

New H&P rigs feature "HSE and value by design"

WITH SUCCESSES and lessons learned from 6 highly mobile land rigs built in 1997-1998, **Helmerich & Payne IDC** (H&P) continues to utilize engineering technology and innovative rig design with the current FlexRig™ construction project.

The rigs were engineered using "HSE and value by design" that minimizes hazards to personnel and the environment and improves efficiencies for both contractor and operator.

Documented improvements include greater safety for rig personnel, decreased flat line times, rig move time reduction, improved penetration rates and round mud tank efficiencies.

The use of technology has proven to reduce the cost of drilling wells for both the contractor and the operator.

"HSE by design" prevents safety and environmental incidents by eliminating and controlling hazards during design and fabrication of a drilling rig.

"Value by design," can improve operator and contractor efficiencies by focusing on the critical path to reduce cycle times and improve drilling efficiencies.

FIRST GENERATION

The first generation FlexRig concept was developed from experience with the highly mobile rigs H&P acquired in 1994. The new rigs were designed to be "depth flexible," allowing them to drill economically at depths from 8,000-18,000 ft.

The economies are derived from rig move costs and cycle times that are competitive with a highly mobile rig, while providing equivalent engine horsepower, mud pumping hydraulics and the rotary capabilities of a conventional 1,500-hp rig that are required for 18,000-ft wells.

Decreasing well cycle time reduces cost

for the operator and adds time value to the revenue stream from early oil and gas production.

To optimize drilling, H&P utilized the **MD-Totco** Auto Driller Block Control System (AD/BCS) on the first 6 new rigs. The electronic driller has the ability to supply near steady state weight on bit that improves drilling efficiency and reduces wear and tear on bits.



Climate-controlled driller's cabin on the latest generation FlexRig allowed addition of more electronic controls, and joystick controls for block travel and cathead operation.

There is another important advantage of rigs that use advanced technology. New technology rigs will help attract new personnel into the drilling contracting industry if designs provide improved ergonomics and a safe work environment.

HSE AND VALUE BY DESIGN

The foundation for safety and environmental protection is determined during design and construction.

| Safety performance | | |
|--------------------------------------------|----------------------------|----------------------------------|
| OSHA incidence rate comparison - 1998-2000 | | |
| FlexRig | All other H&P US land rigs | IADC US land rigs (includes H&P) |
| 2.55 | 2.99 | 9.43 |

Roger Brauer, a safety systems expert, says "procedures and training are the least effective means of hazard control in the workplace." Safety by Design is a systems safety approach to incident pre-

vention that is instrumental in eliminating and controlling hazards.

H&P engineering and field operations personnel teamed with the mast, substructure and drawworks manufacturer, **IRI** (now **National/Oilwell**), and identified more than 80 improvements related to improved personnel safety and reduced environmental impact.

A major improvement was the addition of disc brakes to the drawworks to improve traveling block control and add redundancy to help prevent dropped blocks.

An indirect benefit of the disc brakes is elimination of noise pollution common with the high decibel screeching of conventional band brakes.

Other changes associated with safety improvements involved adding work platforms and fall protection anchor points, and elimination of pinch points that caused many hand and finger injuries in old designs.

The H&P patented round mud tank system eliminated the need for employees to get into tanks with shovels and buckets during cleanout as is required with conventional square mud tank systems. This eliminates hazards associated with entry into a confined space.

Environmental improvements included lubrication systems to eliminate buckets and spills, integrated fluid containment for rig floor and substructure, fluid containment built into mud pump skids, standardization of factory made hose connections and mud system cleanup features.

The results of the safety by design effort are reflected by the **Occupational Safety and Health Administration** (OSHA) performance for the first 6 rigs.

The FlexRig OSHA rate was 17% better than the rest of H&P's rig fleet over a 3-year period and over 200% better than the IADC average.

Further proof of the safety performance improvements is shown by 173 rig moves accomplished by 6 rigs in 3 years with only 2 OSHA recordable incidents.

LESS FLAT LINE TIME

The flat line time of a well is any time not drilling that is considered in the critical path of a complete well cycle.

During design, by minimizing or even eliminating, non-value adding, repetitive or manual tasks, the progress of the well can be significantly improved.

For example, improvement is possible in these areas:

- BOP nipple up and down has been improved by adding 3 BOP dollies incorporated into the substructure. This allows the BOPs to be set in the sub during rig up and eliminates the need for a truck to set in the BOPs during nipple up time. The choke manifold and gas buster are unitized onto one skid that includes rig hydraulics assistance in raising and lowering the gas buster. This design has an average surface nipple up and test of 8.7 hr and nipple down at TD of 6.5 hr—a conventional 1,500-hp rig can take 24 hr and 12 hr, respectively;
- Displacement of unweighted mud with weighted mud or water base mud with oil base mud that can take 24 hr to complete, but can now be done in 8-12 hr using the 750-bbl patented round mud tank system. Estimated cost savings by several operators are as much as \$1,000/hr, resulting from a reduction in third party labor, fewer hours of rig day rate and other rig support costs;
- Efficiencies for cleaning operations are substantial when comparing round mud tank designs to conventional square tank systems. Savings from reduction of third party labor, rentals and rig rate costs have been \$10,000 to \$24,000 per well;
- Downtime on a drilling rig is costly for both operator and contractor. As rig dayrates and operator daily spread costs increase, the importance is magnified. Downtime for the rigs in 1999 was 0.75% and in 2000 was 0.48%. This compares to the rest of H&P's US land fleet at 0.76% and 0.80%, respectively.

H&P FlexRigs move time averages - South Texas

| | Mobile rigs | FlexRigs | Conventional rigs |
|------------------------------------------------------------------------------------|-------------|----------|-------------------|
| Drawworks HP rating | 1,200 | 1,500 | 1,500 |
| Depth capacity, ft | 8-14,000 | 8-18,000 | 14-20,000 |
| Number of wells | 362 | 173 | 34 |
| Average move: days / miles | 2.3 / 30 | 2.2 / 40 | 6.6 / 65 |
| Move cost average per well: Transportation plus rig @ \$12,000/day move rate | \$61,000 | \$63,000 | \$138,000 |

RIG MOVE TIME

Rig moves are in the critical path of a full well cycle and are typically a non-profitable time for both operator and contractor. The rig move is a process that can be mapped and the rig designed more efficiently to move, rig up and rig down.

H&P's highly mobile rig design is accomplished by reducing the number of loads, eliminating suitcases and pulling electric cables, using hydraulically raised and lowered equipment and handling equipment only one time.

On average in South Texas, a FlexRig moves 4.4 days faster and saves \$75,000 compared to a conventional 1,500-hp rig (these data are for 1999 and 2000).

Additionally, rig move equipment requirements are significantly reduced since a crane is not required to rig up or down, and the time required for oil field trucks is reduced by at least 2 days.

OPTIMIZING DRILLING

Drilling optimization was addressed by the first generation FlexRig using the following:

- Disc brakes replaced conventional band brakes on the drawworks, creating a more efficient braking system;
- Addition of the MD-Totco AD/BCS unitized with the disc braking system on the drawworks allows near steady state WOB as well as the ability to drill using delta P;
- The block control portion of the AD/BCS also allows the driller to control block speed to help mitigate surge and swab pressures, a function that is very useful when running casing in lost-cir-

ulation-prone areas;

- 1,300-hp mud pumps were unitized with properly engineered suction and pulsation dampening that reduces wear and tear on fluid end expensables, improves efficiency and improves MWD signal;

- The rotary table is independently driven by a DC electric motor with 2-speed gearbox for improved torque and speed ratios.

A drilling optimization study for the rigs in South Texas completed in December, 1998 indicated 17.7% savings in rotating time, 33.9% fewer bit runs per well and 6.7% more bits able to be re-run. The study results were influenced by many factors, including bit design. However, H&P believes the ability to apply a near steady state WOB enhances bit performance and improves ROP.

ROUND MUD TANKS

Since 1996, H&P has been building round mud tank systems. Conventional square tank designs have internal piping and corners causing dead space which encourages settling. The current patented design incorporates a set of elevated, round mud tanks with hemispherical bottoms and properly engineered agitators and turbulent flow inducing fins in each tank of the system to enhance stirring and mixing.

By elevating the tank bottoms and placing suction on the hemispherical bottom of the tank, all mud volumes are now accessible and usable volumes.

Efficiencies for the patented system can be cataloged in four distinct operations—mud mixing and maintenance; mud displacement; mud tank cleaning; and mud disposal costs.

This article is based on the paper, "Innovative Technology for Today's Land Rigs—FlexRig™," by John W. Lindsay, Shane Marchand and Johnny Tauzin, Helmerich & Payne IDC, presented at the AADE 2001 National Drilling Conference, Houston, 27-29 March.