

safety and environmental risk management

THE POWER TO MANAGE SAFETY



GLOBAL SERVICES TO THE MARITIME, OIL & GAS AND ENERGY INDUSTRIES


- Safety, health and environmental risk management
- Enterprise risk management
- Asset risk management
- Technology qualification
- Verification
- Ship classification
- Offshore classification



Photo: Øyvind Hagen/Stall

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DNV believes that a step change for major accidents and Safety performance can be achieved by adopting a holistic approach to address technical, procedural, human and organisational, and cultural aspects. We assist you in managing and identifying your process risks.

THE POWER TO MANAGE SAFETY

DNV SAFETY SERVICES

As society gradually adopts a “zero tolerance” for failure, excellence in safety becomes increasingly more business critical. At the same time top level managers realise that their companies will never achieve safety excellence through safety inspections and safety audits alone. DNV helps its clients establish safe, efficient and sustainable everyday and long-term operations.

Since 1864, DNV has been an active global social participant based on our purpose to safeguard life, property, and the environment. With more than 150 years of experience from safety related work in a wide range of industries, DNV can assist you to achieving your safety goals and implementing your safety strategy through our broad portfolio of safety services.

DNV’s safety services provide a systematic approach that enables companies to reduce accidents, improve business and operational performance and enhance reputation. By systematically viewing your business through a systems perspective that consists of technical, organisational and human factors and their interactions, DNV helps improve business performance through excellence in safety.

OUR APPROACH

DNV combines technical expertise and advanced risk methodologies with management consulting skills to provide a new and different type of advisory services. Our cross-disciplinary team of consultants, engineers, economists, psychologists and human factors experts, supported by an extensive portfolio of safety assessment software, provides a unique ability to offer safety management services to cover your needs.

Our approach is to understand the specific risk issues impacting your safety performance, by designing a tailored solution for your needs or offering proven off-the-shelf safety services from our portfolio.

Safety Risk Management

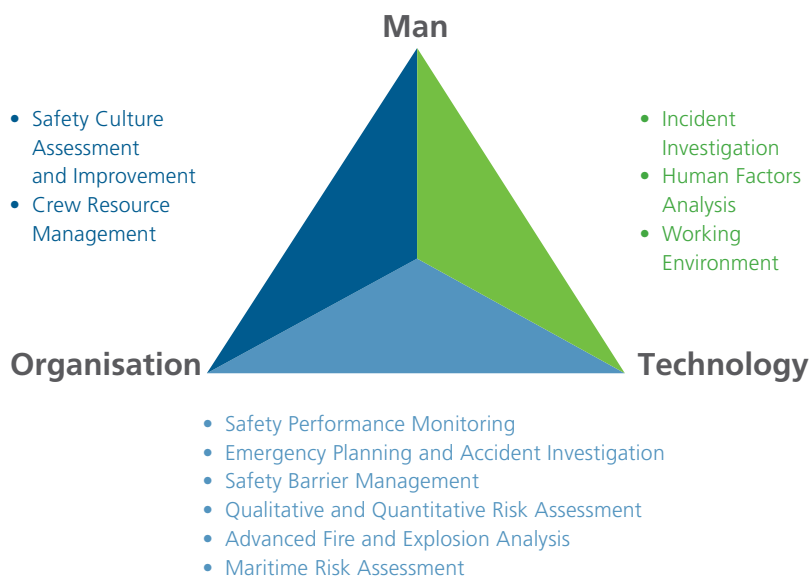


Figure 1: MTO Systems Perspective on safety, with DNV’s Safety Risk Management Services



BUSINESS EXCELLENCE THROUGH A PROACTIVE APPROACH TO SAFETY

DNV believes in the benefit of integrating safety in the overall business performance of a company. Business excellence can be reached through a proactive approach to initiatives to increase the safety level beyond compliance. It is critical that your organisation properly manages safety barriers to prevent and mitigate accidents throughout the lifetime of a ship, offshore or onshore installation.

We combine our technological and organisational know-how into a professional service concept designed to safeguard and improve the performance of your business.

BENEFITS

We assist you in managing your safety performance throughout your operations. Our customised and integrated solutions can help you:

- Reduce business risks and costs
- Protect lives, the environment and investments
- Obtain decision support for increasingly complex operations involving new technologies and challenging environments
- Ensure stable/consistent operations, i.e. prevent accidents
- Improve safety performance
- Improve leadership
- Secure and improve reputation
- Achieve a sustainable business – economically, socially and environmentally
- Promote internal organisational learning and competence building.

Working with us, you share DNV's reputation for independence and integrity, and our worldwide network provides you with up-to-date, best practice advice.

SAFETY CULTURE AND HUMAN FACTORS



Acknowledging the complex nature of accidents has led to an increased focus on human and organisational factors in incident investigations. Investigations of major accidents have shown that while technology and safety management systems still play an important role in minimising risk, it is the interaction of human, organisational and technological (MTO) factors which ultimately determines safety performance. This is referred to as a systems perspective on safety.

BACKGROUND

Organisations in the most hazardous industries have to constantly deal with challenging markets and limited resources in order to stay in business. At the same time, they are expected to operate safely in an increasingly more complex environment. This creates dilemmas where employees at all levels have to make safety critical trade-offs between efficiency and thoroughness on a day-to-day basis. If not managed wisely, pressure from short-term business and operational targets imposes a serious threat of “drifting into failure” – potentially leading to catastrophic losses.

While conflicting goals between safety and production are bound to be ever-present, research and industry experience shows that organisations with resilient and reliable systems, accompanied by strong safety cultures, are capable of avoiding major accidents even in the presence of high-risk conditions. By recognising human strengths and shortcomings, such organisations are capable of utilising the human contribution to achieve enhanced system performance.

OUR APPROACH

DNV has long experience in integrating human factors principles in risk and safety management, both on operator and organisational levels. The aim of both approaches is to reduce conditions that are prone to failure and thereby contribute to accidents, and to strengthen processes that lead to improved safety performance.

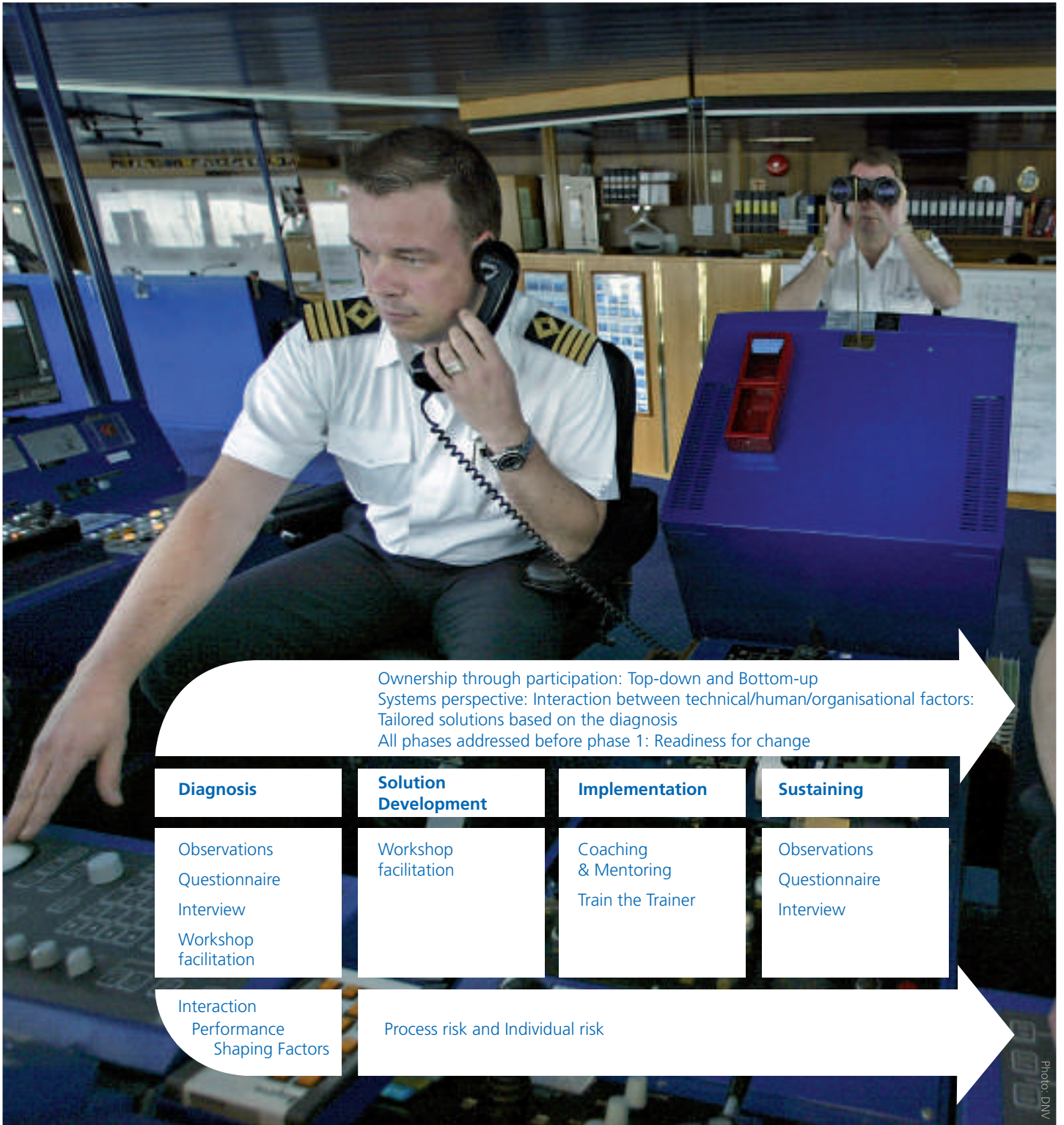
KEY SERVICES INCLUDE

- Safety culture assessment and improvement
- Crew Resource Management (CRM)
- Incident investigations
- Task analysis and allocation of functions
- CRisis Intervention and OPERability analysis (CRIOP)
- Human reliability assessments
- Workload assessments
- Human-Machine-Interface evaluation and design
- Human factors consultancy in projects
- Human factors courses and training.

One of DNV’s safety services is Safety culture assessment and improvement. Using a reliable set of both quantitative and qualitative assessment tools, a cross-disciplinary team of DNV specialists analyse data to create a profile of your company’s safety culture. In addition, a database of over 11,000 unique responses benchmarks your company against the average scores of other companies and different industries. This benchmark provides valuable feedback to your company. A correct diagnosis of your company’s safety culture gives insight to key improvement areas, which again allows for implementation of effective solutions.

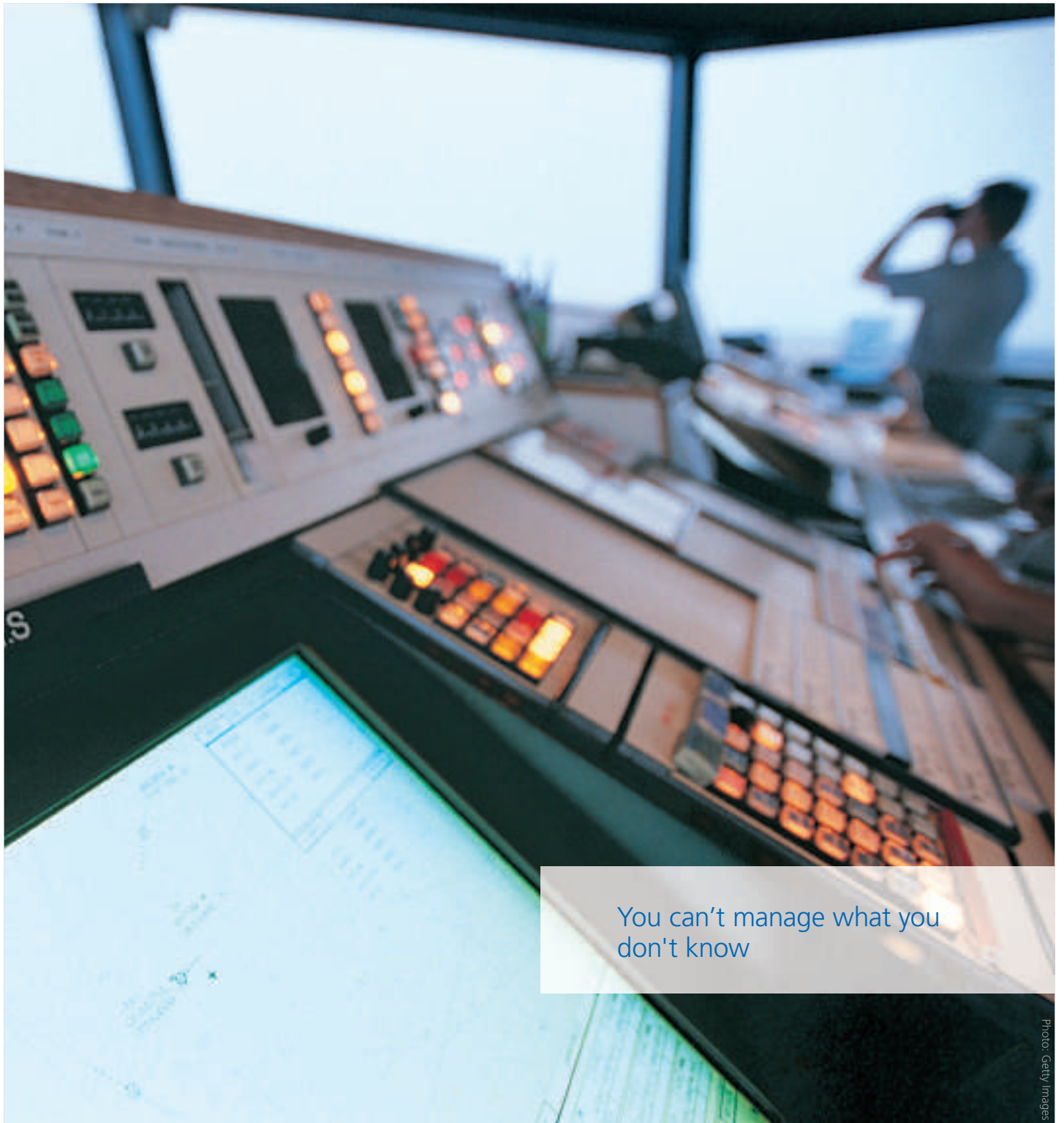
BENEFITS

- Proactive approach to safety
- Improved and sustainable safety performance
- Reduced costs and secured reputation
- More efficient operations
- Benchmarking against other companies.



Ownership through participation: Top-down and Bottom-up
 Systems perspective: Interaction between technical/human/organisational factors:
 Tailored solutions based on the diagnosis
 All phases addressed before phase 1: Readiness for change

Diagnosis	Solution Development	Implementation	Sustaining
Observations Questionnaire Interview Workshop facilitation	Workshop facilitation	Coaching & Mentoring Train the Trainer	Observations Questionnaire Interview
Interaction Performance Shaping Factors	Process risk and Individual risk		



You can't manage what you don't know

SAFETY PERFORMANCE MONITORING



High-risk industries face increasing demands from stakeholders, regulators and the general public for transparency, corporate responsibility and zero tolerance for failure. Safety is thus business critical. Knowing and understanding the safety status of your operation is essential when making operational and strategic decisions. This requires continuous measurement and monitoring of performance indicators that give you a true picture of your safety performance. Understanding your risks through monitoring your safety performance is crucial for operational risk management. You cannot manage what you do not know.

BACKGROUND

Investigations of major accidents have concluded that prior to incidents one has not distinguished clearly between occupational safety (i.e. slips-trips-and-falls, driving safely) and process safety (i.e. safe design, hazard analysis, material verification, equipment maintenance, process upset reporting, safety culture). Typical safety performance monitoring systems have focused on measuring and monitoring occupational safety while paying less attention to process safety. As a result, improving trends in occupational safety statistics have been taken for a general improvement of all types of safety; this does not show the complete picture.

The challenge for most companies that want to monitor the different critical aspects of their safety performance is knowing what to measure, how often to measure, and how to create a culture for feeding back valid and reliable information that forms the basis of the performance indicators.

OUR APPROACH

DNV has gained experience on performance monitoring from many companies in different industries (i. e. maritime, offshore, railway, hydropower) and has over the years established an understanding of what is considered best practice. Our underlying working principle is “correct information, to the right people, at the right time”. Whether this implies risk-based KPIs for strategic decision making or maintenance logs of safety critical equipment will differ from company to company. Our main goal is always to help implement and provide guidance on performance monitoring that is fit for purpose and tailored to your company’s needs.

Our approach also includes operational risk assessments, taking the risk assessments developed during design into the operational phase. This implies making the assumptions and knowledge included in the design risk assessments available to relevant operating personnel. We identify who needs to know what, and how this knowledge should be presented, communicated and processed in order to be included in the operational risk management process.

A key learning point from previous projects is to keep a holistic perspective in mind when designing the performance monitoring system. This means establishing both leading and lagging safety indicators addressing human, technological and organisational factors. This will give you a better system, accounting for both occupational and process safety.

BENEFITS

Our success factors in safety performance monitoring are to create functional systems that are easy to implement and provide the information needed for decision making and continuous improvement.

SAFETY BARRIER MANAGEMENT

Safety barriers are physical and non-physical means to prevent, control, and mitigate undesired events or accidents. If an important barrier fails to provide the protection expected, either because the barrier was degraded or the accident sequence was not anticipated, it is more likely that a major accident will occur. The integrity of the barrier must therefore be managed.

BACKGROUND

Investigation of major accidents shows that the causes for unwanted events are complex and consist of a sequence of safety barriers that fails. The barriers may be technological, organisational or human. In order to systematically identify key barriers and controls, and to monitor that their functionality is available when needed, a barrier management system has to be in place.

OUR APPROACH

Typical barrier approaches include the Swiss Cheese Model, Layers of Protection, and the Bow Tie barriers model. These are frequently used to better understand the full range of critical safety controls deployed, whether these are sufficient for the potential risk, and to communicate this effectively to all staff and management.

A complete safety barrier management system usually involves the following main steps:

1. Build competence and introduce the safety barrier concept
2. Define the framework and requirements in Regulations and International Standards
3. Identify relevant safety barriers for the activity in question
4. Develop performance standards for the safety barriers, based on regulations, standards, internal requirements and risk assessments
5. Define activities and processes for monitoring the safety barrier performance
6. Develop a process for following up substandard performance.

DNV delivers projects covering either single steps or the complete cycle of a safety barrier management regime.

DNV has developed an integrated approach to Bow Tie barrier analysis. Our approach assesses preventive controls before the event. It considers the full range of controls deployed,

wider in extent than, for example, the Layer of Protection Analysis (LOPA) methodology. In DNV, we see barrier diagrams as key means of communicating, measuring and assessing operational and safety risk management performance.

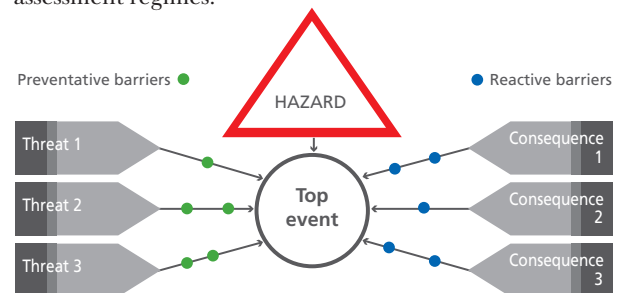
DNV also help customers assess the integrity of the technical safety barriers on their production and processing facilities through data collection, data aggregation and performance indicator programs.

With DNV's approach, leaders can document that they are managing their hazards with real confidence and have the ability to back this up with verifiable details.

BENEFITS

Major accident risk management is challenging, complex and time consuming, but generates great value to the organisation if managed appropriately, efficiently and effectively.

DNV has experienced consultants helping customers manage the integrity of their safety barriers. DNV also advises customers on implementing barrier performance assessment regimes.



A Bow Tie diagram is a barrier method that shows how all threats on the left hand side can propagate through a "top event", usually a loss of containment event, and become consequences on the right hand side. Barriers prevent the propagation and the Bow Tie approach documents each barrier and its effectiveness, and also the means to keep it functioning through life.



Risk is more than numbers



WORKING ENVIRONMENT SERVICES



Your organisation's performance depends on your people.

BACKGROUND

Did you know that, on a global basis, more than two million people die each year as a result of work-related accidents, injuries or illnesses? Working environment aims at protecting workers from exposure to physical, chemical, biological and psychological hazards at work. DNV provides a wide range of services to assist our clients in achieving a healthy working environment.

DNV helps you design and assess processes and workplaces and develop personnel in a way that increases performance safely and responsibly. DNV brings together the competence and experience necessary to assist our clients in issues related to the working environment.

OUR APPROACH

DNV employs competence in all aspects of ergonomics, occupational hygiene and human factors. We provide integrated and multi-disciplinary services helping our clients implement, develop, maintain and improve their working environment.

Our working environment services include:

- Qualitative and quantitative working environment assessments within design, modification, operation and decommissioning

- Measurements of occupational hygiene factors such as noise, vibrations, illumination and chemical exposure
- Ergonomic risk assessments
- Hazardous chemicals management
- Assessment of organisational and psychosocial working environment
- Assessment of workplace and work system design, evaluating physical and cognitive ergonomics related to work tasks
- Optimisation of work processes and development of relevant procedures related to work tasks
- Development and implementation of a working environment management system
- Compliance with national and international working environment regulations
- Advisory services with regards to implementing risk-reducing barriers (technical, organisational and personal).

BENEFITS

By focusing on the physical and psychological working environment, human machine interaction, optimisation and development of work processes as well as workplace design with regard to hazardous exposure and situations, DNV can help you promote a safe, healthy, efficient and productive working environment.

EMERGENCY PLANNING AND ACCIDENT INVESTIGATION



Effective planning for emergencies and other undesired events is an essential part of good business management. Companies need to prepare for situations that could cause potential losses to people, assets, income or harm to the environment and society at large. As an integral part of its risk management services, DNV helps companies develop and maintain effective response plans to control their risk exposure.

BACKGROUND

Emergency planning and accident investigation are two services that address:

1. the potential for events and how to respond to minimise the outcomes, and
2. the identification of direct and underlying causes of incidents in a structured context, especially large accidents with complex technical and human causes.

By undertaking incident investigations and incorporating experience into new response plans, the aim is to ensure that history does not repeat itself.

OUR APPROACH

DNV works together with you to gain a thorough understanding of your operations, threats and risk management needs. We help you improve the effectiveness of your emergency planning, response and investigation capabilities. The emergency response analysis and planning will be based upon a risk analysis approach, identifying and detailing the accidental scenarios that require to be included in the emergency response planning. The service covers all aspects from identifying requirements for emergency response, plan generation, communication and drills to follow-up of major incident investigations.

KEY SERVICES INCLUDE

- **Emergency Preparedness Analysis:**
We help identify and analyse the most appropriate scenarios for emergency planning and areas where the level of emergency preparedness is not satisfactory. The analysis is normally based on a risk assessment; this ensures that emergency planning matches the range of possible events, with increased focus on high-risk events.
- **Planning and Resources:**
We work with you to develop effective emergency plans and response strategies, using tools such as pre-fire planning and consequence modelling. This includes fitting the emergency response resources to suit the intent of the plans.
- **Regulatory and Community Interactions:**
Major hazard regulations in many countries specify emergency response planning. We can help you develop compliant plans tailored to specific needs. Our independent status helps you communicate emergency plans and risks to local communities and regulators.
- **Major Accident Investigation and Crisis Management:**
We provide support in major accident investigation by developing teams with the full range of skills necessary to address technical, management system and accident root cause investigation.
- **Training, Exercise and Reviews:**
Emergency plans are only as effective as the teams that deliver them. DNV has experience developing and reviewing training materials, desktop exercises and more intensive full-scale emergency drills.

BENEFITS

- By tailoring your emergency preparedness, based on a risk analysis, you use your resources smarter and reduce the consequence of an accident
- By including experience from accidents and/or exercises, you enhance organisational learning and are continuously improving your safety performance.

What could a poor safety performance cost you?



QUANTITATIVE RISK ASSESSMENT (QRA)



Business units and managers are facing a fundamentally new and more challenging operating environment—“zero tolerance” for consequential damage. Stakeholders demand that companies demonstrate full understanding of the potential impact of their operations and that they are effectively controlling the associated risks. The company that operates more efficiently, reliably and safely than its competitors will be more successful in the long run.

BACKGROUND

A quantitative risk assessment (QRA) enhances systematic identification and evaluation of possible accidental events, including their causes and consequences. It provides estimates to allow clients to understand risk exposure to people, the environment, business markets or other areas of interest.

QRA does not necessarily have to be a complex exercise. In some cases a relatively simple QRA will suffice. The ability to accurately predict to what level a QRA should be developed, at an early stage, is key for the creation of a cost-effective and useful decision-making tool.

OUR APPROACH

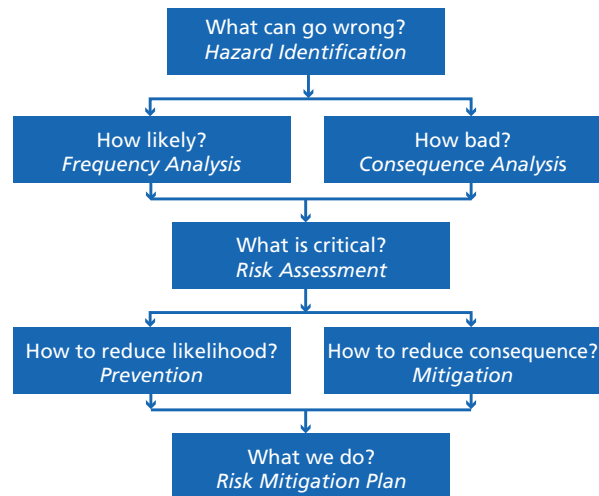
We work closely with you to understand the technical risks and potential consequences of your operations, and thereby making better decisions.

We have extensive experience in planning, execution and implementation of QRA techniques as a risk management tool, ranging in size from small semi-quantitative studies of specific activities with temporarily increased risk exposure to fully integrated QRAs of continuous operations with high technical and operational complexity.

By establishing a transparent model assumption basis, proposed changes can easily be reflected, our assessments can contribute to considerable savings and at the same time drive down risks, ALARP (AS LOW AS REASONABLY POSSIBLE) processes can be documented and optimal safety measures implemented.

BENEFITS

We recognise the need for cost-effective risk management and draw on previous experience and our integrated service provision to deliver value to our clients. By providing a range of tailored QRA principles and techniques, we enable our clients to understand their threats and opportunities. By offering flexible models we enable timely decision support in a changing environment.





Do you know your risks?

MARITIME RISK ASSESSMENT



Compliance with prescriptive requirements is no longer sufficient within the Maritime Industry. Forward-thinking organisations and stakeholders undoubtedly expect clear management of safety, health and environmental (SHE) issues. Efficient, reliable and safe operations are the key to success in the long run. Identification and assessment of risk is a prerequisite for risk and safety management.



Photo: DMW/Hakon Hustad

BACKGROUND

Maritime Risk Assessments may focus on several aspects of risk associated with maritime activities. Some examples may be:

Vessel Concept

under certain circumstances, e.g. for gas fuelled vessels, risk assessments are required for approval of a concept.

Demonstrate Safety Equivalence

When prescriptive requirements are not possible to meet, a concept may still be approved if an equivalent or higher safety level may be demonstrated through risk assessments and analyses.

Navigational Risk

Assessment of frequency and consequence of undesired incidents like grounding, collision/contact, loss of stability or structural integrity, e.g. to assess the risk related to a certain trade, risk related to a port, terminal or defined geographical area, or risk related to a vessel.

OUR APPROACH

A standard risk management process is the basis for our approach. Dependent on the issues to be assessed, the appropriate selection from DNV’s range of risk tools will be

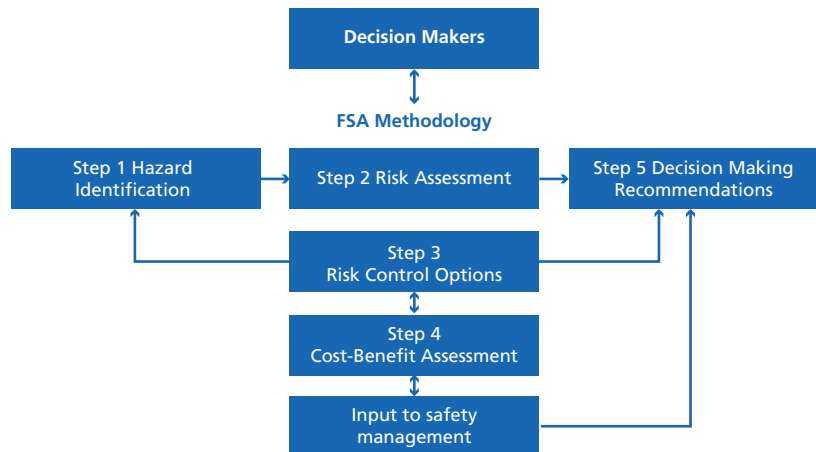
applied, often adapted to all or a selection of the five steps of the Formal Safety Assessment (FSA) process*.

The first FSA step, Identification of Hazards (HAZID), is very important. The aim is to find the answer to the question “What can go wrong?” Unless a hazard is identified, the related risk will not be analysed. The next step is to analyse and assess the risk; “How likely is it?” (Frequency analysis) and “How bad can it be?” (Consequence analysis). When this is established, it is possible to consider options for controlling the risk. A cost-benefit assessment may give a further basis for making decisions on whether or not an estimated risk level is acceptable, or if further measures to reduce and control the risk should be implemented.

BENEFIT

By assessing the risks and relevant risk control options, you have the opportunity to implement the measures that will make you manage your risks. We assist you in this process to ascertain a desired safety level.

Not only can we assist in documenting that risks are managed, and thereby facilitate acceptance and approval by authorities and clients. But a proper safety performance is the best qualification for a sustainable business – economically, socially and environmentally.



FORMAL SAFETY ASSESSMENT (FSA) PROCESS*
 * Ref. the International Maritime Organisation (IMO), “Guidelines for Formal Safety Assessment (FSA) for Use in the IMO Rule-making Process”.

ADVANCED EXPLOSION & FIRE ANALYSES



The maritime and energy industries are entering new frontiers applying new designs and technologies, often in extreme environments. Such operations carry significant inherent safety and environmental risks which can escalate into major accidents. As such, companies need to quantify those risks in an accurate way in order to avoid major accidents and determine cost-effective risk reduction measures that improve safety and minimise production downtime. Standard analytical techniques cannot always adequately capture the impact of novel and different designs, technology and operating environments. Computational Fluid Dynamics (CFD) analysis combined with advanced risk models can provide the high level of accuracy required and better insight into the physics of such complex problems. With our extensive technical knowledge of advanced simulations and practical experience in technology solutions, DNV is ideally positioned to provide our customers with safe and cost-efficient solutions that meet industry best practice.

BACKGROUND

Advanced simulations implemented via the integration of Computational Fluid Dynamics (CFD), Finite Element (FE) structural analyses and advanced risk models are routinely used today to determine risks to people and key assets arising from various events such as fires, explosions and toxic releases. DNV's experienced specialists and engineers provide cutting-edge solutions to complex fluid flow and structural problems that allow you to make optimal risk based decisions. Advanced simulations allow for the modelling of complex geometries and scenarios. By applying these advanced simulations from feasibility and concept selection to life extensions, our customers obtain significant benefits in terms of cost-effective solutions and meeting regulatory and industry best practice.

OUR APPROACH

DNV's approach differentiates us from our competitors. Our advanced simulations expertise is based on a holistic approach, where the probabilistic loading and response can be systematically evaluated whilst considering a range of project-specific variables, activities, their interdependence, and effects, thus allowing us to confidently make judgments and provide value-adding opinions and recommendations with respect to gaps and potential areas for improvement.

DNV's global reach, with CFD teams based in Oslo, Bergen, London, Rio, Houston and Kuala Lumpur, means that we

can understand and address our customers local requirements.

Our services include the following analyses, applying tailor-made analysis tools following industry procedures and practices:

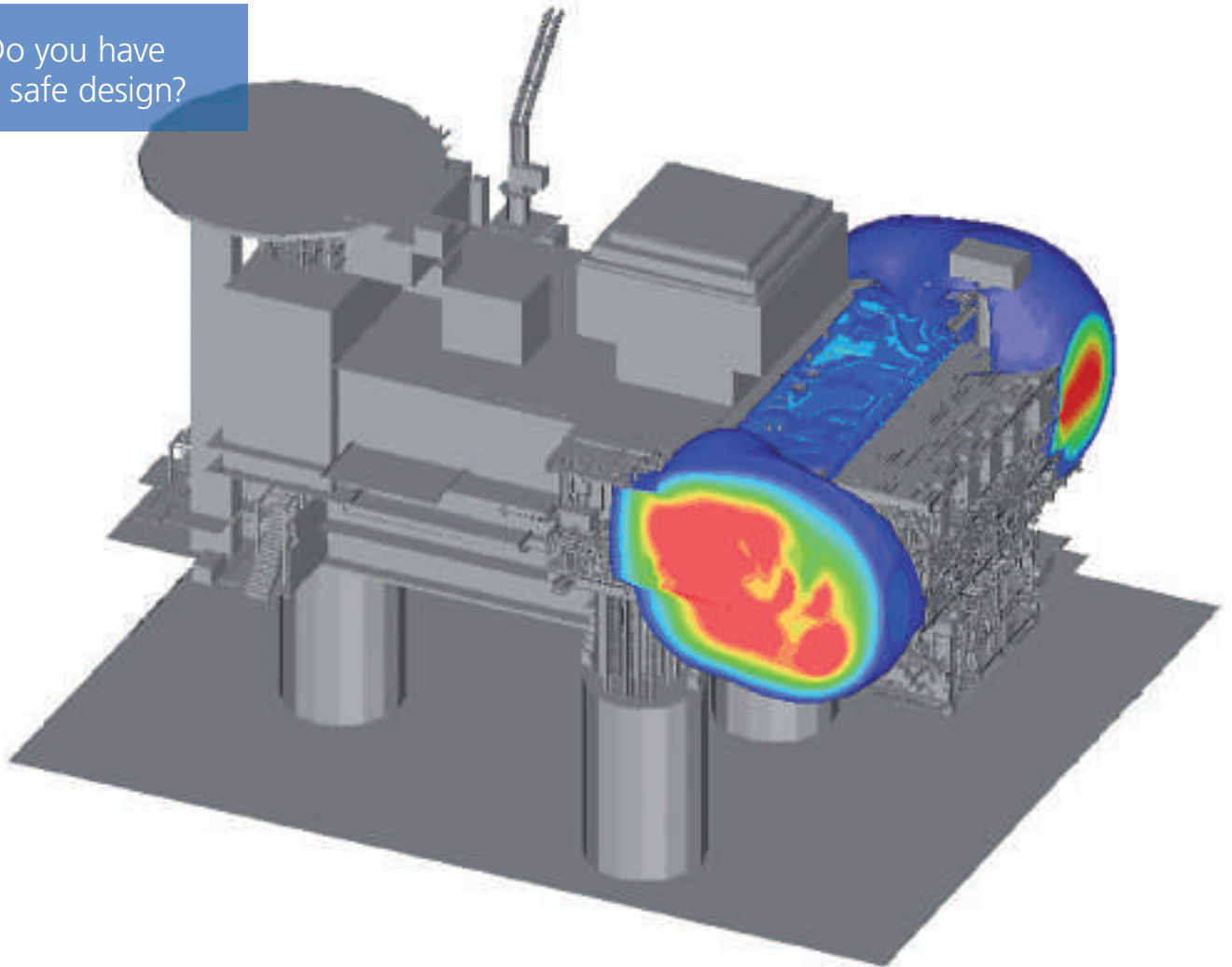
- Probabilistic fire and explosion analysis
- Ventilation studies for hazardous area classification
- Helideck turbulence analysis
- Exhaust gas dispersion
- Fire radiation, smoke and gas dispersion
- Gas detector studies
- Integrated wind chill and ventilation analysis
- H₂/LNG/CO₂ dispersion analysis
- Structural response analysis
- Accident investigation.

We use a range of commercial and in-house software packages providing the flexibility to tailor our own approach.

BENEFITS

- A deeper level of detail allows engineers to understand the real physics of the problem and thereby devise optimal solutions.
- The impact of various mitigating measures can be investigated via sensitivity studies.
- Excessive conservatism is avoided by modelling the complex physics of the problem, thereby lowering design

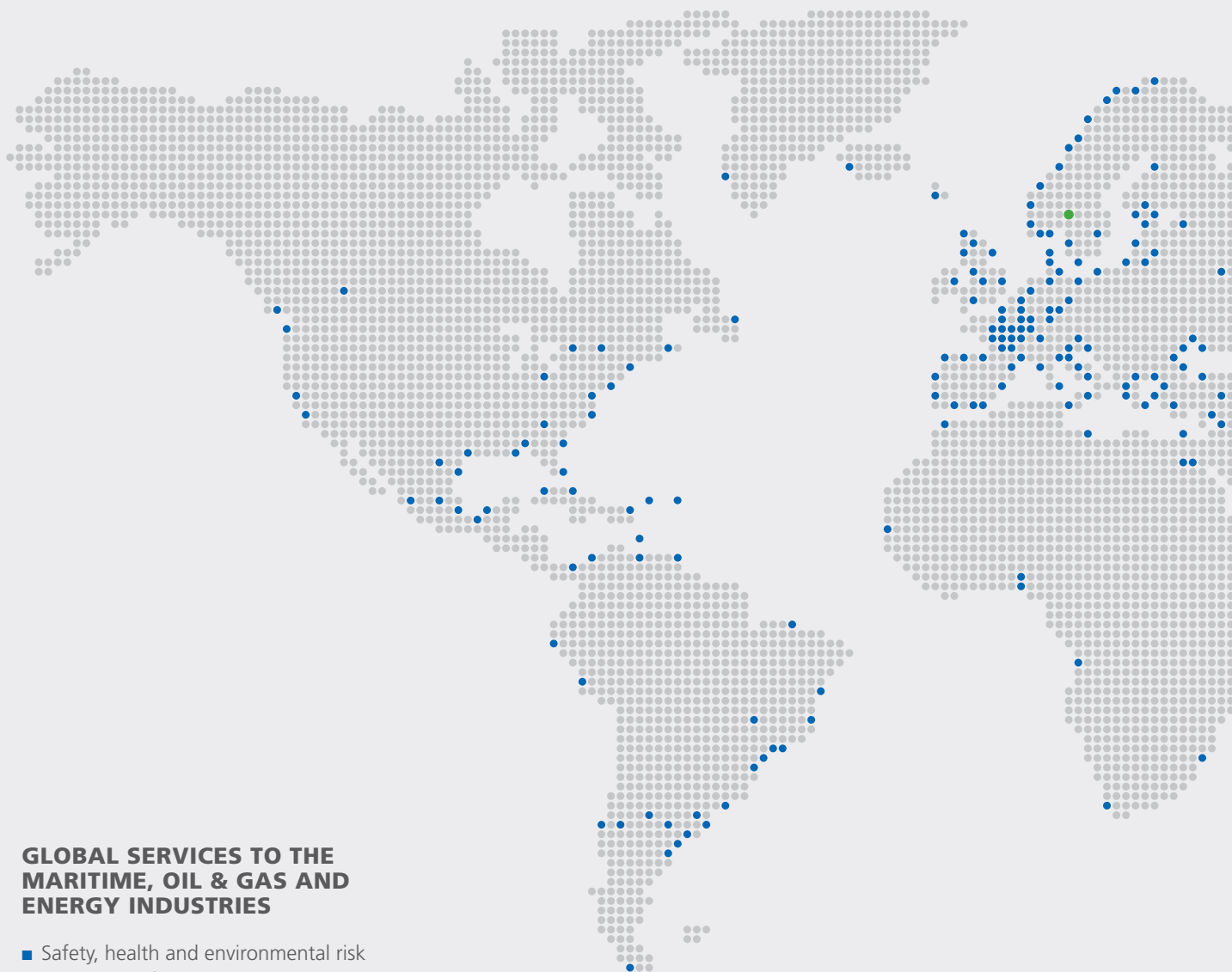
Do you have
a safe design?



loads, this leads to potentially significant savings in material costs.

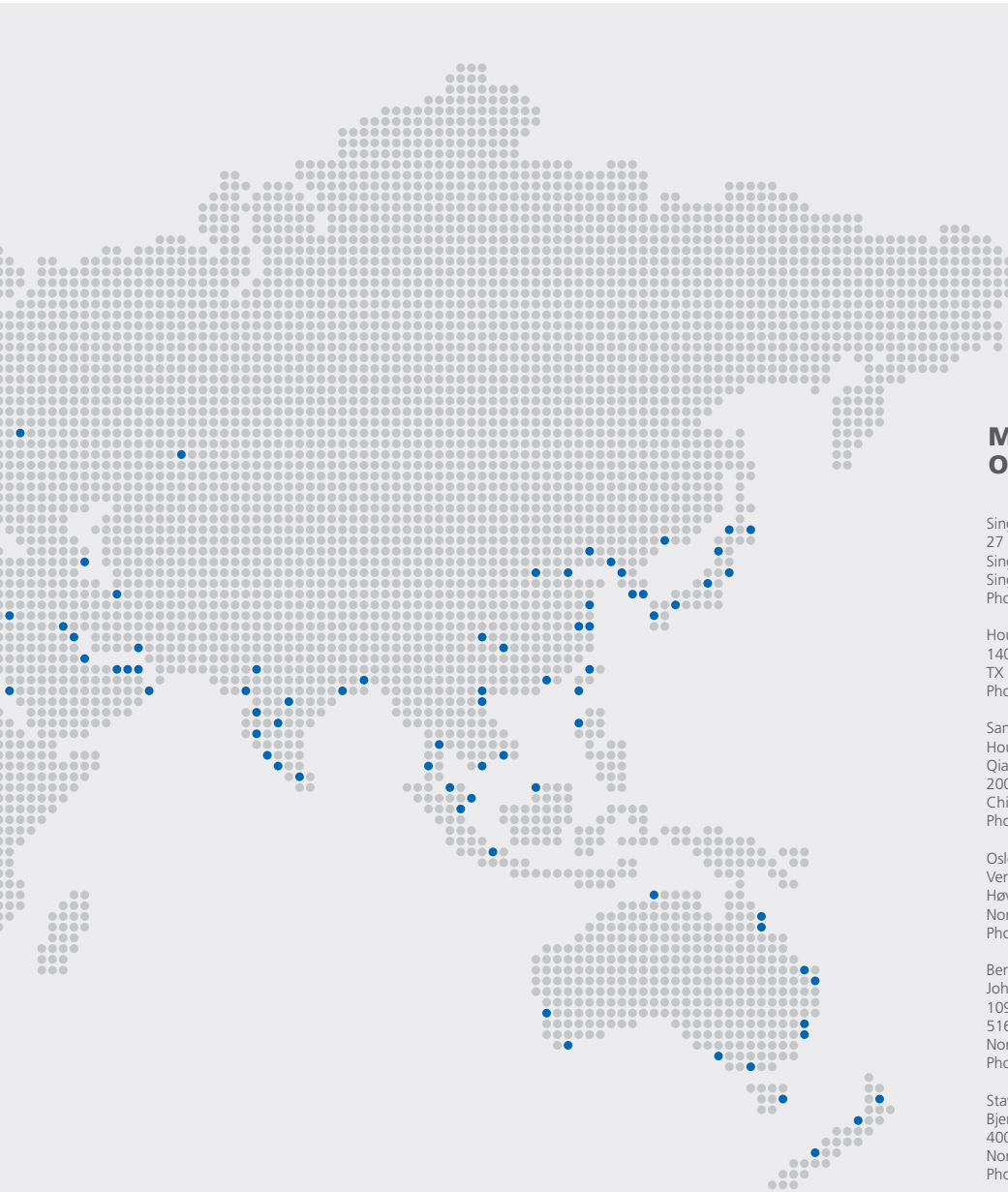
- Identification of key explosion issues at early stages leads to cost-effective layout management.
- Risk communication via the 3D visualisation capabilities provides confidence and assurance to all stakeholders that the results are based on sound physics.
- Solid foundation for decision making.
- Reduced risk and avoidance of hidden pitfalls.
- Identification of cost-effective mitigation measures and development of optimal solutions.

Snapshot of an explosion wave from a gas explosion in a process module. Dark blue is a constant pressure surface; colours show cuts through the pressure wave where red shows the highest pressures inside the explosion wave.



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THIS IS DNV

DNV is a global provider of services for managing risk, helping customers safely and responsibly improve their business performance. Our core competence is to identify, assess and advise on risk management. DNV is an independent foundation with presence in more than 100 countries.

THE POWER TO MANAGE SAFETY