Development of Electromagnetic Susceptibility Testing of Complex Systems at the Naval Surface Warfare Center, Dahlgren Division

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***Abstract*— The Naval Surface Warfare Center has been involved in electromagnetic susceptibility testing of complex systems for over twenty years. Applications have included electromagnetic compatibility, explosives and ordnance, electromagnetic pulse and high-power radio frequency testing. The challenges of testing complex systems have required the development of a complex testing infrastructure because the only way to approach the problem of predicting failure levels of complex systems is through a combined theoretical and empirical approach. This paper will describe the development of that test support infrastructure from its modest beginnings to its present state.**

Keywords-susceptibility, electromagnetic compatibility, high-power radio frequency

I. INTRODUCTION

The interaction of electromagnetic waves with real systems is very complex and requires an extensive span of capabilities and facilities to perform well-designed experiments. Recent recognition of a variety of electromagnetic threats such as high-altitude electromagnetic pulse, lightning, high-power radio frequency weapons, as well as more traditional high-power transmitters used in such commercial applications as radar and communications, have made the understanding and mitigation of the effects of these sources on electronic control systems vital to the continued proper functioning of our critical infrastructures. Test facilities must represent a variety of interesting systems and must be located so that a variety of high-power sources can be employed to mimic the myriad of proliferated electromagnetic threats. Available analytical tools should include a variety of statistical tools for data analysis and test planning, as well as in the prediction and interpolation of test data. This paper describes the development of such a capability base at the Directed Energy Warfare Office at the Naval Surface Warfare Center (NSWC) in Dahlgren, VA along with some of the theoretical developments used to extend the work to tactical scenarios.

II. APPROACH

The first step in building the capability base was to build a series of test facilities as shown in Figure 1. Those facilities include two multi-story buildings that use common commercial building construction techniques. These buildings are populated with electronic systems, such as computer networks, distributed control systems, communications switches, alarm systems, and Supervisory Control and Data Acquisition (SCADA) systems. In addition to the industrial control systems, actual pumps valves, tanks, and indicators are included to help understand the impact to the industrial process being controlled. The test facilities are located in NSWC-Dahlgren in an area where a variety of fields and impressed currents can be applied in realistic ways. A variety of test planning and data reduction techniques had to be developed to support the understanding of the causes of system and subsystem failure. These tools include statistical and analytical models of various types of system interactions. The point of the analysis is to develop the means to predict system and subsystem failure for a variety of illumination scenarios. Finally, numerical tools and analytical techniques are used to understand the coupling of the fields onto buildings, system cables, and other vulnerable parts of the system.

Figure 1. Open-Air Test Facility at NSWC Dahlgren