April 13, 2001

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

SUBJECT: OCONEE NUCLEAR STATION, UNIT 3 RE: SAFETY EVALUATION OF REQUEST TO USE ALTERNATIVE MATERIALS PER ASSOCIATED CODE CASES FOR REACTOR VESSEL HEAD CONTROL ROD DRIVE MECHANISM WELD REPAIRS - SUPPLEMENT (TAC NO. MB1319)

Dear Mr. McCollum:

By letter dated March 6, 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 3. The request is associated with the use of Alloy 690 type filler material (Inconel 52/152) on Control Rod Drive Mechanism (CRDM) nozzle reactor vessel head penetrations for the repair of nozzles and welds. By letter dated April 10, 2001, the staff concluded 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 and approved the request for relief for CRDM Nos. 11, 23, 28, 34, 50, and 56 reactor vessel head penetrations.

Subsequently, Duke informed the staff that CRDM Nos. 3 and 7 that were described in the submittal as possibly needing repairs did, in fact, need to be repaired, and should be included in the request for relief. The staff has reviewed this change and determined that it is acceptable, based on the same analysis used to approve the request for relief for the original CRDMs. Therefore, pursuant to Title 10 of the *Code of Federal Regulations* (10 CFR) Section 50.55.a(a)(3)(i), the staff authorizes the use of the proposed alternative for the additional CRDMs and is issuing this supplement. Our Safety Evaluation to include CRDM Nos. 3 and 7 is enclosed. The changes are shown by marginal lines.

Sincerely,

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

Docket No. 50-287

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

CONTROL ROD DRIVE MECHANISM NOZZLE AND WELDS

DUKE ENERGY CORPORATION

OCONEE NUCLEAR STATION, UNIT 3

DOCKET NO. 50-287

1.0 INTRODUCTION

By letter dated March 6, 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 weld filler materials (Inconel 52/152) in accordance with the 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 certain Control Rod Drive Mechanism (CRDM) penetration nozzles and welds on the Oconee Nuclear Station (ONS), Unit 3 reactor vessel (RV) head.

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) weld filler materials in Code Class 1 weld repair in lieu of Alloy 600 (Inconel 82/182) weld filler materials; and

b. The use of two ASME Code cases that group the new weld filler materials in the same weld 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.

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 the use of Alloy 600 (Inconel 82/182) weld filler materials, but does not include Alloy 690 (Inconel 52/152) weld filler materials. Industry studies indicate that Alloy 690 (Inconel 52/152) weld 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.

2.0 DISCUSSION

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

The licensee has compared the material properties of the existing Alloy 600 (82/182) weld material to the new proposed Alloy 690 (52/152) weld material. The thermal expansion coefficient of the 52/152 weld material is somewhat higher than the coefficient for the 82/182 weld material (at 600°F, the difference is about 4 percent); however, the modulus of elasticity is lower for the 52/152 weld material than the 82/182 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 repair scenarios 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 material, and thus afford superior corrosion resistance. The staff finds the licensee's material properties evaluation acceptable.

A small amount of boron was found on the RV head penetrations associated with the CRDM Numbers 11, 23, 28, 34, 50, and 56 during a normal visual inspection of the RV head following shutdown of the reactor to repair a pressurized code safety valve. As a result, the licensee removed the reactor vessel head and performed eddy current and ultrasonic examinations for the nozzle base metal of these CRDM welds and nozzles. In addition, liquid penetrant inspections of these CRDMs have been completed for each J-groove partial penetration weld connecting these CRDM nozzles to the inside radius of the RV head. Flaw indications were found in each of these nozzles. The indications can be grouped into three categories: (1) indications in the J-groove partial penetration weld, (2) indications in the nozzle base metal above the J-groove partial penetration weld, and (3) indications in the nozzle base metal below the J-groove partial penetration weld. Nozzles 11, 23, and 50 contain all three types of indications. Indications in nozzles 3, 28, 34, 56, and 63 were found in the weld and in the nozzle base metal below the weld. Indications in nozzle 7 are in the nozzle base metal above and below the weld.

The repair design methods have been developed by the licensee for each nozzle based on the indications that were discovered. Excavation of the weld and portions of the outside diameter

of the nozzles has been performed to clear all indications, and then the excavated material was replaced with the proposed Alloy 690 weld filler material (Inconel 52/152). Lower portions of Nozzles 3, 7, 11, 23, 28, 50, 56, and 63 have been cut and removed. The Nozzle 34 indication in the base metal below the weld was repaired without cutting. All cut surfaces and all replacement material have received an overlay using 52/152 material.

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 Station, Units 1, 2, and 3. Therefore, the licensee-proposed use of Inconel 52/152 filler materials for repairs associated with the CRDM nozzle weld reactor presseure vessel head penetrations 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 Station, Units 1, 2, and 3; as well as reactor vessel head penetration repairs for the Oconee Nuclear Station, Unit 1.

3.0 CONCLUSION

The use of Alloy 690 weld filler material (Inconel 52/152) and the associated ASME Code Cases 2142-1 and 2143-1 for the repairs to the CRDM nozzles will provide 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 weld filler materials (Inconel 52/152) per Code Cases 2142-1 and 2143-1 for fabrication of weld overlay and weld repairs of CRDM Nos. 3, 7, 11, 23, 28, 34, 50, 56, and 63 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: April 13, 2001

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