

Structural Feasibility Assessment of a DDG51 Flight IIA

Conversion to D0 Ice Capability

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Global attention has increasingly focused on the Arctic as climate change opens more polar areas to navigation for longer periods of time each year. Oil reserves and other natural resources as well as significantly shorter transoceanic shipping routes have transformed the Arctic into a crucial region of heated international competition. While submarines maintain the capability to breach thin layers of ice in the Arctic, few surface combatant vessels possess the capability to transit the Arctic. Using the current DDG51 Flight IIA, this study provided the US Navy with a greater understanding of achievable and affordable ice capability for the selected hull.

The objective of this study was not to redefine the mission, concept of operations (CONOPS), or operational profile of the DDG51 Flight IIA. Rather, the objective was to expand the current capability set of the vessel to support a nominal level of ice capability required for associated Arctic missions. The goal of this study was to determine the minimal amount of change and cost required to make the DDG51 Flight IIA mission capable with D0 Arctic performance, as defined by the American Bureau of Shipping (ABS) Steel Vessel Rules (SVR), Part 6, Chapter 1, Section 5 (Requirements for Vessels Intended for Navigation in First-year Ice).

With the recommended changes, 100% mission capability was not achievable while operating this vessel in the presence of ice because of potential degradation to sonar capability. However mission capability was maximized to the greatest extent possible with available resources. Analysis will be required to determine if the vessel – after structural ice-hardening – is capable of deploying and using its various installed weapon systems and sensors reliably without risking damage and loss of the system altogether. Due to the structural changes of the ship being confined to the forward 30% of the ship, no impact to deployable systems was expected. Non-deployable systems of immediate concern included the flexible rubber sonar dome attached to the bulbous bow and the pitsword used for speed sensing below the keel. While solutions are presented to either increase mission capability or prevent damage to critical mission systems while operating in ice conditions, it was beyond the scope of this study to analyze their ice effects or design for their protection.

The DDG51 Flight IIA remains a versatile multi-mission platform. It is outfitted with an array of weapons, sensors, and armaments that provide for surface, sub-surface, and air warfare missions. Recent enhancements to the platform have added ballistic missile defense capability as well. Again, this study focused entirely on supplying the US Navy with the ability to use the DDG51 Flight IIA to a mission-limited extent in Arctic regions of immediate concern. It was

undesirable to attempt to redefine how these vessels are currently deployed. The most likely mission-limiting factor was AN/SQS-53C performance after the addition of ice protection steel plating, though onboard assets such as TACTAS and dipping sonar were assumed to mitigate any performance losses.

The Flight IIA model was modified using ASSET, POSSE, and RHINOCEROS as well as a parametric model in MATLAB to achieve the desired ice capability. A parametric analysis was used in accordance with the guidance of ABS Steel Vessel Rules, Part 6, Chapter 1, Section 5 to determine compliance. Once compliance with ABS rules was achieved, the changes to the DDG ship design were analyzed with a weight-based cost model to determine the anticipated incremental cost to the ship delivery process for the desired ice capability. The end product was a comparison of ice capability to expected cost increase.

