A new concept of smart flexible phased array transducer to inspect component of complex geometry

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In most of industries as aeronautics, aerospace and nuclear, the main part of the non destructive testing is carried out directly in touch with the inspected component. Among others, the cooling piping of French pressurized water reactor comprises many welding components with complex geometry: elbows, butt welds, nozzles. In service inspections of such components performed with conventional ultrasonic contact transducers present limited performances. First, variations in sensitivity, due to unmatched contact on depressions or irregular surface are observed, resulting in poor detection performances. In addition, the beam orientation transmitted through complex interfaces cannot be totally controlled, because of the disorientations suffered by the transducer during its displacement. As a result, the possible defect cannot be correctly detected, positioned and characterized. At last, the geometry of some components disturbs the displacement of the transducer, resulting in an uncovered scan area.

To overcome these difficulties and to improve the performances of such inspections, the French Atomic Energy Commission has developed a new concept of transducer, allowing both to take into account the varying profile of the tested component and to efficiently compensate these effects. This transducer is a flexible phased array able to match the surface of the inspected specimen and to efficiently compensate the deformation of its own surface, in order to preserve the ultrasonic beam characteristics in spite of the profile variations encountered during the scanning.

This ability is achieved thanks to a specific instrumentation, which measures the deformation of the transducer radiating surface, made of individual ultrasonic elements mechanically jointed to fit the actual surface of the component being inspected. As those transducers positions over the specimen are known, delay laws can be easily computed, and applied with a multi-channels acquisition system, to master the ultrasonic beam radiated over the specimen.

Inspections in pulse-echo mode have been performed on a specimen with an irregular profile containing artificial embedded reflectors. The comparison with inspection carried out using conventional transducer shows the efficiency of the system to characterize defects under such complex profile.