CHAPTER 10

SYSTEM INTEGRATION

10-1. Outline. This chapter is organized as follows:

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10-2. Introduction. This chapter addresses the integration of HEMP/TEMPEST protection with other engineering requirements. In general, HEMP/TEMPEST protection does not conflict with other considerations of normal engineering construction. Certain critical interfaces require definition. There are nine major interfaces for HEMP/TEMPEST protection, which will be discussed in three groups due to their interrelated purposes. The interfaces include--

a. Protection systems--group 1.

(1) Lightning protection.

(2) EMC/EMI protection.

(3) Physical security.

b. Internal systems--group 2.

(1) Safety/fire protection.

(2) Grounding and bonding.

(3) Corrosion.

c. Environmental systems--group 3.

(1) Thermal expansion/contraction.

(2) Vibration/noise.

(3) Shock/ground motion.

10-3. Protection system integration. Most HEMP- and TEMPEST-protected facilities are also protected in some fashion for lightning, EMC/EMI, and physical security. Each of these considerations entails a protective system that must be coordinated with the HEMP and TEMPEST system for compatibility.

a. Electromagnetic compatibility/interference. HEMP, TEMPEST, and EMC/EMI protection are compatible. HEMP and TEMPEST protection often provide EMI protection as a secondary effect of their shielding. While the three do not conflict, in general, HEMP and/or TEMPEST cannot be seen as a solution to EMC/EMI protection. EMC and EMI problems must be addressed carefully as with any normal facility. There are some indications that EMP high-power filters can cause harmonic distortions that can affect certain communication systems (LF timing sequences). Also harmonic distortion feedback from equipment can destroy filters. Thus, it is important to fully analyze the entire system EMC.

b. Lightning. In general, lightning has a much slower rise time, higher input power, and narrower frequency impact than HEMP. Lightning protection is straightforward and well defined. The only impact of lightning protection to the HEMP system is the analysis of synergistic nonlinear effects due to HEMP and lightning ESAs. Any analysis of protection from surge currents on incoming power and communication lines due to HEMP must include an examination of lightning protection equipment.

c. Physical security. Physical security usually includes camera surveillance, sensor devices, cypher locks, personnel bars, and alarms. The only integration required is that no physical security device compromises the HEMP or TEMPEST shield. This means that camera, sensor, and alarm wires should be fiber optic in WBC where they penetrate the shield and that cypher locks should be placed on a separate door located outside the shielded door in a double door arrangement so as to not compromise the shield door. Personnel entry bar devices also should not be mounted in a way that compromises the shield.

10-4. Internal systems. Internal systems such as safety, fire, bonding, grounding, and corrosion protection are often driven by high authority. Despite the importance of these items, HEMP/TEMPEST survivability is by far a more critical item. With slight alterations from normal procedure, these internal systems can function with full effectiveness with no impact on HEMP/TEMPEST shielding. The greatest problem in this area is generally due to a lack of knowledge, not from a lack of compatibility.

a. Safety and fire protection. Safety usually demands that all shielded rooms have two exits, despite the shielding rule of minimizing penetrations. Usually, the best answer is to include a shielded door with panic hardware interior to the shield on one door. This door should be used only in an emergency, ensuring minimum degradation with time. Also, fire safety may demand that sprinklers be included in all areas. It is usually accepted that waveguide entries can be exempted from this rule since they contain EMP doors on each side and are rendered useless by conductive sprinkler installation, unless it is carefully designed and installed.

b. Grounding and bonding. Grounding systems can be a major problem for HEMP/TEMPEST facilities if not carefully designed and maintained (including configuration control). A good grounding and bonding system provides maximum HEMP and lightning protection, EMC/EMI, and equipment and personnel safety. A poor system can adversely affect all of the aforementioned areas. In general, using the shield as an equipotential ground grid and then grounding the shield to the facility offers many benefits. The grounding system should be designed to allow for future system additions and internal transient control.

c. Corrosion. In general, corrosion systems are not incompatible with EMP shielding. Since EMP shields are usually steel, corrosion is an important consideration. This is especially true in roof areas. In many cases, water is retained in roofs to form standing pools on the steel shield roof. This situation will cause the roof shield to rust through. Waterproofing is thus critical on roof and floor areas. Cathodic protection systems also need to be designed carefully to avoid compromising the grounding protection.

10-5. Environmental systems. Certain environmental considerations can affect the integrity of the EMP shield. Though they can appear obvious, these considerations can and have caused major costs in repair and modification when they were underestimated.

a. Thermal expansion/contraction. EMP shielding is usually attached to the structural members of the facility. The exterior of a facility expands and contracts with temperature. Expansion joints in the facility allow for this natural flexing. The shield must also flex at these points. If not, either the shield or the facility structure will have to give, usually in an undesired way. This can cause cracks in the foundation, split seams in the shield, structural member stress, and other damage. The problem is costly to repair but simple to prevent. Prevention is simply a careful analysis to ensure that the facility and shield expansion/contraction measures are both appropriate and compatible.

b. Vibration and noise. Many facilities protected against HEMP require in-house generators and other equipment which cause high levels of noise and vibration. The steel shielding requires insulation and interior finish designed to dampen noise and vibration. Both insulation and acoustic finish must be installed in a way which does not compromise the shield. Heavy vibration can cause seams to crack, especially around penetrations. Such vibration should be dampened to prevent excessive degradation in the shield.

c. Shock and ground motion. The CONUS area is divided into seismic zones to grade the scale and likelihood of ground motion. Areas that anticipate high levels of ground motion require special construction methods. Shielding in these areas must also include special treatment. This consists of shock isolators and frequent use of expansion/ flex joints to accommodate shield movement. These areas require access to the shield for repair and surveillance to a much higher degree than construction in normal areas. Shock treatment for blast effects must take the shield into consideration when designing blast survivability mechanisms. The shield must be able to move as projected without compromise.

10-6. General integration. When constructing a HEMP/ TEMPEST-protected facility, it is important to keep the HEMP/TEMPEST shielding system in proper context. HEMP/ TEMPEST shielding interfaces must be examined and given careful thought. Each major engineering area should be studied and analyzed.

a. Electrical. The effects of filter/ESA on the normal operating power system must be analyzed. The effect of protective devices on communication devices also must be checked. In general, adverse effects are minimal, but the questions must be answered in these areas. Fiber optic control lines in WBC should be used for automatic control systems.

b. Mechanical. Penetrations to the shield for utilities and HVAC must be welded. HEMP/TEMPEST shielding practices in no way conflict with mechanical needs, but they do require coordination. Utility lines must be capable of being welded or run through a WBC if nonconductive. HVAC ducts must be capable of being welded at the circumference and may require oversizing to compensate for honeycomb WBC filters installed in ducts.

c. Structural. Structural considerations are critical. Steel shielding must be supported, requiring strong structural framework. Expansion joints must be coordinated. Contact from shield to structure must not compromise the shield. The same is true for interior finish. Structural contact should be provided by spot-welding. On larger shield areas, structural strength to support shield weight must be planned carefully.