DDC Corvette Executive Summary

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As older platforms that employ the Vertical Launch System (VLS) are decommissioned, the Navy will lose 20% of its total available VLS cells. This study investigated the design and feasibility of a missile corvette (DDC) that would replace these cells in an affordable and distributed manner while preparing for a future conversion to full autonomy. It will serve as a steppingstone toward a Large Unmanned Surface Vessel (LUSV) which is currently being developed by PMS 406, The Navy's Unmanned Maritime Systems program office. The LUSV concept is centered around deployment as an additional "adjunct" floating magazine to supplement a separate target data ship (TDS). The DDC is meant to bridge the gap between the unmanned vessel challenges of the present and the LUSV of the future. Flexible architecture and a design philosophy prioritizing future autonomy will deliver a vessel that is both initially capable and able to fill the future role of the LUSV.

The initial requirements for the DDC consisted of 24 sponsor-defined requirements with an additional seven derived requirements generated by the design team. Through these requirements and cooperation with PMS 406, the team produced a design philosophy that consisted of the following ordered priorities: lethality, affordability, reliability, maneuverability/endurance, and flexibility. Due to the sponsor-furnished primary missions of Strike Warfare (STW) and Anti-Surface Warfare (ASUW), lethality was nearly synonymous with the number of VLS cells. Flexibility addressed readiness for future autonomy and maneuverability/endurance ensured that the DDC could maneuver with existing battlegroups.

Initial exploration examined a number of combinations of hull forms, VLS configurations, and other systems and characteristics. Through a technically rigorous system-level analysis and evaluation process, the team generated a valid possible solution set within the Rapid Ship Design Environment (RSDE) which weighed cost versus a requirement-based Overall Metric of Effectiveness (OMOE). From this solution set, a preferred variant was selected which utilized the monohull National Security Cutter (NSC) as a base and included 48 VLS cells and an Integrated Power System (IPS).

Further analysis focused on feasibility and optimization of specific capabilities of the DDC. One of the most difficult aspects of this design was the relatively small size of a corvette-sized vessel. While there is no accepted definition of what a corvette class actually entails, parametric analysis of corvettes from navies around the world indicate no more than 4,500 LT or

400 ft length overall. Because of this, the DDC endeavored to be as small as possible while still delivering the desired VLS cells to support STW and ASUW missions. One of the key aspects of the DDC that supported this was the inclusion of an IPS instead of a traditional mechanical propulsion train. IPS offered a number of benefits. First, it enabled flexible engineering plant configuration which allowed the team to include all of the desired engineering systems in a space-limited hull. The team opted to install seven diesel generators to supply power and propulsion to the DDC. IPS enabled the distribution of these generators around the ship, thereby enhancing survivability. Finally, IPS and the team's decision to include multiple medium-sized generators enabled efficient generator loading, reducing lifecycle costs through fuel savings.

Analysis was conducted to ensure the operability of VLS on a relatively small vessel. Because VLS has kinematic constraints, detailed in STANAG 4154, the sponsor requirement of operability in sea state five proved a pervasive problem. Detailed technical analysis was conducted to reduce the motions experienced by VLS to include geometric placement and motion-reducing systems. Ultimately, the DDC was able to launch in a restricted sea state five window.

The team performed detailed technical analysis in three areas of ship design. The first investigated engine room ventilation to effectively manage the heat generated by IPS engineering spaces. Through CFD analysis, intake and exhaust ducting was reduced in size by an average of 17.5% while still meeting ISO standards for diesel ventilation air flow requirements. The second study investigated the inclusion of passive anti-rolling fins to expand the VLS launch window in the most extreme case. While moderately effective, these fins did not appreciably lower the motions to enable VLS launch in the worst case of sea state five. The final analysis explored the replacement of traditional propellers with podded propulsors to further increase fuel efficiency. Podded propulsors would require significant hull modification that would increase resistance, effectively eliminating the increased efficiency from the podded propulsors. Moreover, they would require significant rearrangement of transverse bulkheads, leading to the DDC failing floodable length criteria. For these reasons, they were not included in the final design.

Pursuant to the affordability tenet of the design philosophy, the team conducted a detailed cost analysis which utilized the MIT cost model and an unofficial evaluation by Naval Sea Systems 05C, both of which utilize SWBS-based Cost Estimation Ratios (CERs). The 05C results without inclusion of GFE indicated a lead ship cost of $521.5 in TY23 dollars with follow-on hulls costing an average of $382.0M in CY22 dollars, well within the $500M goal. The MIT cost model assessed the costs to be higher, by including a fixed ratio estimate for GFE costs. The lack of a GFE estimate in the 05C analysis accounts for some of the difference between the two estimates.

The final DDC design offered a modern material solution to the loss of VLS cells brought on by the decommissioning of Ticonderoga class cruisers and SSGNs. Built to be lethal, cost effective, and quickly deliverable, the DDC offered a minimally manned vessel that could be deployed alongside a target data ship to bolster the amount of missile cells available in a SAG, CSG, or ARG. The DDC supports STW, ASUW engagements, and own ship self-defense at an affordable cost.