UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE COMMISSION

In the Matter of:	)	
	)	
CAROLINA POWER AND LIGHT COMPANY	)	Docket No. 50-261
	)	
(H. B. Robinson Steam Electric Plant, Unit 2)	)	

AFFIDAVIT OF VINCENT S. NOONAN
PHILIP A. DIBENEDETTO AND ROBERT G. LAGRANGE

INTRODUCTION

I, Vincent S. Noonan, being first duly sworn, depose and state as follows:

I am employed by NUS Corporation as Assistant General Manager of the General Consulting Services Group, Consulting Division. I am responsible for the technical and administrative management of all consulting services, including environmental qualification (EQ) of equipment, provided by the Group. Prior to working for NUS Corporation, I was Chief of the Equipment Qualification Branch, Division of Engineering, Office of Nuclear Reactor Regulation, U.S. Nuclear Regulatory Commission from 1982-84. In that capacity, my responsibilities included, among other things, overall management of the reviews and evaluations performed by the Environmental Qualification and the Seismic and Dynamic Loads Qualification Sections of the Branch.

I, Philip A. DiBenedetto, being first duly sworn, depose and state as follows:

I am President of DiBendetto Associates, an engineering and management services company. I am responsible for the technical and administrative management of the company, including extensive EQ services provided to the nuclear industry. Prior to establishing the company, I was the first Section Leader of the Environmental Qualification Section, Equipment Qualification Branch, Division of Engineering, Office of Nuclear Reactor Regulation, U.S. Nuclear Regulatory Commission (1980-81). As Section Leader, I supervised the EQ reviews performed by the NRC Staff and its consultants, for all operating nuclear power plants, including those in the Systematic Evaluation Program (SEP), and those plants then under construction. I was involved with the NRC's EQ effort from the inception of the Equipment Qualification Branch until late 1981. Subsequent to leaving the NRC Staff, as Director of Engineering for NUTECH Engineers, I supervised and/or performed the development and implementation of EQ programs for a significant number of operating and near-term operating license (NTOL) nuclear power plants.

I, Robert G. LaGrange, being first duly sworn, depose and state as follows:

I am employed by NUS Corporation as a Senior Executive Consultant in the General Consulting Services Group, Consulting Division. Among other things, I am responsible for providing consulting services regarding EQ to the nuclear industry. Prior

to working for NUS Corporation, I was Section Leader of the Environmental Qualification Section, Equipment Qualification Branch, Division of Engineering, Office of Nuclear Reactor Regulation, U.S. Nuclear Regulatory Commission. I was the Section Leader subsequent to Philip A. DiBenedetto and up until the Equipment Qualification Branch was disbanded in late 1985. During that time, I supervised the EQ reviews and evaluations performed by the NRC Staff and its consultants for all operating nuclear power plants and those under construction. I was involved with the NRC's EQ efforts for the entire six years the Equipment Qualification Branch existed.

In this affidavit we will address the evolution of the issue of instrument loop accuracy, i.e., the overall accuracy of an entire instrument circuit when all or various pieces of equipment that make up that circuit (sensor, cable, terminal blocks, splices, electrical penetrations and power supply) are exposed to the harsh environmental conditions that could result from a design basis accident. The issue of leakage current and insulation resistance (IR) effects on total instrument accuracy has been identified in some relatively recent NRC EQ Staff inspections as being inadequately addressed by licensees. The NRC Staff has concluded in some instances that escalated enforcement action is appropriate since several licensees had not performed evaluations prior to November 30, 1985 addressing the overall accuracy of entire instrument loops resulting from the

potential contribution to error from each piece of equipment within the instrumentation loop.

SUMMARY AND CONCLUSIONS

Whether or not loop accuracy is a safety significant concern today, there was no notice to licensees prior to November 30, 1985, the EQ deadline, that loop accuracy calculations were required for equipment qualification. During the early to mid-80's, although the concept of "loop accuracy" was contemplated in the abstract, virtually everyone -- the NRC, its consultants, and licensees -- addressed the accuracy issue by examining instrument sensors, the implicit assumption being that potential inaccuracies due to the other individual components of the circuit (e.g., splices, penetrations, cable) were insignificant, and would not contribute to overall loop inaccuracy (as long as the component performed satisfactorily during testing). Thus, there were no major concerns associated with regard to IR and leakage current effects generally on total loop instrument accuracy. It was assumed that if an individual device demonstrated qualification (by passing rated voltage and current), the use of the device, with other qualified devices to comprise a system, would not significantly degrade the system's overall performance. At some point in 1986, this underlying assumption changed. Because of it, however, the issue of loop accuracy as we know it today was not, in the 1979-1985 time-period, the subject of any regulatory or industry guidance, or of

any NRC EQ inspection reports or audits per se. Thus, Franklin Research Center, reviewing licensee test reports for qualification purposes on behalf of the NRC, was not instructed to and did not reject any test reports solely for lack of IR (or leakage current) data for loop accuracy consideration. IR data was reviewed when available, and scrutinized only when there appeared to be an anomaly during testing. Subsequently, the NRC Staff accepted the Franklin TERs and incorporated them into safety evaluation reports (SERs) which were then issued to the utilities. Additionally, the loop accuracy issue was not raised by the NRC Staff in any of the meetings it held with licensees prior to issuance of the final round of SERs. For the foregoing reasons, in our view, it cannot be said that licensees "clearly should have known" that loop accuracy calculations were a requirement prior to the EQ deadline of November 1985.

BACKGROUND

In late 1979 the Equipment Qualification Branch of the NRC was established. The initial tasks of the Environmental Qualification Section within the Branch were to review and evaluate licensee submittals in response to IEB 79-01B, to oversee the evaluations performed by the Franklin Research Center of the eleven Systematic Evaluation Program (SEP) licensees, and to establish and implement an audit program for the Near Term

Operating License (NTOL) applicants' equipment qualification programs.

The reviews performed by the NRC EQ Staff concentrated on the 79-01B submittals by licensees. They did not, in the early stages, consider the actual licensee test documents or EQ files, but rather reflected the comparative review of the System Component Evaluation Worksheets (SCEW).

The SEP reviews were conducted by Franklin Research Center under the direction and guidance of the EQ Branch in accordance with the DOR guidelines and IE Bulletin 79-01B. Franklin Research Center performed a 100% review of the component files of equipment, instruments, and cable identified as part of the systems required to perform safety functions in potentially harsh environments; as a result, eleven Technical Evaluation Reports (TERs) were completed by Franklin on the evaluation of equipment qualification programs, which were ultimately attached to the SERs issued by the Staff.

The third type of review performed by the NRC Staff was the review, evaluation, and inspection of the NTOL plants. These reviews concentrated on the assessment and evaluation of a program document submitted by the utility relating to Environmental Qualification of Safety-Related Electrical Equipment to demonstrate compliance with the requirements established in NUREG-0588. The inspections conducted by the EQ Branch Staff focused on the review of selected EQ files prepared by the utility. The EQ Branch Staff and its consultants

performed these reviews and evaluations in accordance with NUREG-0588 and, after its issuance, 10 C.F.R. § 50.49 and Regulatory Guide 1.89 (Revision 1), which supplemented IEEE 323-1974.

During the period of time up until November 1985, the NRC Staff and its consultants continued their reviews and audits of, and prepared SERs for, NTOL plants; Franklin Research Center prepared sixty TERs for all the remaining operating plants; the NRC Staff issued seventy-one SERs with the Franklin TERs attached; the NRC Staff held meetings with each licensee that had received a TER to discuss resolution of identified deficiencies; and the NRC Staff issued a "final" SER for each of those operating plants.

DISCUSSION

From the early 1980's through November 30, 1985, it was generally believed that devices could be individually qualified and assembled into a functioning system without significant concern for overall loop accuracy problems resulting from the integration of the devices into a qualified system. The assumption underlying this belief was that any potential inaccuracies associated with the individual components in the instrumentation loop were insignificant. During this period accuracy was interpreted as an issue related to instrumentation sensors. Thus, instruments were reviewed for individual performance during testing (specified accuracy versus

demonstrated accuracy). The early cable qualification efforts and standards typically relied on test specimens passing rated voltage and current as a demonstration of performance. IR effects were not then considered to be relevant performance criteria for this equipment. Insulation resistance information was reviewed if contained in test reports, but its absence was not considered a reason to reject qualification based on NRC criteria. Indeed, the IEEE-383 standard for cables did not address IR's. Instrument cable was reviewed to establish that the IR remained at or above 10^6 ohms during the testing performed.

In short, instrument accuracy and such review areas as cable insulation resistance and terminal block current leakage were considered by the NRC Staff, its consultants, and the industry only on a component-by-component, equipment-specific basis, the implicit assumption being that integration of qualified circuit devices into a functioning instrument circuit did not significantly affect the overall accuracy, which was dominated by the instrument sensor. The potential error contribution of all items of equipment within an instrument loop to overall loop accuracy was not considered, at that time, a generic review issue by the NRC Staff, its consultants, or the industry. Thus, as noted in the Affidavit of Cyril J. Crane and Gary J. Toman (dated August 29, 1988), which we have reviewed and with which we concur, Franklin Research Center, as the NRC's consultant, accepted from licensees test reports for cables and penetrations

for qualification purposes which did not contain IR or leakage current data. To the extent IR measurements were made by the utility during cable, penetration and splice qualification tests, these were reviewed in the context of engineering information, not necessarily acceptance criteria. Indeed, the NRC Staff issued the SERs with the Franklin TERs attached. The issue of IR or leakage current effects on total loop accuracy calculations was not raised by the NRC Staff at any of the meetings it held with licensees prior to issuance of the final rounds of SERs.

The universal lack of insistence on loop accuracy data or calculations prior to 1985 is evident from a review of the regulatory and industry standards then in effect, as well as a review of NRC inspection reports during that time period.

A. Industry Standards

1. IEEE-323

IEEE 323-1971 and IEEE 323-1974, "Standard for Qualifying Class IE Equipment for Nuclear Power Generating Stations," (endorsed by the NRC as criteria for qualification of electrical equipment) provide general guidance for qualifying individual equipment. As such, they do not focus on performing loop accuracy calculations for instruments. They do not provide direct guidance that would help a user to focus on the need to measure insulation resistance or leakage current information on instrument loop components and do not provide direction on

evaluating the data. Each user of the standards must determine the parameters to be measured and then determine how the measurement results will be evaluated. Explicit guidance is not provided for parameters to be measured and evaluated.

Section 5.2.3.2 of IEEE Std. 323-1971 states that the test program outline should include "the variable to be measured, including accuracy." No further detail is given. Section 6.2(2) of IEEE Std. 323-1974 states that the performance specification must contain "performance characteristics" under the various plant conditions. Section 6.2(3) states that the range of voltage, frequency, load, electromagnetic interference and the electrical characteristic must be defined. Section 6.3.1.1 states that the test plan must provide performance limits or a failure definition. Section 6.3.1.4.5 on monitoring states that monitoring may include insulation resistance of electrical components.

Each of these segments relates to defining the characteristics of a test for an individual component and provides no explicit methodology for testing of any one type of component or for integrating the results of the individual qualification program into a configured "system" qualification. Moreover, the fact that insulation resistance is mentioned only in the context of the monitoring standard, indicates that although this information was perceived as useful, it was not part of the acceptance criteria.

2. IEEE-383

IEEE-383, "Type Test of Class IE Electric Cables, Field Splices and Connectors for Nuclear Power Generating Stations" (1974), endorsed in NRC Regulatory Guide 1.131, requires that cables be energized at rated voltage and current during simulated accident exposure. Functionality and electrical integrity is the primary indicator of successful performance under this standard. Monitoring of leakage current and insulation resistance are not required and are not specified in the IEEE-383 standard.

For cables, in addition to performing during the LOCA simulation, the IEEE-383 standard required a post-LOCA voltage withstand test while the cable specimen was immersed in water. Often insulation resistance was taken before and after but not during the LOCA simulation. Had leakage current and insulation resistance parameters been viewed as significant to cable qualification, it would certainly have been explicitly incorporated into a standard developed by industry consensus (and endorsed by NRC).

B. Regulatory Standards

1. IE Bulletin 79-01B and the DOR Guidelines

IE Bulletin 79-01B (January 1980) provided a generic format for providing equipment qualification summary data, i.e., the System Component Evaluation Worksheet (SCEW). The SCEW and its instructions indicated that demonstrated and required accuracy for "sensors and transmitters for trip functions and/or post-accident monitoring" be provided to NRC. Thus, one of the items

on the SCEW sheets was accuracy with a specified and demonstrated value. This was to be used for individual sensors such as transmitters, RTD, thermocouples and radiation monitors. Specific direction for providing and evaluating this accuracy information was not given. Again, the focus was on the sensors, not the other components of the instrumentation loop.

Enclosure 4 to IE Bulletin 79-01B provided the DOR Guidelines for evaluating Environmental Qualification of Class IE Equipment in Operating Reactors. The DOR Guidelines contained the first clear regulatory discussion of "accuracy" as part of equipment qualification. Section 5.2 (Functional Testing and Failure Criteria) of the DOR Guidelines states that ". . . failure criteria should include instrument accuracy requirements based on the maximum error assumed in the plant safety analysis . . . ." This section, however, implies instrument accuracy by component, not by system. No further direction is provided regarding insulation resistance or leakage current of cable, penetrations, or splices and no direction is given concerning instrument loop accuracies.

2. Supplements to IEB 79-01B

IE Supplement No. 2 and 3 to 79-01B, Environmental Qualification of Class IE Equipment (September 29, 1980 and October 24, 1980), provided questions from the industry and answers from the NRC regarding environmental qualification issues. Instrument loop accuracy and cable insulation resistance issues were not mentioned as a qualification concern.

3. NUREG-0588

NUREG-0588, (Rev. 1), Interim Staff Position on Environmental Qualification of Safety-Related Electrical Equipment (July 1981), addresses performance characteristics for evaluating qualification as follows: (1) section 2.2(7) states that performance characteristics of equipment should be verified during testing, and (2) section 2.2(10) states that expected extremes in power supply voltage range and frequency should also be applied during testing. Determination of specific details such as insulation resistance during testing is not specifically addressed by NUREG-0588.

4. Regulatory Guides 1.89, 1.63 and 1.131

Regulatory Guide 1.89 (Rev. 1) and the initial version, provide endorsements of IEEE Std. 323-1974 as a basis of environmental qualification with additional clarification of NRC positions. Neither the original version nor Revision 1 provide any additional requirements or suggestions related to inclusion of consideration of loop accuracy evaluation in equipment qualification programs. Section C.3.d of Revision 1 states that "[P]erformance characteristics that demonstrate the operability of equipment should be verified before, after and periodically during testing throughout its range of operability. Variables indicative of momentary failure that prevent the equipment from performing its safety function . . . should be monitored continuously to ensure that momentary failure (if any) have been accounted for during testing . . . ." Again, no explicit

definition of methodology to be used is given with respect to accuracy and the effects of insulation resistance or leakage current.

In addition, Regulatory Guide 1.131 endorses IEEE Std. 383-1974 for cables and field connections. The suggestions in Regulatory Guide 1.131 provide direction with respect to accident environment developments and simulation, aging, ongoing qualification and flame testing. No recommendations are provided regarding measuring or recording insulation resistance or leakage current data during accident environment simulation for instrument cables and field connections.

Similarly, Regulatory Guide 1.63 endorses IEEE Std. 317-1976 for electrical penetrations. The Regulatory Guide provides additional suggestions related to qualification of penetrations. Again, nothing regarding insulation resistance or leakage current measurements is said.

None of these Regulatory Guides relating to instrument loop components provided a direction or recommendation regarding recording of data related to loop accuracy, or performance of loop accuracy evaluation for environmental qualification purposes.

5. NUREG/CR-3691 and IE Notice 84-47

NUREG/CR-3691, An Assessment of Terminal Blocks in the Nuclear Power Industry (September 1984), and the related Information Notice, IE-84-87, Environmental Qualification Tests

of Electrical Terminal Blocks (June 1984), brought into question the effect of terminal blocks in a variety of circuits.

IE Notice 84-47 does explicitly refer to instrument "loop accuracy." However, that Notice specifically concerned leakage current identified during terminal block testing performed as part of research conducted by Sandia National Laboratories for the NRC Staff. The intent of the Notice was to call attention to this problem such that utilities would replace terminal blocks in instrumentation circuits with qualified splices. This specific problem was discussed during the meetings held with each licensee, but the broader issue of total instrument loop accuracy was not. The response from both the NRC and the industry was to reassess the use of terminal blocks in these circuits; virtually all licensees simply replaced instrumentation terminal blocks inside containment and other pipe-break areas with qualified splices (one solution suggested by the Notice to resolve the identified problem). The NRC integrated this concern for instrumentation circuit terminal blocks into both its evaluation of NTOL equipment qualification efforts and 50.49 compliance audits. The terminal block IR and leakage current concern, however, were not considered relevant by licensees or the NRC for other instrumentation circuit devices (e.g., cables, splices, connectors), as evidenced by the fact that licensees -- and the NRC Staff -- believed that replacing the terminal blocks alone would solve the problem.

C. NRC Inspections and EQ Audits: Early 80's through 1985

A review of early inspection and audit reports through November 1985, confirms that instrument accuracy remained an individual component/sensor issue through that date. "Accuracy" was an issue in two early reports that we know of.

The inspection report resulting from the January 14-18, 1985 inspection of Commonwealth Edison Company's Zion 2, notes that NRC inspectors examined EQ documentation files both for the "effects of decreases in insulation resistance on equipment performance" and the "adequacy of demonstrated accuracy." One observation delineated as a potential enforcement/unresolved item relates to the potential for excessive leakage current tripping the breaker in control circuits. This concern was raised in connection with terminal blocks for control circuits located in junction boxes which had top conduit entries as opposed to the qualification configuration of side or bottom conduit entries. It says nothing, however, regarding the contribution of leakage current or low IR values from the cable or other devices which could theoretically affect instrumentation loop accuracy.

Also, during the May-June 1985 audit of Ft. Calhoun, questions were raised regarding the required accuracy for accident monitoring circuits, but no concerns were raised regarding the effect of IR on instrument loop accuracy.

The first appearance of a broader approach to the issue of accuracy is found in the EQ inspection report for TVA's Sequoyah 1 and 2, in August 1986, where the term "system loop accuracies"

is used. That phrase, or similar terminology, has appeared in a number of subsequent EQ inspections, which question, in varying degrees, the amount of evaluation and assessments performed by utilities to address instrument loop accuracy.

In our view, however, for the aforesaid reasons, licensees could not "clearly have known" that loop accuracy calculations were required prior to the EQ deadline. Moreover, at the point the Staff did decide that loop accuracy calculations should be incorporated into the formal equipment qualification program, the most appropriate method of doing this would have been to inform the utilities of this concern by an Information Notice or other mechanism which the Staff has not done to date. The identification of a new equipment qualification requirement via audits and inspections bypasses formal NRC management approval that is required whenever a new requirement is to be incorporated into the 10 C.F.R § 50.49 program.

The foregoing paragraphs are true and correct to the best of my knowledge.

Vincent S. Noonan

Subscribed and sworn to before me this 29 day of August, 1988.

Notary Public

My Commission expires July 1, 1990

The foregoing paragraphs are true and correct to the best of my knowledge.

Philip A. DiBenedetto

Subscribed and sworn to before me this 22nd day of August, 1988.

Notary Public

My Commission expires 3/26/92

The foregoing paragraphs are true and correct to the best of my knowledge.

Robert G. LaGrange

Subscribed and sworn to before me this 29th day of August, 1988.

Notary Public

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