THE APPLICATION OF CLAD METALS FOR EMI ROOM SHIELDING

New clad metal materials satisfy normal room shielding requirements and are useful when dealing with extremely high or low magnetic fields.

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INTRODUCTION

In recent years new EMI shielding materials, including several varieties of clad metals, have been developed. These new materials satisfy normal room shielding requirements and are useful when dealing with extremely high or low magnetic fields. Additionally the research and development process has established criteria for the optimum application and use of these products.

The first part of this article will describe the new clad materials, their physical properties, peculiarities and performance. The second part will discuss their application in the construction of shielded rooms. Background information for this article can be found in "Composite Metal Shields for Electromagnetic Interference," (ITEM 1987) by G. Trenkler and L. McBride.

NEW CLAD SHIELDING MATERIALS

The primary family of new clad shielding materials (Table 1) consists of three-layer foils with a core of ferromagnetic alloy metallurgically bonded to outer layers of high purity copper. This approach produces good EMI shielding properties for a wide frequency band. The material works well from the low frequency range up to the gigahertz range, and the performance of rooms shielded with this material will exceed NSA-65-6 requirements. Figure 1 illustrates the performance of different foil combinations versus frequency.

If the shielding requirements are less stringent (e.g., NSA-73-3A standard), they can be satisfied with simple sheets of high conductivity copper (CDA-103 or similar) or with 1100 series pure aluminum.

It is also possible to build an entire room from the new three-layer foils in 50 percent expanded form. Low frequency performance (up to 10 kHz) can be enhanced by the addition of a second layer of the same material. In earlier experiments engineers built shielded rooms with 0.010-inch thick copper-invar-copper; the performance results of these experiments are listed in Figure 2. Later, when a second layer of this material was added, performance was greatly enhanced.

The thickness of some of the newly developed three-layer foils ranges from 0.010 inch to 0.015 inch. The specific density of the copper is 8.9 gm/cm^3, and the nickel-iron binary is from 8.2 to 8.8 gm/cm^3, depending on the nickel content. This metal content produces clad shielding material with a specific weight of 8.48 to 8.84 gm/cm^3. The coefficient of thermal expansion of this material is in the range of 8.0 ppm/C°; the maximum width is 24 inches. It can be bent without affecting the shielding properties as long as the bend radius is greater than 30 t. Also it can be heated to 350°C for soldering. Since the surface layer of the clad foil is copper, the solderability is the same as that of solid copper.

In addition to the foils, there are an assortment of new accessory products for use in construction of shielded rooms (Figure 3). A tinned strip made from the same material as the foils is supplied in continuous coils 2.0-inches wide. The material is tinned (0.0002-inch to 0.0005-inch thick) with 50-50 solder and is used to join shielded wall panels much as sheetrock is joined by tape in conventional wall construction.

Two-dimensional contoured corner strip for use in joining wall panels

Material Combination	Specific Use
Cu-INVAR-Cu	Used for structural members. Low saturation point. Wide hysteresis loop.
Cu-42-Cu	General Shielding. Best Price/Performance Ratio.
Cu-49-Cu	Better general shielding. Wide dynamic range for the strength of the interfering field.
Cu-80-Cu	Best material for low intensity fields.
49-80-49	Wide dynamic range, low frequency material.
Cu-77-Cu	Extremely low fields, wide frequency range.
Cu-Co/Fe-49-Cu	Electro magnetic pulse material extremely high saturation combined with narrow hysteresis loop of 49 material. Experimental material.

Table 1. EMI Shielding Products.

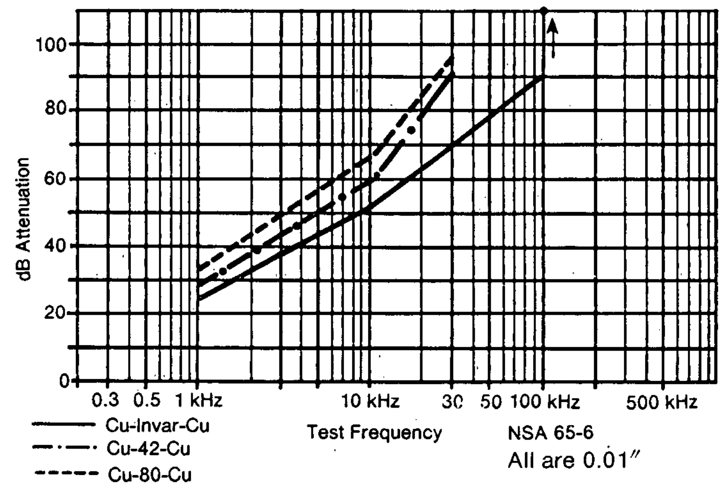

Figure 1. Performance of Different Foil Combinations Versus Frequency

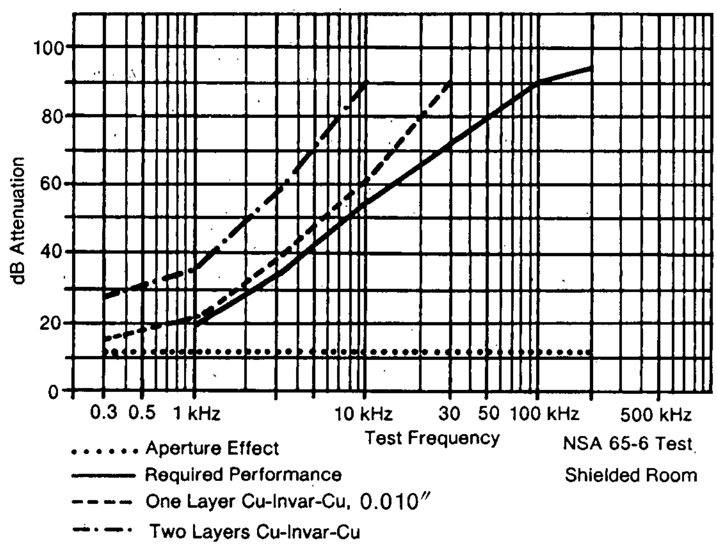

Figure 2. Experimental Performance Results of Different Foil Combinations.

at the corners is produced from the same material as the foils. It is 3.0 inches wide with a 0.375-inch radius corner and is supplied in 7.0-foot lengths. Three-dimensional 0.020- to 0.025-inch thick corner caps, also of the same material, provide closure at the corners. The structural supports for doors, windows and other framed openings are made of 0.050-inch thick copper-invar-copper U-channel with dimensions of 2″ x 4″ x 2″ or 2″ x 3″ x 2″, which may be varied as needed.

Ready-made room windows with the openings shielded with perforated material or expanded mesh are also available. Both provide light transmission and air circulation but at some sacrifice to shielding performance. Multiple layers of mesh or perforated foil will improve shielding properties. Because of the critical nature of the doors in a shielded room, they, too, are fabricated and supplied as finished products. Materials used for construction, including the frame, are copper-magnetic material-copper clad metals in order to optimize shielding performance in the low frequency ranges.

APPLICATION

The first step in designing a shielded room is to determine the size. Planning the room dimension in 24-inch multiples will make construction simpler since that is the maximum width of the shielding foil. Also it may be advantageous at this point to design the room in such a way that it can be dismantled easily and transported at a later date. The number and locations of windows, doors and other openings, as well as power and ventilation requirements, must also be considered.

Incandescent lamps fed with DC voltage should be used for the lighting, and the electric power input should be fed through a constant voltage harmonic distortion neutralized transformer which produces 40 dB filtering. Whether the room is to be used as a secure facility or for testing purposes, most current electronic equipment can be run by 12-24 volt batteries so this choice should also be explored.

In general, there is no need to deviate from standard construction practices when building a clad metal shielded room. Construction of the room must adhere to local fire code requirements which will determine the construction materials that can be used; but typically, the frame is built of 2 x 4s and the walls are plywood or gypsum board. Depending on the equipment load within the room, the floor may need to be reinforced.

However, particular attention must be paid to the dimensional precision of the construction, especially with the doors and windows. The ready-made door opening must be 30″ x 78″, the test window is 24″ x 24″, and the ventilation opening is 18″ x 12″. An additional ¼ inch should be left on all sides of these openings to allow for frame installation and adjustment.

It is also suggested, especially for smaller rooms, that the fourth wall be made removable or be built after the shielding has been installed in the rest of the room. This practice will facilitate installation of the shielding material and will reduce the chances of damaging it in the process.

As the shielding material is installed (Figure 4), it must be galvanically interconnected along all seams by soldering. Experiments have shown that a 1-inch long gap in the soldered connection will produce a shielding performance loss of greater than 10 dB in the medium frequency range. To accomplish this interconnection, the following procedure is recommended. The shielding foil should be pretinned approximately 1.250-inch wide on the perimeter and at other places of interconnection. The material is then butted together and overlayed with 2.0-inch wide pretinned strip and soldered. For soldering operations use of an 800 to 1000 watt soldering iron with a built-in thermocouple and a tem-

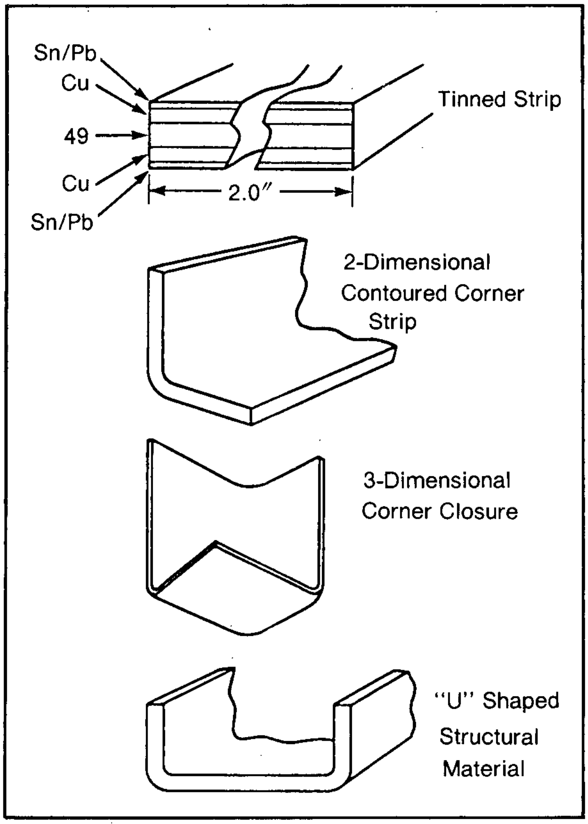

Figure 3. Accessory Shielding Products.

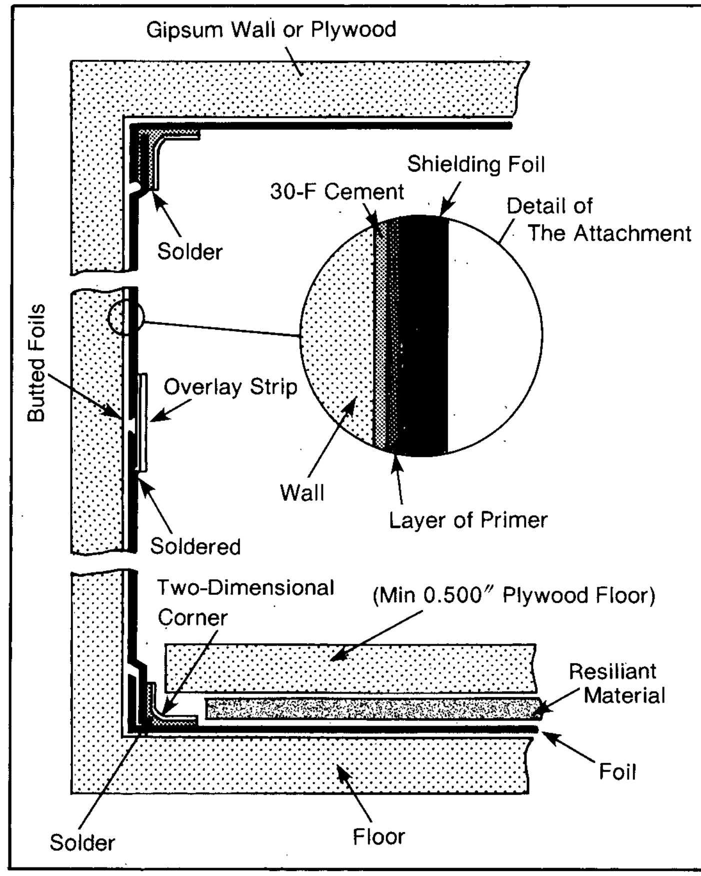

Figure 4. Details of The Attachment For Shielding Foils. Not to Scale.

perature controller is recommended. In this way the soldering iron can be kept at a low temperature (approximately 320 to 350° C) and functions very effectively.

The shielding material should be installed on the floor first. The foil should be cut to the length of the floor plus 6.0 inches, as 3.0 inches will be bent and overlapped on the vertical walls (floor joints on the other two sides will be covered by corner strips). Immediately after the floor foil is in place, it should be covered with a resilient material such as felt or high impact foam and then overlayed with plywood to protect it from damage. (If any of the foil is ever punctured or nicked, it can be repaired easily by soldering in place a patch which extends at least an inch in all directions beyond the damage location.)

The foil is attached to the walls and ceiling of the room with nonflammable contact cement with a latex base. Since it contains chlorine-based components, the side of the foil to be cemented should be treated with epoxy primer. During all operations the surfaces should be kept clean and dust-free. The procedure for cementing the foils in place is the same as that of cementing plastic laminate on countertops. Trays are used to hold the material in place and a slipsheet is used during positioning. A soft rubber roller is used to ensure the bond. After cementing the foils to the various surfaces, the strip overlay can be soldered over the seams; and the two- and three-dimensional corners can be soldered in position.

Next, the doors and windows and other framed openings can be installed taking care to be sure that all butted areas on the frames are underlayed with shielding foil. The frames are attached to the structure with copper-plated flathead sheet metal screws and then soldered to the shielding foil. The fourth wall can now be put back in position (or completed) and soldered in place. Finally, excess flux can be removed, the panels are cleaned, and the room is complete.

If a double shielded room is required, plywood or gypsum board can be attached to the room frame from outside and the shielding installation process can be repeated. Care must be taken, however, that there is no galvanic connection between the inner shielding and the outer shielding. Otherwise the benefits of double shielding will be lost. ■