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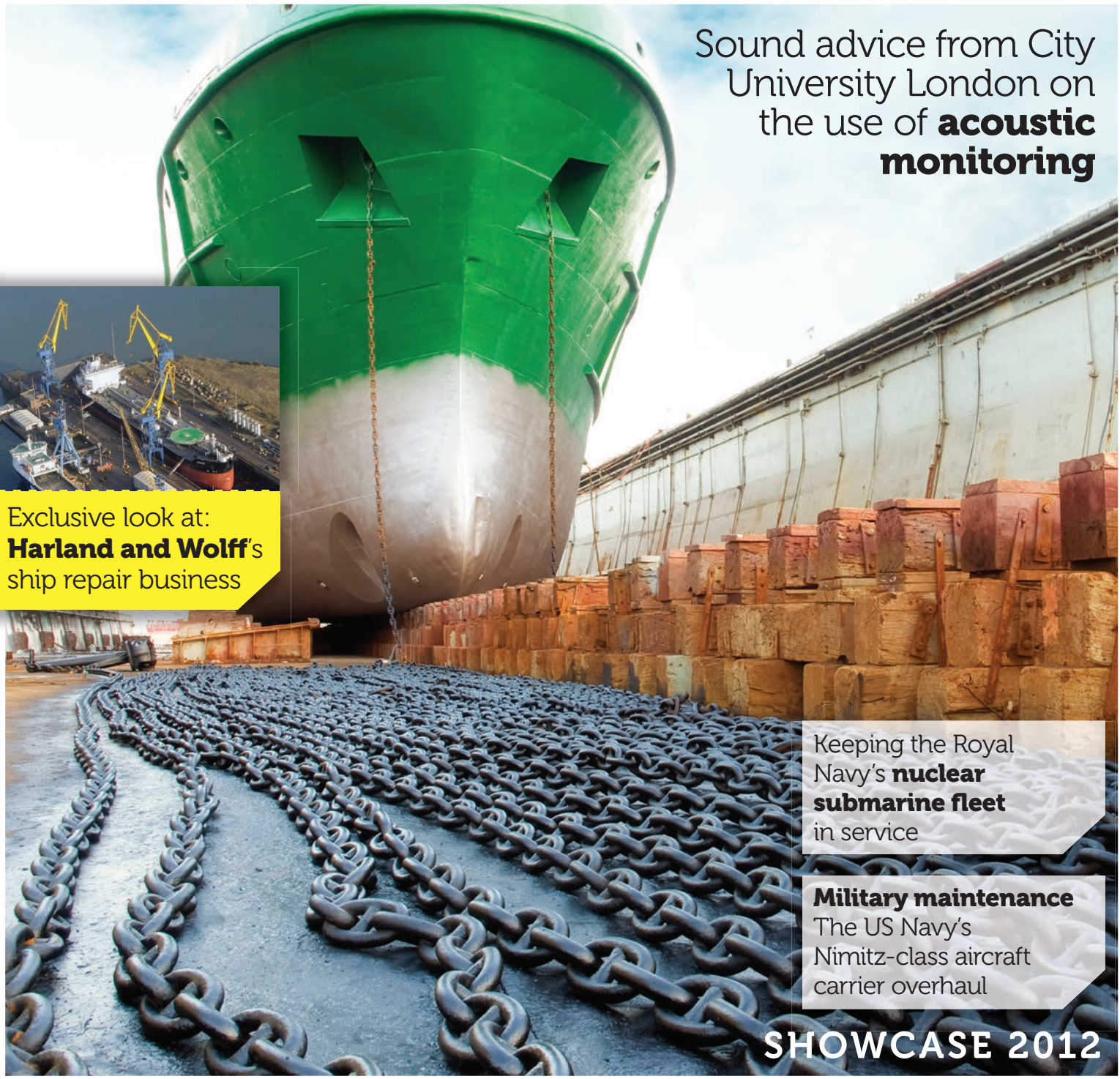
LAUNCH ISSUE

MARINE MAINTENANCE TECHNOLOGY INTERNATIONAL



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Save the day

ABOVE LEFT: **Hydrex divers carried out inspections on severe damage to the hull**
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ABOVE RIGHT: **Hydrex diver/technician performs repair work on one of the smaller damaged areas**

The insertion of a complete, prefabricated replacement hull section in a badly damaged ship at anchor is believed to be a world-first in underwater repair

David Phillips, Hydrex NV

BELOW LEFT: **Repairs to smaller areas of damage where the hull had holes or cracks**

BELOW RIGHT: **The finished section, which will later be lowered into the water and inserted into the cut-out in the hull using chain blocks**

On July 22, 2011, the Tsavliris Salvage Group dispatched salvage tug Stevns Battler in response to an urgent call for assistance from bulk carrier Navios Sagittarius (GRT: 38,849, DWT: 75,756), which was laden with 73,419 metric tons of iron ore pellets. The Sagittarius had run aground on the Tonneberg Banke, about 23.5 miles east of Frederikshavn, Denmark, while on passage from Finland to China. The salvage team arrived the same day and prepared a refloating/salvage plan, incorporating environmental and safety measures.

Stevns Battler's sister salvage tug Stevns Breaker arrived on the scene on July 24 and connected forward. Lightering vessel MPP Shield and crane barge Sanne A were also mobilized. On July 26, the Danish authorities approved a salvage plan, and on July 28, after about 3,000 metric tons of cargo had been transferred to the lightering vessel by pressurizing certain tanks and with the assistance of tugs, the Sagittarius was refloated.

On July 23, a Hydrex diving team contracted by the salvors had carried out a preliminary video inspection, which found large holes, indentations, and cracks in the hull, and heavily deformed plates. However, it was impossible to get a full picture of the damage with the ship still aground. The vessel was then towed to Frederikshavn for a detailed underwater inspection, extensive bottom repairs, and reloading of cargo. The Danish environmental protection agency vessel Mette Miljoe was also in the vicinity monitoring the situation.

Detailed inspection

With the Sagittarius refloated, it was possible to carry out a detailed inspection of the hull and note all damage. Tsavliris had signed a Lloyd's Open Form salvage contract with Navios and subcontracted several companies to carry out inspection and repairs. The chief subcontracting company for the inspection, planning, and repair work was Hydrex. Tsavliris had previously contracted Hydrex to carry out a stern tube replacement on the bulk carrier Minoan Euro in Manila. Captain George Polychroniou, Tsavliris' operations manager in overall charge of both salvage projects, says, "The cooperation with Hydrex was excellent in both operations." This was particularly important in a complex salvage operation that lasted three months and for which Hydrex mobilized 24 divers full time, in two shifts, for the duration of the operation, under the technical directions of Tsavliris naval architects and salvage master. The Hydrex team of 24 full-time divers was assembled and organized by Onno De Nooijer, technical services officer for Hydrex in Antwerp; Tsavliris salvage master captain Barend Visser; Tsavliris technical consultant Michalis Chourdakis; and was headed up initially by Toon Joos, one of Hydrex's most experienced diver/welders, who was able to provide technical input and assistance to the naval architects during the planning stages. Toon was later replaced by Jan Botte, who successfully led the Hydrex divers for the majority of the repair operation.

The Hydrex divers examined the hull, took measurements, and photographed and videoed the damage. They reported two very large holes in the hull, one about 15 x 15ft aft on the port side, and the other about 24 x 6ft near the forepeak on the port side, as well as many smaller holes, cracks, and indentations. All in all, the damage was very severe and the divers sent this information, along with their suggestions for repair, to the Tsavliris naval architects team. Michalis Chourdakis, who manages C. N. Zachopoulos & Associates, the Piraeus, Greece-based marine surveyor and consultant engineer, headed the four-man team. Chourdakis also serves as technical consultant for Tsavliris, overseeing technical matters on the company's fleet of tugs, and also as naval architect in salvage operations where required. In this case, he worked on and oversaw all the necessary planning and engineering that was needed to repair the two main damaged areas of the ship.

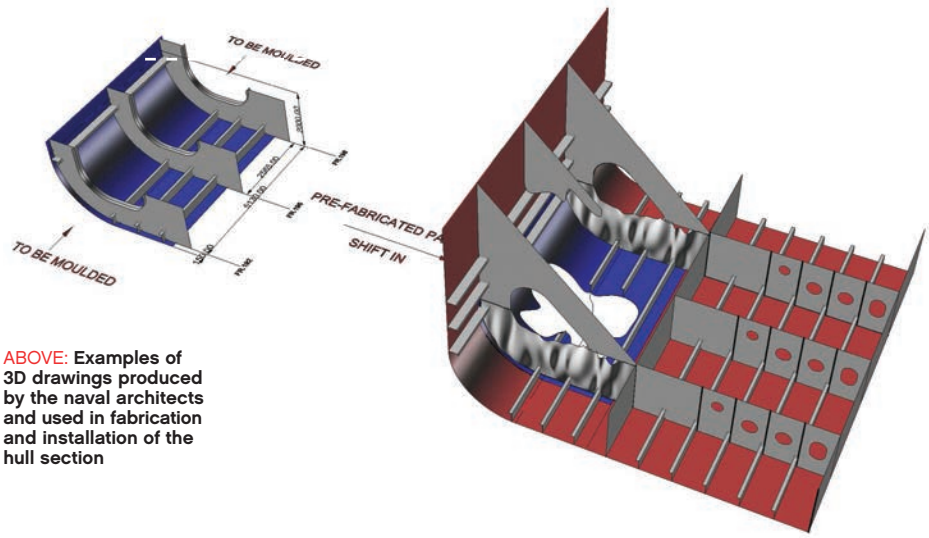
When asked if there were any particular

The construction of a large 3D steel plate to match exactly the shape of the deformed and fractured bottom plate required accurate measurements from the divers and analytical calculations from naval architects

challenges in the Navios Sagittarius underwater repair, Chourdakis explains, "The extended deformed area and local damage (cracks and fractures) caused by this major grounding, in combination with the marginal reserve of remaining local and longitudinal strength, necessitated accurate calculations and detailed step-by-step planning to enable safe repair. Various other parameters, such as the necessity of shifting cargo during the repairs, the vessel's list, the weather conditions, and the working depth, made it vital that we had effective organization and management of all parties involved.

"The construction of a large 3D steel plate to match exactly the shape of the deformed and fractured bottom plate required accurate measurements from the divers and analytical calculations from naval architects," he continues. "Finally, cutting the heavily deformed hull area and fitting a large, new pre-fabricated section following the vessel's original drawings and making it resistant and watertight was the main challenge."

The repair was a combination of accurate engineering and precise cutting, fitting, assembly, and welding, and there was close and continuous coordination between the naval architects and the divers/technicians.



ABOVE: **Examples of 3D drawings produced by the naval architects and used in fabrication and installation of the hull section**

Planning and fabrication

Without accurate measurements and data, the naval architects would not have been able to produce workable drawings and plans, so the first step was to get accurate measurements for the two major areas of damage (one near the forepeak, the other further aft, both on the port side) on a hull that was badly deformed, pierced, torn, and indented. In order to do this, the Hydrex team constructed large frames on the deck and then lowered them into the water and secured them in place over the two large damaged areas. These were then used as a reference so that measurements could be taken and relayed to the naval architects. The frame used to measure the 24 x 6ft damaged area was subsequently also used in the fabrication of the doubler plate.

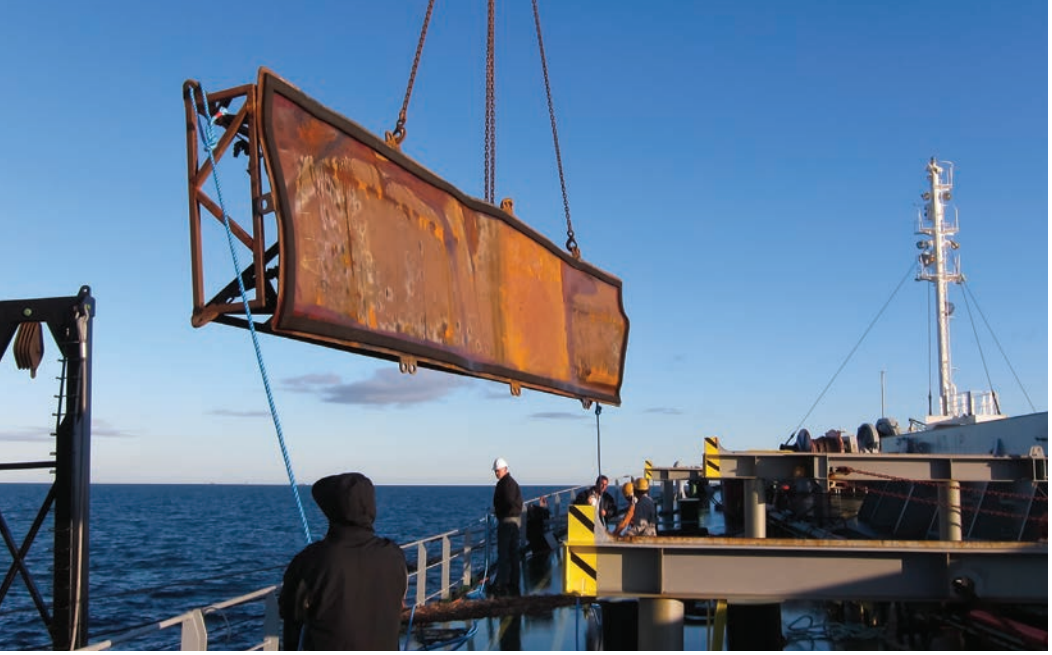
ABOVE: **Navios Sagittarius**

Using these measurements and the original drawings of the ship, the naval architects were then able to produce final drawings from which a doubler plate could be fabricated and installed. Using these drawings, a section was prefabricated at the local dockyard to repair the large hole, and a doubler plate was constructed to cover the long damaged area, with three holes in the area of double-bottom ballast tank (DBBT) No 1. The steel used had to be 12mm thick, which is too thick for easy, rapid bending, so the plates had to be measured and cut to fit the hull as accurately as possible.

Installation, cutting, welding

With 24 diver/technicians on the job, work continued in two shifts – day and night – whenever weather permitted. Once the fabrication of the section and the doubler plate was completed, preparations for its installation began. In the case of the section, it was necessary to cut through the hull plates where the hull was twisted and broken. Divers armed with gas-cutting torches (which use gas without the need for a cutting electrode) and the more common arc cutting torches cut a hole in the hull about 15 x 15ft in size. The prefabricated insert was lowered into the water by a crane barge and pulled into place with chain blocks.

The section was built with a hatch at the bottom so that divers could enter it from the outside and weld inside. Once the section was secured in place, the hatch itself was welded shut. Originally it was thought that the section would then be welded into place all the way around, but due to the difficulty in taking precise measurements, the distortion of the hull, and the gaps left when the section was in place, it was decided that the section would



LEFT: **Preparing and lowering the doubler plate into the water so that it could be welded in place to repair the 26.2ft x 5.9ft rip in the hull near the forepeak**

BELOW: **Diver inspecting damage to hull**

BELOW: **Fabrication of the section used to repair the 16.4ft x 16.4ft hole in the aft section of the hull, port side**

be bolted in place with a seal to ensure a watertight fit and then welded from the inside. This solution proved to be very effective.

While work was taking place on the section, another Hydrex team worked on the fabrication and installation of the 24 x 6ft doubler plate in the area of DBBT No 1. The frame was built and used for measurement, and then the plate itself was cut and attached.

Unlike the section, the hull did not need to be cut in order to install the doubler plate, which was welded onto the hull for reinforcement purposes. Where the gap between hull and plate was too large to weld directly, the divers used metal bars to fill the gaps, and these bars were welded to the plate and the hull. The plate was welded all the way around with a minimum of three passes (as with all the welds on the hull).

In addition to the repair of the two main areas of damage, there were also many smaller holes and cracks that had to be repaired so that the vessel could sail. These were repaired while the design and fabrication of the section and doubler plate was taking place.

The quality of the wet welding was high and when a surveyor, the naval architects, and the owner came inside to inspect, the surveyor was able to confirm to the naval architects that the wet welds were of the required standard. Had the welding not been up to standard, it would have been necessary to go round all the welds on the inside of the hull and dry weld over all the seams, which would have added a great deal of time to the job. Now the team working on the inside of the hull could concentrate on the other repairs needed to fix the section in place and make the vessel seaworthy. Speed was of the essence on this job as the ship was on a long-term charter and each day it was out of service was costing tens of thousands of dollars. It was testimony to the skill and conscientiousness of the divers and salvage team that after 10 weeks and hundreds of feet of wet welding, the work was inspected and found to be of such a high standard.

The final step for the salvor and the diving team was a full inspection of the underwater hull on CCTV in order to gain approval from the classification society for the vessel to sail. The Sagittarius passed the inspection on October 13, 2011, and resumed passage to her destination, China.

A successful operation

It is difficult to convey in a short article and with a few photographs the complexity of carrying out a successful salvage operation of this magnitude on a vessel that had run aground so heavily and was so badly damaged, and all under highly variable weather conditions and constant pressure to complete the repairs in the shortest possible time.

Few salvage companies in the world have the personnel, know-how, equipment, and experience to successfully manage a salvage operation of this nature and few underwater repair companies have the specialized personnel, equipment, expertise, and skills to execute these kinds of repairs. This is believed to be the first time an entire hull section has been prefabricated and inserted into a ship's hull, cutting away the existing damaged plates, with the ship still afloat, thus permitting the vessel to continue on a major voyage without the need to dry-dock. \\

About the author

David Phillips is communications director for the Hydrex Group and has authored a series of white papers on ship hull performance. These publications are available at: www.shiphullperformance.org

ABOUT TSAVLIRIS SALVAGE

// Tsavliris Salvage Group is Greece-based professional marine salvor, dedicated to saving lives and property at sea, and to protecting the marine environment from accident-related pollution. With tugs on permanent station at strategic locations around the world, Tsavliris is ideally situated to deliver immediate assistance to any casualty worldwide. In more than half a century of operations, the group has successfully handled more than 2,000 casualties, offering all services relating to marine salvage and towage, extending to complex wreck removals, and partnering with today's ship-owners in fulfilling their obligations to protect the marine environment from pollution.