

TOPSIDE SOLUTIONS



Rev A, April 2019

ELECTRIC AND HYDRAULIC MOTION CONTROL
SOLUTIONS THAT PROVIDE EXACTING PRECISION,
RELIABLE OPERATION AND GLOBAL CERTIFICATIONS

WHAT MOVES YOUR WORLD

MOOG

ADVANCING AUTOMATION IN RIG EQUIPMENT

To succeed today, oil and gas services companies must explore some of Earth's most hostile environments with unprecedented drilling depths and an array of other critical challenges. To reach those depths, Moog helps our customers increase power and precision through both electrohydraulic and electromechanical solutions. There is a critical need to balance the increased operational efficiency that automation provides with the risk of developing overly complex systems that are difficult to maintain.

While not every piece of drilling equipment can benefit from advanced automation, Moog engineers know how to implement automation successfully to see real, tangible benefits in systems with increased safety, fewer parts, and easier commissioning / maintenance.

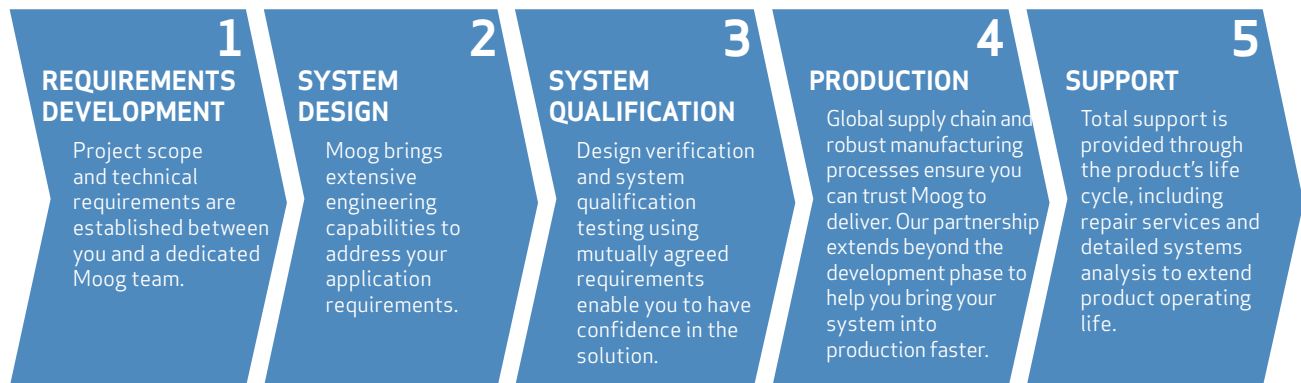
Drawing from the technical resources of a \$2.5+ billion corporation operating in over 25 countries worldwide with over 11,000 employees, Moog engineers leverage our deep portfolio of motion control building blocks. Our proven products are designed and manufactured for long life even in the most extreme environments and have many of the international certifications necessary for use in hazardous environments globally (e.g., UL, CSA, FM, ATEX and IECEx). In addition, our world-class aftermarket support network ensures productivity over the lifecycle of your equipment.

Our mission is to collaborate with customers to engineer high performance motion control solutions that meet unique customer requirements. Moog designs and builds reliable solutions that eliminate problems affecting performance, while minimizing system complexity.

Simply put, we're there for you with the right technologies and the right answers.

COLLABORATIVE ENGINEERING TAILORED TO YOUR UNIQUE APPLICATIONS

A flexible and collaborative approach brings expertise and accountability to the delivery of motion control solutions. Your ideas, input and requirements come first, while Moog delivers a higher level of motion control design and support through five key project steps:



COMMON TOPSIDE APPLICATIONS

When it comes to topside applications, Moog engineers leverage extensive experience in other demanding markets, ranging from heavy industry to space to defense. This proven know-how means that you'll always work with professionals who understand the extreme challenges you're trying to overcome.

Moog has been helping industry leaders push the boundaries of topside applications for decades. Our engineers design some of the most advanced solutions in the Oil and Gas industry today; these same engineers will also be in the field with you during startup, testing and fine-tuning the solution to ensure the success of your topside application.

COMMON TOPSIDE APPLICATIONS UTILIZING MOOG ELECTROHYDRAULIC AND ELECTROMECHANICAL TECHNOLOGY

- Drawworks (Winch, Motor & Brake)
- Iron Roughneck
- Rotary Table (Hydraulic or Electric)
- Pipe Handling (Catwalk)
- Crane & Lifting Systems
- Top Drive & Derrick Auxiliary Systems

Increasing automation on topside systems can impact both safety and productivity, while control architecture and product robustness drives the overall reliability of your topside system. Moog design, project management and field support ensures that you can effectively tackle your topside challenges:

FOCUSING ON SAFETY

Reducing personnel exposure to hazards and complying with global safety directives are an absolute priority. Automation and electrohydraulic/ electromechanical actuators limit direct contact with heavy loads and pinch points.

ADVANCING EXACTING PRECISION

Closed-loop servo control on your equipment can increase accuracy of positioning and force and improve your ability to automate repetitive actions. This will increase productivity both in the the speed of your equipment and reduced operator fatigue.

INCREASING RELIABILITY

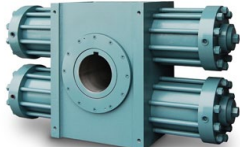
Equipment on drilling rigs is subjected to a variety of extreme conditions at once. Moog hardware is fully qualified to industry-standards, with additional testing in place to simulate the worst possible field conditions. This design validation comprises operation under vibration, shock, fatigue, and thermal testing.

WIDE RANGE OF WORLD CLASS HYDRAULIC PRODUCTS

No matter where in the world you are operating, you'll find that all Moog solutions have one thing in common. Our high performance products are engineered to work together in an optimized solution that enhances the safety, productivity, and reliability of topside systems. Our electrohydraulic solutions have continued to evolve over the past several

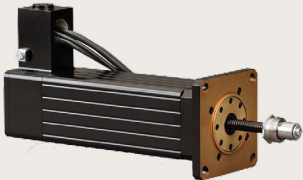
decades, providing heightened levels of control in a variety of demanding applications. Similarly, Moog electromechanical solutions are approaching the power density of hydraulic actuation, excelling in applications where fluid exposure is a concern.

ELECTROHYDRAULIC SOLUTIONS

INTEGRATED MANIFOLD SYSTEMS		• Custom-designed to application-specific requirements • Configured with Hazardous Area Certified (HAC) components • Flow rates up to 1,100 l/min (300 gpm) • Pressure capabilities up to 350 bar (5,000 psi)
EXPLOSION-PROOF DIGITAL CONTROL VALVES		• Onboard digital electronics and integral pressure sensors • ATEX, IECEx and FM Certified for Zone 1 T3/ T4 • Direct Drive Models: Flow rates up to 110 l/min (30 gpm) • Pilot Operated Models: Flow rates up to 3,600 l/min (951 gpm) • Pressure capabilities up to 350 bar (5,000 psi)
PILOT OPERATED PROPORTIONAL VALVES		• Onboard analog electronics • ATEX and IECEx Certified for Zone 1 T5 • Flow rates up to 3,600 l/min (951 gpm) • Pressure capabilities up to 350 bar (5,000 psi)
INTRINSICALLY-SAFE SERVO VALVES		• Proven mechanical feedback, nozzle-flapper valve technology • Certified to: ATEX, IECEx, FM, CSA, and TIIS (model-specific) • Flow rates up to 231 l/min (60 gpm) • Pressure capabilities up to 315 bar (4,500 psi)
RADIAL PISTON PUMPS		• Optimized design for high efficiency and long life • Displacements up to 250 cc (15.3 cu in) in 8 frame sizes • Standard pressure capabilities up to 280 bar (4,000 psi)
ROTARY ACTUATORS		• Hydraulic or pneumatic linear to rotary conversion • Available with ATEX approved accessories • Output torque up to 68,000 Nm (600,000 in lbf) • Standard pressure capabilities up to 210 bar (3,000 psi)

WIDE RANGE OF WORLD-CLASS ELECTRIC PRODUCTS

ELECTROMECHANICAL SOLUTIONS

CUSTOM LINEAR SERVO ACTUATORS		• High performance, application-specific actuators • Configured with Hazardous Area Certified (HAC) components • Continuous power: Up to 56 kW (75 hp) • Output force: Up to 450,000 N (100,000 lbf) • Stroke length: Up to 6.0 m (236 in) • Closed loop control: force, position, velocity
CUSTOM ROTARY SERVO ACTUATORS		• High performance, application-specific actuators • Configured with Hazardous Area Certified (HAC) components • Continuous power: Up to 56 kW (75 hp) • Output torque: Up to 20,000 Nm (15,000 lbf) • Closed loop control: torque, position, velocity
ELECTRIC LINEAR SERVO ACTUATORS		• Continuous power: Up to 12 kW (16.1 hp) • Output force: Up to 96 kN (21,500 lbf) • Stroke length: Up to 2.5 m (98.4 in) • Closed loop control: force, position, velocity • Optimized actuator and drive combinations available
EXPLOSION PROOF DYNAMIC BRUSHLESS SERVO MOTORS		• Certified to: ATEX, IECEx for Zone 1, T3-T6 • Low-inertia, natural cooling • Continuous power: Up to 8.36 kW (11.2 hp) at 40° C (104° F) • Output torque: Up to 66.7 Nm (590 in lbf)
MAXIMUM DYNAMIC BRUSHLESS SERVO MOTORS		• Optimized for high dynamics (lowest inertia possible) • Natural or liquid-cooled designs • Continuous power: Up to 60.4 kW (81 hp) • Output torque: Up to 1,003 Nm (8,877 in lbf)
CUSTOMIZABLE SINGLE-AXIS SERVO DRIVES		• High performance, programmable servo drive • Eight frame sizes available • Input voltage: Three-phase 18V to 560 Vac • Current rating: Up to 450 A • High speed communication via fieldbus

SUPPORTING YOUR APPLICATIONS, MEETING YOUR CHALLENGES

CERTIFICATIONS OVERVIEW

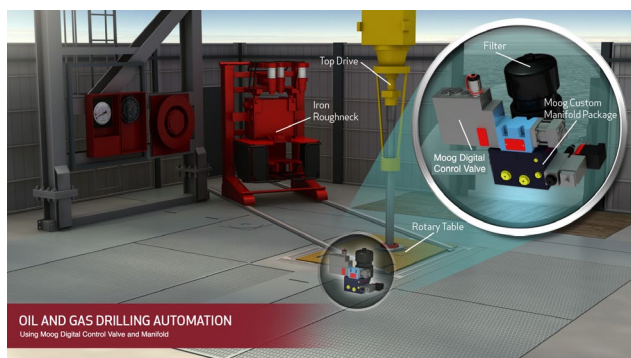
Automation in hazardous locations requires design expertise addressing both motion control needs and the selection of products with appropriate certifications. These certifications are used where fire or explosion hazards exist due to the presence of flammable gases or vapors, flammable liquids, combustible dust or easily ignitable fibers. Moog routinely certifies components for either NEC 500 (class-based) or NEC 505 (zone-based); our highest level of certifications reach Class 1 / Zone 1. We strive to certify products for use in all global locations, utilizing UL, FM, CSA, ATEX, and IECEx standards. Moog engineers will work with you to adapt specific products to suit your application needs.

MOOG GLOBAL SUPPORT™

Moog Global Support™ is our promise to offer world-class Repair and Maintenance Services delivered expertly by our trained technicians. With the reliability only available from a leading manufacturer with facilities around the world, Moog offers you service and expertise you can count on to keep your equipment operating as it should.



CASE STUDY: OPTIMIZING OIL AND GAS WELL DRILLING EFFICIENCY WITH EXPLOSION-PROOF PRODUCTS



Introduction:

A major energy systems company was looking to improve the control of a large hydraulic motor in drilling subsystems. The drilling environment is demanding as it is characterized by heavy use, constant vibration and the potential to release underground gas pockets. The use of Servo Valves certified according to ATEX, IECEx, and FM regulations (ATEX/IECEx II 2G Ex db eb IIC T4 Gb and NEC 505/FM US Class I, Zone I, AEx d e IIC T4 Gb) was required.

The Request:

Initially the requests from the customer were for advanced flow control to dynamically control the hydraulic motor speed with minimal pressure drop in a consolidated package. While working with the customer's engineers, Moog proposed that future systems could benefit from pressure limited flow control that would allow repeatable output torque at slow speed.

The Solution:

To meet the customer's requirements, Moog engineers designed, developed and delivered a solution consisting of the single stage Explosion-proof Digital Control Valve with a unique 4-way spool configuration and custom manifold package, consolidated piping connections with mounting for the servo valve, a solenoid valve, backpressure valve and a drainable pressure filter. All components meet hazardous operating environment ATEX and FM requirements.

One of the unique aspects of the solution was the Explosion-proof Digital Control Valve had sensors coupled to onboard electronics to provide closed-loop control for both flow and pressure which correlate to highly accurate control of speed, torque, position and force. In the past, only pressure or flow control was possible. Having both pressure and flow control on one valve offered this customer new opportunities in motion control.

The Result:

The application evolved over time as more functionality of the digital valve was used. Initial models provided proportional flow control with 4-20 mA analog interface. Later configurations used more advanced valve features with combined flow and pressure control (pQ) control and the Profibus-DP® fieldbus interface. The pQ configured valve is capable of closed-loop speed control through the hydraulic motor's encoder and closed-loop pressure control through a pressure sensor with the valve for active control of the motors output torque. Most importantly the solution has delivered safe, reliable performance in spite of extreme variations in temperature, high vibration and variations in pressure.

MOTION CONTROL FOR THE UPSTREAM OIL AND GAS MARKET

SEGMENTS

DOWNHOLE

- Flexible offering of preconfigured and customizable products
- Available in the lead time and cost you need to be successful

TOPSIDE

- Closed loop hydraulics for exacting precision of positioning and force
- Global certified products for reliable operation and long service life

SUBSEA AND MARINE

- Leader in rugged, long-life solutions for FPSO Swivels
- New innovative product offerings for ROVs and AUVs

TECHNOLOGIES

ELECTROMECHANICAL

Extensive portfolio of electric motors, linear actuators and alternators

HYDRAULIC

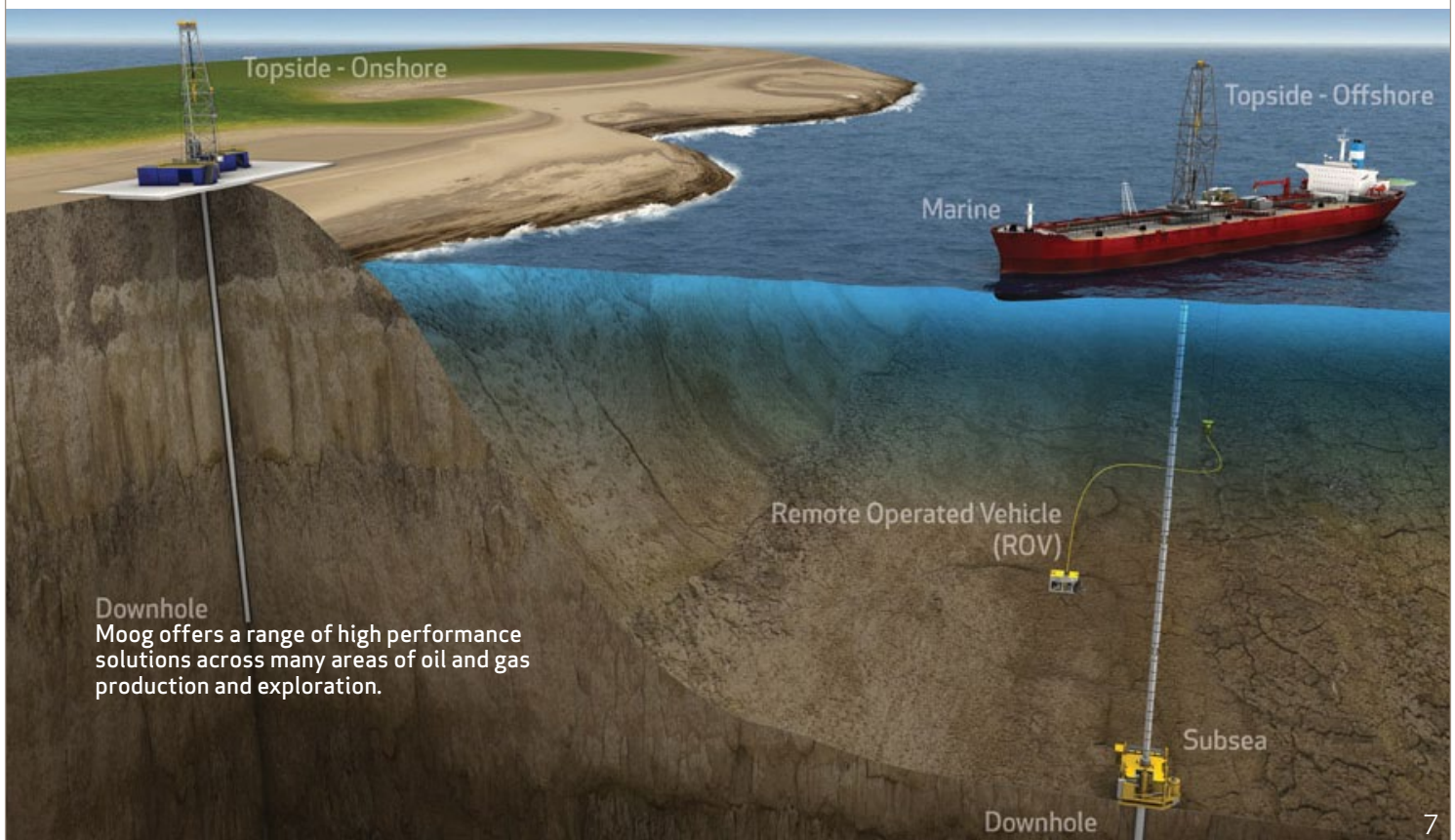
Leader in industrial hydraulic servo controls, including servo valves, pumps, actuators and complex manifolds

ELECTRICAL CONTROL SYSTEMS

Field-proven motion controllers and drives that support an array of industry-standard fieldbus technologies

ADDITIVE MANUFACTURING

Metal additive manufacturing is a key capability to help solve our customer's motion control challenges



TAKE A CLOSER LOOK.

Moog solutions for oil and gas exploration and production are only a click away.
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Moog Oil and Gas Topside Solutions
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