KONGSBERG

OFFSHORE WIND

SOLUTIONS MAXIMIZING PERFORMANCE

MAXIMIZING PERFORMANCE BY PROVIDING

THE FULL PICTURE

OUR MISSION

We shall earn the respect and recognition for our dedication to provide innovative and reliable marine electronics that ensure optimal operation at sea. By utilizing and integrating our technology, experience and competencies in positioning, hydroacoustics, communication, control, navigation, simulation and automation, we aim to give our customers The Full Picture.

The Full Picture yields professional solutions and global services that make a difference enabling you to stay ahead of the competition.

OUR PHILOSOPHY

Our success depends on the success of our customers. Actively listening to our customers and truly understanding their needs and then translating these needs into successful products and solutions is central to achieving our goal.

Our people are the key to our success and we empower them to achieve. Working together in a global network of knowledge, guided by our values, engenders innovation and world class performance.

Every day we have to think a little differently, because every client is unique. We aspire to translate the imagination and dedication of our staff into successful technologies and solutions. Our commitment is to add value to your operations by providing you with The Full Picture.

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TECHNOLOGY FOR THE FUTURE

Increasing productivity, enhancing safety
The global focus on renewable energy has enabled growth in the wind farm sector, creating real market opportunity for vessel owners. However, competition is tough, while costs and demand are high. To gain a competitive advantage, vessel owners must optimize operations, gain real-time and long-term oversight over fragmented vessel systems and, whenever possible, reduce costs. KONGSBERG is dedicated to achieving this.

KONGSBERG is one of Norway's leading technological organizations. We possess both the ability and the determination to take the challenging route from an initial concept to finished industrial solution. For vessel operators in the offshore wind sector, we have a wide portfolio of technology solutions designed to empower operations and deliver tangible efficiencies.

For wind farm management, KONGSBERG EmPower is a turbine independent decision support system providing integrated and modular performance monitoring, condition monitoring, production forecasting and wind farm control from a single platform.

For wind farm vessel operations, KONGSBERG has developed an innovative wind farm support integrated vessel concept. It features the unique K-Walk motion compensated gangway system, which delivers an innovative and automated approach to personnel and cargo transfer during wind farm construction and maintenance operations.

To ensure competence and to enhance safety and efficiency at all stages of wind farm vessel operations, we have the K-Sim Offshore simulator platform, which features advanced physics-based simulators to enable studies and training of crew manning the various marine assets involved.

KONGSBERG has a long tradition in developing world-class high-technology solutions for technical operations in the maritime, offshore and renewables sectors. Today, we are focused on the integration of these solutions to leverage even more safety and efficiency benefits, helping our customers to gain the competitive edge in today's demanding offshore wind marketplace.

KONGSBERG EMPOWER - INTELLIGENT INTEGRATION & OPTIMIZED OPERATIONS

Reduce your maintenance costs by up to 30%
This is possible when you own your own data and can take advantage of the most advanced predictive maintenance system for turbines. All functionality is integrated in one suite of software with highly advanced analytics. Kongsberg EmPower is a turbine-independent decision support system. The system offers an intuitive user interface based on more than 50 years of experience in developing automation and decision support systems for the industry. Specifically for wind power applications, EmPower includes four modules; performance monitoring, condition monitoring, production forecasting and wind farm control. Although the full benefits of the system are in the integration, the modular design ensures that the system is scalable and can be tailored to the customer's needs and business model.

Performance monitoring
The performance monitoring module aims to identify underperforming turbines and thus lost production. The module provides the user with a performance overview at portfolio, farm and turbine level. Selected key performance indicators and other calculations are carried out as data is collected and hence monitored continuously. Analysis tools can easily be accessed to explore data in more detail.

Condition monitoring
The condition monitoring module imports all relevant and available data from the turbines to monitor the most important components. It offers a suite of signal processing methods and algorithms for improved extraction of the information contained in the data. The module supports condition-based maintenance, provides early detection of faults and enables the user to initiate actions before faults develop into unrepairable failures.

Production forecasting
The production forecasting module is designed to minimize imbalance costs by improving the accuracy of production forecast used for trading in intraday and day ahead markets. The module will also support maintenance planning by indicating when losses due to production stops are minimized, and by identifying weather windows when maintenance is most practical.

Wind farm control
The wind farm control module contains functionality to control the wind farm and to operate it as a whole. The module will contribute to increased production and reduced turbine loads by optimization of the total farm production by dynamic down-rating of selected turbines and active wake steering. The novel dynamic farm optimizer functionality represents uniqueness in EmPower.

EmPower on Kognifai

K-WALK
MOTION-COMPENSATED GANGWAY

Fully integrated gangway
Through integrated mission planning, automated vessel maneuvering and autonomous gangway connection, K-Walk introduces an innovative approach to personnel and cargo transfer during wind farm construction and maintenance operations. K-Walk takes a new approach to increasing productivity and efficiency for walk-to-work vessels. While providing a completely safe, motion-compensated gangway for the fast transfer of personnel and materials, integration enables more efficient approach and settlement at wind turbines and more effective logistics.

The system is activated prior to entering a wind turbine's safety zone, reducing vessel speed and launching the K-Walk connection process during approach. Because of the integration with the dynamic positioning, the gangway is able to move into position while the vessel is still moving, positioning it safely as the vessel arrives on station.

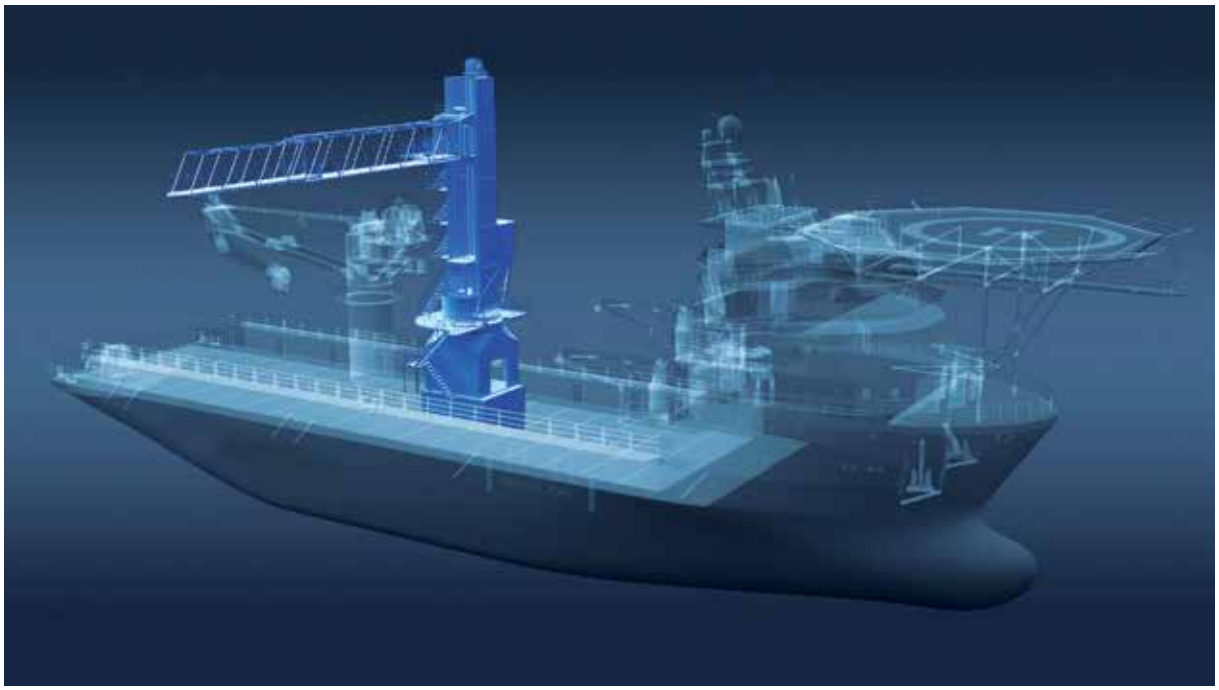
Vessel concept wind support – energy, handling, operation
KONGSBERG's new integrated wind support vessel concept enables increased productivity for offshore wind turbine maintenance operations. The concept provides total oversight, enables better real-time and long-term management decisions, and empowers safer, more predictable, and efficient operations. The concept includes an innovative and integrated gangway with automatic docking, mission planning with weather forecast adaption, and improved energy control.

Supported marine operations
The walk-to-work control solution is designed to optimize time consumption when transporting crew and equipment to turbines for maintenance. When the wind farm administration issues the work orders and decides which turbines needs to be visited, the vessel crew assisted by the system creates the most favorable sailing route between the turbines. The route is used as input to the automatic maneuvering system or as guidance to the operator if he/she prefers to sail and maneuver by using manual control devices.

The motion-compensated gangway can be operated by manual control devices, or it can be automatically directed towards the landing point on the turbine and connected once the vessel has reached the position calculated as the most favorable in terms of vessel motion and energy consumption under the prevailing weather conditions. A camera reference system on the gangway is used for the final gangway adjustments and docking.

Automatic gangway connection/disconnection is synchronized with automatic maneuvering and requires automatic maneuvering to be activated. If manual operation of the gangway is preferred, the camera reference systems on the gangway still support the operator when homing the gangway against the landing point.

When crew and cargo transfer is completed, the vessel can automatically be sailed to the next turbine. When the command is given, the gangway is automatically disconnected and stowed on board while the course is set towards the next turbine.



During the operation, the most significant ship systems in use are the gangway including access systems, the propulsion/thruster/steering systems and the energy production systems. Maneuvering and positioning control systems, the gangway control system and the integrated automation system including energy management control and coordinate operation of the ship equipment.

Main benefits
Increased efficiency and productivity of walk-to-work operation – faster approach and settlement at turbines, quicker transfer of personnel and more effective logistics.

Enhanced safety – innovative gangway design with redundant control systems and reference system allowing automatic connection of the gangway and fail-safe operation. Advanced service operation vessel transfer system with direct, and automatic, bridge control. Reduced human risk, with no need for dedicated gangway operators and technicians.

Reduced cost – improved planning and resource utilization, effective and affordable camera-based passive reference system, reduced downtime, and energy-saving integrated vessel electronic power plant and DP functionality.

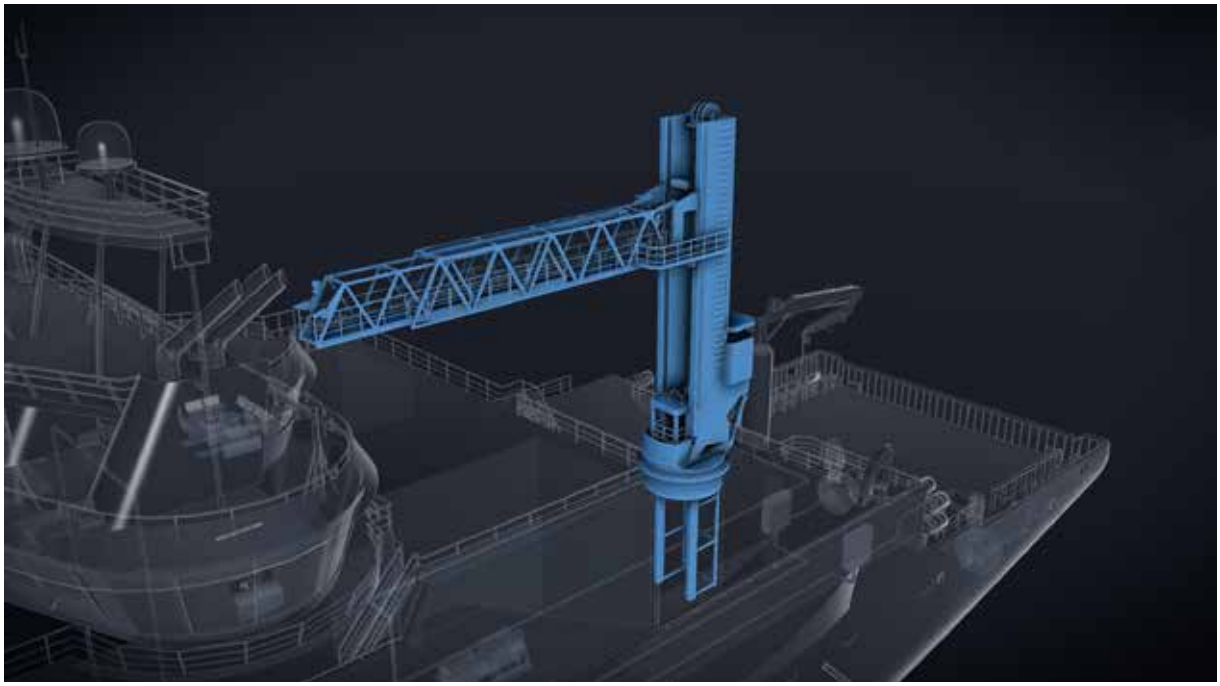
Operability
- Integrated mission planning and automated vessel maneuvering
- Integrated with Dynamic Positioning System (K-Pos for a fully automatic connection using precision reference systems and increasing operability by reduced manning (controlled from DP bridge)

Productivity
- Slopeless transfer of personnel and cargo
- Integrated lift for stepless transfer
- Increased operational weather window due to roll compensation of pedestal

Efficiency
- Improved efficiency through hybrid AC design solution
- Integrated energy control with advisory tools
- Energy management accounting for DP dynamics

Control system
- K-Walk control system is specially designed for gangway operations and is fully redundant
- The controller unit contains two powerful control computers and I/O units to provide an interface to motors, instruments, sensors and dual LAN interface for other KONGSBERG systems
- The gangway control system is designed for seamless integration with KONGSBERG dynamic positioning system, K-Pos dynamic positioning and K-Chief vessel control system, by means of network connections

Integrated operator environment and dedicated gangway views
- Single window operational environment
- Innovative levers and touch solutions
- Adjustable and retractable screen and seating positions for total viewing
- Gangway view with status, sensor, reference and position information



K-SIM TRAINING SOLUTIONS ENHANCING SAFETY & EFFICIENCY

Competence improves safety and efficiency
KONGSBERG's world-leading K-Sim Offshore is the perfect choice to enable advanced studies and training of crew to perform specialized and demanding wind farm operations more safely and efficiently.

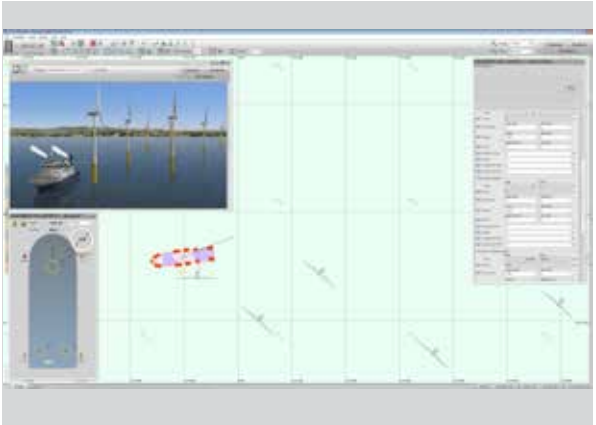
K-Sim Offshore provides a virtual, yet fully realistic training environment, where mistakes can be lessons learned and potentially dangerous scenarios can be fully exercised preparing crew for how to respond to escalating situations and manage crises.

Simulation training benefits
The benefits of utilizing simulators in training of crew for operations in the offshore wind industry are many:

- Cost-efficient alternative compared with training at sea
- Practice on crisis management in a safe environment
- Train industry newcomers as well as assessment, screening and closing of competence gaps for experienced crew.
- Realistic simulation that allows for pre-mission planning, technical and operational skills training of both routine and non-routine scenarios
- Human factors and soft skills training, e.g. teamwork, leadership, communication, situational awareness
- Certification training and assessment of Dynamic Positioning Operators (DPOs), crane and ballast operations
- Integrated training promoting development of strong teams capable of improving margins

Typical training scenarios
For training on windfarm operations, KONGSBERG simulators can provide a wide range of training scenarios, such as:

- Navigation and ship handling of wind turbine Installation Vessel (WTIV) on dynamic positioning and in close proximity of wind-farm installations
- WTIV jacking operations, ballasting and levelling
- Crane operations during erection of wind turbine
- Installation of towers, nacelles and blade.
- Maritime operations for crew transfer vessels and service operation vessels (SOV)
- Walk-to-work gangway operations for WTIV and SOV
- Wind farm foundation installation vessel operations
- Subsea construction, ROV, cable lay and trenching operations.



Fully equipped training environment
The K-Sim Offshore full mission bridge simulator includes instrumentation and bridge equipment with controls and functions necessary to train crew and operators of vessels engaged in offshore wind operations. Integrated with KONGSBERG K-Pos dynamic positioning (DP) systems, the simulator system supports DP training on all levels, including operator training according to DNV GL and the Nautical Institute's standards.

Intuitive and efficient pedagogical tool
K-Sim Offshore instructor system is designed with the user experience firmly in focus. The instructor system provides the instructor with a powerful and efficient tool to design, control and assess customized exercises. By introducing errors and faults on equipment and systems, the instructor can challenge the student to recognize and manage situations and scenarios that cannot be trained at sea, such as an escalating crisis based on real incidents, e.g. punch-through, black-out etc.

Integrated team training
Integrated team training is especially required for operations in environments where human errors can have devastating effects and is recommended for operations with a certain degree of complexity like installation and maintenance of offshore wind farms.

K-Sim Offshore supports interdepartmental crew training through interface to other K-Sim simulators, such as DP, crane and engine room simulators. See the illustration below:

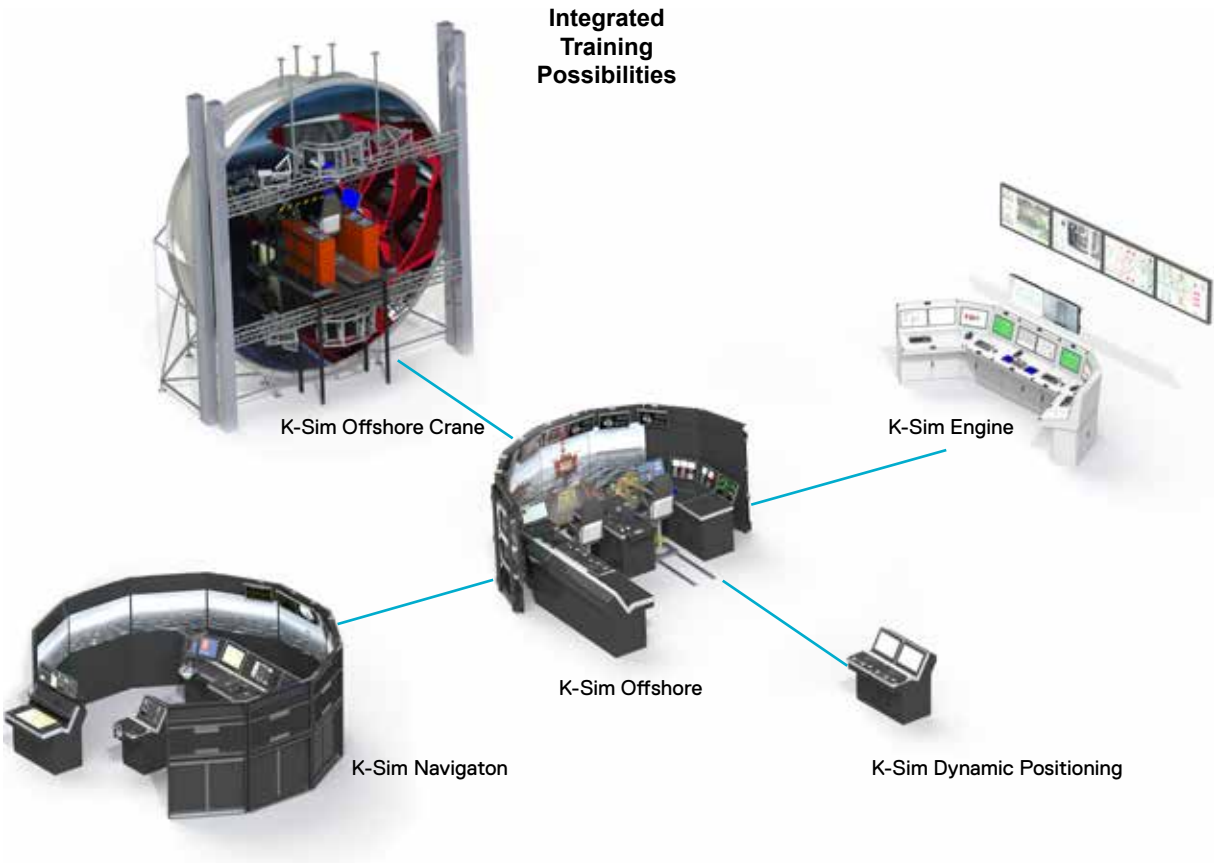
For SOV crew, K-Sim Offshore integrated with K-Sim DP enables training on ship handling, approach and walk-to-work connect/disconnect of automated gangway solutions such as K-Walk as well as other gangway systems used by the industry.

Integrated with an emulated jacking operation system, the K-Sim Offshore simulator will enable WTIV crew to train on ship handling, jacking, ballasting and leveling operations during approach, jacking-up/down and departing site in close proximity to monopiles, wind turbines and platforms.

By integrating a K-Sim Offshore Crane simulator, with operator cabin equipment and view, crane operator training can be accommodated as part of a complete exercise. Seperate simulator operator stations are available for deck personnel such as signal man, slinger etc.

The system can also be expanded with K-Sim Engine (engine room simulator) to include engineers and electricians to facilitate crew resource management (CRM) training.

Research and development
In addition to standard and special task training, the K-Sim range enables testing and R&D for:
- Engineering studies
- Fast prototyping
- Concept testing and verification
- Procedure development and testing
- Vessel behavior studies
- Fuel economy studies
- Crew competence screening
- Operator fatigue studies



LIFE CYCLE SUPPORT

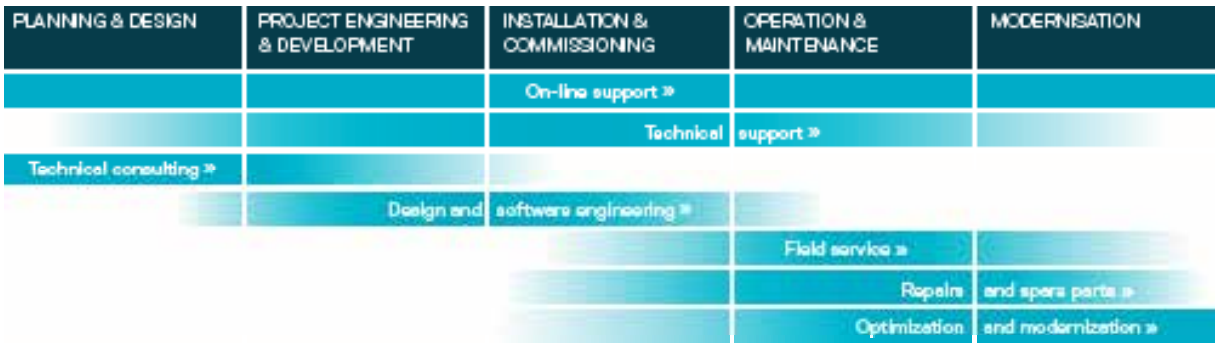
Designed to purpose – maintained to last
Our life cycle management service will assist our customers throughout all the phases, from design to commissioning and during the operational life time.

Solid in-house competence, both in system design and user competence enables us to provide solutions that are fit to purpose and thus yield efficiency in operation. Our common base technology provides robust designs, with few and reliable parts, an execellent foundation to maximise the output at competitive costs.

The distributed and open system design employs an industry standard communication network. Standard hardware components used for various applications and the open network approach results in:
- Increased reliability
- Competitive life-cycle support
- Easy up-grade solutions

Evergreen
We offer continuous hardware and software upgrade to keep your vessel at maximum efficiency. Our system is designed with consistent boundaries between individual systems and control segments. This design strategy makes it easy to add new functionality or complete new control segments, enabling us to offer up-grades step by step to keep your system evergreen.

Training
Qualified personnel are one of your major assets in efficient and safe operations. Thus, we offer modular training courses for all major subjects – from operator training to technical training that keeps your crew fit for the job.



Supported by professionals
Our systems are easy to install and maintain – supported by professionals either on-site or through remote connectivity. They are designed for optimal operational availability and allow for favourable lifecycle expenditure

GLOBAL CUSTOMER SUPPORT

We are always there, wherever you need us
KONGSBERG customer services organization is designed to provide high-quality, global support, whenever and wherever it is needed. We are committed to providing easy access to support and service and to responding promptly to your needs. Support and service activities are supervised from our headquarters in Norway, with service and support centers at strategic locations around the globe – where you are and the action is.

As part of our commitment to total customer satisfaction, we offer a wide variety of services to meet individual customers' operational needs. KONGSBERG Support 24 is a solution designed to give round-the-clock support. For mission-critical operations, KONGSBERG Support 24 can be extended to include remote monitoring. We can adapt the level of support needs by offering service agreements, on-site spare part stocks and quick on-site response arrangements.

Global and local support
We provide global support from local service and suport facilities at strategic locations worldwide. Service and support work is carried out under the supervision of your personal account manager, who will ensure that you receive high-quality service and support where and when you need it.

Your account manager will ensure continuity and work closely with your personnel to improve and optimize system availability and performance. Under the direction of your account manager, and with a local inventory of spare parts, our well-qualified field service engineers will be able to help you quickly and effectively.

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