Inspection and Evaluation of an Steam Turbine LSB PAUT and Automatic Inspection System

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The last stage blade (LSB) of the low-pressure (LP) turbine in a steam turbine has lower steam pressure and temperature. However, due to the need to accommodate the rotation driven by the highest steam volume, it has the largest volume and weight. With the increase in power generation capacity, turbines require significantly longer blades to handle a larger steam volume. Consequently, the load that the LSB root attachment must withstand also increases. This has led to a transition from the traditional pinned finger type LSB root attachment to the curved axial entry type, which has been applied to most 1000MW thermal power plants and 1400MW nuclear power plants Korea. In past power plant maintenance practices, scheduled outages involved the use of Ultrasonic Testing (UT) to monitor Stress Corrosion Cracking (SCC) initiation on pinned finger type blade root attachments. However, with the recent adoption of the curved axial entry type, there is a need for the development of non-destructive testing methods to verify SCC initiation. The blade root attachment and blade airfoil shape incorporate a 3D curve. Due to the limited spacing between blades imposed by equipment dimensions, conventional probes and wedges face challenges in accessing the confined space. To address this constraint, we developed Ultrasonic Testing (UT) technology, utilizing reverse-engineered data and beam simulation results for blades, enabling both manual Phased Array Ultrasonic Testing (PAUT) and Advanced PAUT approaches. The verification of defect detection capability involved Finite Element Analysis to calculate the tensile stress applied to the blade root attachment. The process included selecting points with a high likelihood of crack initiation and conducting tests on specimens machined with notches to validate the results. Advanced Phased Array Ultrasonic Testing (PAUT) technology has undergone development to absorb variations in the shape of each blade and direct ultrasonic beams along the curve of the airfoil. This ensures minimal deviation in inspection results, irrespective of the inspector's proficiency. The technology finds current applications in various field scenarios. Ultimately, the abstract discusses additional challenges requiring resolution for the automation of Last Stage Blade (LSB) PAUT.