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The safety related design studies and evaluations for the *Aoka Mizu* include a concept total risk assessment, HAZID on the concept design, development of the evacuation, escape and rescue strategy (EERS), work environment analysis, preliminary fire and explosion study and strategy and provisional reliability and availability studies.

Environmental Protection

Environmental protection and minimising polluting discharges was also a key issue in the design of the *Aoka Mizu* FPSO. We adhere to a strict zero discharge policy where possible and practical. For this reason, Bluewater chose to design a closed flare system and VOC recovery systems.Low NOx gas turbines and diesel drivers are selected. Produced water is reinjected instead of discharging it overboard. The all-electric drive together with the waste heat recovery also contributes to minimising the CO_2 emissions.

Offloading and Crane Handling *Aoka Mizu* can offload 38,000 bbls/hr of crude oil to tandem moored shuttle tankers up to 150,000 dwt. The standard offloading parcel is 500,000 bbls. Between offloading operations the offloading hose and 21-inch nylon-mooring hawser are stored on reels. A shuttle tanker vapour recovery system can be installed on the FPSO's stern starboard side.

Bluewater's safety philosophy is also carried through to onboard transport so that crane handling in-board operations are kept to a minimum, reducing the risk of dropped objects. Internal transport primarily involves electric driven pallet trolleys. A central transport route is planned inside the pipe rack and transverse transport routes in between the topsides modules. These routes end on laydown areas under the reach of a crane, while the central route gives direct access to the workshop at the aft.

The offshore crane arrangement allows lifts to and from supply boats from dedicated lay down areas. Each crane covers two of the lay down areas. All cranes are located at portside of the vessel: two cranes of 15/20-tonne SWL at 40/28 metres and one crane of 5-tonne SWL at 25 metres.

Power Supply

The *Aoka Mizu* will be equipped with an electrical main, essential and emergency power generating plant. The main power plant consists of two 60 percent gas turbine generators (GTG), located at the aft deck, for normal operation and two 25% back up Essential Diesel generators, located in the aft ER at the 3rd deck, for restricted backup and essential services.

The gas turbines are of a low NOx, high efficiency industrial design with dual fuel capabilities. Each has a waste heat recovery unit for heat generation, to supply saturated steam for heating of the process and vessel systems. The essential power diesel generators are located in the engine room and are capable of independent operation. The vessel's Power Management System governs all power generating equipment. The PMS starts/stops and automatically synchronises the generators and continuously monitors the performance of the generating equipment. Load shedding and load-sharing capabilities provide stable and reliable operation of the plant.

The FPSO Main Technical Data

Hull data

Length overall	248.1 m
Bread moulded	42.0 m
Depth moulded	21.2 m
Crude storage	618,990 bbls
Slop Tanks 4	8,788 bbls

Production

Total liquids	95,000 blpd
Crude oil	80,000 bopd
Produced water	80,000 bwpd
Water-injection	125,000 bwpd @ 275 barg
Gas compression	70 MMscfd @ 300 barg

Expansion capabilities for the process areas *)

Total liquids max.	150,000 blpd
Crude oil max.	120,000 bopd
Produced water max.	120,000 bwpd
Water injection max.	200,000 bwpd
Gas compression max.	100 MMscfd

*) The capacities depend on project specifications

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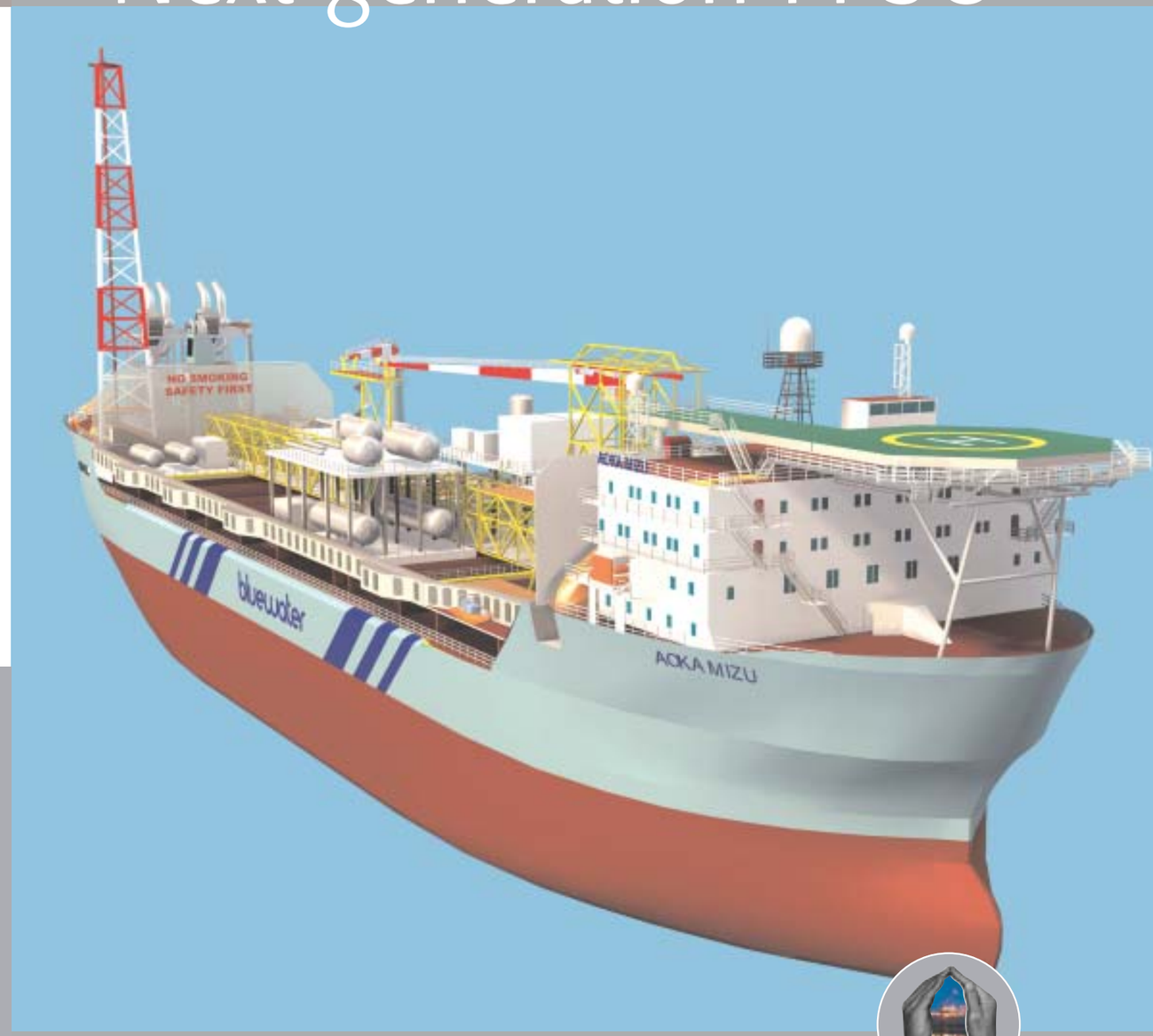
Next generation FPSO



Power by People

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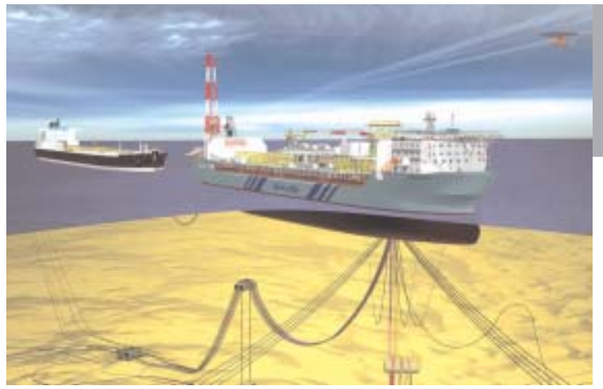

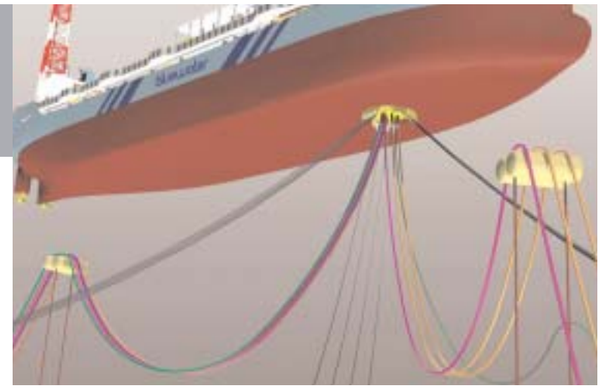

Next Generation FPSO

With over 10 years' experience operating FPSOs in the North Sea and with some 500 offshore cargo offloadings, Bluewater has used its accumulated knowledge to develop a sophisticated, safe, reliable and cost-effective FPSO specifically for operation in harsh environments; the *Aoka Mizu* can operate even in temperatures as low as –20 degrees Celsius.

Bluewater's new FPSO design, which can store 618,000 bbls of crude, has been built to give improved reliability and safety, greater uptime, enhanced structural integrity and longer lifespan, accessible maintenance and inspections and dependable environmental protection. This modified standard Aframax tanker hull has a flexible "generic" design, which can be adapted and expanded to fit specific FPSO project requirements quickly and easily, eliminating the need for a time consuming re-design. This "bespoke" flexibility means that the unit can be adapted to tie in additional wells without leaving the location and it can be redeployed easily.

The *Aoka Mizu* FPSO design was created following intensive consultation with engineers, operators, safety experts and operations crew. They contributed feedback on a wide range of issues, such as inboard transport, considerations for inspection offshore and controls architecture. This was fed into the design process, together with the lessons learned from the company's development of three other FPSOs.

Key design drivers included safety, integrity and lifetime, environment, operation, uptime, reliability and flexibility.

The Origins of the New Generation FPSO

Bluewater's "generic" concept has its origins back in 1994, when the company started its FPSO operations in the North Sea with the Uisge Gorm, a converted doublehull Aframax size tanker. The company's engineers performed an extensive fatigue assessment and concluded that the hull needed reinforcing. The ship shaped hull, however, proved to have favourable motion characteristics. Bluewater continued with the tanker shaped hull design for Bluewater's second North Sea FPSO – the Glas Dowr – in 1996.

The company converted this Aframax size tanker; a new build that was under construction when purchased. Once again fatigue and lifespan was investigated and local structural improvements were made so the Glas Dowr is suitable for operation in harsh environments. As part of a joint industry project (JIP) the structural behavior of the Glas Dowr's hull is continuously monitored. Strain gauges on the structure record the strains and wave loads in the hull structure, whilst simultaneously recording the wave and weather conditions.

In 1996 Bluewater built a copy of the Glas Dowr hull design, with all the structural improvements incorporated. This FPSO was then commissioned – the Bleo Holm. The design for this hull included a turret moon-pool and topside deck supports.

With three FPSOs designed, built and operating Bluewater gained confidence and decided to design a third copy of the hull – the *Aoka Mizu* built by the same shipyard. The structural design was further upgraded to comply with Norwegian requirements for FPSO hulls. The design incorporated improved material selection including deck and bottom integrity with enhanced buckling strength on the longitudinal bulkheads and deck. Also, the strain results obtained from the Glas Dowr were analysed, evaluated and implemented in the design of the *Aoka Mizu* hull. These improvements make this vessel a new generation FPSO, which is suitable for operation at any offshore location.

Designing for Harsh Weather Seakeeping

The *Aoka Mizu* FPSO is designed to be moored in a water depth ranging between 60m and 300m. Its passive mooring system enables unrestricted weathervaning of the unit according to the wind and current. Its turret system design was based on the design Bluewater used for Esso's Jotun FPSO in Norway, which was found to be maintenance and operator-friendly. The turntable design gives the space and flexibility required to adapt the manifolding and riser numbers depending on the specific project requirements. The anchor line system will be arranged in a 3 by 4 configuration, which provides a 3 by 120 degrees free sector to allow the optimal flowline configuration. The turret design allows for 21 risers and the modular swivel design allows for a wide range of fluid, gas, electrical powers and control transfers.

The *Aoka Mizu* has raised forecastle and poop structures. The facilities deck, housing the processing modules, is arranged approximately 3.7 metres above the crude oil storage tanks area. The accommodation and helideck are located at the bow of the vessel. The passive weathervaning turret mooring system will be located aft of the accommodation block; a fire and blast wall protects the latter. The auxiliary machinery spaces are arranged under the accommodation. The main engine and pump room, encompassing the ship and FPSO utility systems will be located to the aft of the vessel, together with the main power and heat generation plant. The shuttle tanker tandem mooring and offloading system are located on the stern. Two thrusters give heading control during offloading, helicopter and supply boat operations.

State-Of-The-Art Processing

Production fluids from subsea wells will enter the FPSO in the turret area and reach the production modules, via the turret manifolding, swivel and production/test header. In the crude oil separating module is designed for processing the well fluids in a two-stage separation train. Each individual well can be routed through the test separator. Pre- and interstage heaters assure an optimum separation temperature. The stabilised crude in the second stage separator is then dehydrated in an electrostatic coalescer, cooled to the required temperature and sent to the storage tanks.

The produced water from the production and test separator will be treated in a coagulation unit, followed by a hydrocyclone to reduce the oil in water content below the required value. Downstream of the degasser the produced water will be directly routed to the water injection module and re-injected into the reservoir. Seawater is filtered, vacuum de-aerated and routed through a sulphate removal plant prior to mixing with produced water and being re-injected into the reservoir. A water-injection pump, complete with variable speed e-motor is proposed.

The high-pressure gas from the production and test separator will be dried in a gas dehydration unit using glycol as the drying agent. A variable speed e-motor driven centrifugal gas compressor compresses the gas, which can be adapted to operate at a reduced flowrate in late field life. In addition, the compression capacity can be expanded for gas injection if required. The low-pressure gas from the second stage separator will be routed to a reciprocating compressor, which boost the pressure to the suction pressure of the centrifugal compressor.

The flare system has a low and high-pressure flare system; both equipped with a flare gas recovery system. To maximise environmental protection, there will not be continuous flaring during operation and a VOC recovery system provides a "zero emission" cargo tank blanketing system. Blanketing gas is extracted from the gas stream to the cargo tanks and the gas vented from the cargo tanks is compressed to the reciprocating compressor suction pressure. To support the above processes chemicals can be injected from a dedicated module on the facilities deck.

Emergency Safe Haven

The *Aoka Mizu* is designed for a basic crew of 28 crewmembers and up to three client representatives. Campaign maintenance crews, consisting of up to 15 to 20 people, will visit the vessel eight times a year. The 80-cabin accommodation is the designated safe haven in an emergency; it can function independently from the vessel's aft, ensuring that the lifesaving facilities can be maintained in the event that the other support system are disabled.

There are three means of escape foreseen: helicopter, lifeboats and life rafts. Although the main refuge area is at the fore accommodation there is an aft refuge area for 12 crewmembers, which is protected from the process area by a firewall. Freefall lifeboat and life rafts are planned at both sides of the accommodation and on the poop deck close to the aft refuge area. There are escape routes on the portside and starboard side of the vessel, which are semi-enclosed and do not depend on a power source. They give protected access to the forward and aft refuge areas. Transverse routes connect the various process modules to the main escape routes.

The helideck is located to the fore of the accommodation. The heliguard room – also a navigation station equipped with communication, radars and thruster controls - is on top of the accommodation. Helicopter fuel will be stored at a safe location on the facilities deck and transferred by pumps to a helicopter- refuelling unit adjacent to the landing area.

Safety Culture

Bluewater maintains a proactive health, safety and environment policy, which has resulted in excellent performance. To achieve this level of safety onboard the *Aoka Mizu*, all activities are managed and executed in line with the Bluewater Safety Philosophy. This objective ranks above all other business objectives. Our philosophy is carried out from the early design phase and through operation. This "safety in design" approach primarily exists to prevent hazardous events, to control and limit the consequences of any such event and prevent further escalation by ensuring mitigating measures and equipment are in place.