SHIELDED CABINETS: DO THEY MEET THE TEST?

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Do these cabinets meet MIL-STD-461C? Is this a TEMPEST cabinet? Do these cabinets meet FCC Docket 20780? Every manufacturer of electronic cabinets hears these questions from customers. The simplest answer is, "No, there isn't a cabinet in the world that tests to any of those standards." Of course, manufacturers who gave that answer would be doing themselves and their customer a disservice. No cabinet, *by itself*, meets these standards.

The technology of reducing unwanted electromagnetic or radio frequency interference to a level which allows an electronic system to operate properly is called Electromagnetic Compatibility (EMC). This technology is used to suppress and contain emissions and also to shield equipment which is susceptible to such emissions. Any barrier placed between an EMI/RFI source that reduces the strength of the interference can be regarded as an EMI/RFI shield. In order to measure a cabinet's shielding effectiveness, a variety of military and commercial test standards have been established. Military Standard MIL-STD-461C and TEMPEST, as well as the commercial FCC Docket 20780, are designed to specify the maximum limits of a fully functional system. Military Standard MIL-STD-285 is generally accepted as the test for shielding effectiveness of an unoccupied cabinet.

Military standards such as MIL-STD-461C deal with both emissions and susceptibility. MIL-STD-285, used to test unoccupied cabinets, is a test of shielding effectiveness only. This test should be performed in an anechoic chamber. It requires a transmitter to be placed outside the cabinet and a receiver to be placed inside. Attenuation readings (in dB) are then taken at various frequencies to determine the cabinet's performance (Figure 1).

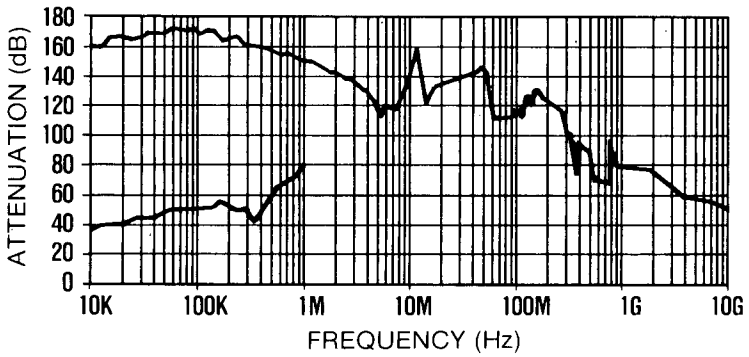

Figure 1. Cabinet Performance.

The ideal shielded cabinet is a metal box with no seams or openings. Any opening in a cabinet creates a potential EMI/RFI path into and out of the cabinet. However, in the real world openings are required for maintenance and ventilation of the equipment, as well as for electrical input. These openings must be covered by panels and/or doors which maintain electrical continuity by either metal-to-metal contact or by using conductive gaskets.

The science of electromagnetic compatibility has an element of *black magic* associated with it. Because a cabinet with one customer's equipment passed a particular EMI/TEMPEST test does not automatically mean that another customer's equipment in the same cabinet will also pass the same test. Whether the results of the particular test meet a required standard depends on many factors: the frequency level at which the equipment operates, its susceptibility level, the level of shielding in the equipment itself, how well the power source is shielded, the connectors which bring the power source into the enclosure, the adequacy of the installation, and even the sizes and shapes of components. This wide range of variables is why the most that any cabinet manufacturer can honestly tell a customer are the results of testing their cabinet to MIL-STD-285. Be wary of any cabinet manufacturer who makes a blanket statement that their cabinet will pass TEMPEST or MIL-STD-461C or any other test intended for a fully functional system.

Designs for EMI/RFI shielded cabinets vary considerably from manufacturer to manufacturer. The design selected will be dictated at least in part by the actual level of shielding required.

Most EMI/RFI cabinets consist of two basic parts: the frame and its component panels and doors which close off the openings in the frame (Figure 2).

Any well-shielded cabinet should take certain design factors into consideration. The shielding effectiveness of a cabinet is determined by the material from which it is fabricated, the construction of the frame, and the cabinet's panel joint design.

A cabinet attenuates an electromagnetic field by reflection and absorption. The absorption loss capa-

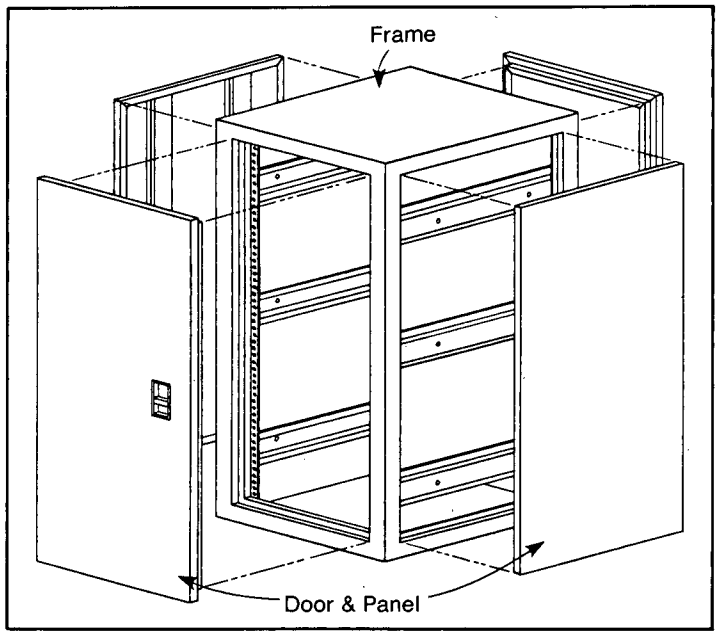

Figure 2. EMI/RFI Cabinet.

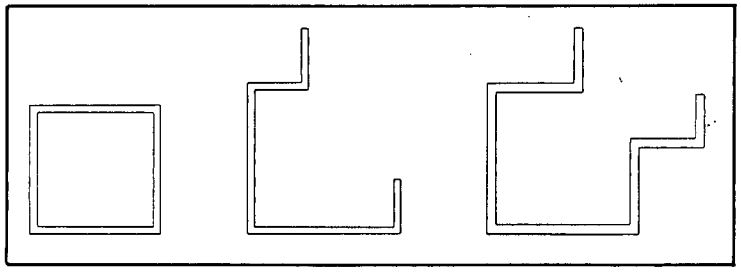

Figure 3. Sample Frame Posts.

bilities at any frequency will vary, depending on the material's thickness, conductivity and permeability. Though a variety of materials, such as stainless steel, aluminum, and even plastics are currently being used, cold rolled steel is generally considered to be the most cost-effective. Whichever material is used, it should be thick enough to provide adequate absorption, as well as to assist in maintaining the structural rigidity of the cabinet. A cabinet that does not have structural rigidity will not maintain flat surfaces between the frame and its component parts, thus making it more difficult to seal, and therefore more susceptible to leaks.

In addition to sufficient material thickness and rigidity, the frame itself should be constructed in a manner which will enhance its rigidity. Frame posts should be constructed from tubing or multiformed frame channel such as those shown in Figure 3. Corner posts should be fully welded to top and bottom pieces. With fully welded joints, the frame is strengthened and areas of potential leakage are minimized.

Panel joints, the areas where a frame contacts a panel or door, must be adequately sealed. Any gap or discontinuity between the frame and a closure panel or door creates a leak area, with consequent reduction in attenuation. In order to prevent leakage in these areas, it is necessary to use an EMI/RFI gasket. However, the shielding effectiveness of the gasket will be severely inhibited if the mating surfaces are not rigid, flat, clean, and free of foreign materials, i.e., as conductive as possible. Rigidity and flatness of mating surfaces are best maintained by using heavier gauges of material and multiformed frame corner posts, panels, doors, etc. Conductivity is accomplished by keeping mating surfaces free of nonconductive finishes, such as paint. These surfaces are then plated or covered with other conductive finishes to prevent corrosion. It is important to note that the plated surfaces and the gaskets being used must be galvanically compatible. If they are not, galvanic corrosion will occur, resulting in reduced conductivity between surfaces. A quality shielded cabinet will use gaskets that are galvanically compatible, conform consistently to all joint surfaces, and retain their resiliency over time and normal use.

In addition to the factors of rigidity, flatness and conductivity, the attachment methods of component closure panels and doors are important in attenuating radiated signals. The use of a sufficient quantity of fasteners to attach a closure panel ensures that gasket compression is adequate to seal the opening. When a door is the preferred method of entry into the cabinet, the problem of attachment becomes more acute. The number of latch points on a door are limited, making it much more difficult to adequately compress the gasket which surrounds the opening. Additionally, hinges, latches and handles which violate the door panel will cause leakage problems if not properly sealed and/or grounded. Doors should be constructed of sufficient gauge material and have multiformed flanging to prevent bowing under the pressure of the latching and gasket compression process. The design of the hinging and latching mechanisms should provide for adjustability in order to maintain a proper seal through the normal process of gasket compression and aging.

These are design features which one should be aware of when selecting a cabinet to meet specific needs. However, in order for any cabinet manufacturer to assist a buyer with specific requirements, it is essential to know at what frequencies the system will operate and what attenuation levels the cabinet will be required to provide. Typically, the higher the level of shielding, the more the cabinet will cost. With this information, the manufacturer will be able to provide the buyer with the appropriate and most cost-effective cabinet. ■

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stantiate the credibility of a candidate. Current plans are that the candidate will provide endorsement from five persons (two of whom are themselves accredited) with whom the candidate has worked and who can attest to the validity of the candidate's work experience.

Examinations will be confined to the area of EMC fundamentals. The object for the fundamentals examination is to test for knowledge in certain specific areas. The examination is expected to take one day. The examination will be open book, and the candidate may bring any text or bound set of notes desired. The following areas will be covered:

• Bonding • Grounding • Shielding • Interface Control • Filtering • Materials • Intersystem Design • Intrasystem Design • Special Devices • Equipment Design • Conducted Interference • Antennas • Radiated Interference • Filter Theory • Terminology • EMI Prediction • EMI Analysis • ESD • Specifications • Standards • EMC Test Plan • Test Equipment • Test Facilities • Safety • Mathematics • Spectrum Analysis • Field Theory • EMP • Lightning Protection

Commercial training organizations are expected to provide refresher courses in EMC fundamentals to assist candidates in passing the examination.

CERTIFICATION AGENT

The National Association of Radio and Telecommunications Engineers (NARTE) is a nonprofit Association of engineers and technicians dedicated to advancing standards by donating their time, energy and expertise. NARTE advocates competence and professionalism in the field and serves as a certifying agent for engineers and technicians. NARTE was formed to fill the void created by the Federal Communications Commission's deregulation of licensing requirements for technicians and engineers. The NARTE program certifies, endorses and tests engineers and technicians who work with either non-RF-radiating or RF-radiating systems and equipment. The program establishes and administers qualification requirements for various certification classes and establishes new endorsement areas to reflect state of the art technology. It allows for the expansion of categories upon a showing of need.

NARTE is being considered as the Certification agent because it is independent, it has a certification program in operation and it has the resources needed to support Navy EMC certification requirements.

GRANDFATHERING

It is recognized that there are a lot of competent people currently providing direct EMC technical support. For a variety of reasons it may not be practical for these people to sit for an examination. As a consequence, there is a provision in the EMC certification process for certification by prior experience. This process will be available only for the first year after the requirement has been established. It will only be available to people who have a minimum number of years (probably nine) of experience and who have been actively engaged in the EMC technical support for the 12 preceding months.

SENSITIVITIES

While the need for certification and accreditation seems to be evident, the requirement is being implemented with the consideration for certain sensitivities. The implementation is proceeding at a slow and deliberate pace to ensure that the competitive process is not disturbed. Rapid implementation would create an artificial shortage of support personnel. To ensure that the concerns of industry are fully considered, the development process for accreditation is open for industry participation and involvement. Comments are invited and should be forwarded to Naval Air Systems Command, AIR-5161, Washington, DC 20361-5160. ■

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Some cooperative efforts will ease the design and manufacturing process. An enclosure should be considered at the outset of the system's design to eliminate potential packaging problems when the equipment is being introduced to the marketplace. The system designer must place equal emphasis on the design of the outer enclosures. Throughout the design process, the system designer should work closely with the enclosure designer so that all the system requirements (thermal, shielding, shock, vibration, ease of access, maintenance, appearance, finish) can be incorporated in the enclosure right from the beginning. This also allows an enclosure manufacturer to react to changes proposed by the system designer without adversely affecting the delivery.

CONCLUSION

Once a system is put together, it must be tested to determine whether it meets shielding requirements. All the commercial, consumer and military specifications governing EMI apply to *total* electronic systems and an enclosure manufacturer cannot guarantee meeting the emission requirements. However, an experienced enclosure manufacturer can help by making necessary changes to the enclosure after a system is tested for emissions. If electromagnetic leakage is found along a non-functional (but necessary for fabrication) seam, that seam can be welded solid. Similarly, the leakages around a panel or door can be eliminated by providing extra latches or fasteners and reinforcing the panels/doors.

An enclosure manufacturer should have the experience, knowledge, and manufacturing flexibility to modify products, the facilities to plate and apply different finishes, a strict quality control program, and a proven track record. But the most important requirement is that the enclosure manufacturer must have a strong desire to work and collaborate with clients to help design a cabinet that would adequately meet EMI/RFI and cooling needs, shock and vibration requirements, and provide ease of access and maintenance to the equipment in the enclosure. ■