January 8, 2001

Mr. W. R. McCollum, Jr.
Vice President, Oconee Site
Duke Energy Corporation
7800 Rochester Highway
Seneca, SC 29672

SUBJECT: OCONEE NUCLEAR STATION, UNIT 1 - SAFETY EVALUATION OF REQUEST TO USE ALTERNATIVE MATERIALS PER ASSOCIATED CODE CASES FOR THE FABRICATION OF REACTOR VESSEL HEAD THERMOCOUPLE AND CONTROL ROD DRIVE MECHANISM WELD REPAIRS (TAC NO. MB0854)

Dear Mr. McCollum:

By letter dated January 2, 2001, Duke Energy Corporation requested approval of the proposed alternative to use Alloy 690 welding filler materials (Inconel 52/152) and associated American Society of Mechanical Engineers Code Cases 2142-1 and 2143-1 on Oconee Nuclear Station, Unit 1. The request is associated with the use of Alloy 690 type filler material (Inconel 52/152) to repair of the thermocouple nozzles and a Control Rod Drive Mechanism nozzle reactor vessel head penetrations. The staff concludes that the use of the proposed alternative for repair of the reactor pressure vessel head penetrations will provide an acceptable level of quality and safety. Pursuant to Title 10 of the *Code of Federal Regulations,* Section 50.55.a(a)(3)(i), the staff authorizes the use of the proposed alternative. Our Safety Evaluation is enclosed.

The staff is concerned with the lack of timeliness and thoroughness shown in the preparation of the submittal for this relief request that resulted in the need for conference calls, additional information, and rescheduling of staff resources to resolve the issues.

Sincerely,

/RA by Gary S. Janosko Acting for/

Richard L. Emch, Jr., Chief, Section 1
Project Directorate II
Division of Licensing Project Management
Office of Nuclear Reactor Regulation

Docket No. 50-269

Enclosure: As stated

cc w/encl: See next page

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SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

REQUEST TO USE ALTERNATIVE MATERIALS AND ASSOCIATED CODE CASES

FOR REPAIR OF THE REACTOR VESSEL THERMOCOUPLE

AND CONTROL ROD DRIVE MECHANISM NOZZLE WELDS

DUKE ENERGY CORPORATION

OCONEE NUCLEAR STATION, UNIT 1

DOCKET NO. 50-269

1.0 INTRODUCTION

By letter dated December 2, 2001, Duke Energy Corporation (the licensee) requested approval under the provisions of Title 10 of the *Code of Federal Regulations* (10 CFR) Section 50.55a(a)(3)(i) to use Alloy 690 welding filler materials (Inconel 52/152) in accordance with American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel (B&PV) Code Case 2142-1, "F-Number Grouping for Ni-Cr-Fe, Classification UNS N06052 Filler Metal, Section XI," and Code Case 2143-1, "F-Number Grouping for Ni-Cr-Fe, Classification UNS W86152 Welding Electrode, Section XI," for the repair of thermocouple nozzles and a Control Rod Drive Mechanism (CRDM) penetration on the Oconee Nuclear Station (ONS), Unit 1 reactor vessel (RV) head. Using eddy current, ultrasonic, and liquid penetrant examination methods, the licensee has detected flaw indications in the base metal of each of the eight thermocouple nozzles and in several of the J-groove partial penetration welds connecting the thermocouple nozzles to the inside radius of the RV head. In addition, liquid penetrant inspections of CRDM #21 has identified a flaw indication in the J-groove partial penetration weld connecting the CRDM nozzle to the inside radius of the RV head.

The current Code of Record at ONS for inservice inspection is the ASME B&PV Code, Section XI, 1989 Edition with no addenda. The Code of Record allows use of Alloy 600 (Inconel 82/182) welding filler materials, but does not include Alloy 690 (Inconel 52/152) welding filler materials. Industry studies indicate that Alloy 690 (Inconel 52/152) welding filler materials are less susceptible to intergranular stress corrosion cracking (IGSCC) than the Inconel 82/182 materials. Alloy 600 type weld metals (Inconel 82/182) were widely used during the construction of nuclear power plants. Operating experience has shown that Inconel 182 weld material is susceptible to IGSCC, although primarily in boiling-water reactor (BWR) environments.

The referenced Code cases introduce and classify new nickel base weld metals that are compatible with Alloy 690 base metal materials. Code Case 2141-1 establishes welding classifications and other requirements for a bare wire filler metal. Code Case 2143-1

establishes welding classifications and other requirements for a coated electrode. These two Code cases have not been incorporated by reference into the regulations; therefore, their use requires NRC approval.

Thus, the licensee's request consists of two issues:

a. The use of Alloy 690 (Inconel 52/152) welding filler materials in Code Class 1 weld repair in lieu of Alloy 600 (Inconel 82/182) welding filler materials; and

b. The use of two ASME Code cases that group the new welding filler materials in the same welding categories as other commonly employed nickel base weld metals. This allows the use of appropriate existing welding procedures and performance qualifications with the new weld metals.

2.0 DISCUSSION

2.1 Alloy 690 welding filler materials (Inconel 52/152)

A small amount of boron was found on the RV head penetrations associated with the thermocouples and CRDM #21 during a normal visual inspection of the RV head following shutdown of the reactor for refueling outage 1EOC19.

Six of the eight thermocouple nozzles will be repaired from underneath the RV head (inside radius). The nozzles and defective weld material will first be removed and the existing weld repaired. A plug made of SB-166 Alloy 690 will be inserted into the remaining penetrations from the inside radius of the head. A structural weld overlay using the proposed Alloy 690 weld filler material (Inconel 52/152) will then be applied on the inside radius of the head underneath the plug.

On two of the eight thermocouple nozzles the excavated weld material included the Alloy 600 weld material, a portion of the Alloy 600 butter to the RV head base material, and a portion of the RV head base material. To reduce the radiation dose to workers performing the repairs, the penetrations will be repaired from the outside radius of the RV head using the temper bead technique. The thermocouple nozzles and any remaining defects will be removed and a plug made of SB-166 Alloy 690 will be inserted into the remaining penetrations. A structural weld overlay, using the proposed Alloy 690 weld filler material (Inconel 52/152), will then be applied on the outside radius of the RV head over the plug.

CRDM #21 will be repaired from the inside radius of the RV head. All defects will first be removed and replaced with the proposed Alloy 690 weld filler material (Inconel 52/152). An overlay of the proposed Alloy 690 material will then be applied over the remaining Alloy 600 material.

The licensee has compared the material properties of the existing Alloy 600 (182 weld material) material to the new proposed Alloy 690 (152 weld material). The thermal expansion coefficient of the 152 weld material is somewhat higher than the coefficient for the 182 weld material (at 600°F, the difference is about 4 percent); however, the modulus of elasticity is lower for the 152 weld material than the 182 weld material. Since the thermal stress is a function of the product of the modulus of elasticity and the thermal expansion coefficient, the effects tend to cancel

each other (at 600°F, for example, the difference in the products is only two percent. Thus, the presence of the two weld materials will have an insignificant effect on the thermal stresses in the total weld.

According to the licensee, an evaluation of the weld dilution has concluded that the percentage of chromium in the deposited welds, in all cases given above, exceeded 22 percent. Materials with chromium concentrations above 22 percent have demonstrated resistance to Primary Water Stress Corrosion Cracking. Consequently, the chromium content of all repaired surfaces containing the proposed Alloy 690 weld material, considering chromium dilution, will exceed that of the original Alloy 600 weld material, and thus afford superior corrosion resistance. The staff finds the licensee's material properties evaluation acceptable.

In summary, the licensee has proposed the use of alternative Inconel 52/152 materials for the fabrication and repair of the subject welds. Laboratory test data have shown that Inconel 52/152 materials are resistant to stress corrosion cracking in simulated pressurized-water reactor (PWR) and BWR environments. The staff has approved the use of Inconel 52/152 in the replacement of steam generators for a number of PWRs, including V. C. Summer; St. Lucie, Unit 1; McGuire Nuclear Station, Units 1 and 2; Catawba Nuclear Station, Unit 1; and Oconee Nuclear Site, Units 1, 2, and 3. Therefore, the licensee-proposed use of Inconel 52/152 filler materials in the thermocouple and CRDM nozzle welds is acceptable since it will provide an acceptable level of quality and safety.

2.2 Code Cases 2142-1 and 2143-1

The purposes of a weld metal code case are the establishment of uniform chemical and material properties and the classification of the weld metal with respect to its welding characteristics. This welding characteristics classification is known as an "F-No." Weld metals with like characteristics are grouped together for welding and welder qualification purposes in order to eliminate unnecessary duplication.

Code Case 2142-1 lists American Welding Society (AWS) specification (AWS A5.14) and Unified Numbering System (UNS) designation (UNS N06052) conforming to Inco 52 (Inconel 52). It establishes the F-No. of this weld metal as F-No. 43 for both procedure and performance qualification purposes. Code Case 2143-1 lists appropriate AWS and UNS specifications for a coated electrode matching Inco 152 (Inconel 152) and establishes F-No. 43 for this material for welding purposes. By this set of specifications and F-No. assignments, these materials are completely described for welding purposes as similar in their welding characteristics to many other Code nickel-based weld metals. Thus, these two weld metals (Inconel 52/152) are exempted from the requirements for specific procedure and performance qualifications for non-Code materials.

The staff finds that these two code cases appropriately specify and classify the necessary weld metal parameters and are acceptable for use. The staff has approved the use of these two Code cases in the replacement of steam generators for a number of PWRs, including V. C. Summer; St. Lucie, Unit 1; McGuire Nuclear Station, Units 1 and 2; Catawba Nuclear Station Unit 1; and Oconee Nuclear Site, Units 1, 2, and 3.

3.0 CONCLUSION

The use of Alloy 690 welding filler material (Inconel 52/152) and the associated ASME Code Cases 2142-1 and 2143-1 for the repairs to the ONS Unit 1 thermocouple and CRDM #21 nozzles will provided superior corrosion protection over that provided by Alloy 600 (Inconel 82/182) material. The use of Alloy 690 has been previously authorized for new construction and other repair activities.

Based on the above evaluation, the staff concludes that the proposed alternative to use Alloy 690 welding filler materials (Inconel 52/152) per Code Cases 2142-1 and 2143-1 for fabrication of weld overlay and weld repairs to the thermocouple and CRDM #21 RV head penetrations will provide an acceptable level of quality and safety. Pursuant to 10 CFR 50.55.a(a)(3)(i), the staff authorizes the use of the proposed alternative.

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Date: January 8, 2001

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