GEANTI have just completed the world’s first RBA (Risk Based Approach) Life Extensions of entire oil rigs based on our world-leading methodology obtained through our Research and Development, which is approved and in accordance with Classification Societies’ Rules and Regulations.

We Make Ideas Float
Our Driving Values

We aim to always achieve our mission by adhering to our six core driving values:

**Inspiration**
We are a group of inspired Marine Consultants that personally support Asset Managers to achieve their duties.

**Innovation**
We innovate using the latest methods to bring success to our clients’ projects. We look at problems from different angles and perspectives.

**Flexibility**
Relocatable to project site team of Naval Architects, Marine Engineers and other Consultants that are always ready to respond in a timely manner.

**Collaboration**
We focus on integrating with our clients, as if we were part of your company and achieve your goals as if they were our own.

**Responsiveness**
We respond to the needs of our clients whilst being respectful to deadlines and the pressures of working in a global industry. Geanti is available to provide 24 hour support and guidance to your business.

**Progress**
Geanti is on the forefront of offshore technology practices and engineering standards.

Project and Consultancy Services

Geanti offers you services with a full range of marine capabilities for all stages of a project’s lifecycle from conceptual design to decommissioning covering desktop/feasibility studies, analyses, appraisals, optimisations, life time extensions, mooring, testing and verification services, risk management and safety. We utilise the most advanced software in the industry including:

<table>
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<tr>
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Our consultants offer their comprehensive range of marine capabilities and experience in all relevant offshore Services including:

Design, desktop/feasibility studies, analyses, appraisals and optimisations etc.

Testing and verification services.

Construction, repair, maintenance, modifications and conversions for all types of offshore structures. Our experience has been gained from our design/technical involvement in the largest and most complex structures ever produced.

We understand the complex challenges that our clients face so we produce safe and pragmatic solutions that are based on our wealth of experience and the particular needs of our clients.

- Naval Architecture
- Structural Engineering
- Conversions
- Marine Engineering
- Marine Operations
- Lifetime Extensions (LTE)
- Full Fatigue Assessments
- Asset Integrity and Risk Management
- Structural Integrity Management Strategies (SIMS)
- Mooring Systems - Fit for Purpose (MSFP)
- Mechanical Completion and Commissioning
- Subsea Construction (Surveyors, ROV Crew, Deck Crew)
- Safety/Risk Analysis – Quantitative and Qualitative (ALARP, HAZID, HAZOP, FMEA, FMECA, ENVID)
- HSE Services
- Project Management
- Project Control
- Document Control
- Contracts and Procurement
- Expert Witness & Litigation Services
- Commissioning/ Decommissioning
- Construction Management
- Marine Warranty Surveying
- Pipelines
- Quality Control and Assurance Services
- Insurance/ Financial Risk Assessments
- Dynamic Positioning and Mooring
## Capability Matrix

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</table>
Our Naval Architects and Structural Engineers integrate their teamwork with the work of other multi-disciplinary engineers to produce an overall design that is “Fit for Purpose”.

Whether your asset is an offshore structure in the south China Sea, the Gulf of Thailand, the UK North Sea or elsewhere in the world, Geanti engineers will employ an innovative approach to achieve the safest and most economical solutions that satisfy our Client’s specific requirements in all of the following Services:

- Mooring Systems Analysis and Design
- Life Time Extensions (LTE)
- Modifications and Conversions
- Fatigue Life Assessments
- Defect Monitoring and Control
- Classification Society Approvals
- Regulatory compliance to international and flag standards
- Hull Selection and Sizing
- Hydrostatics
- Stability Analysis & Stability Info Booklets
- Hydrodynamics, Motions
- Lightweight Surveys & Weight Management
- Structural Design and Scantlings Definition
- Structural FEM Analysis
- Seafastening Design
- Dry - Docking
- Moorings and Dynamic Positioning
Marine Engineering

Our Marine Engineers are experienced consultants always achieving the most successful design, building, installation, inspection, testing and maintenance of the propulsion systems including pumps, piping and other main and auxiliary machinery for any offshore unit/vessel.

Services provided by Geanti include:

- Suitability Surveys and Valuations
- System Commissioning
- Vessel Upgrade Engineering
- Ballast Systems/Hull Systems
- Turrets
- Failure Mode and Effects Analysis (FMEA, FMECA)
- Technical Risk Assessments
- Machinery Evaluation & Conversions
- Hull Systems
- Piping Systems
- Power Generation
- Equipment Selection
- Jacking Systems
Geanti has advanced capability and experience to perform mechanical design to fully optimise and tailor each pipeline for all aspects including:

- All pipeline sizes from large diameter trunk lines to small diameter flowlines
- All project phases from conceptual studies to detailed analysis
- Onshore pipelines (buried or not) and offshore pipelines (shallow and deep water)
- Design of end connections including tie-in spools and risers
- Detail design in accordance with various codes including DNV, API, AS and ASME

Our design capabilities include both conventional pipeline solutions and more complicated scenarios requiring innovative solutions for:

- Upheaval buckling and on-bottom stability analysis of pipelines
- Lateral buckling and pipeline walking analysis
- Corrosion resistant alloys
- FEA and Fracture based fatigue analysis
- Tie-in analysis for flowlines
Fracture Integrity Assessment & Fatigue

We provide in-house expertise and software to perform Finite Element Analysis for complex engineering problems including but not limited to; pipeline installation, dynamic on-bottom stability analysis, lateral and upheaval buckling, pipeline spans including static and modal analysis, umbilical and pipeline pull-in and pull-out assessments, and solid modelling of pipelines for impact assessment, local buckling and local strength checks due to corrosion and or defects, and many more applications.

We also undertake global and local buckling analysis and mitigation system design for pipelines. Typically, a high level study is performed to determine the susceptibility of pipelines and flowlines to buckling followed by an evaluation to determine susceptibility of pipelines and flowlines to determine if a buckling mitigation strategy is required.

Our design philosophy utilises Engineering Critical Assessment (ECA) based on FEA for:

- Fitness for service procedure
- Fracture analysis based on FEA
- Operation and maintenance analysis

In addition, we conduct any type of route survey for pipelines, flowlines, umbilicals and cables, including:

- Planning and cost estimating
- Survey plans and strategies
- Scopes of work and specifications
- Project management and contract administration
- Offshore and onshore survey support including shore and waterway crossings
- Geophysical surveys
- Geotechnical surveys
Marine Operations

Our Mariners and Operations Engineers have experience in all marine operations such as Towing, Mooring, Ballasting, Lifting/Handling Heavy Loads at sea, Personnel Transfers, Surveying and Diving.

They have achieved record time operations in the harshest environmental conditions and have completed projects with minimum available Weather Windows.

- Marine Warranty Surveying
- Client Representation
- Preparation of Marine Procedures
- Project Management
- Marine Contracting
- Lifting/Handling Heavy Loads
- Ballast Plans
- Towing
- Mooring
- Vessel Selection
- Standards and Codes Application
- Transportation and Installation
- Rigging Design
- Personnel Transfers
- Load-In-Out
- Surveying
- Diving
Renewables - Offshore Wind

Offshore Wind Turbines

Geanti has long experience on offshore wind projects for mooring design, subsea cable and offshore structures dynamic analyses.

Taking advantage of our in house experience developed especially for the Oil & Gas industry, we provide engineering support to the stakeholders of the offshore wind sector.

We perform structural analyses of wind turbines considering the fully coupled dynamic response of the system under aerodynamic and hydrodynamic loadings.

We are also capable of analysing the FE model to account for the combination of hydrodynamic and aerodynamic loadings for the following structures:

- Floating systems or foundations
  (Monopile or Jacket)
- Wind turbines including control systems
- Mooring lines
- Subsea Cables

We have also successfully completed projects on Wind Farm Power Cables and Cable Protection System (CPS) including installation engineering, strength and fatigue analyses. In addition, we studied the Vertical Cable Vibration (VCV) and Vortex Induced Vibration (VIV) of the power cable and the CPS free span length, inside and outside the monopile. These were appraised to API-S-17E and DNV F105 standards respectively.

Power-Cable Installation Engineering which was required for the pull-in of subsea power cables through each wind turbine’s monopile at its base, up through the inside of the pile to a fixed hang-off point above sea level. This project involved the power-cable installation methodology and implementation using Orcaflex.
At Geanti we utilise our expertise to provide Decommissioning services that range through all relevant aspects including:

- Condition assessment and status definition
- Evaluation of reusing part/whole asset either in same or other field
- Evaluation of recycling part/whole asset
- Evaluation of disposal onshore or at sea
- Methodology for removal and disposal
- Environmental impact assessment
- Debris clearance
- Impact assessment of the disposal

Our clients benefit during the entire Programme as we:

- Develop economical and safe methods utilising the latest state of the art technology
- Provide relocatable engineers worldwide for clients that need continuous support locally
- Use our strong links with all aspects of the offshore industry – subsea/contractors/surveyors/mariners
- Create new collaborations and partnered support utilising experienced and informed capability in the UK, Norway and worldwide

Geanti knows that ensuring an asset is safe and operating in the most efficient manner, is one of the major drivers for operators worldwide. Geanti helps its clients manage the integrity, performance, and reliability of their assets from the concept phase, all the way through to decommissioning.

Our integrity and inspection engineers can integrate with your existing teams to support on-going operations and provide advice on integrity engineering, fitness for service assessments, corrosion studies, lifetime extension studies, and risk-based inspection methodologies. Geanti delivers support, advice, and engineering consulting to establish and maintain robust management systems.
The Risk Based Approach for Assets

New Designs – Asset Integrity – Life Extensions

Time/Condition Based Approach is inflexible and costly as it is based on stringent class rules and time interval generic surveys.

Geanti employs the Risk Based Approach (RBA) which economically achieves “Fit for Purpose” by employing a Structural Integrity Management Strategy (SIMS) and/or RBI (Risk Based Inspections) that are:

- Complementing partially new designs and Class submissions
- Used for entire new designs and Class submissions
- Replacing generic time-based inspections/surveys
- Used in Asset Life Time Extensions
- Used in Asset Integrity
- Used in Asset Safety

Fit for Purpose Assessment

Owner shall maintain and demonstrate Fit for Purpose and that the risk of structural failure leading to unacceptable consequences is sufficiently low.

ISO 19902

It is permissible to accept limited individual components failure for existing structures, provided that both the reserve strength against the overall system failure and deformations remain acceptable.

ANNEX 1: ISO 19902 OVERVIEW

General practice given in ISO 19902:
- Section 24: ‘In-service inspection and structural integrity management’
- Section 25: ‘Assessment of existing structures’

- Fracture Mechanics (and BS7910) enables the assessment of defects recorded.
- In the cases where structural cracks have been identified, the critical crack lengths, the criticality and propagation velocity of each crack must be computed.
- Cracks must be monitored with surveying.
- Mitigation measures for the defects found from the surveys will be produced and will be in accordance with the recommendations of the risks’ rankings of the defects and the recommendations of periodical HAZIDs – HAZOPs – HIRAs.
- These may have to be continued for the remainder of the FPSO’s life at specified intervals.
Life Time Extensions (LTE)

GEANTI have achieved the world’s first Life Extension of a whole oil rig based on our own research and development which resulted in our world-leading methodology. This is approved and in accordance with Classification Societies’ Rules and Regulations.

Geanti engineers will cost effectively extend the Life Time of an asset. The process will be customised for your asset’s needs and optimised so that the CAPEX invested together with the future OPEX will result in overall savings.

Geanti combine the latest surveying techniques, a unique defect monitoring and control system, state of the art computer modelling, and an innovative Risk Based Approach to perform condition assessments and life time extensions of complete assets or individual structures.

Geanti’s pragmatic approach is based on the recommendations of the HSE’s KP4 Programme and ISO 19902 and Classification Rules that we optimise specifically to our clients’ specific requirements, flag and geographical location, whilst ensuring that safety is maintained and costs are minimised.

1. Asset history and baseline review
2. LTE analyses & appraisal: Fatigue/Strength
3. Condition surveys: focus on hot spot regions
4. Remaining life time calculation
5. Develop SIMS/RBI policies
6. Modifications: detail design and specification
7. Class approval of LTE design: SIMS/RBI

Life Time Extension achieved
A Structural Integrity Management System (SIMS) is custom-designed for your Asset using the Risk Based Approach (RBA). This includes a Risk Based Inspections (RBI) Programme of all relevant components/systems based on the Probability Of Failure (POF) calculated by a Qualitative/Quantitative methodology. The result saves costs as Inspections/Surveys and Maintenance stop being “generic” but become “specific” to your Asset and needs.

- Design Stage Philosophies and Premise
- Maintenance, Inspection and Monitoring Strategies
- Performance Standards and Verification Procedures
- Operational Procedures and Deployment Practices
- Written Programme of ongoing analyses
- Failure Response Philosophy and Procedures
- Quantitative Risk Assessment (QRA) plans
- Operational Risk Assessment (ORA) plans
- Contingency Planning
- Disconnection Planning
- Asset Integrity Review of all components to identify critical risks and their mitigation
- Asset Operational Monitoring Management and Review
- Asset Inspection, Maintenance and Replacement Strategy

**SIMS Optimisation**

We can also negotiate on your behalf:
- “Non-compliant with Class Rules whilst remaining within Class”.
- Partially compliant “On Condition of Class”.
- Operating in “Degraded status”.

**Geanti’s RBA experience has been gained from our involvement in projects such as:**
- Support to the DNV RBI project
- Support to the Hejre Project on inspection planning
- Development of corporate standards on Asset Integrity
- RBI, Project Commissioning, offshore, corrosion, topsides and refineries, subsea pipeline systems and various surveys/inspections

**Mitigating the risk of Life Extensions without downtime**

The Risk Based Approach was specifically developed for this purpose, but is more economical, can be employed with minimal or no downtime/shutdowns whilst maintaining high standards of Asset Integrity.

**Key Issues**
- Availability of historical data.
- Corrosion.
- Design remit changes.
- Equipment obsolescence and replacement.
- Production profile changes.
- Oil/gas properties’ changes.

**Key Facts**
- A great number of FPSOs and fixed platforms are operating outside their design life.
- Extending the asset’s life in the field over and above its design life, whilst minimising shutdowns and maintaining the asset’s integrity will increase risks.
- The Life Time Extension (LTE) must be achieved with minimal or no downtime/shutdown.
- LTE generates a challenging business and technical goal.
- The increased risks will have to be managed over the required timescales.
- Traditional methods for maintaining an asset’s integrity or extending an asset’s life are costly and almost always involve downtime/shutdown.
Surveys & Reviews

Geanti offers specialist advice on defining the survey’s scope of work as well as supervision and participation in all areas of marine surveying for the purposes of Due Diligence, Desktop Reviews, RBA/RBI and Life Time Extensions/Conversions/Modifications.

- **Structural**
  Definition of the survey applicable standards/renewal criteria for ULS and ALS loading for the survey so that the allowable thickness diminution of all structural members can be obtained.

- **Lightship and Loading**
  Definition of the required weight surveys and loading conditions.

- **Mooring**
  Definition of the surveys required for any turrets, connectors, anchors, chain, wire rope, fairleads and other jewellery.

- **Fit for purpose/Due Diligence**
  Defined to satisfy KP4 and other applicable criteria.

- **Piping systems**
  Definition of the required allowable thickness diminution.

- **Machinery/Engineering**
  Definition of the condition of the main and auxiliary machinery.

- **Umbilicals/Flow lines/Risers/Conductors**
  Definition of Underwater surveys to identify condition and defects.
Defect Monitoring and Control

Visual Asset Reality (VAR) and Spherical Photography

Visual Asset Reality can be used to facilitate Risk Based Approach/Inspections and therefore eliminates the need to visit your asset, thus reducing operational costs and time. It also allows your team to become familiar with any project without having to leave the office.

VAR gives users the opportunity of detailed virtual walk-throughs onboard the unit or jumping from room to room using the interactive map. This means that the user can focus on defects, maintenance hotspots or other points of interest.

The software uses Spherical Photography to reconstruct the asset on any computer so that the entire unit can be inspected on the screen, thus saving on the costs of personnel training and their certification required for physical visits.

VAR can be used in the following applications:

- Life Time Extensions (LTE)
- Defects monitoring and control
- Emergency Response
- Operations planning and control
- Risk Assessments
- Inspections and Surveys
- Conversions/Modifications
- Walk-throughs
- Decommissioning
- Ergonomically designed spaces

- Asset Integrity
- Maintenance tool
- Changes management
- Claims investigations
- Personnel training
Advanced Engineering

Artificial Intelligence for Life Extension of Assets

In today’s economically challenging environment, the extension of your asset’s fatigue life has become critically important from an economic perspective and because often, the design life has already been exceeded. Recently, Geanti has developed a new and innovative fatigue assessment tool that achieves the extension of your asset’s design life through AI (Artificial Intelligence) which we can use in conjunction with our advanced Risk Based Approach.

Artificial Neural Networks (ANNS) are excellent in the prediction, damage detection, online monitoring and controlling in offshore structures especially in cases where the formal Finite Element Analysis (FEA) is complicated and time consuming. Geanti uses state-of-the-art Artificial Neural Networks methodology for structural fatigue assessment and structural life extensions. From our experience as well as from several literature studies/surveys it has been proven that ANNs provide more accurate results compared to conventional FE methods in terms of fatigue life. Furthermore, long term erosion and corrosion experienced in such structures require complex analyses when using conventional FE Analysis techniques. ANNs are comparatively faster, reliable as well as computationally inexpensive and thus reduce the overall cost of life extension studies.

Machine Learning in the Environmental Data Prediction

Short-term wave forecast methodology based on the Artificial Neural Network (ANN) concept to predict significant wave heights, zero-up-crossing wave periods and peak wave periods can be achieved from as little as 24 hours of measurement time history. Through our in-house research and development studies we now provide the best possible realistic wave data. For short term prediction of ocean waves, the neural network can be “trained” and thereafter it can be used for wave forecasting for that location.
Flexible & Steel Catenary Risers, Umbilicals, Subsea Jumpers

Orcaflex is employed to model and perform dynamic analyses of flexible risers, steel catenary risers (SCR) and umbilicals. We have experience for doing conceptual, FEED and Detail design of riser system of various configurations. We are experienced in the design of the ancillary part of the riser systems such as the bend stiffener, bend restriction and end fittings.

Geanti consultants have vast experience in performing riser dynamic analyses, tie-in analyses, interference analyses, global fatigue analyses and local fatigue analyses using b-Flex as well as the following:

- Riser/Flowline/Umbilical Dynamic Analysis
- Riser Fatigue Analysis (Global and Local)
- Tie-in Analysis
- Riser Clashing/Interference Analysis
- Conceptual/Detail Component Design
- Riser Vortex Induced Vibration (VIV)
- Jumper VIV (Fluid Structure Interaction)
- Free span VIV Analysis

Optimisation of Riser Configuration using Artificial Intelligence

With the use of Artificial Intelligence and Soft Computing based methodologies such as ANN, Fuzzy Logic and Genetic Algorithms to perform uniquely optimised design and system configurations of Flexible Risers, Steel Catenary Risers (SCR) and Umbilical Systems. These intelligence based systems are proved to be faster and most suitable as well as cost effective when compared with the traditional design optimisation techniques.
Simulations of subsea Risers/Conductors/Jumpers

Subsea Risers/Conductors analyses including multi-risers interference effects is performed whilst considering the combined effects of direct Fluid-Structure Interactions (FSI) and Vortex Induced Vibrations (VIV) which we mitigate with the design of riser strakes and overall optimisation. We then assess the Inflow and Cross flow responses and the remaining fatigue lives.

Geanti has the capability the following types of subsea analyses:

- Pipelines (risers/flowlines) and subsea cables installation using Orcaflex.
- Subsea structures installations such as PLET/PLEM.
- FE analysis for Subsea Pipelines’ and Jumpers’ VIV using direct Fluid-Structure Interactions (FSI) and coupled Soil-Structure interactions.
- Flow forces inside/outside the pipe, deflections/stresses/vibrations, Inflow and Cross flow responses and Fatigue Life calculations due to VIV.
- Jumper VIV fatigue analysis using DNV FatFree when the current direction has conservatively been presumed to be perpendicular to the M-shaped jumper span. The natural frequencies and unit diameter stresses for the VIV analysis are calculated using ABAQUS. Stress Concentration Factors (SCF) are calculated based on API Spec 5L with the weld misalignment value obtained from API 1104 also included in the SCF calculations.
Advanced Engineering

Design of Structural Components by FEA

We perform the detail design of structural components by FEA using the Abaqus and ANSYS software for Pipelines, Risers, Subsea and other Structural Components such as:

- Flanges, connectors, etc.
- Buoyancy tank design
- Bend stiffener and bend restrictor design
- Subsea connector design

Furthermore, we perform:

- Conceptual / detail component design
- Conversions of existing designs
- Procurement support
- Static, dynamic and impact simulations using Abaqus and ANSYS

Fracture Integrity Assessment - Fatigue

Geanti has in-house expertise and software to perform Finite Element Analysis for complex engineering problems including but not limited to; pipeline installation, dynamic on-bottom stability analysis, lateral and upheaval buckling, pipeline spans including static and modal analysis, umbilical and pipeline pull-in and pull-out assessments, and solid modelling of pipelines for impact assessment, local buckling and local strength checks due to corrosion and or defects, and many more applications.

Geanti has engineering professionals with the ability to undertake global and local buckling analysis and mitigation system design for pipelines. High level study is performed to determine susceptibility of pipelines and flowlines to buckling followed by evaluation to determine if a buckling mitigation strategy is required.

We design according to:

- Engineering Critical Assessment (ECA) based on BS7910 using Crackwise
- Fracture Analysis based on FEA

Subsea Structure FE Analysis

- Conceptual / Detail Component Design
- Conversions of Existing Designs
- Procurement Support
- Static, Dynamic and Impact Simulations using Abaqus and ANSYS
Well-designed mooring systems must satisfy the following good practices that have been established by generations of mooring system designers.

**A GOOD DESIGN IS:**

- In accordance with the applicable Class requirements and other applicable standards.
- Correctly designed, so it is fit for purpose.
- Based on proven technology.
- Avoiding discontinuities.
- Minimising rope contact with seabed or other nearby structures.
- Optimised: bigger does not necessarily mean better, e.g. thicker chain does not always make a mooring system stronger.
- Based on a passive mooring policy i.e. no need for slackening (winching).
- Incorporates an “as built” inspection and documents the “as built” system.
- Appraising between designed and as built immediately post installation.
- Taking corrective actions in case of differences between designed and “as built”.
- Enforcing correct strategies for:
  - Inspection
  - Maintenance
  - Integrity
  - Slackening (if part of the system)
  - Rotation/refreshing of the topsides chain
  - Emergency response

A mooring system’s integrity strategy is as important as a good design and Geanti employ the relevant strategies with the most modern methodologies aiming to safely reduce CAPEX/OPEX:

**MOORING INTEGRITY MANAGEMENT STRATEGY (MIMS)**

- System description
- Design Stage Philosophies and Premise
- Performance Standards and Verification
- Operational Procedures and Deployment Practices
- Programme of ongoing analyses work
- Failure Response Philosophy
- Quantitative Risk Assessment (QRA) and Operational Risk Assessment (ORA) plans
- Contingency Planning
- Disconnection Planning
- Emergency Response
- Integrity Review of all components to identify critical risks and their mitigation
- Operational Monitoring Management and Review
- Inspection, Maintenance and Replacement Strategy
- Enforcement of all the above procedures
- **Mooring System Fitness for Purpose (M5FP)**
- **Risk Based Inspection (RBI)**
Most mooring failures occur prematurely, i.e. prior to their design life expiration despite approval and compliance with classification rules and/or other standards.

**WHY MSFP?**
Mooring system failures can endanger life, property and the environment. Additionally, offshore energy operators/duty holders, lawyers, insurers/underwriters and financiers are exposed to risks and losses from mooring system failures. MSFP will mitigate these dangers and risks.

**BENEFITS OF MSFP**
Our standardised approach in assessing the Mooring System Fit for Purpose (MSFP), can predict and prevent failures by providing inside knowledge of the underlying causes of failure. Furthermore, it will establish the current status of *Fit for Purpose* and attribute responsibility to the appropriate party.

MSFP encompasses 5 different tiers with escalating complexity as shown below:

**TIER 1: Remote desktop study**
- Mooring system particulars (design premise, standards, complexity, robustness, age)
- Site particulars
- Operational and maintenance profile
- History
- Design verification
- Installation verification

**TIER 2: Risk evaluation by all stakeholders**
- Evaluation of the Tier 1 desktop study findings by all stakeholders

**TIER 3: Survey – General Visual Inspection (GVI)**
- High visual level survey of mooring components using high definition cameras to identify macro-defects
- The GVI survey is conducted in accordance with the defined specification and the corresponding Code of Practice
- Dynamic analysis/FEA using the GVI recorded data and other findings

**TIER 4: Survey – Close Visual Inspection (CVI)**
- Detailed inspection of hot-spots identified up to this tier to include micro-defects
- The CVI survey is conducted in accordance with the defined specification and the corresponding Code of Practice
- Dynamic analysis/FEA using the CVI recorded data and other findings

**TIER 5: RISK BASED INSPECTION (RBI)**
Key Benefits of RBI (Risk Based Inspections) in Mooring System design:

- Extend your asset’s lifetime.
- Optimise inspections, repairs and maintenance time and cost.
- Increase the effectiveness of your Integrity Inspection Programme.
- Minimise or completely eliminate unplanned shutdowns thus minimising downtime.
- Reduce CAPEX and OPEX.

RBI: reduces risks to predefined acceptable levels

RBI is a risk based methodology that reduces risk by identifying the probability and consequences of failure by adjusting the time intervals between surveys as required.

Each tier is employing the following process:

- The starting point of this process can differ from tier to tier.
- The level of focus increases from one tier to another.
- Certain steps can be omitted during earlier tiers.
- Intermediate steps can be added or repeated between any two adjacent steps.
Mooring Systems: Life Time Extensions

Mooring systems are unique in that they often can fail earlier than their anticipated design life. There are a great number of life expiration causes that can be grouped as shown below:

Replacement of a mooring system is expensive and inconvenient because of the downtime involved and the need of suitable Weather Windows required for the installation of the new system. These considerations govern the decision to be made between replacing the old mooring system with a new one or extending the life of the existing one.

Consignations of Life Extensions

Re-design or replace with a new system?

- Definition of the scope of work and the timescales of any surveys that may be required in the time lapsing between life expiration and mooring system renewal
- Identification and selection of the specialist companies that can perform the required surveys
- Certain localities may add 2 month delays just to obtain entry Visas of personnel
- Time scales in the supply of replacement mooring components
- Minimise down time involved during the replacement of the mooring components
- Consider other bodies that need to be involved depending on field location as HSE, ISO, PSA, NPD, local government authorities etc.
- Develop the new MIMS strategy as required

The decision has to be based on the following:
- Technical-economic criteria and assessment
- Remaining design life
- Improved safety, robustness and integrity required
- Timescales
- Budgetary constraints

The decision maker must be aware that re-designing:
- Is far more complex than the replacement with a new design
- Can be better than the original design
- Requires highly experienced experts
- Can significantly reduce costs
- Can significantly reduce downtime which can be the governing factor
Safety and Risk Management

We are competitive in meeting our client’s specification with solutions that are cost effective at an acceptable level of safety - often being an ALARP level. We perform and can manage all aspects of safety and risk including:

- **ALARP** (As Low As Reasonably Possible)
- **FMECA** (Failure Mode, Effect, and Critical Analysis)
- **FMEA** (Failure Mode, Effect, and Analysis)
- **HAZOP** (Hazard and Operability Study)
- **HAZID** (Hazard Identification Study)
- **SWIFT** (Structural What If Checklist)
- **FTA** (Fault Tree Analysis)
- **ETA** (Event Tree Analysis)
- **CBA** (Cost Benefit Analysis)
- Quantitative Risk Assessment
- Qualitative Risk Assessment
- Formal Safety Case
- Bow Tie diagrams

We integrate the safety and risk management system through the entire lifecycle of an asset. In the case of extended lifetime, we incorporate this process with the Risk Based Approach (RBA/RBI) to achieve maximum safety at minimum cost:

<table>
<thead>
<tr>
<th>Severity of Consequences</th>
<th>Probability of Failure</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>LOW</td>
</tr>
<tr>
<td>1. Rare</td>
<td>LOW</td>
</tr>
<tr>
<td>2. Unlikely</td>
<td>LOW</td>
</tr>
<tr>
<td>3. Possible</td>
<td>MEDIUM</td>
</tr>
<tr>
<td>4. Likely</td>
<td>MEDIUM</td>
</tr>
<tr>
<td>5. Frequent</td>
<td>HIGH</td>
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</tbody>
</table>

Risk Tolerance

<table>
<thead>
<tr>
<th>Risk</th>
<th>Corrective Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>Acceptable/tolerable as is. No immediate action required.</td>
</tr>
<tr>
<td>Medium</td>
<td>Risk is ALARP. Continue to maintain controls and aim to continuously improve.</td>
</tr>
<tr>
<td>High</td>
<td>Risk is acceptable/ tolerable if ALARP. Controls must be set and ALARP is to be demonstrated and documented.</td>
</tr>
<tr>
<td>Extreme</td>
<td>Operation not acceptable. Must NOT proceed. Find an alternative method and re-assess.</td>
</tr>
</tbody>
</table>
Risk Management - Insurance & Finance

Each project presents its own particular risks. Our review of data utilising proven methodologies ensure that we correctly identify and assess all risks associated with any project. We offer the complete range of services required to ensure the successful Risk Management of any offshore project.

- **Risk Identification, Study, Assessment, Mitigation**
  Proactive Risk Engineering that is based on your needs throughout the risk management cycle.

- **Market leading technology**
  Used to identify, quantify and manage the technical risks presented especially to the insurance and finance industry.

- **Quality Reviews of project documentation and assets, Due Diligence assessment**
  Performed by Maritime Advisors who are focused on the Insurance/Financial risks.

- **Marine Liability Appraisals and Advice**
  Appraisals and advice to facilitate your informed decisions.

- **Risk Management**
  A fully managed service assessing your project risks.

- **Technical Assurance Surveys**
  Utilising Interactive Risk Visualisations.

- **Third Party Verifications**
  We can act as your independent representative party to improve your confidence and assure you of the “Fitness for Purpose”.

Knowledge Exchange Courses

We offer tuition through pre-bookable events that are custom designed to your specific needs for knowledge in any of our expert areas. These unique training courses include peer-to-peer tuition and will provide you with a hands-on opportunity to acquire the key concepts of offshore engineering or any other topic that is of interest to you offered by our experts in the field.

<table>
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<tr>
<th>Benefits</th>
<th>Features</th>
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<tbody>
<tr>
<td>Insight and offshore engineering knowledge for insurance or finance/banking professionals</td>
<td>Delivered by engineering consultants</td>
</tr>
<tr>
<td>Understanding of common engineering concepts</td>
<td>One or more days courses</td>
</tr>
<tr>
<td>Increased understanding of key principles, factors, stakeholders and tools used in offshore construction</td>
<td>Modular course concept</td>
</tr>
<tr>
<td>Ability to better identify and quantify risks as they are presented</td>
<td>Key areas: players, tools, operations and installation</td>
</tr>
</tbody>
</table>
Projects: Some examples

Northern Offshore: Northern Producer
Life Time Extension

- The Northern Producer drilling rig of Aker H-3 design floating production facility had been operating at the Don field since 2008 with an all chain mooring system.
- Areas of our involvement:
  ⇒ Technical Authority
  ⇒ Fit for Purpose Assessment
  ⇒ Life Time Extension (LTE)
  ⇒ Mooring system re-design and replacement
  ⇒ Safety HAZIDs, HAZOPs

Mubadala Petroleum: Jasmine FPSO
Life Time Extension

- The Jasmine field FPSO (FPF-003) has been operating South of Thailand.
- Areas of our involvement:
  ⇒ Technical Authority
  ⇒ Life Time Extension (LTE)
  ⇒ Mooring system design and replacement
  ⇒ Mooring fit for purpose
  ⇒ Classification negotiations and extensions
  ⇒ Surveys and Inspections
  ⇒ Mooring system re-design and installation
  ⇒ Safety HAZIDs, HAZOPs

SAIPEM: S7000 SSCV

- SSCV equipped with dynamic positioning Class DP3 and is pipelaying with S-lay (rigid pipeline), as well as transporting and heavy lifting.
- Largest platform installation, decommissioning and pipelay vessel.
- Areas of our involvement:
  ⇒ Naval Architecture
  ⇒ Stability and Motions appraisals
  ⇒ Heavy lifting operations
  ⇒ Pipelaying
  ⇒ Dynamic Positioning software development

AGIP: KASHAGAN oil field development

- Field development by an international consortium of companies.
- Topsides built up by barges.
- Areas of our involvement:
  ⇒ Naval Architecture
  ⇒ Stability and Motions analyses
  ⇒ Barges’ design and transportation
  ⇒ Classification submissions and approvals
  ⇒ Accommodation quarters design
Projects: Some examples

Petronas Carigali: MOPU Saparmyrat Turkmenbashi Life Time Extension

- The MOPU is a cruciform shaped jack-up assembled from 2 slender barges and 3 cylindrical legs at the Diyarbekir Field, Caspian Sea.
- The FSO is a monohull vessel permanently moored alongside the MOPU by means of a turret and 6 spread anchor based mooring lines.
- Areas of our involvement:
  - Fit for Purpose Assessment
  - Life Time Extension (LTE)
  - Class Extensions
  - Asset Integrity
  - Mooring System Fit for Purpose
  - Surveys and Inspections
  - Safety and Risk Assessments, HAZIDs, HIRAs

Allseas: Pioneering Spirit

- SLV/PRV and Barge. The SLV/PRV has dynamic positioning Class DP3 and is pipelaying with S-lay (rigid pipeline), as well as transporting and heavy lifting.
- Largest platform installation, decommissioning and pipelay vessel.
- Areas of our involvement:
  - Naval Architecture and Structural design
  - Hydrodynamics and tank testing
  - Stability and Motions appraisals
  - Classification
  - Dynamic Positioning

Bae Systems: Type 45 destroyer

- The Type 45 destroyer of the Daring class designed for anti-aircraft and anti-missile warfare.
- Areas of our involvement:
  - Naval Architecture
  - Structural design
  - Safety, HAZOPS, HAZID
  - Whole ship design integration

ZURICH Insurance: Offshore Risk Engineering

- Zurich Risk Engineering customer Risk Assessments.
- Areas of our involvement:
  - Consultancy services
  - Onshore and offshore Risk Engineering
  - Risks Assessments on critical/high risk offshore projects
For more information on how we can assist your business, please contact us:

**United Kingdom Head Office**

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<th>Details</th>
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**United Kingdom Registered Office**

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<tr>
<td>Suite 2/3, 2nd Floor</td>
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