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iQRA White Paper

Enhancing oilfield safety and operations using component reliability data

Benchmarking the reliability of safety and cost-critical components against a global reliability component database can increase safety in oil and gas operations and optimise asset performance, writes Wood Group Intetech's Suzana Westaway.

Managing the integrity of assets and ensuring their optimum performance has become a significant strategic concern for oil and gas operators. Integrity management systems deliver the level of visibility, transparency and confidence demanded by today's risk-averse environment.

Advanced software-based solutions for wells combine well integrity and well reliability management – either as separate systems or as an integrated solution. These applications can interface with a wide range of third-party databases to collate the necessary information for analysis.

Well integrity depends upon the reliability of individual components. Reliability can be considered as the ability of a component or system to perform a function within a specified performance range, under defined operational conditions for the required time. The higher the reliability of the components, the higher the integrity of the well.

Reliability is expressed through different reliability figures, some of them being mean-time-to-failure (MTTF), failure rate (FR), survival probability (R) and probability of failure on demand (PFD). They should be calculated based on trusted experience data. The capability to evaluate these reliability figures via a selection of queries provides vital intelligence on the expected life of components.

Component reliability

Component reliability information can help substantially reduce operational expenditure (OPEX) by enabling operators to adopt risk-based inspection frequencies and performance-led maintenance schedules instead of having to contend with corrective remedial maintenance, including urgent well interventions. The insight of equipment performance gained from an understanding of historical information results in a more reliable equipment selection for new wells. This insight may also help vendors improve component performance by highlighting areas for existing product modification or paving the way for the development of new ones.

Reliability data also helps operators to quantify risk. Risk evaluation is already enshrined in UK health, safety and environmental (HSE) practices and in Norway, where the Petroleum Safety Authority (PSA) strongly recommends that each well with compromised well barriers has to be individually assessed. The PSA advises that the dispensations authorised for any well must be presented with a relevant quantitative risk analysis, which must be based on reliability data.

Adding global component reliability data to a well integrity system enables operators to understand how their equipment performs where there are different regulations, working cultures, or different standards of equipment manufacturing or operations. These broader global datasets also allow operators to evaluate the performance of components based on the well environment (subsea or topside offshore, or onshore), and on well types such as oil or gas producers, and water or gas injectors.

Comparing the relative performance of components with identical functions is a critical exercise given that each may have different mechanisms and root causes of failure. Making the correct evaluation with high quality data delivers huge benefits for operators in driving up the reliability of their equipment over time, and realising substantial reductions in total cost of ownership.

The ability to track the performance of components that are not only safety critical, but those that also have a major cost impact on operations for replacement, allows operators to track year-on-year how their assets are performing. In turn, they can assess whether that equipment is failing at a rate that is higher than the industry average.

Well barrier components

The performance of installed well components needs to be predictable. Should a problem arise at any point in time, operators must be confident that they understand how critical well barrier components will respond on demand. For example, if a subsurface safety valve (SSSV) is closed, then it should be known with some measure of certainty that it's going to close and contain the well fluids in the specified timeframe.

Most operators acknowledge that certain well barrier component failures are inevitable and operational constraints may mean that they cannot be repaired immediately. It may still however, be possible for wells with individual damaged or faulty safety-critical components to continue to operate, provided that risk assessment shows that the risk level is acceptable, or the well barrier envelope can be re-defined to make it acceptable. Of course, some types of failure call for the well to be shut-in and repaired immediately, but in many cases repairs can be scheduled to take place within a designated timeframe, or when the opportunity arises.

Safety-critical failures detected by regular testing (such as failure to close on demand, or SSSV leakage when in a closed position) are used to calculate PFD. A PFD figure expresses the average unavailability of a component in two ways: it is the percentage of time the well is unprotected by the safety barrier, and it is the probability that the barrier will fail should it be used in an emergency shutdown. If the PFD value is below that defined by regulators, testing frequency has to be increased.

Testing can reduce the life expectancy of the equipment, especially an active component that is opened and closed – each cycle causing some amount of wear and fatigue. Using risk-based analysis to determine that testing can be safely performed less frequently should extend the lifetime of valves and reduce OPEX. Access to testing and reliability

information makes it possible for operators to identify where they have low reliability equipment or a faulty component installed. Potential failures on other wells can be pre-empted by taking the opportunity to replace a piece of equipment if another well intervention is taking place.

Better insight, better decisions

Obtaining accurate reliability figures for well barrier components requires access to a statistically significant database. Whilst the industry recognises this need, a key challenge has been the hesitance of operators to make data, such as component reliability and failure rates, available externally.

In addition to concerns over data confidentiality, efforts to build such a database have been limited to a specific region. In Norway for example, several operators have recognised the benefits of using component reliability data and made substantial savings as a result. However, they have primarily focussed on specific components such as the SSSV. Some databases have not been ideally structured for purpose. Others have suffered from poor quality of data, or issues with usability and access.

In response to the industry demand, Wood Group Intetech has launched a global database of well component performance data. Known as 'iQRA', this online experience database includes a reliability analysis tool and is providing operators with access to global well and oilfield component performance information.

Subscribers to iQRA can identify the best performing well components, and benchmark the performance of components within their own organisation, and against industry averages. They can also extract reliability and availability numbers to support a range of cost-saving decisions based on facts.

Meeting user needs

iQRA allows operators to make independent and impartial assessments of reliability performance. For example, decisions on well components for new well designs or replacements during workovers can be made based on the best performing and most reliable equipment. High reliability components are essential to reduce well entries, minimise corrective maintenance activities, and extend the life of wells.

iQRA's ultimate aim is to equip operators with the insight they need to ensure safety and optimise well operations by identifying potential weaknesses and pre-empting future issues. The ability to estimate when component wear or fatigue will occur allows operators to optimise workover schedules by evaluating cost versus replacement interval.

Adopting a cost and safety-driven preventive maintenance campaign makes a huge difference in terms of reducing OPEX and risk. OPEX relates not only to the cost of the equipment itself, but the cost of well interventions combined

with the loss of production. Risk relates to loss of company reputation as well as financial and potentially legal restitution should an incident occur if well integrity is compromised.

Reliability figures also enable operators to understand the limitations of existing technology when exposed to certain operating conditions. These figures can then be used as input in further calculations in order to find more robust well configurations and build wells with higher integrity, less failures, and increased production uptime.

Application of reliability data

During the early phase of field development, reliability data supports decisions concerning well configuration, selecting well equipment and materials, and estimating the number and type of well interventions. This forms part of capital expenditure (CAPEX) forecasting when developing the field, i.e. how many wells must be drilled, the equipment needed, and what the cost of that equipment will be. The same calculations apply when forecasting the OPEX for that field.

Operators also require component reliability data for calculating the safety integrity level (SIL) of their platforms or installations, while vendors employ this data to create a safety analysis report (SAR). In some parts of the world, equipment vendors cannot go to tender without presenting this calculation, as operators need the SAR to calculate the SIL.

During the operational phase of a well, component reliability data enables operators to estimate the OPEX associated with extending well life by evaluating factors such as the level of required maintenance versus the profit that can be extracted. Component reliability data also supports QRAs for procedures such as well dispensations when the well barrier is compromised, and recalculating SIL for platforms or installations. Finally, it supports the planning process for plugging and abandonment.

Experience data

‘Experience data’ relates to capturing both the component’s operational service time, and the additional information that describes that failure in more detail: when it happened (failure type); how it was observed (failure mode); why it failed (failure cause category); and, finally, the root cause of failure. Experience data is expressed in terms of predefined failure modes for each component and predefined cause categories and, ideally, the root causes. An example for SSSV would be:

- When it happened: During operations
- How it happened: Failed to close on demand
- Why it failed: Internal cascading failures (control line failure)

- What caused it: Squeezed control line

The amount of experience data available often depends on operating culture. The reporting of failures sometimes lacks rigour due to production demand prioritisation and the focus on repair or replacement which prevents a timely and thorough failure investigation.

In addition, it is valuable to identify instances where:

- The component was used outside of specification (design temperature and pressure)
- There are multiple registrations of the same failure due to inadequate testing methods or unclear definitions of failure modes
- There is inadequate reporting of installation details and failure data
- The quality of the reported data is questionable

The above points are part of the quality review that is undertaken routinely by Wood Group Intetech in reviewing datasets prior to inclusion in the iQRA software. This quality control step ensures operators are able to trust the data behind the evaluation.

Adding certainty

A major driver for iQRA is that users can compare experience data from around the world. They can use this to not only benchmark the performance of their own equipment, but to increase the accuracy of their reliability calculations by filtering out irrelevant data.

Regulatory regimes differ by region, thus the way in which failures are identified and reported subsequently vary. Operating conditions, working procedures and testing regimes also vary from operator to operator, so that the most relevant data for making certain decisions (like preventive maintenance intervals) is that captured from their own assets, as it most accurately reflects their adopted working philosophy.

However, broad performance comparisons of the reliability of specific components can be made on large datasets where the dataset is not heavily skewed to particular conditions. When comparing the same component from two vendors, filtering out data captured from wells with significantly different operational conditions will reduce the uncertainty of the result.

Optimising oilfield performance

There are three key elements in optimising asset performance: designing robust wells with higher integrity; choosing intervention strategies that are the most timely and cost effective; and implementing the correct operating

procedures. Addressing these areas with the appropriate level of rigour, and supported by the necessary component reliability data, increases well production uptime and minimises OPEX.

The benefits of a global database of component reliability thus extend far beyond single component reliability and well integrity. As the global oil and gas industry increasingly aims to quantify decision-making based upon a risk evaluation approach, the need for a trusted resource for oilfield component reliability data will continue to grow.

This reliability analysis tool can be accessed from anywhere via a standard web browser. In a few clicks users can build data queries for individual well components based on regional, environmental and supplier details.

The quality of data and ease of data provision are the most important features of iQRA. Data upload from spreadsheets or direct from third-party systems is supported to make life easier for subscribers with large legacy test failure databases. iQRA's data integrity is assured as all data submitted to the system is automatically passed through a quality assurance workflow incorporating multiple validation steps as well as manual checks by engineers.

Crucially, iQRA keeps the sources of data strictly confidential. Sensitive data is anonymised and access to system functions are protected, using password strength gates and a robust set of user roles and privileges.

iQRA has been developed with flexibility at its core. It can accommodate reliability data from any component with the aim of enhancing the safety and operations of wells and other oil and gas assets.