CP&L

Carolina Power & Light Company

February 8, 1993

SERIAL: NLS-93-045

United States Nuclear Regulatory Commission
ATTENTION: Document Control Desk
Washington, DC 20555

BRUNSWICK STEAM ELECTRIC PLANT, UNIT NOS. 1 AND 2
DOCKET NOS. 50-325 & 50-324/LICENSE NOS. DPR-71 & DPR-62

COMPLETION OF RESPONSE TO NRC REQUEST FOR ADDITIONAL INFORMATION
STEAM LEAK DETECTION INSTRUMENTATION NUMAC UPGRADE
(NRC TAC NOS. M84686 AND M84687)

Gentlemen:

The purpose of this letter is to submit additional information in response to the NRC letter dated November 25, 1992. This letter identified questions that relate to Carolina Power & Light Company's (CP&L) license amendment request dated September 14, 1992 for installation of a General Electric NUMAC-based steam leak detection system at the Brunswick Steam Electric Plant. This letter supplements CP&L's previous response letter dated January 25, 1993. It provides the CP&L response to concerns related to electromagnetic interference (EMI) and radio frequency interference (RFI) issues that were not included in that previous submittal. A detailed response is provided in Enclosure 1.

Please refer any questions regarding this submittal to Mr. D. B. Waters at (919) 546-3678.

Yours very truly,

D B Waters for

D.C. McCarthy
Manager
Nuclear Licensing Section

JCP/jp (nls93045.002)

Enclosures

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ENCLOSURE 1

BRUNSWICK STEAM ELECTRIC PLANT, UNIT NOS. 1 AND 2
NRC DOCKET NOS. 50-325 & 50-324
OPERATING LICENSE NOS. DPR-71 & DPR-62
COMPLETION OF RESPONSE TO NRC REQUEST FOR ADDITIONAL INFORMATION
STEAM LEAK DETECTION INSTRUMENTATION NUMAC UPGRADE
(NRC TAC NOS. M84686 AND M84687)

CP&L letter NLS-93-017, dated January 25, 1993, provided our primary response to the NRC Request for Additional Information (RAI) relative to the license amendment request dated September 14, 1992 for installation of a General Electric NUMAC microprocessor-based Leak Detection Monitor (LDM) system at the Brunswick Steam Electric Plant. NLS-93-017 did not include the CP&L responses to the NRC questions that related to Electromagnetic Interference (EMI) and Radio Frequency Interference (RFI) criteria for equipment qualification. This letter addresses the issues raised in those questions and completes our response to the RAI. General discussion is presented in sections I through III following. A summary of CP&L's approach to EMI/RFI qualification for the NUMAC LDM system is presented in section IV.

I. In-plant EMI/RFI Mapping Overview:

In recent similar licensing actions for other utilities, the NRC's criteria for acceptance of other digital instrumentation applications has been to ensure that the equipment manufacturer's EMI/RFI susceptibility qualification test levels bounded the expected in-situ environment. In those recent cases, definition of that in-situ EMI/RFI environment was based on limited scope in-plant mapping of radiated and conducted interference levels. In actual application, industry experience shows that most EMI/RFI problems in commercial nuclear power plants are due to infrequent and randomly occurring transients, rather than to steady-state noise conditions.

In-plant EMI/RFI mapping, of any reasonable duration, can only provide a brief steady-state emissions model for a limited range of plant operating modes. Short term mapping is statistically incapable of providing a comprehensive profile of credible transient events. There are no nuclear industry standards that specifically require in-plant tests to identify and quantify transient threat levels. In the summary discussion included as a preface to IEEE C62.41-1991, "Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits," it is pointed out that, although short-term monitoring of an individual site often gives some useful information, the environment is so dynamic that the analysis of a brief period may not give a good prediction of the future environment (see Attachment 2).

Steady-state noise problems, when they occur, are typically caused by either installation deficiencies or by equipment or cabling failures. Frequent or continuous occurrences of noise interference can normally be expected to be quickly discovered and then resolved via routine maintenance techniques. Transient noise problems are generally more difficult to diagnose and resolve.

In-plant mapping results, therefore, cannot be used as the sole basis for definition of acceptable minimum susceptibility test specifications. Additional margin, beyond the levels of any actual mapping result, needs to be established to bound all credible transient events. An analogy can be drawn between this issue and the case of seismic or temperature qualification of equipment. Short-term seismic activity or temperature profiles for a given plant location could not establish adequate design and test criteria for those environmental parameters.

The process of developing requirements for any type of qualification test or standard involves the analysis of available empirical in-plant and broader industrial data. It further requires the application of engineering judgement by personnel with appropriate technical qualifications and experience. To date, no unique standards have been developed that are specific to the US nuclear industry. In the absence of such guidance, nuclear instrumentation manufacturers and utilities have applied a variety of Military (MIL), International Electrotechnical Commission (IEC), Swedish and in-house standards and procedures to define lab testing techniques and limits based on reasonable expected maximum environmental conditions.

CP&L is currently an active participant in an EPRI working group whose objectives include the evaluation of nuclear plant EMI/RFI emission threats, the quantification of their levels and the recommendation of appropriate levels of EMI/RFI testing for qualification of nuclear equipment. The working group membership is comprised of utility and consultant personnel with recognized expertise and practical experience in this subject. That group has performed a review and analysis of existing available nuclear in-plant EMI/RFI measurements, including test data specific to Brunswick.

The Brunswick-specific data that is available is documented in NUREG/CR-3270, "Investigation of Electromagnetic (EMI) Levels in Nuclear Power Plants". Lawrence Livermore National Laboratories (LLNL), under contract to the NRC/NRR, performed EMI baseline measurements at Brunswick in 1982. Correspondence between the NRC and CP&L (Attachments 3 and 4) summarized the administrative arrangements. The in-plant activity was authorized by CP&L Special Test Procedure SP-82-45, which endorsed and included the LLNL test procedure "Detailed Plan For Investigation of the Levels of Electromagnetic Interference in Commercial Nuclear Power Plants." The results of that test were published as part of the NUREG. The NUREG includes EMI test results from one typical PWR, referred to as Plant A, and one typical BWR, referred to as Plant B. The NUREG does not identify "Plant B" as being Brunswick; however, based on the plant general arrangement diagram, the power bus identifications and the above mentioned correspondence and procedure, it is clear that Plant B is Brunswick.

The NUREG study determined experimentally, via passive in-plant measurements, the EMI levels existing at various locations within two nuclear power plants. The measurements spanned a 5-day period at each plant and included long-term (up to several days) and short-term (up to 4 minute) measurements of the low voltage (480/208/120 Vac and 125 Vdc) power supply buses. In addition, radiated magnetic field measurements were made at various plant locations. Both the NUREG and the Brunswick Special Procedure provide details as to how the measurements were made. The Plant A data was collected while that unit was operating at a relatively high power level. The Brunswick data was obtained during cold shutdown conditions following a refuel outage. The NUREG states that the data from these two plants provides an initial data base for one plant in the normal power level state and one plant in the shutdown state. It emphasizes that those measurements form an initial data base and are not necessarily "worst case" or design limits. This caution is consistent with the above described philosophy that in-plant testing adds only marginal confidence to a qualification program that emphasizes vendor laboratory qualification testing.

Neither the NUREG data nor the Zion and Turkey Point test results reveal any obvious threat to digital system operations. The radiated field emissions, as measured at these sites, were relatively low as expected, since radiated fields are a generally localized phenomena. Magnetic field strengths were found to be negligible. Likewise, the conducted emissions were well within acceptable limits.

The EPRI working group's tentative plans are to collect broad scope baseline test data at a representative number of nuclear plants and to then utilize that data, in conjunction with the existing data described above, as the basis for recommendation of specific criteria for equipment qualification requirements. Additional data collected for that purpose will be done to consistent test methods that should provide data more easily compared than that which is currently available. It is expected that the typical plant characteristics developed from that program will reinforce the current judgement that plant steady state EMI/RFI conditions do not generally pose a threat to properly designed and installed digital systems.

The EPRI working group is formulating a short term position statement that is expected to conclude that in-plant testing is not an essential element of an overall EMI/RFI equipment qualification program.

On the basis of the above discussion, CP&L's contends that "snapshot" in-plant mapping neither provides a sufficient basis for definition of potential transient threat levels, nor is it likely to identify steady state interference levels higher than those to which the vendor's factory testing is performed. We conclude that equipment which survives an appropriate level of vendor EMI/RFI qualification testing will not be susceptible to in-plant steady state EMI/RFI problems and can be expected to survive credible transients. The expected imminent release of the EPRI working group short term position statement should constitute additional validation of the CP&L position stated above.

II. NUMAC System Operational History Overview at Brunswick:

The purpose of this discussion is to summarize the operational history of existing NUMAC applications at Brunswick in order to demonstrate that the existing NUMAC applications at Brunswick have operated with a high degree of reliability in the same control room environment in which the LDM will be located. CP&L feels that the NUMAC's demonstrated operational reliability under plant specific EMI/RFI conditions is acceptable.

Brunswick currently uses NUMAC in three applications, the Main Steam Line Radiation Monitor (MSLRM), the Rod Worth Minimizer (RWM) and the Steam Jet Air Ejector Radiation Monitor (SJAE LRM). The MSLRM is a safety related system while the RWM and SJAE RM are non-safety related. These units have in-service histories ranging between three and six years.

The MSLRM has had no failures conclusively attributable to EMI/RFI. Problems that have occurred have been due mainly to faulty power supply modules and cable connections. GE has since provided upgrades to the power supplies. Electrical noise is one suspected cause for fluctuations currently being investigated on one of the four Unit 1 MSLRM's. Tests have been conducted to determine cable and shield integrity and to check for imposed noise in the input signal wires. Testing is still in progress and interim results are inconclusive. This problem will be monitored for potential generic applicability.

The RWM units have shown acceptable in-service reliability at Brunswick with no failures attributable to EMI/RFI.

Maintenance attention to the SJAE RM units has mainly involved attention to power supply failures, a condition which has been improved by GE (and for which further improvement is anticipated). The plant trouble ticket history does include one EMI-related situation where spiking on a single SJAE RM was diagnosed and attributed to construction activity in the cable spread room in the immediate vicinity of the interconnecting cabling. This is an example of an EMI transient induced by an abnormal activity. As discussed above, this effect was noticed, diagnosed and corrected via normal operations and maintenance practices.

The overall in-service history shows that NUMAC systems in use at Brunswick have operated for greater than three years with a satisfactory degree of reliability and a low susceptibility to EMI/RFI induced failures. Specific problems that have occurred have been handled by normal corrective maintenance procedures and/or vendor interface.

The Leak Detection Monitor (LDM) NUMAC application is configured within the same product family as the RWM, MSLRM and SJAE RM. The configuration will consist of the same basic main chassis, power supplies, circuit boards and connectors along with additional LDM specific modules and software. As shown on the control room arrangement drawing provided to you as Attachment 1.2.1 to the RAI, the LDM NUMAC will be located in the same general control room area, and their cables will be routed in similarly restricted cable trays and conduits, as are the MSLRM, RWM and SJAE RM. (Although not highlighted on the RAI Attachment 1.2.1, please note that the SJAE RM main chassis are located in the unit 1 and 2 H12-P604 cabinets, very close to the H12-P614 location planned for the LDM system). The LDM NUMACs will therefore be subject to an EMI/RFI environment very similar to that of our existing fourteen NUMAC systems.

III. <u>GE NUMAC EMI/RFI Qualification Testing Overview:</u>

GE has previously performed numerous EMI/RFI tests on NUMAC applications such as their Log Rad Monitor (LRM), Source Range Monitor (SRM), AC & DC Wide Range Monitors (ACWRM and DCWRM) and Reactor Building Vent Radiation Monitor (RBVRM). Specific examples include:

1) continuous-wave radiated electric field susceptibility tests at 65 V/m from 20-990 Mhz (RBVRM) and at 10 V/m from 27-500 MHz (WRNM).
2) continuous-wave radiated magnetic field susceptibility tests with 300 V oscillations at 0.5-1 Hz repetition rates with damped oscillations of 6-7 Hz at 100, 200, 300, 400 and 500 KHz and with 5 V oscillations from 0.5-100 MHz at a rate of 1-5 MHz/Sec (LRM, SRM, WRNM, DCWRM, RBVRM).
3) electrostatic discharge (ESD) susceptibility tests at 2, 4 & 8 KV (WRNM).
4) conducted susceptibility tests as performed for the radiated magnetic field tests (LRM, SRM, WRNM, DCWRM, RBVRM), and 3 KV pulses capacitively coupled to the power and I/O ports, 250 V sinusoid applied to I/O ports at power, +/-2 to 4 KV sawtooth transients (up to 50 nsec) applied to power & signal I/O ports at power and a 0.5-1 KV damped 1 MHz sinusoid at a repetition rate of 300-500 Hz applied to power and signal I/O ports at power (WRNM).

A detailed summary of those tests that are considered to be applicable to the Leak Detection Monitor system is presented in Attachment 1 to this letter. The original GE/CP&L approach to LDM qualification had been to analytically demonstrate that the LDM NUMAC configuration is itself EMI/RFI-qualified due to its similarity in components and design to the other previously tested NUMAC configurations. This technique is frequently utilized for various types of environmental qualification for various models within a broader equipment

product family. However, due to the increased degree of utility and regulatory interest in this topic, it is now planned that additional testing will be performed on the LDM configuration in order to obtain test data specific to this application. This testing will serve to ensure the qualification of the 6 Input Thermocouple Module, a NUMAC circuit board which is unique to the LDM application. It will also extend the RFI qualification to include both higher and lower frequencies than previously tested. A range that will extend from 10 KHz to 18 GHz is currently planned. The additional GE testing will be performed as part of a broader plan to improve the testing and test documentation for the entire NUMAC product line. The GE test program is expected to be completed by September 6, 1993.

Based on the results of the significant testing already performed on various NUMAC units and the high degree of commonality in components and configuration between the LDM and those other NUMAC units, it is expected that tests on the LDM unit will produce acceptable results. CP&L's position is that installation and operation of the LDM prior to completion of the additional GE testing would not constitute a safety concern. It is anticipated that any anomalies identified during GE's testing could be reconciled either through GE hardware modifications or by CP&L installation configuration improvements. Any such actions identified would be planned for implementation on an appropriate priority and would be integrated into the respective Brunswick unit outage schedules.

IV. Conclusions:

CP&L concludes that additional in-plant EMI/RFI mapping for Brunswick is not necessary. The local steady state EMI/RFI environment is expected to be reasonably benign and a profile of credible transients could not be reliably obtained through testing of any reasonable duration.

The appropriate focus in EMI/RFI equipment qualification is on laboratory-type testing performed in accordance with procedures that invoke sufficiently severe test inputs and that specify clear and repeatable test methods. In the absence of specific regulatory or industry-initiated standards, CP&L and GE have determined that the selected MIL, IEC, Swedish and in-house procedures described within this letter and its attachments provide adequate interim guidance. The testing completed by GE on NUMAC applications similar to the LDM permits a high confidence level that the LDM configuration will not be adversely susceptible to EMI/RFI. Installation and operation of the LDM prior to completion of the additional GE testing would not constitute a safety concern. Satisfactory completion of GE's planned additional LDM-specific testing will serve to substantiate that conclusion.

The satisfactory operational history of the fourteen in-service Brunswick NUMAC systems, in conjunction with broader NUMAC experience throughout the nuclear industry, lends significant empirical support to the conclusion that the basic NUMAC product platform is capable of dependable operation in the Brunswick plant environment.

Attachments:

1) General Electric Report "EMI Analysis, NUMAC Leak Detection Monitor," January, 1993 (24 pp)

2) IEEE C62.42-1991, "IEEE Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits" (Summary only, 2 pp)

3) Letter, NRC-D.B.Vassallo to CP&L-J.A.Jones, "Electromagnetic Interference Measurement Program," July 2, 1982 (4 pp)

4) Letter, CP&L-S.R.Zimmerman to NRC-D.B.Vassallo, "Electromagnetic Interference Measurement Program," July 29, 1982 (1 pg)