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GUIDELINES FOR THE USE OF FRP WITHIN SHIP STRUCTURES

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SUMMARY

Executive summary:

Fiber Reinforced Polymers (FRP) present a significant opportunity to reduce the carbon footprint of the maritime industry through lightweighting, contributing directly to the IMO's ambitious GHG reduction targets. However, the unique properties of FRP introduce complex challenges related to fire safety, structural integrity, and lifecycle environmental impact. This paper advocates for the urgent development of comprehensive, goal-based guidelines for the use of FRP in ship structures. Such guidelines must ensure that the environmental benefits of FRP are not achieved at the expense of seafarer safety or marine ecosystem health, mandating a holistic approach that covers design, manufacturing, operation, and end-of-life management.

Strategic Directions: PARAGRAPH 3
Output: PARAGRAPH 4
Related documents: SOLAS; FSS Code; MARPOL; Hong Kong Convention; STCW; MSC.1/Circ.1574; The 2023 IMO Strategy on Reduction of GHG Emissions from Ships.

Action to be taken: Establish a working group to develop comprehensive guidelines for the use of Fiber-Reinforced Polymers (FRP) in the construction of ship structures, with a focus on ensuring safety, environmental sustainability, and seafarer welfare.

1. Analysis of Inherent Deficiencies in Conventional Shipbuilding Materials

The primary material in large-scale vessel construction is marine-grade steel. While it has been the industry standard for decades, its inherent properties present significant problems impacting vessel safety, operational efficiency, and environmental performance.

1.1 Weight Inefficiency:A primary drawback of steel is its substantial mass. Its high density increases a vessel's displacement, which raises the required propulsion power, leading to higher fuel consumption and greater greenhouse gas emissions. This weight also poses a significant barrier to adopting next-generation, zero-carbon fuels that require larger, heavier storage systems**.**

1.2 **Inherent Susceptibility to Corrosion:**Steel is highly susceptible to corrosion, a degradation process accelerated in the marine environment. This process, known as rust, constantly threatens the structural integrity of the ship's hull and critical members. Preventing this requires continuous, rigorous maintenance and coatings. Failure to manage corrosion effectively weakens the vessel, reducing its service life and operational safety.

1.3 **Thermal Limitations and Fire Risk:**Although non-combustible, steel has known thermal limitations. When exposed to high temperatures from a shipboard fire, it loses its mechanical properties and structural integrity. This can lead to the collapse of decks and bulkheads, exacerbating the danger and posing a severe risk to the vessel and crew.

The NGO advocates for a precautionary approach, insisting that before new technologies like FRP are widely adopted, a comprehensive regulatory framework must be developed to address potential risks and ensure the safety of seafarers and the marine environment.

2. The imperative to address material deficiencies to prevent problems

Failing to address the problems in conventional materials has direct and serious implications for maritime safety, as they are underlying risk factors for significant accidents.

The most pressing concern is structural degradation from corrosion.

2.1 Corrosion is a progressive process that reduces the thickness and strength of steel plates. If unmanaged, this can compromise the vessel's ability to withstand dynamic loads at sea, creating a tangible risk of catastrophic structural failure. The only prevention is extensive, costly, and energy-intensive maintenance, such as renewing corroded steel plates.Furthermore, the loss of structural integrity during a fire is a critical safety issue. A ship's ability to contain a fire and remain intact is fundamental for crew evacuation and firefighting. Due to steel's thermal limitations, a severe fire can cause structural collapse, leading to a rapid escalation of the emergency, compromising escape routes, and jeopardizing the safety of all personnel.

3. How FRP minimizes these problems

Fiber-Reinforced Polymer (FRP) is a composite material that offers a direct and effective solution to the weight and corrosion problems of steel. FRP provides a pathway to building safer, more efficient, and more durable vessels.

3.1 Addressing Weight and Enabling Future Technologies: FRP's most significant advantage is its superior strength-to-weight ratio. FRP components can be up to 50-70% lighter than their steel equivalents while offering comparable tensile strength. This dramatic weight reduction lowers propulsion power needs, leading to a direct and significant reduction in fuel use and emissions. Critically, this lightweighting is an essential enabler for the transition to zero-carbon fuels like ammonia and hydrogen, as it can directly offset the "fuel penalty" of their bulky storage systems without compromising the ship's commercial viability.

3.2 Eliminating Corrosion Risk: FRP is inherently resistant to corrosion and does not rust in a marine environment. This fundamentally eliminates the risk of structural degradation that plagues steel vessels. Using FRP dramatically reduces the need for extensive anti-corrosion systems and frequent maintenance, which lowers costs and avoids the energy-intensive process of steel renewal. The result is a vessel with increased durability and a longer, more reliable service life.

4. Recommendations for the use of FRP

4.1 Resins with low smoke emission and minimal toxicity should be prioritized to enhance fire safety and environmental compliance, while fiber materials should be selected based on their superior strength and durability properties.

4.2 Implement specialized training programs for personnel focused on advanced composite fabrication techniques and repair methodologies to ensure high-quality and reliable maintenance standards.

4.3 Establish a circular economy framework for composite materials, emphasizing recycling, reusability, and sustainable lifecycle management to minimize environmental impact and resource wastage.

With request of theCommittee we would like this paper to be used as the basis for our inclusion in the IMO Working Group.