RRS *Ernest Shackleton* – a breakthrough in icebreaker hull protection

When British Antarctic Survey's RRS (Royal Research Ship) *Ernest Shackleton* was drydocked recently in Denmark, the superintendent, engineers and paint specialists there to check the condition of the hull paint were amazed. After two seasons of battering its way through ice up to 2.5 meters thick with a high content of gravel and volcanic lava adding to its abrasiveness, the hull coating was virtually intact and undamaged. This was in strong contrast to the Shackleton's previous drydocking, when almost the entire hull, bearing a conventional ice-going underwater hull coating, was practically stripped to bare, unprotected steel.

RRS Ernest Shackleton in Antarctic ice up to 2.5 m thick.

The difference lay in the fact that when the *Shackleton* left drydock in 2009, the hull was newly coated with Ecospeed, a glassflake vinyl ester resin underwater hull coating proven to have extraordinary anti-corrosion protective strength and flexibility. Even though Ecospeed is not intended specifically for ice-going ships and icebreakers, it consistently outperforms the specialized ice-going ship bottom paints.

The success of the new underwater hull coating on the *Shackleton*, whose hull can genuinely be said to undergo the harshest of conditions of just about any vessel afloat, is a story well worth telling in detail. As in many cases, a picture is worth the proverbial thousand words. In this case, two sets of pictures tell the story more dramatically than any description. *Shackleton* was initially coated with a conventional ice class paint in 1995, from build. BAS took over the operation of the *Shackleton* in 1999 and since then has only ever repaired the hull coating using the recommended repair product. The pictures below show the condition of *Shackleton's* hull after 13 years without a suitable ice class paint system and the comparison of Ecospeed after two hard years working in ice (next page).

"Ecospeed...consistently outperforms the specialized ice-going ship bottom paints."

It is worth noting in the photos on the right above that neither the rudder nor the hull above the water line were coated with Ecospeed in 2009. This

Three photos of the hull of RRS Ernest Shackleton showing the condition of the paint (conventional ice paint and corresponding repair coating) before Ecospeed was applied.



Three comparison photos of similar areas of the hull after the switch to Ecospeed underwater hull coating system and two seasons of sailing in the ice. Note that the boot top and rudder, seen to have suffered damage in the photos on the right, were not coated with Ecospeed in 2009 along with the rest of the underwater hull. This has now been remedied in 2011.

has now been rectified in the 2011 drydocking so that the rudder and the hull above the water line will have the same protection as the rest of the ship bottom.

Some background on the Royal Research Ship *Ernest Shackleton*

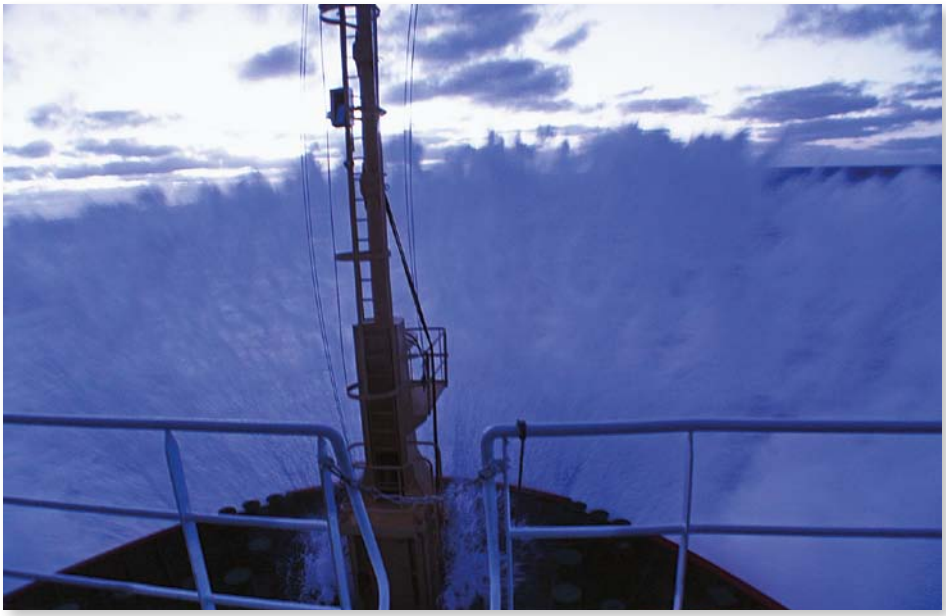
Based in Cambridge, England, British Antarctic Survey (BAS) is one of the world's leading environmental research centers, responsible for the UK's national scientific activities in Antarctica.

The RRS (Royal Research Ship) *Ernest Shackleton* was built by Kverner Klevin Leirvik A/S, Norway and launched originally as the MV *Polar Queen* by Rieber Shipping of Bergen in 1995. She was deployed in the Antarctic by various national programs before being acquired by British Antarctic Survey in August 1999. The vessel was then renamed RRS *Ernest Shackleton* after Sir Ernest Shackleton, perhaps the most famous Polar explorer of all time.

RRS *Ernest Shackleton*, ice strengthened and capable of a wide range of logistic tasks as well as having a scientific capability, is primarily a logistics ship, used for the resupply of the BAS's stations, with occasional scientific and specialist tasking.

"The biggest thing was the surprise at seeing the areas where you'd expect it to have taken a lot of damage..."

In September/October of each year the *Shackleton* sails from the UK to the Antarctic and returns the following May/June. After annual refit/drydock, RRS *Ernest Shackleton* is chartered into commercial survey work. At the end of this northern summer work she loads cargo and scientific equipment in the Humber for return to the Antarctic. The trade pattern of the *Ernest Shackleton* includes breaking ice from 1- 2.5m thick. According to the crew, she has "really been bashing heavy ice" during her recent voyages.



RRS Ernest Shackleton in Antarctic ice up to 2.5 m thick.

Ecospeed performance

Stephen Lee is the Senior Marine Engineer for British Antarctic Survey, the BAS's equivalent of a Technical Superintendent. Stephen and the Antarctic Marine Engineering (AME) department were instrumental in the initial research which led to replacing the underwater hull coating in 2009. He recalls the reaction of those present when the *Ernest Shackleton* was first pulled out of the water at Frederikshaven drydock in early 2011. "The biggest thing was the surprise at seeing the areas where you'd expect it to have taken a lot of damage... when she first came out of the water and onto the blocks it was a complete shock to all those present. All of us there commented on the condition of the hull and in particular that there was negligible damage at the bows, merely some scratch marks. None of us there would have predicted this. I then jokingly asked the question, 'Are you sure you've taken this ship to the ice?'"

Examples of the minor scrapes and chips which were the totality of the damage to the Ecospeed coated hull after two seasons in the ice.

Stephen Lee, Senior Marine Engineer for BAS.

According to Stephen Lee, the crew of the *Shackleton* reported that they had been pushing into 2 - 2.5 meter thick ice, "...and it's just not touched it – just not touched it at all."

"We were really impressed with the performance of Ecospeed," says Stephen, who was the person mainly responsible for switching to Ecospeed in 2009. It was seeing the results after two seasons in the ice that led him to go up another level and have Ecospeed applied above the waterline so that it covers all the ice belt where mechanical damage normally occurs. The rudder was also coated with Ecospeed during the 2011 drydocking so that it too could benefit from the same impenetrable protection as the hull.

Naturally the condition of the paint was carefully inspected. "The paint inspector, Howard Jess, took dry film thickness measurements around the hull and found it was basically something around 970-1000 microns on average so it's hardly lost any thickness," Stephen explains. The original application of Ecospeed was 1000 microns DFT on the entire underwater hull.

"...Are you sure you've taken this ship to the ice?"

Some minor mechanical damage had occurred to the coating but this amounted to some chips and scrapes totaling less than 0.1% of the total surface area. Compared to the virtual total removal of all the paint which the crew of the *Shackleton* had become used to before the application of Ecospeed, the damage was negligible and easily repaired. Only very minor touch-ups were required in drydock.

Stephen Lee stated that BAS also took advantage of the fact that the ship was in drydock to apply Ecospeed to the rudder and the boot top area which had not been included when the hull was coated in 2009.

Maintenance on the Ecospeed has been remarkably low. "The only maintenance undertaken has been one whole underwater scrub in August 2010 in Frederikshaven during our last maintenance period, and then she went down south," says BAS's Senior marine Engineer.

Newly Ecospeed coated boot top area above the water line

and rudder as the Ernest Shackleton is readied for departure from drydock.

Finding the right hull coating system

Stephen Lee recalls his reaction on seeing the *Shackleton* in drydock for the first time, not long after he joined BAS. "In 2008 when she came out of the water it was amazing to see the state of the hull. There was next to no paint protection left on the vessel. The decision was made then that we should start actively searching for an ice class paint that we could put onto the hull to give us that protection." This was the search that led to the application of Ecospeed in 2009.

"We looked at all the alternatives including Ecospeed," recalls Stephen. "There were a lot of comparisons between all of the products. Because of the nature of our business and where we operate we also required a paint system that would have significant environmental benefits as well as conforming to the polar code and latest classification societies regulations. We required a paint system which was cost effective in purchase, application and maintenance. We wanted a simplified paint system that no matter where you went in the world a paint contractor would be able to apply it without having to rent in expensive equipment or shielding to ensure application could continue. We also wanted to be able to conduct minor repairs either by the yard paint contractor or our own crews. Ecospeed gives use this capability. Application of some of the more traditional icebreaker paint requires twin feed paint system which requires a great deal more care during the application process as well as ensuring all the environmentals are correct which can include tenting up space heaters around the area that is going to be painted. Comparing the other paints with Ecospeed they're very comparable as far as purchase price and performance generally in the broadest of terms, but the main, huge difference is the actual cost and complexity of application of the paint. The preparation is the same, 2.5 SA over the hull, but the actual application, not having to get the environmentals right, not having to tent up the area, if it's slightly cool not requiring space heaters, if the area is gingered slightly which may or may not require a sweep blast before you can put the primer on – there's a huge amount of preparation and logistics that have to go into getting the initial coat of traditional ice-going paint onto the hull, whereas with Ecospeed its minimal as long as you have a good paint inspector, and only minimum environmentals are needed."

"...the main, huge difference is the actual cost and complexity of application of the paint."

Cathodic protection areas, Impressed Current Cathodic Protection (ICCP)

Ecospeed was applied with the standard thickness of 1000 microns over the hull. The only area where an increase of thickness up to 2000 microns was applied was around the cathodic protection areas.

Stephen Lee explains, "One of the inquiries I made before we put the Ecospeed on the first time in 2009 was to see how compatible it was with the ICCP that the vessel had because the ship was suffering from the ICCP System not functioning properly. The main problem was not having an adequate paint system. Cathodic protection works best when the hull is undamaged and has a complete paint system covering the hull, unlike in Shackleton's case. Cathodic protection as most people understand works in conjunction with the paint. ICCP has never given complete hull protection but with a good paint system it will. Effectively a common ratio I use is 80% protection from paint & 20% protection from ICCP. A failure in one or the other will quickly see a

deterioration in the paint system. With *Shackleton's* hull the ICCP continued to be ineffective simply because there was no complete paint system and therefore the ICCP system produced eddy currents around the hull, which resulted in the ICCP continually tripping, rendering the system inoperative most of the time. Once we knew what type of paint system we were looking for, we checked into its compatibility with the cathodic system and realized that the actual paint system would act as a dielectric, so we've gone to 2000 microns around the anodes."

Paint inspector's perspective

Howard Jess was the paint inspector for the initial Ecospeed application in 2009 and Stephen Lee was so impressed with "his diligence, his commitment and his professionalism" that he specifically requested Howard's attendance at the yard for the additional application of Ecospeed to the boot top area and rudder in 2011.

Currently working as an independent paint inspector specializing in the marine sector, Howard Jess is a NACE Level 2 Marine Paint Inspector, developer of commercially adopted innovative coating technology who has published a number of technical papers and spoken at many international events. Howard studied chemistry at the Glasgow College of Technology and has nearly 30 years of experience in the paint industry. He has overseen a number of Ecospeed applications, including the original coating of the *Shackleton* in 2009, major cruise ship and RO-PAX ferry newbuilds in 2009 and 2010, and a number of other applications, small and large.

"I was very impressed with the condition of the coating on the Shackleton after two seasons in the ice," says Howard. "Apparently she had been trapped in the ice on several occasions and the procedure is to reverse and then crash forward at full speed. Yet the coating remained intact – pretty impressive. I would have expected to see damage down through the coating exposing the hull. However the bow looked as if it had just been painted. Crew members who had seen the ship out of the water on numerous occasions said that they had never seen the hull looking so good after two seasons in the ice."

Howard Jess at a paint inspection job.

Experienced in paint inspection jobs with a number of different types and brands of marine paint, Howard notes a difference with Ecospeed applications: "If you are ever involved with any marine coating job where there are a number of paint suppliers you will see that inspectors from other paint companies will maybe come in once or twice a week to check things, sometimes daily but only for a coffee and a chat. Ecospeed inspectors are there whenever paint is applied. They also control when the paint can and cannot be applied. This level of control inevitably results in better system performance. There has been a lot of development work into anti-fouling coatings in recent years. Ice coatings tend to have been left behind due to the small market sector so the majors tend to push their new super-duper high-tech coatings which somehow never seem to live up to expectations. I'm not aware of any other company that gives a 10 year warranty on their hull coating."

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Asked to compare the various ice-going hull coatings available, Howard Jess commented as follows: "Taking the technicalities out of the equation, in my view the greatest advantage in using Ecospeed is cost. Two applications means only two times painters' costs when using Ecospeed. When using other 'conventional' systems we could be talking about painters costs times seven. Do the maths! Add to that, reduced repair work meaning less time in dry dock, less time off-hire and increased fuel efficiency and the product should just about sell itself."

Howard also has some advice for shipowners applying Ecospeed to their ice-going vessels: "For some reason the current mind-set is to stop at the waterline. Given that ice tends to ride over itself and up the hull it would seem sensible to extend the coating to 2–3 meters above the waterline." A piece of wisdom obviously shared by Stephen Lee, evidenced by the fact that while the *Shackleton* was in drydock recently, the level of Ecospeed coating was raised from the water line to well into the boot top area for protection.

Conclusion

The RRS *Ernest Shackleton* is living evidence that when it comes to protecting the underwater hull in the very harshest of conditions including 2.5 m ice mixed with gravel such as only the Antarctic can provide, Ecospeed offers easy-to-apply, long lasting, complete protection, and does so in a highly economic way.