CHAPTER 9

EMP AND TEMPEST PROTECTION CONCEPTS

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9-2. Introduction. Critical facilities are very vulnerable to HEMP damage or upset and, in most cases, these facilities have equipment that processes classified information that could be compromised. A single nuclear weapon detonated 300 kilometers above the United States can blanket the entire CONUS area with HEMP effects. HEMP effects are especially damaging to integrated circuits and other sensitive low-voltage/current electronic devices on which facilities rely. It is critical to national security that these facilities incorporate HEMP and TEMPEST protection measures to prevent compromise of information and disastrous damage and upset to the electronics equipment. Generally, there are two concepts to be considered as a methodology for HEMP and TEMPEST protection and a zoning plan which may be applied to either methodology as required.

a. Component or room hardening. This method consists of defining a subset of equipment that is mission-essential and hardening only that equipment and its required auxiliaries. This method is employed in two circumstances:

(1) Equipment separation distances. Equipment is physically separated by large distances and it is not realistic to try to shield the entire area.

(2) Component shielding. The mission-essential equipment is in a facility where it comprises only a small relative part, and thus, it is not advisable to shield the entire facility. When this method is used, each system or piece of equipment is considered a separate entity for shielding. This method employs either small shield rooms or shielded equipment with waveguides-beyond-cutoff (WBC), electric filters, access panels, and RF doors. It differs from facility shielding only in scale. The drawbacks with component shielding are that it is totally inflexible, very expensive, and very difficult to maintain. Also the system is vulnerable during servicing when access panels are open. This method is usually cost-effective only in the circumstances outlined above.

b. Facility shielding. This method is by far the most common for high-level HEMP and TEMPEST protection. It maximizes flexibility since any standard equipment can be used inside the shielded facility. Facility shielding may be low-level or high-level (50- or 100-decibel) attenuation. HEMP shielding (100-decibel) consists of at least 3/16-inch welded steel (12-gauge walls and 10-gauge floors are recommended). TEMPEST shielding (50-decibel) consists of at least 22 to 26 gauge steel walls, floors, and ceiling with clamped joints. All penetrations are protected by WBC, filter or RF seal of some kind. Penetrations should be reduced to a minimum and if possible colocated at one area of the facility in a penetration entry room (PER) or vault. A PER is a small, shielded room that affords extra protection to the facility where all, or most, utilities enter. It is placed on the outside skin of the building using the exterior of the facility shield as an interior wall. The PER is especially effective in control of all penetrations and provides a desirable margin of safety for critical facilities.

(1) Waveguide tunnel. A waveguide tunnel shall be provided for large facilities at the main personnel entry. This long, welded tunnel can provide up to 40 decibels of attenuation (more at low frequencies). It offers valuable protection at the weakest point of the shield. RF doors shall be installed at both ends of the entryway tunnel, interlocked to ensure that only one may be opened at any time. No conductive lines are permitted in the tunnel; lighting shall be provided from above the tunnel through a WBC vent in the ceiling or the lighting circuit shall be protected by a filter.

(2) Grounding system. The grounding system for the facility shall use an equipotential ground and tie into a welded stud that does not penetrate the

shield. Another stud welded to the opposite side should then run to the exterior ground system.

(3) Uninterruptible power supply. Generally, an uninterruptible power supply (UPS) is used to provide power when the commercial source fails during a HEMP event. The UPS is usually contained inside the shield and is often used on a daily basis to provide clean power for computers and mission equipment. Surge arresters shall be used to clamp the HEMP transient pulse on long commercial power lines; the electrical surge arresters also serve to protect the filters from the high voltages, currents, and energies in the HEMP pulse.

(4) Conduit runs. Wherever conduit runs must exit the facility to access some critical equipment such as an outside shielded generator, heavy metal rigid conduit shall be welded at the couplings to form an RF-tight shield. All conduit runs in the PER shall also be heavy metal rigid welded conduit. The conduit extends the shield to envelope critical shielded equipment outside the protected facility.

c. Zoning.

(1) Reason for zoning. Zoning is a method for control used when differing levels of protection are required. For example, the rugged generator set may operate without problems in a very low-level attenuation area, perhaps only under an earth rebar structure. A more sensitive UPS and communication room may require a low to medium protection level of 60 decibels, and a very sensitive control and computer room may require a high level (100-decibel) protection area.

(2) Typical zones. Protected areas can be designated Zone 0 for outside, Zone 1 for generator (40 decibels) area, Zone 2 for UPS and communication area, and Zone 3 for the highly sensitive control room. The zones can be drawn schematically and usually are nested one inside the other so that the highest attenuation area is centered inside the other areas. This method ensures that no potential compromise is overlooked, and the potential savings from nested/layered shielding can be realized. Zoning can be used for component or facility shielding and serves as an excellent tool for deciding what is critical and how it should be protected.

d. Global approach. In global shielding, a single requirement (e.g., 100 dB reduction or 50 dB reduction) is established as the protection level the design must meet. The approach has some advantages, including the following:

(1) Programing and design. Facility programing and design can proceed without an in-depth knowledge of the emanation and susceptibility profiles of the equipment to be housed within the building. Thus, the project can go forward in parallel with development of the mission hardware.

(2) Off-the-shelf products. Construction components and materials are generally off-the-shelf commercial products. Processes used to assemble the HEMP/TEMPEST protection subsystem are common in the design and construction trades.

(3) Performance degradation. This approach minimizes the potential for performance degradation of the subsystem and also minimizes the need for routine maintenance.

(4) Project costs. Overall project cost to the government may be reduced because no extraordinary electromagnetic susceptibility requirements need to be levied on the mission equipment manufacturers. Furthermore, hardware developed for non-HEMP/TEMPEST applications can normally be used without modifications.

(5) Envelope. This approach creates a protected envelope within which equipment and configuration changes can be made without modifying the isolation subsystem.

9-3. TEMPEST requirement in relation to HEMP.

a. Shielding similarity. Shielding and penetration protection techniques are efficient and effective for limiting the passage of electromagnetic energy in either direction--inward in the case of HEMP and in an outward direction for TEMPEST isolation requirements. A single electromagnetic barrier can perform both functions. This approach avoids costs and potential interaction effects associated with double shielding or double filtering.

b. Peak power comparison. The peak power of the HEMP environment is much greater than that in a potentially compromising TEMPEST emanation. Therefore, HEMP protection devices are constructed to survive greater stresses than TEMPEST protection devices.

c. Upper frequency range. TEMPEST protection extends to an upper design protection frequency, typically 1 to 10 gigahertz. This range will require the shield penetrations such as waveguides-beyond-cutoff and filter assemblies to provide protection at this frequency.

d. Critical component location. The conflicts are found when requirements of the two disciplines are compared. HEMP survivability considerations dictate that mission-critical modulator/demodulators (MODEMs) and radio transmitters be afforded the protection provided by the shielding and penetration subsystem. TEMPEST guidelines, in contrast, indicate that these BLACK devices be placed external to the shield. To meet both requirements, the MODEMs and transmitters can be located within the shielded enclosure, provided that RED/BLACK isolation procedures are followed and all associated electrical lines penetrating the shield are filtered properly or otherwise isolated.

e. Dielectric breaks. The second area of conflict relates to the nonconductive section required by TEMPEST considerations in piping, ventilation, and some electrical penetrations. From a HEMP protection standpoint, such dielectric breaks are undesirable. The nonconductive sections should be eliminated where the HEMP threat is increased by their inclusion (such as electrical conduit runs).

f. Common hardening. The facility hardening as provided for HEMP in all other areas of this pamphlet will also provide protection for TEMPEST.

9-4. Generic facility hardening.

a. Overview. Provide a welded facility shield that attenuates the EMP to an acceptable level (usually 80 to 100 decibels, depending on the susceptibility of equipment to a HEMP event). All conductive utility lines are circumferentially welded to the shield and PVC or other nonconductive lines are used in conjunction with WBC-type entries. Telephone lines should be fiber optic (preferred) or filtered. Power lines and antenna lead-ins must be filtered, preferably with electric surge arresters to protect the more expensive filters. The shield is provided with a grounding grid to ensure a good path to ground. Air-conditioning vents and ducts are provided with honeycomb WBC filters. This system provides protection for most of the equipment; however, certain items (such as computers) also may need separate shielded enclosures to attenuate the EMP to a tolerable level. Finally, onsite generators usually exist to sustain mission-essential equipment until commercial power can be restored and to isolate the site from the power lines.

b. EMP protective features. To protect susceptible mission equipment from upset or damage due to the HEMP free-field environment or coupled transients, the following HEMP protective features will ensure a hardened facility:

(1) Welded facility shield.

(2) RFI doors (fingerstock).

(3) Waveguide entries.

(4) Waveguide vents.

(5) Waveguide-beyond-cutoff.

(6) Dielectric inserts.

(7) Fiber optic signal and communication lines.

(8) Filters and surge arresters.

(9) RFI-tight conduit runs and grounding system.