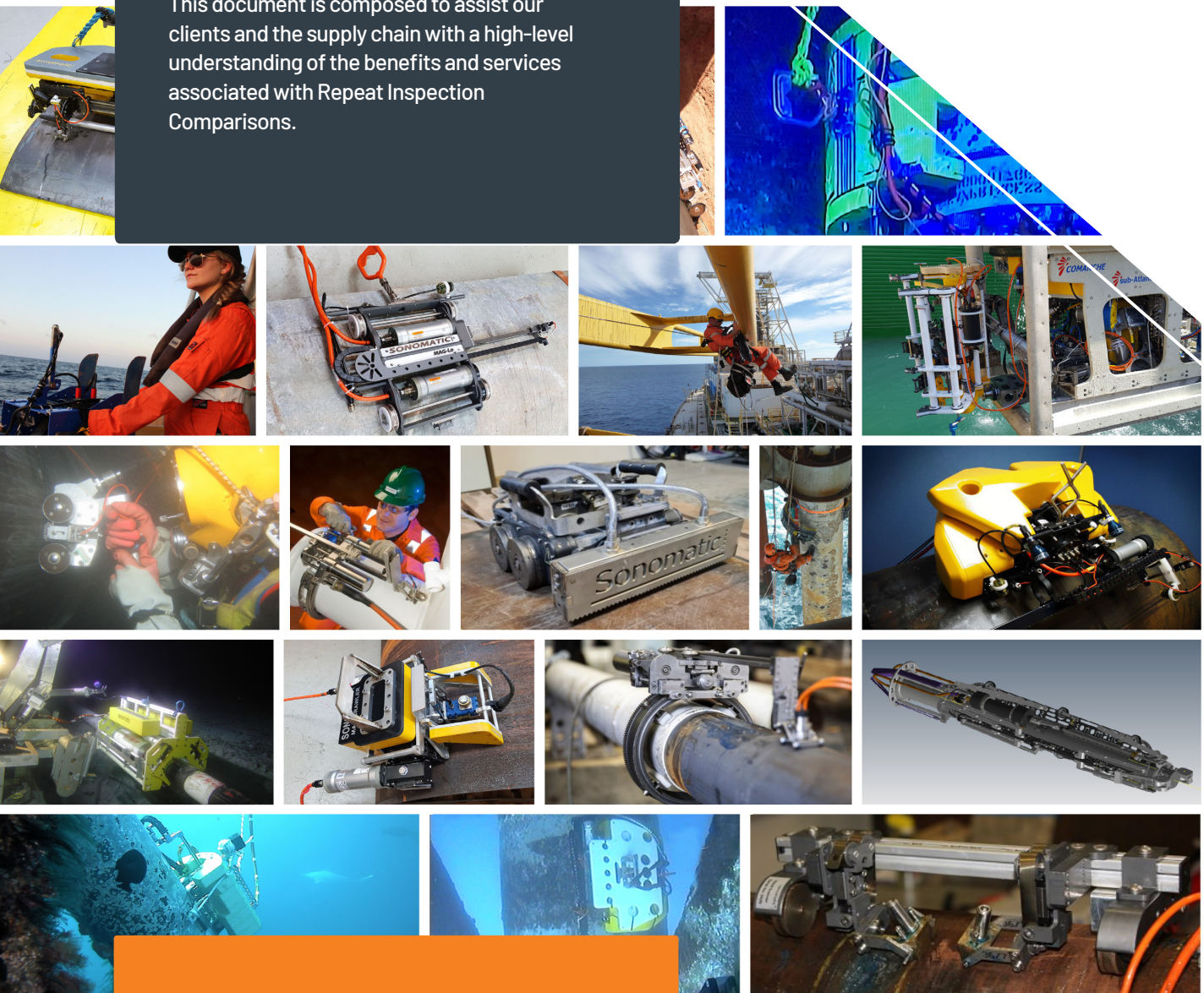
# DATA SHEET

## REPEAT INSPECTION COMPARISONS

SONOMATIC

## THE PURPOSE

This document is composed to assist our clients and the supply chain with a high-level understanding of the benefits and services associated with Repeat Inspection Comparisons.



# REPEAT INSPECTION COMPARISONS

Repeat inspections of areas for monitoring purposes, or an area of concern are routinely performed. The common industry method on which repeat inspections are compared is to simply compare the recorded minimum between the inspections. However, this is likely to be misleading as there are several factors that can cause variation in recorded thickness between inspections such as:

- Surface conditions
- Signal quality
- Degradation morphology
- Coupling efficiency
- Temperature
- Calibration

An ultrasonic signal relies on a signal travelling through steel to the back wall, bouncing off it and returning to the probe. On an uncorroded surface, good quality signals are expected but on an area with corrosion the back wall will not be smooth and thus poorer quality signals are obtained. Therefore, absolute comparison of the minimum reading has inherent limitations due to poorer signal quality.

These factors can make the overall recorded minimum appear to be greater or less than reality and, therefore, not an accurate representation of the current state.

In addition, comparing a single minimum cannot consider the condition of the material elsewhere in the inspection area. Looking at the whole inspection region, additional valuable information can be obtained. For example:

- Growth in areas of thinning while a minimum remains stable, which could have fitness-for-service implications.
- Providing evidence of early stage thinning elsewhere.

To better illustrate inspection regions as a whole, and to provide maximal value from a repeat inspection, Sonomatic has developed and applies a number of specific statistical techniques for the analysis of repeat corrosion mapping inspections. The results are analysed using cumulative thickness distributions, which indicate the proportion of area below a given wall thickness. This allows comparison of all the thickness measurements in a given area whilst emphasising the lower wall thicknesses associated with corrosion.

## REPEAT INSPECTION OF VESSEL DOME

Sonomatic conducted a repeat inspection of a vessel dome. The dome was inspected while the vessel was offline and at ambient temperature in 2018 and again in 2020 while the vessel was online, the operating temperature was 115°C. The inspection results recorded a 0.4 mm increase in minimum thickness between the two inspections. Figure 1, shows the composite thickness maps side-by-side.

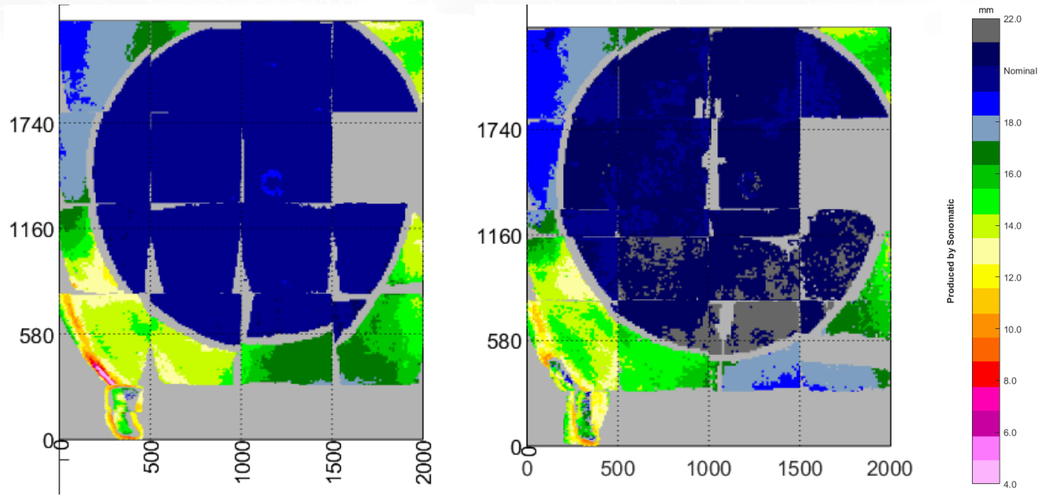



Figure 1: Corrosion map 2018 (left) v 2020 (right)

Ultrasound travels through steel at different speeds for different temperatures, in fact at higher temperature the thickness readings would expect to be thinner (faster speed), but the data indicates an increase in thickness, so other factors must be involved.

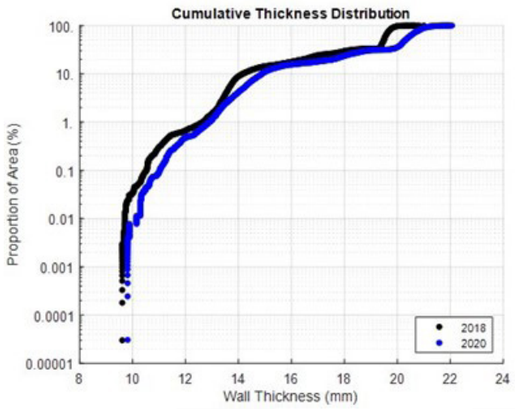



Figure 2: Un-aligned thickness distributions

Plotting the thickness data, as shown in Figure 2, shows that there are discrepancies in large parts of the curves and the data does not align well. This was likely the result of systematic differences between the campaigns, largely driven by the large variation in temperature between the inspections. This discrepancy is illustrated best in the upper parts of the curves, which represents uncorroded material. There is a clear offset between the curves on this portion which is representative of a systematic offset between the inspections.

To correct for this and achieve an accurate comparison of minima between inspections, as well as the inspections more generally, the curves are aligned at uncorroded material as shown in Figure 3. Until approximately 14.0 mm, the curves now align well at thicknesses of 14.0 mm and above, there was no discernible change between the inspections. An offset of 1.0 mm was required to align the curves, meaning that results varied between the inspections by 1.0 mm.

Once accounted for, this highlighted two findings:

1. The true change in minimum between the inspections was a 0.6 mm decrease, not a 0.4 mm increase.
2. There is also a change in behaviour in the curves between 12 mm and 13 mm, showing that measured in that thickness range have grown, which could point to early-stage thinning.

Both of these observations were crucial inputs into the clients ongoing integrity management of the vessel.

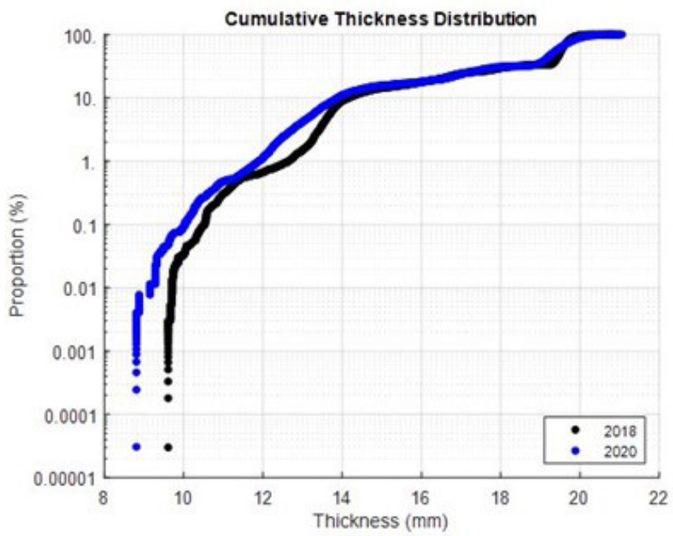



Figure 3: Aligned thickness distributions

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