Application Note

INSPECTING SUBMARINE HULLS FOR CORROSION

Corrosion is one of the most prevalent defects when performing non-intrusive inspection. The consequences of a bad inspection or not inspecting at all can be disastrous. It can lead to leaks that infiltrates the water we drink, leaks that can contaminate the air we breathe as well as explosions and, at worst, loss of lives. Submarines are no exception. The hulls are often built with polymeric tiles to provide better stealth, but corrosion and other defects can develop under the tiles and water can infiltrate the submarine. The challenge of inspecting submarine hulls without removing the tiles was not an easy one. Eddyfi Technologies found a way to solve this problem by customizing an eddy current array probe suited especially for this application, while obtaining repeatable and reliable results. Let's have a deeper look with the following application note.

1

THE CHALLENGE

Elaborating an NDT method able to inspect submarine hulls and characterize damage without having to remove acoustic/anechoic tiles.

2

THE SOLUTION

An electromagnetic solution based on a unique eddy current array probe with special coil design accommodating the presence of the tiles.

3

THE BENEFITS

Detecting corrosion and pitting—but also the disbonding of the tiles—at a fast pace, while obtaining repeatable and reliable results.

Submarines are a key element of most naval military forces. Able to perform reconnaissance missions or to act as a hidden ballistic missile platform, it is often important that they remain undetected by ships and other submarines. For this reason, modern submarine hulls are generally covered with thick polymeric tiles to provide enhanced stealth.

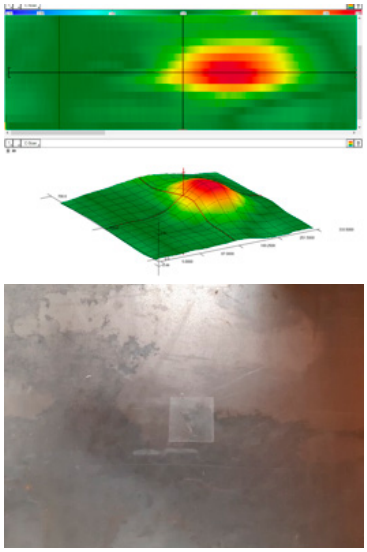
Unfortunately, the presence of these acoustic tiles on the submarine hull can conceal corrosion and other defects. To ensure safety and to maximize the submarine's longevity, it is critical to inspect the hull regularly to detect early stage corrosion and other damage that could be hidden beneath the anechoic tiles.

The Challenge

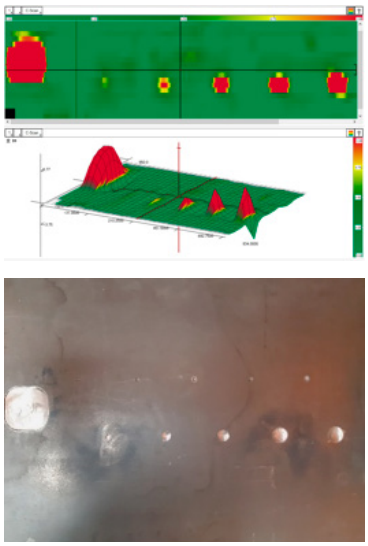
Carbon steel hulls are subject to corrosion when in contact with water. Although the tiles act as insulation from the surrounding water, disbonding or damage to the tiles could result in water infiltration, which can seriously degrade hull strength over time.

While the tiles can be removed to perform visual and ultrasonic inspection, the process is time consuming and very expensive. For this reason, departments of defence all around the world have started to search for a non-destructive evaluation method that could detect corrosion underneath the tiles without having to remove them. Several types of corrosion may impact a vessel's structural integrity: isolated pits, clusters of pits, generalized corrosion, or crevice corrosion.

Various methods have been investigated to solve this application, ranging from ultrasounds, guided waves, thermography and microwave testing, but none of these techniques have provided satisfying results.



ECA custom probe scanning over a 30 mm thick rubber tile with a 1 mm thick plastic film placed underneath



ECA custom probe on various round bottom holes over a 30 mm rubber tile

An appropriate inspection method still needed to be found, one that would safely:

- Inspect from the exterior of the hull without removing the thick rubber tiles
- Detect, locate and quantify corrosion
- Find disbonding of the polymeric tiles

Moreover, the non-destructive inspection technique would ideally offer interesting inspection productivity rates (given the large area to inspect) and allow performing the inspection while the vessel is submerged (if desirable).

The Benefits

The probe designed for this application has a coverage of 600 mm and a scanning speed exceeding 250 mm/s.

Operators can slide the probe over the tiles, visualizing live data as the probe moves. C-Scan imagery makes data analysis a very simple process by allowing positioning and sizing of defects. All data can be recorded for historical analysis.

To simulate disbonding, a 30 × 30 × 1 mm plastic tile was placed on a steel plate, covered by a rubber tile. As the probe moved over the insulation, the additional lift-off caused by the presence of the plastic sheet was clearly detected.

The current ECA probe, used on a plate with round bottom holes, could comfortably detect a 15-mm wide by 3-mm deep defect. All that under a 30 mm thick rubber tile.

The Solution

Eddy Current Testing (ECT) is a widely recognized non-destructive method. ECT has been commonly used to detect flaws on conductive materials in a variety of markets and applications, from nuclear to aerospace. Although ECT probes are generally used in contact with the material or over thin coatings, special coil designs can allow probes to penetrate thicker coatings such as 30 mm or 50 mm rubber tiles, and allow the detection of corrosion and disbonding of the rubber.

An improvement on ECT is Eddy Current Array (ECA): it allows the combining of multiple ECT sensors in one housing to cover larger areas more efficiently. ECA technology is generally faster and less operator-dependent than ECT, with additional benefits.

The probe can be mounted on a telescopic pole for dry dock inspection and could eventually be marinized for diver deployed inspections.

The probe is best used with the Reddy® portable instrument, as it is battery operated and can be easily moved around the hull as the inspection is performed.

This inspection solution represents only a fraction of what we do at Eddyfi. Challenge us with your project specifications!

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