

## Background

Cokebusters was contracted by a client to carry out an in-line inspection of a ten-line Heat Recovery Steam Generator as part of their scheduled maintenance turnaround.

The inspection was executed using the patented Cokebusters smart pigging system for accurate geometric assessment of both the evaporator and economizer coils in ten separate lines, containing two different nominal tube sizes: 3 and 4-inch.

The single bodied, neutrally buoyant design allowed the smart pig to travel easily from inlet to outlet and back again, effectively carrying out two inspection runs in one operating procedure. This superior manoeuvrability is a distinct advantage of the Merlin design over other smart pigging systems. Furthermore, the furnace contained a number of short radius bends which the pig was able to navigate successfully.

## Cokebusters Smart Pig

The Cokebusters' Mark IV Smart Pig is a single bodied un-tethered device, which employs a series of ultrasonic transducers to measure wall thickness and internal radius, circumferentially, along the full length of the heater coil, effectively scanning the process tubes for geometric abnormalities or defects.

The Smart Pig records and stores the received data to its on-board memory, which is later uploaded, via USB, for analysis and post processing.

Reporting formats include tabulated data, graphical plots and a customizable 3D reader version of the entire heater coil (C-scan).

Figure 1 – Example Cokebusters' Smart Pigs



## Bend Coverage

During a meeting with the client, it was requested that an attempt be made to improve measurement accuracy and return bend data coverage.

To achieve an increase in measurement accuracy, a complete calibration process review was carried out, resulting in significant improvements in wall thickness and internal radius measurement accuracy.

Moreover, a new prototype alignment brush was designed and developed in an attempt to improve bend data coverage. Having used this new design concept during this inspection, bend coverage was increased to >70% in the 4-inch return bends.

## Inspection Results

Six areas of possible localized internal wall loss were observed in the Evaporator 2 & 3 tubes in lines 3, 6, 7, 9 and 10. The possible wall loss was identified by an increase in internal radius measurement from the surrounding mean values.

Unfortunately, it was not possible to obtain wall thickness measurements at these points. This is likely to be due to an irregular interior surface topology resulting in ultrasonic scatter or deflection at the areas of internal loss/corrosion. The increase in internal diameter was clearly visible in the graphical plots (**Figure 2**) and 3D C-scans which accompany our report (**Figure 3**).

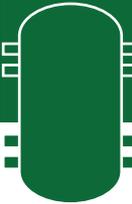


Figure 2 – Graphical plot showing internal diameter increase in Evaporator 2 & 3 Tube 10

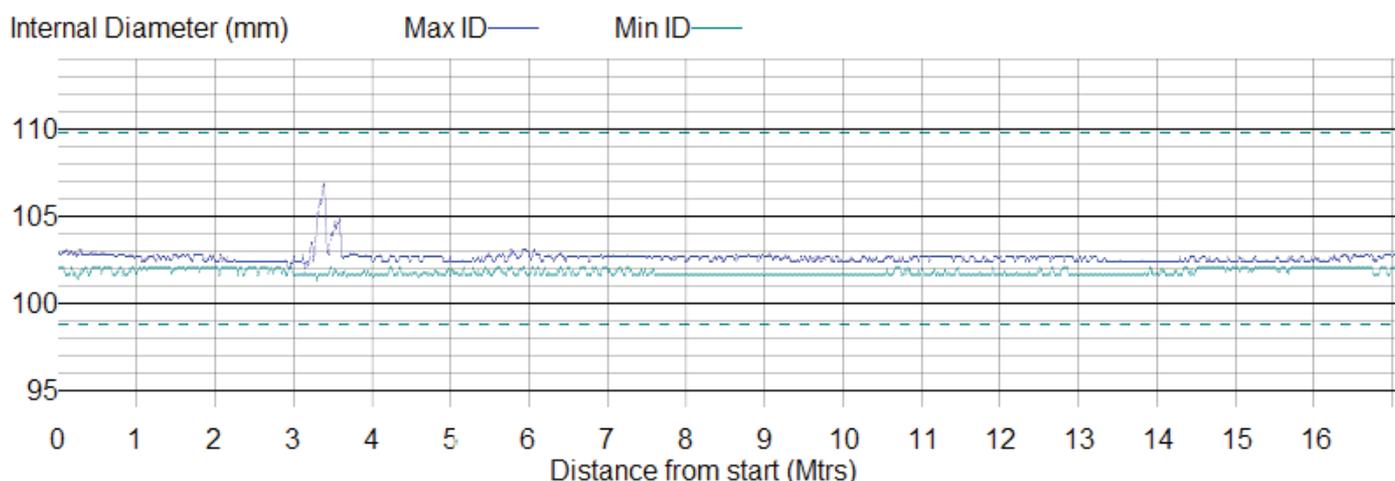
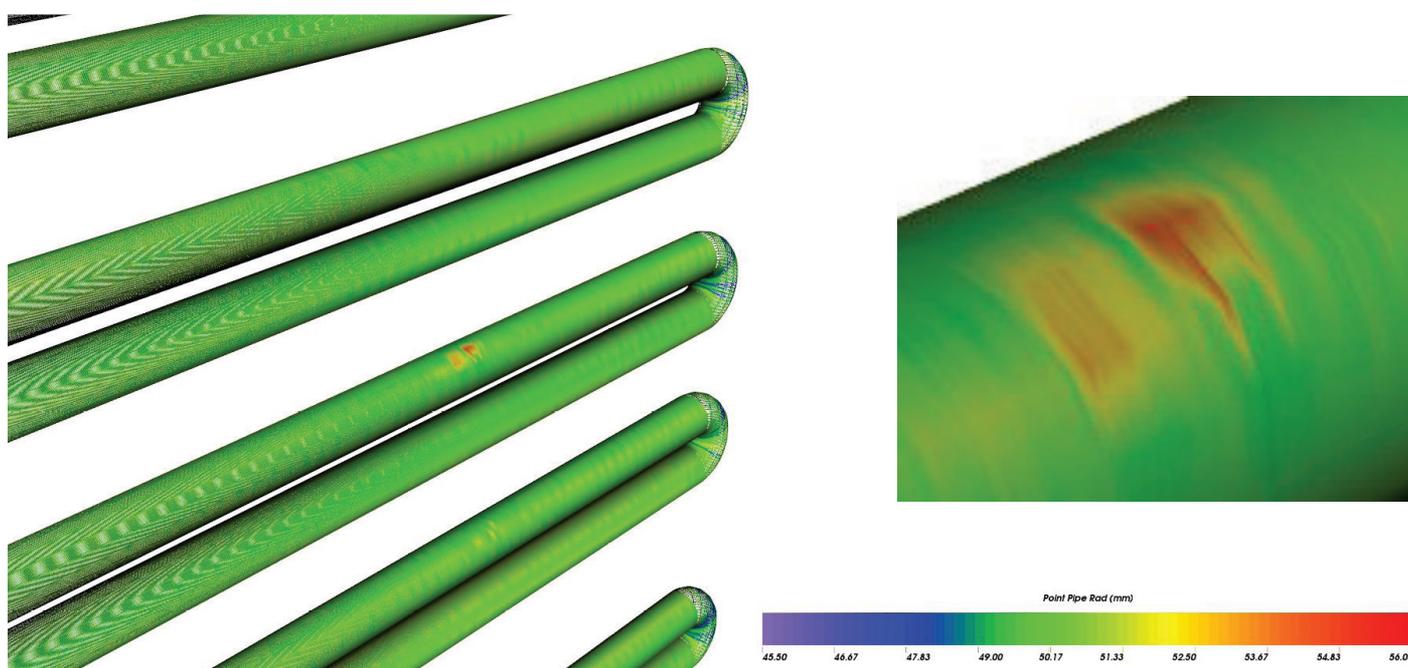


Figure 3 – Internal diameter 3D C-Scan



## Conclusions

Following the Inspection, the tubes that were identified as damaged were removed upon Cokebusters advice. It was recommended by Cokebusters that a metallurgic tube sample was obtained from the affected areas to carry out a full EDX/XRD analysis. The presence of metallic copper, iron hydroxide, magnetite and metal oxide scale would confirm that caustic attack is the mechanism responsible. All defect quantification and location were confirmed by the client using manual UT methods.

Caustic attack is a major concern for HRSG processes, but is avoidable if preventative measures are taken.

It's essential corrosion deposition is minimized by applying a suitable chemical treatment and monitoring arrangement within the feedwater supply system. The prevention of excessive sodium hydroxide concentrations within the feedwater system can be carried out using adequate boiler water treatment and accurate monitoring of the water supply. Regular descaling and smart pigging operations are also recommended for total preventative maintenance.

