

## Statistical Analysis in support of Integrity Management Activities



Integrity management of pressure equipment relies on an understanding of the condition of the equipment. Inspection plays a major role in providing the necessary information and in many instances a significant amount of data will be generated over the life of an equipment item. This represents a valuable resource for input to effective integrity management but it is often the case that it is not fully utilised. There are a range of statistical analysis approaches that can assist in enhancing the value of data available and the results can form valuable input to a variety of integrity management decision making processes. Sonomatic offers a number of these approaches, as outlined in this document.

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Sonomatic has offices in strategic global locations so we can respond quickly to customers' requirements wherever they may be situated. Our high quality products are matched only by our customer service. In addition to our field services, we offer training and consultancy at our sites in the UK or at clients' premises anywhere in the world.

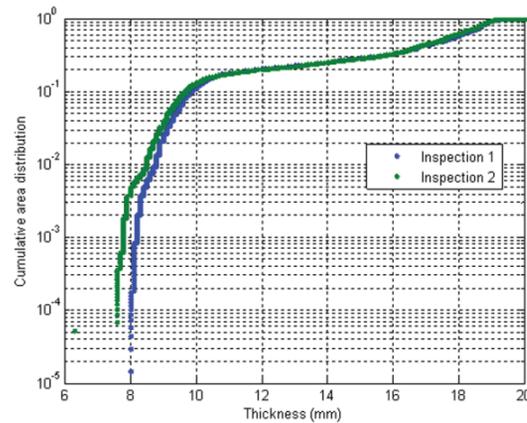
Sonomatic is committed to improving asset performance through applied and innovative technology; to delivering these benefits to our customers in the products and services that we provide; and to working with our customers, as value-added partners, to realise the maximum benefits of inspection technology.



### Analysis of wall thickness data for pipework

Inspection of pipework often involves taking point wall thickness measurements or recording the minimum value measured in a scan over a specified area. When several sets of inspection data are available, it is possible to use the data to identify trends, i.e. to estimate corrosion rates in different regions. The nature of typical ultrasonic wall thickness measurements, particularly with respect to accuracy and repeatability, demands that a specific approach should be used in the analysis of the data to maximise its value.

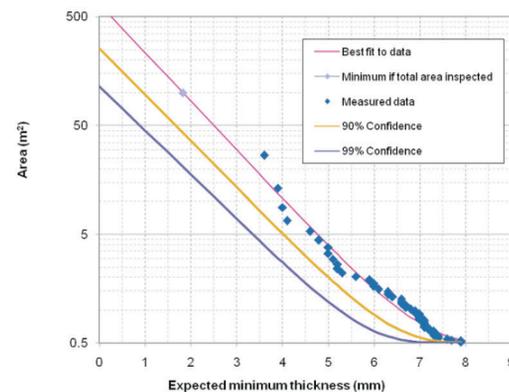
Our approach considers the variability in the measurements and the nature of the techniques employed to estimate confidence limits for projections made using historical data. The value of the data is also enhanced by correlations with areas identified as subject to similar conditions. This type of analysis is particularly valuable as input to decisions on inspection intervals, e.g. does the current interval provide the required level of assurance? Can the interval justifiably be extended, or should the interval be reduced?



### Extreme value analysis to assess coverage requirements

Many systems are subject to inspection that has less than 100% coverage. This is often approached on the basis that areas for inspection are selected so that their condition will be representative (or worse than) the condition of the regions not inspected. It is, however, often difficult to justify, on a quantified basis, that the coverage applied is sufficient to provide the required level of assurance. Statistical analysis of the data measured offers a solution to this problem.

Our approach is to carry out an extreme value statistical analysis of the measured data to estimate probabilities for the minimum thickness in the regions not inspected. The coverage directly impacts on these probabilities and the associated confidence levels. Hence the statistical analysis forms a basis for assessing whether the coverage applied is sufficient to demonstrate the desired level of assurance. We have significant experience in using this approach for the analysis of wall thickness data from vessels, both as a means of supporting non-intrusive inspection programmes in place of internal visual inspection and as input to fitness for service assessments. The approach has also been applied to pipework, as a means of assessing if sufficient inspection has been carried out. It has proven valuable in identifying differences between lines, i.e. which areas demand greater attention relative to others.



### Bayesian updating for inspection planning

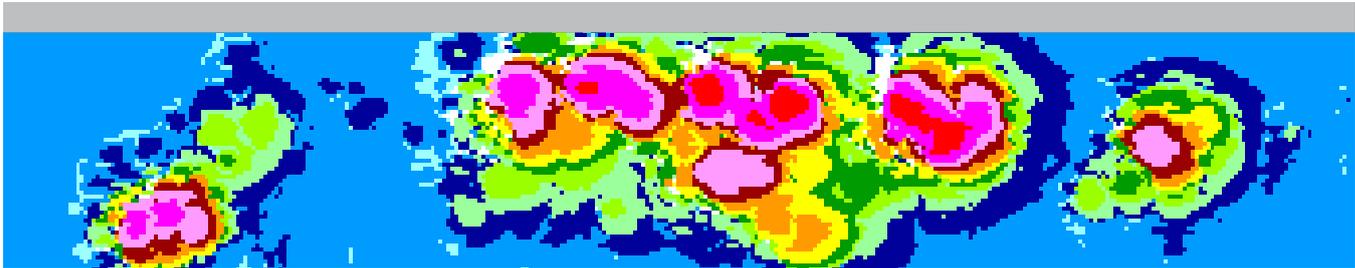
Bayesian statistics provide a means of best estimating probabilities on the basis of limited information. Bayesian updating refers to methods used for revising the estimates as new information becomes available. Hence Bayesian approaches provide a framework for moving from the general, i.e. what would the average expectation be in a situation about which limited information is available, to the specific, i.e. what is the expectation when additional information specific to the case under consideration is available. This has numerous applications in integrity management but is particularly useful as a means of assessing the effects of inspection on the level of assurance. A view on the probability of degradation (of different extents) being present can be arrived at prior to an inspection being carried out on an equipment item. The accuracy of this will depend on how much is known about the operating conditions and the history of the equipment. This estimate will influence the inspection performance requirement (i.e. the probability of detection and coverage) and hence act as useful input to inspection planning. The results of the inspection (and knowledge of the inspection performance parameters) provide input for updating the initial estimate using the Bayesian approach. This forms a quantified basis for the revision of risk rankings, e.g. in an RBI approach, and also allows sensitivity studies to be carried out to assess the impact of different types of inspection on assurance.



We are able to provide assistance in applying the Bayesian approach as a means of enhancing an existing integrity management programme or in developing methodologies for integration in such programmes.

### Summary

We offer a range of statistical analysis methods aimed at enhancing the value of inspection data and providing quantified inputs to assist planning and evaluation. At the same time, we understand the limitations of the methods and only apply them in circumstances where they are appropriate. If you are interested in assessing whether these methods may be of value in your application, please contact one of our worldwide offices.



## Statistical Analysis in support of Integrity Management Activities

### QA and HS&E

It is Sonomatic's ongoing commitment to supply services and products, through the application of technical and engineering excellence, which complement both the customer's and our own QA and HS&E requirements.

Sonomatic's commitment to quality is maintained through continuous assessment and review of our Quality Management Systems to BS EN ISO 9001:2008. Sonomatic actively promotes the development, implementation and improvement of our QMS as a part of our ongoing drive to enhance customer satisfaction by meeting or exceeding customer requirements. In 2009 Sonomatic achieved UKAS accreditation as an Inspection Body to BS EN ISO/IEC 17020 (UKAS IB4276).