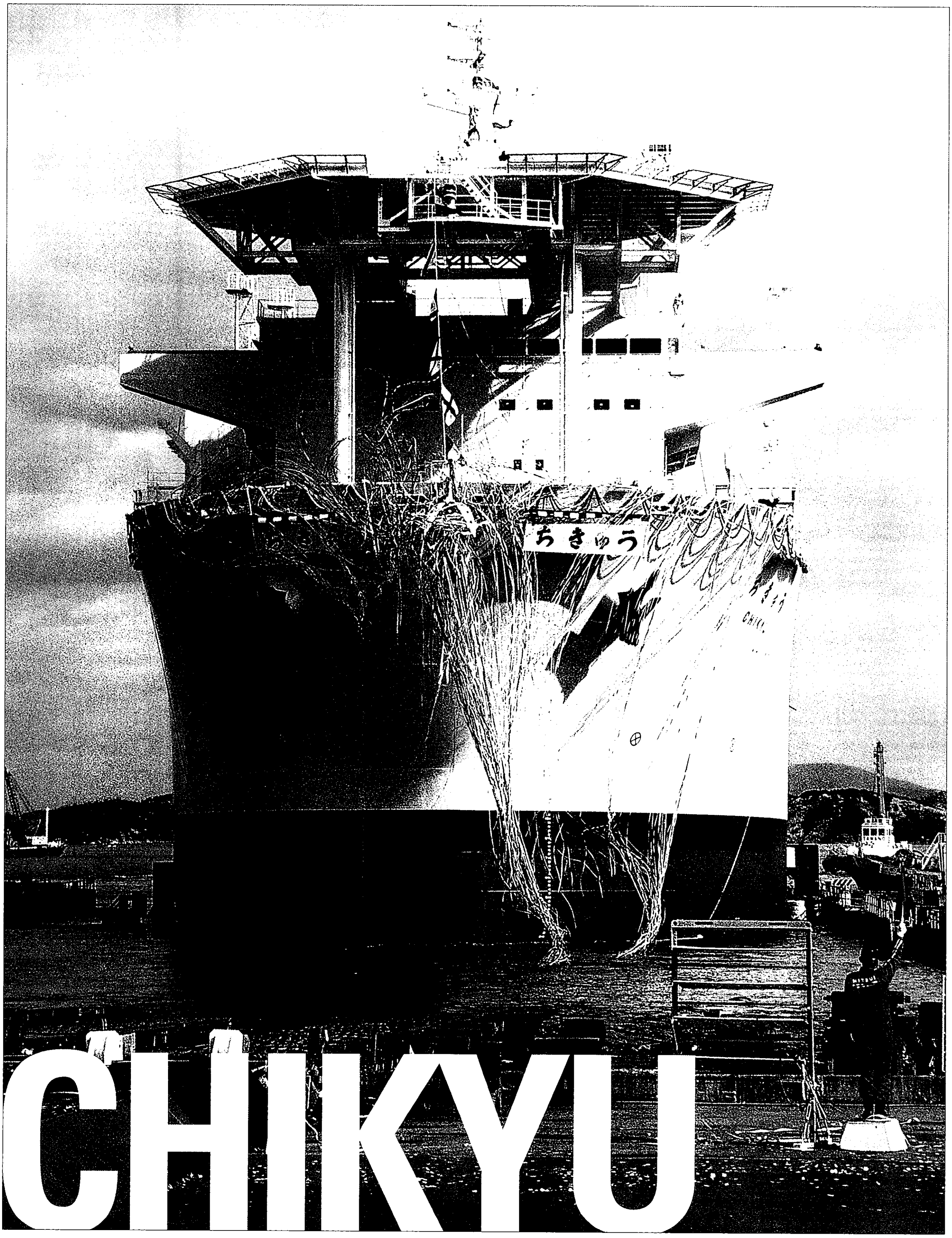
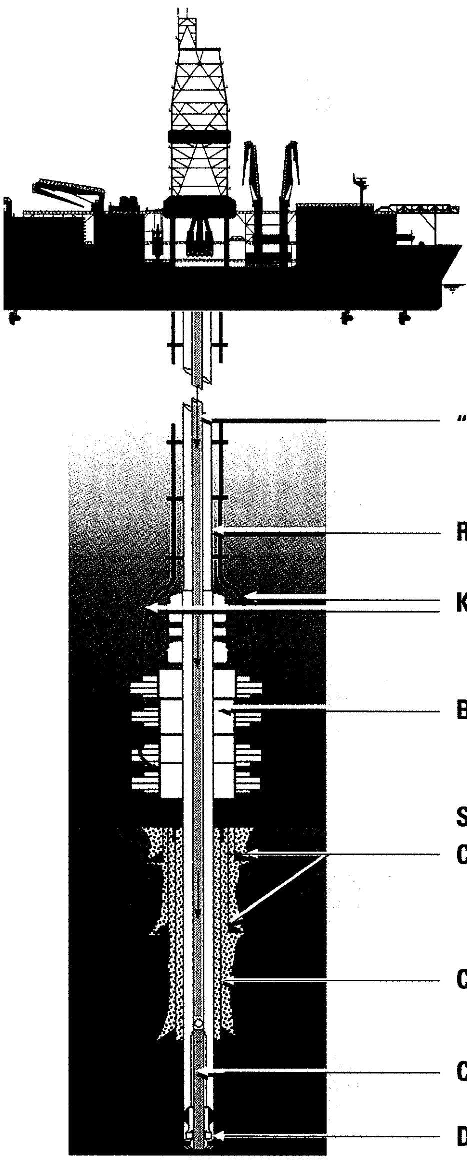
MS *CHIKYU*: AT THE CUTTING EDGE OF DRILLING SHIP TECHNOLOGY



The MS *Chikyu* launching ceremony, prior to final fit out (courtesy of JAMSTEC)

Elsewhere in this year's magazine, you will read about OD21, the deep-sea scientific drilling program being undertaken by the Japan Marine Science & Technology Center (JAMSTEC).



The Riser system (courtesy of JAMSTEC)

Currently, there is only one purpose-built scientific ocean drilling ship in the world, the *JOIDES Resolution*. This vessel was originally built in 1978 as a mobile offshore drilling unit for commercial offshore drilling, and later renamed and commissioned for scientific ocean drilling in 1985, under the auspices of the Ocean Drilling Program (ODP), an international scientific research project. As a part of its own research project, Japan decided to build a new state of the art deep-sea scientific drilling ship. Ordered by JAMSTEC, and being built to NK class, construction of the MS *Chikyu* commenced in 1999. Construction of the vessel is expected to be completed around the middle of 2005. The ship will be the most advanced, deep-sea scientific drilling ship in the world, with a safe and reliable riser drilling system and state of the art dynamic positioning system.

The various Ocean Drilling Programs have several goals. These include studying earthquake generation and plate tectonics and exploring potential new energy resources, among other topics. These programs will require drilling in deeper water and further into the earth than ever before. Because of this, the MS *Chikyu* will incorporate the most advanced drill ship technology available, in two key areas; drilling and positioning.

Current scientific drilling uses a bare drilling pipe system, with seawater pumped down the drill pipe to sweep out cuttings from the drill hole (non-riser system). The advantage of this system is that numerous shallow holes can be drilled in a short period. The disadvantage of this system, however, is that while drilling, the wall of the borehole can collapse, thereby limiting drilling depth. Another problem is the absence of any protection against the risk of hitting oil resources by accident, or similarly, hitting frozen methane or CO_2 gas hydrate pools, causing a potential "blowout" type event. These factors limit the operational area of the current deep-sea scientific drilling ship.

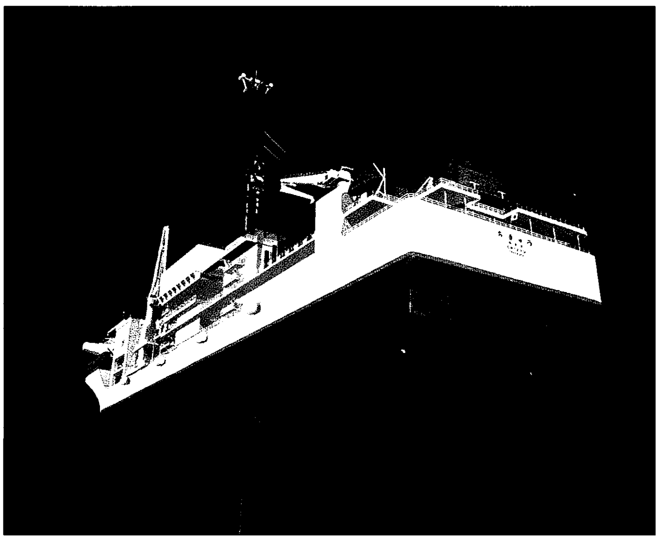
The drilling system being installed on the MS *Chikyu* is an advanced version of the system currently being used in offshore fields. One of the key features of this system is that the cuttings-sweeping system utilizes so-called "Mud" instead of seawater and is a closed circulation system instead of the current open-ended system. The "Mud" is a special fluid, the density, viscosity and chemical composition of which can be adjusted according to the conditions of the formation being drilled. This "Mud" is circulated from the ship, down through the drillpipe, returning up through the annulus of the borehole and the riser, and then back to the vessel. There are multiple benefits from drilling with "Mud", the major one being borehole stability, allowing safer, deeper drilling.

Also important is the use of the riser, which provides the borehole with mechanical protection and helps adequately control pressure. The riser is a pipe surrounding the drilling pipe. Within the drilling pipe, the drill bit cuts the core sample pile, which is kept in the sampling barrel in the middle. The space between the barrel and the drilling pipe is used to circulate the "Mud", bringing with it cuttings through the space between the drill pipe and the riser. Thus, in the underground section of the drilling operation, the riser mechanically protects the borehole walls from being eroded with the "cleaning" fluid, the "Mud", by removing the cuttings. This process has lent its name to the drilling method— "Riser Drilling".

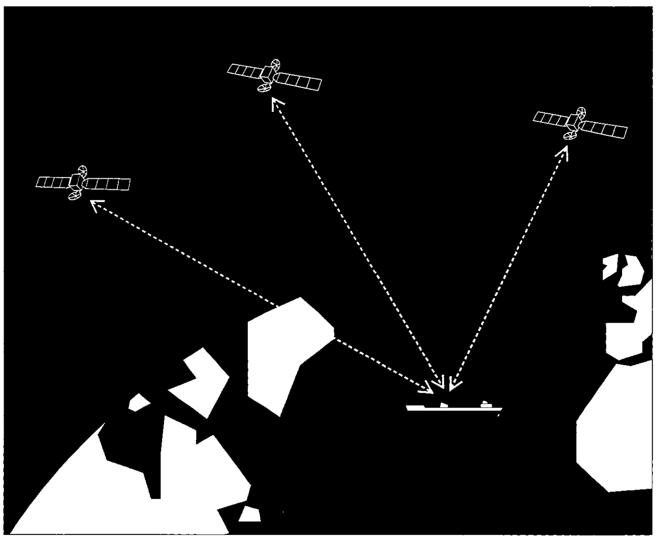
Further protection for the drill holes is provided by the casing pipe, as permanent protection for the borehole. Once the core samples are collected and recovered on board, the core is like a history book, allowing us to observe our planet's past, much like the rings of trees. The continuous protection afforded the drill holes also greatly extends their research potential as historical "observatories".

Another feature that gives the ship greater freedom in choosing drilling areas is the Blow Out Preventer (BOP), a 300 ton piece of equipment positioned at the wellhead, the entry to the borehole, to prevent potential blowouts triggered by, for example, pockets of crude oil or gas hit by the drill. The existing "non-riser" drilling ship is not fitted with this BOP equipment and is therefore not suitable for drilling operations in areas where these fuel resources may be found. The MS *Chikyu*, in its specifications, has a total length of 10,000 meters of drill piping. As a result, with the riser system, the safe drilling depth of the ship will be increased to a possible 7,000 meters from the ocean bottom in sea depths of 2,500 meters. Plans are also on the table to increase potential operating sea depths to 4,000 meters.

The second key technology is the vessel's dynamic positioning system. To ensure secure, safe and steady drilling, the ship positioned above the wellhead must be kept within a restricted area to prevent excessive stress on the drill string and riser. The MS *Chikyu* is intended for initial operation in areas with a maximum sea depth of 2.5 kilometers, so conventional mooring would be useless in fixing the vessel's position. MS *Chikyu* is therefore being equipped with the



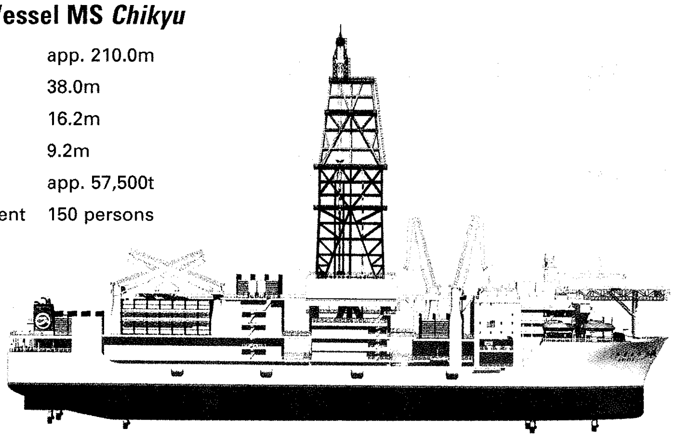
Position of the Azimuth Thrusters (courtesy of JAMSTEC)



A Global Positioning System illustration

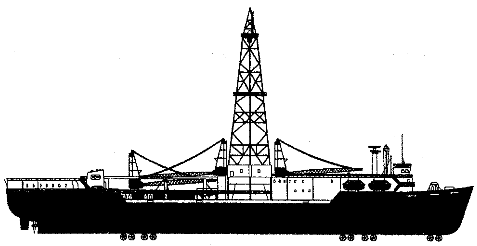
OD21 Riser Vessel MS *Chikyu*

Length Overall	app. 210.0m
Breadth	38.0m
Depth	16.2m
Draught	9.2m
Gross Tonnage	app. 57,500t
Max. Complement	150 persons



MS *JOIDES Resolution*

Length Overall	app. 143.0m
Breadth	21.3m
Depth	9.8m
Draught	7.5m
Gross Tonnage	app. 7,500t
Max. Complement	122 persons



Comparison of key specifications of the MS *Chikyu* and the MS *JOIDES Resolution* (courtesy of JAMSTEC)

most advanced Global Positioning Systems and a Dynamic Positioning System.

Once the position of the wellhead has been identified, the position of the ship has to be accurately fixed in order to drill a hole. Similarly, during drilling operations, the position of the ship has to be fixed within a specified area so drilling can progress without stressing or endangering the system.

To achieve the precise positioning required, the ship has been fitted with two D-GPS (Differential Global Positioning System) units and two hybrid GPS-GLONASS (Global Navigation Satellite System) units. D-GPS, which is in common use in marine navigation, is a more sophisticated version of standard GPS equipment with an improved theoretical tolerance of less than 1 meter, but in practice, of less than 16 meters. GLONASS is a Russian version of GPS, based on the same theory and working on its own set of satellites.

Having established the desired position of the ship, as well as its current position, the next task is to get the ship to the correct position and keep it there. This task is performed by the Dynamic Positioning System, linked to 6 azimuth thrusters and 1 side thruster at the bow section. The system is designed to continually monitor ship position, velocity and heading, together with wind and current, and use its thrusters to maintain optimum position.

As a backup to the GPS, an Acoustic Positioning System is also employed. The ship's relative position can be checked using acoustic signals transmitted by transponders deployed on the seafloor. Another key element in the whole system is the system for monitoring the riser inclination angle at both surface and wellhead positions. This data is also fed into the DPS to help avoid excessive stress on the riser.

The effectiveness of the DPS depends, of course, on the capacity of the ship's propulsion system to respond and keep the ship where the positioning systems says it should be. The ship's 6 azimuth thrusters of 4,100kw each, which are computer controlled and capable of 360-degree free rotation, perform this role. Of these, 4 are located in the flat bottom area (3 forward 1 aft). As they are primarily for maneuvering, they are retractable to improve ocean going efficiency. The remaining 2 are located at the stern and are used for both maneuvering and basic propulsion. Using these two thrusters alone, the ship can achieve 10 knots. Each azimuth thruster has a 3.8m diameter screw propeller. Each is driven by an electric motor powered by six diesel engine-driven main generators.

With all these features, the vessel will be able to conduct deep-sea drilling in challenging weather conditions—maximum wind speeds of 23m/sec, wave heights of 4.5m, wave periods of up to 8.2sec and a surface current of 1.5kt. This set-up is variable, so MS *Chikyu* will be able, for example, to conduct ocean drilling in areas with faster surface currents than 1.5kt, like those found in the Pacific Ocean trough along the Japanese coast, as long as there are mild weather conditions.

The ship is expected to be completed by around mid-2005. After various tests and sea trials, including a familiarization operation to ensure fine-tuning of the ship's systems, the vessel will be ready for full service by 2007, and will lead Japan and the world into a new era of deep-sea ocean drilling and scientific exploration.