

N290. Automating Pump Nozzle Inspection

The problems caused by the complex weld geometry of BWR axial pumps have been overcome in designing equipment for completing an ultrasonic scan where manual inspection was required before, reducing the radiation dose received by the operators. Because of the complex geometrical and ultrasonic boundary condition of the nozzle-to-vessel welds of axial pumps, a suitable manipulator unit with an associated control system was developed.

The manipulator has three degrees of the freedom: circumferential and axial movements as well as probe rotation. It travels on a hinged annular rail around the nozzle and is equipped with a movable vertical boom, the upper end of which carries the swivel probe on a Carden joint. The rail on the skirt for inspecting the bottom closure is used for transporting the manipulator system from one pump nozzle to the next, minimizing manual work inside the skirt itself.

The three-axis control system is designed to perform both horizontal and vertical meanders at a programmable constant inspection density with optimum parameters for ultrasonic inspection, i.e., with the beam axis perpendicular to the most probable direction of a crack. Scanning is controlled to avoid obstacles like weldments and instrument lines in the scanning area automatically. The probe can also be removed manually for alignment and calibration and for any additional analyses of indications that may be necessary. They are matched to the specific geometrical boundary conditions, such as radius of curvature, wall thickness, and scan area. To avoid damaging the thermal insulation, the couplant water is collected and discharged by pump.

The ultrasonic instrument is an "Impulse 1" with a dynamic range of approximately 80 dB to measure the maximum echo amplitude in the programmable gate range together with the corresponding time of flight.

Taken from, "Automating Pump Nozzle Inspection," Nuclear Engineering International, p.39, July 1993.