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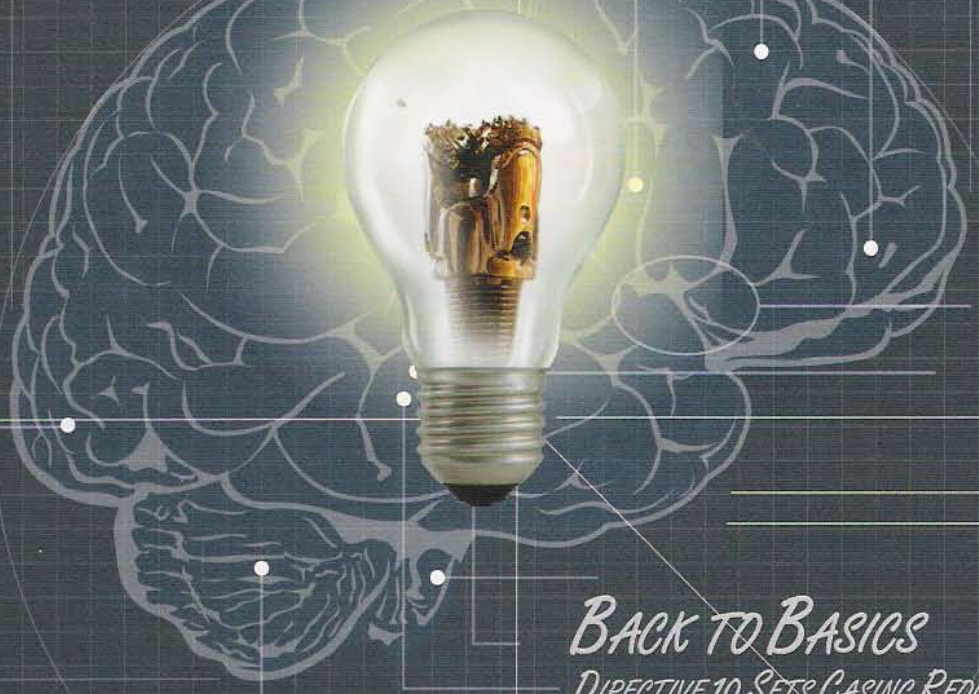
DRILLING CONFERENCE GUIDE

CANADIAN ASSOCIATION OF DRILLING ENGINEERS • CANADIAN ASSOCIATION OF OILWELL DRILLING CONTRACTORS

Innovative Solutions for Unconventional Challenges

A Stimulating Conversation

Water Issues A Challenge For Unconventional Programs



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Directive 10 Sets Casing Requirements

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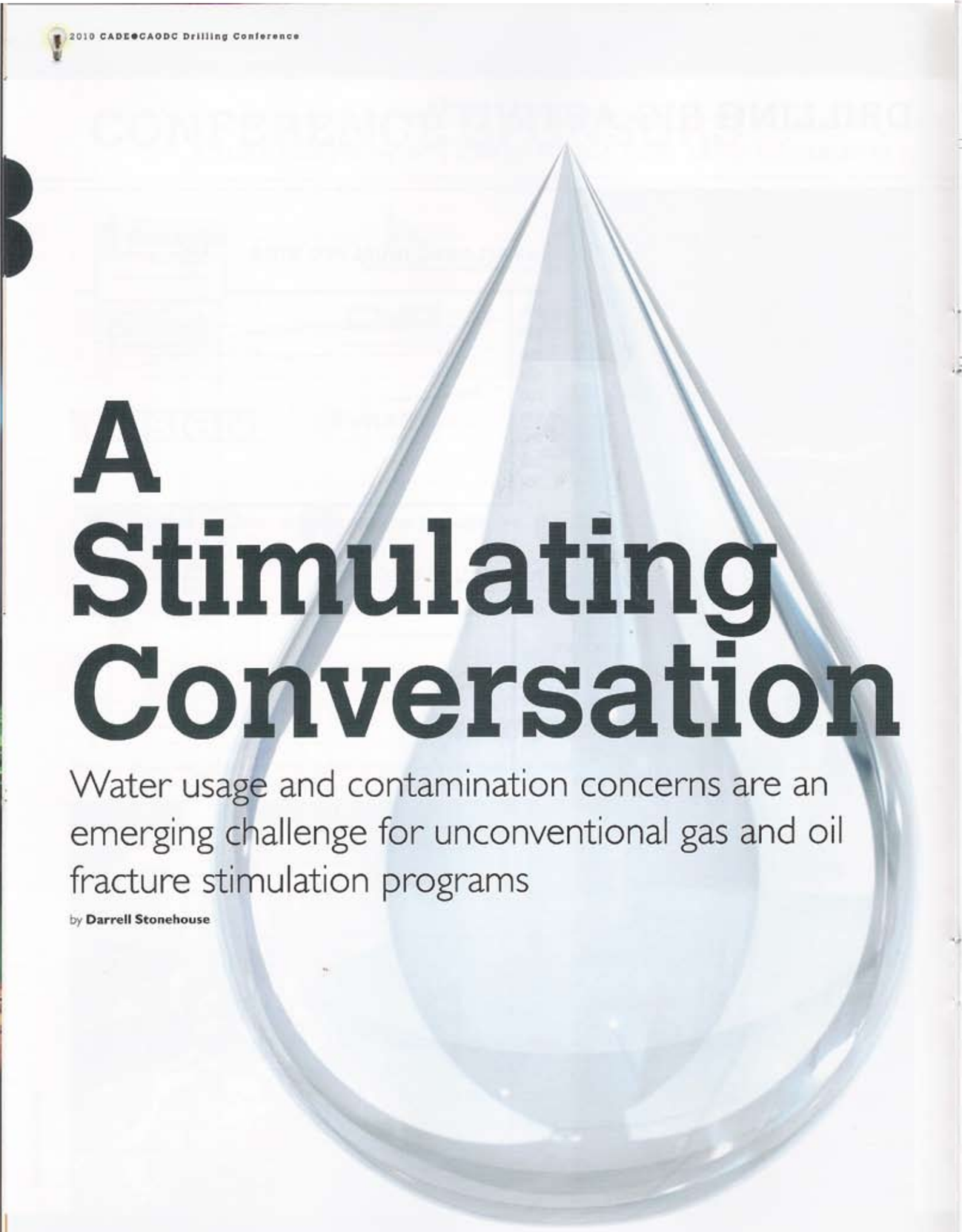

A Stimulating Conversation

Water usage and contamination concerns are an emerging challenge for unconventional gas and oil fracture stimulation programs

by **Darrell Stonehouse**

"As we use this technology in more parts of the country on a much larger scale, we must ensure that we are not creating new environmental and public health problems."

***Rep. Henry Waxman** (D-CA), Chairman, House Committee on Energy and Commerce*

The combination of drilling long horizontal wells and using multi-stage fracturing to open up tight oil and gas reservoirs previously uneconomic to develop is revitalizing the North American oil and gas industry.

The technique has radically altered natural gas exploration and development, adding decades of new supplies to what was a declining inventory. It has also added billions of barrels of new tight oil supply and is now being used to capture left-behind resources in mature fields.

But the multi-stage fracturing revolution comes with a downside—increased water usage and worries about contamination from additives to fracturing fluids. In the United States, the issue has already become a political football. And the rumblings are now starting in Canada as shale gas development moves into more populated areas and multi-stage fracturing is applied to existing oilfields.

Canadian oil and gas companies are looking for innovative technologies to mitigate water concerns before they become a significant problem.

In the United States, multi-stage fracturing is undergoing major scrutiny. The state of New York has placed a virtual moratorium on drilling into the promising Marcellus shale play in western areas of the state until it completes an environmental review.

As shale gas development has spread across the country, the U.S. Congress Energy and Commerce Committee has launched an investigation into the impact of massive fracture programs.

"As we use this technology in more parts of the country on a much larger scale, we must ensure that we are not creating new environmental and public health problems," committee chairman Henry Waxman said in announcing the investigation in February. "This investigation will help us better understand the potential risks this technology poses to drinking-water supplies and the environment, and whether Congress needs to act to minimize those risks."

In March, the Environmental Protection Agency (EPA) announced it was launching a $1.9-million study looking at fracture stimulations. The study is expected to take two years to complete.

"Our research will be designed to answer questions about the potential impact of hydraulic fracturing on human health and the environment," says Dr. Paul T. Anastas, assistant administrator for EPA's Office of Research and Development.

For its part, industry doesn't seem overly worried about the scrutiny. In response to the EPA study, Regina Hopper, president and chief executive officer of America's Natural Gas Alliance,says industry is confident the EPA's effort will prove hydraulic fracturing is safe. →

Back to Basics

New ERCB Directive 10 requirements for casing design apply to all Alberta wells

by **Gord Wagner,** *P.Eng, Summit Tubulars Corporation*

PHOTO: JOEY PODLUBNY

Energy Resources Conservation Board (ERCB) Directive 10 (D10): *Minimum Casing Design Requirements* applies to all wells to be drilled in the Province of Alberta. This article outlines some of the basic steps presented in D10 that need to be considered in casing design. Areas covered are well category table for sweet, sour, and critical sour wells; material selection; simplified method; alternative design method load calculations; and summary. Readers should download ERCB Directive 10 from the ERCB's website at www.ercb.ca, as many references will be made to the actual D10 document.

Well Category Table for Sweet, Sour, and Critical Sour Wells (D10, Section 1.4)

Critical sour well service classification is outlined in ERCB Interim Directive 97–06. There is a discrepancy within the industry as to what hydrogen sulphide (H_2S) content threshold should be used to determine when sweet well service should be considered sour well service. In ERCB D10, sweet well service is for wells with partial pressure $H_2S < 0.3$ kilopascals (kPa). Sour well service is for wells with partial pressure $H_2S \geq 0.3$ kPa. Please see D10 Appendix D for partial pressure definitions. Each casing string section must be checked for sweet, sour, or critical well service and designed accordingly.

Material Selection (D10, Section 1.3)

Critical sour service casing material must meet the material requirements of Industry Recommended Practices (IRP) Volume 1 *Critical Sour Drilling*, Section 4, *Casing Design and Metallurgy.*

Sweet service casing material must meet the requirements of API 5CT/ISO 11960 or proprietary grades can be used that meet D10 Section 1.5 requirements. Sour service casing material must meet the requirements of D10 Appendix B, which outlines additional constraints to 5CT/ISO 11960 requirements. IRP critical sour spec casing can be used for all wells in Alberta and can be substituted Appendix B sour service material.

Licensees must ensure the suitability of the casing and pressure-rated accessories for each specific application for the life of the well. Surface casing must be designed for sour service if the licensee drills into a sour zone prior to setting the next sour service casing.

What about all of the existing API 5CT/ISO 11960 compliant materials purchased or manufactured prior to the issuance of D10? Section 1.3.1, *Materials Not Meeting Requirements of Appendix B*, states existing API 5CT/ISO 11960 materials that do not meet the requirements of Appendix B may be used for non-critical sour service if:

- purchased or manufactured prior to Sept. 22, 2008,
- the H_2S concentration < 1.00%, then the burst design safety factor (SF) is ≥ 1.30,
- the H_2S concentration ≥ 1.00% but less than 5.00%, then the burst SF is ≥ 1.35,
- the H_2S concentration ≥ 5.00%, then the burst SF is ≥ 1.40,
- materials can be tested as described in D10 Section 1.3.2.

Simplified Method (D10 Section 2)

The Simplified Method is a slight modification to design criteria previously specified in Directive 10 (formerly Guide 10), dated September 1990.

For surface casing, the minimum burst design factors are 1.0 for sweet well service and 1.25 for sour well service. The minimum burst design load (kPa) is five times the setting depth (mTVD) of the next casing string. For surface casing, the collapse and tension design factors and assumptions are the same as for production casing.

For production casing, the minimum burst design factors are 1.0 for sweet well service and 1.15 for sour well service. No allowance is made for external pressure. The minimum burst pressure design load is the maximum potential formation pressure that the casing will be exposed to. The minimum collapse design factor is 1.0. The collapse design load should be calculated using the actual drilling fluid gradient. The minimum collapse design gradient is 11 kPa/m. The minimum tension design factor is 1.6. No allowance is made for buoyancy. The lesser of the pipe body yield strength or the joint strength (connection parting strength) must be considered as the casing minimum tensile strength.

Alternative Design Method (D10, Section 3)

The Alternative Design Method allows the licensee to use a detailed engineering approach to determine the design loads and the casing capabilities. A series of Alternative Design Method tables are shown for surface casing (Table 3.2.1), protective intermediate casing/protective liner (Table 3.2.2), and productive intermediate casing/productive liner (Table 3.2.3).

There are several differences between the Simplified and Alternative Design Methods. For collapse design, there is no longer a minimum collapse design gradient. For burst design, the minimum required design factors range from 1.1 to 1.25, depending on the partial pressure of the H_2S and CO_2. The minimum tension design factor is 1.75 for API connections and 1.6 for pipe body yield strength or premium connections with metal-to-metal seals. Buoyancy using the pressure multiplied by pipe body area method is allowed.

Either the Simplified Method or the Alternative Design Method can be used for any casing string. It is this author's opinion that the Simplified Method will be the more widely used casing design approach. The Alternative Design Method will be used when a more detailed engineering approach is required to meet all the minimum design factors.

Summary

- All wells to be drilled in the Province of Alberta must meet ERCB Directive 10 (D10): *Minimum Casing Design Requirements.*
- The well category table in Section 1.4 must be used to determine if the casing string service is sweet, sour, or critical sour service, and the appropriate loading conditions, minimum design factors, and material specifications are used.
- Casing material must meet Section 1.3 material selection requirements. For non-critical sour service, casing material must meet the D10 Appendix B requirements or IRP 1.4 casing can be substituted in. Existing API 5CT/ISO11960 casing that does not meet D10 Appendix B requirements can be used if it the casing meets the requirements of the Section 1.3.1.
- Either the Simplified Method or the Alternative Design Method can be used for the any of the casing strings.

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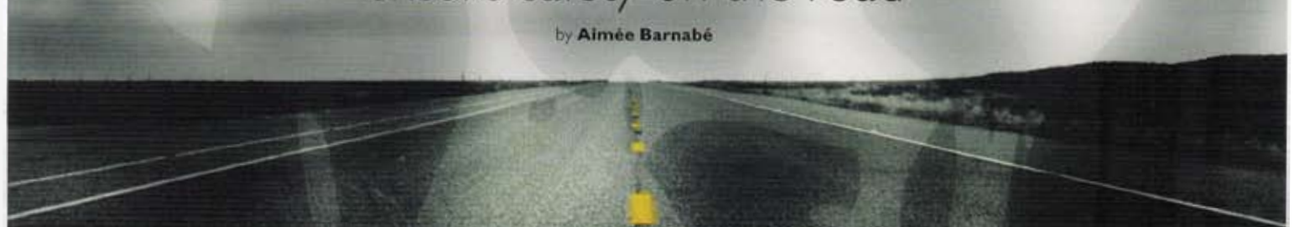
Let's not make 'dead time' deadly

Using Journey Management tools to ensure safety on the road

by **Aimée Barnabé**



When my friend Colin got up yesterday morning his day looked a little like this:

6 a.m.: Woke up after five hours of restless sleep.

Skipped breakfast because there was nothing appealing in the fridge anyway.

Called his girlfriend to tell her he loved her and couldn't wait to see her the following week.

6:30 a.m.: Departed his acreage near Calgary to pick up colleague in Red Deer.

8:00 a.m.: Drove 130 kilometres an hour and arrived in Red Deer in under 90 minutes.

Picked up colleague, filled up his truck, bought an energy drink to give himself a pick-me-up.

Drove to Edmonton.

During the drive: He talked to his colleague, fielded three calls from his girlfriend and two work calls, programmed his GPS with the coordinates for the work site he was travelling to, and found the new track to play for his colleague on his MP3 player.

9:30 a.m.: Arrived at site in under 90 minutes, despite the low-lying fog that hung in the air for most of the trip.

Worked on the assigned project for eight hours.

5:30 p.m.: Picked up fast food in the drive-thru to eat on the way home.

Drove the 376 kilometres, aimed into the sun for the first half of the trip with 60 kilometre an hour crosswinds for the second half.

During the drive: He changed radio stations half a dozen times and called his girlfriend to pass the 'dead time' during the routine journey.

9:15 p.m.: Arrived home. Completed paperwork for 45 minutes.

Did laundry and watched TV to unwind.

1 a.m.: Went to bed and got some rest for the next day that would look a lot like the last one. →

1 studies in innovation

Oilfield service firm claims its rotary steerable cuts a cleaner wellbore

by **James Mahony,** *New Technology Magazine*

Weatherford's rotary steerable system uses point-the-bit technology to drill more accurate horizontal wells.

Many drilling engineers agree that rotary steerable tools using "push-the-bit" technology have a greater tendency to cut scored, spiral wellbores than "point-the-bit" tools.

According to Weatherford, which markets its Revolution rotary-steerable system (RSS) in Canada, the gun-barrel borehole that most drilling engineers consider ideal is due to point-the-bit technology, an innovative solution for an unusual challenge.

Comparing point- and push-steerable tools, Weatherford says point-the-bit tools often use lateral force to cut, using a polycrystalline diamond (PDC) bit's side-cutters, while push-the-bit systems like RSS use a bit-stabilizer as a fulcrum, aiming the bit while using the bit face, rather than side-cutters, to drill.

The result, says Chris Hartley, Weatherford's technical director, is that "production costs of maintaining the well go down, because you don't throw dog-legs or put a kink in it." The borehole "stays fairly smooth…and you end up with an overall lower cost," he adds.

Lower costs partly reflect the ease of getting casing into a clean borehole, as opposed to a scored, twisting one. Rolled out in March 2009, Revolution RSS was designed for long-reach, directional wells in U.S. shale gas plays.

According to Hartley, Revolution RSS has drilled nearly two million feet worldwide and over one million onshore North America. While available in Canada, the U.S. well count for RSS is higher, although exact figures were not available.

RSS may be making its mark. Canadian users would not go on record, but a U.S. user that used RSS in 10 long-reach, horizontal gas wells in Texas and Louisiana was more forthcoming.

"I'd say it gives you speed…and a smoother wellbore," says Matt Madson, Swift Energy Company's drilling engineer. "As far as getting casing into a lateral that's 5,000 feet out, it gives you a lot smoother wellbore to push that casing through."

Before RSS, drillers often drilled directionally with a mud motor and bent sub-housing, and that's the standard against which RSS is measured.

According to Madson, the downside is that, when drilling directionally, RSS can't match the angle-build rate conventional mud motors have achieved.

"But it's a lot faster—it just can't get the same build rate, which isn't a problem," says Madson. "You just have to drill the well a little deeper at the end."

Madson's colleague agrees. "If you're trying to build a curve, I think about the best we ever did with a conventional mud motor was 10 to 15 feet per hour," says Swift's senior drilling engineer, Harry Dearing. "With [RSS], typically, we would do about 20 to 30 feet an hour building the curve."

Dearing says rotary steerables—not just Weatherford's Revolution—tend to make the longer casing strings that are common in long-reach horizontals easier to run. "We found we had a lot more issues around running casing through the curves when we used conventional bent sub-housing [mud] motors," he says.

Under ideal conditions, the men agreed Revolution could shave as many as four to six days off a 40-day well. RSS is available in four bottomhole assembly sizes, from 4 3/4 inches to 8 3/4 inches.

RIG GUIDE reference

Nabors 97ACTD

Complete with moving system

In what application does this rig work best?
It is best suited for multi-well pad drilling. The more wells that are on the pad, the more cost-effective the operation will be. With the moving system and small substructure footprint, this application can also be used for re-entry or new drills on old pads with existing wellheads. Currently, this rig is drilling horizontal Montney wells on multi-well pads.

What advantages does this type of rig offer?
The umbilical system, paired with the moving system, allows the rig to manoeuvre on tight pad configurations. Trucks are no longer required to move equipment between wells, cutting down on time and trucking costs. This rig also offers the latest AC technology, allowing the operator to maximize the capability of the rig without compromising efficiently.

How many of these rigs does Nabors have?
By the end of the year, Nabors will have nine umbilical, self-moving rigs and a total of 15 rigs with self-moving systems in their fleet.

RIG SPECIFICATIONS

Depth rating
4,600 m, with 5" sour service drill pipe

Rig power
Three each—3512C Caterpillar 1100 kW per set

Top drive
Canrig 6027AC capable of 275 tons (244,700 daN)

Umbilical system
Capable of extending 200 ft (61 m)

Mud pumps
Two each—Gardner Denver PZK-10 (1,350 hp)

Hydraulic catwalk and iron roughneck
Canrig Technologies

Derrick and substructure
Cantilever triple with swing-up substructure capable of 240,000 daN

Shale shakers
Two each on central system
Two each on scalping tank

Mud tanks
260 m3 total active volume

BOP
13 5/8" 5,000lb NACE trim

Number of loads
45, with no crane required

reference RIG GUIDE

Ensign Rig 533

ADR 300

What is unique about this rig design?
The ADR 300 does not have a conventional drawworks—it uses hydraulic cylinders to hoist the drill string. The entire tubular handling system (which includes the pipe tubs, pipe arm, slip handler, iron roughneck, and top drive) is automated and remotely controlled from the control cabin. The design allows the entire centre section (mast, sub, top drive, iron-roughneck, catwalk, and pipe arm) to be rigged out in less than one hour and moved as one load. The ADR 300 has a versatile layout, which means that it can be rigged up around existing equipment or even on two separate leases.

Where would this rig usually be found working?
Ensign's hydraulic ADR units are currently deployed throughout the world—Australia, Africa, the Middle East, and all three countries in North America.

What is the effective depth range of this rig?
The small footprint and very fast move and rig-up times allow this rig to work efficiently from 1,000 m to over 3,000 m vertically and deeper horizontally.

What was the most challenging project worked on and why?
The Occidental Petroleum Corporation Elk Hills project in southern California. The locations available to the rig in this very old field are of varying shapes and sizes, with some locations having multiple operating pumpjacks that the rig fit around. Some holes are drilled with the rig itself on one lease and the central system (gen sets, pumps, and tanks) on another. The well profile (3,000 m true measured depth—or TMD—horizontals), weather conditions (over 45°C), and continuous operations (no days off for breakup, etc.) required detailed maintenance planning.

Why would a drilling engineer hire this rig?
The ADR 300 is safe (no rig crew contact with drill string), fast (drilling, tripping, and moving), and efficient (equipped with top drive, runs casing up to 13 3/8" and has pulldown capability). The rig has proven that it can outperform telescopic doubles and triples on a spud-to-spud comparison.

What applications does this rig work in?
With the ability to fit large blowout preventer stacks (over 4.4 m clear working room) and no pipe-racking limit, the rig performs well in any area and well profile up to 3,200 m TMD.

What does this rig do best?
The ADR 300 outperforms the competition in rig release-to-spud times, casing running costs, and rig-up versatility.

What is the deepest well ever drilled with this rig?
2,000 m vertical and 2,900 m TMD in California.

RIG SPECIFICATIONS

Number of loads
11 (not including tubulars)

Depth rating
3,200 m

Hoisting capacity
133,440 daN

Top-drive drilling torque
27,000 ft-lb @ 80 rpm

Pull-down capacity
20,000 lb

Mud pumps
up to 2 x 1,600 hp as per customer requirements

Mud tanks
up to 2 x 60 m3 as per customer requirements