ELECTRIC POWER RESEARCH INSTITUTE

Recently Formed Nondestructive Evaluation Modeling and Simulation Center Already Yielding Results

The center is applying advanced modeling and simulation techniques to address complex inspection reliability issues, such as the need for a qualified procedure for tapered dissimilar metal weld geometries.

The new capabilities being developed through the Nondestructive Evaluation (NDE) Modeling and Simulation Center are expected to reduce the time, cost and complexity of approaches used to develop and demonstrate NDE techniques to meet regulatory requirements and industry commitments.

One of the ways in which modeling and simulation can improve inspection procedures is by condensing the number of physical parameters that need to be investigated. A few of the key elements that typically need to be defined in a single examination procedure include: inspection method, probe, wedge, beam angles and skews, time response window, inspection path and direction. Modeling and simulation can assess many combinations of these to determine the optimum configuration, without the need for a range of time-consuming experiments. In addition, modeling and simulation can be used to extend procedures qualified for one component to other similar components, eliminating the need to build mockups that can cost millions of dollars.

In one of its current activities, the NDE Modeling and Simulation Center is addressing design inspection procedures for nozzle and piping examinations. Current regulations require that dissimilar metal weld (DMW) configurations in nuclear power plants be evaluated using ultrasonic techniques. Some of these DMW components contain tapered geometries that challenge traditional ultrasonic methods. To inspect these tapered DMW components in compliance with ASME Code, inspection vendors must demonstrate their capabilities through the performance demonstration program administered at EPRI. No qualified procedure exists, however, that includes such configurations using an automated approach.

The NDE Modeling and Simulation Center used mathematical tools to augment an existing, qualified EPRI procedure for non-tapered DMW components. EPRI analysis also helped in selecting transducers, wedges and other essential parameters to achieve the optimum qualification and field application methods. This approach avoided possible failed empirical trials that could impact inspection schedules. The images below illustrate how simulation predicted the experimental results with sufficient accuracy to lend credibility to the approach, allowing EPRI to use it for developing the inspection procedure.

Other applications being investigated by the NDE Modeling and Simulation Center include probability of detection analysis, analysis of other inspections methods such as eddy current and radiography, and the development of tools to support computer-based training to help narrow the NDE workforce gap.

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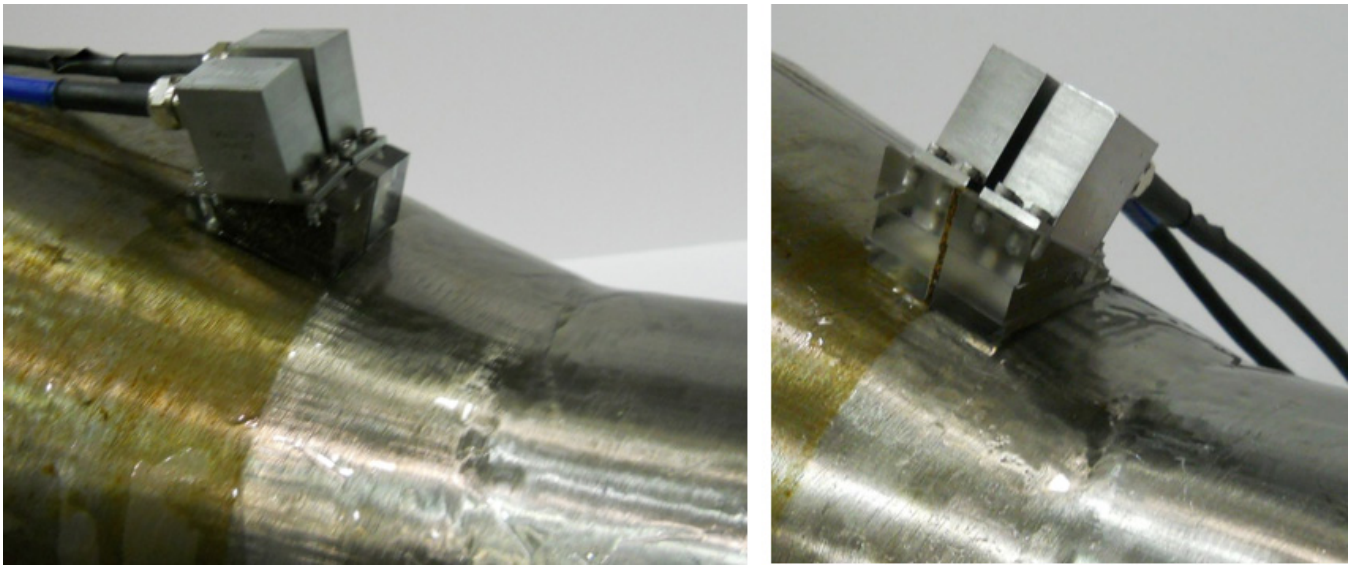

Figure 1: Illustration of experimental setup for an axial scan (left) and a circumferential scan (right) on Combustion Engineering Spray Nozzle mockup.

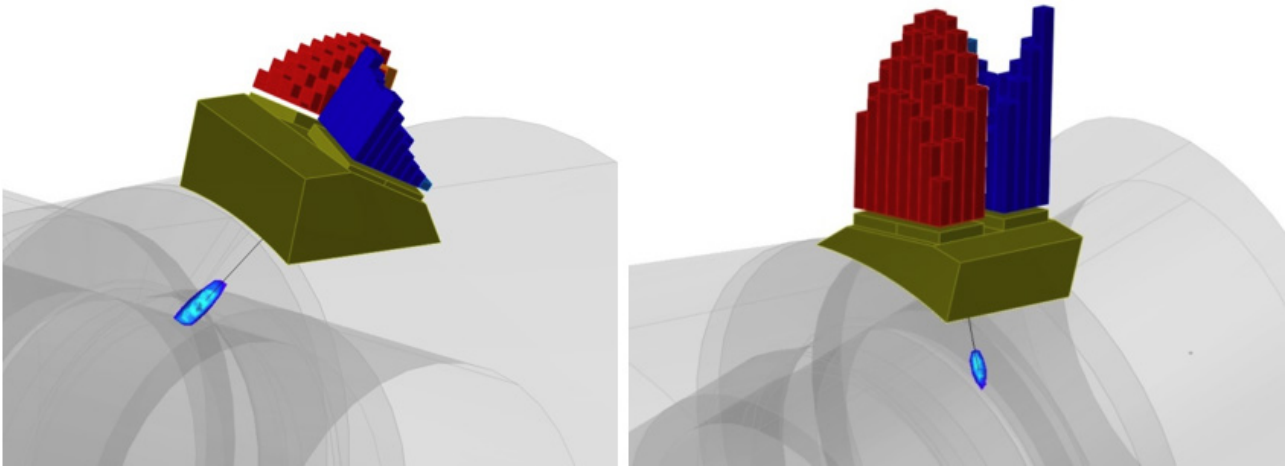

Figure 2: CIVA beam simulation for an axial scan (left) and a circumferential scan (right) illustrating the ultrasonic probe focal point. These results show whether or not the desired focal point is achieved, which is of special interest in complex geometries.

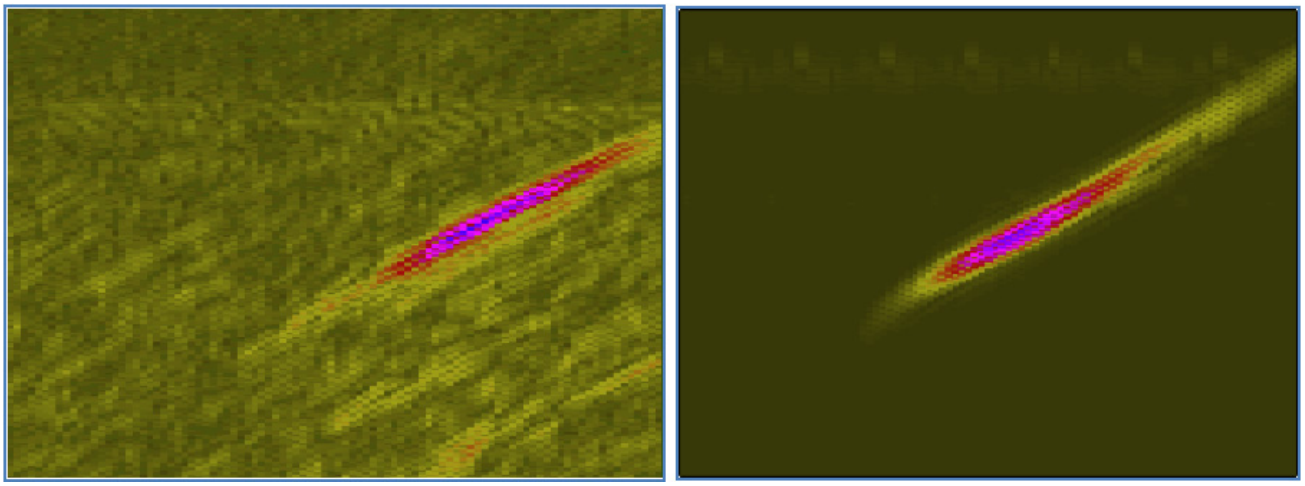

Figure 3: Experimental result (left) and simulation (right) of a circumferential scan on a Combustion Engineering Spray Nozzle mockup. As expected, the experimental result contains more noise, but the simulation was capable of capturing the flaw response remarkably well.