

Power upgrades boost rig efficiency, extend rig life

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NEW RIG DESIGNS are often discussed, but it is a fact of life in our industry that the vast majority of drilling operations are carried out by hundreds of older rigs, many of which have been in service for 20-30 years or more.

Extending the effective life of these older rigs by upgrading their power and control systems is a critical factor in maintaining the efficiencies of drilling operations.

This means meeting the challenges of efficient, cost effective 21st century drilling programs by making the best use of existing capital equipment.

Figure 1: Land rig opportunities

	SCR	Other	Total
US*	264	1,120	1,384
International**	281	600	881
	<u>545</u>	<u>1,720</u>	<u>2,265</u>

Conclusion: 75% of worldwide land rigs could be candidates for some degree of modernization.

*Reed-Hycalog 1999 US Rig Census and The Land Rig Newsletter. **Spears & Associates 1999 International Rig Census.

The overriding challenge is to continue to reduce the overall cost of finding and producing oil and gas. There are at least three ways that the industry is pursuing this goal in drilling operations:

- Utilizing advanced technologies and techniques—Rigs used in the 21st century need to be equipped to handle the latest extended-reach, under-balanced and horizontal drilling programs, many of which put special demands on rig power systems;
- Adding new technology and equipment—Additional drilling equipment equates to additional power required to operate new top drives, pipe handlers and a third (or even a fourth) mud pump;
- Increasing equipment throughput and efficiency—Many rigs now use real-time monitoring of equipment performance, resulting in preventative maintenance procedures that are reducing downtime.

As shown in Figure 1, many rigs are candidates for some degree of upgrade or modernization. Less than a quarter of land rigs are SCR rigs; even in the off-shore market there is still a significant number of mechanical and DC/DC rigs that could be running much more efficiently with upgraded power systems and added drilling capabilities.

In making effective use of existing investments in rigs and equipment, the emphasis is not only on enhancing performance, but also on extending capability so the rig can do more than before.

PERFORMANCE, CAPABILITY

Rig Performance Enhancements for each of the various types of rig modernization programs can be separated into 4 categories.

Those enhancements which increase the rig's drilling and operational efficiency comprise one category.

Another category is made up of those enhancements which minimize downtime and maintenance requirements, improving the rig's reliability.

A third category includes those enhancements which increase safety of personnel and property.

Finally, there are performance enhancements which have a positive impact on the environment.

Rig Capability Extensions might include extending the depth rating of the rig.

Rig fleets originally designed to reach pay zones in the 5,000-10,000 ft range are now expected to drill into deeper, hotter, higher pressure formations.

Capability extensions also include adding the equipment, instrumentation and controls that allow the rig to drill horizontal, extended reach or underbalanced wells.

Here we will look at modernization of rig power equipment for three classes of rigs: Converting mechanical rigs to SCR; converting DC/DC rigs to SCR and upgrading SCR rigs.

MECHANICAL TO SCR

Figure 2 compares a mechanical vs SCR rig configuration. The left side of this drawing reflects a typical 2000 hp mechanical rig, where up to seven engines are required to provide power to run the drawworks and mud pumps.

A modern SCR rig provides significantly greater flexibility using only 4 engine-generator combinations.

The performance enhancements that can be expected when a mechanical rig is converted to SCR operation improve efficiency, reliability, safety and environmental protection.

Efficiency is increased by eliminating low mechanical torque converter efficiencies of only 70-80%. Fewer engine

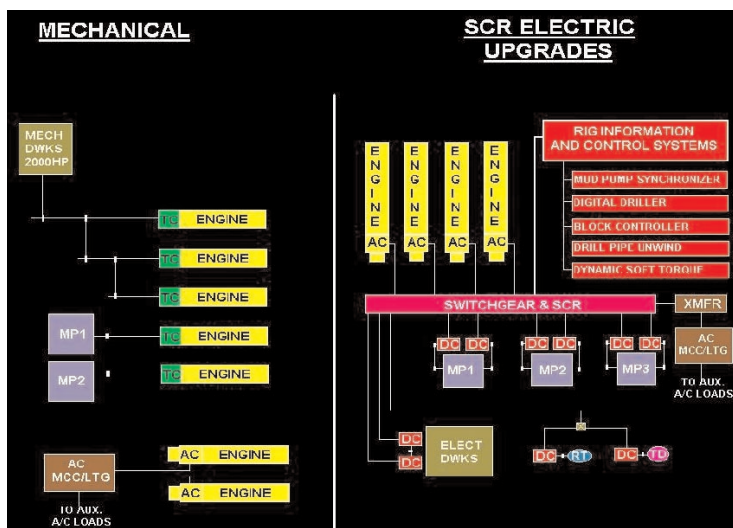


Figure 2: At left is the layout of a typical 2,000 hp mechanical drilling rig; at right is the configuration after the rig is upgraded to an SCR electric powered unit.

hours are required at a more efficient load range. Faster rig moves are possible and there is additional set up flexibility at the rig site. Better torque control and rotary speed help protect the hole. And the enhanced rig is compatible with advanced rig information network and control systems to optimize drilling programs.

Reliability is improved when converting to SCR. Mechanical rig maintenance costs 2-3 times that of an SCR rig. The factors influencing this cost on a mechanical rig include engine life, chain alignment, clutch wear, etc. In addition, the SCR rig eliminates the direct link between a specific engine and a specific component

avoiding the “engine down = rig down” syndrome.

Safety is also increased when a mechanical rig is converted to SCR. Explosion hazard is decreased because engines are located at a greater distance from

mechanical rig conversion includes:

- Modify the drawworks skid and mud pump skids from diesel driven to electric motor driven;
- Consider having the rotary table

the drill floor on the SCR rig. It is also safer to repair engines at ground level. Noise levels on the rig floor are reduced on an SCR rig. And there is an absence of pulleys, chains, rotating shafts and less heavy lifting. Converting a mechanical rig to SCR also provides environmental advantages. SCR rig fuel consumption is decreased by 20-30%. And when it is practical, highline power can be used to run the SCR rig. The scope of work involved in the

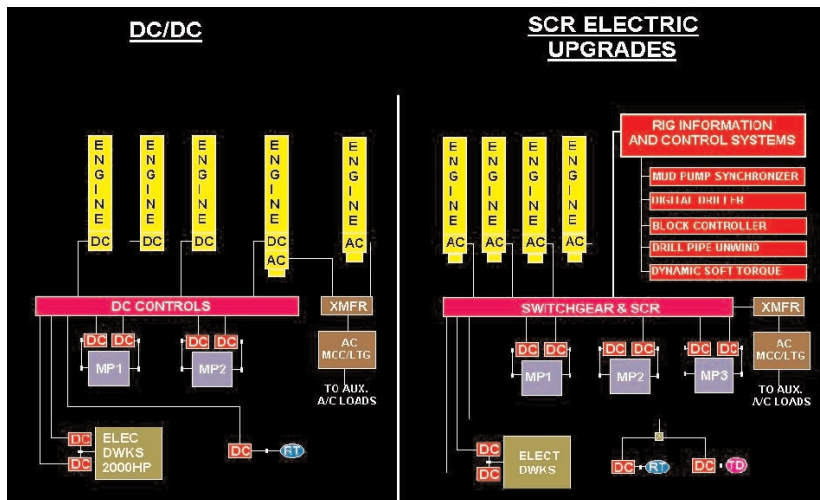


Figure 3: Conversion of a DC/DC rig to SCR improves efficiency by tailoring horsepower to load requirements. Other benefits include increased top drive control and reduced emissions.

chain driven from the drawworks or modify to independent rotary table driven by the electric motor;

- Could involve concurrent overhaul of drilling machinery while working on the electrical system;
- Possible change of the substructure to accommodate modern BOPs and weight balance;
- Add new engine/generator sets or utilize existing engines and add an AC generator with skids;
- SCR powerhouse, driller's console and instrumentation;
- Cabling;
- Optional electric mud pump console located near the mud pumps.

As an illustration of mechanical-to-SCR conversion, Pemex has upgraded a number of mechanical rigs. A typical starting point has been a 1,500 hp rig and upgrades have taken place in 2 phases.

During the first phase, two new engine/generators are installed on the rig to power the drawworks and rotary table. The second phase entails adding a third new engine/generator set to power two mud pumps and the mud processing system.

To simplify the overall process, a complete new SCR house is provided in Phase 1 with the total capacity to provide power control for both phases.

The new SCR house is equipped with 3 engine/generator controls, 4 SCR bridges, a motor control center and a top drive feeder.

DC/DC TO SCR

On the DC/DC system, up to 6 engines may be required to run the rig. Although some efficiencies exist versus the mechanical rig, enough DC generators must be run to provide one for each operating motor.

As with mechanical rigs, AC auxiliary power must be provided through additional engine/generator sets.

The performance enhancements that can be expected when converting the DC/DC rig to SCR include the following.

Efficiency is improved because fewer engine/generators are needed and horsepower is tailored to load requirements—engines on the SCR rig run at constant speed and operate more efficiently. KW and KVA limiting capability prevents blackouts and overloading.

Converting a DC/DC rig to SCR provides better top drive control capability. And the SCR system is compatible with advanced drilling rig information network and control systems to optimize drilling programs.

Moving and maintenance expenses are also reduced.

and reduced emissions from new engines. And highline power can be used to run the SCR rig.

The scope of work involved in the DC/DC rig upgrade includes:

- Consider having the rotary table chain driven from the drawworks or modify to an independent rotary table driven by an electric motor;
- Assess additional equipment requirements such as a third mud pump, top drive or increased mud handling capabilities;
- Consider utilizing the present engines as prime movers to drive 600 VAC alternators or purchasing engine/generator sets for 600 VAC power plants;
- Assess AC motor and lighting loads/requirements;

- Utilize or replace present motor control and lighting distribution;

- Determine cable requirements;

- Add SCR electric driller's console and instrumentation;

- Consider an optional SCR electric mud pump console located near the mud pumps.

Arabian Drilling Company, for example, converted its DC/DC Rig 14 to an SCR system. The four existing CAT 398 engines provided power, with actuators changed to electronic control, and

four AC generators added to complete the upgraded power package.

These engines were used to power an independent rotary, drawworks, and 2 mud pumps. A new SCR house was installed that contained 4 engine/generator control sets, 4 SCR bridges, and a new MCC.

UPGRADING SCR

Modern SCR rigs often require more power and control for additional functions. A fourth engine generator set is often added, along with a third mud pump and top drive capability.

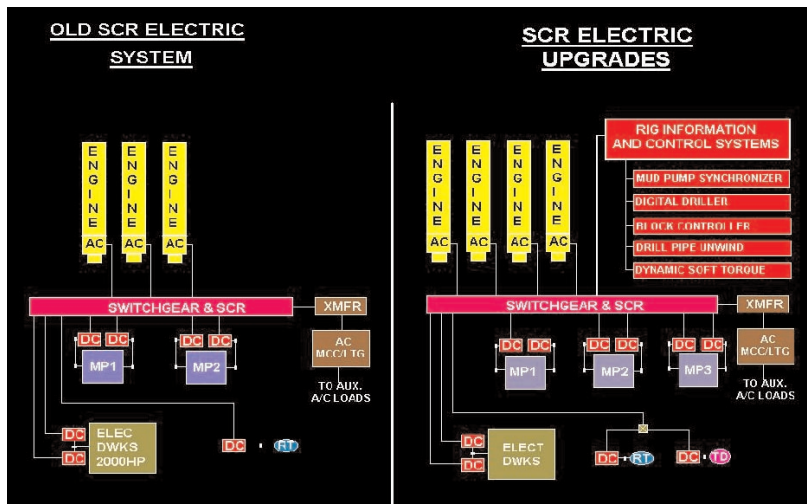


Figure 4: Upgrades of existing SCR power systems can reduce maintenance costs, downtime, and spares sourcing problems. The new power system is can also be more flexible.

Reliability is enhanced by the conversion because one engine can power any load on the rig. Outdated electrical components and rotating DC generators are replaced. And an air conditioned SCR "house" protects electrical systems throughout a wide range of weather conditions.

Safety is improved because the rig up process and drill floor are safer due to better control of the drawworks and rotary power. Better engine safety features also improve overall safety.

Environmental benefits of the conversion include increased fuel efficiency

Most importantly, modern rig information network and control systems can provide unsurpassed rig efficiencies through products like Digital Drillers and Block Controllers linked to draw-works controls; Dynamic Soft Torque Systems linked to the rotary or top drive; and Mud Pump Synchronizers that eliminate disruptive mud pressure pulses.

Power system upgrades can provide the solution for eliminating higher maintenance costs, high downtime, and spares sourcing problems. The chart in Figure 5 was used by **Ranajit Chakraverti, Hitech Drilling Services**, to illustrate these concerns as part of his presentation to the IADC South Central Asia Chapter meeting in Mumbai last May.

A number of performance enhancements can be expected when upgrading an older SCR rig. The new system is more flexible and compatible with advanced rig information network and control systems used to optimize drilling.

Touch screen diagnostics with remote access allow real-time monitoring of rig performances from headquarters. And anti-blackout power limiting features are added.

The upgrade also increases reliability by reducing downtime. Outdated components, cards, and relays are replaced by the new PLC based system.

Maintenance information, such as component failure, is easily located via touchscreen. And new SCR bridges do not require disabling for repair.

The upgrade improves safety by reducing noise levels and includes updated engine controls and safety features.

Environmental hazards are reduced through more precise controls and modern electrical methods and specifications. And emissions from new engines are reduced.

The scope of work is somewhat less involved than with the other upgrades discussed earlier. It includes:

- Assess existing component integrity, service availability and replacement parts availability;
- Assess additional equipment requirements such as third pump, top drive or increased mud handling capabilities;

- Based on whether existing components meet size and electrical ratings (such as interrupt capacity, full load capacity etc), determine if upgrades are required of components including bridges, control nodules, contactors, breakers, field supplies, drilling console, motor control system, air conditioning system;

- Determine cable requirements;

- Consider an optional mud pump console located near the mud pumps;

- Review requirements for optional generators.

An example of an SCR rig upgrade is **Nabors Rig 119** in South America where modernization included adding a fourth CAT 3512 engine and generator with associated controls on a new engine generator skid. A third mud pump was installed, along with a mud pump synchronizer to provide smooth simultaneous operation of all three pumps.

A top drive was also added, along with a Dynamic Soft Torque control system. The design of the electrical system also included provisions for adding a Digital Driller and Block Controller later. The SCR house contains a 4 x 4 system, an MCC, and a PLC control and information system.

CONCLUSIONS

Drilling in the 21st Century requires more rig power for additional new, high-tech drilling equipment and control systems.

Throughout the world, older rigs continue to be modernized to provide optimized drilling performance and extended capability.

The overall result is that our industry is demonstrating how to make the most effective use of existing capital, while minimizing new investment.

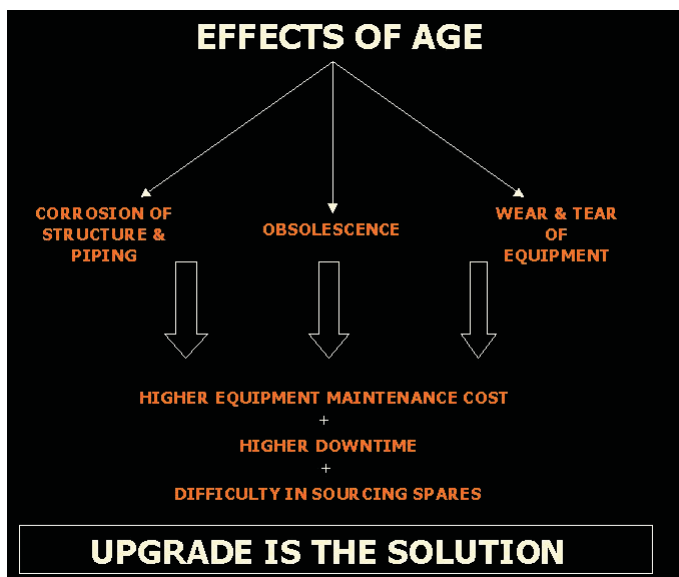


Figure 5: Upgrading an older SCR rig power system can make the system more flexible and compatible with advanced rig information networks.

This article is based on, "Modernization of rig power and control systems to meet the challenges of today's drilling," presented at IADC Drilling Middle East 2000, 21-23 October 2000, Muscat, Sultanate of Oman.

REFERENCES

- 1999 Reed-Hycalog Rig Census.
- "Power System Upgrades Can Enhance Performance", *Drilling Contractor*, September/October 1999.
- Chakraverti, R., "Jack Up Rig Upgradation and Life Extension," presented at the IADC South Central Asia Chapter Meeting, Mumbai, India, May 2000.
- Bhavaraju, V., Dhindsa J. S., and Luna R., "Upgrading Rigs for the Future", presented at ONGC Seminar, Mumbai, India, 7 November, 1997.
- Isenberg, E.M., "Onshore Rig Surplus Diminishes as Demand Rises", *Oil & Gas Journal*, 22 September, 1997.
- Dhindsa, J. S., and Spoerker, H. F., "SCR Based Feed Control Enables 100% Core Recovery in Slim-Hole Wildcats" SPE 23872, presented at SPE European Petroleum Conference, London, U.K., 25-27 October 25-27, 1994.
- Breazeale, W., "SCR Replaces Mechanical Drives," *Oil & Gas Journal*, 6 August, 1979.
- Webb, G. W., "Mechanical?...DC?...SCR? Which Rig is Best for You?" *Drilling-DCW*, May, 1977.