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Use of Guided Wave Inspections to Monitor the Integrity of Nuclear Power Station Boilers

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This paper describes a ground-breaking application of guided wave testing for the nuclear power industry. Hartlepool and Heysham 1 power stations in the UK contain boilers of a unique 'pod' design in which the spiral boiler tubes are supported from above by a central vertical 'spine', which is a tubular component approximately 520mm in diameter and 21m long with complex changes in cross-section and attachments along its length. There are 32 boilers in the two stations. The gas which has passed through the reactor core flows down over the boiler tubes, heating the water inside. Only the top 2m of each spine is accessible above the top of the boiler pod.

Plant Integrity Ltd was engaged by to inspect these 'spine' supports in 2003 using its Teletest guided wave system at statutory outages, which occur on a 3-year interval for each reactor. The Teletest tool was positioned in the only accessible place, just below the inlet header which protrudes approximately 2m from the top of the boiler. A procedure was developed to enable the full 21m length of the spine inside the boiler pod itself to be examined.

Figure 1. Experimental trials on the full scale mock-up at TWI

During one of the regular Teletest inspections, at Heysham 1 power station in September 2013, a significant change in response was detected from the central part of one of the boiler spines. As a result, two of the eight boilers at Heysham 1 Reactor 1 were shut down pending further investigations. The indication was confirmed to be a structurally significant crack in the spine concerned. The crack detected was at the exact position and of the approximate extent reported by Teletest, which had detected the flaw from some 10m away.

All four reactors at Hartlepool and Heysham 1 power stations were shut down in the latter part of 2014 while a new safety case for return to service of the remaining boilers was made. There is currently no viable alternative to guided wave inspection for monitoring the integrity of these boiler spines and a significant programme of work has been carried out to demonstrate the performance of Teletest for detection of flaws in these components under a variety of circumstances in order to support the safety case for operation. This has involved theoretical modelling, review of information contained in historical inspection data, practical tests on a full scale mock-up component, development of high temperature Teletest tooling to allow in- service tests and production of automated Teletest data collection equipment to allow real time in-service monitoring of the spines. TWI's and Plant Integrity's support enabled all four reactors to be returned to service before the end of 2014.