Ultrasonic as an NDT method

((Ignacio Garcia de Carellan, BIC University)

By definition, NDT techniques are the means by which materials and structures may be inspected without disruption or impairment of serviceability. NDT is a branch of the materials sciences that is concerned with all aspects of the uniformity, quality and serviceability of materials and structures. The science of NDT incorporates all the technology for detection and measurement of significant properties, including discontinuities, in items ranging from research specimens to finished hardware and products [15].

Ultrasonic testing is a well-known non destructive technique [16]. This applies ultrasonic waves to detect where the "sound" is reflected back to the transducer. These reflections occurs due to the change in the acoustic impedance produced at any interface, such as the back wall of the object or any imperfection such as corrosion, cracks, pitting, delamination, and others. As a non-destructive technique, it can evaluate the properties of a material, component or system such as a ship hull without causing any damage.

This technique falls in two different big branches; Classic ultrasonic used to detect defects or measure the thickness in one point location in which the measurement is taken, and Ultrasonic guided waves which are used for the physical analysis of large structures such as; Pipes, rails, cables, or ship's hulls. This is possible due to the large distances that can be covered with each shot [17].

Cleanship uses guided waves for the prevention of biofouling in ship's hulls. For that, high power ultrasonic transducers are used in a level that can be considered also as a non-destructive technique. Some studies have been done with different materials and it has been proved that for steel, power density levels below 80/100 W/cm^2 result in zero stress on the samples analysed [18].

Cleanship system has the capability of exciting its transducers up to 60 W. Considering that the transducers contact surface has a diameter of 56 mm, the area can been obtained from $a_{circle}=\pi\cdot d^2/4$. Then, the contact surface of the Cleanship transducers is 24.69 cm^2 and the maximum power per unit of the transducers contact surface is $P_{density}= P_{contact\_area}/ a_{plate}=2.43$ W/cm^2, which is well below the stress threshold estimated for steel structures.

On the other hand, the cross sectional area of the ship hull plate in which the ultrasound is propagated has to be considered. Thus, the power density depends on the transducers contact surface perimeter and on the thickness of the ship's hull. As the plate gets thinner, the power density gets higher. Figure A.1 shows the cross sectional area in which the power density could be higher.

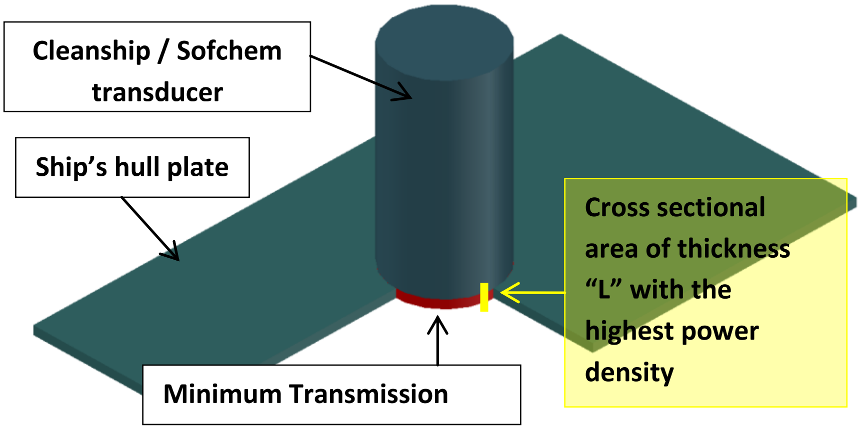

Figure A.1: Illustration of the cross sectional area of the plate in which the power density can be higher

To find the power density in that area the calculations have to be as follows; the cross sectional area is $a_{plate}=2\cdot\pi\cdot d/2\cdot L$ for a ship hull of thickness "L", where $2\cdot\pi\cdot d/2$ is the perimeter of the transducer's contact surface. Then the power density $P_{Density}$ in that area is:

$$P_{Density}= P_{Transducer}/ a_{plate}$$

Where $P_{Transducer}$ is the maximum power that can be driven by the transducer. Figure A.2 below represents the difference between the power densities applied by Cleanship system at each different ship hull thicknesses, the power density in the contact surface and the stress threshold.

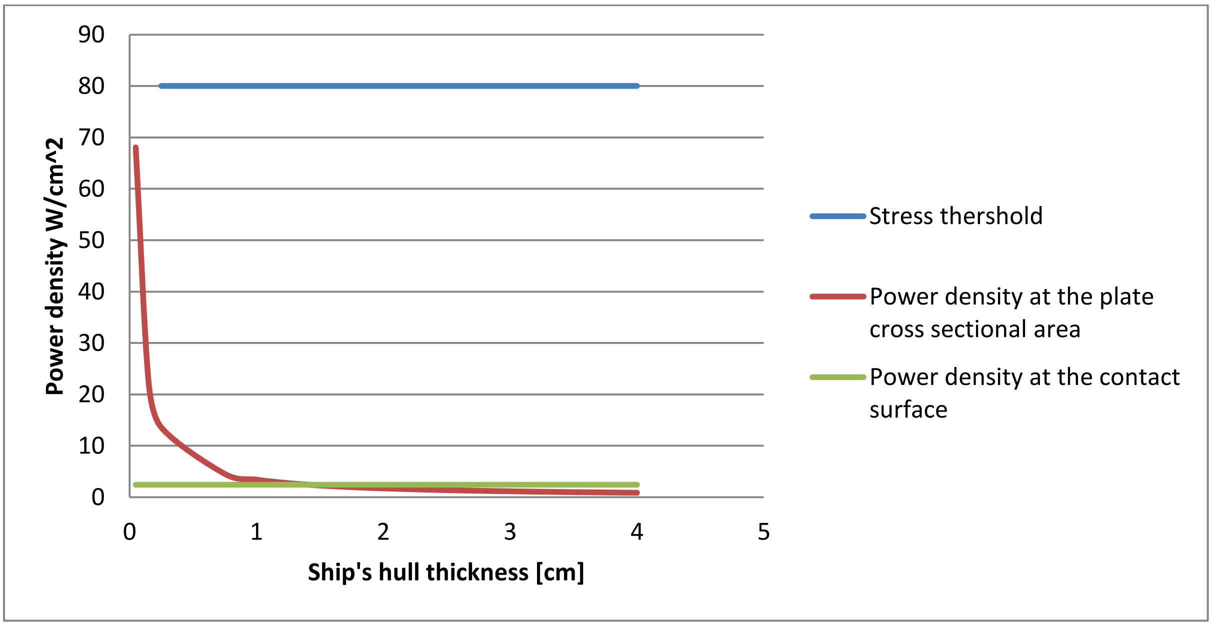

Figure A2: This figure is to be changed by the final one representing the different between our device and the damage threshold.

In figure A2 it can be seen that the power densities in a common ship hull excited with Cleanship system are always below the power density threshold and therefore it can be concluded that Cleanship system produces no damage.