



## Electromagnetic Shielding for Fixed Facilities

### Problem

The term “electromagnetic environmental effects” (E3) refers broadly to the effects of diverse man-made and naturally occurring electromagnetic phenomena such as electromagnetic interference (EMI), electromagnetic pulse (EMP), radio frequency interference (RFI), and lightning strikes — all of which can disrupt and potentially damage sensitive military communication and electronic equipment. E3 is of concern in a wide variety of fixed facilities, especially those associated with critical Command, Control, Communications, Computer, Intelligence, Surveillance and Reconnaissance (C4ISR) functions. Effective C4ISR is a critical ingredient for the success of any military operation. Ensuring reliable, continuous service in a hostile environment is an important task, made more difficult by the fact that the essential nature of C4ISR facilities makes them likely targets for hostile attacks.

Apertures and openings (seams, access ports, and doors) are the parts of the shield most susceptible to E3 intrusion. For example, tests show that the electrical conductivity of many of the gasket materials used to seal the apertures and openings in shielded enclosures is weakened by exposure to the environment. This loss of conductivity can significantly reduce the enclosure’s shielding effectiveness. There is a vital need to improve the long-term performance of electrically conductive EM gasket materials.

### Description of Research

EM shielding is accomplished by placing an electrically conductive surface between the source of an EM disturbance and the region to be protected. This may be achieved by either shielding the EM source, the sensitive facility, or both so that the shield attenuates the undesired signals to an acceptable level. Penetrations, and joints or seams in the enclosure must be treated to preserve shielding effectiveness.

The Construction Engineering Research Laboratory (CERL) has investigated new materials and processes for EM shielding applications. Research has focused on:

*Low-Cost Shielding.* Conservative shielding designs are typically very expensive to design, construct, test, and maintain. CERL has experimented with low-cost electromagnetic shielding designs for several years through the use of:

- New Materials, including conductive polymers, advanced coatings for use on shield components, amorphous metals and intercalated graphites, and methods for making concrete electrically conductive.
- Standard Construction Materials, including aluminum-foil-backed gypsum board, aluminum-foil-backed insulating sheathing, metallic-clad siding, copper foils (normally used for vapor barriers), wire meshes, and sheet metal roofing.
- Adapted Application Techniques, e.g., thermal spraying of molten metals, and laser welding, which allows efficient welding of very thin sheet metals.

*Testing.* Researchers have investigated alternatives to the standard multiple frequency radiated radio frequency (RF) test techniques specified in standards. These tests can be time consuming and disruptive to system operation, and can require expensive test instrumentation. CERL has experimented with alternate techniques such as induced RF current, shielded conduit sense wire, and shield monitoring using commercial broadcast station signals. Variations of some of these techniques are now being specified for monitoring the shielding performance of HEMP protected facilities.

*Maintenance.* CERL research has investigated maintenance methods, such as ultrasonic thickness gauges for steel enclosures, and maintenance procedures, such as those described in the *Fingerstock Maintenance Guide* for maintaining fingerstock gaskets on shield doors, for shielded facilities. Additional research included advanced coatings for EM shielded interfaces to produce new gasket materials and designs to improve performance while reducing application and maintenance costs of building intrusion points.

*Distributed Shields.* CERL has worked with the U.S. Army Nuclear and Chemical Agency (USANCA) and the Federal Emergency Management Agency (FEMA) to develop design techniques using distributed shielding. Distributed shielding is a more cost-effective approach to EMI/RFI protection than the single shield method. In the distributed shield method multiple shields (a shield with a shield) or multiple protection elements are used instead of constructing a single high quality shield.

### **Expected Products**

Current CERL research, done on a reimbursable basis, has focused on the properties and behavior of ferromagnetic materials, which offer potential shielding advantages in “main shield” shielding applications where weight and size limitations are important.

### **Potential Users**

CERL has provided technical expertise on a reimbursable basis to a number of EM shielded construction activities:

- *Pentagon Renovation.* The Pentagon includes EM-shielded C4ISR facilities. CERL has supported the Pentagon Renovation project in the area of EM shielding, most recently to address problems with the reliability of EM shielded doors.
- *Radar Upgrade at Clear, Alaska.* CERL provided technical expertise to the Alaska District for the EM shielding construction associated with the PAVE PAWS (Phased Array Warning System) radar facility at Clear, Alaska.
- *National Missile Defense (NMD).* Currently, USACE is involved with the design development for fixed facilities associated with the NMD system for the Ballistic Missile Defense Organization (BMDO/JNP). Proposed designs include high-altitude electromagnetic pulse (HEMP) shielding for various facilities including the X-Band Radar facility for Shemya, AK.
- *Objective Force/Future Combat System (FCS).* Although the Objective Force and FCS emphasize agility and mobility, they will rely on fixed facilities associated with C4ISR “Reach Back” (the Army’s means for connecting deployed forces to the broader communications and information systems infrastructure). Recent military operations have shown that EM shielding for these facilities more important.

### **Projected Benefits**

Effective electromagnetic (EM) shielding is an essential component for critical C4ISR fixed facilities; it protects against intrusive damage and against leakage of classified electronic communications and high levels of EM signature.

### **Program Managers**

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### **Participating ERDC Laboratory**

Construction Engineering Research Laboratory (CERL)