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| THIS IS DNV |

DNV is a global provider of services for managing risk. Established in 1864, DNV is an independent foundation with the purpose of safeguard life, property and the environment. DNV comprises 300 offices in 100 countries, with 9,000 employees. DNV Energy is one of four business areas in DNV, alongside, DNV Maritime, DNV Business Assurance and DNV IT Global Services. Our vision is global impact for a safe and sustainable future.

Marine  
operations

Go strong.

DNV provides world-class expertise in thechnology, operations, management and risk. We combine our know-how into a professional service concept designed to safely improve the performance of your business. So you can go strong on all dimensions.

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#### DNV SERVICES TO THE ENERGY INDUSTRY

- ▶ Enterprise Risk Management
- ▶ SHE Risk Management
- ▶ Technology Qualification
- ▶ Verification
- ▶ Offshore Classification
- ▶ Asset Risk Management
- ▶ Training
- ▶ IT Risk Management
- ▶ Certification



History tells that major offshore accidents occur due to the fact that certain areas have not received proper attention. The verification carried out has been satisfactory, but undefined grey areas between the different parties involved have not been handled sufficiently, or in most cases, at all. This emphasises the **importance of continuity between the different stages** of design, construction, installation and in service operation and calls for an **integrated approach**, not fragmented verification carried out by different bodies.

Marine  
operations

## Ensuring safe and cost effective marine operations

#### TARGET SEGMENTS

Through these services, our teams of highly qualified professionals deliver cutting-edge solutions to customers across the industry:

- ▶ Deep and ultra-deepwater field development
- ▶ Floating offshore installations
- ▶ Fixed offshore installations
- ▶ Offshore and onshore pipelines
- ▶ Natural Gas/LNG
- ▶ Refining and petrochemicals
- ▶ Wind energy
- ▶ Power generation and transmission
- ▶ Carbon capture and storage
- ▶ Arctic operations and technology



When DNV is involved in classification, certification or structural verification for an offshore field development project, the organisation already has detailed information about many aspects of the project. This information is vital when it comes to the installation phase. It is therefore **highly advantageous to integrate** marine verification under the same scheme. This prevents double work and poor communication between the different parties involved. Also, such comprehensive involvement gives the best possible experience feedback loop for **continuous updating** and **delivering excellent services**.

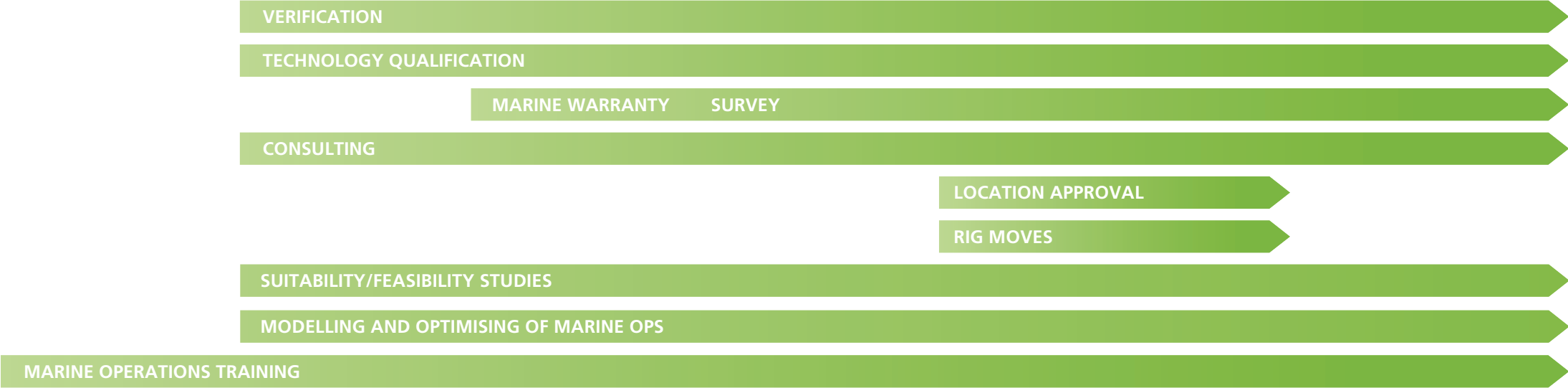
THE BUSINESS LIFECYCLE

DNV – assisting companies in the energy industry along the entire life cycle to safeguard and improve business performance

PROJECT PHASES:



DNV ENERGY DELIVERIES:





# Marine operations

At DNV, our main objective is to assist clients, through the qualities and characteristics of our services, in reducing and controlling exposure to risks.

DNV provides independent assessments, verification or approval services for complete operations, or elements thereof. Applied methods include document review, inspection of equipment, attendance during testing, survey of equipment, survey of preparations, and assessment of environmental conditions. For complex or critical operations, DNV offers to attend operations, in order to confirm on site acceptability of environmental conditions, performance according to procedures, required deviations or modifications to procedures, and act as an independent third party observer.

When delivering marine verification and advisory services, the importance and value of clearly defined technical and operational requirements, accurately defined scope of work and excellence in performance was early realised by DNV. As a consequence DNV established a dedicated unit for marine operations, staffed with skilled and experienced personnel.

The team, consisting of master mariners, naval architects and marine- and structural engineers, work closely to ensure integration between theoretical analysis and real life practice. The unit offers in-depth services within independent marine advisory, verification and approval of marine operations. The theoretical competence and practical experience available within the unit, combined with the multitude of other specialist competence available within DNV, ensure that these services creates a significant return on investments.

The potential financial and technical liabilities incurred as a result of an incident or occurrence during marine operations can be devastating.

It is our ambition to share our experiences and carry out marine advisory and verification as an active partner, aiming for safe, smooth, efficient and robust performance of marine operations.

# Marine verification

The production of oil and gas offshore in harsh environments requires sophisticated solutions. The prohibitive cost of failure during temporary phases has resulted in zero tolerance for failure. Under these conditions, only an advanced verification approach will add value. DNV has over 30 years experience in delivering verification work and warranty approval to the offshore industry.

### LOCATION APPROVAL

The location approval service is an independent third party verification and approval of a MOU (Mobile Offshore Unit) at one specific location. All marine aspects affecting the safety of the unit are considered. Environmental data, soil conditions, mooring pattern and the units positioning equipment are paramount input in mooring calculations, and are carefully considered. Minimum safe clearance to any obstacle is evaluated. Anchor holding capacity compared with maximum calculated anchor force is checked in order to assure no dragging of anchor will occur.

Location approval of a Self-Elevating Unit (Jack-Up) needs special consideration with regard to structural strength and documentation of the seabed and soil conditions on the actual site. Global strength and foundations are considered, with main focus on the utilisation of legs, leg-hull interaction, spudcan-soil interaction and foundation capabilities. Given the strict environmental operational limitations for jacking and towing

operations, DNV will attend all such rig moves, and issue declarations for the jacking down operation, the transit between the locations and jacking up and preloading, before issuing the final location approval.

### RIG MOVES

DNV also delivers independent third party verification for all types of MOU transit operations. This service is basically associated with towing of the MOU or transit on heavy lift carriers. After review of analyses, towing manuals and procedures, we issue a review note or statement with respect to the status of the document. If our formal acceptance of documentation and preparation is required before departure, we will do so in the form of a "Towing Declaration" or a "Marine Operation Declaration" as appropriate. In order to issue such declarations, a DNV Marine Surveyor will attend on site for survey of the MOU, towing equipment and tugs prior to departure.

### BOLLARD PULL

A certificate for a bollard pull may be given



by DNV. Issuing of such a certificate is done on the basis of evaluation of the site, the vessel and operational aspects.

### LAY UP RIGS

DNV offers a lay-up certificate. Before such a certificate is issued, an evaluation of the site (including location, bottom, depth and shore bollards), rig (including type, anchor/mooring equipment, wires, capacity of mooring system and emergency procedures) and environmental forces (waves, tide, current, wind and ice) is performed.

### DP VERIFICATION

DNV offers services within verification and consultancy of dynamic position (DP), such as annual DP trail Failure Mode and Effect Analysis (FMEA) and Environmental Regularity Number (ERN) Calculations. DNV Classed DP vessels have ERN entered in the Class Register as ERN (a,b,c) where a, b, c are integer numbers reflecting probable regularity for keeping position in a defined area. DNV offers calculation and approbation of optimal ERN.





# Marine warranty survey

In a world less than perfect the only thing you can expect for certain is the unexpected. Using our rules for planning and execution of marine operations, DNV's Marine Operations Declaration satisfies the insurance underwriter requirements and ensures optimum safety for the operations.

DNV offers warranty surveys and marine verification of all structures, objects, vessels and equipment, systems and procedures involved in marine operations. The service covers the range from simple coastal transportations to complex offshore installations. Our acceptance reference is the DNV Rules for Planning and Execution of Marine Operations. Upon acceptance of design calculations, equipment, procedures and preparations we will issue a Marine Operation Declaration. The DNV Marine Operation Declaration satisfies the insurance underwriter requirements for approval by a marine warranty surveyor. The purpose of marine verification and warranty surveys is to ensure that marine operations are performed within defined risk levels. The risk levels, as defined in the DNV Rules, should be tolerable to marine insurance and also to the industry, as well as to the national and international regulatory bodies.

Marine operations are in general all activities pertaining to the sea, but in this context limited to specially designed, non-routine operations of limited duration carried out at sea. This covers the temporary phases in connection with load transfer, transportation and/or securing of units at sea.

Typical marine operations where DNV offers marine warranty survey are:

- ▶ load out, float out, float on/off
- ▶ towing
- ▶ launching, upending, positioning
- ▶ setting, piling, grouting
- ▶ lifting, lift off, mating
- ▶ transit and positioning of semi submersibles or jack-up rigs
- ▶ subsea operations, special marine operations
- ▶ other marine installations

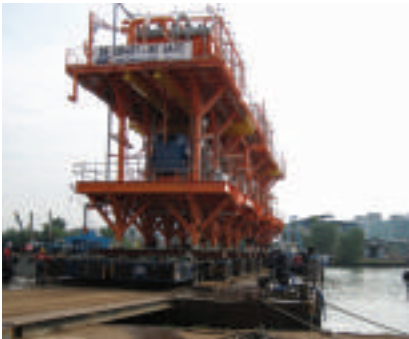


### SPECIAL SEA TRANSPORTATION

- ▶ Transport of heavy objects on deck or in holds of conventional vessels, supply vessels etc.
- ▶ Heavy Lift Vessel (HLV) transports
- ▶ Multi barge tow in connection with mating operations
- ▶ Self-floating towing, such as steel jackets, gravity base structures, offshore towers and loading buoys supported by their own buoyancy
- ▶ Transport of subsea structures by submerged towing

### TOWING

- ▶ Towing of vessels, barges and MOUs
- ▶ Towing of partly built or incomplete hull structures
- ▶ Towing of other self-floating structures (docks, concrete structures, etc.)



### LOAD TRANSFER OPERATIONS

- ▶ Load-out of objects, e.g. jacket, modules, etc. by means of skidding or trailers
- ▶ Inshore/at shore deck mating operations
- ▶ Controlled grounding of barges

### SUBSEA OPERATIONS

- ▶ Installation of subsea structures by subsea lifting or by purpose built vessels and equipment
- ▶ Laying of pipe lines and umbilicals
- ▶ Pull-in and tie-in operations
- ▶ Launch, tow and installation of pipe-and umbilical bundles



### OFFSHORE INSTALLATION

- ▶ Launch installation of jackets, including upending, positioning, setting, piling and grouting
- ▶ Laying and hook-up of mooring systems
- ▶ Offshore installation of floaters, FPSO, FSU and loading buoys
- ▶ Float over operations

### TRANSIT AND POSITIONING OF MOBILE OFFSHORE UNITS

- ▶ Assessment of mooring patterns and analyses
- ▶ Assessment of anchor handling procedure
- ▶ Transit and positioning operations
- ▶ Location approvals

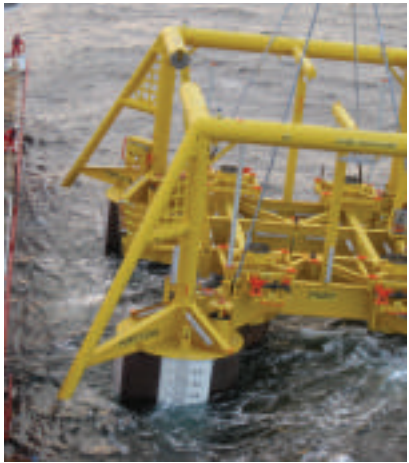


### LIFTING

- ▶ Onshore, inshore and offshore lifting of modules and structures

### REMOVAL OF OFFSHORE INSTALLATIONS

- ▶ Lifting
- ▶ Re-floating
- ▶ Transport to shore
- ▶ Dismantling





# Marine consultancy

Together with the industry, DNV has established best practices that enable customers to safely and economically perform operations at sea. We use this experience to assist our clients to succeed in their projects.

To increase the value of our services in combination or as an alternative to a marine verification scope, DNV offers services and support to clients as third party marine advisors/consultants. Our practical experience, our insight with the Rules, combined with the close interface to other DNV competencies is used as a solid and independent basis to provide advice and support for critical project decisions. Typical scope as a marine consultant includes:

- ▶ Independent feasibility/suitability assessments and studies
- ▶ Cost effective marine operations
- ▶ Independent analysis/modelling (structural, hydrodynamic etc.)
- ▶ Technology qualification
- ▶ Marine operations course

### SUITABILITY/FEASIBILITY STUDIES

The suitability survey service is delivered by DNV as an independent third party verification of the vessel-, equipment-, systems- and manning- suitability for a specific marine

operation. The suitability survey can be carried out as a complete survey of the vessel or be limited to parts of equipment specifically related to an operation, as agreed with the client. Marine operations are not in this context limited to non-routine operations nor limited in time as the more common definition of marine operations states.

The applied method for the suitability survey is a combination of:

- ▶ survey of vessel and equipment
- ▶ review of vessel and equipment documentation and certificates
- ▶ interview with relevant vessel crew
- ▶ review of documentation and, if found necessary, independent calculations.

Every single survey will be taken as an unexampled task and requires unique planning and execution. A DNV suitability survey will normally involve the following scope of work:

- a) Review of plans and outline procedures for the marine operation, and obtain full overview and understanding of the operation in question and the equipment involved
- b) Review of strength calculations, stability calculations, deck layout, crane capacity, positioning capabilities, etc.
- c) Plan survey, establish survey-team and prepare checklists
- d) Carry out survey, perform testing of equipment and interview relevant personnel and crew members
- e) Report the survey and conclude the suitability of the vessel

If required by the complexity of vessel and/or equipment, the suitability survey service will interface with the following other DNV services:

- a) Pipeline
- b) Cranes and machinery / lifting appliances
- c) Classification of ships
- d) Structure



Sea Fork One  
by Master Marine



- e) Machinery and systems
- f) Diving systems
- g) Subsea intervention/components
- h) Hydrodynamics
- i) Condition Assessment Programme

### TECHNOLOGY QUALIFICATION

Qualification is defined as the process of providing the evidence that the technology will function within specific limits with an acceptable level of confidence.

A technology can either enable a project to be realised or it can enhance the value of it. Either way the technology developer has to build the operator's confidence in the technology. The operator needs to build the confidence of the other stakeholders in the project before a decision to implement the technology can be taken. In order to build this confidence a systematic risk-based qualification process must be performed that clearly documents the performance of the technology.

### Our approach

DNV developed the first industry recommended practice for qualifying new technology (DNV-RP-A203 "Qualification Procedure for New Technology"). DNV has extensive experience in assisting our clients in qualifying their technologies according to this procedure. We combine our risk management expertise with our extensive knowledge of the technologies within the energy industry. Since we are an independent company working with both operators and technology vendors we have great insight into most of the failure modes and mechanisms that have been experienced in the industry. This knowledge base makes us a unique partner for qualifying technologies and improving the reliability and performance of it.

### Our solutions

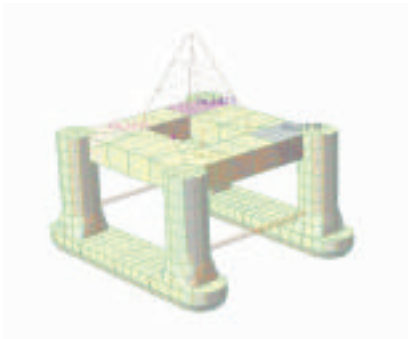
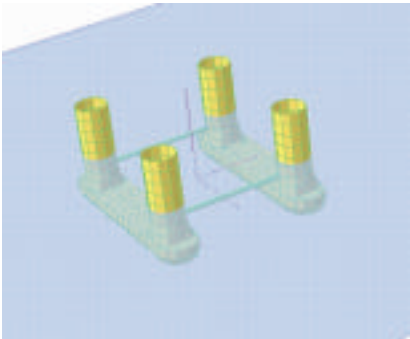
The basic steps in the qualification procedure are shown in the figure below. This is a risk based systematic process to ensure that

the technology will function reliably within specific limits. One of the main principles is that the level of effort required to qualify a technology is increased with the risk level.

DNV provides a number of services to assist in qualifying a technology within marine operations:

- ▶ Qualification management – manage the qualification process according to the principles in RP-A203 with certificates
- ▶ Facilitate threat identification sessions (FMECA, HAZID, HAZOP, Design Reviews, etc.)
- ▶ Technical analyses and studies
- ▶ Modelling of failure mechanisms
- ▶ Reliability analyses
- ▶ Laboratory testing
- ▶ Metallurgical evaluations





**COST EFFECTIVE MARINE OPERATIONS**  
Marine operations are involved at all major stages of an offshore field. Transportation and installation operations are essential in the field development phase during platform installation, later for in-service maintenance and repair interventions during its operational phase, and finally during decommissioning at the end of its lifetime. Significant costs are related to marine operations in particular for deepwater field developments where the installation operation is a major cost driver. Numerical modelling methods can be used to establish safe operational criteria that will contribute to more optimised and cost effective marine operations. One benefit can be the possibility for a prolonged profitable tail-production. This can contribute to increased exploitation

of petroleum resources and at the same time ensuring adequate safety levels.

The increased focus on field development based on subsea production will introduce new marine operations challenges. The regularity of subsea production plants depends on the ability to perform planned or unplanned in-service interventions for the entire lifetime of the field. In particular unplanned interventions due to emergency repair will be a challenging task. It may for example be necessary to perform intervention operations during the winter season to avoid production loss. In addition, planned interventions constitute a substantial part of the operational costs of subsea production plants.

Satellite field development and tie-ins to existing infrastructure are other challenges involving marine operations. Marine operations constitute about one third of the costs for connecting a satellite field to an existing platform. Hence such developments need optimised and cost effective marine operations to be initiated. This will typically involve use of relatively small installation vessels combined with carefully planned operations and time schedules using accurate methods in order to establish safe operational limits. Marginally economic satellite fields need to be connected to existing main platforms at a reasonable early time in their lifetime to be able to benefit from previous large investments in the platform infrastructure.



Offshore contractors have gained a lot of experience during the last 20-30 years with development of offshore oil fields where successful marine operations have played a key role in many projects. Complex marine operations have been planned using numerical modelling and statistical descriptions of environmental conditions and environmental loads. The need for such modelling is reinforced considering new challenges of the offshore industry:

- installation operations in deep water
- planned and unplanned inspection, maintenance and repair in deep water
- decommissioning of offshore fields in mature areas

Each of these areas present challenges with respect to extreme environmental forces,

new physical effects that become important for deep water and uncertainties with respect to the limiting operation criteria.

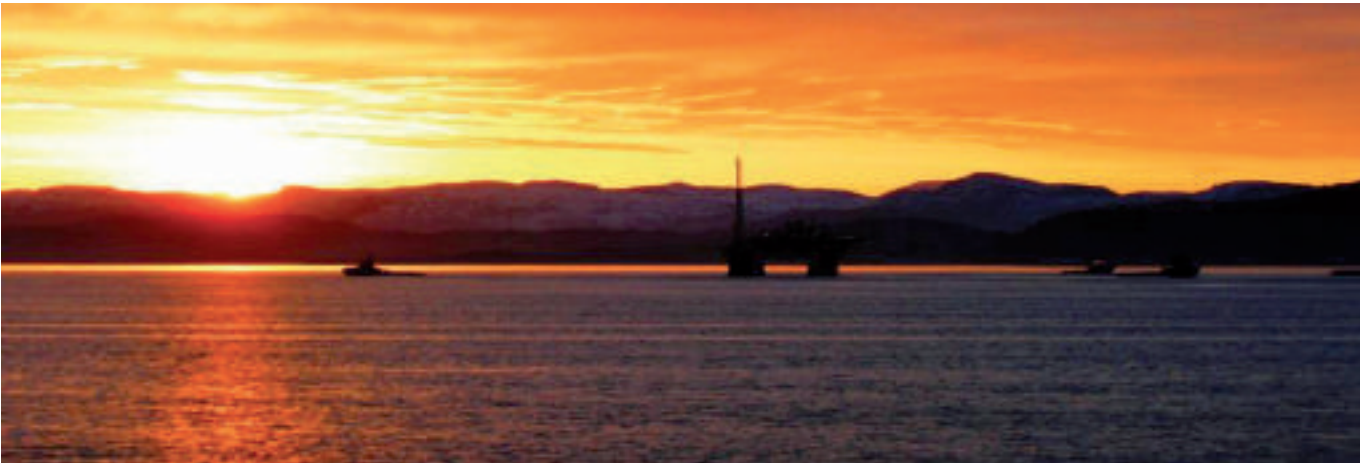
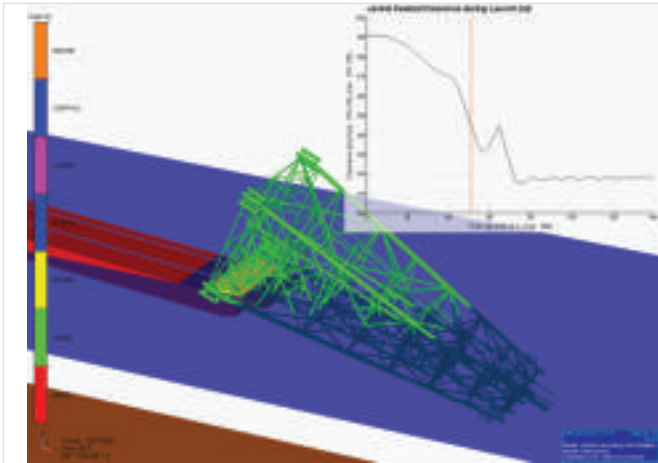
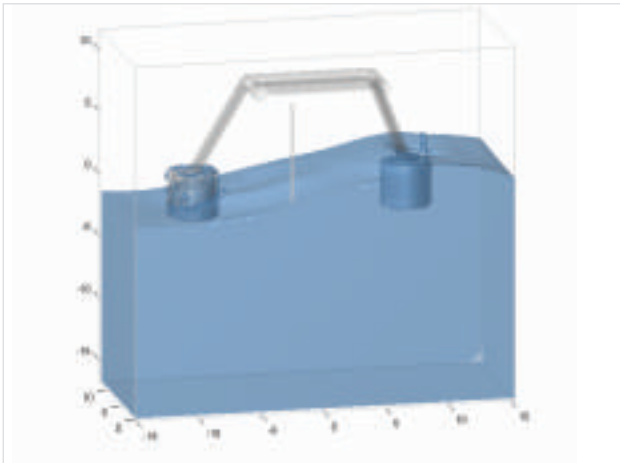
Use of physical modelling and numerical analysis in the context of these marine operations is not widespread. DNV has the capability to assist/perform such analysis.

**MARINE OPERATIONS COURSE**  
Whether you are a new or an experienced engineer or manager, our technical training courses offer a variety of levels to help you be productive in your work.

Introductory and expert level courses as well as customer specific on-site training are offered upon request. The courses may be held at DNV's offices worldwide or at your

own site. Our courses are led by managers and lead engineers responsible for development of the relevant DNV offshore standards and recommended practices and are designed and delivered in accordance with the latest educational methods.

In addition to the scheduled public courses, we also offer customised technical training. DNV may offer general introduction courses to the current Rules or more specialised courses tailor made according to the customer's requirements. The course contents will be revised according to the Offshore Standards requirements as they are being developed.





# DNV locations

DNV serves the energy industry from more than 40 primary locations worldwide. In addition, we draw on DNV's entire worldwide network of 300 offices in 100 countries.

