

SKF

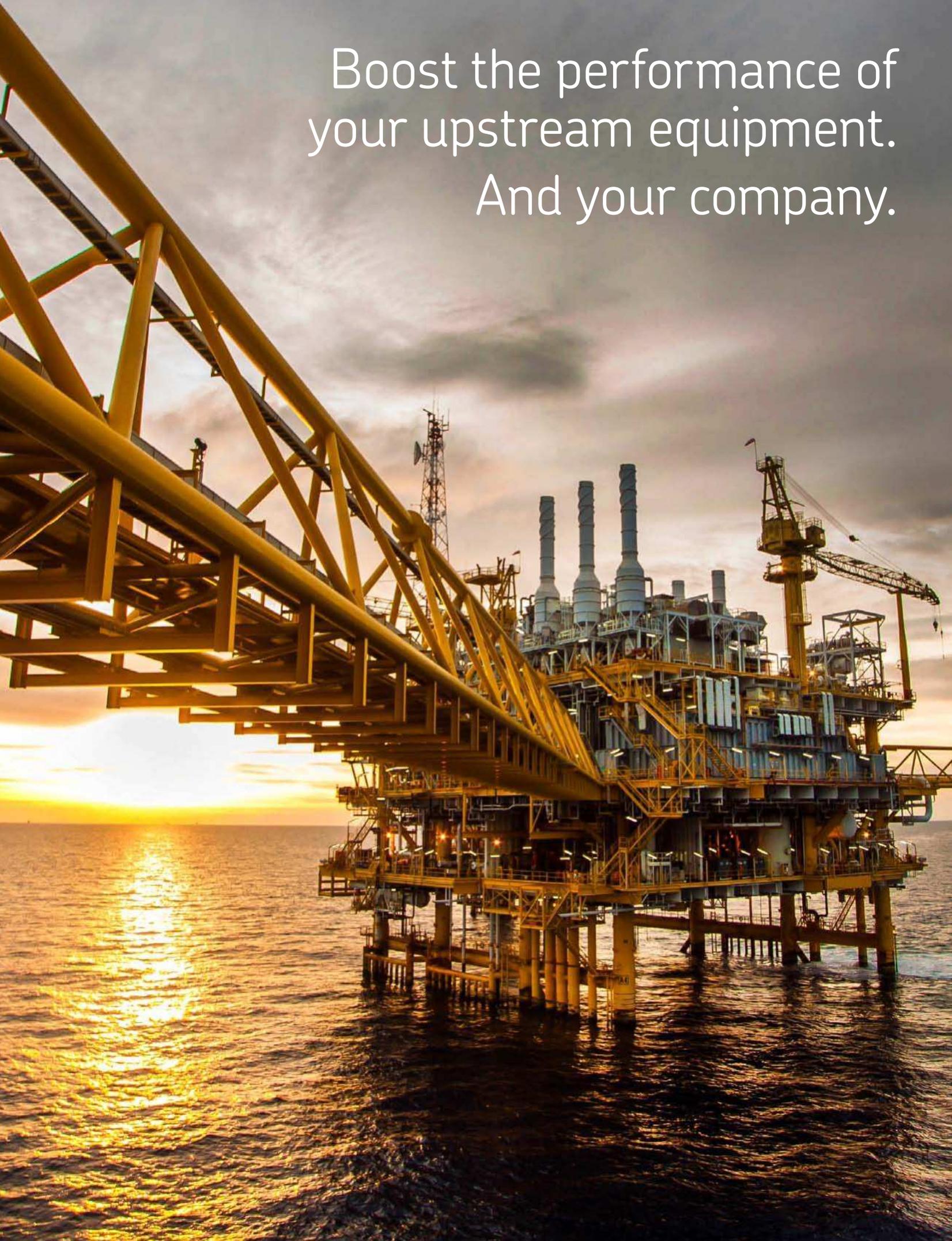
SKF upstream oil and gas solutions

Boost equipment reliability and performance with an experienced partner to OEMs around the world



The Power of Knowledge Engineering

Boost the performance of
your upstream equipment.
And your company.



Challenges from all sides

Oil and gas OEMs face significant challenges in helping their customers achieve increased reliability and service life. Operators are basing equipment procurement decisions on lowest Total Cost of Ownership and there are many technological, regulatory and environmental issues to contend with.

Accessing onshore shale deposits is subjecting equipment to new extremes of pressure and temperature. Offshore drilling is moving into deeper and harsher conditions. Mounting pressure to increase recovery rates of offshore reserves and increasing complexity of subsea infrastructures add challenges as well. Safety and environmental regulations are constantly, and necessarily, increasing.

Add to all of these challenges an increasing emphasis on asset life cycle management while needing to reduce time to market for new products, and it's easy to understand why oil and gas OEMs value partners that can provide innovative, quality solutions, and nimble delivery anywhere in the world with responsive local support.

Providing all of this – along with unmatched engineering knowledge and experience – SKF is proud to be just such a partner to the world's leading oil and gas OEMs.

Delivering experience and expertise

For many decades now, SKF has been at the forefront of upstream oil and gas technology. Both onshore and offshore, above the ocean's surface and below, SKF solutions are helping OEMs improve equipment reliability and availability with reduced equipment maintenance for exploration, drilling and production.

SKF has a unique understanding of rotating equipment and how critical machine components and industrial processes are interrelated. Based on our heritage of over 100 years as global leader in bearing technologies, we've made strategic investments over the last 30 years to also become a leading supplier of sealing systems, lubrication systems, condition monitoring technology and services, and electromechanical solutions. These competence areas enable us to deliver effective, integrated solutions, while improving machine reliability and performance.

Working closely with both OEMs and their customers, SKF has provided assistance to improve designs of all types of upstream equipment. These span the entire range of drilling platform, downhole tools, well stimulation, well completion, well control and artificial lift.



Optimizing the machine life cycle for max



SKF Life Cycle Management

As a supplier of critical components, systems and engineering expertise to builders of all types of machinery, our view of the world is shaped by a full understanding of the Life Cycle Management (LCM) of an asset. We also draw from a deep knowledge of material sciences and tribological systems.

Combining all this with relevant application experience from other industries and a wealth of oil and gas experience dating to the earliest days of SKF, we're able to create design improvements for your most demanding applications. Often these improvements are a packaged solution encompassing multiple technologies from bearings, seals, lubrication, condition monitoring and mechatronics.

As oil and gas industry OEMs initiate new "clean sheet" designs to handle ever-increasing application requirements, you can count on SKF to partner with you to help achieve the next-generation design objectives of your particular project.



imum reliability and performance

Specification

SKF provides support for designers in developing specifications aligned with the requirements of regulatory bodies to assure compliance with industry standards. We work with your engineers to find the correct solution – right from the start – and we factor in the requirements of API, ATEX, Norsok, ABS, DNV and other regulatory bodies.

As you develop your specification, our global network of research and development centers can support project conception and feasibility. And we can help you choose from thousands of off-the-shelf products, as well as fully customized solutions, to help your project succeed by starting out in the right direction.

Design and develop

SKF can assist OEMs with front-end engineering consultancy services to investigate new solutions that achieve optimal product performance. In the process, we also factor in ideas that bring the lowest Total Cost of Ownership (TCO) of your product over the remainder of the asset life cycle. We achieve this by using a systems approach to designs.

Our proprietary 3-D modelling and simulation tools explore the interaction of machine components, materials and geometries to optimize and verify designs in a virtual domain – before actual prototyping. We also fully apply Design for Six Sigma (DfSS) methodologies so the proposed design is producible and at the right price. When it's time to redesign, we can apply a range of knowledge about how that machinery was operated, maintained and repaired over the course of its service life.

Manufacture and test

SKF is your one-stop source for proven, world-class products delivered worldwide. Operating in 130 countries with over 140 manufacturing plants and our extensive global logistics network, we provide reliable delivery and local support for your manufacturing operations wherever they are located.

Comprehensive SKF testing services include prototype testing that simulates actual application conditions, as well as production line and final quality test systems. Many of these technologies can also be applied within your production facilities to increase throughput and create a fully auditable quality trail to give your customers greater confidence in your products.

Install and commission

Improper installation can reduce machine service life, affect product quality and drive up maintenance costs. SKF Life Cycle Management features a range of expert services, training and products to provide timely, accurate commissioning of new and replacement machinery.

SKF can also validate machine condition after installation using check-to-conformance technology. For OEMs, this provides a valuable record of machine condition at the point of commission.

Operate and monitor

SKF helps enable safer, more profitable operations and increased availability with our industry-leading reliability and condition based maintenance technologies and services. By collecting and analyzing the right condition and operating data, SKF can help identify the need for machinery maintenance activities and the operational conditions which caused them.

Using a proven methodology we call Asset Efficiency Optimization (AEO), we help you identify and implement the right maintenance strategy – corrective, preventive, predictive or proactive – and the appropriate maintenance processes that your customers will require to keep your products running in peak condition.

Maintain and repair

SKF offers a wide range of maintenance tools, technologies and services to boost asset reliability and uptime. Our remanufacturing services can restore a damaged, large-sized or high-value bearing to full working specifications, avoiding costly replacement. And when equipment failure does occur, our professional Root Cause Failure Analysis service provides valuable insight to prevent recurrence and to harvest this knowledge for input back into the first stage of the asset life cycle.

We also offer training in the latest precision maintenance and condition monitoring practices. SKF specialists can even supplement your field service team with expert, hands-on, high-skill, high-impact services.

Strengthening your solutions with many

SKF is a world leader in bearings, seals, lubrication, mechatronics and services. From low-torque gate valves for fracking operations to sensorized bearings for encoders and beyond, we bring this cross-platform knowledge and technology to bear when designing solutions to meet the needs of our oil and gas OEM customers.



Bearings and units

SKF works closely with customers to address increasing industry demands on oil and gas production equipment, from rate of penetration to subsea reliability and maintainability. As a result, specialized SKF solutions are at work today in a wide range of equipment including tri-cone drill bits, down hole motors, top drives, rotary control devices, subsea pumps and compressors.

Using advanced SKF modelling and simulation software, SKF engineers are able to optimize bearing designs to increase equipment performance and productivity. Unitized, sealed designs, super strength steels, and ceramic elements combine to enable SKF bearings to cope with the harshest operating conditions including sour gas attack, cryogenic and subsea environments.

Seals

Drawing on extensive oil field experience, SKF provides high quality, highly reliable sealing solutions for an extensive range of oil field equipment operating in extreme temperatures ranging from -240 to 315 °C (-400 to 600 °F), and under pressures from vacuum to $24,900$ psi (172 MPa). SKF sealing solutions have been proven on critical equipment such as drill motors, measurement-while-drilling tools, electric submersible, positive suction and injection pumps, packers, wash pipes, blow-out preventers, valves, chokes, risers, pipes, rotary control devices and slewing ring bearings.

SKF application engineers have the competence and experience to provide custom-made sealing solutions to complex problems, utilizing industry standard and in-house developed materials. Computer aided design and finite element analysis can be employed to develop custom engineered sealing solutions that meet specific customer requirements.

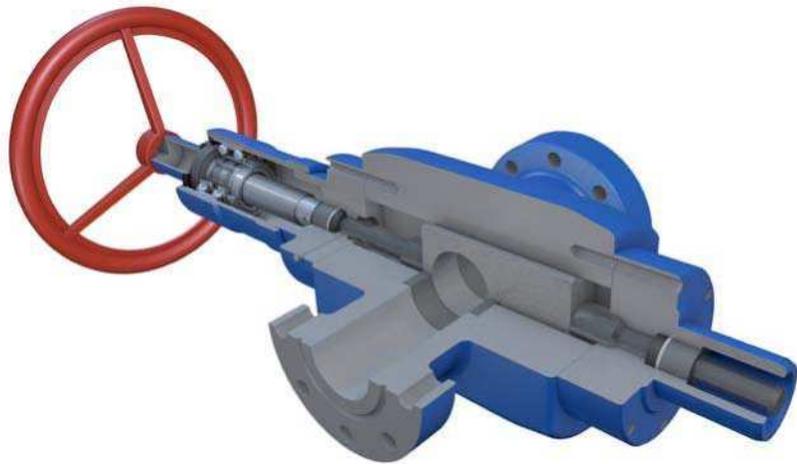
areas of expertise



Lubrication

Since developing the first greases for rolling element bearings, SKF has extended its capabilities to reduce lubrication-related problems in equipment such as motors, pumps, top drive gearboxes, turbines and compressors.

Solutions range from basic oil management to simple automatic lubricators and more complex, intrinsically safe, multi-channel grease and oil lubrication systems. These systems provide more efficient, controlled lubrication of machines, significantly reducing unplanned failures due to lubrication problems while enabling smoother running and extended maintenance intervals.



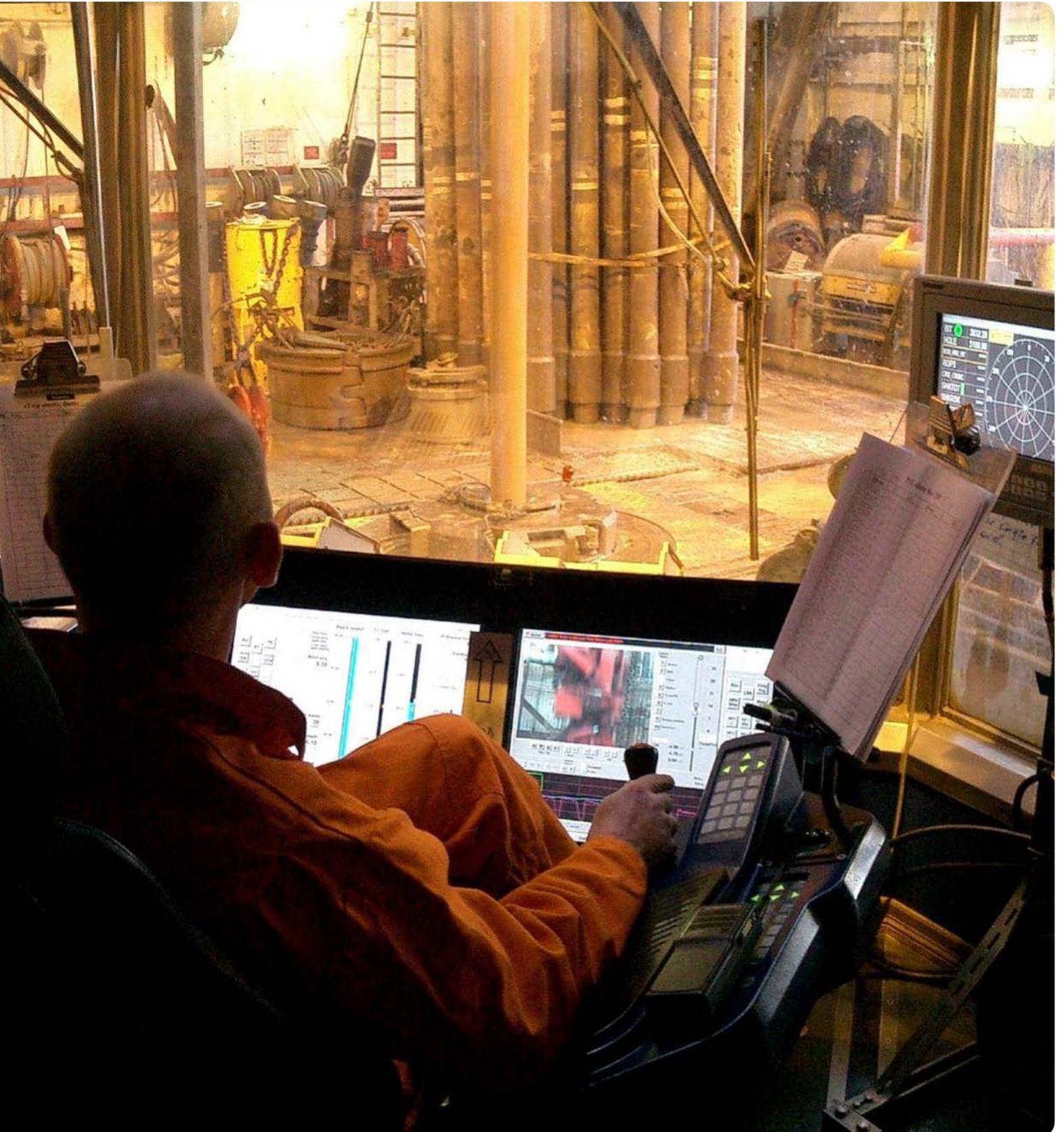
Mechatronics

Integrating mechanical, electronic and information-processing technologies, SKF mechatronics solutions are enabling designers to move from hydraulic and pneumatic actuation to a new generation of lightweight, energy-efficient and environmentally friendly solutions.

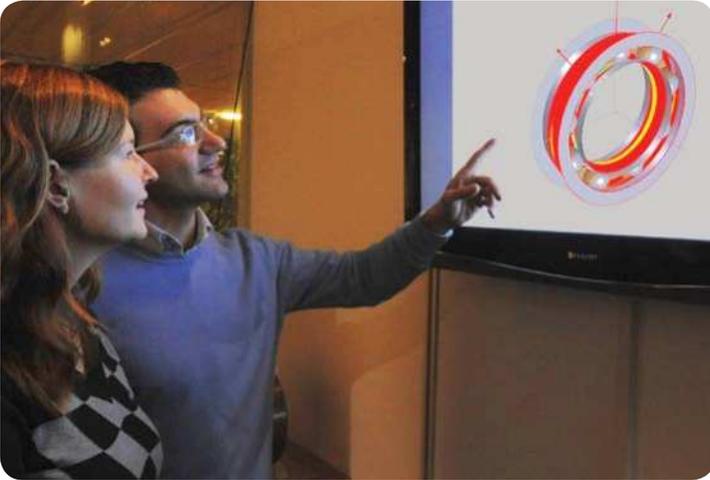
Surface and subsea applications include wellheads, Christmas trees and manifolds with blow-out preventers, chokes, gate valves, downhole tools, with manual or electric actuation, encoders and winches.

Expert services and integrated condition

Warranty and reliability issues can be extremely costly for oil and gas OEMs. For over 25 years, SKF has provided a wide range of on- and off-site services and condition monitoring solutions to help oil and gas OEMs optimize overall equipment effectiveness and safety, while reducing equipment downtime, maintenance and life cycle costs.



monitoring



Engineering Consultancy Services

SKF Engineering Consultancy Services has the experienced engineers and project leaders to support oil and gas OEMs with everything from material science, lubrication and tribology knowledge to verifying new designs using SKF's unique simulation programs. We apply proven processes, such as Design for Six Sigma, to enable you to develop robust solutions faster. We can combine the right SKF knowledge, experience and equipment into a tailor-made solution specific for your needs, and support you during the entire life cycle of your products.

SKF Engineering Consultancy Services has helped many customers to:

- Optimize quality and performance of their designs
- Reduce time-to-market by faster design verification and professional testing
- Find the root cause of bearing and machine failures



SKF Six Sigma

Condition monitoring

A pioneer in the condition monitoring field since its inception, SKF has continued to lead the way with new products, systems and services that enable OEMs to integrate monitoring solutions into equipment for improved reliability, efficiency, safety and lifetime asset value. Whether maintenance is performed under warranty, by the manufacturer, or by the end-user, condition monitoring helps to identify problems before they become catastrophic.

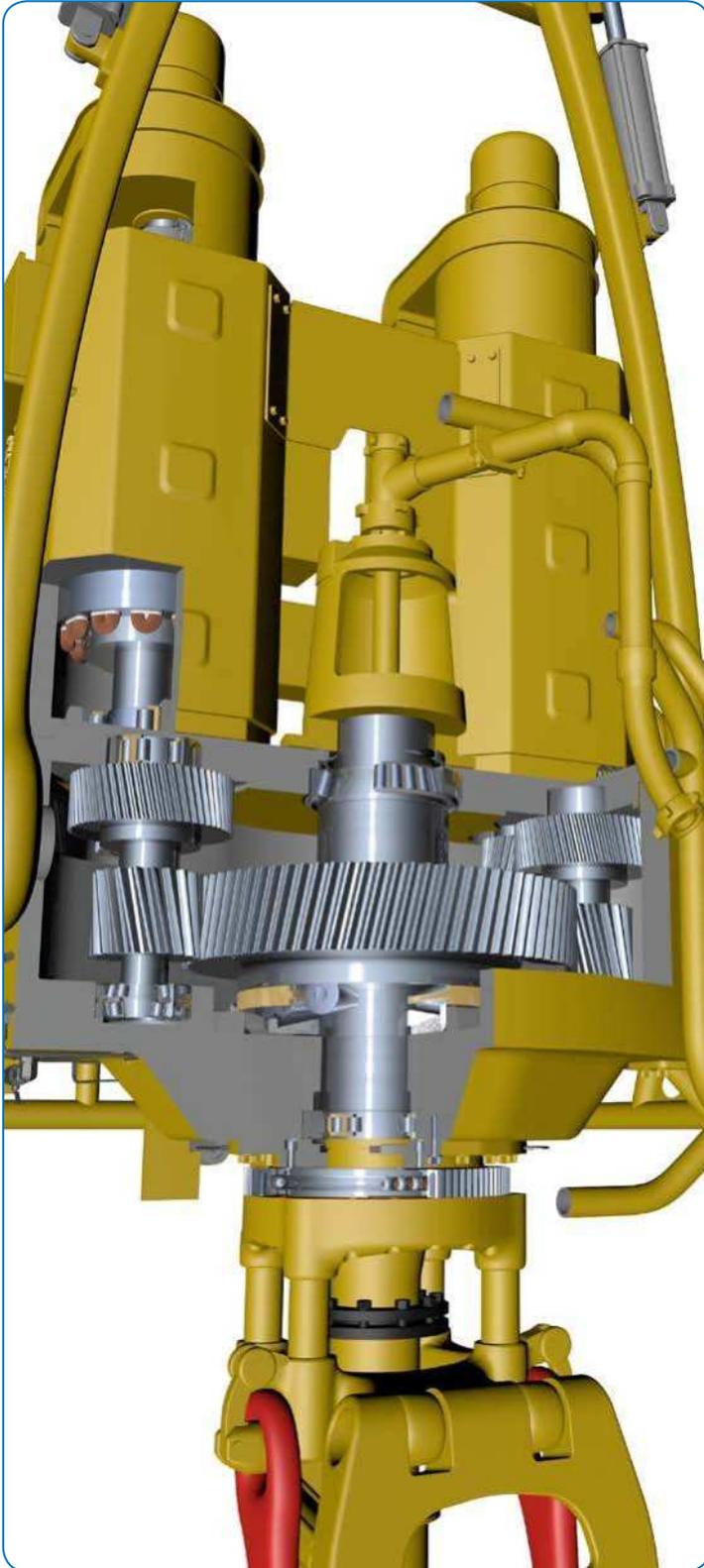
Today, SKF provides a complete, integrated suite of enabling technologies, called the SKF @ptitude Monitoring Suite (@MS), to help improve and maintain reliability while reducing maintenance costs. Data that can be presented in @MS includes both on-line and off-line vibration data, lube oil analysis data, process data and operator round data.

SKF offers a wide portfolio of advanced condition monitoring systems and hardware including our IMx and DMx systems and SKF Baker electric motor testers – the leading electrical testing equipment in the industry. To further increase reliability, these technologies can be combined with various sensor solutions including:

- SKF Insight for monitoring load and remaining bearing life
- Sensorized bearing units for accurate and robust speed measurement
- In-line oil sensors to observe contamination or particles within the lubricant

SKF solutions for top drives

Drawing on our multi-platform expertise, SKF works in close collaboration with the world's leading oil and gas OEMs to design and manufacture top drives able to deliver increased reliability and safety in extreme conditions.



Main thrust bearings (tapered roller thrust bearings)



Main thrust bearings in a top drive must accommodate extreme operating conditions including very heavy axial loads, shock loads and shaft deflections. Plus, the combination of low speeds and heavy loads limits the oil's ability

to form an effective lubricant film, which results in metal-to-metal contact and accelerates wear. To meet these demanding conditions, SKF has optimized both the design and manufacturing process of tapered roller thrust bearings to provide:

- High load-carrying capacity
- High wear-resistance under an ineffective lubricant film condition
- Ability to accommodate shock loads

Gearbox bearings

Gearbox bearings take radial and axial loads generated throughout the gearbox by the motor, the gearing and shaft torque of the drilling string. SKF Explorer gearbox bearings combine material and design innovations that can increase bearing service life. SKF's gearbox bearing offering includes:



- Angular contact ball bearings
- Tapered roller bearings
- Spherical roller bearings
- Cylindrical roller bearings

Gearbox seals



Good lubrication conditions are essential to gearbox performance. SKF provides a wide range of high-performance motor and gearbox seals for both oil and grease that are optimally designed to:

- Retain lubricant
- Exclude contaminants
- Withstand pressure differences

Slewing ring bearings

Pipe handling systems and iron rough necks are critical to rig efficiency. SKF can offer a full range of slewing ring bearings for these applications. Our capability was further enhanced through the 2013 acquisition of Kaydon, a leading North American supplier of slewing ring and thin section bearings.



Gearbox oil lubrication

Top drive gearboxes generally use oil splash lubrication for all bearings including the main thrust bearing. As a world leader in lubrication, SKF is a single source for lubrication systems that include motors, pumps, heat-exchangers, flow controls, filters and pipes with ATEX certification. SKF also offers services such as simulations for temperature regulation and foam elimination through tank modification.



Pipe handling system lubrication

Grease lubrication of top drive pipe handling systems generally requires manual re-greasing and maintenance. SKF offers ATEX-certified, fully automated grease lubrication systems to ensure the right amount of grease is applied at precisely the right time. In addition, SKF offers compact, easy-to-use grease pump components including distributors and pipes.

Mechatronics



Currently, most top drive systems (typically the motor) are equipped with old encoder technology that frequently fails, leading to downtime. To perform speed and rotation measurements of the motor shaft, gearbox and the main shaft (drill string), SKF offers compact, sealed, greased-for-life, sensorized bearing units that provide benefits such as:

- Reduced life cycle costs
- Retrofit design – fully interchangeable
- Maintenance-free bearing unit
- Integrated sensor – ready to mount without adjustments
- Mechanical redundancy due to second sensor
- Excellent electric motor torque stability

Engineering Consultancy Service (ECS)



SKF helps OEMs boost top drive performance and reliability with advanced simulations of the overall gearbox in combination with Design for Six Sigma tools. Our experienced engineers identify critical design and operating parameters and help to select the right bearing system to achieve the best performance.

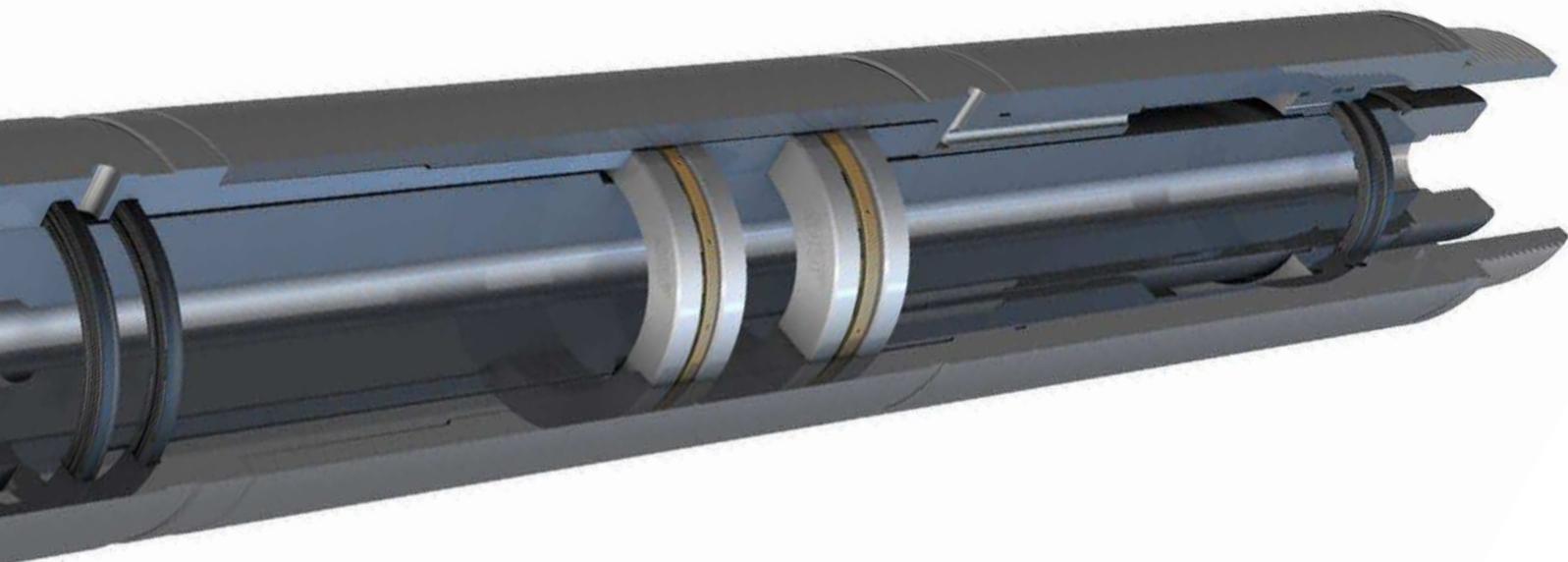
Condition monitoring

To help end-users avoid costly, unplanned shut downs, SKF offers a wide array of condition monitoring equipment for top drives. Our portfolio includes the industry-leading SKF Microlog family of portable vibration analyzers and a full range of online systems, and SKF's static and dynamic lines of motor testing and monitoring products. It also includes:

- The broadest range of instruments with a hazardous area certification (ATEX Zone 0)
- SKF Insight sensors for determining load and remaining bearing life
- Sensorized bearing units for accurate and robust speed measurements
- In-line oil sensors to observe contamination or particles within the lubricant and to increase top drive reliability

SKF solutions for downhole drilling tools

Whether you're drilling for oil or gas, drill strings must endure extreme operating conditions. SKF solutions for downhole drilling tools are designed to increase performance and reliability.



Cylindrical thrust bearings

To provide superior axial thrust load support for sealed motors, SKF's cylindrical thrust bearings are manufactured to the highest quality standards. The contact surfaces between the rollers and the raceways, and the internal geometry are all controlled to extremely tight tolerances to improve performance compared to low-quality cylindrical thrust bearings available in the marketplace.

Tungsten carbide radial bearings

Specially designed to provide excellent radial load support for both sealed and mud motors, SKF tungsten carbide radial bearings are made using a unique microwave sintering process (resulting in 1 600 Vickers hardness) as compared to typical conventional sintering (with 1 000 Vickers hardness). This results in a high hardness of 92 HR_a for excellent wear resistance and longer life.

Downhole sealing solutions

SKF has innovative seal designs and quality materials for downhole rotating seals exposed to high pressure. The SKF Teflathene seal incorporates a low-friction PTFE seal ring bonded to a rubber body. The all-rubber DM2 seal separates drifting mud from lubricants in oil-lubricated mud motor bearings.

Bottom hole assembly (BHA) tools such as shocks and jars require seals to protect the tool hydraulics from the abrasive drill muds and cuttings in the hole. Measure-while-drilling (MWD) tools sometimes require high-temperature sealing solutions. SKF has developed a full line of field-proven seals to work in this demanding environment, including a seal capable of withstanding up to 315 °C (600 °F).



Mudstack thrust bearings

Mud bearings close to the drill string end have a major impact on productivity and reliability. In addition to severe axial and shock loads, these bearings are “lubricated” with highly abrasive mud, which for a bearing is the definition of an extreme operating condition. SKF’s mudstack bearings are optimized for our customers’ applications through rigorous finite element analysis and physical lab tests by testing the bearings with drilling mud circulating through them. SKF mudstack bearings provide:

- Improved wear resistance
- Increased load-carrying capacity
- Optimized load distribution
- Increased robustness
- Improved reliability
- Customized design

Ball and roller screws

SKF ball and roller screws help provide linear motion for actuating downhole drilling completion tools and surface completion production equipment. They have a very high capacity range and maximize the force output with high efficiency and accuracy.

SKF offers the widest range of screw products for downhole systems:

- Miniature/small ball screws
- Planetary roller screws
- Recirculating roller screws
- Inverted roller screws
- Differential roller screws
- Zero lead screws and bearings

Zero lead screws and bearings

Derived from high-efficiency screw technologies, SKF zero lead screws and bearings can be used on the same drive screw shaft to match capacity ratings with the highest compactness. They are extremely robust to provide stability and long service life. Screw materials or coating are adapted for severe HP/HT conditions to maintain high hardness or to provide corrosion resistance.

SKF solutions for well stimulation

From developing low-torque, well control gate valves to increasing frac pump service life and beyond, SKF uses its multi-platform expertise to help oil and gas OEMs compete in this rapidly expanding and continually evolving market.



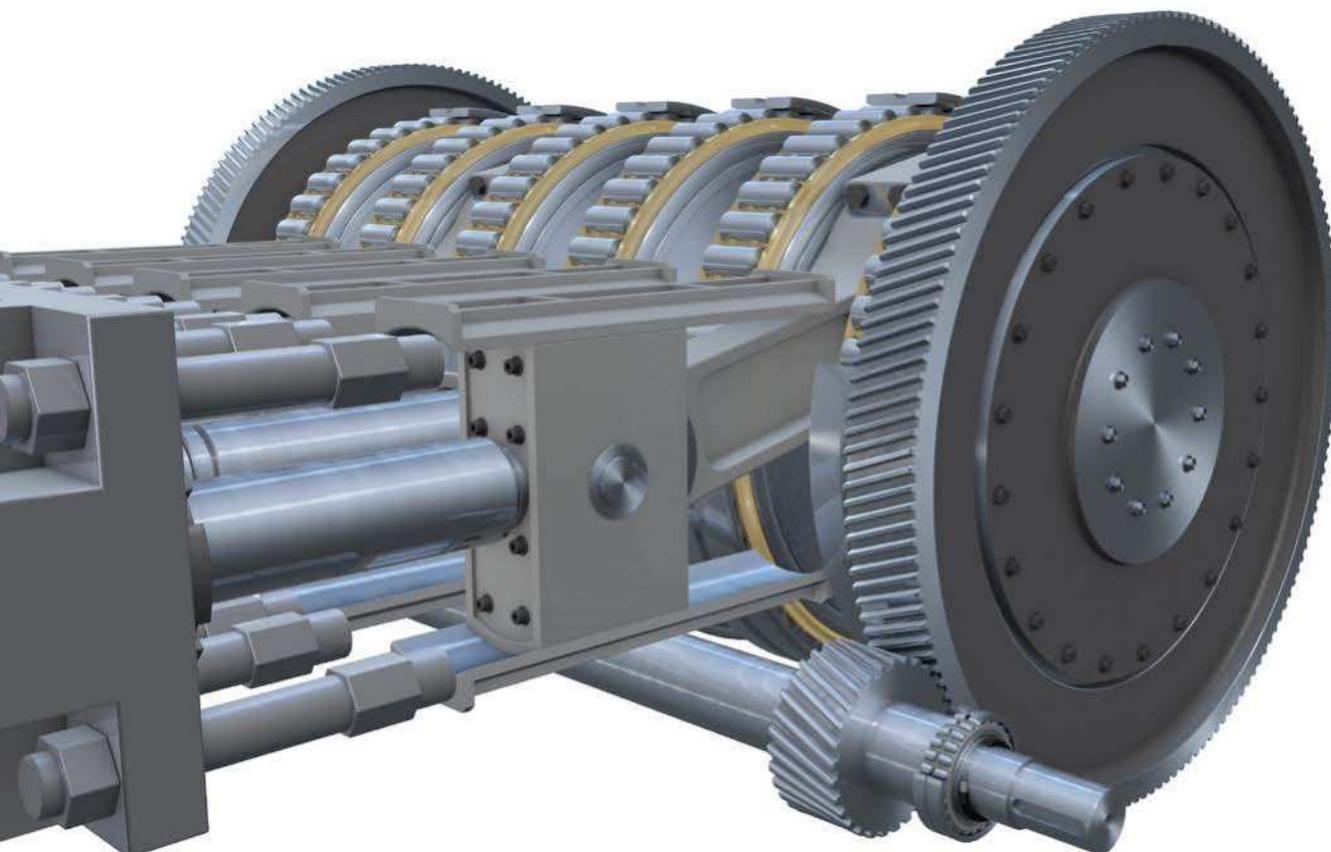
Main crankshaft and pinion shaft bearings

Early field failures often result from using low cost, low quality cylindrical roller bearings and spherical roller bearings as main crankshaft and pinion shaft bearings respectively. This is due primarily to a lower quality material composition that can lead to dimensional changes during operation, and failure when you can least afford it.

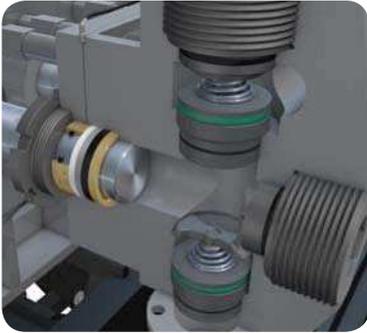
SKF offers high quality cylindrical roller bearings for main crankshafts and world-class spherical roller bearings for pinion shafts. The internal dimensions of these bearings are optimized and expertly engineered to withstand the harsh conditions encountered during well stimulation.

SKF frac pump bearings:

- Help achieve maximum uptime with high capacity ratings capable of handling large crankshaft and pinion loads
- Are designed using advanced bearing simulation and analysis tools with a Design for Six Sigma approach to optimize the bearing for given application loads
- Can be customized for a variety of application loads and life requirements – SKF has developed custom bearing solutions with a target life of 10 000 hours compared to 3 000 hours



Frac pump seals



From plunger packing and valve seats to access cover and pony rod seals, frac pumps use a variety of these critical components. SKF offers designs and a wide variety of seal materials developed to handle the high-pressure requirements of reciprocating and static applications.

In addition, oil and gas OEMs benefit from a robust global supply chain network thanks to SKF's local presence in worldwide locations.

Frac pump lubrication systems

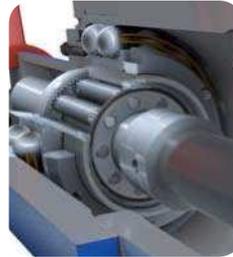
To increase the life of critical plunger packing seals, SKF offers Lincoln automatic lubrication systems that deliver the right quantity of oil lubricant at the right time.

Benefits include:

- Increased packing seal life – 300 to 400 hours on average compared with 60 to 80 hours with competitive systems
- Reduced maintenance – no need to fill system during operation
- Increased rig crew safety – minimized exposure to high-pressure iron as lubricant is transported to location rather than filled at location



Ball and roller screws for low-torque gate valves



SKF offers the widest range of robust solutions for low-torque gate valves designed with ball and roller screws. Complete sub-assembly of the mechanical operator is available for fracking or production valves. This unit is highly efficient and optimized for the lowest torque and lowest number of turns.

Benefits of SKF frac gate valves include:

- Robust, reliable and proven design – over 15 years of experience
- Replaces screw, gearbox and hydraulic power or other ball screw designs
- Easy customization to match any thrust requirement
- Optimized torque and number of turns
- Lowest torque achieved with optimized designs for screws, bearings, seals and lubricant
- Minimized operator time, increased productivity and safety
- Easily connected to customer valve bonnet and stem interfaces
- Can include new features – internal stops, optimized lubrication paths, extra strokes, self-locking and more
- Available for balanced stem and non-balanced stem valves

SKF Engineering Consultancy Services (ECS) for frac pumps

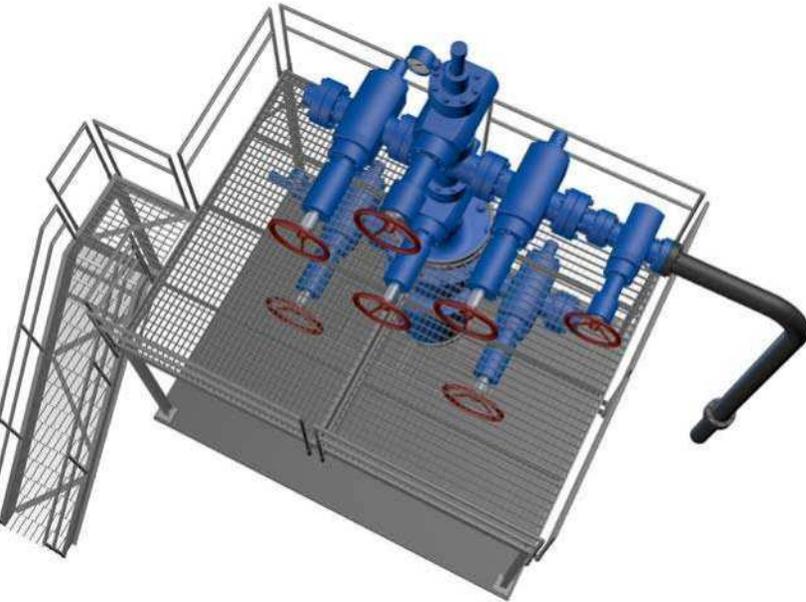
Drawing on years of experience and multi-platform expertise, SKF can help oil and gas OEMs design their next-generation frac pumps.



SKF's ECS capabilities, along with a Design for Six Sigma (DfSS) approach, can help OEMs model and simulate various application load case scenarios to better analyze and understand bearing performance, shaft deflections, relubrication intervals and the behavior of surrounding components.

Well completion and control seals

The right sealing solutions for well completion and control are critical to avoid leakage, contamination and reduce maintenance while protecting the environment. SKF technologies and materials are developed by some of the world's leading sealing solutions scientists and engineers.



Proven sealing expertise

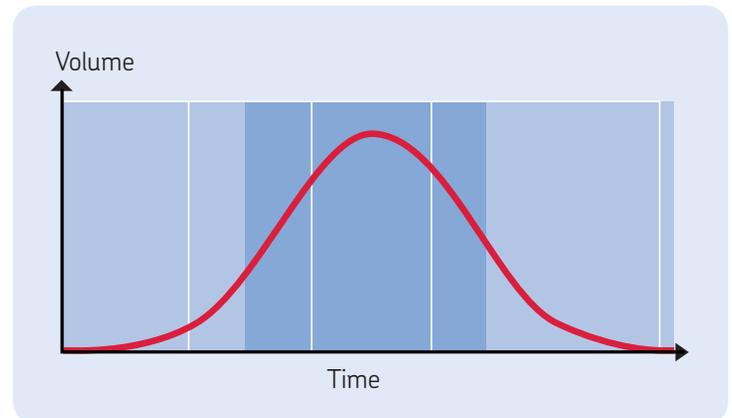
Building on our long leadership in the area of rotating seals, SKF has made strategic investments to expand our capabilities in static applications for oil and gas. Leveraging our experience in material development along with advanced modelling and testing, we have supported the industry with innovations for many years.

Many breakthroughs in valve development have three things in common:

- Collaboration between valve OEM and seal development partner to meet a demanding new end user requirement
- A rapid prototyping phase to validate the initial concept
- Aggressive production ramp-up with expectations to control cost of series production

SKF has the proven experience to keep pace with your needs throughout the full cycle of innovation and volume production. One key aspect of this is our global fleet of strategically deployed CNC machining centers (over 100). And these are linked to our volume production plants for seamless transfer to a moulded seal design.

Life Cycle Supply Model



■ Machined seals

To cost effectively produce prototypes and seals in low volumes with short delivery time (in the introduction, initial growth, declining phase to meet replacement demand)

■ Moulded seals

To cost effectively produce seals in high volume (time in the growth and maturity phases)

Benefits of SKF sealing solutions

- Tailor-made to customer's needs
- Partnership with customers from the design phase to serial production
- Rapid prototyping for design evaluation
- Extensive range of polymeric materials with Norsok and API certifications
- A wide range of seal configurations
- Application engineering support





Seals for hoisting and rotating equipment

Draw works, top drives, rotary control devices (RCDs) and other large rotating equipment have critical bearings that require protection from the elements and/or production fluids. Keeping lubricants in and contaminants out of systems is a serious challenge in tough oil field environments. SKF heavy industry seals can meet the challenge with heavy-duty metal-cased seals, rubber outside diameter seals with metal inserts or fabric-reinforcement, and polyurethane seals.



Wellhead static seals

S-seals and FS-seals: High-pressure static sealing against casing and tubing surfaces and tolerances presents a considerable challenge. To meet these challenges SKF produces high quality FS-seals from a proprietary NORSOK M710 approved grade of HNBR with excellent resistance to explosive decompression and chemical attack.

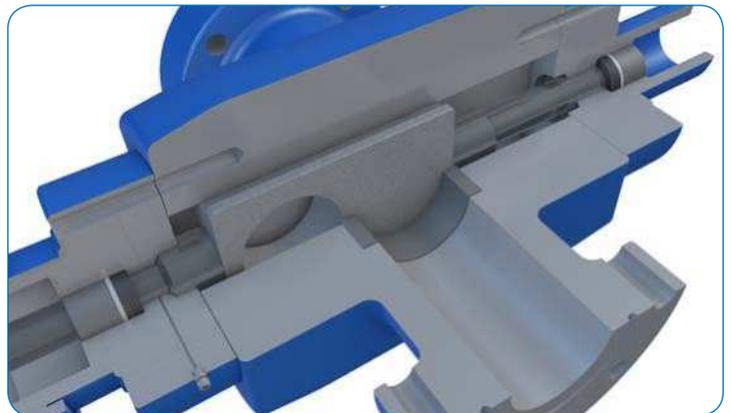


Locking T-seals are a patented innovation on the well known T-seal design. Retention features on the backups provide ease of installation without damage. For this reason, locking T-seals are used to replace S-seals, enabling higher pressures and temperatures while reducing damage to metal components.



Hydraulic seals for blow-out preventers

For ram blow-out preventers, SKF offers a wide variety of rod seals, piston seals and guide rings.



Valve seals

SKF offers an array of choke and valve seals for pressure control applications during drilling or production on Christmas trees. In customer valve installations, SKF gate valve stem and seat seals have passed API 6A PR2 tests up to 20 kpsi (1 378 bars).

SKF solutions for artificial lift systems

The pace of evolution of artificial lift systems continues to increase. SKF can assist with your next-generation design requirements, and also provide supply chain and field service support to meet the needs of your existing fleet.



Reciprocating rod lift pumping units

Operating unattended in remote areas, reciprocating pumping units demand reliable bearings, sealing solutions and lubrication systems to prevent unplanned downtime. SKF's suite of solutions includes bearings engineered for unrivaled performance, seals designed for long life under harsh field conditions, and condition monitoring tools to maximize uptime and simplify fault diagnosis. Ball and roller screws and electro-mechanical actuators can also be used for artificial lift, for surface or downhole pumping.

Ball and seat valve assemblies

As part of the SKF acquisition of Kaydon in 2013, SKF now offers a broad range of ball and seat valve solutions for downhole artificial lift pump assemblies. With a full range of the highest quality materials, double-lapped ball/seat sets with both a guide radius and large sealing radius, SKF can develop a solution to satisfy your most demanding application requirements.



Horizontal multi-stage pumps

Used for fluid transfer, pipeline boosting and water disposal, reliability is key for these pumps. Specially engineered SKF bearings, optimized for extreme loads and high speed, are used to maximize load capacity and run life, while SKF sealing and condition monitoring solutions provide an extra measure of protection and peace of mind.

Wellhead drive units

SKF bearings carry the load of up to two miles of drive shaft for these rotary pump drives. SKF sealing solutions provide well fluid containment and minimize environmental risk associated with production. Condition monitoring tools provide site surveillance, operational data logging and early fault detection.

SKF solutions for mooring systems and material handling cranes

These assets are crucial to the oil and gas upstream industry. They are typically “bottle neck machines” with no alternate option to fulfill their function if they go down. Add this to the fact that they operate in extreme marine environments, and the need for reliable components becomes even more critical.



Slewing bearings

The addition of Kaydon to the SKF Group expands our capability to provide the broadest range of slewing ring bearing designs, and our expanded global manufacturing base allows us to be more responsive to your project schedule. Additionally, our unique modelling capabilities can simulate the bearing system in a virtual environment, taking into account all application considerations so the bearing design is done right the first time.



Sealing systems



SKF can provide custom-designed sealing systems within the slewing ring bearing and/or as redundant external seals for an extra measure of protection when warranted. We offer large-diameter seals of proprietary G-ECOPUR polyurethane with enhanced chemical and hydrolysis resistance. We also use a special welding technique to join split-profile segments on site, eliminating the need for costly, time-consuming equipment disassembly.



Bolting systems

Bolting systems with a range of hydraulic tensioning designs are available to simplify and automate the slewing ring bearing installation process and ensure bolt system integrity.

Lubrication systems

The lubrication of a slewing ring bearing and its gearing is essential to achieve its 25-year design life. Lubrication type, quantity and intervals are included within the bearing design package. As the leading global supplier of lubrication delivery systems, we can automate this important task with a variety of centralized, multi-point systems.



Condition monitoring



Condition monitoring can be integrated into the bearing to monitor health over its lifetime or provided as a service for trouble-shooting or for confirming condition before/after commissioning. Additionally, because of the slow speed operation of a slewing ring bearing, SKF has developed special vibration analysis techniques for very slow speeds.

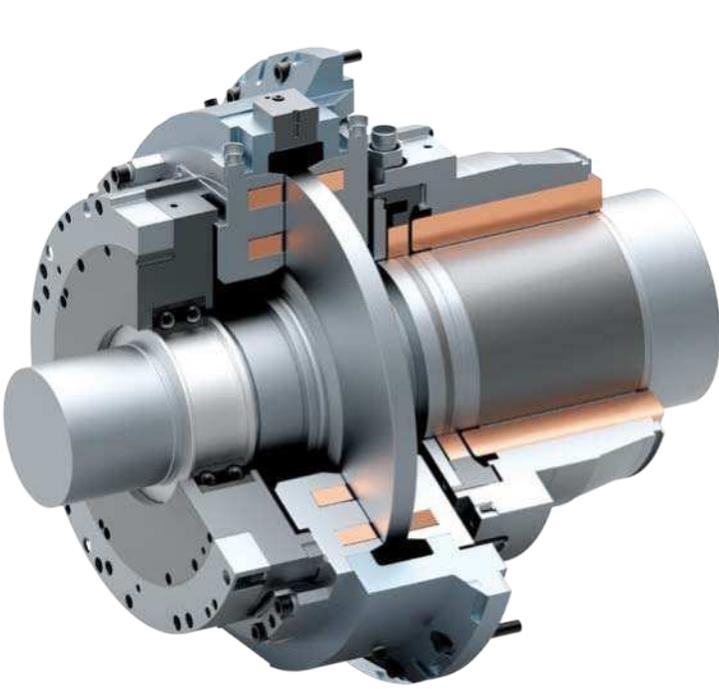
Geometric alignment

To help ensure proper flatness, levelness and straightness of machine bed and foundation surfaces, SKF provides geometric alignment as a commissioning or trouble-shooting service. In addition to inspecting the form of the mounting surfaces, we can also provide on-site machining to create or repair those surfaces.



Magnetic bearings – rotation without con

SKF S2M Magnetic Bearings leverage more than 35 years of leadership in active magnetic bearing technology.



Active magnetic bearing capabilities overview

The first compressor equipped with an SKF S2M Magnetic Bearing, commissioned in 1985, is still running. Since then, we have partnered with many of the world's leading OEMs and operators to harness the power of magnetic levitation to address the need for high speed and high reliability compression in the most demanding operating environments.

SKF experience includes more than 1 000 installations in the oil and gas industry, including upstream, midstream and downstream processes. SKF is now pioneering the use of magnetic bearings for the first natural gas centrifugal compressors placed on the seabed at the Åsgard subsea field in the Norwegian Sea.

SKF S2M Magnetic Bearings were chosen for this subsea compression station due to their proven high reliability for an application where access to the system is impossible / impractical after placement on the sea floor. In fact, their contact-free design makes them virtually maintenance-free, while their oil-free design eliminates contamination risk.

SKF S2M Magnetic Bearings also allow for sealed and compact machine design, high-resolution, real-time condition monitoring of the machine, and unmanned remote control and data diagnostics.

Advantages over oil-lubricated bearings

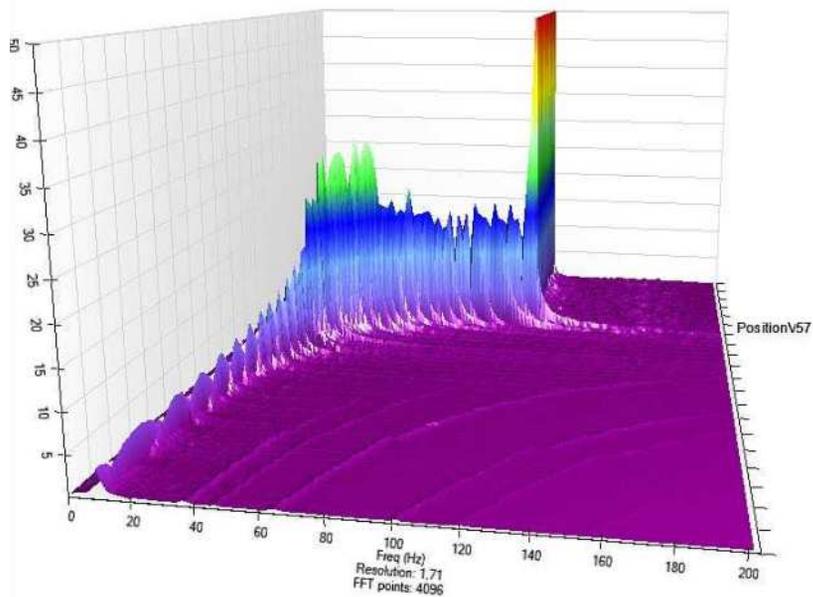
Using oil lubricated bearings in cryogenic turboexpanders can be problematic with operating temperatures as low as $-150\text{ }^{\circ}\text{C}$ ($-238\text{ }^{\circ}\text{F}$). Should bearing seals fail, oil will enter the process, freeze and begin to solidify, at which point the process must be shut down and the equipment laboriously cleaned.

SKF S2M Magnetic Bearings eliminate the possibility of oil freezing and reduce the risk of oil spills, contamination and leakage because they operate without lubrication. SKF S2M Magnetic Bearings have operated in applications as low as $-250\text{ }^{\circ}\text{C}$ ($-418\text{ }^{\circ}\text{F}$) and are ideally suited for small frame turboexpanders used for gas processing applications.

SKF S2M Magnetic Bearings can also operate directly in a natural gas environment, so there is no need for shaft seals, thereby eliminating seal wear, maintenance, replacement and downtime issues. Shaft length can also be reduced, which improves shaft stiffness and rotor dynamic stability.

And, when elimination of lubrication system, gearbox, couplings and drive motor are considered, SKF S2M Magnetic Bearings dramatically reduce the footprint and tonnage requirements for designers and end users of offshore platforms and FLNG vessels. In addition, process availability, equipment reliability and OPEX are significantly improved.

tact



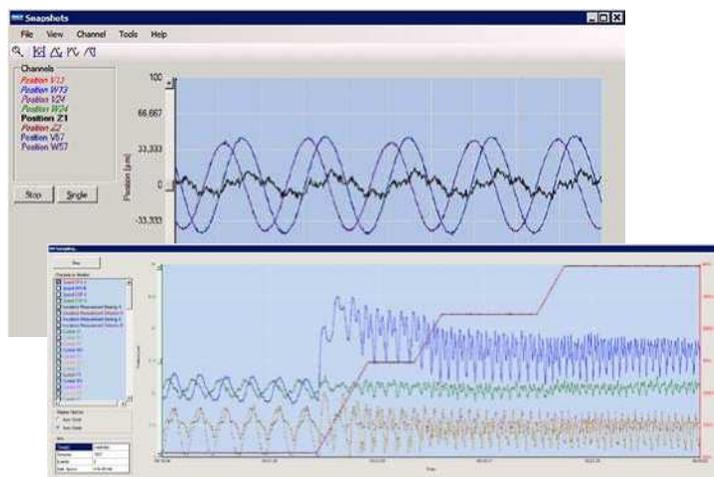
Magnetic bearing controllers

Developed to meet the demanding conditions of subsea compression stations, our newest system provides a fully digital control loop for remote monitoring and servicing of magnetic bearing applications, with a broad range of functionalities previously available only through secondary and tertiary systems. The controller's calculation core delivers an optimized control loop for turbo machines, proven on 30 MW compressors and beyond. Real-time data is digitized through a high sampling rate and all data is available for post processing through the SKF software monitoring suite.

A new approach to commissioning

The benchmark for software solutions dedicated to magnetic bearing control and management, the SKF software suite significantly reduces time for system commissioning. Deployed on site or viewed remotely, it enables highly accurate, real-time monitoring for an immediate overview of data, trends and events.

Time snapshots



Trending



SKF S2M Magnetic Bearings are part of the SKF Beyond Zero portfolio. See back cover for details.



SKF improves OEM's encoder reliability



The challenge

Speed and position reliability is critical to preventing downtime on rigs in oil and gas exploration. An OEM sought a replacement for the encoders in their equipment to increase reliability and customer satisfaction.

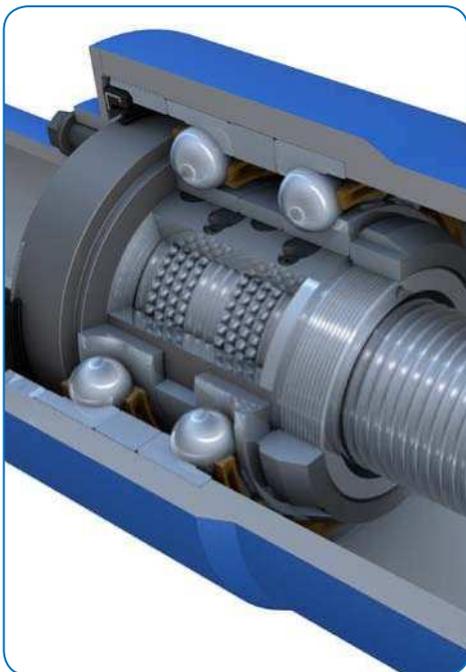
The SKF solution

SKF gained a thorough understanding of the need by working closely with the rig owner and rig operator, as well as leading the collaboration with the OEM. SKF proposed an integrated sensor bearing solution that incorporated SKF expertise in hybrid bearings, robust sensors, lubrication, seals and engineering knowledge. This expertise was leveraged from SKF experience in providing hub unit assemblies to the automotive and truck market for many years.

The result

The manufacturer and end user now have an innovative solution to a high-value problem, as SKF technology and application expertise has helped increase encoder reliability. The use of a hybrid bearing with ceramic rolling elements also prevents passage of electric current through the bearing – a common source of failure. By providing a unitized assembly, the OEM and end user have a very simple solution for field retrofits and upgrades. Additionally, because the bearing, lubrication and seal were engineered as a system, the unit will operate with virtually no maintenance over its lifetime.

SKF helps gate valve OEM to grow market share



The challenge

An OEM wanted to offer a low-torque gate valve design that allowed manual operation without the use of mechanical assistance tools so as to differentiate their product for the hydraulic fracturing market. High pressures created during well stimulation and completion were causing stuck valves. Due to this problem, multiple workers were needed to actuate the gate valve and, in some cases, valve wheels were broken off in the process.

The SKF solution

SKF engineered a customized “operator assembly” consisting of a precision ball screw, seals, support bearings and lubrication in an SKF-supplied housing for a 5", 15 000 psi gate valve (127 mm, 1 034 bar). The design took into account all possible operating pressures and temperatures and can be operated by a single operator with manual hand-wheel torque. It also reduced the number of turns for actuation, enabling quicker operation.

The result

The new product has contributed to the OEM's rapid market share growth by differentiating their product with the SKF low-torque solution. Workers' exposure to the hazardous environment was dramatically reduced. Additionally, the OEM did not need to develop an alternate solution, such as a gearbox or hydraulic actuation system, thereby reducing the CAPEX and OPEX spend by the end user. The OEM has since expanded the solution across their product range, including consideration of subsea valves that are actuated by ROV (remotely operated vehicle).

SKF helps OEM/OES increase reliability and service life of ESP

The challenge

An artificial lift system OEM was experiencing field failures with their ESP (Electric Submersible Pump) high-horsepower series. Their Original Equipment Service (OES) division had reported inadequate service life due to premature motor burnout. Operators were in turn seeing excessive downtime and high, unplanned retrieval expenses.

The SKF solution

SKF evaluated the application using the competence of its application engineering team dedicated to electrical testing equipment. A careful root cause failure analysis revealed winding insulation failure; and SKF recommended use of one of its Baker AWA-IV portable static motor analyzers, which is designed to assess winding insulation health when the motor is powered down, or off-line. The instrument supports all major electric motor tests in a lightweight unit, including surge, polarization index, DC hipot, megohm and winding resistance tests.



The result

The OEM/OES and SKF worked together to define a PM (Planned Maintenance) schedule for testing of motors before they are put downhole. The motor tester was configured for an automated test sequence and clear description of acceptance criteria that ensured a consistent procedure would be performed by all field personnel, regardless of experience level. The OEM/OES has since deployed the system across its global field service organization with major improvements reported from all locations.

SKF helps support full LCM of hydraulic fracturing pump

The challenge

A well stimulation pump OEM wanted to design a new family of pumps for the hydraulic fracturing market. Their objective was to increase service life of the power end crank shaft bearings. Meanwhile, one of their key end users wanted to reduce consumption of wet end plunger pack seals, which needed frequent replacement before all stages of the fracturing job had been completed.

The SKF solution

SKF collaborated with the OEM's engineering team to do a "clean sheet" design of the power end bearing arrangement, including bearings, seals and oil flow and delivery system. The wet end seals were addressed with the end user by designing an innovative automated grease lubrication system that can be easily deployed as a field retrofit.

The result

The SKF solutions effectively increased pump design life with expected improvements in service life for the end user, who will benefit from higher reliability of the drive end bearings. Lower operating expense related to frequent changes of wet end seals was achieved, which can now survive an entire fracturing job without need to stop to replace seals. The two solutions combine to provide greater flexibility of horsepower deployment.



SKF helps OEM expand top drive offering

The challenge

An OEM top drive manufacturer sought to improve and dramatically increase their offering in the growing top drive market with four new models. Due to previous success with SKF on other equipment development projects, the OEM requested SKF assistance.

The SKF solution

SKF provided customized solutions consisting of multiple tapered roller bearings, cylindrical roller bearings, rotary lip seals and lubrication system recommendations. The package included extensive load simulations and finite element modelling of the top drive structure under all anticipated conditions. Close cooperation among several SKF international locations allowed for a quick response time, competitive pricing and timely delivery.

The result

The SKF solutions helped the OEM to offer industry competitive designs and to standardize components across multiple top drive models. The OEM also benefited from strong SKF technical support that augmented their internal resources, allowing them to develop the necessary design packages in the time allotted.

SKF helps develop 1 000-ton top drive and consolidate OEM supply chain

The challenge

A manufacturer of top drive and pipe handling systems embarked on the development of a new 1 000-ton top drive system and requested SKF assistance to help them meet an aggressive development schedule.

The SKF solution

Due to the massive scope of the project, SKF utilized a team approach and worked very closely with the manufacturer's engineers, project managers and procurement. Our responsive local technical team coordinated support from multiple SKF engineering and development locations.

The result

Thanks to a close working relationship with the customer, SKF was chosen as the supplier for most of the bearing and seal positions, including the dual gearbox and main thrust bearing. The customer met their tight project timeline and was able to consolidate suppliers across multiple products, allowing them to achieve supply chain management efficiency objectives.

Note: The slewing ring bearing of the pipe handling system was also awarded to SKF. With the 2013 acquisition of Kaydon by SKF Group, we can offer the customer an extended manufacturing footprint.



SKF sealing solutions support Life Cycle Management of BOP OEM

The challenge

A well control OEM in Texas needed to create a new seal package for a critical new blow-out preventer (BOP) and required rapid prototyping to meet a tight development schedule. Eight different positions were required along with subtle differences in material and design details across the range of the application.

Once the designs passed the stringent qualification test, the OEM wanted volume production with tight quality controls and at an economical price. It was also necessary to support their sister facilities in the North Sea and Asia over the production lifespan.

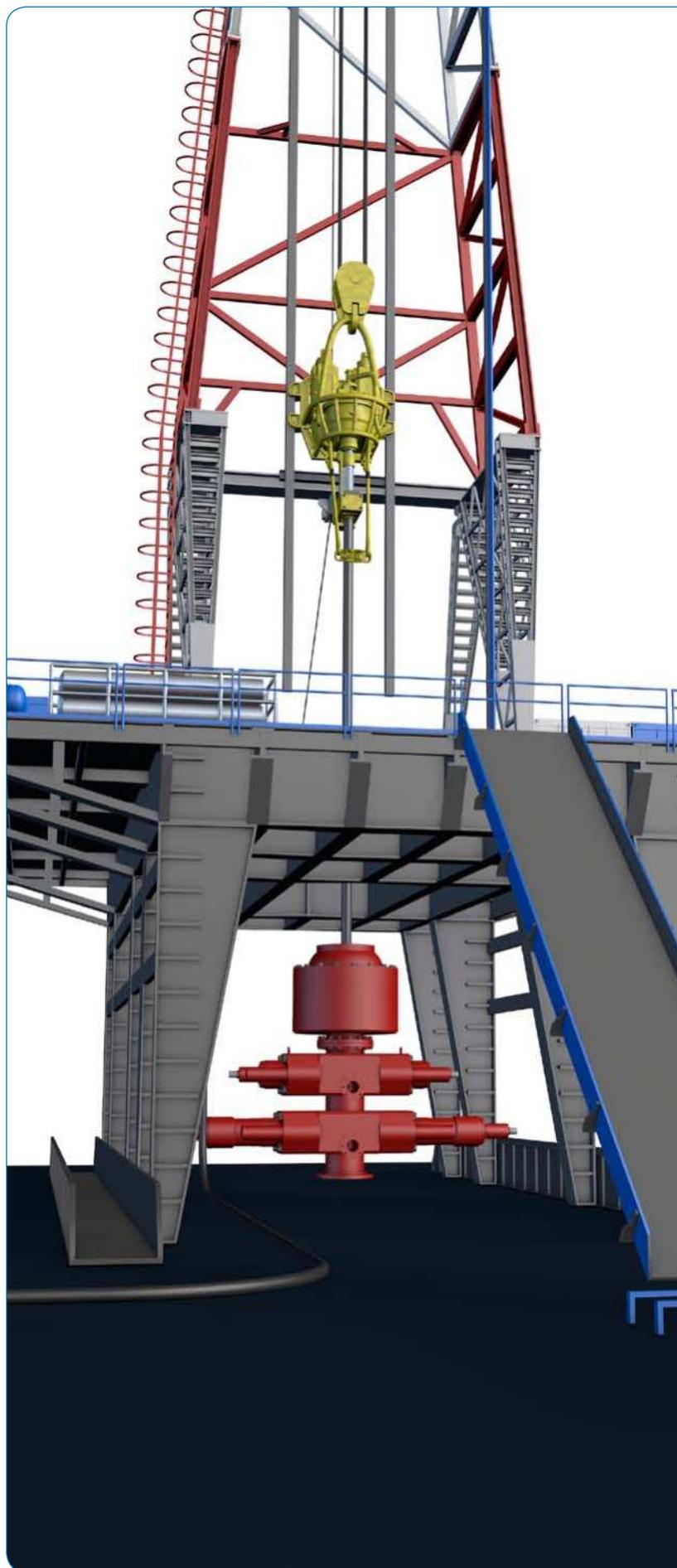
The SKF solution

Working closely with the OEM development team, a combination of SKF proprietary NORSOK-approved materials were selected to fulfill the demanding application requirements. Utilizing the SKF SEAL JET machining center in Houston, we responded quickly with a set of high-performance polymeric seals that met the prototype schedule. The SKF global network pre-arranged logistics planning for all customer locations.

The result

The SKF solution helped the OEM achieve the requirements of their end user for this critical application in the time frame required. The OEM could then take their new BOP design to other customers with similar requirements.

SKF was able to keep pace with a structured transition from a machined seal to a molded seal design, which met the long-term economic objectives of the procurement team. And the SKF global manufacturing footprint and logistics network fulfilled the world-wide supply chain requirements of the OEM.



SKF Solution Factory: a local gateway to SKF capabilities



Applying a unique mix of resources to address your challenges

To provide our customers with direct access to SKF's global capabilities, SKF has created a unique concept: SKF Solution Factory.

Here, under one roof, we offer a wide range of specialized services that draw on all of our core competencies and industry-specific knowledge. An SKF Solution Factory is a place where customers can come to solve difficult application challenges, consult with lubrication specialists, have a custom machined seal designed and manufactured on the spot, or explore design options with SKF engineers using knowledge-engineered software that functions as a virtual test rig.

The SKF Solution Factory in Houston, Texas specializes in the oil and gas upstream, midstream and downstream sub-segments. Locations in Aberdeen, Scotland, UK and Stavanger, Norway provide extensive product and service capabilities to the offshore exploration, drilling and production platforms in the North Sea and throughout Europe.

Typically, an SKF Solution Factory also offers bearing remanufacturing and spindle repair services, training and total shaft solutions including expert mounting, alignment and balancing. And depending on location, customers can also take advantage of remote condition monitoring and expert diagnostics.

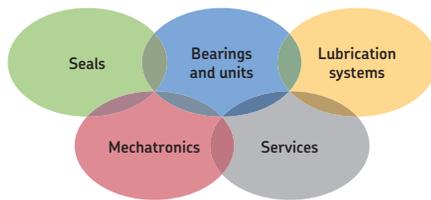
By combining multiple areas of expertise, an SKF Solution Factory is able to provide integrated, value-added solutions to customers, whether they are designing a new piece of equipment or working to optimize plant asset efficiency.

The network of SKF Solution Factories is continually expanding, making customized SKF services and solutions available to more customers worldwide.



*See inserts for more details
about SKF solutions for traditional
energy production.*





The Power of Knowledge Engineering

Combining products, people, and application-specific knowledge, SKF delivers innovative solutions to equipment manufacturers and production facilities in every major industry worldwide. Having expertise in multiple competence areas supports SKF Life Cycle Management, a proven approach to improving equipment reliability, optimizing operational and energy efficiency and reducing total cost of ownership.

These competence areas include bearings and units, seals, lubrication systems, mechatronics, and a wide range of services, from 3-D computer modelling to cloud-based condition monitoring and asset management services.

SKF's global footprint provides SKF customers with uniform quality standards and worldwide product availability. Our local presence provides direct access to the experience, knowledge and ingenuity of SKF people.



SKF BeyondZero is more than our climate strategy for a sustainable environment: it is our mantra; a way of thinking, innovating and acting.

For us, SKF BeyondZero means that we will reduce the negative environmental impact from our own operations and at the same time, increase the positive environmental contribution by offering

our customers the SKF BeyondZero portfolio of products and services with enhanced environmental performance characteristics.

For inclusion in the SKF BeyondZero portfolio, a product, service or solution must deliver significant environmental benefits without serious environmental trade-offs.

SKF S2M Magnetic bearings are part of the SKF BeyondZero portfolio, which includes products and solutions with significant environmental benefits, because they reduce energy consumption and lubricant use compared to other bearings used in oil and gas applications.



© SKF, BeyondZero, ECOPUR, Kaydon and SEALJET are registered trademarks of the SKF Group.

© Lincoln is a registered trademark of Lincoln Industrial Corp.

© SKF Group 2014

The contents of this publication are the copyright of the publisher and may not be reproduced (even extracts) unless prior written permission is granted. Every care has been taken to ensure the accuracy of the information contained in this publication but no liability can be accepted for any loss or damage whether direct, indirect or consequential arising out of the use of the information contained herein.

PUB 75/S2 14866 EN · September 2014

Certain image(s) used under license from Shutterstock.com