

## **NAVAL SURFACE WARFARE CENTER – CARDEROCK DIVISION**

### **Our Capabilities**

The Carderock Division has a very comprehensive set of technical capabilities to support its mission. These capabilities cover all aspects of surface ship and submarine hull mechanical and electrical systems (HM&E) and cross all life cycles. In essence, the Division supports ships from keel to masthead and from cradle to grave.

The Division's technical capabilities were developed to support Navy and military requirements. However, because the mission of the Division is oriented to platform systems and not weapon systems, many of these capabilities are equally applicable to commercial ships. In fact, the legislation establishing the Division specifically requires the Division to "provide support to the Maritime Administration and maritime industry."

### **Products and Services**

The Carderock Division addresses the full spectrum of applied maritime science and technology, from the theoretical and conceptual beginnings, through design and acquisition, to implementation and follow-on engineering.

The scope of Division products encompasses individual components, subsystems, the ship/submarine as a whole, and the Fleet. This includes all technical aspects of improving the performance of ships, submarines, military water craft, and unmanned vehicles, as well as research for military logistics systems.

In addition, the Division is uniquely chartered by Congress to support America's maritime industry.

### **Core Competencies**

The Carderock Division addresses the full spectrum of applied maritime science and technology, from the theoretical and conceptual, through design and acquisition, to implementation and follow-on engineering. Our seven core areas of research and engineering expertise include:

#### **Signature and Silencing Systems**

Our people and facilities represent the Navy and the nation's capability to develop technologies and methodologies to reduce ship (including submarine, unmanned vehicle, and craft) signatures. Silencing products are the development of silencing requirements, silencing technology, materials, equipment and systems necessary to ensure that all Navy ships have the lowest possible

acoustic, radar, infrared, electro-optical and magnetic signatures that are cost effective and compatible with the ship's mission. In their application, the products reduce the signature(s) at its source, reduce the signature(s) before it is radiated, and/or impede the return of threat sensor energy to its source. Major functions include:

- Structural Acoustics, vibrations and target strength of ships and machinery
- Hydroacoustics of hull, turbomachinery, propulsor and flow control devices
- Signature mitigation materials sciences
- Active and passive acoustic signature measurement and diagnostic technologies
- Data acquisition, processing, and imaging systems
- Ship signature control integrated design
- Development of electromagnetic signature theory and analysis
- Infrared scale modeling and scaling
- Infrared signature measurement & diagnostic technologies; data acquisition, processing and imaging systems
- Signature mitigation materials sciences
- Electromagnetic signature measurement & diagnostic technologies; data acquisition, processing and imaging systems
- Radar cross section measurement & diagnostic technologies; data acquisition, processing and imaging systems
- Ship signature control integrated design

#### Vulnerability and Survivability Systems

The Carderock Division provides the facilities and expertise to conduct full-spectrum RDT&E, design/acquisition support, life-cycle management, and in-service engineering of vulnerability and survivability systems for current and future surface ships, submarines, Marine Corps vehicles, and related applications which require improved survivability against weapons (including chemical and biological agents), shock hardened hulls and equipment, enhanced safety, improved ability to fight hurt, weight reduction, advanced hull forms, the ability to operate in shallow water in order to meet the changing threat, the ability to meet Congressionally mandated Live Fire Legislation, and affordability. Major functions include:

- Provide a Vulnerability and Survivability capability to partner with industry and academia to translate military requirements into concepts, technical specifications, and systems (includes capability to conceive, engineer, guide the development of, and technically package ship and major weapon systems), that ensure an integrated and interoperable warfighting capability.
- Develop and validate procedures for the safe and effective design, development, validation, certification, storage and use of Vulnerability and Survivability systems and weapons.
- Ensure the stewardship of Navy Vulnerability and Survivability capabilities that have little or no private sector counterpart.

- Ensure the continued availability of a Vulnerability and Survivability capability, including ILS.
- Provide Vulnerability and Survivability technical information and analysis for development of effective training and tactics.
- Provide Vulnerability and Survivability expertise and oversight as smart buyer to ensure product and technical integrity.
- Retain those critical and unique Vulnerability and Survivability facilities that could only be replicated at great cost, or not at all; and provide access to test ranges and equipment.

### Machinery Systems and Components

This area provides the facilities and expertise to develop the concepts, technologies, equipment, systems and procedures necessary to enable all existing and future Navy ships to reliably, affordably, and effectively meet performance and mission requirements, from enabling technology throughout their life cycles for mobility in all sea states; environmental compliance; habitability; and combat systems interfaces.

NSWC scientists and engineers translate the basic findings from scientific research into useful naval machinery components, equipment and systems for naval vehicles (including ships, submarine, unmanned vehicles, and boats and craft). When selected for acquisition, these products and their management over the life cycle to a large part determine the viability of operation and the affordability of the naval platforms. Major functions include:

- Maintain accountability for the safety and effectiveness of our products.
- Provide the technical capability to anticipate and respond to current and future National needs.
- Serve as the interface between the Fleet and the shore infrastructure.
- Provide the necessary government oversight and ensure technical integrity of the acquisition and Life Cycle Engineering processes.
- Ensure interoperability of warfare systems and integrated warfighting capability.
- Ensure the availability of uniquely military products facilities, and services.

### Hull Forms and Propulsors

This area provides the Navy's only technical capability for surface and undersea vehicle hull forms and propulsors. It supports all naval vehicles (surface ships, submarines, unmanned vehicles, and craft) by developing the technologies for systems and procedures which define the external shape of the vehicle, control systems and control surfaces, and its propulsor interaction with the hull and its environment.

These systems are necessary to ensure that the performance of each platform meets mission requirements for controllability, mobility, seakeeping and propeller noise. These characteristics to a large part determine the safety, efficiency and affordability of the platform operation, and contribute to its signature

characteristics. This area requires extensive and highly specialized model testing facilities to support the development and validation of analytical tools. Major functions include:

- Conduct hydrodynamics research, development, testing, and evaluation.
- Develop Submerged Operating Envelopes and validate automatic maneuvering and depth control systems for submarines.
- Develop high efficiency, low-noise and affordable integrated hull propulsor designs for ships, submarines, and other vehicles that meet or exceed combat/weapon/sensor system interface requirements.
- Review designs and concepts for hydromechanics adequacy and suitability for operational use. and platform cost/performance trade-offs.
- Develop/validate advanced design and analysis tools for naval vehicles and propulsors.
- Provide hydrodynamic support for towed arrays and systems including minesweeping.
- Conduct R&D in fluid dynamics and experimental techniques related to naval vehicles.
- Validate and improve Computational Fluid Dynamics codes for propulsor design, submarine maneuvering and fluid dynamics.
- Support the investigation into the physics of non-acoustic signatures.
- Maintain corporate knowledge and data base of hydrodynamic performance of fleet submarine maneuvering control behavior and ship performance characteristics.
- Test & validate the hydrodynamic performance of new ship and submarine construction, modifications, and advanced hull forms (e.g. SWATH's, UUV's, amphibious assault craft) for safety, sea keeping, signatures, maneuvering and control, resistance and powering.

### Structures and Materials

Structures and Materials is a combination of specialized expertise and unique facilities for the full spectrum of research, development, testing, evaluation, design, acquisition support, operations and maintenance, and in-service engineering for naval vehicles - surface ships, submarines, advanced craft, other vehicles, and their component systems (including weapons).

Structures and Materials includes the development of technology, concepts and procedures which enable the manufacture and safe operation of Navy ships and their component systems. These products to a large degree determine the efficiency of operation and affordability of the platform, its signatures, and its survivability. Major functions include:

- Certify/Validate safety and effectiveness of Ship Structures and Materials, and Weapon Materials.
- Develop and validate procedures for the safe and effective design, development, and use of Ship Structures and Materials, and Weapons Materials.
- Provide Navy unique safety procedures (radiation monitoring).

- Provide the body of knowledge to sustain stewardship of Structures and Materials.
- Provide in-house Ship Structures and Materials, and Weapons Materials research partnering with industry and academia to ensure technological superiority for future fleet's warfighting systems.
- Provide Emergency Fleet Response.
- Understand the application of commercial technology to military requirements.
- Ensure the continued availability of Structures and Materials in-service engineering capability, including ILS, to support all ships and weapon systems.
- Provide the in-house Structures and Materials technical expertise required to manage the acquisition, maintenance and modernization of ship and weapon systems.
- Ensure independent and objective Ship Structures and Materials, and Weapons Materials testing, validation and integration of products.
- Provide the Navy's Structures and Materials capability to engineer technically superior warfare systems that ensure an integrated and interoperable warfighting capability.
- Retain those critical and unique Ship Structures and Materials, and Weapons Materials facilities that could only be replicated at great cost, or not at all.

### Environmental Quality Systems

The Navy is continuing its substantial investment at the Naval Surface Warfare Center, Carderock Division to design, engineer, test and evaluate military mission compatible, efficient, and cost-effective shipboard environmental systems to allow ships to train and operate unrestricted by environmental constraints, to minimize waste generation, to eliminate the use of harmful chemical compounds, and to destroy or appropriately treat wastes on board ship.

The Environmental Quality Systems area at the Carderock Division provides the core technical expertise necessary to equip Navy ships with procedures, equipment and systems that are best suited and/or designed to meet the unique requirements within the constraints of the warship environment (e.g., space, weight, stealth, noise, logistics, manning, etc.).

The engineers and scientists at the Carderock Division utilize internal and external Navy resources to expertly integrate the latest commercially and university developed technology into products for today's ships and the environmentally sound Fleet of the future. Major functions include:

- Provide in-house Environmental Quality research partnering with industry and academia to ensure technological superiority for the future fleet's war fighting systems.

- Provide government Environmental Quality expertise and oversight as smart buyer to ensure product and technical integrity, and to enhance competition.
- Ensure the continued availability of in-service Environmental Quality engineering capability, including ILS, to support all ships and weapon systems.
- Provide interrelated and broad Environmental Quality capabilities for systems engineering solutions to complex problems.
- Provide the body of knowledge to sustain stewardship of Environmental Quality systems throughout their lifecycle.
- Provide expertise in the acquisition of and integration into Environmental Quality systems for ships.
- Ensure independent and objective Environmental Quality testing, validation and integration of products.

### Design and Integration Technology

This area focuses on the capability to integrate multi-disciplinary technologies and systems into total ship designs and support analyses for surface ships, submarines, combatant craft, and Marine Corps vehicles.

Included are the engineering processes that cut across the ship and craft designs including cost/warfighting effectiveness, total ship design concepts, shipbuilding and manufacturing technologies, logistic support systems, physics-based modeling and simulation, and information systems.

It is a combination of specialized expertise, unique and complex computer codes, computer workstations, large screen computer visualization, Integrated Product Team spaces, facilities, and secure working environments.

These building blocks provide a total system capability, technical depth and breadth, operational understanding, and a vision for producing effective and affordable naval and maritime ships and vehicles. Major functions include:

- Provide acquisition milestone support, especially pre-Milestone 1.
- Perform Analysis of Alternative evaluations.
- Evaluate the Total Ownership Cost (TOC) of naval forces, ships, ship systems, and ship components.
- Perform Cost as an Independent Variable (CAIV)
- Technical Authority Boats and Crafts
- Life Cycle Management, Configuration Management, Integrated Logistics Support
- Program manager and Technical Development Agent for USMC Maneuver.
- Generate ship and submarine designs, and assesses their performance.
- Support Navy ship acquisition programs through all phases of design, construction and in-service engineering.
- Automated ship fabrication and repair technologies

- Proven Integrated Process and Product Development (IPPD) expertise
- The Division also provides limited support to other Naval Surface Warfare Center core business areas in surface combat systems, littoral warfare, ordnance and strategic systems.

## **Facilities**

The mission and workload of the Carderock Division requires extensive facilities. Work is performed across the life cycle of naval vehicles and includes the full breadth of technologies associated with surface ships; submarines; boats and craft; unmanned vehicles, ranging from small models in laboratories to large models; and operational ships in the ocean environment.

Many of the facilities needed to support the Division's mission are unique in the Navy, in the nation or in the world. Since workload is variable for individual facilities from year-to-year and because many of the facilities have little or no commercial application, there is little economic incentive for industry to develop or maintain similar capabilities.

Although analytical models and analysis techniques have been developed and are being continually refined, facilities are still needed to validate the models/techniques and to ensure that new ships meet performance specifications on delivery and operational units continue to perform as designed before going in harm's way. Consequently, the Carderock Division is one of the Navy's most facility-intensive research and engineering activities.

Carderock Division facilities are available for use by outside sources (both government and private sector) through Cooperative Research And Development Agreements (CRADA) and Work For Private Party Agreements.