Power Electronic Module

DDG 1000 Cost Reduction Initiatives

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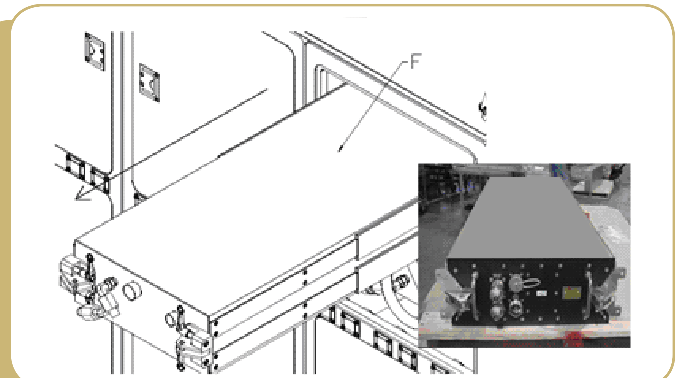

The current configuration of warships separates their propulsion system from their weapons and auxiliary systems. This confines a large amount of power in the mechanical drive train, which is not available for other uses. Future all-electric warships will change this situation, allowing large amounts of energy to be shared among different systems, such as pulsed power weapons and sensors, on a prioritized, as needed basis. This paradigm shift to an integrated all-electric design will significantly improve efficiency, effectiveness, and survivability while simultaneously increasing design flexibility, and reducing costs.

This next-generation warship integrates numerous critical technologies and systems into a complete warfighting system where propulsion is no longer the only significant power load. An electric weapons system, the continuous use of active and passive sensors, and a Dual-Band Radar (DBR) suite draw an even greater amount of electric power. Even the requirements for enhanced computer capability are increasing power requirement levels. The US Navy's revolutionary vision for 21st Century surface combatant designs provide for continuous incremental increases in warfighting capability while reducing costs. This can only be accomplished with greater standardization across programs and an open architecture approach to electronics system design.

DDG 1000 introduces a wide range of new technologies that will generate tangible breakthroughs in performance and affordability. Advances such as the Integrated Power System (IPS) provide continuous power throughout the ship, allowing enhanced survivability by reducing the susceptibility to damage and increasing the ability to fight through damage. This integrated fight-through power (IFTP) is based on a modular power system building block or power electronic module (PEM) that can be connected in parallel or in series to support a wide range of power. These are line replaceable units designed by DRS that are based on lessons learned from a previous program. By leveraging the commonality in equipment for the two programs, there is a reduction in non-recurring engineering costs (NRE), as well as a lower schedule risk and reduced cost. The Navy benefits from this approach in lower acquisition and life cycle costs, increased quantity buys of common PEMs, reduced inventories of spare PEMs required, and more affordable training and maintenance activities.

To further reduce acquisition costs, the EMPF has begun a new project sponsored by Navy ManTech titled "Power Electronic Module

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Cost Out for the IFTP Program" that will focus on a series of improvements to advanced power electronics hardware devices. The PEMs used in the IPS are currently designed for use in DDG 1000 and can extend DDG 1000 technology/systems developments to other ships of the US Navy Fleet. The scope of this project is to optimize the manufacturing technology of the PEMs to achieve higher production yield and reduce cost and schedule risk.

This program will investigate and implement additional cost reduction opportunities for the PEM that will improve the affordability of the IFTP System. After proposing changes that can reduce the materials and assembly price of each system, a prototype manufacturing cell will be developed that will produce four PEMs. The four Generation 1 IFTP PEMs will be built in series to validate the improvement in the build process by measuring improvements achieved in successive builds. The building of these modules will substantially accelerate the manufacturing learning curve. The building of four PEMs is also necessary to enable DRS to perform full-power parallel operation tests. Demonstrating the Generation 1 PEM design is capable of full-power parallel operation will enable early retirement of a high risk design milestone and the schedule risk associated with waiting for delivery of production qualification PEMs to perform this test. The findings of the build and test activities will be documented to capture the manufacturing improvements between each build. Any anomalies can also be investigated and resolved sooner than could be done under normal manufacturing conditions.

Further improvements and lessons learned during the first build, will be redesigned, incorporated, and built into assemblies to retrofit the four existing PEMs, resulting in a second generation of PEMs. This will reduce the risk of encountering performance issues during the First Article manufacturing and test phases, and ensure that delivery schedules will be met.

This program will also develop several enabling manufacturing technologies. Enhanced modularity in the design will target improved manufacturing cycle time and reduced sourcing expense. Manufacturability will be improved by eliminating cables through packaging and connectivity designs. By designing a circuit board to distribute power between other boards, assembly will be simplified and reliability enhanced. This will provide mechanical structure as well as route both control and control power to the other circuits. A number of packaging concepts will be evaluated. The selected approach will drive the packaging, layout, and connectorization of the PEMS. Difficult to assemble connectors will be replaced by board to board connectors to decrease labor time for assembly.

Recurring manufacturing costs in terms of applied labor and materials can be reduced by simplifying the design to reduce part count and increase the reliability. Key parts will be targeted for cost reduction opportunities. Commercial off the shelf solutions will be evaluated to replace custom designed assemblies where they meet all requirements. To validate and accelerate the implementation of the cost reduced designs, this project will also prepare an efficient manufacturing cell. As the design progresses, materials will be procured and documentation prepared to support a prototype build of PEMs. By building and testing two generation one prototypes and two generation two prototypes, the cost reduction methods are validated, the manufacturing learning curve is accelerated, and the lessons learned are quickly incorporated into the production build of the power electronic module. Manufacturing costs will also be reduced for labor and materials by using validated designs.

The manufacturing process improvements developed as a result of this work is potentially applicable to other shipbuilding programs, thereby offering the Navy an exceptional return on investment. Along with increased performance, decreased weight, and higher reliability, benefits to the Navy include reduced system costs and improved maintainability and supportability. The Second Generation PEMs would be immediately utilized in the DDG 1000 program as well as in planned U.S. Navy growth initiatives, including IPS commonality initiatives planned for future surface combatants, submarines, auxiliary ships and carriers.