OIL&GAS JOURNAL

Jack up for 400-ft water depths feasible

PETER M. LOVIE
EDWIN L. LOWERY
Engineering Technology Analysts Inc.
Houston

Reprinted from the January 10, 1972 edition

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TO DATE, drilling in water deeper than 300 ft has been the exclusive preserve of semisubmersible and floater-type drilling units.

Why should we not use jack-up units for 300 to 500-ft water depths? A preliminary analysis has been made of the problems of getting such a rig on and off location, severe wind and wave conditions, and construction costs and operating efficiencies. This analysis points to the practicality of a 400-ft-water-depth jack up—today.

Such a unit could be applicable to the North Sea where water of this depth combines with rough weather to cause excess loss of drilling time.

In 1965, the first jack up designed for 300 ft of water was put into service.[1] By December 1971, 10 such units were in operation for 300 ft and deeper, and 11 more being built.[2,3] At that time, these 11 units made up 69% of the jack-up rigs under construction. Three of the 11 are for use in up to 350-ft water depths.

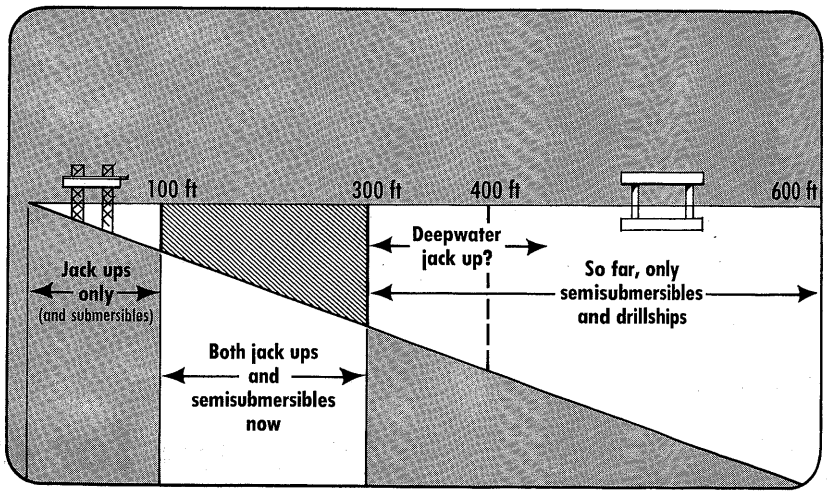
Further, the demand for semisubmersibles has increased, Fig. 2, also indicating the trend to deeper water.

Currently, a semisubmersible or other floater-type unit is required for drilling on the outer continental shelves in depths from 300 to 600 ft, Fig. 1. But semisubmersibles are often used in water as shallow as 100 ft because of convenience or rig availability.

These arguments could be advanced for using jack-up rigs more extensively in water depths up to 400 ft:

Fig. 1

Current water-depth ranges



- **Operating semisubmersibles in shallow water is costly. They are expensive to construct ($12-$25 million). With this investment it is usually more economical to use a jack up wherever possible.**
- Though semisubmersibles are designed and rated for 600-ft-plus water depths, many are actually working in much shallower water. It is difficult to get good information on all current working depths, but it appears that most are working in the 300-450-ft range. So, all that appears necessary for most jobs is about a 400-ft capability.
- Technology for production in 400-ft water depths under North Sea conditions is still in very early stages. For the near future, at least, concentration will be on work in 400 ft or less water.

Thus far, design technology has limited the jack up to water depths of 300 to 350 ft. A lot of design work has been done, however, and the technology is now available to build a jack up for depths of 350 to 450 ft.

A jack up at these depths can safely withstand the more severe wind and wave stresses. And as the search for oil goes to deeper and deeper water, economic pressure will build to develop a 400-ft bottom-supported unit.

The key design problems for such a unit boil down to these: greater difficulty in getting on and off location; more severe wind and wave conditions; and an exponential increase in size and costs with water depth for current designs.

Getting on location. The difficulty in

Fig. 2

Rigs operating, being built

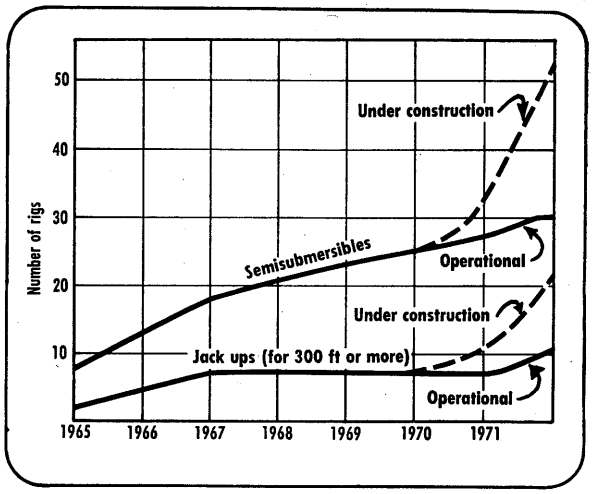
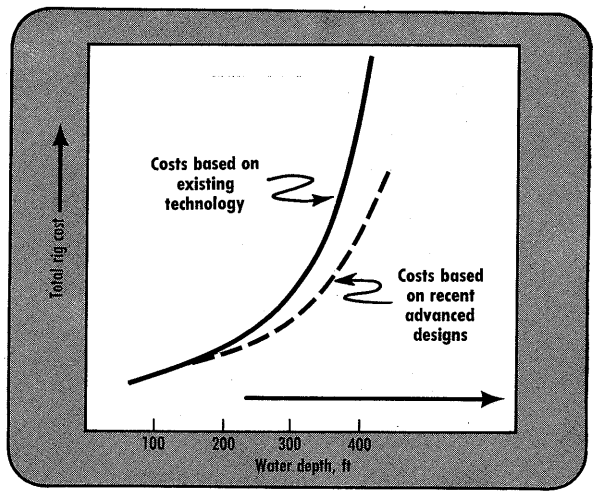


Fig. 3

Jack-up-cost trends



a jack up on and off location increases with increasing water depths and the consequent increase in leg length. This has already proved a serious problem in areas with unusual sea conditions, such as certain parts of offshore West Africa and Australia.

Motion of the hull causes the spud can to move at a velocity proportional to the leg length, thus the impact on the leg as it first hits bottom increases dramatically with longer legs.

This problem is compounded by the rough sea conditions that prevail in areas where such a large unit may be used. The unit may have to get on location with 15-ft swells running, or in higher, confused seas.

To get such a mammoth unit in position in relatively rough weather, new designs are needed. These advances, along with innovations in basic jack-up-rig design have been developed.

Wind, wave conditions. As operating water depths increase, the wind and wave storm criteria usually becomes more severe. Stresses caused by storm action tend to increase exponentially with wave height and wind velocity. Construction costs go up more than linearly with water depth, the effect being a sudden steepening of the cost curves at around 250-300 ft, Fig. 3.

One aspect of this, however, is that a rig designed for the severe storm criteria typical of 400 ft of water in the North Sea, would probably be good for 500 ft under less severe conditions such as those found in the Gulf of Mexico during nonhurricane seasons, or off the coast of West Africa.

To be useful—and safe—in the areas of the world where 400-ft jack-up rigs are needed, such a rig must be able to withstand at least 125-mph winds and 80-ft waves.

Preliminary design figures show that these wind and wave criteria can be met at competitive costs. Factors of safety should perhaps be less for a 100-year storm (1.1-1.2) than for a 10-year storm (1.5-1.7) and careful analysis, design, and construction is needed, because stresses increase so dramatically with increased wave height and wind velocity.

The cost just to resist storm loadings and support the drilling equipment at an offshore location is now so high that it is worthwhile to consider constructing a lighter unit and accepting a greater risk. At more severe storm conditions, a small increment in design criteria can bring a large increase in cost, Fig. 3.

Size, cost. A 400-ft water-depth jack up requires a deck about 530 ft above the mud line and legs about 580 ft long. This includes a 60-ft air gap to handle waves 80 ft from trough to crest, and provides 30 ft of penetration.

Such a unit has a maximum weight on location of around 34 million lb, suggesting a cost range of $17-$19 million.

This price can be attractive, however, considering the operating records of jack ups vs. semisubmersibles. A jack up offers more drilling days and fewer days waiting on weather. One authority[4] has set this productive time record at 86% drilling time for jack-up rigs, compared to 75% for semisubmersibles in the North Sea. These data were compiled over a period when 155 holes were drilled by both types of rigs.

None of these wells were drilled in water depths greater than 400 ft (up to Jan. 1, 1970).

Phillips Petroleum Co.'s experience over a 4-year period in Norwegian waters is comparable in the case of semisubmersibles.[5]

This suggests a performance ratio of 75:86 = 0.87:1.0. Using this ratio to factor costs reduces the $17-19 million cost range to $14.8 to $16.6 million for a comparable drilling performance per capital-investment dollar.

All of this assumes that these, or future, semisubmersibles would be operated at this efficiency in the even more extreme sea conditions found in 400-ft water depths in the North Sea.

It appears that a "fixed" drilling platform—a jack-up unit—would spend a larger portion of its time in these rough conditions making hole.

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