The Expanding Role of Architectural Shielding: Four Case Studies

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INTRODUCTION

During the past few years, there has been a decided proliferation in the once limited area which those in the electromagnetic environmental sciences call architectural shielding. In a 1989 *ITEM Update* article,[1] architectural shielding was defined as: "the overall design and construction of an entire building or a building area with the specific intent to:

- Protect electronic equipment from external disruptive/destructive radio frequency emanations (radar, high power transmitters, nuclear/lightning electromagnetic pulse effects).

- Protect personnel working within buildings from hazardous environmental conditions.

- Prevent classified information processed within a building/area from being intercepted through the utilization of espionage techniques."

These definitions still apply and will continue to apply. In order to accomplish these goals, the use of unique building materials to form conductive, absorptive or reflective barriers or shields is required during building construction. To the novice, it may seem that nothing is new. If the goals are the same and the shielding means are basically the same, then one might ask, "What is new in the world of architectural shielding?"

Architectural shielding has become an integral part of many commercial building programs.

In today's world entire structures must be shielded, but the nature of the projects is changing, partly due to military cutbacks. What is evident today is a decided increase in commercial requirements for architectural shielding. The new requirements are a direct result of increased awareness of health hazards (as reported by the media) and the very real effects of magnetic and electric fields on sensitive computer, video, transmission and medical equipment. This awareness of potential and actual problems has triggered medical research and has generated architectural and construction programs emphasizing electric and magnetic field shielding considerations. The following examples of actual shielding programs will illustrate the ever-broadening requirements for architectural shielding.

MOBILE COMMUNICATIONS

The first case involves a mobile communications company located in the Rocky Mountain area. The company had problems relating to the quality of received telephone signals in vehicles in which their equipment was installed. They also experienced signal processing chip failures, and were unable to access their accounting systems. Their telephone receiver transmitter was located on a 200-foot tower which was located on a mountaintop, the elevation of which is 10,700 feet (Figure 1). The equipment was housed within a wooden building along with two FM transmitters and several other transmitters. The actual interference problems were monumental, and were exacerbated by the fact that the road to the transmitters/receivers was 11.5 miles long, one vehicle wide, and composed of dirt and rock with no guard rails. It was totally uninhabited (not counting mountain lions, deer and occasional bears).

Since the area where the mobile communication equipment was located was not shielded, and power, signal, and telephone lines were not filtered, the interfering signals were free to enter the referenced equipment at a multitude of points. In order to make the phone and accounting system equipment immune to RF radiation, the equipment area had to be shielded and filtered. In order for the shielding and filtering to work properly, the facility grounding had to be adequate. Discussions with the builder revealed that the actual ground was made up of several thousand feet of copper wire

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underground at a depth of approximately 42".

To reduce the RF radiation within the equipment room, a design goal of 60 dB of shielding effectiveness was used. In order to achieve this goal the equipment room was painted with two coats of copper paint. For power entering the room, power-line filters were utilized (Figure 2). These filters had filter attenuation characteristics of at least 80 dB between 100 kHz and 10 GHz. All telephone lines entering the building were filtered. The filters provided at least 80 dB of insertion loss between 30 kHz and 10 GHz.

The equipment room contained an exhaust fan and wall openings for ventilation purposes. These openings featured EMI dust filters plus a honeycomb filter for the exhaust fan. In addition, EMI gasket material was used around the door jamb and copper fingers were attached to the door bottom to create a metallic door threshold. Additional measures were taken to run incoming and outgoing cables through waveguide sleeves. Since completing the program, no transmitting/receiving problems have been noted due to interference problems.

PUBLISHING FACILITY

Another case involved a Virginia concern that was having a new facility designed to incorporate a computer center which would operate their newspaper plant through all stages of production, including printing. The computer center was to encompass an area of over 2000 square feet. The shielding design for the facility was done in conjunction with an architectural firm, while fabrication of the shielded area was accomplished by the contractor and a shielding consultant and coordinated with the computer equipment supplier.

The ultimate objective of shielding the computer center within the production facility was to prevent electromagnetic interference (magnetic and electric field) from disrupting the operation and printing of newspapers. Again, electric field shielding was provided by copper paint especially formulated for architectural applications. This copper paint was applied directly to the walls, ceiling and floor of the bare computer room. Magnetic fields were shielded by utilizing a sheet steel lining between the power room and the computer facility (0.125-inch steel was utilized). The steel shield covered one complete wall and overlapped onto the other four adjoining surfaces (ceiling, walls, floor). An uninterruptible power supply system required additional magnetic field shielding.

The radiated and conducted susceptibility criteria for the computer equipment was specified for both electric and magnetic fields. The criteria entailed a facility shielding effectiveness of approximately 60 dB. The susceptibility criteria underscored the need for power-line filters in conjunction with the shielding measures. The shielding measures also included the use of cooper mesh to shield viewing windows, gaskets and copper spring fingers for use with three doors. The project was completed and has been successfully operating for over two years.

SEMICONDUCTOR MANUFACTURER

A case relatingto a semiconductor/chip manufacturer that utilizes electron microscopes in various stages during the manufacturing process is also illustrative. The manufacturer had built a new manufacturing facility in which the electron microscopes were located near or directly adjacent to power plant

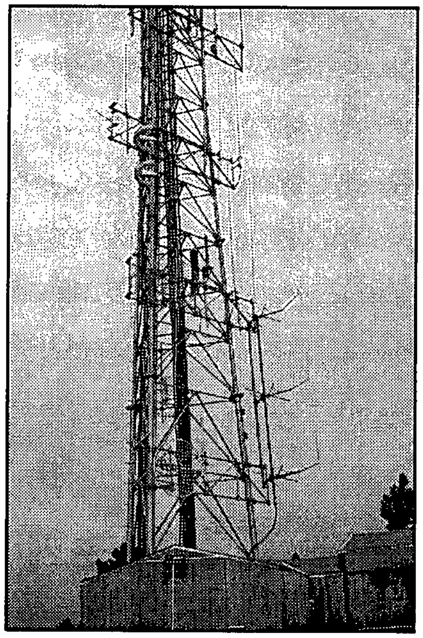

Figure 1. *Transmitter Tower and Equipment Building.*

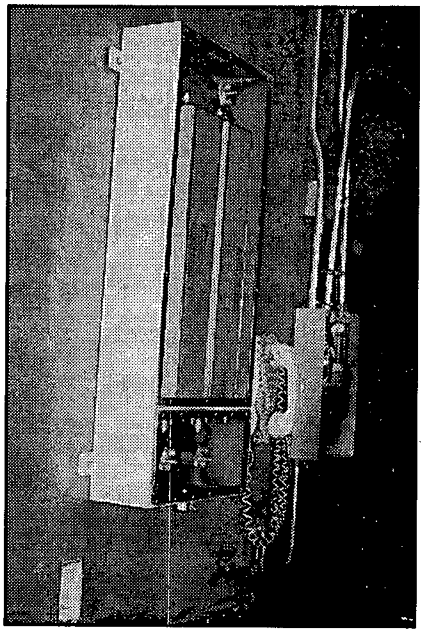

Figure 2. *Power Line Filters Mounted on Copper-Coated Wallboard.*

distribution areas. The manufacturer of the microscopes had specified that the microscopes be located in areas where ambient magnetic field levels were 0.5 milligauss or less. Measurements of magnetic field levels taken in the company's main lobby area exceeded 5 milligauss. Obviously the solution to the problem was to relocate the microscopes to areas where magnetic field levels were below 0.5 milligauss. Since the chip manufacturer insisted that relocation was impossible, shielding the areas became necessary. In order to achieve the degree of shielding necessary, an area fabricated from relatively high permeability steel had to be designed. The alternative would have been to design an area utilizing mu-metal material. Ultimately, steel sheets were incorporated within the microscope areas with great success. This solution to the magnetic field problem is currently being implemented at another semiconductor/chip manufacturer located in the southwestern part of the United States.

RADIO TELESCOPE

The Naval Radio Observatory giant telescope in the mountains of West Virginia offers a final example of architectural shielding being utilized in a somewhat unusualmanner. This particular project, as yet incomplete, has been given rather extensive media attention and deservedly so. The radio telescope is part of a structure larger than the Statue of Liberty. The structure will support a 100-meter (diameter) dish antenna.

In a support role, an operations building will house a large collection of electronic equipment that collects, reads, and analyzes the data collected by the dish. The data will consist of numerous low-level electronic signals and as such must be protected. The operations building will contain several completely shielded areas where the electronic equipment is housed.

There are other radio telescopes located at the Naval Observatory similar in nature but physically smaller than the 100-meter unit. Signals collected from these telescopes are low level. Due to the sensitive nature of these signals, no internal combustion engine vehicles are allowed on the base; transportation is either by base-owned diesel vehicles or bicycles. Knowing all this, it was quite important to carefully design the shielded areas housing the electronic equipment. The shielding system has been designed and consists of the following basic elements:

- Grounding of the building structure, including the shielded envelope and all systems with a low impedance system
- Shielding materials installed in walls, roof, door leaf, etc.
- Waveguide treatment of all duct penetrations
- Grounding, isolating, and RF sealing of all metallic pipe penetrations
- Feed-through boxes for alarm, signal, and telephone cable connections
- Ground provisions from shield to each electrode system
- Shielded doors, frames, thresholds, gaskets, windows
- Shielding materials to bond seams, joints, and interface points

Construction of the antenna structure has been started. Building construction will begin shortly. It is hoped that the entire system will be in operation by the end of 1995.

SUMMARY

Architectural shielding has become an integral part of many commercial building programs. The reasons for building and area shielding have not changed, but the need for the shielding has grown greatly. Current programs underway include several large buildings in New York City where magnetic fields emanating from power distribution units are causing computer upsets and distortion and safety concerns. Other programs involve a university physics building where research and development programs are being disturbed by a campus radio tower, and computer facilities in a Manhattan high-rise building which are being affected by the ambient noise levels present within the building in areas above the twenty-fifth floor. The problems continue to grow.

As recently as 10 years ago electromagnetic environmental effects (E^3) engineers knew that the shielding of structures was essential for the proper operation of sensitive electronic equipment and to protect sensitive information from falling into the wrong hands. What we didn't know was how far the needs would spread.

REFERENCES

1. Roy W. Bjorlin, Jr. and Frederick L. Helene, "The Use of a Copper Conductive Coating for Architectural Shielding Purposes," *ITEM Update* (1989), pp. 6-10.

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