holder.

The main mast can be moved a certain distance in the circumferential direction of the vessel. On the end of the main mast is an electromagnetic sensor which is used to locate the exact position of a lug in the shroud flange. At this position the extension arm can be lowered past the shroud and between the longitudinal clearance passage way of the jet pumps. The extension arm can be lowered to the level just above the core shroud support shelf. A scan of the circumferential weld in this area can then be made in a raster scan by moving the extension arm up and down and incrementing the compound slide in the circumferential direction after each vertical scan. In this position of the mast the circumferential and longitudinal beltline welds can be examined for a distance of approximately 2 feet on either side of the mast; i.e., plus and minus 16 degrees of the vessel wall from the shroud support shelf to the shroud flange. After examination of the welds in this area is complete, the extension arm is extracted and the tool is moved to the next

lug position in the shroud flange where another longitudinal clearance passage way of the jet pumps is present. The passage ways are separated by 30 degrees so complete coverage of the welds behind the jet pumps is possible.

To examine the welds above the core shroud, the main mast is replaced with another one of similar design, which allows transducer scanning to take place on the welds between the core shroud flange and the upper flange of the vessel.

TOOL EVALUATION

A video tape of the operation of the manipulator in the area of the core shroud as seen on a mock up of the vessel was also viewed on April 14. The tape demonstrated that manipulation of the transducers passed the restricted area of the core shroud and jet pumps was easily accomplished. The tape also showed how the extension arm worked and how the transducer holder was moved laterally with the compound slide mechanism. All positions of the tool motion are encoded. Transducer motion is encoded to give a 0.2 mm resolution in the scanning directions.

At approximately 2:00 AM on April 25, the tool was lowered and mounted in the vessel. At approximately 9:00 AM a scan of 15 degrees of the circumferential weld number 2 which is just above the core shroud support shelf was scanned using the Dynacon acquisition system. Approximately 100 scans were taken across the weld crown with an increment of 7 mm between each vertical scan. The scanning and data acquisition time for this preliminary test took approximately 1.5 hours. The transducer head was then moved to scan the same area of the circumferential weld number 3 which is at the core shroud flange. At the beginning of this scan, I was present in the data acquisition tent to witness the exam. Unfortunately, a problem developed with the interface of the encoder pulses of the transducer positions and the Dynacon data acquisition system. This problem was not resolved while I was there, but I was able to observe a manual movement of the transducers over the clad surface as seen on the TV monitor. From what could be seen, the transducer movement over the clad surface worked smoothly and only an occasional drop out of the ultrasonic signals occurred from lift off of the transducer over the clad roughness.

CONCLUSIONS

The tool design and transducer holder are well conceived designs. Manipulation of the transducers in the restricted area of the jet pumps can be effected efficiently with the tool design. One hundred percent coverage of the weld in this area can be accom-

plished. A raster scan pattern of the full volume of the weld can be accomplished. After experience with the tool, it is estimated that on the average a 30 degree section of a given weld can be accomplished within 2 hours for two opposing transverse and longitudinal scans.

Sincerely,

John H. Gieske

John H. Gieske
NDT Technology
Division 7552

JHG:jk

Copy to:
William O. Long
MS 13-D-18
U. S. Nuclear Regulatory Commission
Washington, DC 20555