# How Jack-Ups Fit in North Sea Boom

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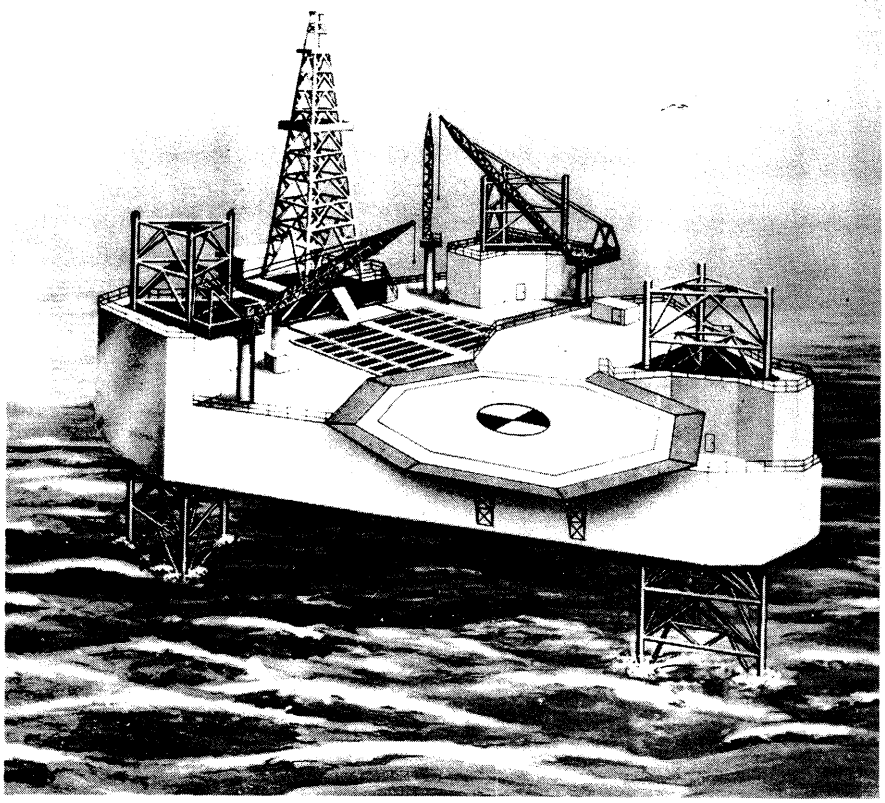

Fig. 1. The Europe Class jack-up in operation.

In the rush to get as many offshore mobile drilling units as possible into the booming North Sea activity, the long popular jack-up has been pushed into the background. Of the 135 offshore units now under construction for delivery through 1977, over half (72) are semisubmersibles. Forty-five of these are destined for North Sea use (Table 1). The semisubmersible's excellent performance and stability in the face of the severe North Sea criteria cannot be denied. However, the jack-up's capabilities, while they will not replace the semi, meet many of the requirements for North Sea operation so well that renewed interest in this unit is growing as new jack-ups are designed specifically for the North Sea.

Engineering Technology Analysts, Inc.'s (ETA) Europe Class Jack-up (Fig. 1) was designed specifically for use in the severe criteria of the North Sea in up to 350-ft water depths.

## Depth Limitations

Part of the reason for the semisubmersible's stronghold on the North Sea activity is the vast amount of area in water depths between 300 and 1500 ft, too deep for many existing jack-ups (Table 2). This area is four and one-half times greater than that for comparable water depths in the Gulf of Mexico. However, North Sea offshore acreage extending from 0 to 300-ft water depths, the normal range for jack-ups, is 33% greater than that for the Gulf of Mexico, comprising 47% of the total offshore North Sea area. Although semisubmersibles are designed for 600+ ft water depths, 15 of the 29 semis in the North Sea are operating in the 200 to 300-ft range, in many locations where jack-ups would be suitable.

**TABLE 1. International Offshore Rig Fleet**

| | North Sea | | | | Worldwide | | | |
|---|---|---|---|---|---|---|---|---|
| Year | Jack-ups | Semi-submersibles | Floaters | Total | Jack-ups | Semi-submersibles | Floaters | Total |
| 1960 | 0 | 0 | 0 | 0 | 31 | 2 | 8 | 41 |
| 1965 | 9 | 0 | 1 | 10 | 56 | 8 | 23 | 87 |
| 1970 | 8 | 5 | 8 | 21 | 89 | 24 | 42 | 155 |
| 1974* | 12 | 36 | 3 | 51 | 130 | 68 | 43 | 241 |
| 1975* | 15 | 57 | 5 | 77 | 150 | 100 | 48 | 298 |
| 1976* | 18 | 71 | 8 | 97 | 164 | 123 | 48 | 335 |

*Projections assume ⅔ of speculative semisubmersibles will operate in North Sea.

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**TABLE 2. North Sea, Gulf of Mexico Bathymetry Comparison**

| | Area in square miles | | |
|---|---|---|---|
| | 0-300 ft | 300-1,500 ft | 0-1,500 ft |
| Offshore Louisiana | 28,000 | 8000 | 36,000 |
| Offshore Texas | 22,000 | 5000 | 27,000 |
| Gulf of Mexico (total) | 182,000 | 60,000 | 242,000 |
| United Kingdom | 77,000 | 91,000 | 168,000 |
| Norway | 15,000 | 61,000 | 76,000 |
| North Sea (total) | 243,000 | 271,000 | 514,000 |

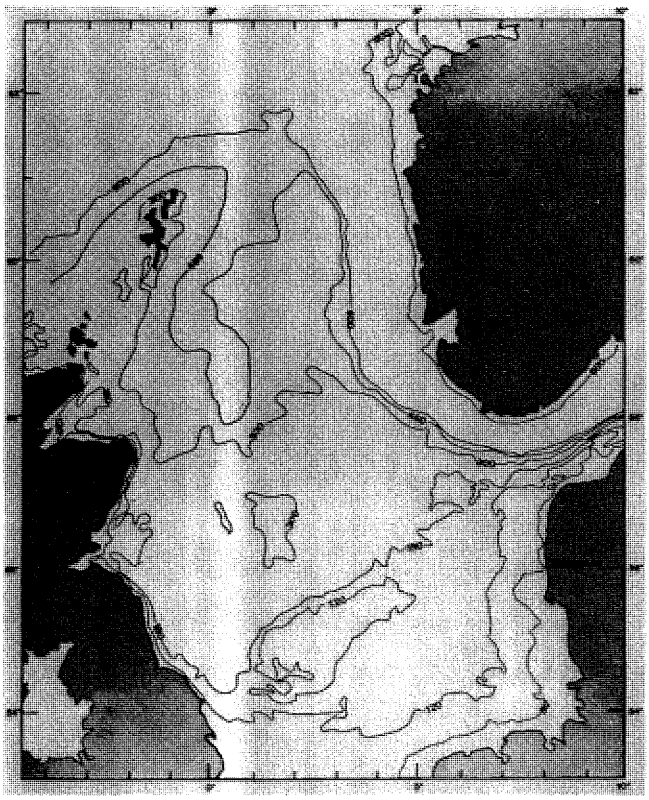

Fig. 2. Bathymetry of the North Sea (depths in ft).

## Weather Restrictions and Stability

Most critical periods for a jack-up occur when the unit is under tow and when it is going on and off location. The stability of the unit at these times is extremely sensitive to weather conditions. Customarily during long tows, the top of the legs are partially removed to ensure hull stability. If the leg is cut off, it must be rewelded when the unit has completed its tow. If mechanical disconnects are used for leg removal, there is the danger that the mechanical device, installed in one of the most highly stressed areas of the leg, will become faulty through long periods of submersion.

During short tows, often the legs are fully raised rather than cut off. This procedure requires favorable weather so that wind and wave forces will not upset the hull stability, which is now top-heavy. If the weather should become extreme during a short tow, there are two alternatives. The legs may be lowered to jack the hull up out of the water, providing of course that the water depth does not exceed the allowable leg length. In this case, the tow comes completely to a halt. Or, the unit may proceed with the legs partially lowered. This ensures excellent hull stability, but greatly increases towing time and costs.

Favorable weather is again a requirement when the jack-up is moving on and off location. The safety of the jack-up during the transition from tow to location generally becomes jeopardized when in wave heights over six ft.

The influence of weather on the structural integrity of the semisubmersible is not the determining factor for the unit while it is in tow and going on and off location. In the transit mode, the limiting criteria is the ability of a unit of such extreme weight and mass to make headway in severe winds and waves. When going on and off location, the semisubmersible is restricted only by the ability of support vessels (in particular workboats) to deploy the mooring system. Except under very extreme weather conditions, the semisubmersible's ability to relocate is not hindered.

When abandoning the wellsite, the semisubmersible can quickly be underway after the mooring system has been released. The jack-up must wait for the legs to be raised to a suitable towing position, which may entail a departure delay of several hours.

While in the drilling mode, the jack-up is inherently a much safer rig than the semisubmersible, since it is

**TABLE 3. Average Construction Costs (Millions U.S. Dollars)**

| Year Delivered | Jack-ups | Semisubmersibles |
|---|---|---|
| 1961 | $ 3.3 | $ 6.67 |
| 1966 | $ 5.15 | $ 7.57 |
| 1971 | $ 7.9 | $11. |
| 1976 | $16.75 | $30.76 |

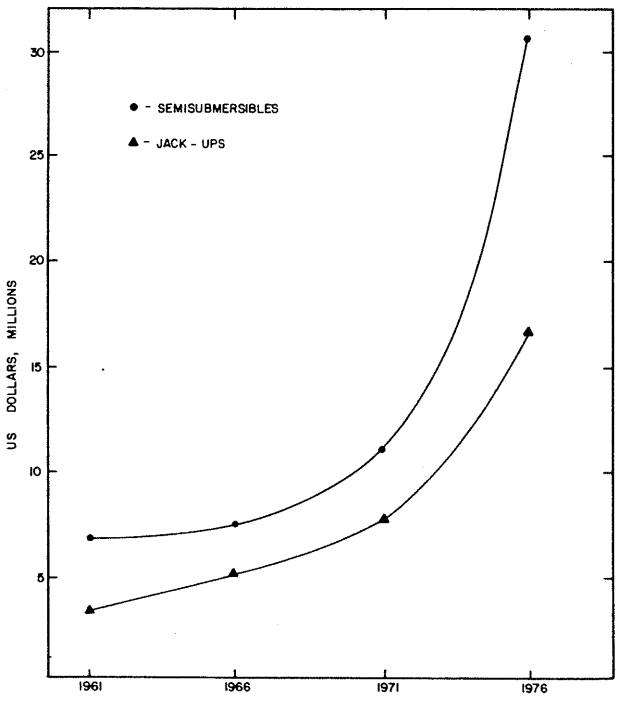


Fig. 3. Chronological rig cost comparison.

the closest offshore equivalent to land drilling. The jack-up's platform stability at this time is especially significant when considering the procedures for well testing. Another safety factor is that the blowout preventor is located on the platform for jack-ups (as opposed to beneath the surface for semisubmersibles) and is easily accessible for surveillance and repair.

## Rig Costs

Initial investment costs of offshore mobile drilling units are rapidly increasing due to the rising cost of

**TABLE 4. Effective Time Breakdown**

| Activity | % Time Jack-ups | % Time Semisubmersibles |
|---|---|---|
| Drilling, tripping | 50% | 45% |
| Running casing | 6% | 5% |
| Conditioning hole | 12% | 10% |
| Logging, coring | 12% | 10% |
| Abandoning well | 6% | 5% |
| Surface BOP handling | 1% | — |
| Subsurface BOP handling | — | 5% |
| Platform Elevation, Lowering (No weather downtime) | 1% | — |
| Anchor Handling (No weather downtime) | — | 5% |
| Weather Downtime | 6% | 10% |
| Towing | 6% | 5% |
| Total time | 100% | 100% |
| Effective time | 86% | 75% |

*Source: Starink, A., West, F. G., "Various Types of Exploration Drilling Rigs for Non-Shallow Water Depths (50 ft. - 600 ft.)" R.I.N.A. Symposium on Offshore Drilling Rigs, 1970, London.*

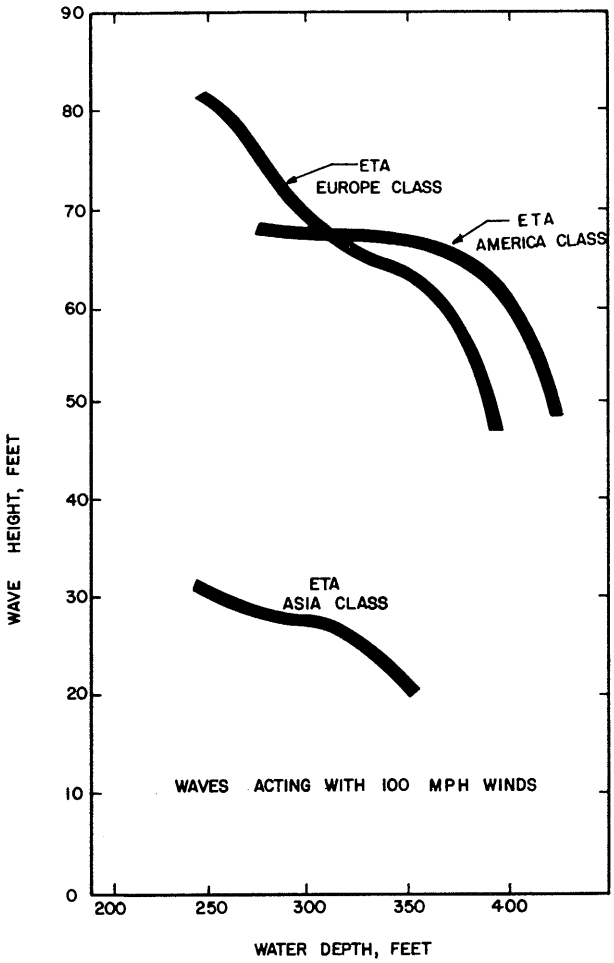


Fig. 4. Maximum allowable wave height.

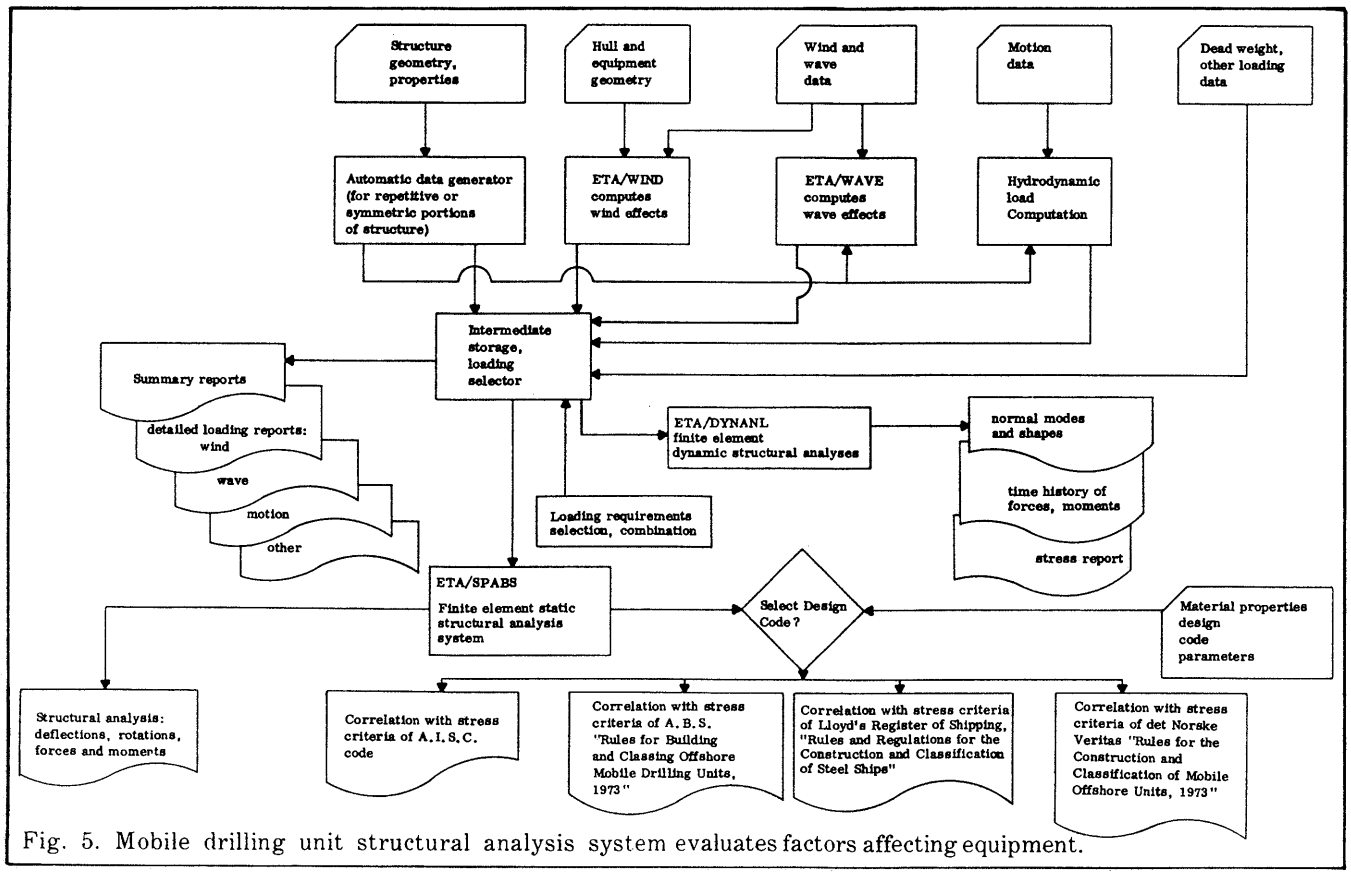


Fig. 5. Mobile drilling unit structural analysis system evaluates factors affecting equipment.

materials and labor. Inflation is now worldwide, and today's larger and heavier units in particular require more and higher priced steel.

Fig. 3 and Table 3 compare the initial costs for jack-up and semisubmersible rigs. Both rig types show an established trend toward escalation in cost, especially in the past five years, with initial costs today approximately five times those in 1961. This is particularly important in planning future investments, as the day rates and operating costs are directly dependent on the initial investment cost. In past years, the day rate was calculated to be approximately 0.10% of the original investment. Recently, however, that figure has changed to about 0.12%. The operator's costs on a daily basis are approximately double the day rate. It would not be unreasonable to expect total drilling costs of $50,000 to $60,000 per day or more for a North Sea drilling operation with a new, large semisubmersible in 400 ft of water.

## Rig Efficiency

In addition to capital investment costs, rig efficiency plays an important role in offshore economics. Table 4 compares the effective time breakdown for both jack-ups and semisubmersibles: actual drilling time for jack-ups is quoted to represent 50% of the total time, compared to 45% for semisubmersibles. This effective time means that the jack-up will make 11% more hole per year than the semisubmersible. Other authorities maintain that the jack-up has a higher advantage.

Another check on rig efficiency is the number of wells per year that a unit drills. A review of the movements of five jack-ups and five semisubmersibles operating in the North Sea during the past two years shows that the jack-ups, with 134 total rig-months service, drilled 47 wells at a rate of one well every 2.96 months, or 4.1 wells per year. The semisubmersibles, with 122 total rig-months service, drilled 37 wells at a rate of one well every 3.31 months, or 3.6 wells per year. This translates into 14% more hole per year for jack-ups.

## Overcoming the Limitations

A new generation of offshore mobile drilling units for worldwide use in water depths up to 430 ft has been designed to offset some of its historic limitations. These are designed to meet the latest requirements of the

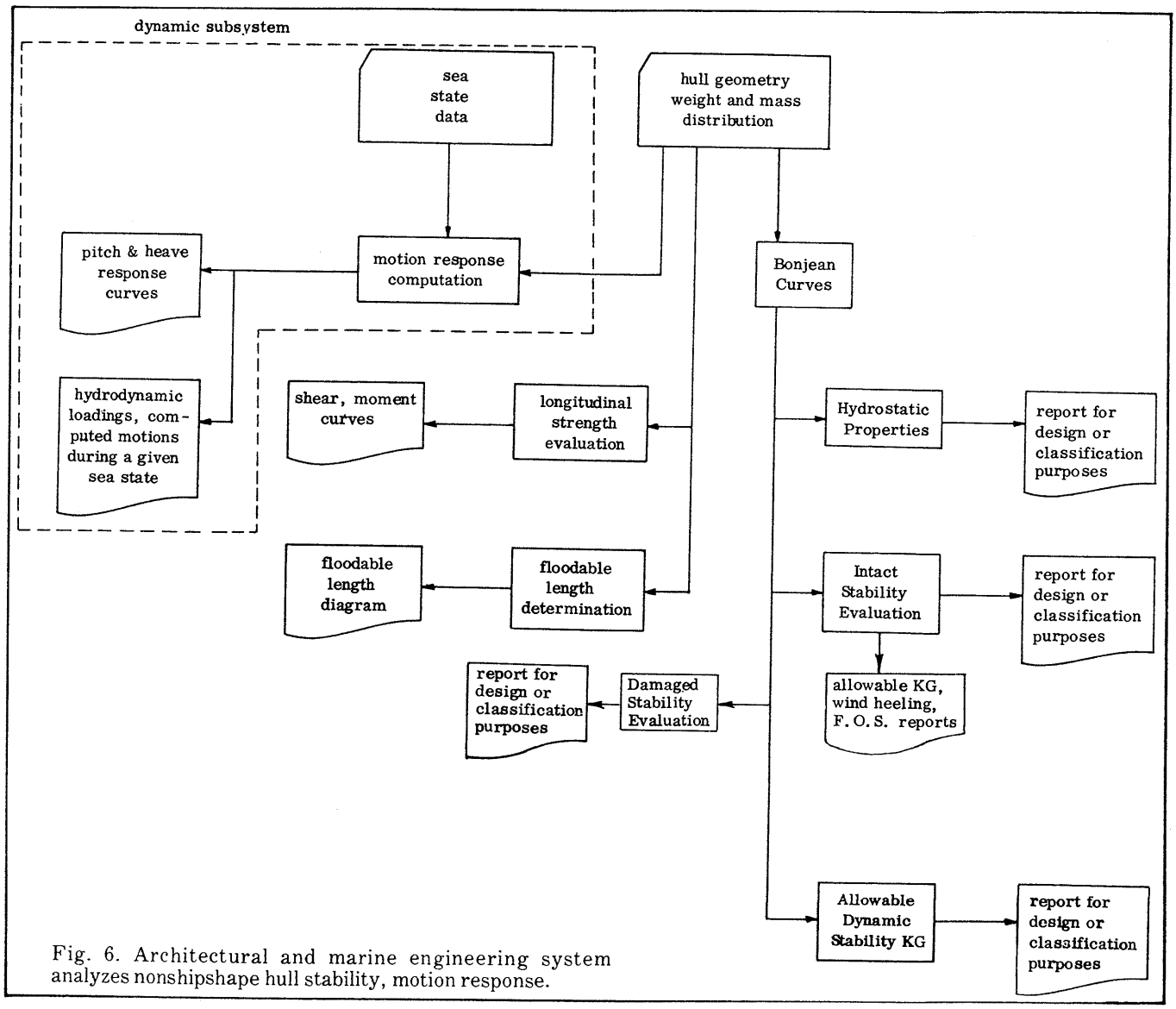


Fig. 6. Architectural and marine engineering system analyzes nonshipshape hull stability, motion response.

American Bureau of Shipping. Fig. 4 shows the performance criteria for the standard ETA jack-ups, the Europe, Asia and America Class units.

Probably the most unique aspect of the new design is the use of specialized, computer-based analytical techniques. Mobile drilling unit structural analysis system (ETA/MDUSAS) evaluates the behavior of wind, operational, wave, and hydrodynamic effects on offshore structures and then checks the structure directly against the design criteria of A.B.S., Lloyd's Register of Shipping, det Norske Veritas, or A.I.S.C. (Fig. 5). ETA Naval Architecture and Marine Engineering (ETA/NAME) program analyzes the stability and motion response of unusual, nonshipshape hulls (Fig. 6). Very close comparisons with model tests and full-scale performance results have been obtained.

The Europe Class unit can resist 75-ft waves and 125-mph winds, and has a wave period up to 14 sec. Particularly important for North Sea operations, the rig can get on and off location in 10- to 15-ft seas. Optimum design of the hull by the use of comprehensive finite element routines provides the unit with a high factor of safety against overturning (Fig. 7). Det Norske Veritas has given this jack-up design approval for Class ✠1A1 Self-elevating Platform.

Another, more innovative design for North Sea use is the mobile monopod, a gravity-based, multiservice jack-up for exploration, drilling and production in 450 ft of water (Fig. 8). A single center jack-up leg connects the upper hull (with quarters and drilling equipment) and lower hull (with a capacity for crude oil storage of 220,000 bbl). The upper hull acts as an erection platform during leg construction and has sufficient buoyancy to support the entire flooded weight of the lower hull as an added safeguard against uncontrolled flooding. The monopod is designed to accommodate almost any given North Sea soil condition and has a large consumables capacity of 8500 kips.

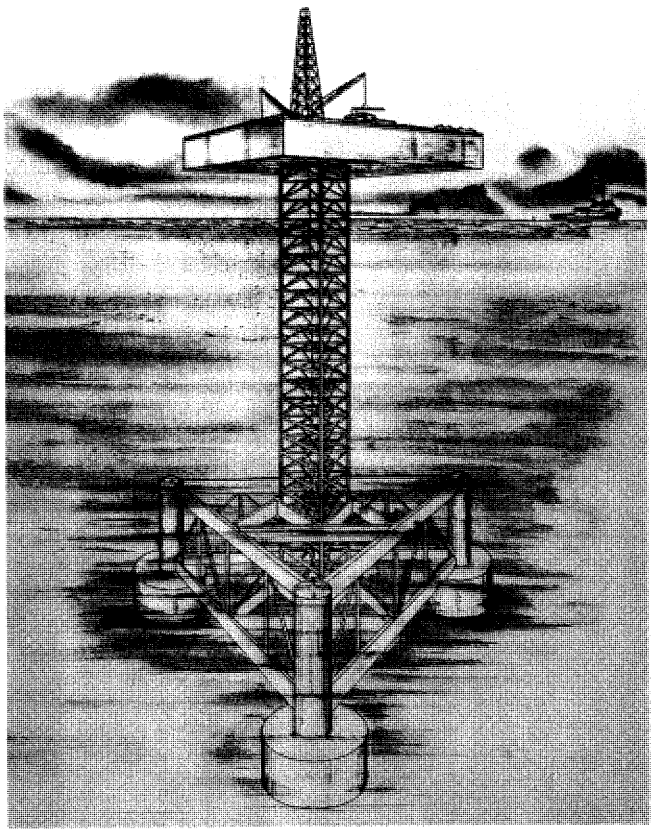

Fig. 8. The Mobile Monopod in operation.

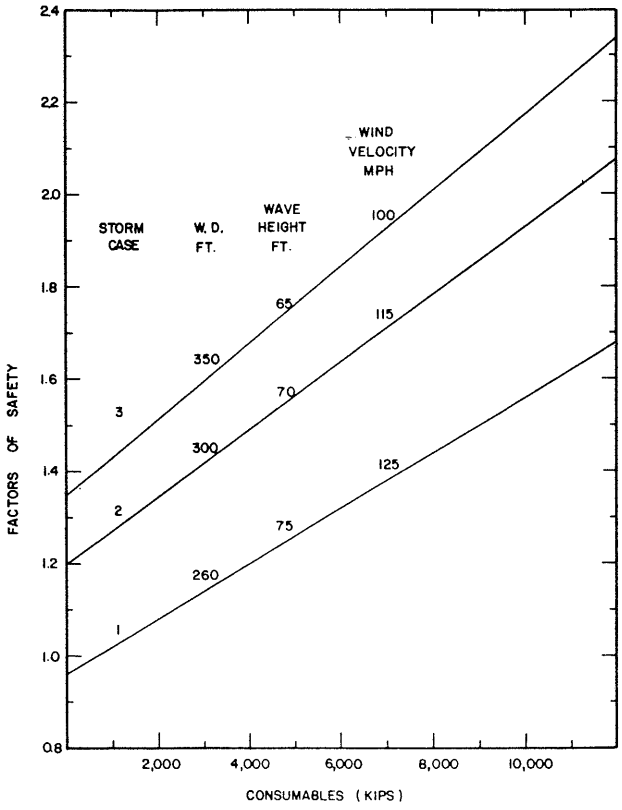


Fig. 7. Europe Class overturning safety factors.

The development of jack-ups for the North Sea is paralleled by the design of units for areas with less severe criteria. The Asia Class unit is designed for exploratory and developmental drilling to 25,000 ft in 250 to 300-ft water depths. It is suited for operation in relatively moderate environments such as Southeast Asia, offshore Brazil, West Africa, and the Middle East, and has a consumables capacity of 6700 kips. The America Class is a large unit which drills to 30,000 ft in up to 380-ft water depths in the U. S. Gulf Coast hurricane season criteria and to 430-ft water depths in nonhurricane season. This unit has an unusually large consumables capacity of 11,100 kips.

Innovations in the design of jack-ups, increasing leg length while maintaining a high consumables capacity, extend the jack-up's potential range of operation. Self-elevating units designed specifically for the North Sea may prove to be the most effective and efficient drilling mode for part of that area now being drilled by semisubmersibles and drillships. Most particularly important to the rig owner, they require the lowest investment cost. ■

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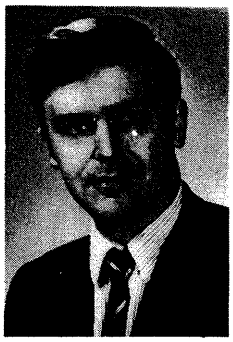

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