

N291. Automating Inspection of Vessel Penetrations in French PWRs

A variety of ultrasonic heads for detecting defects can be installed on MIPAC, an integrated inspection system built by Intercontrole in France to inspect vessel penetrations. The desire to reduce the exposure of operators to radiation, combined with the large number of inspections that needed to be made, motivated efforts to automate the procedure. This team has carried out vessel operation with television equipment. The mobile base of a television manipulator used for that work was adapted for MIPAC by connecting a motorized telescopic arm and a transducer carrier. MIPAC enters under the closure head through a door in the biological shield, so no manipulation of the closure head itself is required. Since the manipulator is operated remotely, manual work under the closure head is avoided. The centering plate installed under the closure head stand in each French plant is used for centering MIPAC automatically. A remote power unit supplies the motors, actuators and water pumps for the ultrasonic coupling, which makes the equipment autonomous.

The control and command system, which is linked with a camera, allows the ultrasonic head to move into position quickly. A laser target helps to center it in the penetration to be inspected. The operators stand in the annular gallery 20 to 50m from the manipulator.

Specially focused transducers are used. The different models applied, which are fitted into removable examination heads, operate under water. MIPAC's ultrasonic equipment is suitable for detecting both circumferential and axial defects, as well as for controlled inspection of the penetration weld geometry. The miniaturization needed was obtained by using a special arrangement of transducers and curved mirrors. Scanning is achieved by combining rotational and translational movements of the head.

Data processing is achieved by using an ultrasonic system currently used for inspecting French nuclear vessels. The software manages acquisition and digitization of the complete ultrasonic signals and analyses them on a Hewlett-Packard workstation. The diffraction echoes from the tips of the cracks allow the defect geometry to be determined. Processed results are printed out in color.

The equipment was used at a rate of less than 50 min per penetration, a complete vessel head inspection can be carried out in a week. The cumulative personal dose is around 10 mSv or 1 rem for the inspection of 65 penetrations.

Equipment is being developed to inspect penetrations without having to remove their thermal sleeves. Eddy current will provide detection, and defects will be characterized by ultrasound, from the 3-mm gap between the thermal sleeve and the penetration.

Taken from, "Head to Head: Automating Inspection of Vessel Penetrations in French PWRs," Nuclear Engineering International, p.36, July 1993.