

February 29, 2000

Mr. Charles H. Cruse  
Vice President - Nuclear Energy  
Baltimore Gas and Electric Company  
Calvert Cliffs Nuclear Power Plant  
1650 Calvert Cliffs Parkway  
Lusby, MD 20657

SUBJECT: RELIEF REQUEST TO USE CODE CASES N-20-4, 2142-1, AND 2143-1 IN THE FABRICATION AND REPLACEMENT OF STEAM GENERATORS, CALVERT CLIFFS NUCLEAR POWER PLANT, UNIT NOS. 1 AND 2 (TAC NOS. MA7335 AND MA7336)

Dear Mr. Cruse:

By letter dated December 1, 1999, Baltimore Gas and Electric Company (the licensee) requested approval under the provisions of 10 CFR 50.55a(a)(3) to use the American Society of Mechanical Engineers (ASME) Section III Code Case N-20-4 and ASME Section IX Code Cases 2142-1 and 2143-1 during the fabrication and replacement of the steam generators for the Calvert Cliffs Nuclear Power Plant, Unit Nos. 1 and 2. Code Case N-20-4 describes various requirements for three nickel-based alloys (alloys 600, 690 and 800) for use in the construction of Class 1 components in accordance with Section III, Division 1. The licensee intends to use alloy 690 tubing in its replacement steam generators. Code Cases 2142-1 and 2143-1 classified the welding filler material group number as F-No. 43 for the alloy 690 shielded metal arc welding electrode designated as UNS W86152 and the bare filler wire designated as UNS N06052. Since these weld filler materials are similar in welding characteristics to many other Code nickel base filler weld materials and have metallurgical properties similar to the base metals, separate procedure and performance qualifications for these materials are not warranted. Affirming this Code F-number designation for Code Cases 2142-1 and 2143-1 permits the specified filler weld material to be used in previously qualified weld procedures, thus eliminating the need for creating new procedures and performance qualifications.

The Nuclear Regulatory Commission staff has reviewed the licensee's request and concludes that Code Cases N-20-4, 2142-1, and 2143-1 provide an acceptable level of quality and safety. Pursuant to 10 CFR 50.55a(a)(3)(i), the licensee is authorized to employ Code

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Cases N-20-4, 2142-1, and 2143-1 as an alternative for the replacement steam generator project at Calvert Cliffs. The staff's safety evaluation that documents the basis for this conclusion is enclosed.

If you have any questions regarding this matter, please contact Alexander W. Dromerick, Project Manager, at 301-415-3473.

Sincerely,

*/RA/*

Marsha Gamberoni, Acting Chief, Section 1  
Project Directorate I  
Division of Licensing Project Management  
Office of Nuclear Reactor Regulation

Docket Nos. 50-317 and 50-318

Enclosure: Safety Evaluation

cc w/encl: See next page

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Unit Nos. 1 and 2

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SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

ALTERNATIVE ALLOY 690 MATERIAL PROPERTIES,

WELDING ELECTRODES AND FILLER METAL

FOR USE IN REPLACEMENT STEAM GENERATORS

BALTIMORE GAS AND ELECTRIC COMPANY

CALVERT CLIFFS NUCLEAR POWER PLANT, UNIT NOS. 1 AND NO. 2

DOCKET NOS. 50-317 AND 50-318

1.0 INTRODUCTION

By letter dated December 1, 1999, Baltimore Gas and Electric Company (the licensee) submitted a request for relief from certain base metal and weld filler metal requirements to be used in the fabrication of replacement steam generators at the Calvert Cliff Nuclear Power Plant, Unit Nos. 1 and 2. The licensee proposed implementing the criteria from the American Society of Mechanical Engineers (ASME) Code Cases (a) N-20-4, "SB-163, Cold Worked UNS N08800; and SB-163 UNS N06600, UNS N06690, and UNS N08800 to Supplementary Requirements S2 of SB-163, Section III, Division 1, Class 1," (b) 2142-1, "F-Number Grouping of Ni-Cr-Fe, Classification UNS N06052 Filler Metal, Section XI," and (c) 2143-1, "F-Number Grouping of Ni-Cr-Fe, Classification UNS W86152 Welding Electrode, Section XI." These Code Cases would be used as an alternative to the requirements in the ASME Boiler and Pressure Vessel Code (ASME Code). Code Case N-20-4 provides revised yield and ultimate tensile strength values for those alloys previously reported in Code Case N-20-3. Code Cases 2142-1 and 2143-1 provide criteria for weld material F-number group classifications.

2.0 DISCUSSION

2.1 Background

Pursuant to Section 50.55a(g)(4) to Title 10 of the Code of Federal Regulations (10 CFR 50.55a(g)(4)), ASME Code Class 1, 2, and 3 components (including supports) must meet the requirements, except design and access provisions and preservice examination requirements, set forth in Section XI of editions of the Code and addenda that become effective subsequent to the editions specified in paragraphs (g)(2) and (g)(3) of this section and that are incorporated by reference in paragraph (b) of this section, to the extent practical within the limitations of design, geometry, and materials of construction of the components.

The replacement steam generators for Calvert Cliffs are being designed and fabricated to the 1989 Edition, with no addenda, of the ASME Code. The licensee plans to install the steam generators in spring 2002 and spring 2003 for Units 1 and 2, respectively. Subarticle IWA-4120(a) to Section XI of the Code states that "repairs shall be performed in accordance with the Owner's Design Specification and the original Construction Code of the component or system. Later editions and addenda of the Construction Code or of Section III, either in their entirety or portions thereof, and code cases may be used."

Pursuant to 10 CFR 50.55a(a)(3) proposed alternatives to the requirements of paragraphs (c), (d), (e), (1), (g), and (h) of 50.55a or portions thereof may be used when authorized by the NRC. The applicant shall demonstrate that: (i) the proposed alternatives would provide an acceptable level of quality and safety, or (ii) compliance with the specified requirements of 50.55a would result in hardship or unusual difficulty without a compensating increase in the level of quality and safety.

## 2.2 Code Case N-20-4

### 2.2.1 Code Requirement

Subsection NB-2121, "Permitted Material Specifications," to ASME Section III, states, in part, that pressure retaining material and material welded thereto shall conform to the requirements of one of the specifications for material given in Tables I-1.0 of the Mandatory Appendices.

### 2.2.2 Request for Relief

The licensee has stated that the Calvert Cliffs replacement steam generators will utilize alloy 690 tubing material complying with ASME Section II, SB-163, nickel-chromium-iron alloy seamless tubing, Type Designation UNS N06690. The licensee stated that this alloy material has been approved by ASME through Code Case N-20-4. Thus, the licensee requested to use this code case.

### 2.2.3 Licensee's Basis for Relief

The licensee stated that the alloy 690 tubing material has been previously approved by ASME in Code Case N-20-3. Also, Code Case N-20-3 was accepted by the NRC staff for use in the construction of components in Regulatory Guide (RG) 1.85, Revision 31, dated May 1999, "Materials Code Case Acceptability ASME Section III, Division 1."

The licensee indicated that Code Case N-20-4 corrected the values for yield and ultimate tensile strength previously reported in Code Case N-20-3. At the time of issuance of Code Case N-20-3, the properties for alloys 600 and 690 were assumed to be similar. However, further industry experience, it was determined that a difference existed in their material properties. For alloy 690, the yield strength decreased with temperature at a slightly higher rate than for alloy 600. The tensile strength for alloy 690 shows higher values at lower temperature and lower values at higher temperatures than reported in Code Case N-20-3. The licensee considers the use of Code Case N-20-4 to be conservative since the relevant design analyses will be performed using the more accurate values for material strength.

## 2.3 Code Cases 2142-1 and 2143-1

### 2.3.1 Code Requirement

Subparagraph NB-2539.2 of Section III of the Code states that "the welding procedure and welders or welding operators shall be qualified in accordance with NB-4000 and Section IX." Subparagraph QW-200.1 (c) of Section IX of the Code states that changes in essential or supplementary essential variables require requalification of the welding procedure specification. Essential variables for the different welding techniques are outlined in Paragraphs QW-250 through QW-280. These paragraphs identify the F-number as an essential variable. In Paragraph QW-432, welding rods and electrodes with similar chemistries and usability characteristics are grouped together and assigned an F-number.

### 2.3.2 Request for Relief

In a letter dated December 1, 1999, the licensee requested authorization to use Code Cases 2142-1 and 2143-1. These code cases are needed to classify weld material not listed in QW-432. The weld materials have chemistries similar to the chemistries of the alloy 690 material to be welded in the steam generators. The materials approved by these code cases are designated as UNS N0652 and UNS W86152.

### 2.3.3 Licensee's Basis for Relief

These code cases were approved by ASME on June 5, 1995, and reaffirmed on July 22, 1998. The code cases classified the weld material as F-No. 43 for both weld procedures specifications and performance qualification reports. The weld material has been designated as UNS W86152 for the shielded metal arc welding electrode for alloy 690 and UNS N06052 for the companion bare wire electrode. The weld materials have been shown in an Electric Power Research Institute (EPRI) study to provide superior corrosion resistant weldments for applications with alloy 690 material.

## 3.0 EVALUATION

As stated, the licensee is using alloy 690 in its fabrication of the replacement steam generators. Alloy 690 was chosen for this application because of its improved resistance to intergranular stress corrosion cracking (IGSCC) and general corrosion in a simulated reactor environment.

The current steam generators were fabricated with alloy 600 tubing. In a study by the EPRI Report NP-5882M, "Stress Corrosion Cracking Resistance of Alloy 600 and 690 and Compatible Weld Metals in BWRs," these alloys were evaluated for corrosion susceptibility. The results showed that the alloy 690 weld metals were more resistant to IGSCC as well as general corrosion in pure water than alloy 600. Another study, "Corrosion Testing of Inconel Alloy for PWR Steam Generators," by J. R. Crum and R. C. Scarberry, in the Journal of Materials for Energy Systems, Vol. 4., No. 3., December 1982, drew conclusions similar to the EPRI report. Not considered in either study was the effect 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 that the effects from heat-to-heat variations would be minimal.

### 3.1 Code Case N-20-4

Alloy 690 is the material of choice in place of alloy 600 for newly fabricated steam generators. This choice is the result of numerous laboratory studies that show alloy 690 has little or no susceptibility to IGSCC in environments that simulate pressurized-water reactor and boiling-water reactor plant conditions. Licensees for domestic facilities have used alloy 690 in the fabrication of replacement steam generators since 1989. Industry experience to date continues to support the use of this material as an enhancement over alloy 600. The NRC approved the use of alloy 690 tubing by incorporating the code case into RG 1.85, "Materials Code Case Acceptability ASME Section III, Division 1." The latest revision of RG 1.85, Revision 31, dated May 1999, approves the use of Code Case N-20-3.

Code Case N-20-4 differs from N-20-3 in a few minor ways. Code Case N-20-4 no longer includes a chemistry table for alloy 690 nor does it include a "specified mechanical properties and size ranges" table. The staff finds this acceptable because Code Case N-20-4 references material specification SB-163, "Specification for Seamless Nickel and Nickel Alloy Condenser and Heat-Exchanger Tubes," and the material specification contains this information. Code Case N-20-4 added a table containing tensile strength values at various temperatures. The staff finds this acceptable because this provides additional useful information relevant to steam generator design. Lastly, Code Case N-20-4 revised the design stress intensity values and yield strength values for alloy 690. These revisions resulted from increased industry experience with alloy 690 tubing. According to the licensee, industry experience at the time N-20-3 was issued was limited primarily to alloy 600. Because of the similarity of the materials, it was assumed that the mechanical properties would be similar. As industry experience with alloy 690 grew, it was determined that a consistent difference exists in the mechanical properties between alloy 600 and alloy 690. Alloy 690 has a yield strength approximately 10 percent lower than alloy 600 and a tensile strength less than 10 percent lower. ASME subsequently issued N-20-4 to accurately reflect the alloy 690 mechanical properties. The staff finds the revised stress intensity values and yield strength values acceptable because they reflect more accurate material property information. In addition, the revised values are lower and thus more conservative than those provided in the previous code case.

In summary, the staff concludes that Code Case N-20-4 is acceptable. Code Case N-20-4 provides the same general requirements as Code Case N-20-3 which was approved by the staff in RG 1.85, Revision 31. Code Case N-20-4 provides updated mechanical property information about alloy 690 tubing that is conservative relative to the previously approved revision.

### 3.2 Code Cases 2142-1 and 2143-1

Weld filler materials that are similar to alloy 690 were approved by the Code on June 5, 1995, in Code Cases 2142-1 and 2143-1. These code cases were reaffirmed July 22, 1998. The code cases established the F-No. 43 for the specified weld filler material under nickel-base alloys. By allowing the licensee to use Code Cases 2142-1 and 2143-1, the staff is affirming the Code designation of F-No. 43. Affirming this Code designation for Code Cases 2142-1 and 2143-1 permits the specified filler weld material to be used in previously qualified weld procedures, thus eliminating the need for creating new procedures and performance qualifications. Since the specified filler weld materials are similar in their welding characteristics to many other Code

nickel base filler weld materials and have metallurgical properties similar to the base metals, the staff has concluded that separate procedure and performance qualifications for these materials are not warranted. The use of previously qualified procedure and performance standards for welding with the filler weld metals described in Code Cases 2142-1 and 2143-1 will provide an acceptable level of quality and safety.

#### 4.0 CONCLUSION

The staff concludes that ASME Section III Code Case N-20-4 and Section IX Code Cases 2142-1 and 2143-1 provide an acceptable level of quality and safety. Pursuant to 10 CFR 50.55a(a)(3)(i), the licensee is authorized to employ these Code Cases for the replacement steam generators at Calvert Cliffs. The use of Code Cases N-20-4, 2142-1, and 2143-1 are authorized until the code cases are approved by reference in RG 1.85. At that time, if the licensee intends to continue to implement one or more of these code cases, the licensee is to follow all provisions in the applicable code case with limitations issued in RG 1.85, if any.

Principal Contributor: P. Milano

Date: February 29, 2000