A New Self-Defense Test Ship

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Since 1981, the U.S. Navy has employed a series of unmanned ships to conduct self-defense weapons system testing. The current Self-Defense Test Ship (SDTS) is not equipped with a SPY-6 Air and Missile Defense Radar (AMDR), Aegis Combat System, or Block-2 Evolved Sea-Sparrow Missile (ESSM) and is therefore unsuitable to conduct testing for the Flight III series of *Arleigh Burke*-class destroyers which are expected to enter service in 2023. As part of MIT's four-week course 2.704: Projects in Naval Ship Conversion, three graduate students sponsored by NAVSEA 05 investigated the academic feasibility of converting an existing naval vessel to fill this capability need without jeopardizing the crucial testing for non-Aegis combat systems conducted onboard the existing SDTS.

The group selected a *Ticonderoga*-class cruiser as the most suitable starting point for this conversion after a brief analysis of alternatives, and quickly narrowed the focus to the ex-*Ticonderoga* which is currently moored in Philadelphia awaiting disposal. Using this stricken ship bypassed the opportunity cost of taking an operational cruiser away from the Fleet. Equipped with a general impression of *Ticonderoga's* current status gleaned through a brief tour of this vessel, and technical data from a match-model in the Navy's Advanced Ship & Submarine Evaluation Tool (ASSET) software package, the group set about analyzing the feasibility of system-level modification options capable of satisfying the project requirements. Distilling 34,992 permutations of feasible propulsion systems, electrical systems, weapon systems, and combat system architectures yielded a configuration which balanced cost, capability, and future flexibility.

In this final variant, propulsion would be provided exclusively by the starboard propeller shaft powered by a single marine gas turbine engine, which, along with the steering system, would be converted for remote operation. The as-designed electric plant would be returned to operation and supplemented by an additional gas turbine generator. A 4160 VAC electric distribution system would be installed in the space vacated by the removal of the port propeller shaft. The aft twin-arm missile launcher would be replaced by an eight-cell vertical launch system to accommodate the ESSM, and large portions of the forward and aft superstructures would be removed entirely to accommodate a combat system modularized into a shipping-container-like architecture. To operate in a manned condition during transit, the pilothouse would similarly be modularized and would tie in to the remote-control infrastructure; berthing and messing for the reduced crew would be accommodated in the areas formerly designated for Chief Petty Officers.

The weight and stability changes associated with these modifications were analyzed using the Navy's Program of Ship Salvage Engineering (POSSE) software package, which demonstrated that in this configuration the vessel could safely accommodate up to 214 tons of combat system payload, centered 20 meters above the keel, in addition to 128 tons of modularized containers. With the addition of approximately 1,000 tons of solid ballast, this vessel would be capable of carrying an additional 300 tons of combat systems payload at the same height, making SDTS capable of accommodating Aegis and non-Aegis combat systems.

A cost analysis using a combination of data from the Navy's Regional Maintenance Centers, the MIT 2N cost model, and ship repair estimation techniques established a total estimated conversion

cost of approximately $75 million, excluding the cost of the combat systems payload. While unconventional in design, the cost and future flexibility provided by this conversion represent a reasonable option to satisfy the Navy's SDTS capability gap.

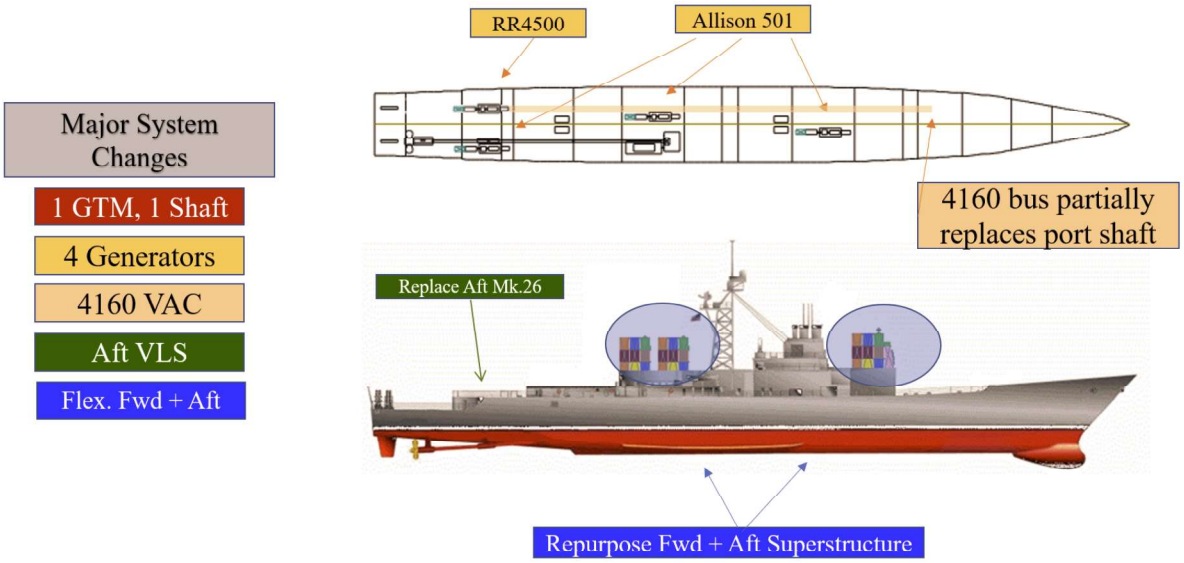

Figure 7: New Self-Defense Test Ship Concept