Oil and gas services
Frazer-Nash Consultancy

Services

Case studies
Structural integrity services
Mechanical integrity services
Subsea engineering services
Flow assurance services
Process engineering services
Safety, risk and reliability services
Electrical, control and instrumentation services
At Frazer-Nash, we develop project requirements, assess new concepts, optimise performance, assure safety, and plan through-life support.

We’re renowned for our expertise in solving the oil and gas industry's toughest challenges, and pride ourselves in providing the clear, accurate, independent and timely advice our customers require to succeed. Our clients range from the largest operators to smallest innovators; our services span the needs of new developments, legacy assets and decommissioning programmes.

With some 600 engineers, analysts and project managers operating from a network of UK and Australian offices, our employees are experts at ensuring fixed and floating structures, topside equipment, and subsea flowlines and risers are optimised to endure their serve environments and to operate safely and reliably throughout their design-lives and beyond.

We provide expert support:

- Design studies and guidance
- Fault finding and troubleshooting
- Advanced engineering analysis
- Independent review and assurance
- Project management and cost estimating
- Research and development

Using integrated teams:

- Mechanical integrity
- Structural integrity
- Process engineering
- Flow assurance
- Electrical, control and instrumentation
- Safety, risk and reliability
- Decommissioning and abandonment

Formed in 1971, Frazer-Nash operates independently of its shareholder – the £3.5 billion engineering support services organisation, Babcock International Group.
Services

We provide an immense breadth of analysis and design services to the oil and gas industry, allowing us to take on complex packages of related tasks, or deep studies into specific problems. Our clients value our ability to understand their requirements rapidly, and provide a service that is timely, accurate, and efficient.
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Providing services to operators, engineering companies and equipment suppliers across the world.

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• Fitness for service assessment: water injection header

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• Engineering critical assessment (ECA): pipe reeling

**Flow assurance services**
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**Process engineering services**
• Root cause analysis: NGL Spiking System

**Safety, risk and reliability services**
• Technical safety: blast-resistant design
• ATEX compliance: offshore power generation
• FMECA: crane winch

**Electrical, control and instrumentation services**
• Design and commissioning: emergency generator
LIFE EXTENSION: FPSO

THE CHALLENGE
Floating Production, Storage and Offloading (FPSO) systems are valuable and complex assets. To assure our client of the integrity of one such vessel and its ability to withstand its operating conditions, we were asked to perform strength and fatigue assessments.

OUR SOLUTION
We built a global model of the ship structure, turret and module frame structure using SESAM (DNV software). Using over 600 different combinations of wave height, frequency and direction to give a complete picture of the vessel’s response, we performed three assessments:

- Strength assessment of the ship structure under the impact of extreme waves
- Spectral fatigue assessment to account for cumulative damage of through-life offshore operation, including seasonal changes in wave loading
- Strength assessment of the mooring system for an extreme 10,000-year wave

THE RESULT
By comparing the predicted stresses on the FPSO hull and internal structures with the classification society rules, we concluded that the vessel was sufficiently strong.

After assessing the potential fatigue damage that the FPSO would accumulate, we calculated its fatigue life using a statistical model of wave loading.

Finally, we developed a non-linear model of the mooring system that included the mooring lines, risers and buoyancy. After these additional refinements we applied the extreme loading conditions, and assessed the integrity of the mooring chains.

THE BENEFITS
Frazer-Nash was able to provide assurance to our client that their asset would survive its projected operational life.

We not only satisfied their current design needs but were able to save them significant cost by anticipating future requirements that could affect the overall strength of the FPSO.
Case study

FAILURE INVESTIGATION AND REDESIGN: GAS TURBINE EXHAUST

THE CHALLENGE
Offshore gas turbine exhaust systems must support heat recovery and also be light enough to be easily installed or removed, whilst remaining unaffected by cyclic thermal loads and dynamic pressure fluctuations. Failures are common due to the extremes of gas temperature and velocity that occur. Gas turbine downtime can be extremely costly, and remedial measures can involve long lead times and may not address the root cause of past failures.

The gas turbine exhaust systems on a North Sea platform have suffered repeated failures during their operating lifetime. A multinational oil and gas company came to Frazer-Nash to determine the shortcomings of the existing design and to suggest and evaluate design solutions to prevent future failures.

OUR SOLUTION
We diagnosed the cause of the problems in a three-stage process:

• A Computational Fluid Dynamics (CFD) model incorporating advanced turbulence modelling techniques to capture in detail the pressure fluctuations inside the exhaust system.
• These fluctuations were applied to a structural model of the system to determine local stresses and pinpoint regions of likely failure. A thermal model of the system then determined the stresses generated by thermal cycling during start-up and shutdown.
• New design concepts were developed and assessed based on the results of the analyses. This included additional analyses to cover installation and lifting loads.

THE BENEFITS
We undertook detailed analysis of the failure mechanisms of the existing exhaust systems; provided concept designs for improved replacements; supported the engineering, procurement and construction; undertook overall project management and assessed the suitability of the installation and lifting systems. As a result, our customer had greater confidence that the new design would improve the overall reliability of the system.

WHY CHOOSE FRAZER-NASH?
During the last 20 years we have worked with a range of clients providing design and analysis for auxiliary gas turbines. This includes Gas Turbine OEMs, package manufacturers and operators. Our extensive knowledge in multiple disciplines enables us to resolve all aspects of a problem, including fluid dynamics, manufacturing and installation, and structural design and optimisation.
Case study

FITNESS FOR SERVICE ASSESSMENT: WATER INJECTION HEADER

THE CHALLENGE
During routine maintenance, damage was found to have occurred to the inner bore surface of a branch connection in a Water Injection Header. This was an unexpected problem and only a very short period of time was available to inspect the branches and substantiate their integrity before production would be affected. The branch connections were quickly identified to be a bespoke design and no detailed drawings were available.

OUR SOLUTION
We developed a simple, flexible and effective approach to quickly identify those branch connections that had suffered damage attributed to a combination of corrosion and erosion damage. Our structural analysis team identified the key dimensions and the necessary inspection grid for Non-Destructive Testing (NDT) thickness measurement. The offshore inspection team then used this to gather the data from the branches most at risk. We developed an initial screening assessment against which the damaged branches could be assessed, which involved:

- API 579 level 2 assessments, using a simple area replacement approach to better understand the extent of the damage on each branch
- When the results of the analysis produced low reserve factors, a more detailed finite element model was built in accordance with a level 3 assessment to demonstrate protection against plastic collapse
- The wall thickness of these detailed models was then reduced until the limits of the solution for the applied loads were reached
- The mesh of the finite element model was built to match the inspection grid so that individual elements could be removed easily and the associated damage on each branch assessed
- When branch connections were in close proximity to major structural discontinuities, we adapted the model to consider these scenarios

THE BENEFITS
The initial assessments and finite element model were developed in a few days, allowing the analysis to drive the inspections. These models were developed so that individual branch connections and their associated damage could be assessed without the time-consuming process of rebuilding separate models. By quickly mobilising the right team with many years of experience, we demonstrated the fitness for service of all the damaged connections before the completion of the outage, resulting in no further loss to production.
We provide an immense breadth of analysis and design services to the oil and gas industry, allowing us to take on complex packages of related tasks, or deep studies into specific problems.
Case study

SYSTEM DESIGN: SUBSEA CATHODIC PROTECTION

THE CHALLENGE
Offshore structures present unique corrosion challenges that require innovative Cathodic Protection (CP) systems. Retrofitting systems to old platforms requires an understanding of both the existing structure and CP systems, plus the requirements of the new systems and the interactions between each. By understanding the complexities of the local subsea environment, intricacies of corrosion mechanisms and practicalities of working offshore, we can determine the protection offered by the existing systems and develop and predict the performance of retrofit solutions. This helps the operator to plan and efficiently maintain their CP systems, aiding continued and safe production.

OUR SOLUTION
Using computer simulation our engineers design, assess and optimise Cathodic Protection (CP) systems, such as sacrificial anodes and Impressed Current Cathodic Protection (ICCP) and hybrid systems using the following techniques:

- Performance assessments of installed cathodic protection systems
- Identification of hot spots that potentially accelerate corrosion
- Calculate corrosion rates in affected zones
- Review of system operation; areas of over- or under-protection?
- Assessment of human factors on operating procedures of cathodic protection systems
- Cost-benefit assessments of cathodic protection options based on complexity of installation as well as capital and operational expenditure

THE BENEFITS
We can predict the locations most susceptible to galvanic corrosion and model the protection provided by various types and configurations of CP systems. This enables us to rapidly design and assess the optimum CP solutions for offshore assets. By providing an optimised cathodic protection system configuration, we can provide measurable technical and commercial benefits to designers, manufacturers and operators of vessels and offshore structures.

Prediction of the protection levels on subsea jacket and manifold structure fitted with an ICCP system
Case study

ENGINEERING CRITICAL ASSESSMENT (ECA): PIPE REELING

THE CHALLENGE
Our client procured a section of lined pipe to be installed from a reel lay vessel. The ECA which had been carried out at the design phase had assumed three strain cycles during the reeling event, and the flaw acceptance criteria at manufacture had been specified on that basis. However, during installation the number of strain cycles was significantly greater.

Our client required assurance that defects at the limits of the flaw acceptance criteria would not grow to a critical size by end of life, under the revised installation procedure.

OUR SOLUTION
Reviewing the results of the previous ECA, it was apparent that additional ductile tearing could be caused by the extra strain cycles during reeling. This could lead to end-of-life defects larger than the calculated critical defect size.

Our experts used their experience of API579, BS7910 and R6 to re-evaluate five elements of the ECA:

- The stress intensity factor and reference stress solutions and how appropriate they were
- The use of revised vortex-induced vibration fatigue cycles during installation
- Any adjustments to the fatigue crack growth curves to represent the operational phase
- The bending stress calculations associated with joint misalignment for the actual adjacent pipe geometries
- Revised analysis-based residual stress assumptions for the pipe at end of life

Based on these refinements a more detailed and accurate, and less conservative, assessment was then possible.

THE BENEFITS
The calculations were reworked to determine revised defect growth estimates during reeling and fatigue crack growth predictions during installation and service. The critical defect size calculations were also revised and larger limiting sizes calculated.

Using our extensive fracture mechanics expertise, we were able to significantly reduce the conservatism in the ECA carried out at the design stage. This allowed the additional growth caused by the increased number of reeling strain cycles to be accommodated without changing the original flaw acceptance criteria.
THE CHALLENGE
Subsea oil and gas flowlines operate in extreme conditions, with exposure to high thermal and mechanical loads whilst transporting complex multiphase fluids. The majority of these challenges are concerned with optimising production, minimising structural loads and mitigating the risk of blockages forming during flowline shutdowns. However, production streams often contain significant sand content; therefore, flowline erosion is a real concern.

The consequences of sand erosion are irreversible and given the risks of impact on production and safety it is important to understand the erosion characteristics. Often erosion risk can be managed by operators’ rules of thumb developed through years of experience. However, when unusual production conditions or flowline geometries are encountered, further information is required to quantify the erosion risk. Erosion assessments can be performed experimentally but this is a complex process with long lead times, high costs and difficulty in replicating realistic production conditions. What was required was a means of quantifying erosion rates and risk for a variety of flowline components within short timescales without resorting to testing.

OUR SOLUTION
Using our significant experience of Computational Fluid Dynamics (CFD) to model complex multiphase flows, we were able to develop and run a set of numerical experiments to simulate the mechanics of flowline erosion. This comprised:

- Computing the underlying fluid flow behaviour within the flowline component at realistic production conditions
- Numerically injecting thousands of individual sand particles into the flowline, and tracking their movement within the fluid stream and their interactions with internal walls in terms of impact velocities and collision angles
- Collecting all of the data for the particle impacts and using this as input to established erosion rate models which are tailored specific material

Using this approach, we were able to generate detailed and statistically robust erosion patterns on the internal walls and quantify peak erosion rates. This information enabled us to rapidly explore the sensitivity of erosion hotspots to component geometry and production conditions and identify how component life could be safely increased.
Our breadth of knowledge in oil and gas and other safety-critical industries allows us to deliver insight and innovative solutions to the industry’s toughest challenges.
THE CHALLENGE
Vibrations caused by the unsteady flow of production fluids are hard to predict (Flow Induced Vibration, or FIV), and can create unacceptable levels of fatigue. If FIV problems occur, then the situation must be rapidly examined to establish how production can be maintained at an acceptable level.

In this project our client measured vibration levels that were neither predicted nor explained by conventional engineering methods. We were asked to undertake a more detailed study that would explain the phenomenon and hopefully provide a justification for continued high production rates.

WHY CHOOSE FRAZER-NASH?
Frazer-Nash’s expertise in detailed fluid dynamics, fatigue analysis and subsea pipelines means that we are ideal for multi-discipline investigations of this type. The complexity of the subsea systems required detailed analysis of specific features and components coupled with a parallel assessment of the global system dynamics.

OUR APPROACH
Our investigation followed three lines of study:

- An analysis of the most credible sources, using a combination of scoping calculations and the measured data
- Detailed transient analysis using Large Eddy Simulation (LES), an advanced computational fluids technique that provides detailed, time-varying analysis of turbulent flows, and is considerably more accurate than conventional CFD methods
- Expert guidance for an onshore testing programme, including advice on scaling, set-up, instrumentation, and the analysis of results

THE OUTCOME
We discovered that a small set of components was responding to a previously unsuspected source of vibration. We were able to predict the flow rate bands at which the phenomena occurred, allowing production to return to an optimum level. Furthermore, the fundamental insight we gained has been incorporated into our client’s design guidelines, ensuring that future facilities will avoid the problem.
ROOT CAUSE ANALYSIS: NGL SPIKING SYSTEM

THE CHALLENGE

Our client’s asset was designed with a spiking system to extract Natural Gas Liquids (NGL) from the export gas stream to achieve pipeline specifications and transfer them to the crude export to increase output. Over previous years the system transfer pump had suffered repeated failures, causing process downtime. Our client had undertaken various mechanical investigations and potential remediations, yet could not identify the root cause of the failure. For many years the spiking system lay dormant with the liquids being recycled back to the start of the process chain, passing through the compression train on the way.

There was a growing need to free up operational compression capacity, and an increase in commodity prices made NGL a saleable product. Frazer-Nash were appointed to conduct a forensic study of the NGL spiking system to help make the system operational.

OUR SOLUTION

We developed a multifaceted approach to conduct the forensic study, which included:

- Review of historical analyses and assessments conducted by the operator and the pump supplier
- Analysis of process data and trending flow conditions
- Development of a dynamic model of the process system, including representation of the control logic to investigate sensitivity to process flow and pressure perturbations
- Detailed three-dimensional flow modelling of select components to examine performance

BENEFITS

Our analysis showed the cause of failure was attributed to poor pressure stability within the flash drums upstream of the pumps. Under certain conditions this could cause the fluid within the transfer pump suction line to partially vaporise over time this would lead to pump failure.

We provided our client with a number of recommendations which enabled them get the NGL spiking system back to long-term operation. These included modifications to the existing control system architecture, adding cooling for fluid entering the transfer pump and consideration of upgrading the pump in terms of a new impeller or multistage design.
Case study

TECHNICAL SAFETY: BLAST-RESISTANT DESIGN

THE CHALLENGE
Control buildings and other critical structures on oil platforms must be blast-resistant to ensure that people and critical equipment are protected. Our client builds the fully fitted blast-resistant modules, including control buildings and substations, in parts to be shipped to site. There are often requirements for large open spans, which means that the roof structure and connections are particularly critical.

Our skills and experience mean we can design a building which meets all the strength requirements but is as light as possible and easy to construct, enabling our client to win projects in a competitive marketplace.

OUR INVOLVEMENT
Initially we carried out scoping calculations on the building which enabled our client to enter a competitive bid and win the work. We were then awarded the contract to carry out the outline design and supporting blast and code assessments for the building.

Using the structural form we proposed at the bid stage, a finite element model was produced and analysed under the blast loading defined by the operator. A full dynamic analysis was carried out with each wall facing the blast, which showed that the building was efficiently designed, with some plasticity but deflections within allowable levels. The finite element model was also used for the transportation analysis, since lifting the half-sections of building places large loads on the structure. Since the building was to be manufactured in the UK and shipped to Australia, an assessment of the fatigue damage from transportation and shipping loads was carried out.

The building had to meet Australian structural steelwork codes, so a set of calculations was prepared demonstrating compliance under the required environmental loads, including the extremely high wind speeds for North Western Australia.

EXTRA ADDED VALUE
By building good relationships with our client and keeping them informed of the direction of the design, we ensured that when it came to construction, there were no hold-ups. This enabled the client to produce the building on schedule for shipment to Australia.

Our blast design skills have been applied to numerous applications such as concrete structures, offshore steel structures and pressure vessels for internal and external blast.
We care passionately about delivering for our clients and we strive to be the best at what we do. We pay close attention to detail, always see the bigger picture and we’re not afraid to explore new ways of doing things.
ATEX COMPLIANCE: OFFSHORE POWER GENERATION

THE CHALLENGE
The considerable power demands of offshore production and processing platforms are usually met by the use of gas turbine power generators that provide reliable and cheap energy. However, these units are encased within acoustic enclosures which can create the risk of explosion if the hot surfaces and natural gas combine. The design of these enclosures is governed by the pan-European DSEAR and ATEX Regulations which require assurances that the largest undetectable gas leak will not lead to an uncontained explosion.

OUR SOLUTION
Frazer-Nash worked under a joint industry project with the Health and Safety Executive to develop a process that would provide this assurance. Using Computational Fluid Dynamics (CFD), we analysed how the turbine and its enclosure would behave.

The CFD model highlighted areas where escaped gas could pool inside the acoustic enclosures, and then simulated the ventilating airflow throughout the enclosure. This identified a series of possible leak locations which could potentially lead to an explosion. The model also established whether a cloud of sufficient size could be created without tripping the gas detectors at the exit of the enclosure.

Using this data, we were able to propose a number of modifications to the enclosures, including:

• Using plating to control the ventilation flow and remove dead zones
• Modifying the ventilation flow volume
• Modifying the number, location, and setpoints of gas detectors

The Health & Safety Executive was satisfied that once the acoustic enclosures had been amended, they would fully comply with the DSEAR and ATEX Regulations.

THE BENEFITS
Advanced CFD is just one of the tools Frazer-Nash utilise to calculate the probability and impacts of overpressure explosion. We also use FLACS (FLame ACceleration Simulator) which is an advanced tool for the modelling of ventilation, gas dispersion, vapour cloud explosions and blast in complex process areas.
FMECA: CRANE WINCHES

THE CHALLENGE
Our customer was supplying two hydraulically powered, heavy-capacity winches to a Danish oil and gas company as part of a repair scheme requiring various lifting arrangements at different stages of the programme. Due to the inherent risks associated with the particular platform, additional design integrity assurance was required in the form of a Failure Mode Effects and Criticality Analysis (FMECA). The identified failure modes needed to be assessed in terms of severity and probability, the mitigation in place, and also if any further risk reduction activities were required.

OUR INVOLVEMENT
The purpose of this FMECA Study was to identify potential design weaknesses through a systematic analysis of the modes of failure, their causes and effects. The FMECA included analysis of failure mode criticality in terms of severity and probability, which enabled the failure modes to be ranked in terms of criticality (risk).

To accomplish the analysis, we facilitated a series of review meetings at the client’s site where both our knowledge of the FMECA process and their technical knowledge of the system allowed us to extract and record relevant information. This form of review process allowed the analysis to be performed effectively and within very short project timescales.

EXTRA ADDED VALUE
The analysis we undertook highlighted the areas of significant risk and enabled the client to focus design effort where needed, and to present mitigating evidence to prove that the risks were being appropriately managed.

As the FMECA was conducted at the design stage, potential problems were able to be resolved before manufacture, saving both time and money, as well as reducing operating risk.
Case study

DESIGN AND COMMISSIONING: EMERGENCY GENERATOR

THE CHALLENGE
Following the failure of the dedicated emergency diesel generator, new temporary emergency diesel generators (TDGs) had to be integrated within an oil platform in the North Sea. This had to be carried out within a limited time frame while maintaining the integrity of the platform safety case and operational needs. The new TDGs had to fully integrate within the existing Electrical, Control and Instrumentation architecture with minimum disruption to maintain automatic operation. Our client required rapid design assurance and support in commissioning of the new generators.

OUR SOLUTION
Using our power system analysis capabilities, we conducted design substantiation studies to demonstrate the suitability of the proposed modification and that the impact on an existing (and demanding) operational and safety environment was minimised. Using IPSA, we did an electrical power system analysis to assess the suitability of the existing electrical architecture, as this had to accommodate the new TDGs, from a load flow and fault level viewpoint in relation to the various operating configurations of the platform. We also carried out transient studies to assess the start up and established the new protection settings to maintain adequate discrimination with the existing protection architecture. Our analysis also addressed the impact of the modification on the platform’s earthing arrangement.

Frazer-Nash also provided documentation and offshore support during the commissioning phase of these new TDGs. We devised the new operating and control philosophy, defined new tests and identified physical amendments to Inputs/Outputs of the existing and new systems. To allow the automatic operation of these new TDGs, we modified the existing controller’s logic to accommodate the control and operation of the TDGs via the existing control and instrumentation systems.

BENEFITS
Using wide range of electrical, control and instrumentation capabilities and understanding of offshore systems, we were able to integrate these TDGs safely, with minimum disruption to production time.
To find out more about our work and how we can add value to your business, email oilandgas@fnc.co.uk or visit our website:

www.fncaustralia.com.au