

August 4, 2003

Mr. D. M. Jamil  
Vice President  
Catawba Nuclear Station  
Duke Energy Corporation  
4800 Concord Road  
York, South Carolina 29745-9635

SUBJECT: CATAWBA NUCLEAR STATION, UNITS 1 AND 2 RE: EXEMPTION FROM  
THE REQUIREMENTS OF 10 CFR 50.44, 10 CFR 50.46, AND 10 CFR  
PART 50, APPENDIX K (TAC NOS. MB6907 AND MB6908)

Dear Mr. Jamil:

The Commission has approved the enclosed exemption from specific requirements of Title 10 of the *Code of Federal Regulations*, Part 50, Sections 50.44, 50.46, and Appendix K, for Catawba Nuclear Station, Units 1 and 2. This action is in response to your letter dated December 3, 2002, as supplemented by letter dated April 8, 2003, that requested the use of eight lead test assemblies containing fuel rods, guide thimble tubes, and instrumentation tubes fabricated with a cladding material that contains a nominally lower tin content than the already approved ZIRLO material.

The basis for approving the Exemption is contained in the enclosed Safety Evaluation. A copy of the Exemption is enclosed. The Exemption has been forwarded to the Office of the Federal Register for publication.

Sincerely,

*/RA/*

Robert E. Martin, Senior Project Manager, Section 1  
Division of Licensing Project Management  
Office of Nuclear Reactor Regulation

Docket Nos. 50-413 and 50-414

Enclosures: As stated

cc w/encls: See next page

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UNITED STATES OF AMERICA  
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DUKE ENERGY CORPORATION  
NORTH CAROLINA ELECTRIC MEMBERSHIP CORPORATION  
SALUDA RIVER ELECTRIC COOPERATIVE, INC.  
CATAWBA NUCLEAR STATION, UNITS 1 AND 2  
DOCKET NO. 50-413 AND 50-414  
EXEMPTION

1.0 BACKGROUND

Duke Energy Corporation et al, (the licensee) is the holder of Facility Operating License Nos. NPF-35 and NPF-52, which authorize operation of the Catawba Nuclear Station, Units 1 and 2. The licenses provide, among other things, that the facility is subject to all rules, regulations, and orders of the U.S. Nuclear Regulatory Commission (NRC, the Commission) now or hereafter in effect.

The facility consists of two pressurized water reactors located in York County, South Carolina.

2.0 REQUEST/ACTION

Title 10 of the *Code of Federal Regulations* (10 CFR) Part 50, Section 50.46 and Appendix K identify requirements for calculating emergency core cooling system (ECCS) performance for reactors containing fuel with Zircaloy or ZIRLO cladding, and 10 CFR 50.44 identifies requirements for the control of hydrogen gas generated in part from a metal-water reaction between the reactor coolant and reactor fuel having Zircaloy or ZIRLO cladding.

The licensee has requested, in its letter dated December 3, 2002, as supplemented by letter dated April 8, 2003, a temporary exemption to 10 CFR 50.44, "Standards for combustible gas control system in light-water-cooled power reactors," 10 CFR 50.46, "Acceptance criteria for emergency core cooling systems for light-water nuclear power reactors," and Appendix K to 10 CFR Part 50, "ECCS Evaluation Models," that would allow the Catawba Nuclear Station, Units 1 and 2 to operate using eight lead test assemblies (LTAs) with a tin composition that is nominally below the lower bound licensed limit of 0.80 percent, as specified in WCAP-12610-P-A, "VANTAGE+ Fuel Assembly Reference Core Report," in non-limiting core locations. The purpose of the LTAs is to obtain data that would allow the optimization of ZIRLO corrosion resistance, in order to support improved fuel performance and reliability at increased burnup levels.

### 3.0 DISCUSSION

Pursuant to 10 CFR 50.12, "Specific exemptions," the Commission may, upon application by any interested person or upon its own initiative, grant exemptions from the requirements of 10 CFR Part 50, when (1) the exemptions are authorized by law, will not present an undue risk to public health or safety, and are consistent with the common defense and security; and (2) when special circumstances are present. Under Section 50.12(a)(2), special circumstances include, among other things, when the application of the regulation would not serve, or is not necessary to achieve, the underlying purpose of the rule.

The underlying purpose of 10 CFR 50.44, 10 CFR 50.46, and Appendix K to 10 CFR Part 50, is to establish requirements for the calculation of ECCS performance, and acceptance criteria for that performance, in order to assure that the ECCS functions to transfer heat from the reactor core following a loss-of-coolant-accident, such that (1) fuel and clad damage that could interfere with continued effective core cooling is prevented, and (2) clad metal-water reaction is limited to specified amounts.

The mechanical properties of the low-tin ZIRLO in the LTAs are very similar to those of the approved ZIRLO, since both of these alloys are zirconium-based materials with slight variations in tin content. The licensee will perform an evaluation of the fuel rod design using the same methods used for the current robust fuel assembly design. No new or altered design limits need to be applied, nor are any required for this program for the purposes of 10 CFR Part 50, Appendix A, "General Design Criteria for Nuclear Power Plants," Criterion 10, "Reactor Design" (GDC 10). The licensee has evaluated the three areas of the mechanical design that could potentially be impacted by low-tin ZIRLO, namely, material properties, corrosion and thermal creep. The staff evaluated the data provided to substantiate that the material properties are similar to Zircaloy and that the corrosion and thermal creep will remain within established acceptance criteria. The NRC staff concludes that the data show that the selected LTA mechanical design will satisfy established acceptance criteria and should perform safely in the Catawba Nuclear Station.

The licensee has performed evaluations of the impact of the LTAs on the nuclear design. The approved reload methodologies can be used to model the LTAs since the features of the LTAs do not challenge the validity of the standard methodologies. The licensee has limited the number of LTAs to eight, and all of the LTAs will be placed in non-limiting locations in the core. The licensee will use the approved reload methodologies for the Catawba Nuclear Station reload design containing the LTAs. Given the limited number of LTAs to be installed and the installation in non-limiting locations, the NRC staff concludes that the LTA core design is acceptable for use in the Catawba Nuclear Station.

10 CFR 50.46 identifies acceptance criteria for ECCS performance at nuclear power plants. The material properties of the low-tin ZIRLO are similar to those of the current ZIRLO cladding. Because the current analyses are done with material properties that approximate the low-tin ZIRLO properties, the current ECCS analysis remains applicable and unchanged for the

LTAs. Therefore, the NRC staff concludes that the ECCS performance of the Catawba Nuclear Station will not be adversely affected by the insertion of eight low-tin ZIRLO LTAs. As such, the licensee has achieved the underlying purpose of 10 CFR 50.46. The staff has also concluded that should these LTAs fail, the consequences will be bounded by the current analyses for fuel failures and radiological assessments because the source term will not be affected by a different cladding material.

Paragraph I.A.5 of Appendix K to 10 CFR Part 50 states that the rates of energy, hydrogen concentration, and cladding oxidation from the metal-water reaction shall be calculated using the Baker-Just equation. Since the Baker-Just equation presumes the use of Zircaloy clad fuel, strict application of the rule would not permit use of the equation for determining acceptable fuel performance of advanced zirconium-based alloys. The underlying intent of this portion of the appendix, however, is to ensure that analysis of fuel response to LOCAs is conservatively calculated. Due to the similarities in the chemical composition between the low-tin ZIRLO and ZIRLO, the application of the Baker-Just equation in the analysis of low-tin ZIRLO clad fuel will conservatively bound all post-LOCA scenarios. Thus, the underlying purpose of the rule will be met. Therefore, special circumstances exist to grant an exemption from Appendix K to 10 CFR Part 50 that would allow the licensee to apply the Baker-Just equation to low-tin ZIRLO.

The purpose of 10 CFR 50.44 is to ensure that means are provided for the control of hydrogen gas that may be generated following a LOCA. The hydrogen produced in a post-LOCA scenario comes from a metal-water reaction. Tests performed by Westinghouse on the low-tin ZIRLO alloy have demonstrated that the reduction in tin content will have no significant effect on current assessments of hydrogen gas production. As such, the licensee has met the underlying purpose of 10 CFR 50.44.

The NRC staff examined the licensee's rationale to support the exemption request and, for the reasons set forth above, concludes that allowing these eight LTAs with a nominally lower tin composition would meet the underlying purpose of 10 CFR 50.44, 10 CFR 50.46, and Appendix K to 10 CFR Part 50. Further, the NRC staff has determined that the reduction in tin content will have no significant effect on current assessments of a metal-water reaction, and that the mechanical design of the LTAs would perform satisfactorily. Therefore, ECCS performance will not be adversely affected and application of 10 CFR 50.44, 10 CFR 50.46 and 10 CFR Part 50, Appendix K, is not necessary to achieve their underlying purpose.

Based upon the considerations above, the NRC staff concludes that, pursuant to 10 CFR 50.12(a)(2), the granting of this exemption is acceptable.

#### 4.0 CONCLUSION

For the reasons set forth above, the Commission has determined that, pursuant to 10 CFR 50.12(a), the exemption is authorized by law, will not present an undue risk to the public health and safety, and is consistent with the common defense and security. Also, special circumstances are present. Therefore, the Commission hereby grants Duke Energy Corporation an exemption from the requirements of 10 CFR Part 50, Section 50.44, Section 50.46, and Appendix K to 10 CFR Part 50, with respect to the use of low-tin ZIRLO LTAs at the Catawba Nuclear Station.

Pursuant to 10 CFR 51.32, the Commission has determined that the granting of this exemption will not have a significant effect on the quality of the human environment (68 FR 42136).

This exemption is effective upon issuance.

Dated at Rockville, Maryland, this 4<sup>th</sup> day of August 2003.

FOR THE NUCLEAR REGULATORY COMMISSION

*/RA/*

Herbert N. Berkow, Acting Director  
Division of Licensing Project Management  
Office of Nuclear Reactor Regulation

SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION  
RELATED TO REQUEST FOR EXEMPTIONS TO THE CLADDING MATERIAL  
SPECIFIED IN 10 CFR 50.44, 10 CFR 50.46 AND 10 CFR PART 50 APPENDIX K  
FOR THE USE OF LEAD TEST ASSEMBLIES CLAD WITH  
ZIRCONIUM-BASED MATERIALS OTHER THAN ZIRCALOY OR ZIRLO  
DUKE ENERGY CORPORATION  
CATAWBA NUCLEAR STATION  
DOCKET NOS. 50-413 AND 50-414

## 1.0 INTRODUCTION

By letter dated December 3, 2002 (Reference 1), as supplemented by letter dated April 8, 2003 (Reference 2), Duke Energy Corporation, the licensee, submitted a request for exemptions from Title 10 of the *Code of Federal Regulations* (10 CFR) Section 50.44, "Standards for combustible gas control system in light-water-cooled power reactors," Section 50.46, "Acceptance criteria for emergency core cooling systems for light-water nuclear power reactors," and Appendix K to 10 CFR Part 50, "ECCS Evaluation Models," for Catawba Nuclear Station. Without the exemptions, the provisions of the regulations would require that Catawba use fuel clad with Zircaloy or ZIRLO. The licensee has requested permission to use up to eight lead test assemblies (LTAs) with a tin composition that is less than the tin composition used in the licensing basis for ZIRLO as specified in WCAP-12610-P-A, "VANTAGE+ Fuel Assembly Reference Core Report." Irradiation of these fuel assemblies will provide data on fuel and material performance to support the low-tin ZIRLO fuel program. The technical specifications specifically allow the use of LTAs; thus, the licensee is not required to make any additional changes to the technical specifications for the use of LTAs utilizing low-tin ZIRLO material. The Nuclear Regulatory Commission (NRC) staff has reviewed these proposals and found them acceptable, as discussed in the following sections of this Safety Evaluation.

## 2.0 REGULATORY EVALUATION

Duke Energy Corporation proposes to operate its Catawba Nuclear Station plant with up to eight LTAs that would contain fuel rod cladding composed of low-tin ZIRLO. The purpose of the LTAs is to obtain data that would allow the optimization of ZIRLO corrosion resistance, in order to support improved fuel performance and reliability at increased burnup levels. Low-tin ZIRLO is currently a developmental fuel cladding that utilities may only use for LTAs. The NRC staff would have to review and approve this low-tin ZIRLO cladding before utilities could implement batch reloads with this material.

Pursuant to 10 CFR 50.12, the licensee requests an exemption from certain requirements of 10 CFR 50.44, 10 CFR 50.46, and Appendix K of 10 CFR Part 50. 10 CFR 50.44 specifies requirements for the control of hydrogen gas generated after a postulated loss-of-coolant accident (LOCA) for reactors fueled with Zircaloy or ZIRLO cladding. 10 CFR 50.46 contains acceptance criteria for emergency core cooling systems (ECCSs) in reactors fueled with Zircaloy or ZIRLO cladding. In addition, Appendix K to 10 CFR Part 50, requires that the Baker-Just equation be used to predict the rates of energy release, hydrogen concentration, and cladding oxidation from the metal-water reaction. The Baker-Just equation assumes the use of Zircaloy or ZIRLO cladding. The requested exemption relates solely to the specific types of cladding material specified in these regulations for use in light water reactors. In order to use a different cladding material, the licensee would need a limited exemption to these regulations. The licensee has requested such an exemption. The licensee has provided information to justify the exemption in accordance with the requirements of 10 CFR 50.12, "Specific Exemptions."

The proposed exemptions would allow up to eight LTAs containing fuel rods, guide thimble tubes, and instrumentation tubes fabricated with a low tin-version of ZIRLO to be inserted into the core in non-limiting core locations. The licensee plans on initially inserting the LTAs into the core of Catawba, Unit 1, during the Cycle 15 refueling outage in the fall of 2003. These plans call for an exemption due to the tin content in the ZIRLO material falling below that of the current licensing basis of ZIRLO, as specified in WCAP-12610-P-A. The current licensing basis for ZIRLO provides that the tin composition be between 0.80 percent and 1.20 percent. The NRC approved the use of similar LTAs with a tin content between that proposed by the licensee and the lower licensing limit at the Byron Nuclear Station in February 1999.

### 3.0 TECHNICAL EVALUATION

The NRC staff has reviewed the licensee's regulatory and technical analyses in support of its proposed exemption as described in the December 3, 2002 submittal (Reference 1). Duke Energy Corporation and the Westinghouse Electric Company will jointly perform evaluations of the LTAs during the development phase of the program. These evaluations will include both testing and analyses, and will cover all of the design feature changes for the LTAs. They will examine all aspects of safety, including mechanical, neutronic, thermal-hydraulic, transient, and LOCA analyses. In addition, the licensee has considered the applicable recommendations from WCAP-15604-NP, Revision 1, "Limited Scope High Burn-up Lead Test Assemblies" (Reference 3). The following is the NRC staff's detailed evaluation.

#### 3.1 Mechanical Design

The mechanical properties of the low-tin ZIRLO in the LTAs are very similar to those of the approved ZIRLO, since both of these alloys are zirconium-based materials with slight variations in tin content. The licensee will perform an evaluation of the fuel rod design using the same methods used for the current robust fuel assembly design. No new or altered design limits need to be applied, nor are any required for this program for the purposes of 10 CFR Part 50, Appendix A, "General Design Criteria for Nuclear Power Plants," Criterion 10, "Reactor Design" (GDC 10). The licensee has evaluated the three areas of the mechanical design that could potentially be impacted by low-tin ZIRLO, namely, material properties, corrosion and thermal creep. The staff evaluated the data provided to substantiate that the material properties are similar to Zircaloy and that the corrosion and thermal creep will remain within established

acceptance criteria. The NRC staff concludes that the data show that the selected LTA mechanical design will satisfy established acceptance criteria and should perform safely in the Catawba Nuclear Station.

### 3.2 Core Design

The licensee has performed evaluations of the impact of the LTAs on the nuclear design. The approved reload methodologies can be used to model the LTAs since the features of the LTAs do not challenge the validity of the standard methodologies. Traditionally, the NRC staff had two criteria for LTA programs, i.e., the number of LTAs should be limited and the core locations of LTAs should not be in the highest power or limiting regions (Reference 4). The licensee has limited the number of LTAs to eight, and all of the LTAs will be placed in non-limiting locations in the core. The licensee will use the approved reload methodologies for the Catawba Nuclear Station reload design containing the LTAs. Given the limited number of LTAs to be installed and the installation in non-limiting locations, the NRC staff concludes that the LTA core design is acceptable for use in the Catawba Nuclear Station.

### 3.3 LOCA Analysis and ECCS Exemption

10 CFR 50.12(a)(2)(ii) sets forth criteria under which NRC may grant an exemption from the requirements of 10 CFR Part 50. The NRC may grant an exemption only if special circumstances are present. One such special circumstance is that application of the regulation in the particular circumstances would not serve the underlying purpose of the rule, or is not necessary to achieve the underlying purpose of the rule. For the reasons set forth below, the NRC staff has concluded that the requested exemption meets the special circumstances of 10 CFR 50.12(a)(2)(ii).

The underlying purpose of 10 CFR 50.46 and 10 CFR Part 50, Appendix K, is to establish requirements for the calculation of ECCS performance. 10 CFR 50.46 identifies acceptance criteria for ECCS performance at nuclear power plants. The material properties of the low-tin ZIRLO are similar to those of the current ZIRLO cladding. Because the current analyses are done with material properties that approximate the low-tin ZIRLO properties, the current ECCS analysis remains applicable and unchanged for the LTAs. Therefore, the NRC staff concludes that the ECCS performance of the Catawba Nuclear Station will not be adversely affected by the insertion of eight low-tin ZIRLO LTAs. As such, the licensee has achieved the underlying purpose of 10 CFR 50.46. The staff has also concluded that should these LTAs fail, the consequences will be bounded by the current analyses for fuel failures and radiological assessments because the source term will not be affected by a different cladding material.

Paragraph I.A.5 of Appendix K to 10 CFR Part 50 states that the rates of energy, hydrogen concentration, and cladding oxidation from the metal-water reaction shall be calculated using the Baker-Just equation. Since the Baker-Just equation presumes the use of Zircaloy clad fuel, strict application of the rule would not permit use of the equation for determining acceptable fuel performance of advanced zirconium-based alloys. The underlying intent of this portion of the appendix, however, is to ensure that analysis of fuel response to LOCAs is conservatively calculated. Due to the similarities in the chemical composition between the low-tin ZIRLO and ZIRLO, the application of the Baker-Just equation in the analysis of low-tin ZIRLO clad fuel will conservatively bound all post-LOCA scenarios. Thus, the underlying purpose of the rule will be met.

Therefore, special circumstances exist to grant an exemption from Appendix K to 10 CFR Part 50 that would allow the licensee to apply the Baker-Just equation to low-tin ZIRLO.

The purpose of 10 CFR 50.44 is to ensure that means are provided for the control of hydrogen gas that may be generated following a LOCA. The hydrogen produced in a post-LOCA scenario comes from a metal-water reaction. Tests performed by Westinghouse on the low-tin ZIRLO alloy have demonstrated that the reduction in tin content will have no significant effect on current assessments of hydrogen gas production. As such, the licensee has met the underlying purpose of 10 CFR 50.44.

### 3.4 WCAP-15604-NP, Revision 1, "Limited Scope High Burn-up Lead Test Assemblies"

WCAP-15604-NP, Revision 1, (Reference 3), contains guidance for participation in a Limited Scope Lead Test Assembly program involving high burn-up lead test assemblies. At this time, the licensee does not intend to operate the LTAs to "high burn-ups." While WCAP-15604-NP is explicitly dedicated to high burn-up LTAs, many of the recommendations in WCAP-15604-NP apply to a non-high burn-up lead test assembly program, such as the one currently proposed for Catawba. Furthermore, the definition of a limited scope high burn-up LTA includes use of an NRC-approved cladding material. In its review, the NRC staff has used applicable recommendations of WCAP-15604-NP, Revision 1, as guidance in the review of the proposed Catawba lead test assembly program. The licensee has considered all of the recommendations in WCAP-15604-NP, Revision 1, as discussed below.

The licensee has proposed the insertion of up to eight LTAs, which is within the limit of nine LTAs as documented in the NRC staff's May 31, 2002, safety evaluation (Reference 4). The fuel used in the LTAs is typical production fuel and will be pre-characterized before operation since the licensee and Westinghouse will jointly perform evaluations of the LTAs during the development phase of the program. These tests and analyses will examine all aspects of safety, including mechanical, neutronic, thermal-hydraulic, transient, and LOCA analyses, and will cover all of the design feature changes for the LTAs. The licensee plans on using the same design methods used in current robust fuel assembly fuel design. A fuel rod design evaluation was performed for the Catawba LTAs to show that all fuel rod design criteria, i.e., specified acceptable fuel design limits as required by GDC 10, were met.

The proposed post-irradiation examinations scheduled for the Catawba LTAs include: visual examinations; fuel assembly length; fuel assembly bow; fuel assembly drag; fuel rod length; fuel rod wear; fuel rod profilometry; cladding oxidation; and grid cell measurements that include dimensions and oxidation. In addition, predicted oxidation is less than 100 microns with no blistering or spallation. The Catawba LTA program will not irradiate the assemblies beyond the current licensed burn-up limit included in Appendix D of the operating license, and the licensee states in Reference 2 that it will ensure that all the LTAs are designed and operated to be in compliance with the current licensed limits for Catawba.

## 4.0 CONCLUSION

The NRC staff has reviewed the licensee's exemption request for the use of LTAs with low-tin ZIRLO cladding. The licensee has achieved the underlying purpose of applicable regulations including 10 CFR 50.44, 10 CFR 50.46, and Appendix K to 10 CFR Part 50 and, therefore, special circumstances are present. Based on its evaluation, as set forth above, the NRC staff

approves the request for exemption, that allows the insertion of up to eight LTAs into the Catawba Nuclear Station.

Based on the consideration discussed above, the staff has concluded: (1) there is reasonable assurance that the health and safety of the public will not be endangered by operation in the proposed manner, and (2) such activities will be conducted in compliance with the Commission's regulations, and issuance of this exemption will not be inimical to the common defense and security or to the health and safety of the public.

## 5.0 REFERENCES

1. Letter from Gary R. Peterson, Vice President, Catawba Nuclear Station, to NRC Document Control Desk; "Request for Exemption Pursuant to 10 CFR 50.12- Exemption to the Cladding Material Specified in 10 CFR 50.44, 10 CFR 50.46 and 10 CFR Appendix K," December 3, 2002.
2. Letter from Gary R. Peterson, Vice President, Catawba Nuclear Station, to NRC Document Control Desk, April 8, 2003.
3. Topical Report from Westinghouse Owners Group to NRC Document Control Desk; WCAP-15604-NP Revision 1, "Limited Scope High Burnup Lead Test Assemblies." November 29, 2001.
4. Safety Evaluation by Jared Wermiel, Chief, Reactor Systems Branch to Stuart Richards, Project Director, PD IV; "Topical Report WCAP-15604-NP-Rev. 1, Limited Scope High Burn-up Lead Test Assemblies," May 31, 2002.

Principal Contributor: B. Rini, SRXB/DSSA

Date: August 4, 2003

Catawba Nuclear Station

cc:

Mr. Gary Gilbert  
Regulatory Compliance Manager  
Duke Energy Corporation  
4800 Concord Road  
York, South Carolina 29745

Ms. Lisa F. Vaughn  
Legal Department (ECIIX)  
Duke Energy Corporation  
422 South Church Street  
Charlotte, North Carolina 28201-1006

Anne Cottingham, Esquire  
Winston and Strawn  
1400 L Street, NW  
Washington, DC 20005

North Carolina Municipal Power  
Agency Number 1  
1427 Meadowwood Boulevard  
P. O. Box 29513  
Raleigh, North Carolina 27626

County Manager of York County  
York County Courthouse  
York, South Carolina 29745

Piedmont Municipal Power Agency  
121 Village Drive  
Greer, South Carolina 29651

Ms. Karen E. Long  
Assistant Attorney General  
North Carolina Department of Justice  
P. O. Box 629  
Raleigh, North Carolina 27602

NCEM REP Program Manager  
4713 Mail Service Center  
Raleigh, NC 27699-4713

Mr. T. Richard Puryear  
Owners Group (NCEMC)  
Duke Energy Corporation  
4800 Concord Road  
York, South Carolina 29745

North Carolina Electric Membership  
Corporation  
P. O. Box 27306  
Raleigh, North Carolina 27611

Senior Resident Inspector  
U.S. Nuclear Regulatory Commission  
4830 Concord Road  
York, South Carolina 29745

Henry Porter, Assistant Director  
Division of Waste Management  
Bureau of Land and Waste Management  
Department of Health and Environmental  
Control  
2600 Bull Street  
Columbia, South Carolina 29201-1708

Mr. C. Jeffrey Thomas  
Manager - Nuclear Regulatory  
Licensing  
Duke Energy Corporation  
526 South Church Street  
Charlotte, North Carolina 28201-1006

Saluda River Electric  
P. O. Box 929  
Laurens, South Carolina 29360

Mr. Peter R. Harden, IV  
VP-Customer Relations and Sales  
Westinghouse Electric Company  
6000 Fairview Road  
12th Floor  
Charlotte, North Carolina 28210

Richard M. Fry, Director  
Division of Radiation Protection  
North Carolina Department of  
Environment, Health, and  
Natural Resources  
3825 Barrett Drive  
Raleigh, North Carolina 27609-7721