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SUBJECT: Forwards description of lead test assembly burnup for NRC info.

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102-03374-WLS/SAB/JRP
May 24, 1995

U. S. Nuclear Regulatory Commission
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References: 1. Letter 102-02730, dated November 19, 1993, "Fuel Rod Transfer," from W. F. Conway, Executive Vice President - Nuclear, APS, to USNRC

2. Letter dated June 22, 1992, from A. C. Thadani, USNRC, to A. E. Scherer, Combustion Engineering Inc., "Generic Approval of C-E Topical Report CEN-386-P, Verification of the Acceptability of a 1-Pin Burnup Limit of 60 MWD/kg for Combustion Engineering 16 x 16 PWR Fuel"

Dear Sirs:

**Subject:** **Palo Verde Nuclear Generating Station (PVNGS)**
**Unit 1**
**Docket No. STN 50-528**
**Lead Test Assembly Burnup**

Arizona Public Service Company (APS) and ABB Combustion Engineering Inc. have been collaborating in an ongoing fuel performance program at PVNGS. This program is designed to help APS achieve higher fuel rod burnups by evaluating the oxide film thickness of standard and improved fuel rod cladding compositions that have been subject to reactor coolant temperatures and water chemistry at PVNGS. A discussion of this fuel performance program was previously submitted to the NRC by Reference 1. The plant specific data will ultimately be used to support efforts to achieve the economic benefits of higher burnup fuel cycles consistent with the generic NRC approval for higher burnups described in Reference 2.

As part of the fuel performance program, fifteen Batch D fuel rods, fabricated with several Zircaloy-4 variants, were initially irradiated in lead test assembly P1D001 for three cycles (cycles 2, 3, and 4). The average burnups of these fifteen rods ranged from 45,000 to 51,000 megawatt-days per metric ton of uranium (MWd/MTU) at the end of cycle 4 (EOC-4). During the EOC-4 refueling outage, these fifteen rods were transferred into a Batch E lead test assembly (assembly P1E001) for additional exposure in cycles 5 and 6. The purpose of the continued irradiation is to demonstrate acceptable corrosion



A001

resistance of ABB Combustion Engineering Nuclear Fuel (CENF) low-tin Zircaloy-4 fuel rod cladding. The fifteen Batch D fuel rods achieved less than 60,000 MWd/MTU average burnup at EOC-5. Eleven of the fifteen Batch D fuel rods have been loaded with the Cycle 6 core and are expected to accumulate average burnups up to 69,000 MWd/MTU at EOC-6. Four of the rods were replaced in order to obtain burnup data on rods with minor variations in fabrication characteristics. The burnup for the fifteen rods is greater than the 52,000 MWd/MTU described in Section 4.3.1.1 of the PVNGS Updated Final Safety Analysis Report. However, safety and design analyses have shown that the performance of the subject fuel rods is non-limiting and is bounded by the results of the Unit 1 Cycle 6 safety analysis. This lead test assembly has been evaluated as part of the Unit 1 Cycle 6 reload using NRC approved methodologies, with predicted performance bounded by the safety analysis results. In accordance with 10 CFR 50.59, no unreviewed safety question is involved.

This letter is being provided to the NRC for information. Enclosed is a description of the lead test assembly burnup. Should you have any questions, please contact Scott A. Bauer of my staff at (602) 393-5978.

Sincerely,

WLS/SAB/JRP/rv

Enclosure

cc: L. J. Callan
K. E. Perkins
B. E. Holian
K. E. Johnston

ENCLOSURE

LEAD TEST ASSEMBLY BURNUP

## Lead Test Assembly Burnup

Fifteen Batch D fuel rods, fabricated using Zircaloy-4 cladding with tin content in the lower range of the ASTM specification for Zircaloy-4, were initially irradiated in fuel assembly P1D001 for three cycles (cycles 2, 3, and 4). The average burnup of these fifteen rods ranged from 45,000 to 51,000 MWd/MTU at EOC-4. During the EOC-4 refueling outage, these fifteen rods were transferred into a Batch E lead test assembly (P1E001) for additional exposure in cycles 5 and 6. During the EOC-5 refueling outage, four of the fifteen Batch D rods that resided in lead test assembly P1E001 were replaced by similar low-tin clad fuel rods with lower average burnup. These replacement rods from assembly P1D002, were irradiated in Cycles 2, 3, and 4, but were not irradiated in Cycle 5. The primary reason for the four replacement rods is to expand the data base of fuel rods with certain minor variations in fabrication characteristics that show improved corrosion resistance. The four replacement rods will attain rod average burnup greater than 55,000 MWd/MTU but less than 58,000 MWd/MTU in Cycle 6. The fifteen fuel rods in the lead test assembly are part of a continuing program to demonstrate improved corrosion resistance of fuel rod cladding in the Palo Verde reactors and are a subset of pre-characterized Batch D rods fabricated using cladding material with varying chemical compositions and fabrication histories.

The fifteen rods being loaded in the Cycle 6 core were visually examined and oxide thickness was measured during the EOC-5 refueling outage. The maximum oxide thickness for each rod was determined and compared to the maximum oxide thickness permissible for continued operation in Cycle 6. The overall length of each rod was determined and compared to the maximum permissible length for continued operation in Cycle 6. Calculations have been performed to determine a maximum permissible, circumferentially averaged oxide thickness (standard convention for defining maximum oxide thickness) and maximum permissible rod length for each of the Batch D test rods at EOC-5. These maximum permissible values were used as a benchmark to determine suitability of the fuel rod cladding in Cycle 6 where eleven of the fifteen Batch D fuel rods are expected to accumulate rod average burnups up to 69,000 MWd/MTU. The maximum permissible oxide thickness at EOC-5 was determined to ensure that the End-of-Life (EOL) thickness of each rod would not exceed 120 microns. The maximum permissible fuel rod length at EOC-5 was determined to ensure that adequate shoulder gap exists for each rod and no contact will occur between the top of the rod and the bottom of the flow plate during Cycle 6.

The mechanical performance of the cladding, considering allowable cladding stresses, strains, fatigue, and cladding collapse, was evaluated and found to be acceptable and, with the exception of average burnup, within design limits. Furthermore, an analysis of shoulder gap shows acceptable margin for operation through Cycle 6. A fuel performance calculation shows that predicted results for fuel rod internal pressures, fuel temperatures, and power to fuel centerline melting for the fifteen test assembly rods are bounded by the results calculated for the rest of the core. LOCA and non-LOCA transient results remain bounding and applicable for the fifteen test assembly rods.