CASCADE COIL
DEFENSE SYSTEMS

RFI/EMP/HEMP ABATEMENT

1. Overview.

In an effort to evaluate Cascade Coil mesh for applications in reducing electromagnetic signals in an enclosure surrounded wire mesh, some preliminary signal attenuation measurements were performed on various meshes. As expected, high surface conductivity and small mesh weave sizes gave greater signal attenuation at about 2 MHz. An unanticipated finding was that 3/32-21 silver tin weave gave the best measured attenuation, surpassing that of even gold plated steel.

Accurate signal attenuation values are very difficult measurements to make and require great attention to detail and sophisticated equipment. What we did was to approximate attenuation measurements without the attention to those important details and so what we have, while it may fairly represent the order of mesh usefulness in this application, does not give us those absolute values that expensive testing will provide.

That said, we have some very promising results in that within our experimental accuracy, we find that some of our meshes provide the same level of attenuation as solid sheets of aluminum and copper foils at this frequency. These measurements combined with previous attenuation measurements at 10 GHz suggest that our mesh is not much affected by wire to wire conductivity as was previously thought. Also, aging of the surface of the wire and reduction of attenuation with contamination and oxidation does not seem to be a limiting problem in this application.

According to the military HEMP protection standard, MIL-STD-188-125-1, NOTICE 1, 7 April 2005, for stationary enclosures, an attenuation of 80 dB is required between 10 and 100 MHz, and about 65 dB at 2 MHz where our measurements were conducted. Our measurements were limited by our equipment to about 40 dB. Several meshes measured indicated values better than our capability and are candidates for further testing. No separate magnetic field testing was performed at this time.

2. Experimental Mesh Attenuation Measurements.

A low power signal generator was built and mounted on the back of a two pound coffee can. A small antenna consisting of a short piece of #24 copper wire was mounted on the inside of the can. A similar can and antenna was mounted facing the transmitter with a ½ inch gap between the cans. A Hammarlund HQ100A receiver was connected to the receiving antenna using 50 ohm coaxial cable. The HQ100A was modified to replace the "S" meter with a mirrored scale 1 mA meter. Additional shielding was provided for the input connection on the HQ100 and to cover the transmitter. The test apparatus is shown in Figures 1-4.

With no power into the transmitter we measure 13.5% on the "S" meter. The meter is 60 dB full scale (100%) referred to 50 micro Volts at the antenna input. The extra zero signal level may be from stray pick up or from internal bias. With the transmitter powered up and stabilized and the receiver tuned to maximum signal strength we read 66.5% or 39.9 dB. No effort was made to check signal strength linearity since we are mainly interested in relative attenuation properties of our meshes and the good ones were near the limits of our measurement capabilities anyway.

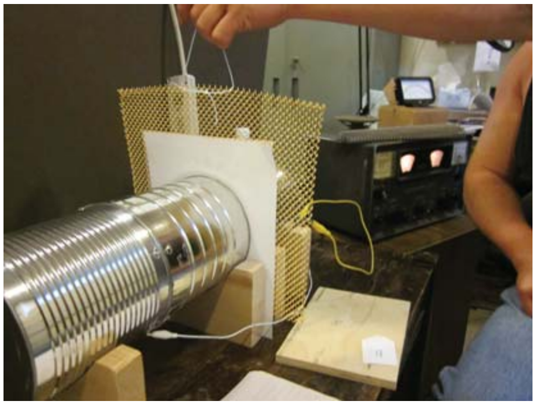

Figure 1.

Figure 2.

Figure 3.

Figure 4.

When a solid sheet of 0.003" copper foil is placed between the transmitter and receiver cans, we read 13.5% or 8.1dB. A sheet of 0.0045" aluminum yields a 15% reading. All items placed to measure attenuation are grounded to the receiver can by a wire. The copper and aluminum sheets are the same 1 foot by 1 foot size as the mesh samples. We believe that 13.5% copper sheet reading represents the sealed or "zero" reference signal level. Without a tight conductive gasket to seal the measurement channel and without characterizing the transmission or receiver signals to eliminate changes in the standing wave ratio we have a large and uncharacterized noise floor. Mitigating these shortcomings is the fact that all of the measurements were reproducible within about +/- 0.5%; that is, (X +/- 0.5) %.

Three 3/16" meshes that were previously evaluated at 13.5 GHz were subsequently measured using this setup. Several other meshes were also evaluated and the results are tabulated in Table 1. Some variability in measurement was found for meshes with obvious surface oxidation and average measurements were recorded.

Mesh material	Mesh size	Measurement	Mi-M0	Signal	Attenuation
Signal Reference	-	66.5%	13.5%	39.9dB	-
Brass	3/16-19	15%	1.5%	0.9dB	>39.0dB
Copper clad steel	3/16-19	25%	11.5%	6.9dB	>33.0dB
Gold plated steel	3/16-19	16%	2.5%	1.5 dB	>48.4dB
Silver tin	3/32-21	14%	0.5%	0.3dB	>39.6dB
Titanium	¼-19	17%	3.5%	2.1dB	>37.8dB
Aluminum painted	3/16-18	47%	33.5%	20.1dB	>19.8dB
Stainless Steel	¼-19	16%	2.5%	1.5 dB	>38.4dB
Aluminized steel	¼-16	13.5%	~0%	~0dB	>40dB
Nickel steel	3/16-19	18%	14.5%	8.7dB	>31.2dB

Table 1

3. Conclusions

Given the rudimentary state of our experimental determination of EMI mesh attenuation, we anticipate that several of our standard mesh weaves may meet or nearly meet the HARP criteria for stationary enclosures. In consideration of the flexibility of woven mesh compared to solid sheeting competing abatement alternatives coupled with the blast abatement properties of our steel based meshes, mesh may offer valuable properties for application in the field and for those cases where moveable closure may be preferred in stationary enclosures.

If there are compatible applications for our mesh in EMI abatement and/or blast mitigation, then we feel that there are some vacuum sputtered durable conductive coatings that we could apply to our mesh to give superior service in the field. These materials will need to be evaluated with more sophisticated equipment for attenuation certification.