# TYPICAL MAGNETIC SHIELDING PROBLEMS AND HOW TO SOLVE THEM

The continuing trend toward denser component packaging has compelled many firms to turn to magnetic shielding as the practical way to attain top performance from components and systems. Many of these companies had not previously evinced interest in magnetic shielding. Now that components are crammed closer and closer together, a radiating component's electromagnetic interference deteriorates adjacent component performance.

Whether to shield the radiating or the affected component depends on ease of access. Whenever practical, it is best to shield the source of the interference. However, as spacing becomes very close, AC shielding must be attained by absorption, or magnetic hysteresis. This is because the reflection mechanism which is a major cost-free shielding effect at plane wave conditions, changes sign, becoming "antenna gain", which is counter productive.

### Two Solutions to Airborne Shielding Problems

A common problem on airborne electronics, for example, is keeping the radar display free of distortion. There are two primary approaches to solving this problem.

First, due to limited space in small aircraft instrument panels, instruments must be placed very close to each other. Tachometers with magnetic coupling radiate a rotating field which significantly distorts the radar tube's performance. Other close magnetically radiating devices further deteriorate the display.

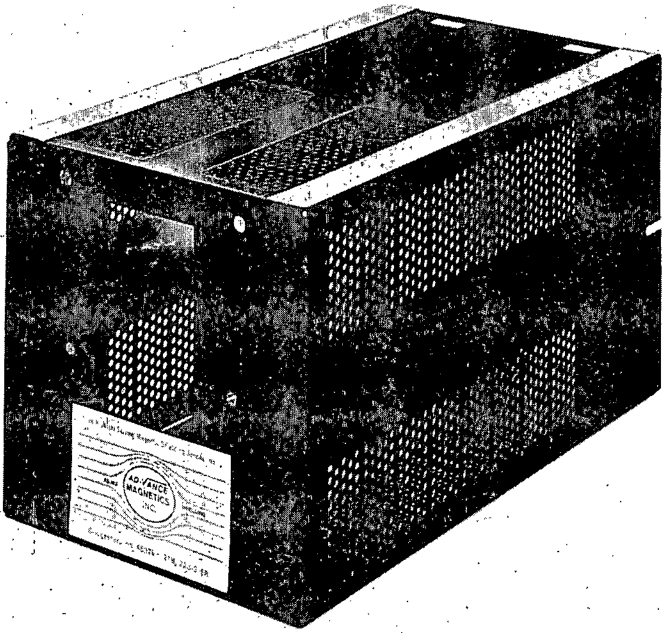

**Figure 1:** One-unit dual function dust cover/magnetic shield.

The solution was a combination magnetic shield/dust cover which, by actual test, prevents CRT display distortion and optimizes resolution, replacing the conventional and more costly dust cover with its separate magnetic shield. The shield/cover is a single layer 5-sided rectangular box made entirely of high permeability magnetic shielding alloy .031″ thick. Perforations provide vital ventilation.

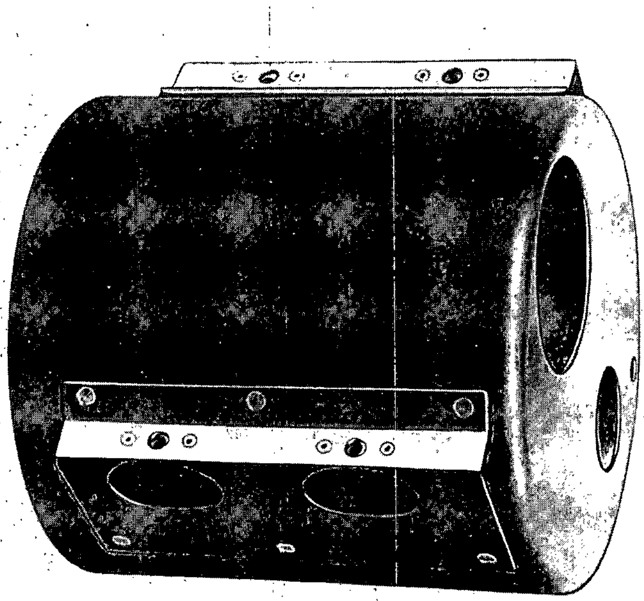

**Figure 2:** Efficient aircraft weather radar display tube magnetic shield.

Secondly, radars are subject to some position shift of the display whenever the aircraft changes direction or altitude. The display is also subject to distortions from electromagnetic interference generated by electronic devices in its proximity. A shielding enclosure to minimize these effects, support and position the tubes, and meet aircraft minimum weight requirements was necessary.

The solution was a multi-purpose shield of high permeability material which provided needed support and positioning for the tube, diverted interfering electromagnetic fields which could cause detrimental display distortion, and minimized positioning errors caused by the earth's magnetic field that could occur during aircraft orientation. In addition, its one-piece hydroformed design and seamless construction offered maximum functional capability for its weight, an important factor in airborne applications. A conventional attenuation test procedure showed 200-300 times attenuation to a nominal field normal to its axis.

## Avoiding CRT Shield Problems at Their Source

Most CRT shield problems arise because of insufficient space at the tube neck. If ample room had been designed around the tube neck for the optimum shield, the display could function optimally, the customer would be happy, and unneeded problems could be averted. Instead, the eventual possibility of a shield being needed is frequently overlooked. Then come complaints from an unhappy customer whose display is not functioning at its full effectiveness. After a scarcely adequate shield has been jammed into too small an area, there is some improvement but not the optimum display the designer intended.

The solution is to design-in adequate space for the proper shield. The optimum neck clearance for a shield should be approx. 0.7 of the CRT neck glass OD. In our increasingly computer oriented society, CRTs are depended on to function at their best in spite of various radiating fields. There must be enough room for an exactly right magnetic shield to achieve this.

## Puzzling Problems From Modern Construction

Cost cutting efficiency in construction can sometimes backfire. Modern reinforced concrete edifices are a case in point. Their lower ceilings contain more reinforced steel beams. The resulting performance-affecting magnetic fields are thus brought nearer to sensitive equipment. This was not the case in older structures with higher ceilings.

Mystification and consternation result. Laboratory researchers and production technicians know they had no such problem with identical equipment when it was housed in their former building. Frequently they don't realize the cause is simply aggravated electromagnetic interference from their present structure's lower steel beam contained ceilings. In fact, a magnetic field gradient much more than the typical 150 Gamma/cm of the high ceilinged buildings is present in the newer low ceilinged reinforced concrete edifices. Magnetic shielding is a necessity; otherwise there is too much disturbance in such newer buildings for research or production equipment to function at desired resolution levels when the equipment is not packaged to function is such an inhomogeneous environment.

## Protection of Valuable Recorded Data

There are unforeseen and unexpected hazards affecting valuable or irreplaceable recorded data. Partial erasure, distortion or degradation can result without anyone knowing it.

For example, who would expect such data to be affected by a thunderstorm? Yet, an ordinary bolt of lightning could strike very near to data in presumed safe storage and cause extensive damage in just that split second. Other hidden hazards might include power generating equipment, as well as passing or nearby radiating electronic and electrical gear or equipment. Different additional types of hazards could include carelessness by unheeding or uninformed personnel and deliberate vandalism with powerful permanent magnets.

Consider just the value of data stored on the widely used 3M Data Cartridge Type DC 100 or similar cassette tapes. Fortunately, cheap insurance is available in the form of a newly developed magnetic shield case that safely, economically protects these cassette tapes from any magnetic pollution. Construction is of low permeability alloy .050" thick, including internal partitions. Up to 36 cassette tapes fit easily in two rows with 18 individual compartments each at a one-time cost of under $2.75 per stored cassette when case is full.

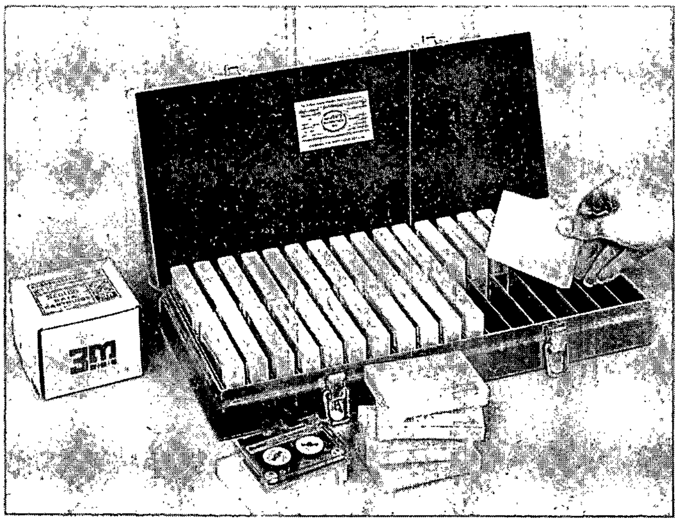

**Figure 3:** 36 Data Cartridge magnetic shield case prevents distortion, partial erasure or degradation of valuable cassette tape recorded data during routine transport or safekeeping.

For ready access, tapes protrude slightly higher than partitions. A 3/4" thick foam lining inside the cover compresses to .62" when case is closed, holding tapes firmly in place without jiggling. For minimal magnetic leakage, there is a 1/2" cover joggled overlap when unit is closed. Two padlock type security latches, piano type hinges and a foldover handle for convenient storage are other construction features. ID case dimensions are 16.65" L x 7.42" W x 3.35" H.

Various other protective cases are available for single conventional cassette protection and for other tape types.

As damage to precious recorded data could occur in various ways without anyone knowing it, during supposedly safe storage or during routine transport, the protective cases are in increasingly wider use. Users include all branches of the armed forces, NASA, other government organizations and numerous private firms.

### Simple Foil Shields Are Cut With Scissors & Hand Shaped

These are ideal for research and experimental work and for hard-to-get-at places. Their on the spot handiness and fast forming convenience can shorten production emergencies by holding downtime to minutes or hours instead of days or weeks. Such an emergency could arise on a production line when unanticipated magnetic fields may be discovered that affect the performance of the component system being manufactured or assembled. Of course, in larger quantities, a fabricated shield could be less costly.

To use foil shielding, one must first lay in a supply from any reputable magnetic shielding manufacturer. Foils are ready for instant use upon arrival, as the manufacturer has already heat treated them. It is advisable to order foils for low and high permeability needs because many applications require a combination of two permeabilities. When combinations are called for, it is best to place the low permeability foil closest to the offending source, as it tends to increase the flux density shielding capabilities. Shielding is accomplished by the low permeability foil diverting most of the field, permitting the high permeability foil to function at a lower reluctance mode with maximum attenuation. Of course it is necessary to first identify the disturbing field.

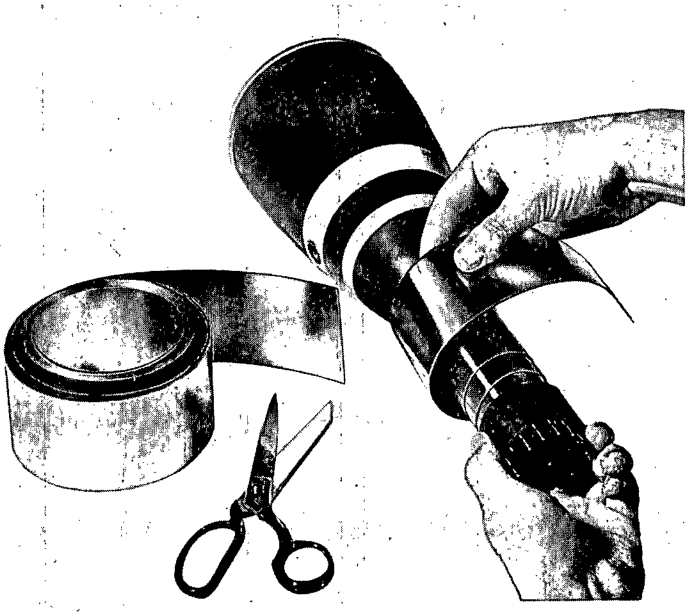

**Figure 4:** Foil alloy easily cuts with scissors and hand trims to outline desired.

Making a foil shield is simplicity itself. The ductile foil is cut with ordinary scissors and easily hand molded to the required outline. It can be applied at once, a great benefit especially to those in experimental research. If the single layer doesn't produce the desired result, as many more layers as needed may be added easily. If guidance is needed, the shielding manufacturer may be asked to furnish a single formula to provide such guidance.

Time and cost saving are the twin advantages of using shielding foil. Eliminated are the design and tooling costs of prefabricated shields. The solution to the shielding problem is quickly available, eliminating time-consuming delays and possible costly downtime.

### Most Applications Require Prefabricated Shields

Quantity orders are common. Under such circumstances, prefabricated shields are more economically feasible than foil shields. There are also single shields designed and fabricated for a certain precision application. All prefabricated shields are exactly tailored to a specific requirement.

After analyzing the offending field, the shield designer picks the shielding alloy which best matches that field. Permeability, saturation, shock sensitivity and proper annealing after fabrication are some of the major considerations. Shield shapes may range from the simple to the very complex and may include eddy current shield layers of copper or aluminum. For lighter fields, a single layer may be all that's needed; heavier fields require two or more shielding layers.

Shielding effectiveness is governed by material permeability, the ratio of wall thickness to the shield's outside radius, wave impedance, and the frequency (conductivity is more important than permeability at high frequencies).

The air gap between shield and the component being shielded helps to produce optimum static magnetic shielding. That's why the shield must be fitted loosely. When several shielding layers are called for, air gap spacing also is vital when absorption loss must be the main shielding mechanism.

### Overdesigning Only Adds Cost

To obtain the maximum amount of shielding for your application at minimum cost, work closely with the engineering department of the shielding manufacturer of your choice. By avoiding too tight tolerances, unnecessary conformal shapes, too elaborate mounting, or too thick a material, cost reductions can be accomplished.

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*This article was prepared for* **ITEM** *by Richard D. Vance, President, Ad-Vance Magnetics, Inc.*