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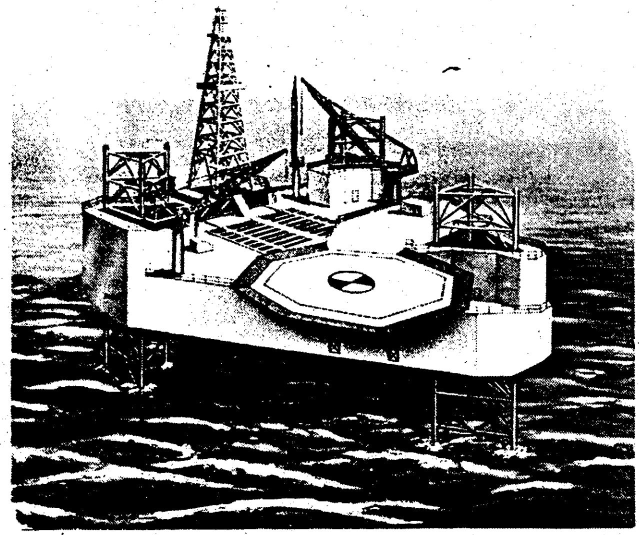


ETA Europe Class jackup in operation.

New, innovative designs for jackups for the North Sea oil patch

The increasing performance demands made on offshore drilling units and the higher costs of construction and installation are causing many of the design concepts used in the past to be questioned since merely "scaling up" past designs creates uneconomic solutions. The "scaling up" approach is probably one reason the development of North Sea jackups has been hindered in the past.

The high costs of construction of semisubmersibles today, coupled with the large amount of drilling now required in water depths of up to 400 or 450 ft in the North Sea, have led many owners to reconsider the use of jackups in the extreme conditions of the North Sea.

Starting with a "clean slate," using current techniques and materials together with extensive use of computer techniques, a new series of North Sea jackup designs has been developed over the last three years to meet these needs.

Drilling unit designs

This new generation of drilling units has been designed by Engineering Technology Analysts, Inc. (ETA), a Houston-based engineering design and consulting firm. This development effort started back in July 1971, based on a feeling that the emphasis then being placed on semisubmersibles was perhaps extreme and the realization that existing designs had just about reached the limit of their performance. The many man-years of work and large investments in these new jackup designs are finally coming to fruition.

More than eleven ETA-designed jackup units are now either under construction or are in the construction contract negotiation stages. Three of the jackups are under construction in Singapore for operation in 300 ft water depths with a drilling depth capability of 25,000 ft. The units are scheduled to be delivered in 1974, in April 1975, and in the third quarter of 1975. Two more ETA-designed jackups are scheduled for construction in Singapore in 1975 and in 1976 for operation in Southeast Asia. Several ETA Europe Class jackups are currently scheduled for construction in Europe pending final confirmation of shipyard space, delivery, and final price. These units are to be delivered during 1976.

The ETA North Sea jackup designs include ETA Europe Class jackup, the Deepwater jackup, and the Mobile Monopod (see drawings). They represent an intriguing design approach backed by considerable experience in dealing with all types of offshore units. Many of ETA's exclusive design techniques are used on the units, including several design innovations for which patent applications have been made. These new jackup units are designed specifically for operation in the severe environment of the North Sea (75 ft waves, 125 mph winds).

Designs for severe conditions

The ETA Europe Class jackup is designed for operation in severe North Sea criteria in up to 350 ft water depths. The unit can resist 125 mph winds and 75 ft waves-and has a maximum drilling depth of 30,000 ft. Even with the heavy duty 395 ft long legs, the unit is designed to have sufficient stability and leg strength to make ocean tows without leg removal.

The Europe Class jackup features an unusually large consumables capacity of 9,500,000 lbs. This increased capacity allows the operator flexibility in drilling operations as well as additional storage room for operation in severe North Sea criteria, or later for production purposes.

ETA deepwater jackup

The ETA deepwater jackup is a slant leg configuration of a three-legged jackup drilling rig designed to handle the more severe requirements of the Northern North Sea.

Design studies investigated units for two sets of storm criteria. For the more severe of the two, it can withstand 100 ft, 14 to 18 sec. period waves and 125 mph winds in up to

450 ft water depths. A fourth leg can be added to the unit for conversion to a production platform.

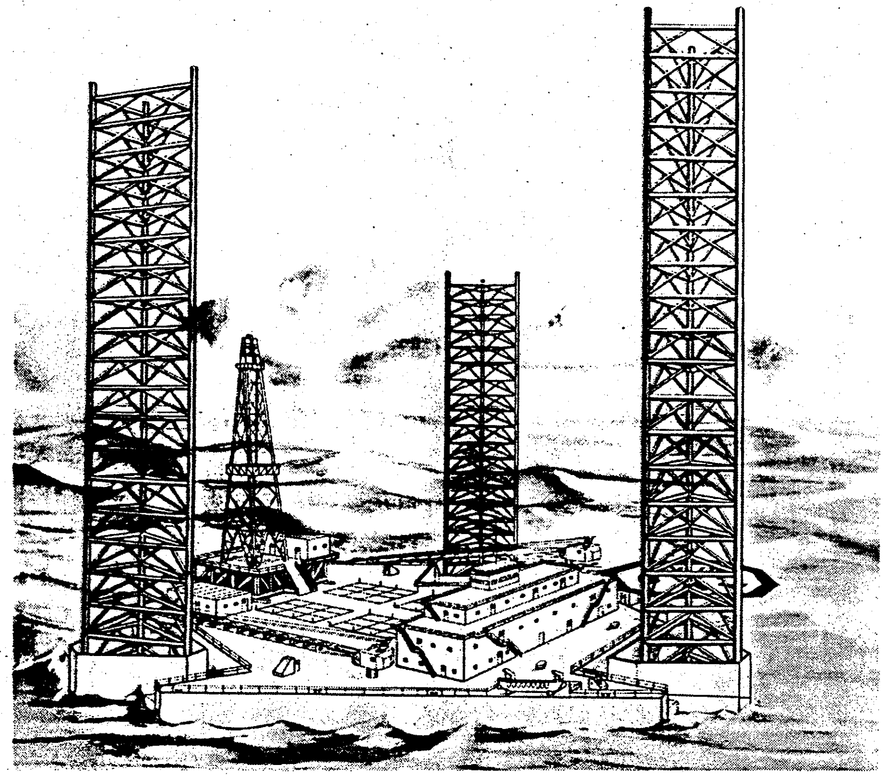
The design of the deepwater jackup provides for an 8,500,000 lb consumables capacity for North Sea operation. In the design study for less severe criteria, the unit was investigated for 400 ft water depths, with an 80 ft wave/125 mph wind combination.

The deepwater jackup is reinforced in critical locations to allow for severe environmental loadings. It features larger chord centers and heavier structural members. Several design innovations are incorporated into the unit to solve the problems of handling long lengths of leg and reducing the increases in size and weight occurring when scaling up existing designs for more severe criteria. Extensive computer analytical techniques were also used in the design of the unit to determine motion response, structural adequacy, and floating stability.

The legs of the deepwater jackup are specifically designed to endure severe storm conditions. The deepwater jackup features a slant leg configuration during drilling operations. Since the leg centers are reduced with this design, the hull weight is thus decreased. This design technique eliminates overturning problems created when parallel leg units operate in deeper waters. The jackhouses of the deepwater jackup are equipped with shock absorber systems to reduce impact stress while going on and off location.

ETA Mobile Monopod

A novel design for exploration, drilling, and production in the North Sea, the ETA Mobile Monopod is a multiservice jackup for operation in up to 450 ft of water. The monopod is a steel, gravity-base structure with a single jackup leg and two hulls. The single center leg acts as a template for 20 to 24 conductor pipes during drilling or production operations. The watertight upper hull of the monopod holds the quarters and drilling equipment and the lower hull can be used for oil storage. The design has capacity for crude oil storage of 200,000 bbl. This can easily be increased. The Mobile Monopod has an 8,500,000 lb. consumables capacity under the current design study. This capacity can be increased significantly with very minor modifications.



ETA deepwater jackup in tow.

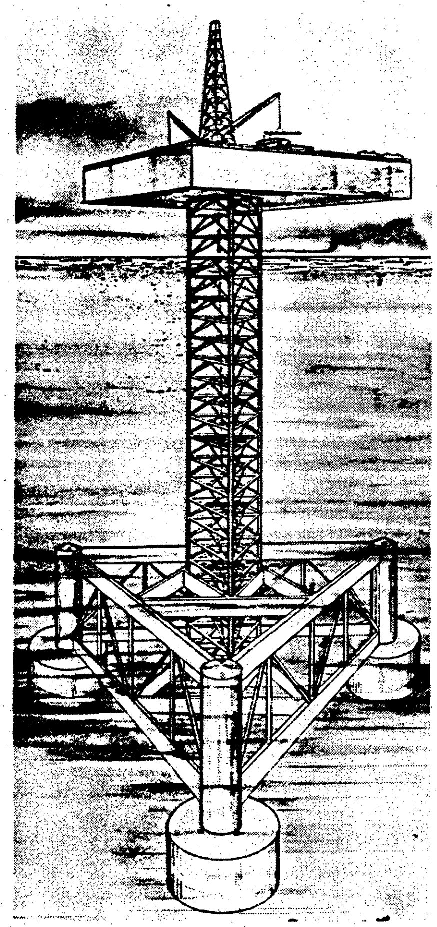
To install the monopod on location, the bottom hull is flooded and lowered to the ocean floor using the center leg's elevating system. The upper hull has sufficient buoyancy while floating to support the entire flooded weight of the descending hull and center leg, even if uncontrolled flooding should occur. This acts as an important safeguard against potential loss of the unit in the event that the flooding control system malfunctioned.

With the lower hull on the ocean floor, the upper hull is elevated clear of the water. It is then preloaded to drive the lower hull more securely into the ocean bottom. The upper hull is of a rectangular shape for ease in construction and efficient use of internal space. It also acts as an erection platform during construction of the center leg.

The design of the monopod can make allowances for installation in varying bottom soil conditions and can be altered to accommodate almost any given North Sea soil condition.

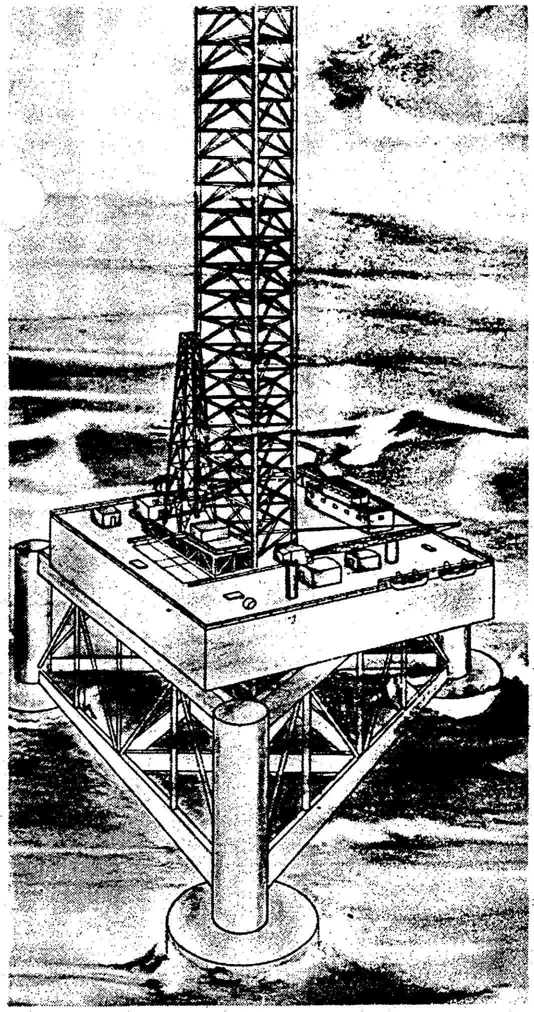
Flexibility in construction

As independent designs, the ETA jackups have the primary advantage of being able to be constructed in any qualified shipyard in the world. The complete designs of the ETA jackups can be made available to any shipyard. With this flexibility, the



ETA Mobile Monopod in operation.

owner can shop around for a shipyard with the best combination of delivery, cost and location. By selecting a shipyard which is close to the drilling



ETA mobile monopod in tow.

site, expensive and time consuming long tow charges are alleviated.

Possible uses

An operating advantage of the ETA North Sea jackups is their unusually large consumables capacities. These capacities provide for economy in supply functions and easier operation in remote areas and in the hostile environments of the North Sea.

With the choice of either using these unusually large consumables capacities, or using this load carrying capability for production equipment, the jackups can be thus used as production platforms with minor modifications to enable fast cash flow from immediate production.

For additional ease in construction when these rigs are used in lieu of fixed platforms, all production equipment can be installed on the jackups in the shipyard. For the North Sea area particularly, the time required for crane barges to install equipment on fixed platforms under severe conditions is extensive. Costly towing and onsite installation charges are thus greatly reduced with this procedure.

Design features

* Unprecedentedly large consumables capacities.
* New stronger leg design, easy to build.
* No leg removal for ocean tow.
* As independent designs can be built in any qualified shipyard.
* Can withstand severe North Sea storm criteria.
* Rack and pinion elevating system design can be manufactured by any qualified gear company.
* Low shipyard weights (hence cost) for a given set of performance criteria.

Equipment

Derrick
147'x30'x30'—1,300,000 lbs. Gross Nominal Capacity, 125 mph design wind load
Draw Works—2,000 hp 25,000 Foot Nominal Depth
Rotary—37½" opening 800 hp

Drilling Positions
The extreme position for rotary table is approximately 30' 9" from the slot bulkhead, 9 feet off centerline of unit. Hook load can be the maximum load of 1,300,000 lb. at all locations.

Elevating System
Rack and pinion system, 1.5 ft/min. hull elevating speed, 3 ft/min. for raising or lowering legs. Higher speeds possible at owner's option.

Deck Cranes
3—75-ton Diesel Powered Cranes with lights and weight indicators
1—30-ton Electric—for handling BOP

Power Systems
4 or 5 Diesel Engines skid mounted with 1,000 KW A.C. generators
D.C. Distribution by SCR Units
1—Auxiliary Generator Skid with a 250 KW A.C. generator
A.C. Distribution Panel
A.C. Motor Control Centers
D.C. Switchboard for seven (7) D.C. traction motors

Heliport
S-61 Capacity, removal panels, shown on starboard side, can be mounted elsewhere at owner's option.

Thrusters
2—2,500 hp units optional

Mud and Other Equipment
2—1,600 hp Triplex Mud Pumps
Shale Shaker
De Sander
De Silter
De Gasser
2—300 GPH Sea Water Distillation Units
2—Centrifugal Maximum Pumps
Cement Unit—2-300 hp Diesel Pumps
2—Air Compressors—600 CFM plus starting air
Well Logging Unit
Warehouse
Machine Shop
Electric Shop

Quarters
Living Quarters (air conditioned) for 80 men
Radio Communications Center
2—Offices
Radio Room
Control Room
2—Galleys (interconnecting)
2—Dining Rooms
Laundry
Hospital
Dry Stores

Safety and Emergency Equipment
Emergency Generator
Emergency Power Batteries
Emergency Fire Pumps
2—Brucker Survival Capsules—Shielded by Heliport
Life Rafts and Inflatable Rafts

Pollution Control Equipment
Sewage Disposal Unit
Crude Oil Burner (Optional)
Trash Compactor/handling unit (Optional)

To meet the unit's operational requirements, the types and arrangement of the equipment can also be easily modified at the shipyard. Similarly the choice of spud tanks can be made then to allow for expected bottom conditions.

The design of the units provides for a 2,000 hp drawworks and a 1,300,000 lb gross nominal capacity derrick to resist 125 mph winds. Safety and emergency equipment, pollution control devices, and large quarters capacities are among the typical equipment features for the jack-ups.

Consumables capacities
(Typical for Drilling Operations)

	Europe class	Deepwater Jackup	ETA Monopod
Drilling water, barrels	7,380	6,000	6,100
Potable water, barrels	1,290	900	850
Diesel fuel, barrels	4,870	4,500	4,500
Dirty oil, barrels	260	100	100
Liquid mud, barrels	2,800	2,800	2,800
Bulk mud (4-12 ft. diameter tanks), cu ft.	4,520	4,520	4,520
Bulk cement (4-12 ft. diameter tanks), cu. ft.	4,520	4,520	4,520
Deck pipe rack capacity, lbs.	1,000,000	900,000	900,000
Sack storage, sacks	6,000	6,000	6,000
Additional consumables capacity unassigned, lb.	1,460,000	403,000	388,000
Total consumables capacities, lbs.	9,500,000	8,500,000	8,500,000

Weight and fabrication

With current steel and construction costs, innovations in fabrication techniques (for easier construction) and structure (for less weight) are important.

In comparison with existing similar units and with shipyard cost data, the Europe class jackup, the deepwater jackup, and the Mobile Monopod are lighter in weight than comparable units with the same performance criteria.

The jackup designs use conventional materials and fabrication techniques, and although some design innovations have been incorporated, shipyard data to date indicate fast, economical construction of the units. The ETA North Sea jackups feature lighter but stronger hull structures through the use of efficient structural framing. Very extensive structural and naval architectural calculations using computer analytical techniques are applied in the design of the units. These analyses ensure the structural integrity, stability, and dynamic behavior for operation under severe North Sea conditions.

A significant part of the weight and fabrication advantages, and thus cost reductions, is the design of the triangular space frame legs. The leg configuration allows for maximum structural efficiency and simplicity. The tubular chord design of the legs aids in reducing wind and wave loads and the wave forces on the legs in severe storms. A new connection design for the structural members of the leg reduces the possibility of failures at connections or fatigue damage to the units. As a final safeguard against structural problems, the legs are designed to allow for a maximum amount of automatic, high quality welding.

The Europe class and deepwater jackup designs also allow for easy on and off location movement in unusually severe conditions since they are primarily exploration tools. The units are expected to get on and off location in up to 10 to 15 ft seas, compared to the usual 5 to 7 ft limit. This advantage permits the contractor to reduce his "waiting on weather" loss of drilling time. By comparison, the need for ease in getting on and off location easily with the Mobile Monopod, while important, is not as critical since it may only be installed on location in a relatively few locations (perhaps no more than one).

Independent design

A rack and pinion elevating system of independent design is used on the ETA designed jackups for ease in manufacture worldwide. With the U.S. production of critical elevating systems being tied up for almost the next two years, the use of an independent design allows for faster delivery and flexibility in selecting a vendor. The units have an elevating speed of 1.5 ft/min. A high speed option of 3 ft/min. is also offered for lowering or raising legs while not under load.

Computer-based design checks

For units such as these, structural stability is of prime importance. A critical ingredient in the success of the ETA jack-up units is the extensive use of computer analytical techniques and naval architectural calculations to ensure the soundness of the designs.

ETA uses computer techniques developed specifically for offshore drilling and production platforms in the design of all their units. Naval architectural calculations are used to thoroughly investigate the intact, damaged and dynamic stability of the units and responses to heave, pitch and roll.

Computer techniques are used to establish the effects of loadings on the units and next to perform the structural analyses. The results are then used to check the design structures against the latest criteria of the regulatory and certifying organizations.

With the increasing costs of construction and use of offshore units, many design concepts have been investigated and revised to allow offshore drilling units to operate effectively in the deeper waters and severe environment of the North Sea. The new designs of the ETA jack-ups are a result of this endeavor. They reflect many needed innovations in design techniques for North Sea drilling operations. □