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Transport

The RRS Sir David Attenborough

A case study

From 2019 environmental scientists will board the most advanced scientific maritime vessel in the world to conduct their polar research.

This case study, written by Rolls-Royce for the IET, outlines the advanced technology which will be demonstrated on the vessel.

Introduction

UK Shipbuilder Cammell Laird has selected a Rolls-Royce design for the UK's future polar research ship. From 2019 scientists researching oceans, ice and atmosphere will have access to state-of-the-art facilities on this floating laboratory. When built, the 128 metre long *RRS Sir David Attenborough* will be one of the most advanced scientific maritime vessels in the world, capable of spending 60 days at sea without resupply, and have a range of over 35,000 km.

Commissioned by the UK's National Environment Research Council (NERC), and operated by the British Antarctic Survey (BAS) the design meets a demanding list of design requirements.

Ice breaking

"The first requirement," says designer Einar Vegsund, "was ice breaking capability." The vessel is - Polar Class 5 and can break ice to a thickness of 1.5 m at a minimum speed of 3 knots. This required focusing on hull design, the integration of the propeller and rudder with the hull and the use of powerful yet efficient engines.

Rolls-Royce created a unique hull shape that cuts through the ice, pushing it away from the vessel and under the ice sheet being crossed. According to Vegsund this was "based on years of design experience, advanced computer modelling techniques, and multiple model tests."

The stern of the vessel is equally important. The vessel will encounter ice beyond its design specification and need to retreat. The vessel can turn around in the ice and is able to break ice going backwards.

The powerful, efficient and compact Bergen B33:45 (two nine and two six cylinder) engines provide both mechanical propulsion and electric power generation.

The B33:45 has a bore of 330 mm with a 450 mm stroke. Running speed is from 450 to 750 rpm as a marine propulsion engine on propeller law, and 720/750 rpm for genset drive delivering 60/50 Hz power. In-line six, and nine cylinder units span a power range from 3,600 to 5,400 kW.

The B33:45 runs on low sulphur fuel and has good fuel efficiency down to very low loads. Specific fuel consumption is 175 g/kWh at 85 per cent of Maximum Continuous Rating (MCR) and 177 g/kWh at full load.

Variable valve timing, an intelligent system that responds to load, ensures the engine always receives the ideal amount of air for maximum responsiveness and efficiency. The engines are fitted with a Selective Catalytic Reduction (SCR) system. The control unit is integrated into the electronic engine management system and monitors and controls all key engine functions and exhaust after treatment. The vessel complies with both International Maritime Organisation (IMO) Tier II and Tier III rules.

To reduce noise the foundation of the B33:45 is a more rigid cast iron block made from a compound with a specialized molecular structure. This has reduced vibration levels to 10-11 m/sec. The 9-cylinder engines are mounted on huge double resilient mounted rafts to further reduce the underwater noise.

The engine range incorporates health monitoring.

The vessel has electrical systems with 5 MW peak effect battery capacity. Batteries reduce the vessel's fuel consumption, emissions, noise and vibration as well as increasing redundancy and consequently safety. Using electrical winches instead of hydraulic ones where possible also reduces pollution risk.

Very low levels of underwater radiated noise

One of the most stringent design requirements for the vessel to achieve was very low levels of underwater radiated noise – vital for underwater survey work. The vessel will meet DNV Silent R class.

Propellers are the main source of noise but are also very important for vessel efficiency. For Polar Research Vessels blade strength is a further requirement.

The *RRS Sir David Attenborough* is fitted with two Rolls-Royce five bladed 4.5 m diameter Controllable Pitch Propellers (CPP).

To make a quieter propeller, designers seek to move the thrust generated by the propeller further from the tip and closer to the hub. Unloading the propeller tip decreases the "disturbance of the water" by the propeller closer to the hull reducing the noise it creates. At the same time, unloading the tip reduces the efficiency.

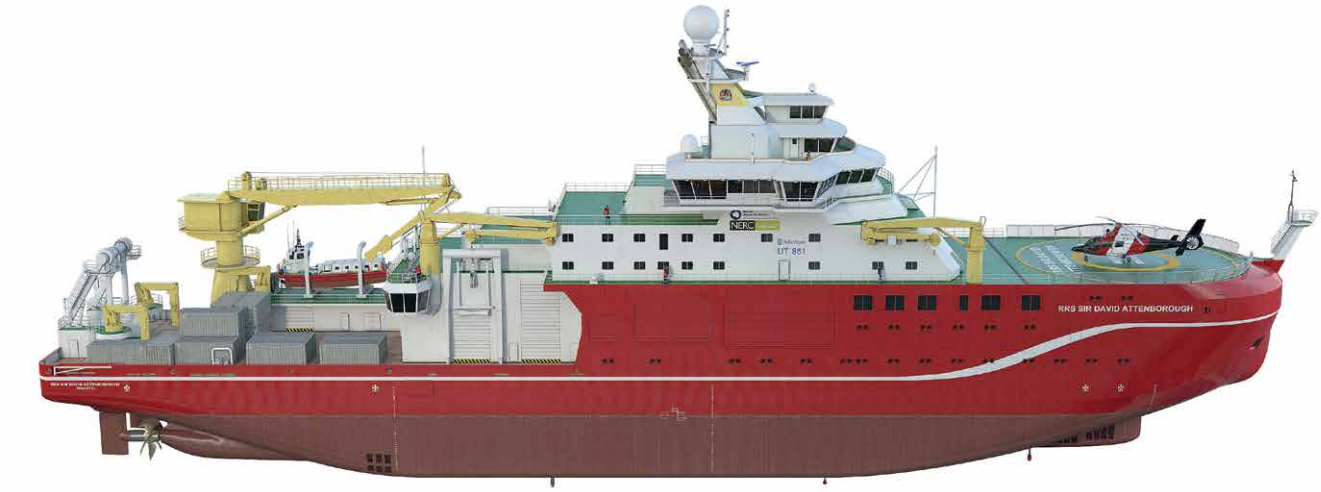
According to hydrodynamicist Björn Schröder: "The preliminary propeller design did not meet the strict noise requirements. The main source of noise was the tip vortex cavitation. So instead of further unloading the tip of the propeller, we optimised the propeller to deliver a high cavitation inception speed (CIS) like a naval vessel, and thus mitigating the tip vortex cavitation and achieve Silent R requirements."

Model testing was undertaken in a cavitation tunnel and showed mild cavitation; less than expected.

The propeller forms part of a Rolls-Royce Promas unit. This integrates the propeller with a hubcap, rudder bulb and a special rudder profile, providing very high steering forces yet minimising drag. Designing the propeller and rudder together delivers optimum performance.

Endurance, comfort and safety

The vessel will undertake voyages up to 19,000 nautical miles and is self-sufficient in fuel and supplies. It is able to hold its own waste water reducing the impact on the sensitive polar environment. Two helicopters will operate from its helideck.



According to Vegsund, "This meant clever design to use all of the ship's available volume, have everything in the right place operationally whilst finding the optimum balance of trim, stability, and dead weight."

A large proportion of the vessel's passengers are research scientists not mariners. Passenger comfort is therefore vital if they are to perform their duties effectively. Accommodation and laboratories are mostly grouped around the centre of buoyancy - midships. The vessel also has a roll reduction system. The crew also benefit from the attention that has been paid to minimising noise and vibration in the accommodation.

Rolls-Royce deck machinery systems support a wide range of tasks combining a large number of different winches in a small space. These include winches for subsea acoustic survey equipment using up to 12,000 m of wire, or deploying equipment at depths of up to 9,000 m to collect seabed samples.

Rolls-Royce Automation and Control Systems, including Dynamic Positioning, PMS and the award winning Unified Bridge – allow the captain to control every aspect of the ship's operation simply, efficiently and above all safely.

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Images used are an artist's impression courtesy of Rolls-Royce

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