Raising Awareness to Organizational-Level Maintenance Activities to Electromagnetic Vulnerability Problems in the Fleet

By Anthony Staton, Electromagnetic Environment Effects (E3) Engineer, Naval Surface Warfare Center Dahlgren Division (Q52)

Identifying, understanding, and reporting properly shielded or unshielded cables and grounded and bonded 360-degree cables are essential to the organizational (O-level) sailor or marine. Having the prerequisite knowledge could reduce material down-time, trouble-shooting efforts, and increase resilient ordnance circuitry.

A signal ground is a point where voltage does not change, regardless of the current applied to it or drawn from it [Ott, Henry W. (1988). *Noise Reduction Techniques in Electronic Systems, 2nd Edition*.] Just as important as the physics behind a ground are the three fundamental types of signal grounds: single-point, multi-point, and hybrid grounds. Safety grounds such as those used in household wiring and other consumer products have a different application and will not be addressed in this article. Alternately, cable shielding is essential because cables are the largest and longest portion of the circuit, and will act as antennas that are passive or active radiators. Keep in mind that to be an antenna means that currents are present on the transmission line and will act as noise in the circuit. Too much noise can cause slight interference or may even kill the circuit.

Based on exhaustive electromagnetic vulnerability (EMV) testing by the E3 Assessment and Evaluation Branch (Q52) of the Naval Surface Warfare Center, Dahlgren Division (NSWCDD), the most common signal grounding technique used in Department of Navy systems is the single-point ground. Although this type of grounding is cheaper and easier to implement, it is also the most susceptible to its electromagnetic environment (EME). The grounding method is a poor choice due to the lack of redundancy. Acting as an antenna, the induced currents flowing in the circuit make the entire circuit susceptible. Figure 1 shows a basic single-point ground.

Figure 1. Single-point ground [Ott]

Figure 2 shows a much more robust multi-point ground with significant redundancy that increases cost by means of complicating the circuit. Cost issues aside, this is great for high frequencies because of return loop area. A more in-depth examination of the return loop area and how it reduces inductance can be found in *Noise Reduction Techniques in Electronic Systems, 2nd Edition* by Henry W. Ott. Acting as independent circuits, any susceptibility will not hinder the overall operation.

Figure 2. Multi-point ground [Ott]

The hybrid ground takes on the best characteristics of the single- and multi-point grounds. The low and high frequency characteristics permit a wider usage and are equal to or less complex as the multi-point signal ground. Figure 3 shows a typical—yet simple—hybrid ground.

Figure 3. Hybrid-point ground [Ott]

In addition to shielding and grounding the transmission lines, these techniques must be terminated in a fashion that consistently ensures the electromagnetic integrity of the circuit [Department of Defense Naval Air Systems Command AD 1115 (1988). *Electromagnetic Compatibility Design Guide for Avionics and Related Ground Support Equipment 3rd Edition*.] Terminating with MIL-SPEC connectors that are hardened specifically for high EMEs will ensure circuit integrity.

The final step in completing the circuit is terminating the shielding at a proper distance to the connector, which makes future maintenance/troubleshooting easier and less frequent. A proper distance is an appropriate length to compensate for cable bends and installing or removing connections. Additionally, bonding the connector 360 degrees not only provides maximum durability, but more importantly, ensures a good radio-frequency (RF) seal. It is well established that grounding and shielding are important in any environment that contains emitters. Also, it has been shown that when proper shielding is used, the shield should be grounded by some method. The location of the grounding is also important for robust designs. Finally, hardened connectors that are also terminated 360 degrees demonstrates quality design that will reduce troubleshooting and equipment lifecycle costs.

Figures 4 and 5 below show the best and worst fixes to O-level problems. Figure 4 is a Remote Weapons Station (RWS) connector that

continued on page 15

2011 DON Explosives Safety Conference

By Margaret Hayes, NOSSA Explosives Safety Operations Policy, Publications, and Training Branch Manager

The next DON Explosives Safety Conference will be held 28-30 June 2011 at the Armed Forces Recreation Center, Shades of Green Resort, Lake Buena Vista, FL. Commands involved in the ashore and afloat handling of, storing, transporting, testing, and/or manufacturing of ordnance or explosives and Arms, Ammunition and Explosives (AA&E) physical security are encouraged to send a representative. NOSSA sponsors this biennial event to discuss ashore and afloat explosives safety issues, including policies, criteria, compliance, personnel qualification/certification, AA&E physical security, ordnance environmental, lessons learned and program initiatives.

The conference will convene at 0800 and adjourn at approximately 1630 each day, 28-30 June. In addition to primary sessions, workshops will be conducted to address specific problems and ideas submitted by attendees and to provide explosives safety training.

Advanced registration via the NOSSA website is required; registration closes 21 June 2011 or prior if available slots are filled. A registration fee will not be charged for attending this conference. All attendees must pre-register as seating capacity is limited. Contractors wishing to register must acquire DON government sponsorship; form and requirements are located on the conference page of the NOSSA website at https://nossa.nmci.navy.mil/.

Early check-in to the conference will be held 1600-1900 on Monday, 27 June. Regular check-in will begin at 0700 on Tuesday, 28 June. The Shades of Green Resort has per diem rooms blocked for conference attendee reservation through 27 April 2011 or until all rooms in the block are filled if prior to that date. The conference webpage provides instructions on making these reservations.

A conference agenda will be posted on the website and updated as new information becomes available. Questions regarding the conference may be submitted by e-mail to INHDNOSSA-ESCONFERENCE@navy.mil.

Maintenance Awareness *continued from page 6*

has not been terminated properly. Although the cable is shielded and a MIL-SPEC connector was used, the connector back-shell periphery was not bonded 360 degrees. The result was inadvertent movement of the RWS when exposed to its test EME.

Figure 4. Remote weapons station improperly terminated connector

Figure 5 depicts a different approach to O-level problems. The M9 ACE program made extra effort in the design stages including robust component level testing and using properly shielded cables and correct, properly bonded connectors. Figure 5 shows a baseline test of the predecessor electrical system to ensure no prior susceptibilities exist in the M9 ACE. The baseline ensures subsequent testing will isolate problems to the new electronically controlled hydraulic system.

Figure 5. M9 ace acquisition: phased approach of electronically controlled hydraulics

O-level maintenance can quickly identify and solve problems. Constantly striving to increase one's mental toolbox improves the overall effectiveness of the enterprise solution [International Council on Systems Engineering (INCOSE) (2007). *Systems Engineering Handbook, Version 3.1.*] This means a problem identified quickly by a highly skilled technician requires a prompt response by other stakeholders. A system engineering approach has been promulgated by NSWCDD (Q52) to obtain faster answers to problems in the Fleet. A centralized point-of-contact has been put in place and given authority to investigate interference problems in the Fleet. Due to ever-increasing frontline battlefield systems that exhibit radiating capabilities, standard shipboard problems have transitioned to the battlefield. ✯

FY 11 COURSE SCHEDULE FOR EXPLOSIVES SAFETY TRAINING

Requirements for on-site classes must be requested in writing via the offices listed below:

- Requests should be submitted a minimum of 120 days in advance of start date.
- Classroom quotas, web based and refresher training available at http://ammo.okstate.edu and via the NOSSA Website
- NOSSA POC: Margaret Hayes, Code N52, 301-744-5634
  DSN: 354 FAX: 6087 margaret.hayes1@navy.mil
- DON Military & Civilians required to take the training for their current positions are placed first

AMMO#	DESCRIPTION	DATES	LOCATION
29	ELECTRICAL EXPLOSIVES SAFETY FOR NAVAL FACILITIES	7-11 FEB 2011	NAS JAX, FL
29		11-15 APR 2011	KEYPORT, WA
29		6-10 JUN 2011	DAC
33	EXPLOSIVES SAFETY AND ENVIRONMENTAL RISK MGT	1-2 JUN 2011	NORFOLK, VA
36	EXPLOSIVES SAFETY FOR NAVAL FACILITY PLANNING	14-18 FEB 2011	SAN DIEGO, CA
36		9-13 MAY 2011	NORFOLK, VA
36		1-5 AUG 2011	DAC
51 (MV/R)	NAVAL MOTOR VEHICLE & RAILCAR INSPECTION	15-18 FEB 2011	DAC
51 (MV)		8-10 MAR 2011	NAS JAX, FL
51 (MV)		5-7 APR 2011	SAN DIEGO, CA
51 (MV)		19-21 APR 2011	NORFOLK, VA
51 (MV/R)		19 -22 JUL 2011	NMC DET CHARLESTON, SC
51 (MV/R)		9-12 AUG 2011	DAC
74	EXPLOSIVES SAFETY OFFICER ORIENTATION	22-31 MAR 2011	KEYPORT, WA
74		17-26 MAY 2011	SAN DIEGO, CA
74		14-23 JUN 2011	NAS JAX, FL
74		16-25 AUG 2011	NORFOLK, VA
74		13-22 SEP 2011	DAC

Refresher training available at http://ammo.okstate.edu