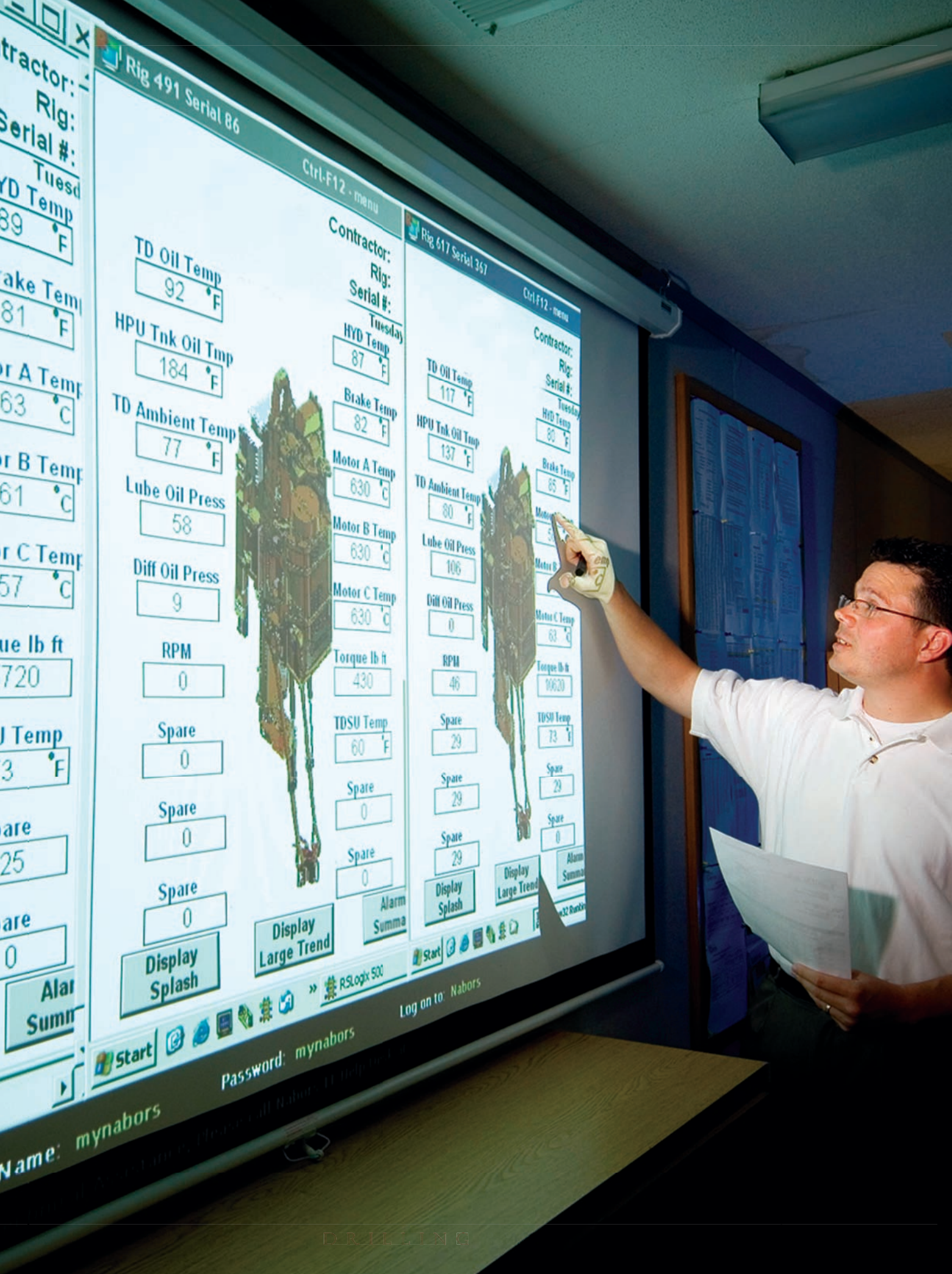
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Serial #:
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HPU Tnk Oil Tmp
184 °F
TD Ambient Temp
77 °F
Lube Oil Press
58
Diff Oil Press
9
RPM
0
Spare
0
Spare
0
Spare
0
HYD Temp
87 °F
Brake Temp
82 °F
Motor A Temp
630 °C
Motor B Temp
630 °C
Motor C Temp
630 °C
Torque lb ft
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TDSU Temp
60 °F
Spare
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Spare
0
Display Splash
Display Large Trend
Alarm Summa
Start
RSLogix 500
Log on to: Nabors
Password: mynabors
Name: mynabors
Rig 617 Serial 367
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HPU Tnk Oil Tmp
137 °F
TD Ambient Temp
80 °F
Lube Oil Press
106
Diff Oil Press
0
RPM
46
Spare
29
Spare
29
Spare
29
Display Splash
Display Large Trend
Brake Temp
85 °F
TDSU Temp
73 °F
Spare
29
Spare
0

Improved top drive systems boost reliability, push capacity limits

By Jerry Greenberg, contributing editor

ABOUT 20 YEARS ago, drilling contractors were struggling to decide whether to use a relatively new, to the drilling industry at least, piece of equipment that could drill wells 20% to 40% faster. In the mid-1980s, top drive drilling systems were estimated to cost between $500,000 and $750,000, a veritable bargain today. However, drilling contractors were concerned about the reliability of such a new machine, whether they could pay for the equipment during its lifetime, much less during a particular contract, and whether the equipment would even be accepted by operators.

In fact, operators embraced the technology when they saw how much time and money it could save them. Most of the cost savings in the mid-'80s resulted when an operator had a multi-well directional drilling program. In some cases, operators purchased the equipment themselves and installed them on rigs they contracted for multi-well programs. In one instance reported in 1985, **Chevron**'s cost for fishing stuck pipe cost an average of more than $500,000 per incident. Eliminating that cost due to the top drive's ability to back ream would just about pay for the top drive.

There are several similar examples of dramatic time and cost savings resulting from the use of top drive systems. It turned out that top drives were usually more efficient than drilling with a rotary and Kelly, especially for directional and horizontal wells but also for many vertical wells.

The equipment provides numerous benefits to the drilling industry. They have the ability to back ream, helping to reduce stuck pipe, particularly in directional wells. With a rotary and kelly, the driller can move the pipe up and down, or he can engage the slips and rotate, but he can't do both at the same time. Additionally, top drive systems provide the ability to drill with triple stands rather than single joints, saving two-thirds of the connection time.

Today, it's difficult to find an offshore rig without a top drive drilling system, and many more land rigs are being outfitted with top drives. The top drive system capacities today generally range from 250 ton to 1,000 ton, with a couple 175-ton units available. With operators and drilling contractors moving into deeper and deeper waters to drill deeper and deeper wells, a couple of manufacturers have developed 1,250-ton units — although the number of such units demanded by the industry is still severely limited.

NOT NEW

While top drive drilling systems became popular with the drilling industry in the early- to mid-1980s, their history goes back about 30 years before then. In fact, it's been noted that some small workover land rigs utilized a form of the top drive during the 1950s, according to early information from **ODS-Petrodata**. Big hole drilling, primarily in the mining industry, has been accomplished via top drive systems since the '60s, drilling holes 12ft to 20 ft in diameter.

CanRig can remotely monitor the condition of its top drive systems with up to 24 data points from a central location at its offices in Magnolia, Texas.

ODS-Petrodata also noted that the drillship Glomar Challenger, built in 1968, was fitted with a **Bowen** hydraulic power sub during the Deep Sea Drilling Project, which successfully drilled thousands of cores. The vessel's successor, the Sedco BP 471, used a top drive system and carried a complete spare as well. **Brown Oil Tools** teamed with Bowen in the '60s to develop an electric power swivel designed primarily for drilling operations. The first electric-powered unit was installed on a self-contained platform rig in the Gulf of Mexico in 1972.

Eventually, electric top drives gained favor over hydraulically powered systems. Electric top drives came in two flavors, DC and, later, AC drive systems. DC-powered systems have been yielding their popularity to AC units due to the latter's capability for better power and torque as well as better speed control. Several top drive manufacturers are predicting the demise of DC units during the next several years.

Top drive manufacturers are still concerned with reliability, especially since the priciest machines can cost several millions of dollars. The rig cost alone for state-of-the-art drillships and semisubmersibles can be more than $500,000/ per day, so increased reliability is a significant factor. The ability to monitor the system's condition, make quick repairs and perform routine maintenance is also being designed into the latest iterations of top drive systems.

MONITORING SERVICE

CanRig Drilling Technology, a subsidiary of **Nabors Industries**, delivered its first top drive drilling system in 1986. It took the company 15 years to deliver its 200th unit on 1 June 2001, but only six years to deliver 300 more. Its 500th top drive system was delivered in April 2007, illustrating the significant gain in popularity of top drive systems for onshore as well as offshore applications. The company says 85%-90% of its top drives are installed on land rigs.

On reliability, the company said the first top drive system it delivered in 1986 is still operating after working almost continuously for the past 21 years. However, CanRig, and the top drive industry, continues to seek ways to make the equipment even more reliable. CanRig says the biggest change since system number one is the overall improvement in reliability. "This comes from a variety of sources," said **Greg Kostiuk**, vice president, sales & marketing for CanRig, "including engineering changes, materials, components and the human factor, as well as educating users and ensuring they are trained."

CanRig has delivered 500 of its top drive systems as of April 2007. About 90% of them are installed on land rigs.

Mr Kostiuk said the first top drives for land rig use were rental items and were treated as such, meaning they weren't treated with the same affection as if they were owned by the contractor. "As a result, they developed a reputation for lack of reliability," he said, "but improvement in reliability has opened the door to much broader potential marketplace for land rigs."

To continue to increase reliability, the company offers a monitoring service for its top drives to determine if parts of the system need replacing or repairing, or when general maintenance is required. CanRig can remotely monitor up to 24 data points, or sensors, on the top drive in real time from a central location at their offices in Magnolia, Texas, north of Houston. The service has been live for about 18 months.

"With that information we advise our customers when they may be looking at a maintenance issue so they can address it off the critical path," Mr Kostiuk explained.

The company is presently monitoring approximately 80 top drives around the world. The service monitors different levels of significance depending on the particular alarm or condition that is breached, he noted, and it automatically sends an e-mail to the drilling contractor's maintenance supervisor. Additionally, the customer can access the monitoring service via a secure website to view the condition of its top drives at any time.

Sensors can be retrofitted to the company's earlier top drives, although beginning with serial number 350 or so, according to Mr Kostiuk, the sensors were installed on all of its units. It's up to the drilling contractor whether it wants to utilize the monitoring system.

LIGHTWEIGHT MOTOR

At least one manufacturer of top drives says when it comes to the latest and largest offshore drilling rigs, the weight of the top drive system is an insignificant factor in the overall scheme of things. Other top drive manufacturers say that reducing weight is still a significant factor in their designs. One company, **Tesco Corporation**, has been designing and building top drive systems since the mid-1980s and pioneered casing drilling and casing running with a top drive system.

Tesco has been utilizing permanent magnet motor technology on its top drives for several years. The technology results in higher horsepower output with significantly less weight than a typical electric motor, according to the company. AC technology motors employ copper winding and large cast iron cases and can weigh from 1,200-1,500 lbs while producing 450 hp, according to **Barry Beierbach**, vice president, top drives for Tesco in Calgary. In comparison, permanent magnet motors weigh approximately 200-250 lbs while still producing 450 hp.

"The permanent magnet motor is a rotor and stator with opposing mag-

Tesco assisted with the development of a permanent magnet motor for top drive systems that can reduce the weight of the motor from up to 1,500 lbs for a conventional electric motor to as little as 250 lbs.

nets that, as they pass the face of each other, result in a repulsing force," Mr Beierbach explained. "If they are controlled in a synchronized way, they can produce a lot of horsepower from a small package."

Tesco teamed with a company that owns the permanent magnet motor IP and worked together for 10 years to develop the technology, including the motors and drives. The technology has been commercial for about eight years, according to Mr Beierbach, and he says it is getting better with time.

"Everyone shies away from technology," he said. "PLC systems were a (bad) omen for the first 5-8 years until the industry accepted them, and now they're the norm. I think that's where the permanent magnet motor technology is. The industry is just waiting to see the reliability factor.

"There were a lot of problems and skepticism the first couple of years," Mr Beierbach admits, "but now (permanent magnet motor technology) is very well known and we have a very good uptime record with that technology."

Mr Beierbach noted that while the cost of Tesco's top drive systems utilizing permanent magnet motors is about 20% higher than a top drive outfitted with the typical electric motor, the company has been selling quite a few such units. "The higher performance nails it," he said, "because you can have smaller masts with higher output. We have installations on jackups and rigs on offshore platforms, and there have been some retrofits."

HIGH-CAPACITY TOP DRIVE

Two companies, **Maritime Hydraulics** and **National Oilwell Varco** (NOV) are separately manufacturing the industry's largest capacity top drives rated at 1,250 tons. They are aimed at the ultra-deepwater and ultra-deep well market. Both have been designed to reduce downtime for repairs or preventive maintenance and are designed with easy-to-replace modules and redundant parts and systems.

Maritime Hydraulics' 1,250-ton top drive is designed to significantly reduce nonproductive time due to its robustness, according to **Transocean**, which will utilize two of the top drive systems on its newbuild dual-activity drillship Discoverer Clear Leader. The unit will be modular so that any repairs can be completed in a matter of hours.

Additionally, the top drive will include features such as a redundant lubrication system with online oil monitoring, an automated greasing system, work platforms to eliminate man-riding operations, dual and redundant drives, online condition monitoring and troubleshooting and offline load path inspection.

NOV's 1,250-ton unit, dubbed TDX-1250, draws features from all of NOV's top drive lines, including Varco, Hydralift and National Oilwell. The TDX-1250 includes two AC electric motors and was designed with high-reliability systems such as water-cooled, flameproof motors with quick decouple drive connections, easy-to-remove main shaft and a 1,220-ton API main bearing in a constant wet sump gearbox.

Several NOV innovations are included on the unit, such as a "FlexFit" link adapter that can accept standard 350-1,250 ton links, and a four-point "X-Clamp" pipe grab to accommodate high-performance connections recently developed.

National Oilwell Varco's dual-motor 1,250-ton TDX-1250 top drive design includes numerous innovations to increase reliability and allow for easier and quicker repair and maintenance.

NOV also designed several features to enhance safety. The "SwingClear" internal blowout preventer (IBOP) handling system positions the IBOP assembly for safe handling. The hammerless washpipe system is capable of having its seal changed in 10 minutes, according to the company.

"We focused on reliability," said **Darrin Yenzer**, product line manager, top drive systems for NOV. "With the TDX we took the opportunity to redesign several items that we hope will transgress through the rest of our new models."

NOV reduced the number of parts as one way to increase reliability. For example, the gearbox is a single stage reduction. Rather than utilizing a pinion gear on the motor and then an idler between the

main bull gear, the pinion motor goes straight to the bull gear. "We eliminated a whole gear set, which drops the heat load in half," Mr Yenzer said. "There is also a gearbox sealing system that provides a backup seal already built into the system."

By utilizing water-cooled motors, NOV was able to eliminate the blower assembly with its own motors, fan and temperature sensors. Another feature is the ability to decouple a motor from the gearbox without having to remove the motor itself. "You can continue drilling without having to halt operations," Mr Yenzer explained. "You can turn off the drive package for that motor and keep drilling."

While this results in half the power and half the torque, Mr Yenzer noted, there is still 45,000 ft/lb of torque available with one motor.

The first TDX-1250 is destined for one of **Noble Corporation**'s semisubmersibles. NOV also has additional orders for the unit, with the first system set for delivery before year end.

ELIMINATING GEARBOX

LeTourneau Technologies Drilling Systems (LTI) developed its DirectDrive top drive a couple of years ago at the request of **Rowan**, who said it wanted a top drive without a gearbox due to reliability issues associated with the gearbox. LTI completely eliminated the gearbox and associated bearing and gearing problems and fluid leaks.

Eliminating the gearbox allowed LTI to develop a low-speed, high-toque motor. The motor, manufactured by LTI Power Systems (formerly **Oilfield Electric Marine**), weighs about the same as other top drive motors. It includes high-density magnetic steel and windings that the company says delivers up to twice the peak torque as conventional AC motors from 0 rpm through rated rpm. The motors provide more copper and iron content than conventional AC motors as well as additional mass, allowing them to withstand high temperatures associated with continuous operation.

A unique feature of the system allows drilling fluids to pass through the hollow shaft of the motor.

In addition to eliminating the gearbox, the company continued to simplify the design. "We tried to eliminate linkages and areas that seem to overcomplicate the system," said **Chris Dellaughter**, engineering manager, top drive division for LTI. "We tried to make things straightforward.

LeTourneau Technologies' DirectDrive top drive system eliminates the gearbox and utilizes an AC motor that delivers up to twice the peak torque as conventional AC motors. The company said it tried to simplify all parts of the system's design.

"If you move something, you use a cylinder and actuate it, you don't use a cylinder to actuate a linkage to do something else," he explained.

Richard Bradley, manager of product development, was the primary developer of the DirectDrive unit. "The way I approached the original design was with the mechanic in mind," he said. "If it's easy to maintain, you have less downtime. Everything is accessible and not hidden."

LTI keeps the monitoring of the DirectDrive simple with sensors to only measure temperature in the main thrust bearing area. The monitoring system is built into the PLC and is set up to send an alarm when temperatures reach a certain level.

"We haven't seen a need at this time to (provide monitoring) beyond this point," Mr Dellaughter said.

The first of LTI's top drive systems was installed on Rowan's Bob Keller Tarzan Class jackup. Since then, the company has sold about a dozen units, primarily for land rig operation. The 500- and 750-ton units are available, and the company is developing a 250-, 350- and 1,000-ton top drive. Mr Dellaughter said the company has been approached to develop a 1,250-ton system.