American Competitiveness Institute
One International Plaza • Suite 600
Philadelphia, Pennsylvania 19113
Ph: (610) 362-1200 • Fax: (610) 362-1290
www.aciusa.org
www.empf.org

IPS Integrated Power Systems

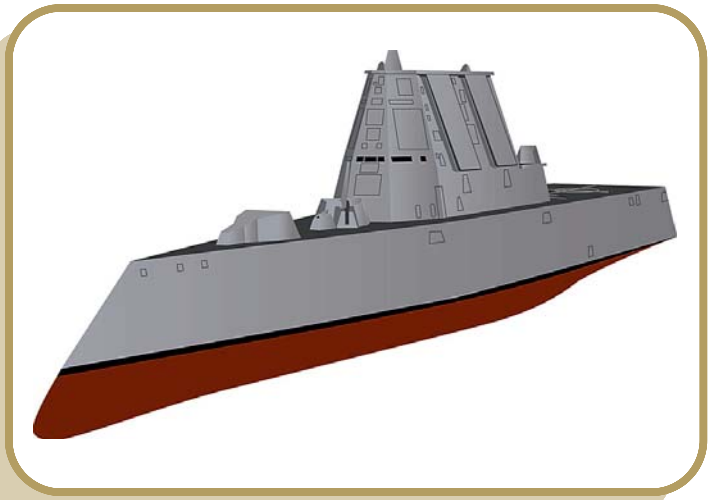
ACI has begun a new project sponsored by "NAVSEA titled Advanced R&D for Navy Integrated Power Systems (IPS)," that will focus on a series of advanced power electronics hardware devices. These devices will be evaluated for their performance to determine the effectiveness of these new technologies for direct use in high power Navy applications. To evaluate these new advanced technologies, the project was broken down into three major subtasks: fiber optic sensors, wide band gap devices, and advanced heat exchangers. These new advanced technologies have the potential to increase system reliability, increase power densities, and improve system performance monitoring. The objective is to validate these alternative technologies on a suitable demonstration vehicle capable of providing significant IPS fault anomalies. Upon demonstrating the effectiveness of these technologies versus the current standard, ACI will assist with the implementation of these technologies within the Navy DD(X) IPS systems.

Task 1: Fiber Optic Sensors

Current sensor technologies are not capable of providing the necessary depth of data necessary for today's advanced power electronics. New advanced fiber optic sensors presently available offer several advantages over conventional sensors:

- ♦High Accuracy
- ♦High Frequency Response
- ♦High Resolution
- ♦High Sensitivity
- ♦Light Weight
- ♦Remote Operation
- ♦Self Adjusting
- ♦Small in size

Other benefits are that fiber optic sensors are immune to Electromagnetic Interference (EMI) and hazardous environments, remaining in operation at temperatures as high as 3,000°F and at pressures up to 20,000psi. An added benefit is that a single sensor may have the capability of measuring different variables simultaneously (i.e. temperature and pressure).



Computer render of the DD(X)

The objective of the Fiber Optic Sensors task is to develop a conceptual design of a Fiber Optic and advanced Sensor System (FOSS) utilizing these technologies to more accurately and reliably monitor the health and status of a ship's electric power system(s). ACI intends to evaluate advanced fiber optic and radio frequency (RF) sensor technologies to determine their capability to monitor component performance and power levels accurately and reliably.

There will also be an investigation into the ability of these sensor topologies and applications to report to an Integrated Condition Assessment System (ICAS) for ship wide Condition Based Maintenance (CBM). This will lead toward an open architecture standard allowing different manufacturer's fiber optic and RF sensors to operate within, and independently of, the power system.

continued

American Competitiveness Institute

Task 2: Wide Band Gap Devices

Another task integral to the IPS project is the study of advanced Wide Band Gap power electronic devices and their direct application within the different IPS topologies. Today's power system development demands that electronics demonstrate the ability to operate at higher temperatures, frequencies, and power densities. The benefits of these demands are reduced heat sink requirements, smaller magnetics, and improved efficiency, respectively. To help meet these demands, ACI's task involves a study of the different power conversion hardware within the IPS architecture and a subsequent assessment of the potential for applying Wide Band Gap (WBG) devices to those applications. ACI will evaluate the power requirements of IPS sub-systems, and identify the potential of adapting today's Wide Band Gap devices within those sub-systems. This is to include identifying the potential advantages and disadvantages for each application and a transition plan for implementing the devices. ACI will look to WBG device suppliers for information on the status of current device development and compare that with current system require-ments. Future WBG device applicability versus current sys-tem requirements analysis will provide the basis for WBG technology insertion.

Task 3: Advanced Heat Exchangers

The final task of the IPS project encompasses the assessment of various advanced heat exchanger cold plate materials, cooling media and concepts to determine their performance in a Navy DD(X) IPS power conversion, motor controller, and/or system protection application. There is a need to extract the heat that is generated by the operation of today's power electronics. Reducing the junction temperatures of electronic devices enables them to operate at higher ampacities. Lower operating temperatures also reduce stresses on the device which leads to improved efficiency and reduced failures. To improve the heat removal process, ACI will analyze and test today's heat transfer technologies along with advanced materials now available. Advanced heat exchanger and thermal interface materials to be investigated include phase change material, foamed graphite, micro-channeled copper, foamed carbon and aluminum. These materials shall be tested to determine their heat transfer capabilities, heat transfer mechanisms and properties. Alongside the materials investigation will be a complete cooling media assessment. ACI will assess water and propylene glycol along with Dynalene® HC cooling media, and test those media for both spray cooling and flow cooling applications. To complete the task, ACI will build prototype cold plates that can be installed in candidate IPS hardware and test the advanced heat exchanger in environments suitable for Navy applications.

The Navy has plans for advanced and integrated power electronics in future platforms. To fully exploit the electric power available on these new platforms, a fundamental change in how electric power is converted, delivered and managed will be required. ACI will utilize it's facilities in Philadelphia, PA to complete low power testing of the advanced power electronics hardware. For high power testing, ACI will partner with NSWCCD-Philadelphia to utilize the Land Based Test Site (LBTS) facility, and with their assistance, utilize the U.S. Army Aberdeen Test Center (ATC) located at Aberdeen Proving Ground, Maryland to complete testing and analyses of these new technologies. Along with increased performance, decreased weight, and higher reliability, benefits to the Navy include reduced system costs, improved maintainability and support-ability, and decreased man-power requirements.

One International Plaza, Suite 600, Philadelphia, Pennsylvania 19113
ph: (610) 362-1200 • fax: (610) 362-1290 • www.aciusa.org