

Meeting Summary
Public Meeting on Electromagnetic Compatibility Guidance
Held at MPR, Associates, in Alexandria, Virginia
October 19, 1999

Participants

- * Christina Antonescu, Nuclear Regulatory Commission, RES
- John Calvert, Nuclear Regulatory Commission, RES
- Doug Chapin, MPR, Associates
- Robert Carritte, MPR, Associates
- Bob Fink, MPR Associates
- Bruce Geddes, Baltimore Gas and Electric
- Dave Harrell , MPR, Associates
- Joe Naser, EPRI
- Michael Violette, Washington Laboratories, Ltd.
- Richard Wood, Oak Ridge National Laboratory
- J.F. Ziegler, PECO Nuclear
- NRC, NRR staff although invited did not participate at meeting

Scope

Based on concerns over **existing** electromagnetic compatibility guidance (SER endorsing the TR 102323 report) that were expressed by Mr. Doug Chapin, MPR, Associates, in a letter dated November 2, 1999 to Ashok Thadani, Director, U.S. Nuclear Regulatory Commission (NRC) Office of Nuclear Regulatory Research, NRC staff and contractors participated in a public meeting to describe the technical basis for proposed guidance in draft regulatory guide DG-1029 "Guidelines for Evaluating Electromagnetic and Radio-Frequency Interference in Safety-related Instrumentation and Control" and to facilitate technical discussion of implementation issues.

Purpose

The purpose of this meeting was to provide a forum in which the technical basis for proposed electromagnetic compatibility guidance could be presented, nuclear power industry experience with existing guidance could be identified, and technical concerns over implementation of electromagnetic compatibility practices could be discussed. Specifically, the purpose of the meeting was to discuss the rationale previously presented at the public meeting of July 23, 1998 of DG-1029, which represents the incorporation of all the public meeting comments up to that point.

Summary

Mr. John Calvert of the U.S. Nuclear Regulatory Commission (NRC) Office of Nuclear Regulatory Research (RES) and Mr. Doug Chapin of MPR Associates, opened the discussions with introductory comments that identified the purpose of the meeting. Mr. Calvert explained that NRC was interested in providing the opportunity for the public and nuclear power stakeholders to understand and discuss the technical basis for proposed electromagnetic compatibility (EMC) guidance. He stated that recent comments and concerns provided to NRC

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illustrate the need for such technical exchanges. Mr. Chapin offered that his letter to NRC questioning the perceived overly conservative nature of some elements of the EMC guidance was prompted by experiences of MPR staff with EMC practices in current nuclear industry projects.

Ms. Christina Antonescu of NRC/RES the EMC project manager presented the overall background (the overview of the history and the benefits of the EMC Regulatory Guide, and the public comments overview relating to the technical issues) of the effort to develop EMC guidance. Also Ms. Antonescu stated that the NRC encouraged interactions among the nuclear industry representatives and the public on issues of common concern. Dr. Richard Wood of Oak Ridge National Laboratory (ORNL) then presented the technical basis for the proposed EMC guidance contained in draft regulatory guide DG-1029. Specifically, Dr. Woods explained the technical basis of the EMI/RFI operating envelopes (limits). These presentations provided that framework for technical discussions regarding the issues and concerns expressed by Mr. Chapin in his letter and amplified by attendees based on recent experience.

DETAILS

An overview of the history of the EMC project, a description of the technical issues discussed, and a summary of the conclusions reached by the participants follows.

Development History for DG-1029

A project at NRC was begun in late 1991 to address the unresolved issue of appropriate methods and practices to establish EMC for safety-related instrumentation and control (I&C) equipment. Oak Ridge National Laboratory (ORNL) was engaged to provide technical support. Military and commercial standards for design, installation and testing practices were identified and assessed for relevance to nuclear power plant applications. Based on the findings from this investigation, the technical basis for guidance on test methods and implementation practices was generated. Following review, it was determined by NRC that the technical basis for EMC guidance needed to be enhanced to identify generic electromagnetic operating envelopes for the nuclear power plant environment that serve to determine EMC testing limits. As a result, long-term electromagnetic measures were conducted at nuclear power plants that participated on a voluntary basis. The results of these efforts have been the technical basis for EMC guidance that has been embodied in draft regulatory guide DG-1029, which was issued for public comment in early 1998. The guidance in DG-1029 represents an acceptable method for establishing EMC for safety-related I&C systems.

Concurrently with the NRC investigation, EPRI established an utility working group to investigate the issue of EMC as well. The working group performed similar assessments of existing commercial and military standards and performed short-term electromagnetic measures at selected nuclear power plants. A topical report (EPRI TR-102323 entitled " Guidelines for Electromagnetic Interference Testing in Power Plants") was generated and submitted to NRC for review. A Safety Evaluation Report (SER) was issued in 1996 that endorsed the guidance in EPRI TR-102323, subject to stated exceptions and clarifications, as an acceptable method for establishing EMC for safety-related I&C systems.

In July, 1998, a public meeting was held at NRC Headquarters to present the technical basis for the proposed guidance in DG-1029 and to discuss the technical response to public comments on the guide. Representatives from EPRI, Nuclear Energy Institute (NEI), I&C system suppliers, and nuclear power utilities attended that meeting. The presentation of the EMC technical basis focused on the electromagnetic operating envelopes and the enhanced guidance afforded by improved technical understanding of the electromagnetic phenomenon and the nuclear power plant environment. The results of the meeting were that there was general satisfaction with the response to public comments on DG-1029 and the NRC staff initiated a reassessment of the technical basis for the electromagnetic emissions operating envelopes to ensure their relevance to nuclear power plant considerations. Following the technical enhancement of the emissions envelopes, a subsequent teleconference was held among NRC, ORNL, EPRI, and utility representatives to discuss the resolution actions taken. There was consensus agreement on all of the operating envelopes proposed for the final revision of DG-1029. The regulatory guide package was subsequently submitted into the NRC internal procedures for review..

Technical Basis for EMC and Remaining Issues

Dr. Wood described in detail the technical basis for each operating envelope (susceptibility, emissions, and surge withstand) contained in DG-1029. The technical basis for susceptibility and emissions envelopes for electromagnetic interference (EMI) and radio-frequency interference (RFI) in nuclear power plants begins with the test limits for military ground facilities that are given in the military standards (MIL-STDs). Based on an analysis of layout, equipment type, and usage, military ground facilities were deemed to be the military electromagnetic environment that best corresponded to the commercial nuclear power plant electromagnetic environment.

For EMI/RFI **susceptibility** envelopes, the measurement data taken in electromagnetic site surveys by ORNL and EPRI were used to ensure that the generic nuclear power plant envelopes bounded the projected electromagnetic environment at locations in nuclear power plants where safety-related I&C equipment is installed. In cases where there was insufficient margin, the envelopes were adjusted from the MIL-STD basis. When changes were made, the DG-1029 envelopes were adjusted (as supported by the measurement data) to levels consistent with those endorsed by the SER. Therefore, the DG-1029 susceptibility envelopes are **equivalent** or **less restrictive** than the EPRI TR-102323 limits.

For EMI/RFI **emissions** envelopes, the MIL-STD rationale was assessed. Where a strong technical relationship existed between the military concerns and nuclear power plant concerns (e.g., harmonic distortion of power distribution systems), the MIL-STD envelopes were adopted unchanged. In some instances, the military concern was found to be related to protecting sensitive receivers (e.g., antennae). In those cases, the European and U.S. commercial emissions limits were included in the basis for adjustments to the envelopes. As a result, equipment that meets commercial conducted and radiated emissions requirements also fulfill the EMC requirement in DG-1029 over the corresponding frequency range. The comparison of DG-1029 emissions envelopes with EPRI TR-102323 emissions limits shows that the DG-1029 envelopes are somewhat more restrictive in certain frequency ranges and less restrictive in others.

For **fast transients and surge** tests, the commercial industrial guidance given by IEEE Std. C62.41 provided the basis for the operating envelopes. Since these envelopes are intended to apply to a range of plant locations, industrial site conditions that characterized the projected worse case conditions at a nuclear power plant were selected to bound the projected conditions. These industrial location categories consist of plants with medium- to low-levels for switching transients and lightning activity at plant locations near the service entrance for the power distribution system. Dr. Wood acknowledged that these assumptions would be conservative for many locations in a nuclear power plant (e.g., control rooms) but that there are areas covered by this guidance which correspond to the worst case conditions covered by the surges and transient levels. In addition, it was observed that there is not much data for actual nuclear power plant conditions is available for these conducted electromagnetic phenomena. Nevertheless, the DG-1029 envelopes for power surges and fast electrical transients are **equivalent** or **less restrictive** than the EPRI test limits. In fact, due to what appears to be an error in interpreting the guidance in IEEE C62.41, the surge limit in EPRI TR-102323 is considerably more restrictive than the DG-1029 or IEEE C62.41 guidance. (Basically, IEEE and DG-1029 guidance specify surge levels in terms of open circuit voltages while EPRI guidance specifies the surge level as voltage into a 50 ohm load).

During the course of the presentation on the technical basis for EMC, industry representatives identified areas in which the test limits were causing qualification difficulties. It became clear that the "over conservative" test limits referred to in the Chapin letter are, in fact, the EPRI TR-102323 limits. Experience with that guidance, in terms of qualifying equipment, has not been positive. In addition, the participants at the meeting were not aware of the revisions to the DG-1029 guidance that resulted from technical considerations brought up at the 1998 public meeting. Nevertheless, the industry attendees suggested that additional investigation into the technical basis for the DG-1029 operating envelopes was warranted to ensure a more optimal tailoring of those limits to the nuclear power plant environment. As part of the discussions, the need for reevaluating the operating envelopes were ranked in terms of priority. Conducted EMI/RFI susceptibility in the high frequency range and power surge withstand (both fast transient and continuous waveform) were the operating envelopes of most concern. Operating envelopes for conducted EMI/RFI emissions in both low and high frequency ranges were given medium priority. Radiated emissions for electric fields, radiated susceptibility for both electric and magnetic fields, and conducted EMI/RFI susceptibility in the low frequency range were given low priority.

The two most critical problem areas were discussed in more detail. For conducted EMI/RFI susceptibility in the high frequency range, two considerations offered by the DG-1029 guidance were presented. First, for the CS114 test, the DG-1029 guidance permits an exemption of the test above 25 MHz if the RS103 test (radiated susceptibility, electric fields) is also conducted. Testing in this high frequency range contributes most of the qualification difficulties experienced to date in the industry. In addition, the guidance in EPRI TR-102323 does not account for test equipment limitations that increase the difficulty in performing the test (i.e., the test equipment is not designed to generate high currents in high frequency ranges to the level specified in the EPRI guidance). These limitations are taken into account in the DG-1029 operating envelope. It was agreed that the DG-1029 guidance would provide some relief. However, the participants asked that additional technical investigations be performed to determine if lower levels would be suitable. This may be possible by a more in depth analysis of the ORNL electromagnetic survey data.

The second most pressing area of concern involves the surge withstand levels. Both the EPRI and DG-1029 guidance give 3 kV test limits. However, the meeting participants requested that the rationale for these levels be revisited to determine if 2 kV might not be acceptable for most plant locations. It was agreed that this may be possible if a location categorization approach were adopted for identifying operating envelopes rather than a generic plant approach. However, some additional investigations would be required.

Conclusions

The general consensus during the meeting was that the presentation and discussion of the technical basis for EMC guidance was very beneficial in terms of clarifying the guidance, identifying enhancements to DG-1029 that had not been widely disseminated, and facilitating discussions of technical issues that warrant further investigation. It was agreed that the draft regulatory guide provides enhancements over the guidance in EPRI TR-102323 that would provide some relief to the industry in qualifying commercial equipment. However, there are still technical areas in which the guidance could be improved.

The group discussed three options for addressing the DG-1029 guidance. First, the guide could be withdrawn and the SER on EPRI TR-102323 could stand as the only guidance on EMC. Given the benefits of several exemptions offered by the draft guide that are not available in EPRI TR-102323, this option was dismissed. Second, the guide could be delayed while further confirmatory research improved the technical basis to support relaxation of the troublesome test limits. This approach was considered but it was agreed that delay would deny access by the industry to the aforementioned benefits during the intervening time. Third, DG-1029 could be issued and additional investigations could be undertaken to support any revision. The third option was the consensus choice.

It was proposed that a joint NRC-EPRI Working Group be formed to facilitate the research and revision process. In particular, it was requested that the ORNL electromagnetic survey data be made available via the internet to Working Group participants.