

# LEADING

Volume 7, Issue No. 1

NAVAL SURFACE WARFARE CENTER, DAHLGREN DIVISION

# EDGE



# E3

## ELECTROMAGNETIC ENVIRONMENTAL EFFECTS

# Challenges & Solutions for the 21st Century



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# E3



*E3 – Electromagnetic Environmental Effects*

# Introduction

ELECTROMAGNETIC ENVIRONMENTAL EFFECTS (E3) AND THE NAVSEA WARFARE CENTERS



Rear Admiral James J. Shannon  
Commander, NSWC

Communications, electronics, and sensor systems aboard U.S. naval ships and submarines must operate effectively in order to support the execution of military missions and operations. Whether operating alone or with coalition forces, the Navy must be prepared to execute its missions anywhere in the world and under any condition. We must also be prepared to operate effectively throughout the entire frequency spectrum. As such, the Navy's systems must operate and interoperate safely and effectively without interfering with or degrading the system performance of other systems aboard ship. It is also necessary that U.S. systems do not impact, or be impacted by, other coalition or adversary systems operating in the same electromagnetic environment.

This issue of *The Leading Edge*, sponsored by the NAVSEA Warfare Centers, is dedicated to the critically important area of electromagnetic environmental effects, otherwise referred to as E3. It is an area that touches all naval operations—afloat and ashore, and all spectrums of conflict. So, whether the Navy's actions involve combating traditional adversaries, countering terrorism, thwarting pirates, responding to natural disasters, or supporting humanitarian operations, the Navy's systems must operate effectively and reliably in the electromagnetic environment in order for its missions to succeed. Ensuring that the Navy's missions succeed underlies one of the NAVSEA Warfare Centers' most important roles.

The Naval Surface and Undersea Warfare Centers research, develop, test, and evaluate cutting-edge technologies to arm the Navy with the capabilities it needs to fight and win in the electromagnetically challenged environment. They make certain that the Navy's individual components are designed, developed, and integrated as systems so that they perform optimally and interact seamlessly with other systems to achieve operational readiness. As an experienced commander and operator at sea, I understand the critical need for electronic, communications, and sensor systems to operate safely and effectively. I also understand how important it is for a ship commander and crew to have confidence in the ship's systems. If they do not function properly, missions can be seriously degraded, and lives can be lost.

With these thoughts in mind, I am pleased to introduce this issue of *The Leading Edge*. I invite you to explore its pages and learn about the exciting and important work being accomplished by Warfare Center scientists, engineers, technicians, and professional support personnel. As a result of their dedication, hard work, and contributions, I am proud to say that our warfighters, our Navy, and our nation are stronger, safer, and more capable than ever before.



## Introduction

MEETING THE ELECTROMAGNETIC ENVIRONMENTAL EFFECTS CHALLENGE



Captain S. A. Patterson, USN  
Commander, NSWCDD



With the ever-increasing number of complex systems and systems of systems aboard ship, electromagnetic interference is a continuous challenge. I am encouraged that we are meeting this challenge by providing technological solutions to ensure a safe environment, both afloat and ashore. Through the genius of our scientists and engineers—who constitute our collective electromagnetic environmental effects (E3) expertise—we are keeping our sailors safe and achieving operational readiness.

By taking a look at where we've been, beginning with the earliest hazards of electromagnetic radiation to ordnance (HERO) research and development, it is evident that our grounding in electromagnetic technologies is the bedrock of our continuing solutions for the hazards posed by magnetic fields. The importance of our history is further confirmed in the evolving methodology and examples of applications of our engineering analysis that are presented in this E3 issue of *The Leading Edge*.

It is enlightening to read about the history of E3 research and the continuing investigation into E3 technology here at NSWC Dahlgren. Tackling E3 challenges, however, has not been our job alone, but has been, and continues to be, a joint effort across the warfare centers. As David Johnson, NAVSEA 05W43, points out in discussing the Tri-SYSCOM EM Leadership team, our E3 solutions are the product of careful coordination and broad collaboration of scientists and engineers across NAVSEA.

Besides featuring the many ship and submarine applications, some of the articles in this issue of *The Leading Edge* demonstrate how we employ E3 technology beyond the U.S. Navy. Wider applications include support of our warfighters through innovations in counter remote control improvised explosive device electronic warfare and defending our nation here at home through integrated topside design support for the U.S. Coast Guard. In addition, our Afloat Electromagnetic Spectrum Operations Program (AESOP) engineering team's analysis of electromagnetic interference tells the story of how we applied E3 knowledge to support Hurricane Katrina Disaster Relief Operations. Other articles show how we ensure that the latest EM technologies are infused into our knowledge-sharing initiatives and training.

I am proud to be Commander of one of the Navy's premier research and development facilities for E3 technology and am confident that NSWCDD will continue its legacy as a leader in providing E3 solutions for the Next Navy and the Navy After Next.

# E3

# Introduction

## ELECTROMAGNETIC ENVIRONMENTAL EFFECTS (E3): ENGINEERING THE NAVY'S MISSION SUCCESS



Mrs. Virginia S. Hudson  
Head, Electromagnetic and Sensor Systems  
Department

Welcome to our E3 issue of *The Leading Edge*. If you are new to the world of electromagnetic environmental effects, prepare to be surprised by the spectrum of products and services that we provide to our Navy and nation.

Electromagnetic environmental effects, or E3, as it is also known, represents the impact of the electromagnetic environment upon the operational capability of military forces, equipment, systems, and platforms. It encompasses all electromagnetic disciplines, including electromagnetic compatibility and interference; electromagnetic vulnerability; electromagnetic pulse; electronic protection; hazards of electromagnetic radiation to personnel, ordnance, and volatile materials; and natural phenomena effects, such as lightning and precipitation static. Understanding and controlling E3 is essential for the protection of people, ordnance, and missions when operating electronic systems (e.g., communications, radars, weapons, sensors, etc.) in the electromagnetic environment.

The Electromagnetic and Sensor Systems Department, located at NSWC Dahlgren, Virginia, supports the U.S. surface Navy's current and future E3 needs. Our mission is to deliver unsurpassed electromagnetic technologies, systems, and solutions to our naval forces and nation. We take great pride in performing our mission, while also recognizing that much more needs to be done.

A number of organizations—some of which have offered articles for this publication—and people representing our partners from across government, academia, and industry contribute toward making sure that our Navy maintains spectrum advantage over its adversaries. Our Electromagnetic and Sensor Systems Department, for example, is frequently called upon for its expertise in solving some of the Navy's most complex electromagnetic and sensor system challenges. A continuing concern we face, however, is that sometimes we might not be called upon for our expertise until after systems have already been designed, developed, and integrated on naval platforms. As such, situations sometimes surface when radar or sensor systems interfere with communications systems, or vice versa, or when extremely hazardous situations result from electromagnetic radiation impacting fuel, ordnance, or people. Consequently, not only are our sailors and our Navy's missions at risk, but by operating this way, achieving naval readiness takes longer and costs more.

Many of today's electromagnetic problems could be prevented by applying our E3 expertise at the front end of the acquisition systems design, development, and integration cycle rather than at the end. By doing so, electromagnetically dependent naval systems would be designed and systems engineered and integrated—as systems—designed to work optimally together to achieve peak performance while concurrently ensuring naval readiness and the safety of naval personnel. Thus, it's not just about understanding or fixing things in the electromagnetic environment; it's about designing a better future for the Navy.

Clearly, a great many E3 challenges require solutions in the 21st century—a statement that also serves as the theme for this issue of *The Leading Edge*. It further serves as our enduring quest as we work to arm our Navy and our nation with the capabilities necessary to help ensure that missions succeed, that adversaries are defeated, and that our homeland remains protected. I invite you to explore the broad and varied spectrum of articles in this issue to learn about our products and services, and the tremendous value that the E3 community provides.