

ThruLife – Integrity Management of Deepwater Subsea Systems

a report by

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The process of integrity management of subsea systems has been adopted by the industry for a number of years where there has been a local legislative or corporate requirement to do so. A recent example of this is in the Gulf of Mexico, where new draft regulations published in October 2007 for the first time require risk-based integrity management of riser systems. The draft regulations require a documented integrity management programme, an emergency response plan and a personnel qualification programme, which would bring the US Gulf of Mexico to a similar level of integrity management regulation as required by UK regulations post-Piper Alpha.

Traditionally, the drivers for integrity management were ensuring that a safe system was in operation and increasing system availability in the short term. Today, operators are increasingly looking at their integrity management systems to identify possibilities for extending field life past the original design conditions. The quantity and quality of data required to make these assessments can be significant and above that which is required to determine the integrity of a system today.

The integrity management of deepwater subsea systems is a special case in the oil and gas industry given the cost of subsea inspection and intervention, the limited inspection intervals available, the lead times for replacement or repair and new technologies working in deeper and harsher environments. New inspection and measurement tools are being developed throughout the industry to limit the impact of some of these challenges, and more operators are identifying the need to consider integrity management at the feed and design stages of new installations.

Integrity Management – Carrot or Stick?

Integrity management has long been considered in some parts of the industry as a required exercise that provides little or no benefit to an operator. For this reason, regulatory authorities have had to adopt a prescriptive approach to integrity and often an operator will undertake the minimum level of work required. In recent years, operators have identified additional non-regulatory benefits of operating an integrity management strategy, such as:

- long-term field planning for life extension or re-use;
- reduced inspection costs through rationalisation;
- next-generation design benefits through capturing lessons learned;
- an ability to proactively plan for repair and maintenance rather than reacting to problems as they occur;
- increased system uptime and availability; and
- rationalisation is spared.

The Integrity Management Process

Integrity management systems the world over are based on three main building blocks:

- risk assessment;
- inspection/monitoring strategy; and
- periodic review.

Depending on the subsea component, guidance exists on how to technically carry out the assessments in the form of American Petroleum Institute (API)/International Organization for Standardization (ISO) specifications, regulator guidance notes or joint industry projects. However, the main variation in integrity management system quality tends to be associated with the actual implementation of the integrity management system.

Common Problems with Integrity Management Systems

Data Management

One of the main problems associated with subsea integrity management systems is the vast quantity and range of data required. Typical information that needs managing and analysing includes:

- historical process and production data, such as pressure, temperature, flow rate, pH, composition, etc.;
- erosion and corrosion probe data;
- chemical injection data;
- material sample test results;
- dropped object register;
- vessel motion data;
- metocean data;
- manufacturing history;
- design documentation;
- corporate and regulatory governance;
- risk assessment methods and results;
- inspection strategies;
- corrosion management strategies;
- detailed inspection procedures and offshore workpacks;
- general visual inspection (GVI) and close visual inspection (CVI) videos and images;
- industry advances and best practices;



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the oil and gas industry for the last 12 years, and is a Chartered Engineer with the Institution of Mechanical Engineers (IMechE).

- future field requirements;
- specialist analysis and reports; and
- pigging results.

All of these data typically reside in separate and individual databases. This means that in some cases cross-referencing data becomes difficult, and data are often considered in isolation. Data quality can also become an issue on ageing installations where over time subsea sensors and topside probes have stopped functioning and limited data are available due to redundancy of the remaining system. Key staff change-out over the life of the asset adds another dimension.

Other problems with data management include legacy systems and information exchange and handover during change of ownership.

New Technologies

Unless new technology for integrity management is considered during the early design stages of a subsea development, it can become technically or commercially prohibitive to retrofit systems. With different staff managing the operating expenditure (OPEX) and capital expenditure (CAPEX) budgets, it can be difficult to make an argument for up-front investment, even where this is a relatively small value. This is especially true in the early stages of asset design when the OPEX budgets may not have been identified.

Big-picture Assessment and Management Visibility

Integrity management systems have a tendency to look at the present-day status based on historical conditions. Very little time is

spent looking at the future suitability of a system. Equally, subsea systems tend to be considered on a component-by-component basis, which can mean that the bigger picture of system integrity is missed.

Improvements to the Integrity Management Process

Data Collection, Analysis, Storage and Reporting

In terms of inspection data that are gathered by remotely operated vehicle (ROV), there are various methods and processes that an operator can adopt to improve the quality of the inspection data received. For example, the ROV operator could be provided with a detailed set of inspection requirement documents that have been prepared in advance of the survey. Alternatively, an integrity specialist can act as client representative offshore during the inspection campaign so that decisions can be made on-site, again limiting the need for follow-up surveys.

Software solutions are available that can take online process data, analyse them for data quality and then use them to undertake an integrity assessment of the system. The integrity status of the system is updated on a 'continual/live' basis, preventing continued damage that traditionally may not have been detected until the next periodic review, which may be annually. Integrity management reporting has a number of issues that can be improved by the use of online systems. A good integrity management system should be a live document, adapting to changes during the operation of the system.

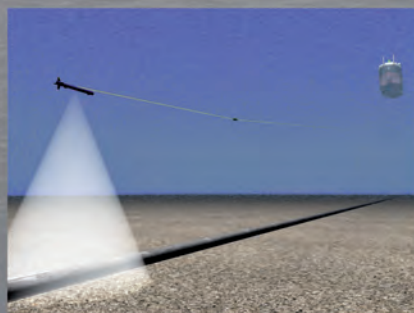
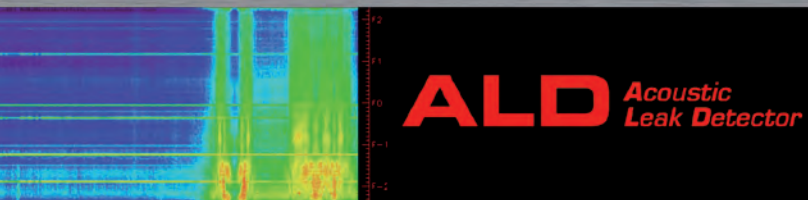
It is common to end up with yearly revisions of risk assessment reports, integrity management strategies, inspection schedules,

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New Anchor-handling Simulator Launched at ONS 2008

New specific operation simulation and procedure development functionality added

ONS 2008 was the launch pad for Kongsberg Maritime's next-generation anchor-handling simulator (AHS). Currently in development, the new AHS is scheduled for release before the end of 2008 and is being developed in parallel with a bespoke AHS for Maersk Supply Service, following a co-operation agreement that was signed in February 2008 based on over a decade of simulator collaboration. The new Kongsberg Maritime AHS fulfils all training objectives of both the anchor-handling vessel navigator and the winch operator. It also offers the possibility to simulate specific anchor-handling operations prior to them taking place and to develop safety procedures and review them after the procedure is introduced in real life.

"Anchor handling is dangerous and expensive and therefore requires maximum knowledge of the equipment and its operation," comments Kongsberg Maritime's Product Advisor, Geir Lilje. "The extra functionality in the new AHS will help to make anchor-handling operations safer as the industry concentrates on the development of such procedures in light of recent anchor-handling tragedies such as the Bourbon Dolphin."

Kongsberg Maritime's new AHS is clearly focused on very accurate ship movement and the calculation of external forces acting on the ship. To achieve this goal the company has developed a new 'line' module to present the wire, chain or rope acting on winches, guide pins or other anchor-handling equipment. It can be rendered in variable resolution and takes into account the entire range of actions possible of a line, including tension and forces, free hanging (catenary curves), interaction (or wrapping) around rigid bodies (deck, hull, etc.) and interaction with objects at ends or in the middle (winch, shark jaw, pin, drum/roller, chaser, anchor, plough, etc.). Using Kongsberg Maritime's latest SeaView R5 visual technology, the new AHS is able to create a highly realistic scene that covers all elements of anchor handling operations and can be used to train on various scenarios, such as:

- ship manoeuvring • operation of different types of AH equipment • AH operations with offshore drilling units and other anchored floaters
- retrieve and run anchors using all common type of equipment • find the optimal positions/designs of handles and instruments • towing and accurate positioning of semi-submersibles and jack-ups • deck operations and procedures. ■

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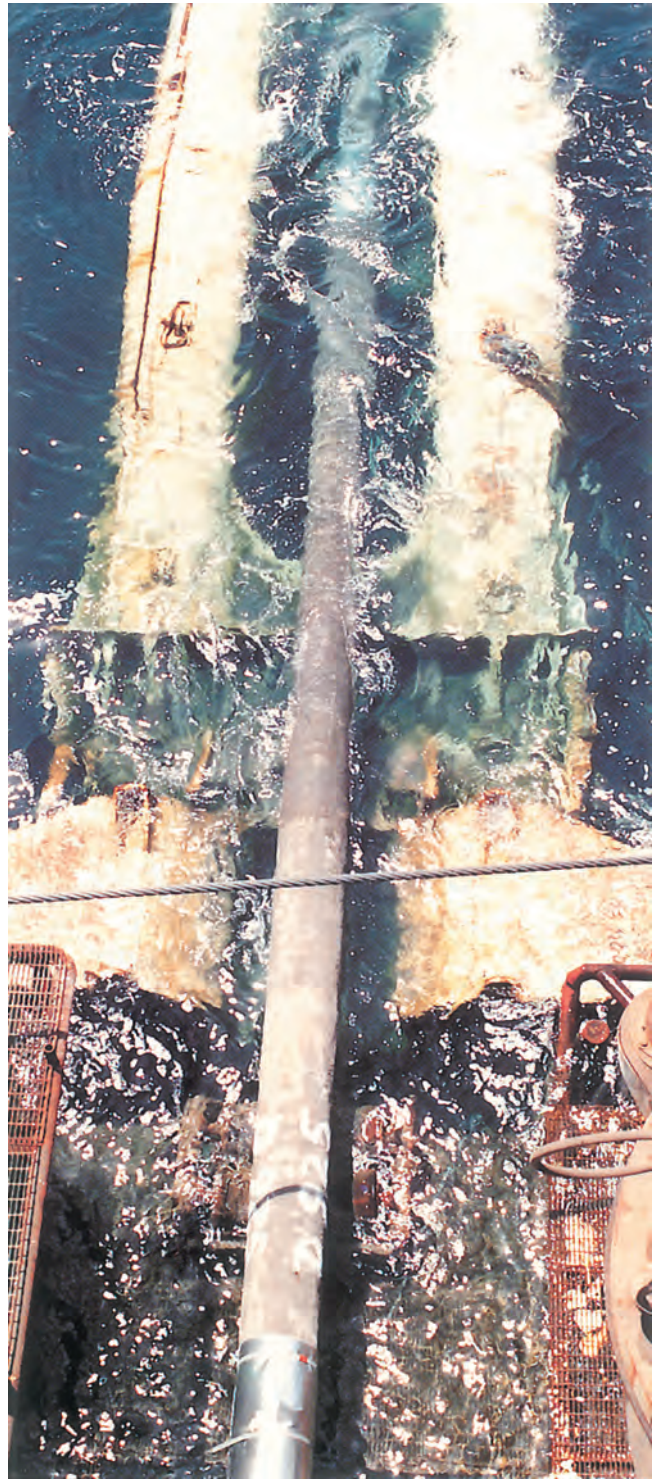
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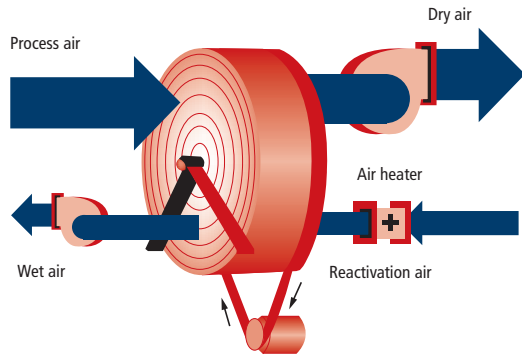
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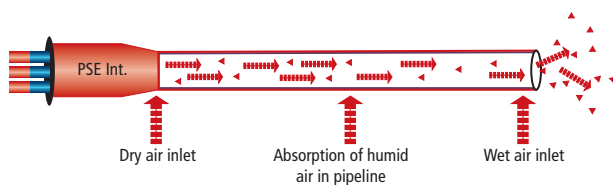
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Figure 1: Rotary Honeycomb Unit



The rotary wheel is the heart of the drying unit. The dehumidifier is designed around the drying wheel, which is divided into a segment where moisture is absorbed from the process air, and a reactivation segment where heated reactivation air absorbs moisture from the rotor wheel. The rotor wheel revolves slowly, at about 10 revolutions per hour. Dehumidification and reactivation are continuous. The dehumidifier operates unaffected even at temperatures below 0°C.

Figure 2: Dry-air Method



(special pipelines with a large diameter). Upon entering the pipeline, the air has a dewpoint of approximately -40°C. The dry air absorbs the water in the pipeline due to the difference in partial pressure between the air and the vapour. The temperature of the air in the pipeline determines the amount of water that can be absorbed.

To achieve efficient drying, the following conditions are required:

- high velocity of the air, to allow rapid evaporation;
- low dewpoint at inlet;
- high ground temperature; and
- a large surface area for the water film, which is achieved by using foam pigs to spread the water in the pipelines.

Dry air provides effective corrosion protection in the pipeline, as a relative humidity of below 50% halts corrosion; however, this does not apply to polluted air. This drying system has many advantages compared with the conventional compressor systems.

For example, let us take a customer who needs to dry a pipeline to a dewpoint of -25°C. The air capacity for the job is 6,000m³/h.

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In contrast, a conventional compressor system requires:

- five to six 1,500m³/h compressors;
- two 3,000m³/h desiccant air containers; and
- after-coolers and manifolds. ■

Developing the First CO₂ Pipeline Standard

Together with major industry partners, Det Norske Veritas (DNV) is now developing a new standard for the transportation of CO₂ in pipelines. Specific issues related to CO₂ in the dense, high-pressure phase are not covered in existing pipeline standards or regulations. "As carbon capture and storage (CCS) projects could become an important mitigation option related to climate change, this broad co-operation is an important step forward," says project manager Freydis Eldevik at DNV. As for CO₂ pipeline transmission, today stakeholders demand a robust, traceable and transparent approach that gives credibility to the proper management of risks and uncertainties. Unfortunately, the current pipeline standards do not take into account considerations related to the pipeline transmission of CO₂ from large-scale capture plants to suitable storage sites. This serves as a barrier to the effective large-scale deployment of CCS.

Broad Joint Industry Project

Therefore, DNV has initiated a specific industrial collaboration to develop a standard reference guideline for the onshore and submarine pipeline transmission of dense, high-pressure CO₂. Freydis Eldevik informs us that the project's partners are StatoilHydro, BP, Shell, Petrobras, Vattenfall, Dong Energy, ArcelorMittal, Gassnova, Gassco and ILF. The technical reference group consists of government representatives from the UK, The Netherlands and Norway. The European Commission is also supporting this DNV initiative. "The joint industry project is an important milestone for CCS and is absolutely timely, since the industry really needs this recommended practice. It will be an important contribution to the development of large-scale CCS projects," emphasises Eldevik. The novel issues related to the onshore and submarine pipeline transmission of dense, high-pressure CO₂ will be covered. The point of departure will be existing pipeline standards for the transmission of hydrocarbons such as International Standard for Organization (ISO) 13623 and DNV OS-F101.

Minimising Risk Throughout the Life-cycle

The CO₂ transportation guideline is intended to help designers and operators limit and manage uncertainties and risks related to the pipeline transmission of CO₂ by incorporating knowledge about offshore and onshore operations. It will state rules for managing risks and uncertainties concerning the design, testing, inspection, operation, maintenance and de-commissioning phases of a pipeline. It will also incorporate the lessons learned from existing and previous projects. Freydis Eldevik states: "Due to the features lacking in the current industry standards, the scope of work of this project is related to issues such as safety, fast propagating ductile fractures, fatigue crack growth, pipeline operation conditions, flow assurance, corrosion and material compatibility." ■



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