Casing is run faster, more safely with new systems

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ONE KEY AREA of the well construction process, which until recent years has seen little advancement in automation, is running casing.

The sight of a casing crew member tied off at the casing stabbing level high above the rig floor watching and assisting as each single joint is raised to vertical guided by ropes, slings and shackles has been a part of life in the oilfield.

Casing operations were always seen as a unique operation requiring specialist crews who manually stabbed the casing singles before making them up with tongs hanging from a tugger.

These operations were widely regarded as one of the most hazardous in the industry. Only recently has the industry placed focus and commitment to change this status quo.

Non-drilling activity is represented by "flat spots" on the depth/time graph typically used to chart the progress of any well as it is drilled.

As our industry drives towards continuous improvement of both safety and efficiency, so we have turned to technology to drill faster, improve safety, and reduce the flat spots on the depth/time graph.

A published best practices study of deepwater exploration drilling allows us to look at the time breakdown for a well in 2,664 ft water depth in the Green Canyon, Gulf of Mexico.

The results show that 7% of the total time on location is associated with casing running. The example in the study is of a fairly conventional casing program:

- 30-in. structural;
- 20-in. conductor;
- 16-in. liner;
- 13 ⅜-in. intermediate casing;
- 9 ⅝-in intermediate casing.

However, one of the technical challenges of moving into ultradeep water (greater than 5,000 ft) is in casing program design. The conventional method of plotting pore pressure and fracture gradient allows the drilling engineer to determine the casing seats, of which more are required.

Additional intermediate liners are now needed to allow the well to be drilled, protecting weaker formations from the higher density muds.

An example of such a casing program is as follows:

- 36-in./38-in. structural;
- 28-in. conductor;
- 21 ¾ -in. conductor;
- 18-in. liner;
- 16-in. liner;
- 13 ⅝-in. casing;
- 11 ⅞-in. liner;
- 9 ⅝-in. liner;
- 7-in. production liner.

Unquestionably the additional strings of liner and casing which are required will increase the flat spots on the drilling curve. Therefore any process which increases the efficiency of running casing will have a significant effect on the overall performance of the rig.

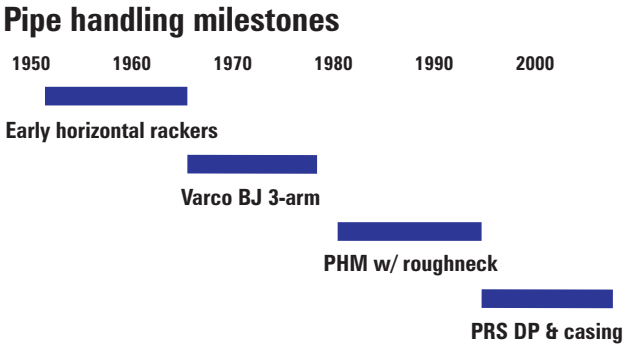
AUTOMATED PIPEHANDLING

The need for improved safety and increased efficiency has driven the development of automated pipehandling over the last 50 years.

Noteworthy milestones include the early horizontal rackers of the 1950s and 1960s, followed by the development of the **Varco BJ** 3-arm racking system in the late 1960s and 1970s.

Thirdly were those rackers which adopted semi-automation and were used in conjunction with power equipment such as iron roughnecks and power slips, greatly improving safety while maintaining the performance gains of earlier machines.

All the above were focused on the handling of drill pipe and drill collars.



The fourth and most recent milestone in automated pipehandling has extended the tubular handling capability to include a range of casing diameters (5-20 in.), drill pipe and drill collars.

These machines, known as Pipe Racking Systems (PRS), were developed not to merely automate a manual process, but to change the process itself.

Common components are configured in different ways to produce four machines with a range of capabilities. Drill pipe and casing to 13⅝ in. is handled in range II triples and range III doubles by the PRS-4i.

The other machines have the capability to handle drill pipe, drill collars and casing to 20 in. in range II quads and range III triples.

The PRS-5R has the added feature of handling double stands of marine riser.

OPERATIONAL EXPERIENCE

Transocean Sedco Forex's three Enterprise-class drillships have each adopted the Varco PRS-5 as the core of the pipehandling system.

These rigs have demonstrated their ability to make up a range III 135-ft triple stand of casing from 5-20 in. and rack it back vertically in the derrick.

This operation is performed off the critical path and has proved to be the foundation of improved casing efficiency.

Furthermore this operation is performed with no hands-on interaction from the rig crew with the exception of thread inspection and doping as required. Virtually all pinch points eliminated.

The step change in operations offered

by the capabilities of the Pipe Racking System demanded significant advancement in fingerboard philosophy.

The Discoverer Enterprise's ability to handle a range of casing sizes meant that it is no longer feasible to rack pipe in the conventional X-Y configuration with fixed fingers.

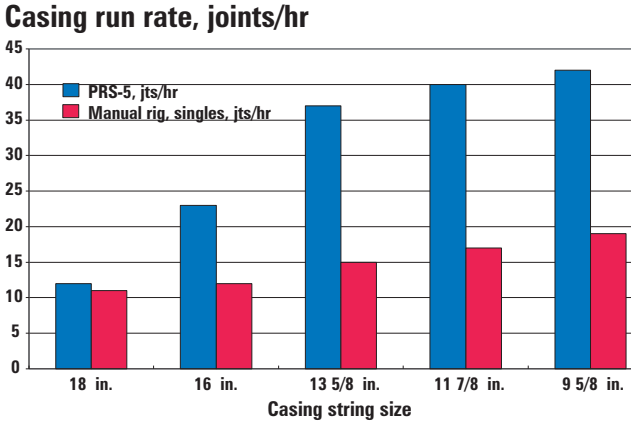
Therefore, the advent of the PRS brought with it Parallel Racking, where the rows of fingers point towards the drawworks side of the derrick (see photo).

The Discoverer Enterprise maximizes this technology by having an 80 ft x 80 ft rig floor spanned by the setback area.

The fingerboards are either "fixed" for predetermined drillpipe sizes, or "adjustable." The adjustable fingers accommodate tubulars from 5 in. to 20 in. and are moved by hydraulic actuators connected to a chain, which is engaged on each adjustable finger.

The adjustable fingers provide enormous flexibility to rig operations as they can be reconfigured for each casing string to be racked.

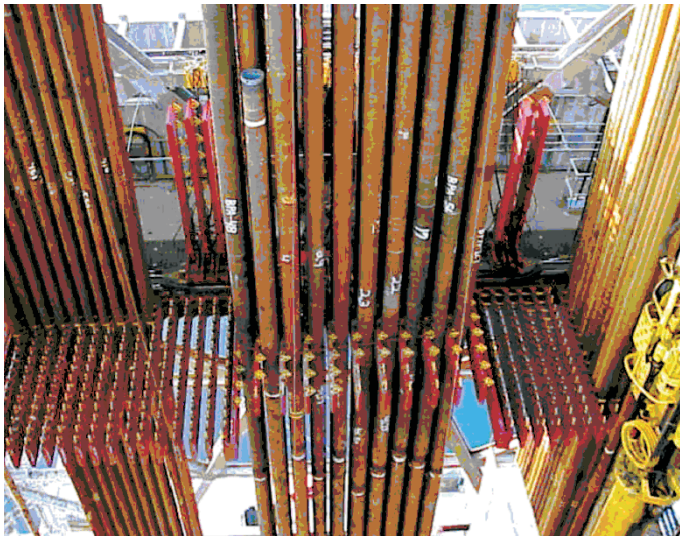
For example, the racking capacity in the adjustable fingerboard alone is as follows:



- 15 stands of 20-in. casing (2,025 ft) or;
- 24 stands 16-in. casing (3,240 ft) or;
- 63 stands of 13 ⅝-in. casing (8,505 ft) or;
- 77 stands of 10 ⅝-in. casing (10,395 ft) or;
- 84 stands 9 ⅝-in. casing (11,340 ft) or;
- 112 stands 7-in. liner (15,120 ft)or;
- 112 stands 5-in. liner (15,120 ft).

There are two fixed fingerboards each able to rack 225 stands of 6⅝ in. drill pipe, a total of 60,750 ft of drill pipe.

These fingerboards are configured to minimize the distance from well center to the fingerboard to optimize efficiency for the most common PRS operation—tripping pipe.



135-ft stands of 16-in. casing are racked in the adjustable fingerboard, which provides flexibility to handle a range of tubulars from 5 in. to 20 in.

A further 10 fingers of the fingerboard are devoted to heavyweight drillpipe and drill collars.

Casing is run in the hole in triple stands. The PRS-5 takes a stand from the vertical setback area and presents it to well center where it is made up.

As the blocks are lowered the PRS-5 retrieves the next stand of casing and is ready to present it to well center once the casing spider is set. Lateral movement of the PRS-5 on the critical path is minimal.

The accompanying graph shows the performance to date of casing runs as compared with manual operations where casing joints are run as singles.

Casing run rates have now been attained of greater than 35 joints per hour over the duration of the entire casing run for sizes of 13 ⅝ in. and below. These results are a 100% improvement in efficiency based on a manual rig.

In addition to casing running operations, complete shoetracks and liner hangers have been racked back successfully cutting significant time out of the critical path.

Centralizers and other casing jewelry are strategically placed in the stand considering the vertical travel of the upper and lower PRS-5 jaw assemblies.

Early concern was expressed regarding the compressive loading on the casing connections when racked vertically in the setback.

Casing stands have been stood back on bare pins or with pin protectors attached depending on the connection with no deformation of the connections.

An ultra high density polyethylene pad is utilized to set stands down on in the fingerboard setback area.

CONCLUSIONS

The automated pipe racking systems on the Discoverer Enterprise-class drillships have significantly enhanced safety on the rig floor and provided capabilities and flexibility that have directly resulted in critical path time savings to the operation.

In addition to the benefits of the pipe racking systems to planned operations, the value of the systems when unplanned events occur are very powerful.

During completion and testing work a new set of efficiencies will be capitalized on utilizing the systems.

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