Fluorescent Lighting & EMI

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This Web exclusive comes from Leslie North, PE and Jack Black. Submitted by HeidiTFM.

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Electromagnetic Interference, or EMI, has been a subject of considerable discussion, regulation, and public concern for years. While the effect of EMI can be as insignificant as a buzz on the car radio when driving underneath a power line, it can also be catastrophic, such as when interfering with the proper functioning of a life support monitor in a healthcare facility or compromising the operational integrity of sensitive safety equipment.

While many of the most frightening EMI-related events tend to occur in medical or scientific research environments, the potential for EMI-related problems exists across the spectrum of commercial, institutional and industrial facilities. In these environments, EMI can cause significant problems with computers, industrial process controls, security systems, electronic test equipment, intercoms, climate control systems, cyclotrons and even electro-explosive devices, to name just a few examples.

Consequently, minimizing the potential for EMI-based events has become increasingly important in the design and fit-up of many facilities, even in situations where EMI-based problems aren't likely to cause injury or death. Downtime, production errors, communications failures and invalid test results represent just a few of the potential problems facility design and management teams need to prevent.

FLUORESCENT LIGHTING AS A SOURCE OF EMI

One piece of equipment common to almost all non-residential facilities with the potential of creating unwanted EMI-based events is the ubiquitous – yet often overlooked – fluorescent lighting fixture.

Back when magnetic ballasts were the norm, design of EMI-sensitive spaces called for lensed fluorescent troffers with an EMI filter on the line side of the 60 Hz ballast and an RFI grid lens covering the lamp chamber. Although often compromised by ineffective manufacturing processes, this remedy was effective enough for most applications.

ELECTRONIC BALLASTS: CHANGING THE RULES

With the advent of high frequency electronic ballasts, however, these traditional "fixes" no longer sufficed. Electronic ballasts operate at significantly higher frequencies than their 60-cycle magnetic predecessors, effectively turning the fluorescent lamp's arc into an emitter of radio frequencies high enough to defeat the mitigating potential of both the EMI filters and the RFI grid lenses used with magnetic ballast fixtures.

Concerned facilities teams often avoided the problem simply by specifying old-style magnetic ballasts; doing so in this age of high-energy costs and mandated energy conservation, however, is no longer realistic. Today, the considerably more energy-efficient electronic ballasts are all but required in many states in order to meet lighting power density or overall facility energy consumption regulations, while magnetic ballasts aren't even available for many of the newer fluorescent lamps.

Fortunately, approaches to emissions control have now been developed for electronic ballast-equipped fixtures, though the fixture's design and construction quality remain crucial since high frequencies can exit the fixture through even the smallest hole or gap.

PROACTIVE INSTEAD OF REACTIVE

Despite the expanding presence of EMI-sensitive equipment in a variety of facility types, the value of prevention-based design is often underestimated, with responses to concerns about lighting and EMI often being: "I'm not aware of lighting causing EMI problems on my last job, so I don't need to worry about this one either."

Identifying the source of an EMI event after it's occurred, however, can be extremely difficult due to the number of confounding variables that can come into play, from the quantity and type of potentially offending devices and issues of their electromagnetic compatibility with other devices to changes in atmospheric conditions, unstable electrical loads, voltage spikes and other power system irregularities. As a result, identifying lighting as the problem after the fact may be highly problematic.

Clearly, the most effective means of eliminating light fixtures as an EMI source is by ensuring they perform as they should in the first place. Fortunately, there are now fixtures effective at trapping EMI-producing electrical energy within the fixture itself. The question that remains is how to be sure the fixtures you choose will perform as needed.

A PATCHWORK OF STANDARDS

As is the case with many critical product types, a performance specification based on an appropriate standard is the safest approach.

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The European Community (EC) has instituted stringent requirements for electrical or electronic devices that could generate harmful electromagnetic interference. The EC standards include specific requirements for emissions – both conducted and radiated – plus immunity standards requiring that these same devices function normally in the presence of electromagnetic interference. Though we might expect equally clear and comprehensive standards for lighting and EMI here in the U.S., identifying the appropriate ones can be confusing.

While it would be convenient to simply apply EC standards to U.S. projects, the testing standards aren't transferable because of the different voltage and frequency characteristics of European electrical systems.

Currently, the one mandatory U.S. legal standard for fluorescent luminaires comes from UL, but UL listings are limited to electrical and fire safety only. The Federal Communication Commission (FCC) issues testing standards for electromagnetic compatibility (EMC) between electronic devices, plus standards for the maximum electromagnetic emissions from certain types of electrical equipment, but the FCC's requirements for lighting apply to RF lighting devices and ballasts only (instead of complete fixture assemblies) and don't cover radiated emissions.

Further complicating the standards issue, the Food & Drug Administration (FDA) has the authority to require medical devices to comply with certain EMC standards that fall outside FCC authority.

Trying to understand and correctly apply different aspects of different standards from different agencies and organizations is a daunting task. It's also hard for facilities personnel to defend the time and expense of commissioning tests to meet what boils down to a patchwork of standards, particularly when some ballast manufacturers tend to oversimplify and understate the issue by responding that their electronic ballasts "meet FCC requirements."

MILITARY STANDARD 461E

Until an American regulatory agency, professional society, or industry organization creates a comprehensive standard for electromagnetic emissions from light fixtures, the recognized standard that can be effectively applied is Military Standard (Mil Std) 461E.

461E is mandatory for certain military installations, including military hospitals, and voluntarily for other public and private applications. 461E represents a significant advance over earlier versions, such as version 461C, under which the potential for unwanted occurrences to be accidentally missed was substantially higher. Testing measurements required in accordance with Mil Std 461E are specific to both the fixture's radiated and conducted emissions, with the maximum allowable amounts of emitted energy based both on frequency range and field strength.

The most effective test procedures within 461E (when dealing with lighting fixtures) are those sections pertaining to requirements for Navy Fixed and Air Force limits for electronic devices. These limits are more stringent than those required by FCC or EC standards, as the specific tests outlined under test methods CE 102-1 (for conducted emissions) and RE 102-4 (for radiated emissions) are designed to emulate "worst case" operating conditions, making them the most appropriate and effective standards currently available. Consequently, fixtures that meet the Military Standard pose a significantly lower risk of creating unwanted EMI-based events. Further, the standards are reasonable, definable and easily defensible.

GOVERNMENT CERTIFIED LABS

These Mil Std procedures require specialized test equipment, such as line impedance stabilization networks, spectrum analyzers, specially tuned antennae, EMI receivers and current clamps and probes, and not all testing labs are capable of accurately performing the required tests. So, when evaluating a fixture's test results, make sure the tests have been performed by a qualified independent laboratory accredited by the NIST and/or the US Dept. of Commerce to have both the equipment and the expertise to perform these tests with procedural exactness. Also check the application distances used in the tests, since some labs measure electromagnetic emissions from as far away as 10 meters when the appropriate distance is one meter.

While we should be able to expect comprehensive U.S. EMI standards sometime in the future, in the meantime facilities managers can minimize the potential for costly and potentially dangerous EMI problems from fluorescent lighting by requiring that fixtures meet Military Standard 461E – an often overlooked standard that provides the best protection currently available.

SAMPLE SPECIFICATION

Looking for the correct specification language? Try the following:

Provide complete luminaire (luminaire defined as a complete lighting unit including lamps and parts required to distribute the light, position and protect lamps, and connect lamps to the power supply) meeting requirements CE-102-1 for conducted emissions and RE-102-4 for radiated emissions of Mil Std 461E for all luminaire operating parameters. Measurements to be taken one meter from source.

We also recommend that health care equipment specifiers/purchasers also require equipment to meet the CS and RS portions (as applicable) of standard 461E.

HOW ELECTRONIC BALLAST-EQUIPPED FLUORESCENT FIXTURES PRODUCE EMI

Unwanted electromagnetic energy, in the form of an electromagnetic field and propagated as radiated emissions, is a common phenomenon of electronic ballast-equipped fluorescent fixtures. The unwanted energy generated from the ballast can couple on to any wire or cable, light bulb, or ungrounded lighting fixture, and emit unwanted interference into the airwaves. This energy can also couple on to power lines that other devices are plugged into, causing unwanted energy to enter those devices.

An important – though often overlooked fact – is that ceiling-mounted fixtures in multi-storey buildings not only affect the space they're lighting, but also the space immediately above the lighted area.