How To Avoid Electromagnetic Interference Hazards

The damaging effects of EMI.

By Alan Lowne, CEO, Saelig Company Inc.

Based on a true story, the movie *Lone Survivor* tells the story of four Navy SEALs on an ill-fated covert mission to neutralize a high-level Afghan Taliban operative in 2005. Ambushed by enemy forces, one of the SEALs climbs to higher ground to make an emergency call via a satellite phone — not a wise move since transmissions like this are easily detected and can pinpoint a soldier's position. Modern warfare acknowledges the vulnerability of continuous transmissions, and the technique of choice is to use bursts of short, packetized up/down data transmissions via satellite, doing subsequent information retrieval, evaluation, and creation in an electromagnetic interference (EMI)-shielded, undetectable environment.

Figure 1: 15' by 20' EMI/RFI airframe enclosure with external foyer.

Complex electronic systems often create unwelcome EMI/radio frequency interference (RFI), which can interfere with the operation of critical communication, computer, command, and control systems. Almost all electrical and electronic equipment can create interference or emit an electronic signature that is detectable by those of unfriendly intent. Electromagnetic energy can escape from one product and interfere with another. Signals can be radiated via an unwanted antenna extending from (or appearing in) the product — connecting leads or gaps in cases, for instance. Radio interference can be caused by sources such as electric motors, drills, poorly suppressed vehicle engines, high-power flashing lights, or nearby broadcast transmitters. Switching power supply circuits, used with many electronic products including lighting systems, are famous for contaminating the main supply voltage by adding harmonics at multiples of the 50 Hz or 60 Hz supply. These emissions can catastrophically interfere with emergency radio communication and aircraft navigation systems. This interference may not just be a radiated phenomenon, because it can also be distributed via a building's power wiring. Powerful nearby radar installations or MRI machines in field hospitals can create unwanted interference, too, disturbing operational activity of command centers.

Security personnel are often required to ensure "EMI-clean" buildings or rooms, providing instant electromagnetic wave shielding to protect confidential or proprietary information on electronic equipment from interception by unauthorized persons outside the building. The information can be intercepted through the detection and analysis of electromagnetic waves emanating from the equipment or even from the audio pattern of voices intercepted by lasers trained on exterior windows. To protect against EMI-eavesdropping, government embassies, traveling diplomatic staff, industrial computer facilities involved in classified government contracts, and sensitive military communications facilities all need some level of electromagnetic shielding over a specified frequency spectrum.

In all of the aforementioned scenarios, an instant EMI tent (Figure 1) is a reliable solution. Portable EMI shelters, which can be the size of a warehouse or an aircraft hangar, provide EMI and RFI shielding in excess of 90 dB using Ni/Cu/Ag woven material pulled over quick-setup support structures – the fastest to erect made with air-inflated supports. Configured to rapidly deploy and provide a fast, uncomplicated, state-of-the-art shielded enclosure, these environments not only shield against electromagnetic emissions, but they

also absorb infrared (IR) emissions emitted from personnel and equipment to prevent detection by overhead satellites and aircraft. Many of these fire-retardant structures are currently in use in the harsh desert and high mountain environments of Iraq and Afghanistan and are built to be able to handle snow load and high winds with proper anchoring. Tent enclosures are usually constructed from multiple layers of conductive fabric, such as electroless plated silver etched directly on to ripstop nylon fabric. Copper and nickel layers are then plated over the silver along with an outer protective coating for durability. This material provides greater than 90 dB signal attenuation from 10 MHz to 18 GHz.

Applications And Considerations

Custom-made shielded tents and enclosures can create EMI-quiet environments for situations like product evaluation and testing, electromagnetic susceptibility, and providing secure communications facilities. Portable RF-shielded enclosures are ideal for applications including wireless device development and testing, satellite communications testing and isolation, EMC precompliance, medical and aerospace equipment shielding, cellular and computer forensics, and RFID shielding when needed. Designers of radio devices often need to perform special tests for the RF immunity of parts to be used in a system — tests that must be done in a controlled RF environment or shielded enclosure to prohibit distortion. On a small scale, RF isolation boxes and pouches are now available that make bench-testing procedures convenient and cost-effective, while on the other end of the scale, shielded environments can be made big enough to hold a tractor or even an aircraft. RF signal reduction structures are widely used for command and control operations as well as other applications where strength, weight, collapsibility, and portability are vital to a successful field operation. RF signal-secure portable tent enclosures are purpose-designed for safe communications applications where maximum signal attenuation is required for the flexibility that a freestanding, portable system provides.

Portable RF-shielded enclosures are designed to suit a variety of environments. Shelters can be designed to withstand rugged conditions such as 2"/hr of free falling and blowing rain for 30 minutes without intrusion of water into the shelter, 10 lbs/sq.ft of snow load for 12 hours without damage, steady winds of 55 mph with gusts of up to 65 mph for 30 minutes, temperatures of minus 40°F to 135°F, and more than 50 erect/strike cycles without structural damage. These enclosures can also endure blackouts, as they contain interior shelter lights not visible during ingress/egress within 100 meters with the naked eye or within 300 meters with night vision goggles.

Considerations when specifying an EMI-proof enclosure include the operational environment, mobility, temperature/humidity, level of attenuation, erection and strike time, transportability, snow load, wind load, moisture permeability, illumination, air-conditioning, type and number of I/O connections, EMI standards, etc. Some materials are available that can withstand explosions and can even be self-healing and sealing to some extent. Custom-required connectors with precision machined I/O panels and options to suit actual test procedures should be specified to maintain the shielding integrity of the enclosure at the locations of cable penetrations, electronic filters, or shielded cables.

Just as the enclosure shielding design is the last line of defense for radiated EMI control, I/O filtering is the last line of defense for controlling conducted EMI. Higher filter insertion loss levels are often required for military equipment operating in severe electromagnetic environments or mission-critical scenarios. Some designs feature roll-up, drive-through doors with magnetic seals, while other EMI solutions also need to consider shielding effectiveness during the physical entry and exit of an enclosure. Vestibule designs are often employed for walk-in enclosures, since opening the door can degrade immediate shielding effectiveness, resulting in a possible data capture compromise or measurement data corruption. With the addition of a vestibule that is integrated with the enclosure, the shielding environment is kept uncompromised for consistent shielding performance.

The vestibule is usually designed with its own separate conductive floor, door, and inner walls apart from the tent itself, which allows maximum isolation for continuous testing or examination. Waveguide ventilation ports, full air conditioning, or a fan and ventilation system also need to be shielded to preserve the EMI-quietness of the structure, while making the environment usable for extended periods in many locations. A double-seal door system, a shielded floor, and a built-in, through-connector panel with filtered power and suitable network connections are also common requirements. LED lighting that does not compromise EMI measurement situations or reduce power and heat issues can also be specified.

Electromagnetic Pulse (EMP) Protection

Hollywood has used many scare tactics over the years, and EMP threats are a common plot line. The 1983 movie *The Day After* suggested that automobiles may not keep functioning after an EMP attack. In the 2012 movie *Red Dawn*, an EMP weapon disables the domestic defensive infrastructure of the U.S. In the 2013 film *Pacific Rim*, a gargantuan creature fires an EMP that disables the electrical systems of two robots defending a city. Although electromagnetic pulses were movie makers' fictional ideas for paralyzing enemy forces and eliminating strategic deterrents, the risk of an EMP attack today may be even greater than before due to compact nuclear weapons. A high-altitude electromagnetic pulse could easily be formed from the detonation of a nuclear warhead at altitudes of about 25 miles over a target for widespread effect, or at ground level for a more localized result. Electronics can be manipulated and even destroyed by being subjected to an EMP, and as electronic devices have become portable, so too have EMP generators. Today they are as small as a briefcase. Resultant critical equipment and infrastructure failures could seriously jeopardize our forces' ability to execute their mission tasks, since the coordination of military operations is totally dependent on telecommunications and information systems. U.S. military forces routinely consider EMP threats and outcomes in their missions — such as the damage an EMP could cause to vehicles carrying mission-critical electronic equipment, to data storage in U.S. embassies, or to the operational systems in a military base. Portable EMI tents can be an effective military tool for surviving an EMP attack as well.

Ensuring Electromagnetic Compatibility (EMC)

Another use for EMI enclosures is to ensure that products are able to function correctly in their designed environments and are not susceptible to ambient electromagnetic noise and interference. Along with radiated and conducted RF requirements, ESD, magnetic fields, main power glitches,

Figure 2: EMI/RFI clothing.

dropouts, and brownouts must all be tested in a controlled environment. Electromagnetic compatibility refers to design philosophies that ensure a product is not interfered with by other products as a result of electromagnetic radiation or conduction. External electromagnetic radiation coming from another source must not cause a product to malfunction or affect its performance adversely. One military application for these EMI-clean environments is to examine what level of electromagnetic interference causes munition ordnance fuses and detonators to activate.

EMI Blankets And Pouches

Shielding material is also available in the form of blankets and large pouches. Blankets have been extremely valuable in Iraq and Afghanistan when placed over improvised explosive devices (IEDs) to prevent possible radio transmission detonation, as no signal can penetrate the blanket when thrown over a suspicious object. Blankets designed for this purpose can also incorporate anti-explosion technology, such as Kevlar layers, and can be weighted with water-absorbing granules.

EMI shields in the form of large pouches are valuable for personnel working with cellular network installations. An EMI pouch can be placed over antennas on a cellphone tower to silence their transmissions while work is done on tuning and installing other antennas or determining the frequencies emitted by each antenna in turn. EMI protective shielding can also be "fashioned" into wearable clothing (Figure 2) for personnel working in high-radiation environments such as radar installations.

EMI pouches (Figure 3) are also used to provide an RF-tight environment for military investigators capturing wireless communication devices such as cellphones, tablets, GPS units, and laptop computers. Designed to guarantee that internal cellphone and PC data is not compromised from the moment of capture, these pouches ensure that data cannot be changed or even erased by a single external call or text received to modify compromising information. A see-through window and a USB 2.0 connection on the EMI pouch provide fast and secure device manipulation for evidence collected in the field, since the window allows for phone keypad operation in the enclosed EMI-proof environment.

Figure 3: Lightweight forensic pouch.

Future Considerations

As our dependence on electronics increases, the need to protect critical operational data, electronic equipment, and personnel should also increase. The threats discussed in this article can be averted with the proper electromagnetic shielding materials in the form of versatile, portable EMI enclosures, blankets, and clothing. Usable in shipboard environments as well as on land or inside buildings, quick-inflate enclosures provide the vital security needed for sensitive electronic equipment. Not only do air-inflated support beam tents provide the fastest set-up and strike time of any shelter, they minimize the manpower needed for setup. Finally, other uses of EMI material are invaluable when radio signals need to be silenced. ■

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