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INTEGRITY MANAGEMENT OF AGEING ASSETS

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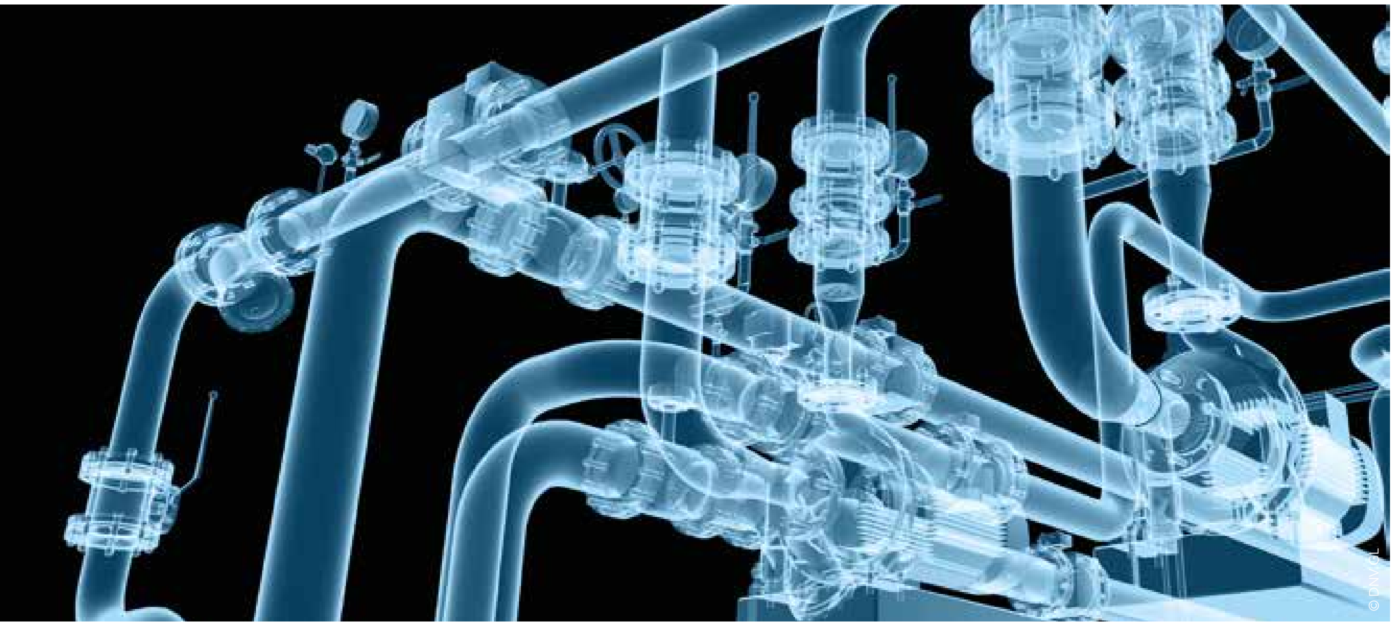
The oil and gas industry has been operating with mature assets for some time, so there is perhaps nothing "new" about managing "old" assets. But ageing and life extension is not about how old your asset is, it's about what you know of its condition, and how that is changing over time.

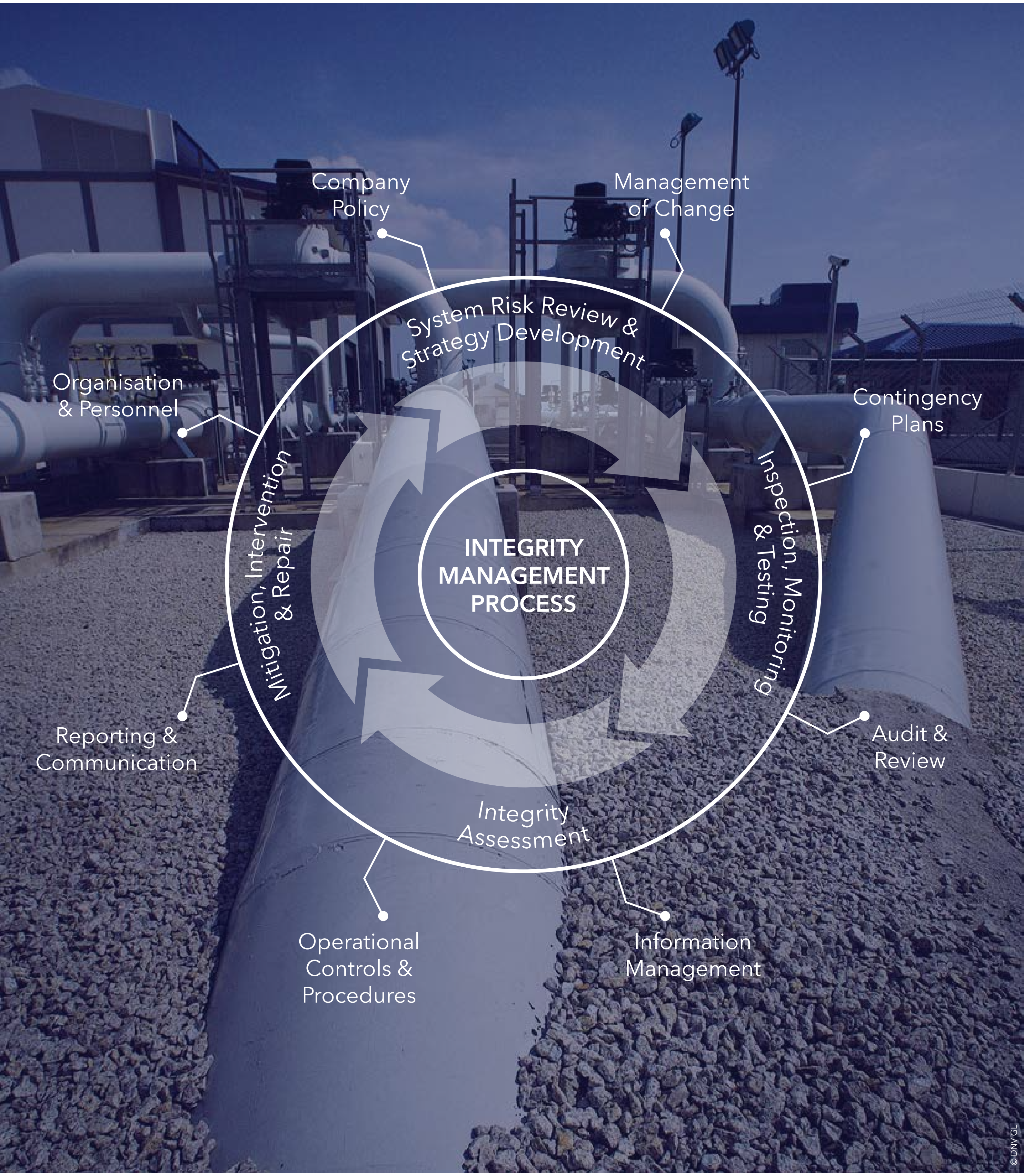
Many operators around the world are managing assets which are operating way beyond their original design lives, under conditions which were never envisioned, while under pressure to keep inspection and maintenance costs to a minimum. And this all needs to be done without compromising our standards on protecting safety and the environment. This is the challenge of working as an integrity engineer within today's oil and gas industry, and it is a challenge that DNV GL relishes.

Whether the asset you are managing is an offshore structure, pipeline, pressure vessel or any other piece of equipment, integrity management processes tend to follow the same principles. All are based on the following key activities:

- Identification of relevant threats (failure modes or mechanisms such as corrosion, fatigue etc.)
- Risk assessment (RBI) to evaluate the relative probability and consequence of different threats
- Development of risk based plans for inspection and monitoring activities, to mitigate the above threats.
- Execution of inspection and monitoring activities to collect information on the asset condition.
- Evaluation of the inspection and monitoring data. This may involve trending of data, fitness-for-service assessment or remaining life calculations.
- Execution of appropriate repairs or modifications where these are needed.
- Feedback of information from inspection and repair activities into an updated threat assessment and risk assessment process to ensure a loop of continuous improvement.

DNV GL has experience in the integrity management and life extension of all types of asset, and is able to offer a multi-disciplinary team to tackle any integrity challenge. Some examples are given in the sections below.




Company Policy
Management of Change
System Risk Review & Strategy Development
Organisation & Personnel
Contingency Plans
Mitigation, Intervention & Repair
Inspection, Monitoring & Testing
INTEGRITY MANAGEMENT PROCESS
Reporting & Communication
Audit & Review
Integrity Assessment
Operational Controls & Procedures
Information Management
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Structures

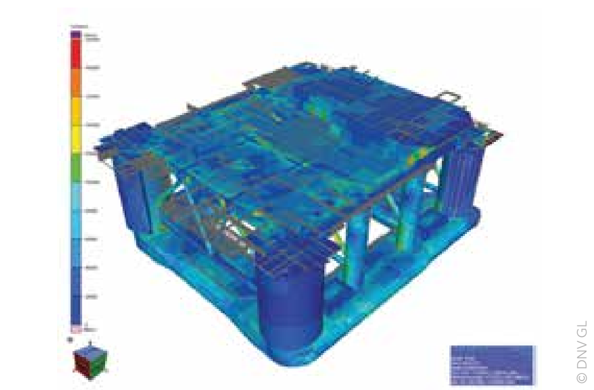
Processes for structural integrity management are largely based on international codes such as API RP2SIM and the ISO 19900 series of documents. For floating structures there are also Classification Society rules, depending on the type of unit, which stipulate additional requirements. In almost all cases, a risk based approach to the planning of inspections or surveys is allowed. For most offshore structures, the main mechanisms of ageing that drive inspection planning are corrosion and fatigue. DNV GL Offshore Technical Guidance DNVGL-OTG-17 "Inspection planning of MOUs in-service by use of RBI methodology" covers each of these threats, and makes reference to other supporting recommended practices where relevant, such as DNVGL-RP-C302 for Risk Based Corrosion Management, and DNVGL-RP-C210 for Risk Based Inspection for Fatigue Cracking.

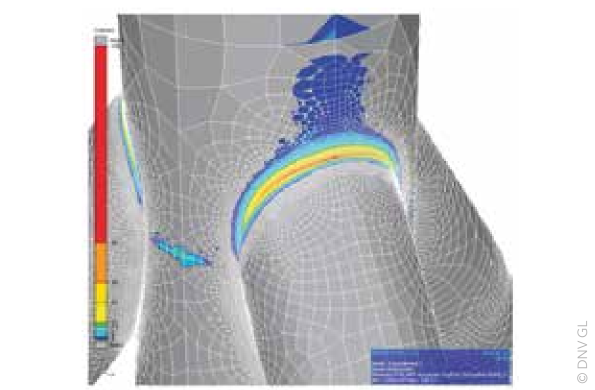
DNV GL has used these processes to help clients optimise their integrity management strategies for a wide variety of assets such as:

- Fixed platforms
- Semi-submersible drilling rigs
- Jack-ups
- FPSOs

Where necessary, DNV GL can support the above activities in different roles as required, such as performing structural analysis, inspection planning, integrity reporting, fitness-for-service assessments or specification of appropriate repairs or structural improvements.

For FPSOs there is often a strong incentive to optimise an inspection plan, beyond a conventional time based Class approach. This will depend on the number of years that a vessel will be on station, but there will usually be a desire to develop a flexible plan for the inspection of hull areas such as cargo oil tanks or ballast tanks, so that costs and disruptions to production are kept to a minimum so far as possible. Where risk based approaches involve arbitrary steps with little or no technical justification, these will typically be challenged by both Class and HSE. However, where a robust approach is put forward, backed up by quantitative technical analysis where appropriate, a risk based approach will be supported or even encouraged.





Pressure Equipment

The integrity management of pressure vessels and piping often presents one of the biggest challenges for an ageing asset. The sheer volume of inspection and monitoring tasks often results in significant backlog. Risk based approaches are arguably then even more important, as we need to focus on doing the things that are really important. Standards such as API 581 or DNVGL-RP-G101 provide approaches for generating risk based inspection plans for a variety of equipment types, and these help to prioritise effort.

However, sometimes an inspection may need to be deferred, beyond the point at which the RBI recommended an inspection. Such a deferral usually involves a risk assessment, and these should be carefully considered. The RBI process is itself a risk assessment, and the recommended inspection was an activity designed to mitigate risk. So removing that inspection, or deferring it, cannot be justified by simply carrying out another risk assessment. It is important to have a technical justification, and this most likely comes from reviewing historical inspection and monitoring data for the equipment item in question. This usually provides a more up-to-date view of the current condition of the asset, than was available at the time the RBI study was undertaken. It is therefore possible to re-evaluate the risk associated with relevant threats. For instance, corrosion monitoring may reveal that corrosion rates are lower than expected, or process monitoring may reveal that operating conditions are not so severe. Maintaining a set of Integrity Operating Windows (IOWs) and good record keeping and trending of corrosion monitoring data, often pays dividends when deferrals or periods of life extension need to be justified.

Internal visual inspection of pressure vessels can be very expensive and critical in terms of scheduling, as equipment needs to be taken out of service, isolated and prepared for entry. Where a vessel has well documented service history and the nature of corrosion threats is well understood, non-intrusive inspection is an attractive alternative. An increasing variety of inspection technologies are now available for carrying out inspections from the outside of vessels, and in many cases this can be demonstrated to be at least equivalent to an internal visual inspection. Standards such as HOIS-RP-103 provide technical guidance for carrying out this type of assessment, and where applicable this approach can yield significant benefits by taking activities off from the critical path during a busy turn-around period.

Where inspection reveals the presence of equipment damage or material degradation, it is important to carefully consider different options for mitigation. In many instances, although steps may need to be taken to prevent further deterioration, a fitness-for-service assessment can be used to demonstrate that the damage can be tolerated, even if it is beyond what was envisaged during original design. In some cases this may require de-rating the equipment to a lower pressure, but this may be preferable to an expensive and disruptive repair. DNV GL has many years of experience in using codes such as API 579 or BS 7910 to assess the significance of features such as corrosion damage, cracks and blisters. This can help to reduce the need for costly repairs and improve plant uptime.

Pipelines

As with many other types of asset, the integrity management and life extension of pipeline systems requires close co-operation between integrity, operations and maintenance personnel. Risk based approaches to pipeline integrity management are widely adopted, for example as described in DNVGL-RP-F116. These typically follow a Plan-Do-Check-Act cycle, with historical inspection and survey data feeding in to an updated risk assessment that enables the evolution and optimisation of an integrity plan as experience with an asset improves. In some instances, the risk associated with specific threats may diminish with time, for instance where the corrosivity of a fluid lessens as the pressure and temperature fall in late life. In these instances it may be possible to reduce inspection and monitoring effort, particularly where good corrosion monitoring data has been accrued to give confidence to future predictions, and historical inspections show that the pipeline is in good condition. However, in some instances a threat may increase, or new threats may arise. For example, flow assurance challenges may arise as flow rates fall, and this may have a knock-on effect on the ability to inspect or maintain a pipeline by operational pigging. An increase in sand content may also increase susceptibility to erosion or under deposit corrosion, as well as having a likely impact on downstream equipment.

Rotating Equipment

For critical rotating equipment such as compressors or export pumps, an understanding of risk is again at the heart of developing an optimum maintenance strategy. Condition based monitoring, rather than conventional time based approaches, helps to ensure that resources are focused on the right areas. Vibration monitoring, thermography or oil sampling analysis can all form part of condition based maintenance program tailored to suit the assets in question.

Understanding the criticality of different equipment with respect to operational efficiency is also key. DNV GL has developed sophisticated RAM simulation tools to help identify critical equipment, optimise planned maintenance schedules and assess the optimum spares holding for specific equipment items.

Flare Systems

For special items such as flares, integrity management requires a multi-disciplinary approach to ensure that all threats are identified and understood. DNV GL has been working with the Energy Institute to develop a guidance document for the integrity management of flare tips and ancillaries. The document is a collaborative effort involving contributions from operators, flare specialists and consultancy companies. It includes recommended practices for in-service and out-of-service inspection, management of defective flare tips and life extension strategies. The guidance also covers recommended practices for aerial inspection using an Unmanned Aerial System (UAS) or helicopter "fly-by". Case studies are included that illustrate different failure mechanisms and demonstrate the value of a robust design and integrity management approach.

Mooring Systems

Mooring systems are another example of where specialist knowledge is essential in putting together a robust and optimised integrity management plan. DNV GL Rules for Classification of FPSOs (DNVGL-RU-OU-0102, Edition Jan 2017) explicitly allows for a mooring integrity program to be applied in lieu of prescriptive Class survey requirements. DNV GL has developed a new recommended practice for Mooring Integrity Management (to be issued later this year) which includes guidance on risk based approaches for the planning of inspection and monitoring activities. This enables reliability, availability and safety of complex systems to be increased, whilst having the potential to reduce inspection costs over the life-cycle of an asset.

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About DNV GL
DNV GL is the technical advisor to the oil and gas industry. From project initiation to decommissioning, we enhance safety, increase reliability and manage risks in projects and operations.

Our oil and gas experts offer local access to global best practice in every hydrocarbon-producing country. Driven by a curiosity for technical progress, we provide a neutral ground for collaboration; creating competence, sharing knowledge and setting industry standards.

Our independent advice enables companies to make the right choices. Together with our customers, we drive the industry forward towards a safe and sustainable future.