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Guidelines for Electromagnetic Interference Testing

Status of Industry and NRC Activities—February 2008

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Technical Update, February 2008

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PRODUCT DESCRIPTION

This Technical Update summarizes the status of industry and Nuclear Regulatory activities that may affect existing industry and regulatory guidance on electromagnetic compatibility (EMC) qualification and testing. EMC issues usually involve testing to show that critical equipment will not be adversely affected by EMI in the plant. Because of the rapid evolution of electronic equipment due to factors such as higher operating frequencies and lower signal voltages, requirements for emissions and susceptibility qualification testing are constantly being challenged.

Results & Findings

For the immediate future, ongoing EMC activities and research will involve the EPRI EMI Working Group and Nuclear Regulatory Commission (NRC) Research. The principle objective of their collaboration will be to reconcile differences between their two EMC guides.

Challenges & Objective(s)

The two standards for EMC guidelines are the NRC's Regulatory Guide 1.180 Revision 1 and EPRI's *Guidelines for Electromagnetic Interference Testing in Power Plants, Revision 3* (EPRI report 1003679). With each update, the two documents have become more closely aligned with each other. However, NRC's guideline and EPRI's differ significantly in their treatment of one high-frequency-conducted susceptibility test, CS114. This discrepancy can result in users designing and implementing costly custom filters that are unnecessary. A few relatively new EMI issues involving wireless communications devices also may warrant more detailed treatment in industry and NRC guidance. EPRI and its industry EMI Working Group are interacting with NRC Research to address these issues.

Applications, Values & Use

Operators of nuclear power plants must be able to replace and upgrade equipment in a cost-effective manner to continue meeting safety and reliability requirements while controlling costs. One issue that has been problematic for new plant equipment and especially for digital instrumentation and control (I&C) systems is EMC. EPRI recommended that industry and NRC work together to resolve this EMC issue to avoid regulatory confusion and unneeded hardware modifications. Another EMC issue requiring the attention of NRC Research and the EPRI EMI Working Group is the use of cell phones in nuclear plants, where cell phone EMC standards have not been evaluated.

EPRI Perspective

This Technical Update provides a status report on ongoing EPRI and NRC activities that may affect existing industry and regulatory guidance on EMC qualification and testing. The document is intended as an informal report and should not be considered final.

Approach

Continuing interactions and open dialog among NRC Research, their contractors, and EPRI EMI Working Group technical experts will continue to provide a practical, effective mechanism to identify and resolve EMI-related issues.

Keywords

Electromagnetic interference (EMI)
Electromagnetic compatibility (EMC)
Instrumentation and control
Digital systems

ABSTRACT

One issue that has been problematic for new plant equipment and especially for digital instrumentation and control (I&C) systems in recent years is electromagnetic compatibility (EMC). Guidance from the Nuclear Regulatory Commission (NRC), EPRI, and various standards organizations has been evolving for many years and generally converging. However, the NRC's most recent guidance, Regulatory Guide 1.180 Revision 1, and EPRI's most recent EMI Guideline (*Guidelines for Electromagnetic Interference Testing in Power Plants, Revision 3 to TR-102323*, Product Number 1003679, October 2004) differ significantly in their treatment of one high-frequency-conducted susceptibility test, CS114. This difference in treatment causes confusion among suppliers and utility engineers and can result in users designing and implementing costly custom filters that are actually unnecessary. A few relatively new electromagnetic interference (EMI) issues involving wireless communications devices also may warrant more detailed treatment in industry and NRC guidance. EPRI and its industry EMI Working Group are interacting with NRC Research to address these issues. This technical update provides a status report on ongoing EPRI and NRC activities that may affect existing industry and regulatory guidance on EMC qualification and testing.

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INTRODUCTION

To continue meeting safety and reliability requirements while controlling costs, operators of nuclear power plants must be able to replace and upgrade equipment in a cost-effective manner. One issue that has been problematic for new plant equipment and especially for digital instrumentation and control (I&C) systems in recent years is electromagnetic compatibility (EMC). The EMC issue usually involves testing to show that critical equipment will not be adversely affected by electromagnetic interference (EMI) in the plant environment. Because of the rapid evolution of electronic equipment, requirements for emissions and susceptibility qualification testing are constantly being challenged by new characteristics such as higher operating frequencies and lower signal voltages. This technical update provides a status report on ongoing EPRI and NRC activities that may affect existing industry and regulatory guidance on EMC qualification and testing.

Background

EMC received renewed attention in the early 1990s when nuclear power plants started replacing obsolete analog I&C systems with digital systems. Little guidance was available on EMC for nuclear plants, and the industry and the Nuclear Regulatory Commission (NRC) pursued the issue in a series of iterations that reflected the increasing knowledge base and evolution of testing standards. EPRI assembled a working group of industry and utility experts on EMC (see Appendix A for complete list) to develop guidance for utility engineers that was published in a series of EPRI guidelines. EPRI TR-102323, *Guidelines for Electromagnetic Interference Testing of Power Plant Equipment* (1994), received NRC approval through a safety evaluation report (SER) in 1996 and became a de facto standard within the U.S. nuclear industry. NRC published its guidance in a regulatory guide (1.180) in 2000 with a revision in 2003, and the third revision of the EPRI EMI Guideline was published in 2004 (EPRI 1003697). With each update, the two guidance documents have become better aligned with each other and with EMC standards used by the military and other industries.

One issue of special note in Revision 3 of the EPRI Guideline (EPRI 1003697) is its treatment of CS114, a high-frequency conducted susceptibility test that has proven particularly problematic for most equipment. The CS114 test levels recommended in earlier revisions of the EPRI EMI Guideline and in Regulatory Guide 1.180, Revision 1 were based on plant data acquired by EPRI in the early 1990s. The results of a 2003 reevaluation by EPRI (*Review of High Frequency Conducted Susceptibility Limits: Assessment of CS114 Test Limits in TR-102323*, EPRI 1007998, December 2003) indicate that the early data was misapplied, and less conservative test levels are proposed in the Revision 3 EMI Guideline (EPRI 1003697).

However, the CS114 guidance in Regulatory Guide 1.180, Revision 1 is still based on the 1994 version of the EPRI EMI Guideline, so there is now a significant discrepancy between the two guidance documents. Utility experience and results of the more recent investigation indicate that using the Regulatory Guide approach may lead plants to design and implement costly EMI filters that are actually unnecessary. EPRI recommended that the industry and NRC work together to resolve this final EMC issue to avoid regulatory confusion and unneeded hardware modifications in the future.

In 2006 a new EMC issue was identified that may need the attention of NRC Research and the EPRI EMI Working Group. Cell phones use is expanding rapidly, but neither the EPRI nor NRC guidance addresses them adequately. There is currently no consensus on how they should be handled in nuclear plants or what type of qualification testing might be appropriate. Some cell phone EMC standards exist, but they have not been evaluated for use in nuclear plants.

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STATUS OF INDUSTRY AND NRC ACTIVITIES

For the short term, the ongoing activities of interest will involve the EPRI EMI Working Group and NRC Research. The principle objective is to reconcile the differences between the regulatory guide and the EPRI EMI Guideline. Two previous versions of the EMI Guideline were submitted to the Instrumentation and Control Branch of the Office of Nuclear Reactor Regulation NRR for formal review. However, this time it was judged that the more cost-effective path would be to work with NRC Research, which had originated Regulatory Guide 1.180, and would be responsible for producing another revision, if it is needed. Accordingly, copies of Revision 3 of the EPRI EMI Guideline were provided to NRC Research to assist their assessment of the need for another revision of the regulatory guide.

NRC Research

NRC Research had contracted with Oak Ridge National Laboratory (ORNL) to review the new information provided by EPRI and assess the need for a revision to the regulatory guide. After reading Revision 3 of the EPRI EMI Guideline, NRC Research requested additional information on the EPRI effort to reexamine the data and analysis that were used to establish recommended test levels for CS114 in the previous revisions of the EPRI guidelines as well as Regulatory Guide 1.180. In response to the NRC request, EPRI updated the existing informal report on the CS114 review (Reference 5) and produced a technical report version (Reference 7), which was provided to NRC Research through official channels in January 2008. The intent is to bring NRC Research, their contractors, and the EPRI EMI Working Group together for further technical discussions after NRC has had a chance to look over all the information on CS114. However, at this point the NRC Research effort on EMI is one of several projects competing for resources, and a firm schedule for the next steps has not been established.

EPRI EMI Working Group

In 2008 the EMI Working Group will continue to function primarily in a support role, and does not have sufficient funding to develop new guideline materials. The Working Group will be convened when the NRC Research effort is ready for further dialog on the CS114 issue and other potential areas of concern in the EPRI EMI Guideline and the regulatory guide (e.g., wireless and cell phone issues not currently addressed in the guidance). If needed, the Working Group may help the NRC Research project team in several areas:

- Explain details of EPRI CS114 investigation
- Design confirmatory tests and demonstrations for plant and laboratory environments
- Locate nuclear plant candidates for on-site testing

EPRI now has a technical group in Knoxville, TN that has specific expertise and capabilities in EMI and EMC, including a test lab. They are currently engaged in research efforts looking at the need to refine or extend current regulatory guidance, particularly in the area of high frequency EMC. Technical staff members from the EPRI Knoxville group have been recruited to participate in the EPRI EMI Working Group, with the intent that responsibility for Working Group administration and future technical EPRI efforts in this area will transition to them. It is expected that this transition will occur later in 2008, following discussions with NRC Research and the EMI Working Group.

It is anticipated that continuing interactions and open dialog among NRC Research, their contractors, and the EPRI EMI Working Group technical experts will continue to provide a practical, effective mechanism to identify and resolve EMI related issues as they arise.

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