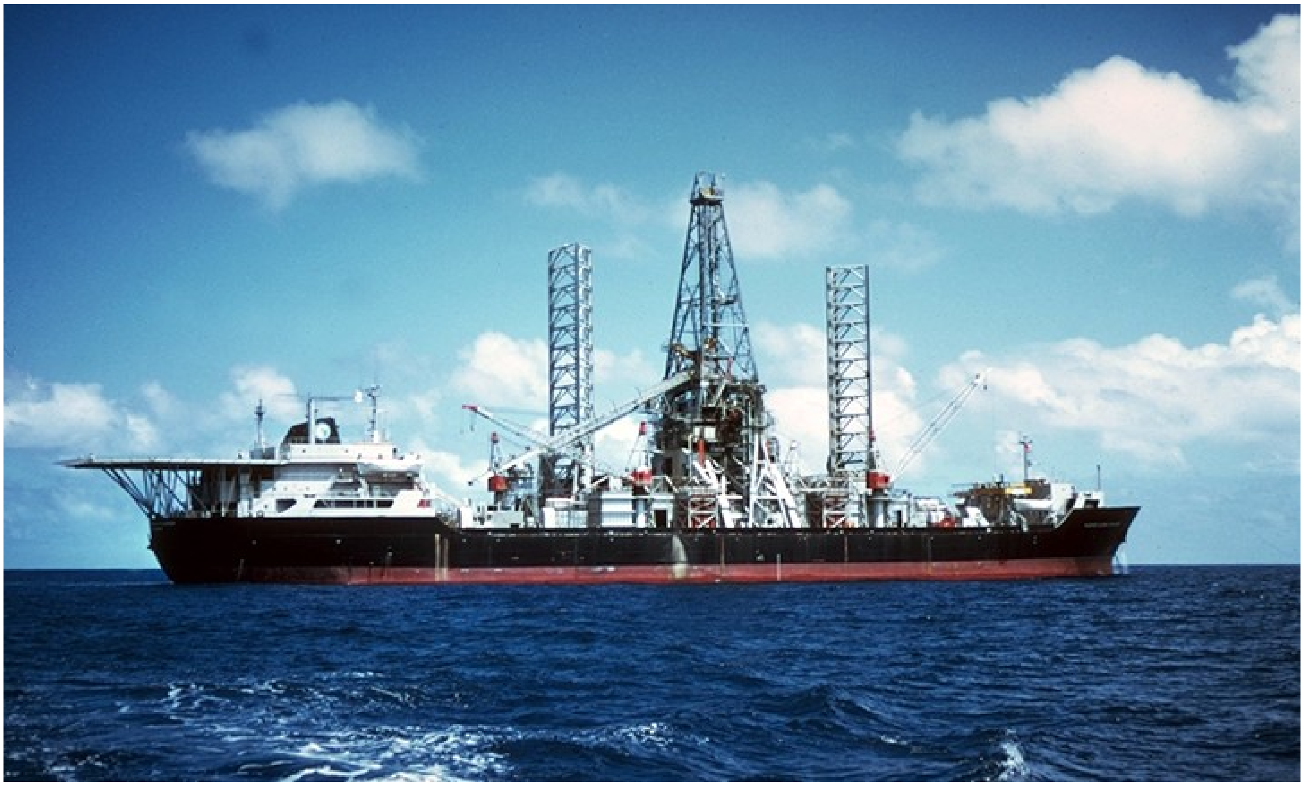
HUGHES GLOMAR EXPLORER

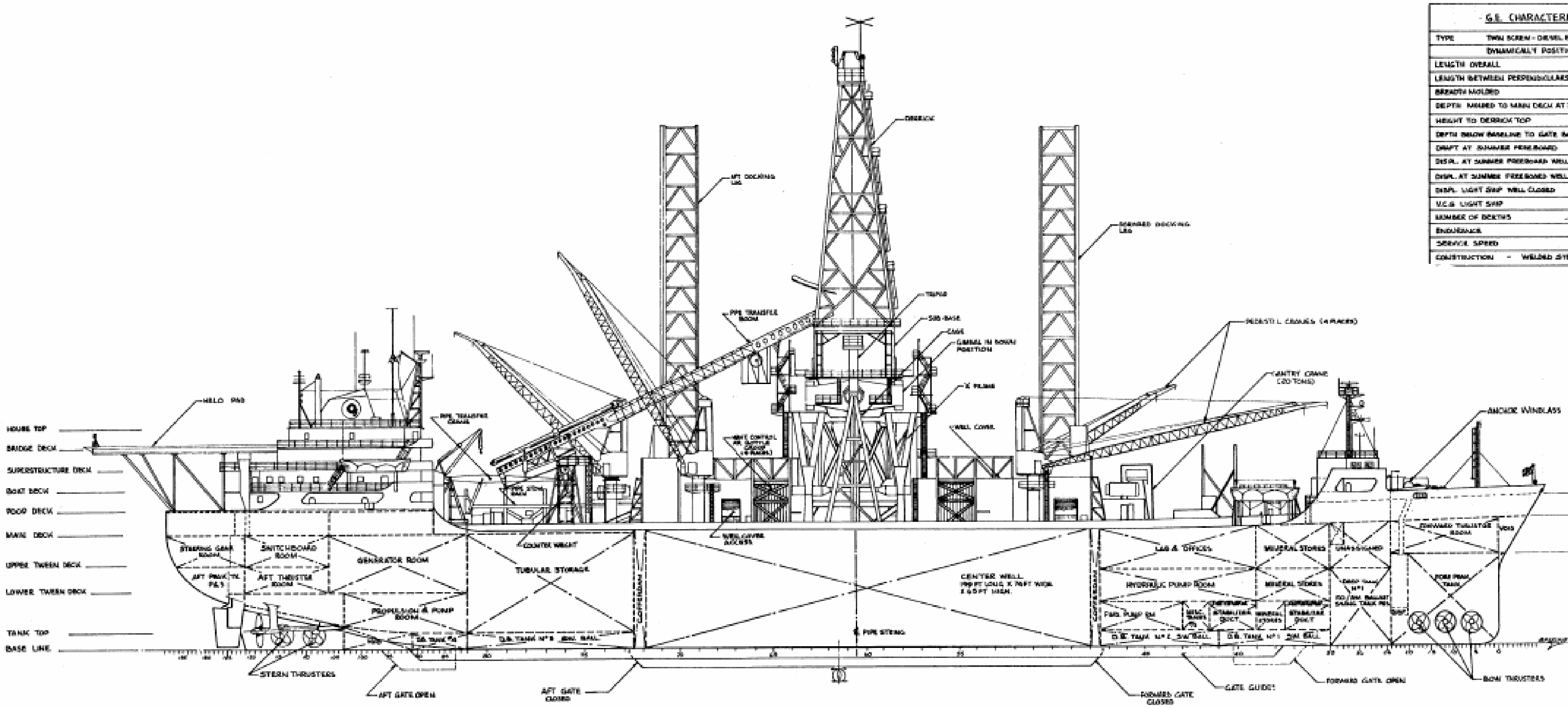


An ASME Historic Mechanical Engineering Landmark
Houston, Texas
July 20, 2006

GLOBALSANTAFE

ASME
SETTING THE STANDARD

G.E. CHARACTERISTICS	
TYPE	TWIN SCREW - DIESEL ELECTRIC
	DYNAMICALLY POSITIONED
LENGTH OVERALL	618'-8"
LENGTH BETWEEN PERPENDICULARS	569'-7"
BREADTH MOLDED	115'-8½"
DEPTH MOLDED TO MAIN DECK AT SIDE	50'-10"
HEIGHT TO DERRICK TOP	263'-0"
DEPTH BELOW BASELINE TO GATE BOTTOM	8'-10"
DRAFT AT SUMMER FREEBOARD	46'-8"
DISPL. AT SUMMER FREEBOARD WELL CLOSED	63,000 L.T.
DISPL. AT SUMMER FREEBOARD WELL OPEN	43,000 L.T.
DISPL. LIGHT SHIP WELL CLOSED	21,000 L.T.
V.C.G. LIGHT SHIP	44.50 FT.
NUMBER OF BERTHS	178
ENDURANCE	100 DAYS
SERVICE SPEED	10.0 KNOTS
CONSTRUCTION - WELDED STEEL A.B.S.	



PROFILE
(BELOW DECK SPACES SHOWN AT MIDSECTION)

Introduction

The success of the *Hughes Glomar Explorer* proves that the impossible is, indeed, possible when talented engineers with the courage to take prudent risks are provided an incentive to stretch the state-of-the-art. The objective of the *Hughes Glomar Explorer* mission, retrieve a 2,000-ton (1,814-tonne) asymmetrical object from a water depth of 17,000 feet (5,182 meters), required a design incorporating unique solutions which were well beyond the state-of-the-art in numerous engineering and scientific disciplines, particularly mechanical engineering. For this reason the *Hughes Glomar Explorer*, as a complete deep-sea recovery system, has been designated an ASME Historic Mechanical Engineering Landmark.

Grasping and raising a 2,000-ton (1,814-tonne) object in 17,000-feet (5,182-meters) of water in the central Pacific Ocean was a truly historic challenge requiring a recovery system of unprecedented size and scope. Major innovations and advances in mechanical engineering specifically required in the design of the Hughes Glomar Explorer include:

1. A large center well opening in the hull and a means of sealing it off so that the objective could be examined in dry conditions
2. A hydraulic lift system capable of hoisting a large, heavy load
3. A tapered heavy lift pipe string, including tool joints, designed, constructed and proof tested to exceptionally demanding standards
4. A “claw” with mechanically articulated fingers which used surface supplied sea water as a hydraulic fluid
5. A motion compensated and gimbaled work platform system that effectively isolated the suspended load from the roll, pitch and heave motions of the ship
6. A “docking leg” system which supported the weight and controlled the motion of the “claw” and load during the transition from dynamic open water conditions to the shelter of the ship’s center well

Much of the specialized equipment employed on the *Hughes Glomar Explorer* was conceptually derived from standard drilling industry practice. The innovative, pragmatic application and adaptation of these concepts to meet the mission’s specific needs, however, is a testament to sound, creative mechanical engineering practice. The engineering design and manufacturing capabilities resulting from this project are used today by the deepwater offshore petroleum industry, particularly the use of electrical power to control sub-sea equipment.

The *Hughes Glomar Explorer* and all of its subsystems, except the “claw”, were mothballed at the U.S. Navy fleet reserve center at Suisin Bay, California in 1975. The “claw’ was returned to Lockheed Ocean Systems in Redwood City, California and its disposition is unknown, but reportedly it has been scrapped. In 1979 the ship was re-activated, and, ironically, contracted to recover manganese nodules in anticipation of a commercial ocean mining venture. When the venture didn’t materialize the ship was re-mothballed in 1980. In 1996 GlobalSantaFe Corporation, a major U.S. drilling contractor leased the *Hughes Glomar Explorer* and converted it into a deep water drillship, re-named it the *GSF Explorer*, and currently operates it worldwide. Unfortunately, the conversion resulted in the removal and disposal of the unique equipment designed specifically for the deep water recovery mission.

The Mission: The Jennifer Project

In April 1968 the Soviet Golf-II class submarine K-129 sank in the Pacific Ocean near Hawaii. After an exhaustive but unsuccessful months-long search by Soviet vessels, it was clear that only the U.S. knew its whereabouts. The U.S. government contacted Global Marine Inc. in early 1970 regarding the feasibility of salvaging the vessel. In August 1970 a subsidiary of Global Marine Inc. submitted a proposal for construction and management of a recovery system and was subsequently designated the prime contractor, system integrator, and operations manager for the entire program. Sun Shipbuilding and Drydock Co. was selected in April 1971 to construct the *Hughes Glomar Explorer* portion of the recovery system. Major contracts were also awarded to Lockheed Ocean Systems Division for development and construction of the “claw” and to Hughes Tool Co. for development and fabrication of the heavy lift pipe. The hull of the partially outfitted *Hughes Glomar Explorer* was launched in November 1972. The ship was completed in July 1973 (at a cost of over $200 million) then mobilized via Cape Horn to the U.S. West coast, arriving in September 1973. After loading the 17,000-feet (5,182-meters) of heavy lift pipe and mating the “claw”, integrated sea trials were conducted off the California coast. In May 1974 the *Hughes Glomar Explorer* was declared ready for the mission and departed for location. The salvage mission commenced in July 1974 and was completed just five weeks later.

The Cover Story: The Deep Ocean Mining Project

Oceanographers have long known that areas of the Pacific sea floor at depths from 14,000 to 17,000 feet (4,267 to 5,182 meters) are carpeted with manganese nodules. Taking advantage of this phenomenon, the U.S. government approached Howard Hughes' Summa Corporation about using its Deep Ocean Mining Project's search for nodules as the reason for building the *Hughes Glomar Explorer*. The mission and the cover story remain shrouded in mystery to this day due to their national security implications. There is, however, no secret surrounding what is described herein regarding the specifications of the vessel and the great engineering challenges and unique solutions that are contained in her design and construction.

The Ship: The Hughes Glomar Explorer

The *Hughes Glomar Explorer* was designed and built as a self-contained, integrated mechanical system consisting of three major elements: the vessel *Hughes Glomar Explorer*, the heavy-lift pipe string, and the sub-sea grapple or "claw". The specific engineering works considered most unique and representative of advances in mechanical engineering design are as follows:

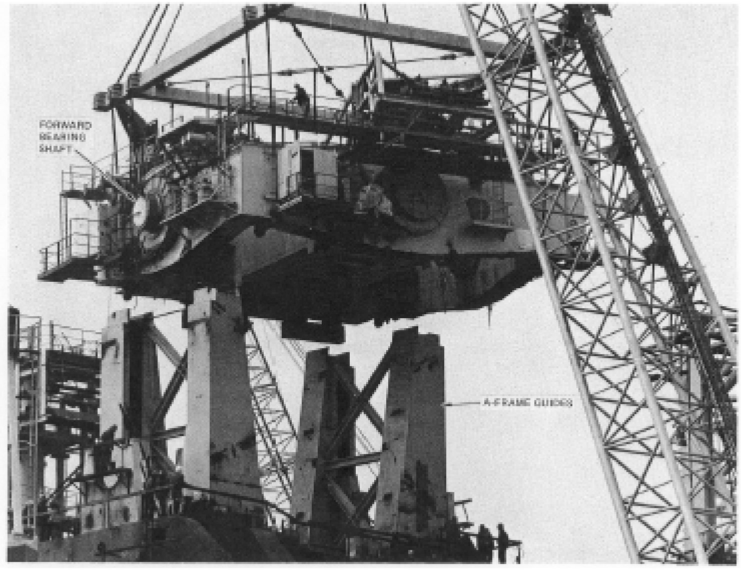
1. Gimbaled platform which isolates the suspended load from the ship's dynamic pitch and roll. A gimbal is a pivoted ring, mounted at right angles to one or two other rings, to ensure that something, such as a ship's compass, always remains horizontal.
2. Hydraulic/pneumatic heave compensation system which prevents the ship's heave motion from dynamically exciting the suspended load
3. Hydraulic heavy-lift system to raise and lower the underwater machinery via the pipe string and attachments
4. Heavy-lift pipe string
5. Shipboard heavy-lift pipe handling system
6. Vessel center well and sealing system
7. Docking system that enabled the underwater machinery to be mated with the ship while in a dynamic seaway
8. Underwater work platform or "claw"
9. Sea Water Hydraulics and Umbilical Cables
10. Submersible Barge.

The following sections provide detailed descriptions of the ten major systems listed above.

1. Gimbaled Platform

The gimbaled platform provides a passively stable support structure for the heavy-lift system from which the "claw" and load are suspended during operations. This structure consists of outer and inner gimbaled elements that eliminate bending stresses in the pipe string as the ship rolls and pitches in a seaway. The 40 x 40-foot (12.2 x 12.2-meter) outer gimbal ring is a box weldment fabricated from high strength steel which is vertically supported by 48-inch (122-centimeter) diameter forged, hollow shafts attached to yokes mounted on the top of the heave compensator rams. The shafts turn through triple race anti-friction bearings mounted in the fore and aft faces of the outer gimbal, thus providing the roll axis of the platform. The inner gimbal element is an "H" shaped weldment which is connected to the outer gimbal element by two 48-inch (122-centimeter) diameter pins extending from its sides through similar bearings mounted in the port and starboard faces of the outer gimbal element, thus providing the pitch axis of the platform.

The four gimbal bearings, each with a capacity of 5,000 tons (4,535 tonnes), are unique in size and design. The bearings consist of three races enclosing two sets of rollers. The 48-inch (122-centimeter) bore inner race accepts the gimbal's structural pins. The outer race has an 8-foot (2.4-meter) outside diameter. An inner, double set of straight rollers and an outer double set of barrel rollers are separated by a middle race. The middle race is continuously rotated by an electric motor, and run at a speed sufficient to prevent any of the rollers from actually changing direction as the ship rolls and pitches in a seaway. The bearings are self-aligning to allow for structural deflections and construction tolerances.



GIMBAL PLATFORM BEING LOWERED DURING INSTALLATION

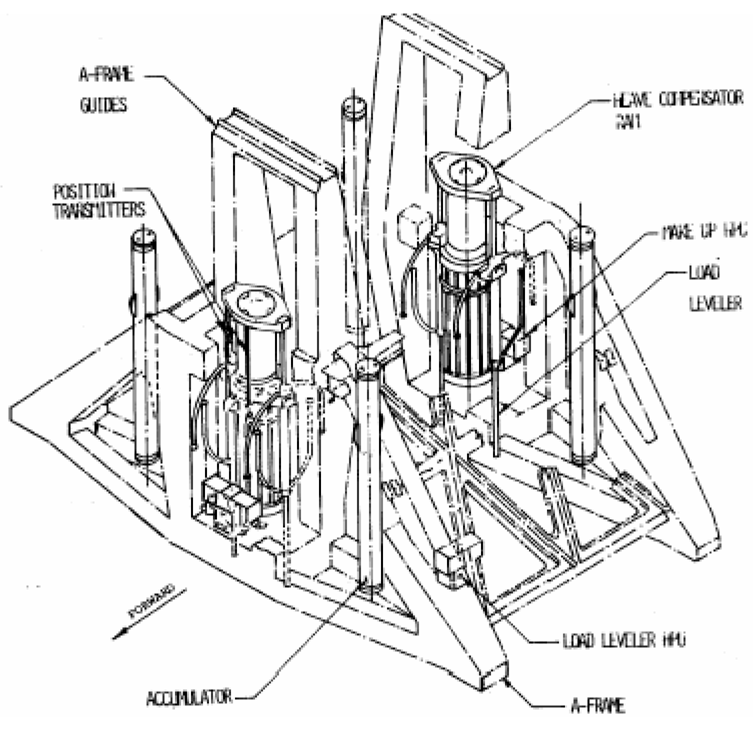
The inner gimbal, which is independent of ship roll, pitch, and heave motions, is the heart of the stable platform concept. The gimbaled platform is capable of accommodating ship motions of +/- 8.5 degree roll, +/- 5 degree pitch and 15-feet (4.6-meters) of heave. The upper pair of heavy-lift cylinders is mounted directly on top of the inner gimbal. The 20-foot (6.1-meter) high rig floor substructure is also attached to the top of the inner gimbal and serves as the upper working deck for pipe handling operations.

The lower pair of heavy-lift cylinders is welded to the underside of the inner gimbal. A strengthened foundation with a seating surface for a pipe tool joint is also provided at this level. This "parking brake" is used to take the load off the heavy-lift system for maintenance or during severe weather. A 10,000-ton (9,070-tonne) thrust bearing installed below the inner gimbal is used to rotate and align the axis of the "claw" with the docking legs during docking.

2. Heave Compensator System

The heave compensator system is installed between the gimbaled platform and the ship's structure. Its function is to minimize the dynamic axial stresses in the heavy-lift pipe string by allowing a controlled amount of relative motion between the gimbaled platform and the ship. The system's spring rate (rate at which it responds to movement of the ship) can be adjusted to the specific dynamic environment resulting from wave forces, ship motion characteristics, platform motion, suspended loads, and length of the pipe string.

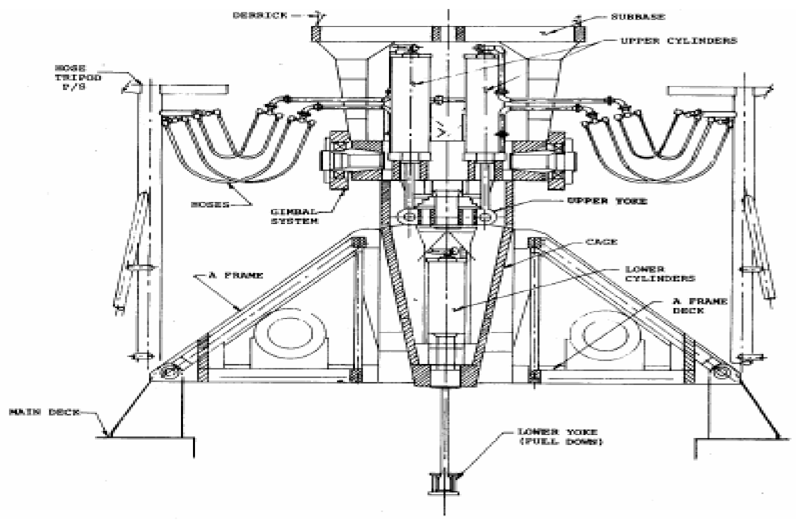
The passive, hydraulic/pneumatic heave compensation system consists of two 65-inch diameter upward stroking rams mounted on the centerline of the ship on two large structures that span the center-well. The outer gimbaled platform is supported on top of the two rams. The design range for vertical motion is +/- 7.5 feet (2.3 meters), and the system's maximum load capacity is 10,000 tons (9,070 tonnes). The system air pressure is adjusted to match the load on the gimbaled platform at mid-stroke, while the number of air bottles placed on line controls the effective spring rate of the system.



HEAVE COMPENSATOR SYSTEM

A 36-inch (91-centimeter) rubber and steel flex joint installed on the bottom of each ram cylinder isolates the rams from structural deflections and construction tolerances. The rams are fitted with a patented internal hydraulic "snubber" to protect the system in the event of a rapid over-travel during their stroke.

3. Hydraulic Heavy-lift System



SECTION THROUGH HEAVY LIFT (LOOKING FORE/AFT)

The 7,000-ton (6,350-tonne) capacity hoisting system is the nucleus of the *Hughes Glomar Explorer's* ability to lower and raise heavy loads to and from the seafloor. The lift system utilizes two pairs of 60-inch (152-centimeter) internal diameter hydraulic cylinders with a 15-foot (4.6-meter) nominal stroke mounted on the inner gimbaled platform. The rod ends of the cylinders point downward and each pair is connected with heavy steel yokes which support the pipe string at its tool joints which are spaced every 30 feet (9.1 meters). The cylinders are arranged with one pair 45-feet (13.2-meters) above the other and rotated 90 degrees so that the upper yoke can move between the cylinders of the lower pair. During operation the upper and lower cylinder pairs alternately pick up and release the load in a continuous, automated hand-to-hand sequence. The system is designed for a constant lifting/lowering speed of 18-feet (5.5-meters) per minute, although actual operations were carried out at a lesser rate.

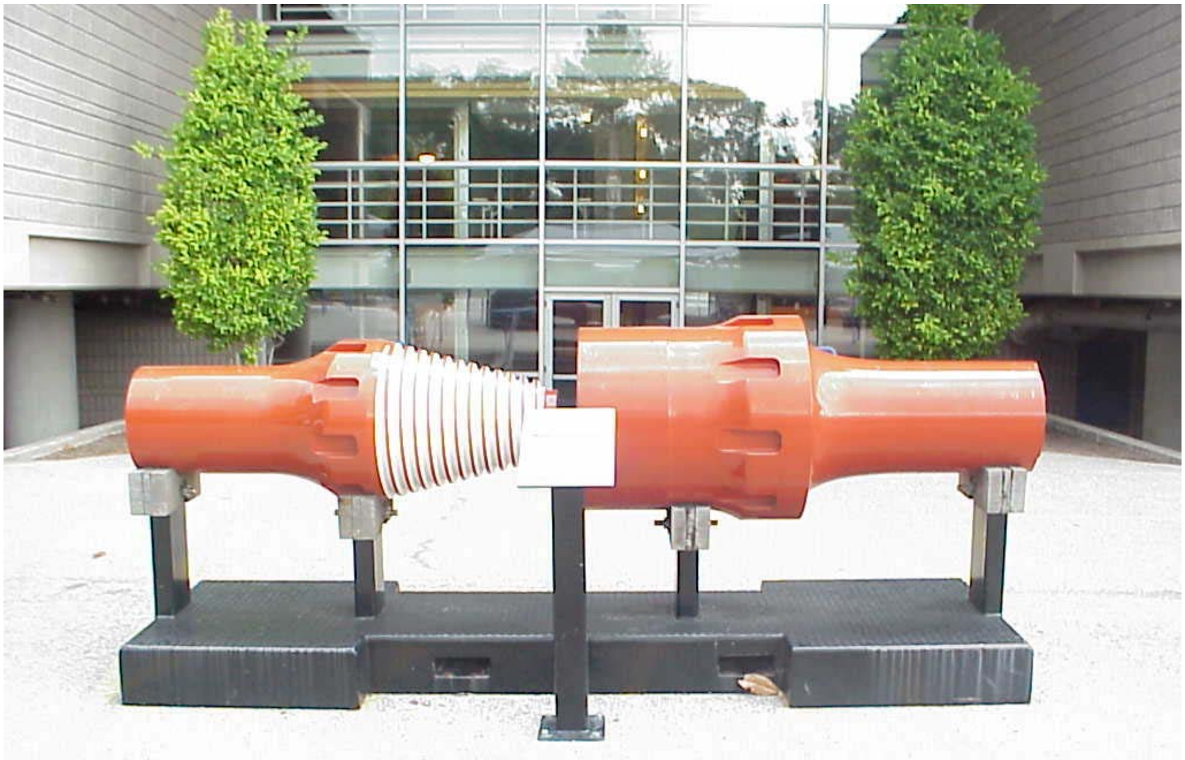
The structural yokes connecting each pair of cylinder rods have a clear opening through their centers that can pass the heavy-lift pipe tool joint. Each yoke has two sliding mechanisms that hydraulically move into place under the tool joint's flat shoulder to assume the 7,000-ton (6,350-tonne) load. The upper yoke also contains a device that can apply 500,000-ft-lbs (677,900-newton-meters) of make up torque to the tool joints and exert up to one million-ft-lbs (1,356,000-newton-meters) of breakout torque if needed.

4. Heavy-lift Pipe String

The 17,000-foot (5,182-meter) forged steel heavy-lift pipe string is comprised of 570 joints, each one being 30-feet (9.1-meters) long. The pipe material and the manufacturing process are derived from the military specification for large bore naval and shore battery gun barrels. The pipe sections are hammer forged with large upsets on each end to accommodate the machining of integral tool joints.

Physical scale model tests of various thread configurations resulted in the selection of a modified buttress thread with a steep taper. All finished pipe joints were proof tested to approximately 88 percent of the material's minimum yield strength in a specially constructed machine capable of 24,000,000 pounds (10,884,000-kilos) of tensile pull.

To minimize the wet weight of the pipe string yet meet the strength requirements, six pipe body outer diameters are used ranging in size from 15.5 to 12.75 inches (39.4 to 32.4 centimeters). Although all pipe sections have a constant 6-inch (15.2- centimeter) bore, there are three tool joint diameters ranging from 28 to 25.5 inches (71.1 to 64.8 centimeters). Each box end tool joint has a flat support shoulder that rests on the heavy-lift yokes during operation. Both the pin and box tool joints have nine machined slots around their diameter to accommodate the make-up/break-out torquing device on the upper lifting yoke. Normally, the pipe is stored, handled, made up, and broken down from the string in 60-foot (18.3-meter) long double sections, ranging in weight from 12 to 20 tons (10.9 to 18.1 tonnes). The finished, dry weight of the pipe string is approximately 4,000 tons (3,628 tonnes) and the pay-load capacity at the end of the fully deployed 17,000-foot (5,182-meter) string is approximately 4,250 tons (3,855 tonnes).



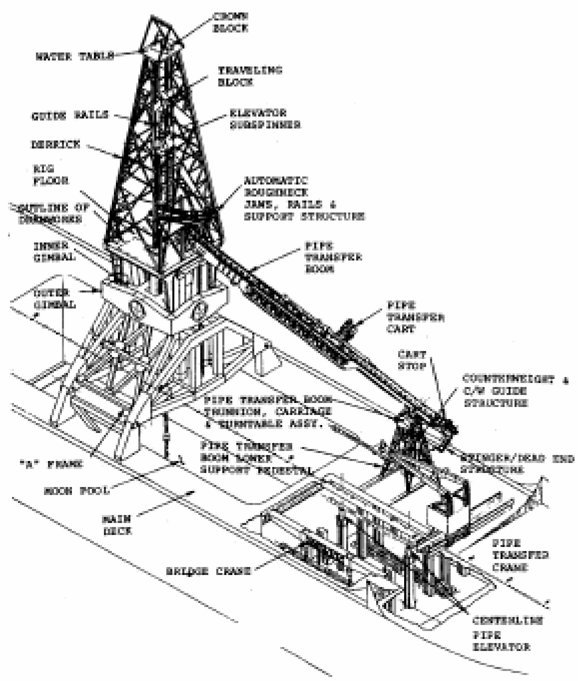
HEAVY-LIFT PIPE TOOL JOINT MANUFACTURED BY HUGHES TOOL COMPANY

5. Heavy-lift Pipe Handling System

The 18-foot (5.5-meter) per minute raising/lowering speed of the heavy lift system dictates that a 60-foot (18.3-meter) long pipe section be inserted (or removed) every 3.3 minutes. The handling procedure includes retrieving a 12 to 20-ton (10.9 to 18.1-tonne) pipe section from a horizontal position in the storage hold below deck, transporting it to the rig floor located over 100-feet (30.5-meters) above the deck, raising it to a vertical position, and stabbing it into an upward facing box connection which is continuously being lowered by the heavy-lift system. This operation must be carried out while the ship is rolling and pitching in a seaway.

The Pipe Handling System is comprised of six distinct machines:

Two manually operated **bridge cranes** in the storage hold retrieve a 60-foot (18.3-meter) section of pipe from a bin, lift it to the top of the hold, and transport it transversely to a centerline elevator. Telescoping guide tubes are fitted around the hoisting blocks so that the two pipe grapples are made rigid, even at their maximum 35-foot (10.7-meter) vertical extension. The **centerline elevator** utilizes two hydraulic cylinders to raise the pipe through a hatch in the main deck into position for pick up by the transfer crane.



PIPE HANDLING SYSTEM

The **transfer crane** has a grapple device at the end of its boom which grasps the pipe around its center tool joint, picks it up from the elevator, and transports it to starboard where it places it on the pipe transfer cart. Despite the motion of the ship the pipe is always under rigid hydraulic control.

The **pipe transfer cart**, which rides on rails atop the transfer boom, carries the pipe from the deck to the gimbaled rig floor. The transfer cart is pulled along the boom by a hydraulically driven winch.

When the pipe section arrives at the rig floor its top (box) end is directly in line with the center of the lift system and between two, upward curving, "banana-shaped" guide rails. The guide rails hold the lifting and stabbing guide which positions the **automatic roughneck**. The **elevator/sub-spinner,** which is attached to the traveling block bails, is clamped around the pipe. A stabbing guide mechanism firmly controls the lower end of the pipe as the upper end is raised into the derrick by the elevator/sub-spinner. The automatic roughneck controls the lower end of the pipe and guides it into vertical alignment with the heavy-lift pipe already in the system. The elevator/sub-spinner spins the pipe as it is lowered to engage the threads of the downward moving tool joint box and then applies approximately 50,000-ft-lbs (67,790-newton-meters) of torque to the tool joint.

6. Docking Well

The size of the object to be raised determined that the ship must have a dry center-well 199-feet (60.7-meters) long and 74- feet (22.6-meters) wide with a 65-foot (19.8-meter) clear vertical height. The center well is closed from the sea by two gates that roll longitudinally, one forward and one aft, in gate guide rails built onto the bottom of the ship's hull. The two gates are 9-foot (2.7-meter) deep barge-like pontoons with wheels along their sides and a two-compound rubber sealing gasket on the topside where the gates overlap the ship's hull. Regulating the air volume in each gate's free flooding (open bottom) compartments allows their buoyancy to be controlled. When the gates are closed and made positively buoyant, the perimeter gasket seals against the ship's hull and high volume pumps remove water from the center-well. When the hydrostatic pressure differential between outside and inside reaches a few feet the gates are adequately sealed and held in position.

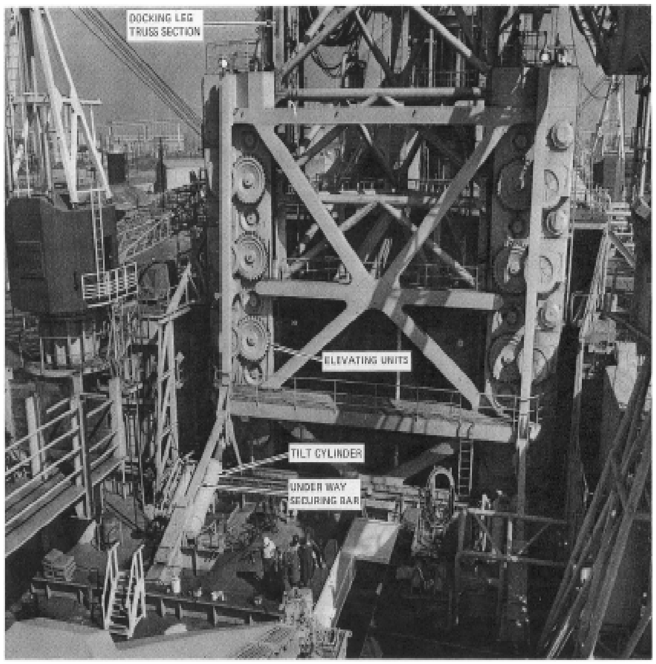
To open the gates, the well is flooded with seawater to equalize the pressure and the floodable gate compartments are flooded. The gates become negatively buoyant and sink several inches until their steel wheels contact the gate guide rails. The gates can then be powered open (or closed) by a rack and pinion arrangement. Once in the fully open position the gate ballast tanks are blown down, become positively buoyant, and hold their position against the hull.

7. Docking System

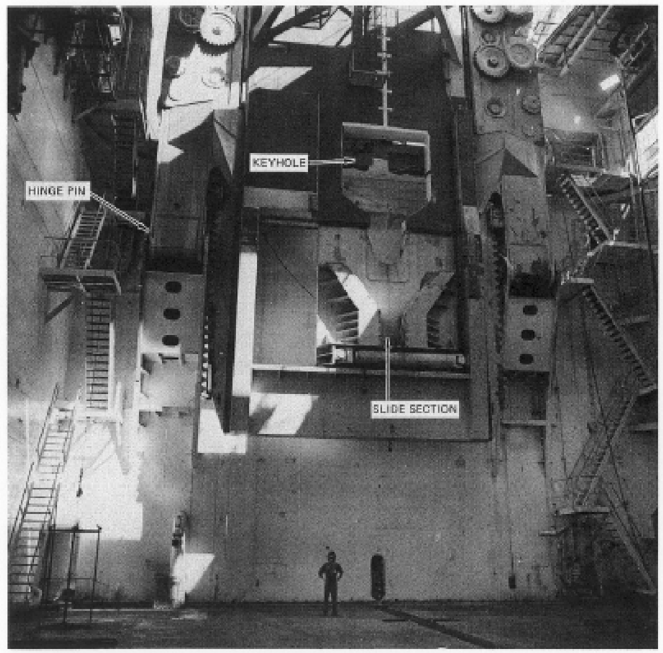
The docking system is an innovative solution to one of the most vexing problems facing the mission – how to stabilize a 4,000-ton (3,628-tonne) load which is suspended from a single point in a dynamic seaway environment and then hoist it into the narrow confines of the ship's center-well. Furthermore, when the load is transferred to or from the pipe string and heavy lift system, the "claw" must be supported by some other structure. The solution was to provide two semi-rigid structural arms or "docking legs" that could support the weight and also reach below the ship's hull to guide the "claw" and payload as it is hoisted into the center-well.

The docking legs are modified sections of jackup drilling rig legs with continuous racks on two of the three vertical members. The electric driven, rack and pinion elevating system and integral guide structure are also standard modular design. The upper portion of the leg is made up of simple triangular trusses. The flat lower section incorporates a "keyhole" that engages a 48-inch (122-centimeter) diameter "docking pin" located on each end of the "claw". A second structural pin on the "claw", located about 10 feet (3 meters) directly below the main support pin, engages a second slot on the leg and serves to resist the torque from asymmetrical loads on the "claw". Once seated in the supporting keyhole, the "claw" can be shifted laterally about 8 feet (2.4 meters) to accommodate the asymmetrical dimensions of the load being raised into the ship.

The legs are raised and lowered by standard jack-up electric elevating units. When docking/undocking, two hydraulic tilt cylinders on each support truss are actuated to allow the legs to tilt up to 7 degrees fore and aft. The hydraulic system incorporates a pneumatic/hydraulic circuit that allows for the gradual dampening of relative surge and pitch motions as the ship and the "claw" respond differently to the wave forces. The submerged claw acts as a massive damper, significantly reducing the ship's roll motion. Once the bridle connecting the "claw" to the heavy-lift pipe is attached and the weight transferred to the heavy-lift system, the load is raised from the leg's keyhole slots, the legs are fully tilted to clear the pins, and the claw is lowered to the sea bed using the hydraulic heavy-lift system.



DOCKING LEG SYSTEM

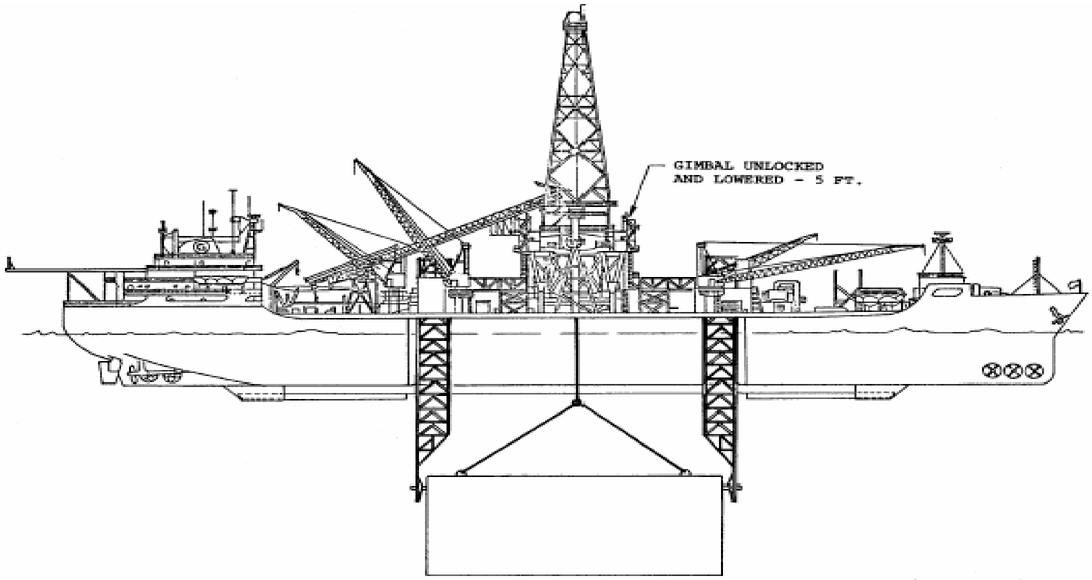


DOCKING LEG SYSTEM

8. Underwater Work Platform or "Claw"

The structural spine of the Underwater Work Platform, or "claw", is a deep box girder which, when fully outfitted, weighs approximately 2,000 tons (1,814 tones). It is supported by a three-point, hinged bridle when suspended from the pipe string. During docking/undocking operations, 48-inch (122-centimeter) diameter "docking pins" support the "claw" at the ends. Multiple hydraulically operated, articulated fingers are attached to the underside of the box girder. The welded beam fingers, some of which are over 30 feet (9.1 meters) long with multiple articulated joints, are fabricated from high strength steel plate, 1 to 2 inches (2.53 to 5.08 centimeters) thick. Large bore hydraulic cylinders, using seawater as a hydraulic fluid, actuate the fingers. Four low pressure, vertically telescoping legs are installed at the corners. After the fingers are closed around the object, these legs are actuated with seawater to exert an additional 2,000-ton (1,814-tonne) force against the seabed to overcome the soil's embedment restraint on the object.

Eight hydraulically driven, fixed azimuth propeller thrusters are located on top of and at the extremities of the "claw". A hydraulic motor, specially modified with dry film lubricant to operate on seawater pressure, drives the 5-foot (1.5-meter) diameter propellers. During near bottom operations a sub-sea acoustic positioning system commands the thrusters to position the "claw" over the desired spot on the seafloor, irrespective of the position of the ship three miles (4.8 kilometers) above. The ship's positioning system then senses the bias in the "claw" positioning system and commands the ship's thrusters to position the ship directly over the "claw".



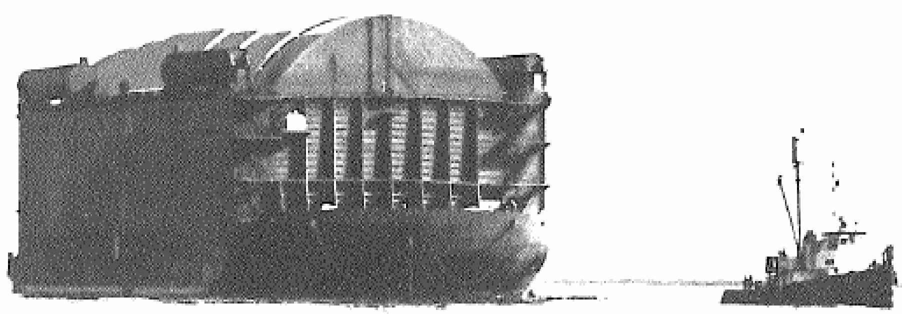
SUBSEA EQUIPMENT LOWERED TO RELEASE DEPTH

9. Sea Water Hydraulics and Umbilical Cables

Pressurized seawater is supplied to the “claw” via the 6-inch (15.2-centimeter) bore of the heavy-lift pipe string. The pressure is generated from the ship’s two 1,600-HP oilfield mud pumps. Electric power and control wiring is provided from the surface to the “claw” via two 18,000-foot (5.5-kilometer) waterproof cables. Each cable has the capacity to transmit 75 kW of power.

10. Submersible Barge

The “claw” was transported fully outfitted from the shipyard to the *Hughes Glomar Explorer* on a large submersible barge, the HMB-1 (see picture below). This barge has a retractable cover to conceal its contents. The barge was submerged to the shallow seabed prior to the ship being positioned over it so that the claw could be lifted into the center-well by the docking legs. The barge has since been used to transport the “Sea Shadow” stealth ship for sea trials.



Participants

Due to this project's large scope and complexity it is impossible, and perhaps unfair, to identify individual engineers as responsible for the many integrated elements of the *Hughes Glomar Explorer* program. Suffice to say it was literally a cast of hundreds, primarily mechanical engineers, many of them ASME members, who contributed their own expertise. It is appropriate, however, to name the major corporations that participated and their area of involvement.

Global Marine Development Inc. – prime contractor, systems integrator, operations manager, vessel designer and marine operator.

Lockheed Ocean Systems Division – development, construction, and operation of the sub-sea machinery including the submersible barge.

Hughes Tool Company – design, development, fabrication, and testing of the heavy-lift pipe string. Summa Corporation, a subsidiary of Hughes Tool Company, was the surrogate "client" who provided the cover story of a commercial deep-sea manganese mining venture.

Western Gear Corporation, Heavy Machinery Division – development, construction, testing, and at-sea operation of the heavy lift and heave compensating systems.

Honeywell Ocean Systems – development, construction, installation, and operation of long and short base line acoustic positioning systems.

Sun Shipbuilding & Drydock Corporation – detailed design and construction of Hughes Glomar Explorer vessel.

American Bureau of Shipping – commercial agency responsible for certifying the ship and its systems meet the applicable rules for classification as Maltese Cross A1 – E.

General Electric Corporation – development and provision of the vessel's electrical components including a first-of-its-kind 4160 volt distribution system and the first marine application of SCR variable speed drives.

Battelle Memorial Institute – proof testing of each section of the heavy-lift pipe with 12,000 ton (10,884 tonnes) tensile pull machine

Marathon-LeTourneau – fabrication of docking legs and jacking motors

The significant involvement of many other companies not listed above who contributed to the success of this project is recognized.

The following references are provided for visitors who are interested in reading more about the *Hughes Glomar Explorer* and the Jennifer Project. GlobalSantaFe, however, assumes no responsibility for the accuracy of any of the material.

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We wish to recognize Global Marine personnel who contributed to the design, construction, operation and support of the *Hughes Glomar Explorer* during the deep-sea salvage project. Unfortunately, time has taken its toll on our personnel records. While every effort was made to compile a complete list, we are certain there are individuals who were inadvertently overlooked, and for that we apologize.

Terri Adamic
Grant Allen
Richard Allen
Charles Alonjie
Maynard Amundson
Robert Arnall
Carl Atherton
John Bachino
Jay Bamber
Warren Bebow
Maurice Belleville
Julius Berczik
Cindy Berry
Alfred Bilang
Barry Bird
James Black
Vance Bolding
Don Borchardt
Stephen Blanchard
Leon Blurton
Philip Blurton
Charles Bozarth
Sebe Bracey
Harold Bradley
Sonja Bridgeforth
Cindy Brinkley
Clarence Brown
Donald Bull
John Burford
Charles Canby
Chuck Cannon
Carl Carlisle
John Carpenter
Philip Carpenter
Richard Casse
Dale Cheeseman
Malcolm Clark
Glenn Clemens
Micky Cohen
Eugene Coke
James Cole
Renee Comeau
Danny Constantino
James Cooper
Robert Cooper
Curtis Crooke
Laura Crouchet
Henry Cuffle
Jim Culp
Malcolm Currie
Bud Cusick
James Cusick
Tullio D'Angelo
Vernon Davenport
Jim Dean
Don deBourguignon
Bob Demichelle
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Jack Delaney
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The History and Heritage Program of ASME

The ASME History and heritage Program began in September 1971. To implement and achieve its goals, ASME formed a History and Heritage Committee, comprised of mechanical engineers, historians of technology, and the Curator Emeritus of Mechanical and Civil Engineering at the Smithsonian Institution. The committee provides a public service by examining, noting, recording, and acknowledging mechanical engineering achievements of particular significance. The History and Heritage Committee is part of the ASME Council on Public Affairs and Board on Public Information. For further information, please contact Public Information, the American Society of Mechanical Engineers, Three Park Avenue, New York, NY 10016-5990, 212-591-7740, fax 212-591-8676.

An ASME landmark represents a progressive step in the evolution of mechanical engineering. Site designations note an event or development of clear historical importance to mechanical engineers. Collections mark the contributions of several objects with special significance to the historical development of mechanical engineering.

The ASME Mechanical Engineering Recognition Program illuminates our technological heritage and serves to encourage the preservation of the physical remains of historically important works. It provides an annotated roster for engineers, students, educators, historians, and travelers, and helps establish persistent reminders of where we have been and where we are going along the divergent paths of discovery.

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HUGHES GLOMAR EXPLORER

1972

THE HUGHES GLOMAR EXPLORER WAS BUILT FOR A COVERT U.S. GOVERNMENT PROJECT THAT RETRIEVED PART OF A SUNKEN SOVIET SUBMARINE FROM THE PACIFIC OCEAN IN 1974. IT WAS BUILT AROUND AN INTEGRATED MECHANICAL SYSTEM DESIGNED FOR THE DAUNTING PURPOSE OF RAISING A 2,000-TON OBJECT 17,000 FEET FROM THE OCEAN FLOOR. KEYS TO ITS SUCCESS WERE AN INNOVATIVE CLAW MECHANISM, A GIMBALED MOUNT TO STABILIZE THE PIPE STRING AND A DYNAMIC POSITIONING SYSTEM THAT MAINTAINED THE VESSEL'S LOCATION THROUGHOUT THE RECOVERY OPERATION.

CONVERTED FOR DEEPWATER DRILLING IN 1998, ITS STABILIZING AND POSITIONING CONCEPTS BECAME A MODEL FOR SUBSEQUENT DRILLING RIGS.

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