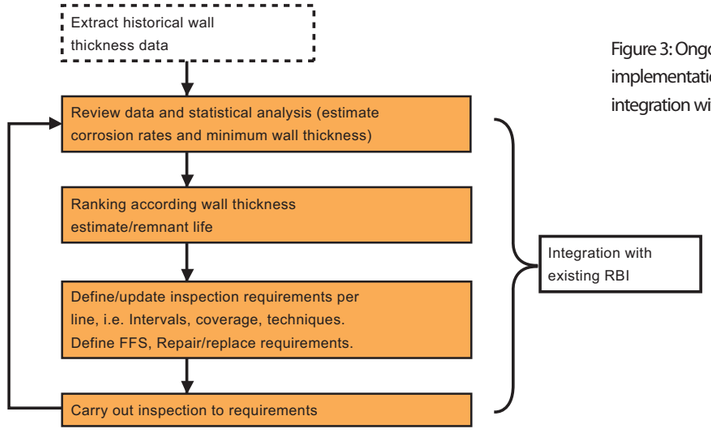


Figure 3: Ongoing implementation and integration with RBI

Ongoing application and integration with existing RBI schemes

The process outlined above forms a basis for ongoing pipework inspection planning as shown in Figure 3. Most operators have RBI schemes already in place and these are actively used for planning of pipework inspection. Hence the Sonomatic approach to pipework inspection planning is designed to integrate with existing RBI schemes through provision of additional information, based on the analysis of the inspection data. This information is taken on board at two stages in implementation the RBI scheme, (i) during workpack development to identify inspection requirements and (ii) during the integrity review stage when requirements are updated on the basis of all relevant information available. To ensure straightforward integration, the data is provided in a number of formats ranging from a detailed analysis and planning pro-forma for each type of feature on a line by line basis through to summary sheets providing high level information. This makes it straightforward to access the level of detail needed at any stage in the review and planning process.

Experience

Sonomatic has worked with many of the major UK North Sea operators to maximise the value of existing pipework inspection data and to develop inspection planning processes that include statistical analysis. These projects range from analyses on single lines through to development of planning approaches for significant process systems covering several thousand lines. References are available on request.

We offer a unique combination of in-depth understanding of (i) statistical analysis methods for corrosion data, (ii) the capability and limitations of inspection methods and (iii) inspection planning approaches that deliver value.

Benefits to the operator

Our approach to application of statistical analysis to enhance inspection planning for pipework has a number of significant benefits to operators. These are summarised below.

- Process makes best use of measured condition of pipework as input to planning. There is value in the inspection data beyond "condition acceptable" and the approach uses this to enhance decision making.
- Improved classification of corrosion/failure susceptibility and increased confidence that inspection is appropriately applied according to risk.
- Structured approach to inspection planning ensuring that value of investment made in inspection is maximised.
- Assists in achieving a cost effective inspection programme without compromising integrity.
- Provision of information allowing effective QA checks on the inspection planning and delivery processes.
- Tailored to individual requirements.

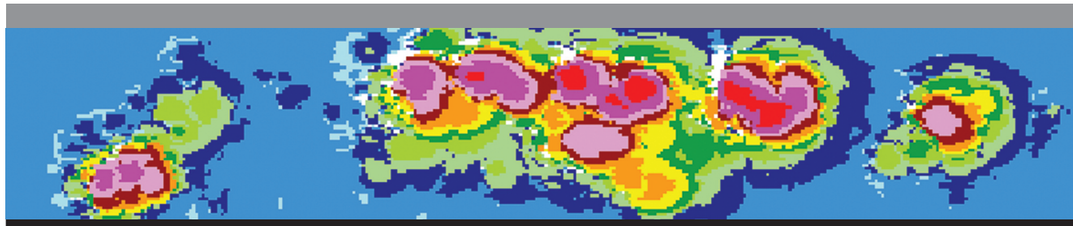
Implementation of the approach yields a significant cost-benefit ratio through a combination of more focussed inspection spend and improved understanding of risk that can be expected to reduce unplanned shut-down time.

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).

sonomatic®
innovative inspection technologies



Pipework Assessment and Inspection Planning

Integrity of pipework is essential to safe and reliable operation of process plant. The results of inspections, during which wall thickness measurements are made, form the main basis for providing assurance of pipework condition. The inspection requirements for pipework systems are typically significant, with wall thickness measurements being made at large numbers of locations in an ongoing programme. Large volumes of inspection data are generated over time and this contains information that is of considerable value in understanding pipework condition and ongoing integrity requirements. Sonomatic has developed and implements a methodology, based on in-depth statistical analysis, that makes use of already available and newly generated data to understand the current state of the pipework, identify active degradation and significantly enhance the inspection planning process. This represents a major advance over planning processes currently in place and delivers substantial benefits to operators adopting the approach.

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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.

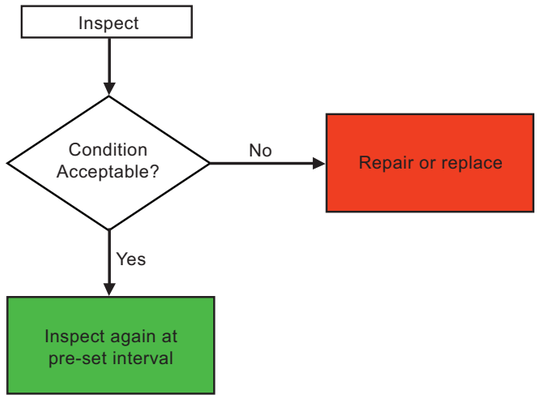

Figure 1: Historical Pipework Inspection Planning Process

Background

Integrity of pipework is essential to safe and reliable operation of process plant. The results of inspections, during which wall thickness measurements are made, form the main basis for providing assurance of pipework condition. The inspection requirements are typically significant, with wall thickness measurements being made at a large number of locations in an ongoing programme with intervals determined by Risk Based Inspection (RBI) methods. Historically this data has been used principally to establish confidence in the condition of the pipework at the time of the inspection and to identify anomalies that require follow up action. This process is summarised in Figure 1

A large amount of data is generated in the process but it is often not put to full use. In many cases the inspection results are simply filed on completion of review and play little further role in the integrity management process. In certain cases the data is used as input to corrosion databases that have some limited trending capability but again full advantage is not taken of the available information.

Sonomatic has developed and implements a methodology, based on in-depth statistical analysis, that makes use of already available and newly generated data to significantly enhance the inspection planning process. A key difference in this approach is, as shown in Figure 2, that the data is used for more than just an assessment of current condition but the results of the analysis carried out become a key input to the planning process.

The analysis carried out allows identification, with quantified reliability, of corrosion susceptibilities in the system and is used to provide prioritisation of activities. This ensures significantly improved alignment of the inspection requirements with the risks per line or system. The resulting benefits to the operator are significant, through ensuring best use of inspection resource and an improved understanding of system risk. This process maximises the value of already existing inspection data and enhances the return on the investment made, typically over many years, in gathering this data and likewise maximises the value of the forward inspection programme.

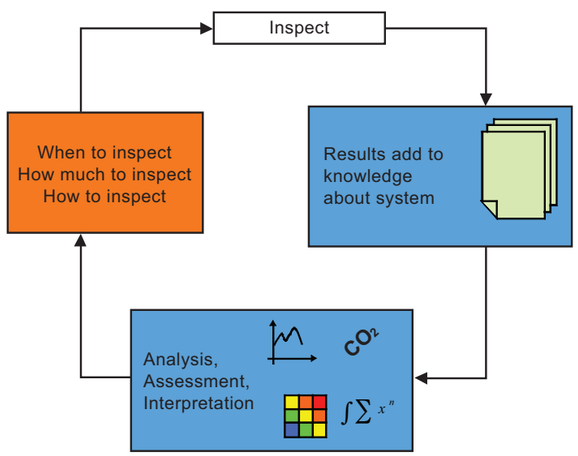

Figure 2: Improved use of inspection data for effective planning

Data analysis and inspection planning approach

The main objectives of the approach are to generate a reliable ranking for inspection and to provide inspection recommendations for each line in the system(s) under consideration. Sonomatic has developed a structured approach to ensuring these objectives are met. The main steps in the process are summarised as follows.

- Review of pipework system(s) to develop an understanding of corrosion circuits, similar corrosion conditions, isolation of different feature types, most effective approaches for grouping of data etc. At this initial stage a good understanding of the system(s) is developed so that there is a basis for interpretation of the analysis, i.e. results from the analysis are not just blindly accepted but there is a strong level of interrogation to assure reliability of conclusions. Application of time based trending to identify degradation on a grouped basis. This approach can reliably discriminate down to low rates of degradation, which analysis of individual inspection locations can overlook or attribute to measurement error.
- Application of extreme value analysis on existing data to make estimates of the minimum thickness values for each feature type (e.g. straight, bend, reducer etc) on a line by line basis. The approach includes detailed error analysis, based on an understanding of the inspection systems/processes used to gather the data, to provide a measure of the reliability of the estimates made. The estimates of minimum thickness are used to generate a ranking of corrosion damage throughout the system.
- Application of statistical analysis of all available history to make estimates of corrosion rates.
- Estimation of remaining life based on the thickness and corrosion rate distributions. This allows remaining life estimates, with quantified reliability, to be made based on the available data. The remaining life estimates consider a range of conditions including corrosion limits, fitness for service limits, and leakage or rupture as appropriate. An understanding of the remaining life distribution provides significant insight to the susceptibility to failure for different lines in the system.
- Generation of a ranking according to current condition and estimated remaining life.
- Provision of inspection recommendations per feature type in each line in the system. These recommendations include the type of inspection to be carried out, the coverage (number of features of each type) and the inspection interval. The recommendations are made by consideration of the ranking and take into account the consequences of failure.
- In addition to the above recommendations which form the basis for ongoing implementation, a series of short term, immediate priority actions are identified to deal with, for example, lines identified as having an unacceptable risk of failure in the short term, assessment of anomalies and lines where there is insufficient information to come to a reliable view on risk ranking.

At each stage at which results are obtained a review is carried out to check the validity of the result and the basis of applicability of the analysis based on the available data. This is essential to making reliable recommendations.

It is also worth noting that the process provides a range of useful information for a QA review of the inspection planning system and management/execution of the inspections. The analysis identifies, for example, any outstanding inspections, outstanding anomaly reviews, outstanding integrity reviews. It can also help identify issues related to the inspection itself, e.g. to what extent are the workpack requirements in terms of inspection locations followed, is there consistency in procedures, is the variability in results consistent with best practice implementation of the inspection methods. In all cases the output is tailored to meet the customer's specific requirements.