ENHANCING ELECTROMAGNETIC COMPATIBILITY (EMC) ON NAVAL SHIPS WITH RADAR ABSORBING MATERIAL

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ABSTRACT

Radar Absorbing Material (RAM) has proven extremely useful in solving electromagnetic interference problems (EMI) in a metallic shipboard environment where many high power emitters and sensitive receivers are so closely packed together. RAM offers a unique solution to system-to-system coupling and antenna degradation problems. The British Navy is ahead of us in use of RAM; at present, there is no institutionalized acknowledgement of the use of RAM within the U.S. Navy. It is urged that a systematic approach to topside integration utilizing RAM is essential for the growth of Navy capability in the EM performance area.

The electromagnetic environment (EME) aboard Navy ships presents the EMC engineer with a herculean challenge. There are only a few other places--an airplane, for example--where so many high power emitters and sensitive receivers are so closely packed together. Operational requirements severely constrain physical arrangements on a ship. Figure 1 shows just the island mast area of a typical aircraft carrier. Figure 2 shows a typical modern cruiser. EM mission requirements have grown to the point where major combatants now have in excess of one hundred EM emitters and receivers. There are emitters with power levels as high as several megawatts peak power and receivers with sensitivities as low as -130 dBm/kHz. These emitters and receivers sometimes need to be within several feet of each other.

FIGURE 1. MAST STRUCTURE OF TYPICAL AIRCRAFT CARRIER

FIGURE 2. TOPSIDE OF TYPICAL MODERN CRUISER
To successfully manage this growing problem, the EMC engineer has to continually enlarge the benefits provided by the three key relief areas: time, space and frequency. We have developed better blankers, better hardware for frequency tuning and better methodology to alleviate several EMI problems. This paper addresses one area where the Navy thus far has made little headway; the EMC improvement potential offered by radar absorbant material (RAM), especially at the intersystem and platform levels.

On Navy ships physical constraints cause EMC problems that are directly traceable to antenna placement and relative location on the ship involved. Simply stated, given the large metallic shipboard environment and the cramped quarters, there is not space for adequate antenna separation and for obstruction-free radiation. Over the last several years, the Navy's Shipboard Electromagnetic Compatibility Improvement Program (SEMCIP) has experienced first hand degradation of prime equipments due to these problems and, in many cases, has been able to supply immediate remedies for them through the use of RAM. Before going any further, it should be noted that there is some disagreement within the EMC community as to what constitutes EMC. SEMCIP defines the EMC problem areas to include not only system-to-system EMI, but also the EM incompatibility problem which results when objects or structures in the field of an antenna perturb the antenna pattern and produce degraded performance.

RAM offers a unique solution to two of the more common EMI problems plaguing the Fleet. These two EMI problems are system-to-system coupling and the problems resulting from antenna pattern degradation. Since the purpose of RAM is to absorb or otherwise eliminate EM energy, it is easy to see its utility in decoupling EM systems close to each other. Antenna pattern degradation merits further discussion. With the increasing requirements for complex performance, such as radar, side-mode cancellation, SHIP, clutter, track, sidelobe blanking, etc., the development effort and the resulting expense of providing required antenna pattern performance can be a major part of a systems development cost. The purchased performance can be seriously degraded or even lost after the system is installed on a ship if topside arrangements are not well engineered and every available tool utilized where appropriate. Metal objects on ships, whether they be superstructure or other conducting objects intercept and re-radiate EM energy. This creates two problems, the energy often goes somewhere it shouldn't go and conversely does not go where it should. In the radar area, the most obvious problems caused are ghost targets and blind spots, respectively. SEMCIP usually finds the blind spot problem to be overstated. Typically, the loss of real target sensitivity can be estimated roughly by observing how area of the aperture is blocked, e.g., a mast in front of a radar usually blocks half or less of the antenna. Visibility in respective. SEMCIP usually finds the blind spot problem; however, it is ideal to cure the ghost problem and will often cure or dramatically improve the other problems mentioned, and will provide this benefit usually without exacerbating any blind spot problems.

Despite RAM's utility, there has been no recent (within the last ten years) institutionalization of the use of RAM to improve topside integration. There have been occasions where equipment manufacturers have employed RAM to cure serious post-installation EMI problems. Indeed there are cases where RAM was used to assure passing OPEVAL and TECHEVAL, the two key Fleet acceptance tests prior to systems acquisition (TASM 23, for example). But the Navy has implemented no consideration of RAM as a part of a systematic design approach to topside integration. However, SEMCIP, as part of its mission of finding and fixing EMI problems in the active Fleet, has used RAM effectively.

Figure 3 shows a RAM-covered barrier SEMCIP installed aboard a cruiser to cure a significant EMI problem. Figure 4 shows an LHA class ship

![Figure 3. RAM Barrier on Modern Cruiser](image-url)
FIGURE 4. TOPSIDE VIEW OF LHA CLASS

where SEMCIP worked three problems of this nature. Two of the three situations were dramatically improved by utilizing RAM. The third required effort beyond SEMCIP’s present capability. Figure 5 shows a SEMCIP engineer installing RAM on the support spar of a yardarm. We are not specialized in RAM application and often find our equipment woefully inadequate.

The British are quite a lot ahead of us in the institutionalized use of RAM on ships. Figure 6 shows HMS INVINCIBLE with RAM installed (as photographed by SEMCIP during a recent visit to Portsmouth, England). RAM is used routinely on British ships and the use is supported throughout the ship’s whole life cycle. For example, when a ship goes into the yard for overhaul or repairs, the RAM is refurbished automatically, and the ship returns with the RAM intact, restored, or unimpaired. By contrast, in the U.S. Navy, there is at present no institutionalized acknowledgement of the existance of RAM. Unless the designer/manufacturer of a particular system steps in and returns the system to the factory to refurbish it, RAM gets no special consideration in the overhaul process. In fact, on a platform basis, if RAM is found on a ship, it is usually ripped off as part of the painting process and not replaced.

As to the question of the origin of this state of affairs, the best that SEMCIP has been able to find out is that some eighteen years ago there was a major push on the use of RAM. It caught on in the British Navy, despite what, at the time were severe shortcomings of RAM. The U.S. Navy considered these shortcomings unacceptable.

RAM has come a long way since that time. SEMCIP’s review of RAM state of the art has revealed that dramatically improved types of RAM are now available as a result of efforts to use it in radar cross section reduction and target vulnerability applications. These new types are vastly superior in terms of weather resistance, structural capability and performance. Thus the topside designer who wishes to go out with a shopping list will find that compared with a few years ago the state of the art of RAM performance and suitability for shipboard applications has been significantly upgraded. It should be pointed out that some of this material is just reaching the marketplace, but it is there and available. Unfortunately, some are not easily available; many of the materials are still classified because they were developed for various target vulnerability applications.

FIGURE 5. SEMCIP INSTALLING RAM
In conclusion, SEMCIP urges the use of RAM aboard ships to preserve system performance from an EMC standpoint and believes that an institutionalized and systematic approach to topside integration utilizing RAM is essential for the future growth of Navy capability in the EM performance area. RAM materials are mature available, and indeed, where they are being used, they have proven quite successful.