UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

REQUEST TO USE ALTERNATIVE MATERIALS IN

THE REACTOR COOLANT SYSTEM

FLORIDA POWER COMPANY

CRYSTAL RIVER NUCLEAR PLANT, UNIT 3

DOCKET NO. 50-302

1.0 INTRODUCTION

By letter dated January 11, 1996, Florida Power and Light Company, the licensee, requested approval under the provisions of 10 CFR 50.55a(a)(3) to use ASME Section IX Code Cases 2142 and 2143 on the Reactor Coolant System (RCS) for Crystal River Unit 3 (CR-3).[1] These two Code cases introduce and classify new nickel base weld metals that closely match and are intended for welding Alloy 690. Code Case 2142 establishes welding classifications and other requirements for a bare wire filler metal. Code Case 2143 establishes welding classifications and other requirements for a coated electrode.

The subject Code cases were adopted by the ASME on December 7, 1992 and were published in ASME Code Case Supplement 3 in April 1993. Due to the fact that this is a Supplement to the 1992 edition of the ASME Boiler and Pressure Vessel Code and that the 1992 edition of the ASME Code has not yet been incorporated by reference into the regulations, these Code cases may not be used by licensees without prior NRC staff review and approval.

The licensee intends to use Alloy 690 materials in the fabrication and installation of components in the reactor coolant system of Crystal River Unit 3. The licensee believes that use of the new weld metals will enhance the service life of the components. Industry studies indicate that these new weld metals are less susceptible to intergranular stress corrosion cracking (IGSCC) than the other nickel base weld metals currently applied.

Use of Code Cases 2142 and 2143 is advantageous to the licensee because it eliminates the burden of requiring qualification of separate welding procedures for each weld metal, as is the case for non-Code welding materials.

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[1] Although 10 CFR 50.55a references only the applicable portions of Sections III and XI of the ASME Boiler and Pressure Vessel Code, ASME Section III requires in NB-2400 that all welding material used in the construction and repair of ASME Code Class 1 components and material conform to the requirements for other welding material as permitted in Section IX.

Thus, this relief request incorporates two issues:

1. use of Alloy 690 type weld metals in ASME Code Class 1 construction, and,

2. use of two ASME Code Cases which group the new weld metals 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 EVALUATION

Due to the extensive history of IGSCC problems in Alloy 600, the industry has sought an alternative alloy. Currently, Alloy 690 is the industry material of choice. This choice is the result of numerous laboratory studies which show that Alloy 690 has little or no susceptibility to IGSCC in environments that simulate PWR and BWR plant conditions. NRC staff review of these laboratory test results has resulted in the staff position that, based upon the available technical evidence, there is no technical reason to disallow the use of Alloy 690 base material in nuclear plant construction.

Alloy 600 type weld metals (such as Inco 82 and 182) were widely used during the construction of nuclear power plants. Operating experience showed that Inco 182 was also susceptible to IGSCC, although primarily in BWR environments. Weld metals matching Alloy 690 have also been tested in simulated PWR and BWR environments. Commercial development of these weld metals lagged that of the Alloy 690 base metal. No matching weld metal has been commercially available until now. Thus, staff evaluation of these weld metals had not been previously conducted.

Corrosion studies examining the susceptibility of weld metals to IGSCC in reactor coolant system environments are scant compared to the voluminous base metal studies. This is because the base metal performance is a strong indicator of the expected performance of a matching weld metal. Results of the principal study which included weld metals are found in the Electric Power Research Institute (EPRI) report NP-5882M, titled "Stress Corrosion Cracking Resistance of Alloys 600 and 690 and Compatible Weld Metals in BWRs." Experimental Alloy 690 weld metals were tested in laboratory simulations of a BWR environment. They were tested under the same conditions as the base metals, thus allowing direct comparison of results. Results showed that the Alloy 690 weld metals are highly resistant to IGSCC in pure water environments.

In this report the designations R-127 and R-135 were used for the experimental weld metals. These were the Inco designations for the developmental weld metals that became Inco 52 and 152 respectively. Inco 52 is the commercial filler metal (tig wire) described in ASME Code Case 2142. Inco 152 is the coated electrode described in Code Case 2143.

Another paper, "Inconel 690: A New High Nickel Alloy for Corrosive Environments at Elevated Temperature," by A. J. Sedriks, et al., of the Inco Research and Development Center, included tests of a matching filler metal in a wide variety of environments. The two most interesting tests were conducted in simulated SG environments: deaerated, ammoniated and borated water at 316 degrees C. Test results showed the welds and weld metal were highly resistant to general corrosion.

IGSCC susceptibility was tested by exposing welds to a variety of chloride environments. The controls used in these tests were Alloy 800 (not 600) and type 304 stainless steel. Both of these alloys are known to crack in elevated temperature chloride environments. In all cases, Alloy 690 was tested for periods significantly longer than the time to crack Alloy 800 (the more resistant of the two control alloys). In no case did the Alloy 690 welds crack despite test durations eight times longer than that of the control alloys.

Additional testing for IGSCC susceptibility in pure water environments was conducted. Another group of Alloy 690 welds plus control alloys were exposed to undeaerated water at elevated temperatures in the presence of a crevice. Cracking was readily initiated within the controls. None of the Alloy 690 welds cracked despite testing durations 24 times longer than for Alloy 600 and 12 times for Alloy 800 and 304 stainless.

Not considered in either study is the effect, if any, of heat to heat variations in the weld metal compositions. Such variations were found to play a substantial role in the IGSCC susceptibility of Alloy 600. The strong performance of Alloy 690 suggests there would be minimal effect.

Code Case 2142 lists the American Welding Society (AWS) specification (AWS A5.14) and UNS designation (UNS N06052) for a filler metal conforming to Inco 52. It establishes the F-No. of this weld metal as F-No. 43 for both procedure and performance qualification purposes. Code Case 2143 lists appropriate AWS and UNS specifications for a coated electrode matching Inco 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 base weld metals. Thus, these two weld metals are exempted from the requirements for specific procedure and performance qualifications for non-Code materials.

3.0 CONCLUSION

On the basis of the available technical evidence as discussed above, the staff concludes that the use of the subject weld metals provides sufficient material integrity and is acceptable as a substitute for other weld metals when the licensee has determined that their use could enhance the safety of the reactor coolant system. Additionally, the staff finds that the Code cases appropriately identify and classify these same two weld metals for welding purposes, and there is no need to impose requirements for special procedure and performance qualifications for non-Code materials. Therefore use of the classifications are sufficient to ensure weld integrity.

The staff has reviewed the licensee's request and supporting information and concludes that the use of the subject Code cases as an alternative to the ASME Boiler and Pressure Vessel Code, Section IX requirements will provide an acceptable level of quality and safety and is authorized pursuant to 10 CFR 50.55a(a)(3)(i).

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