Docket File

March 14, 1973

R. C. DeYoung, Assistant Director for Pressurized Water Reactors, L

OCONEE NUCLEAR STATION, UNIT 1, DOCKET NO. 50-269, FUEL DENSIFICATION

We are reviewing the subject plant with regard to the effects of fuel densification. Our review to date has considered the technical information provided in B&W reports BAW-10054 (B&W topical on fuel densification) and BAW-1837 (Oconee 1 fuel densification) that were transmitted by the applicant's letter of January 12, 1973. The intent of our review is to establish a model for analysis of fuel densification suitable for application to B&W designed plants in general as well as for the review of the Oconee Unit 1 plant. We are using the staff's densification report of November 14, 1972, as a basis for our review.

Technical meetings on this subject were held with B&W on January 31, 1973, in Bethesda and on March 1 and 2, 1973 in Lynchburg, Virginia. The applicant was represented at the meetings. As a result of these meetings and our review of relevant documents listed above, we have established that additional information is required as listed in the enclosure. The applicant should be requested to provide this information by April 13, 1973. In most cases these questions and draft answers have already been considered.

/S/

Victor Stello, Jr., Assistant Director
for Reactor Safety
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1. Provide the values for the following physical properties and dimensions of the Oconee Unit 1 fuel pins:

a. fuel pellet length, diameter, dished end volume and chamfer volume

b. fuel pellet density

c. clad inside and outside diameter, initial ovality, and wall thickness.

For each of these parameters, provide the nominal value, the specified value and tolerances, and the average value (as built) with standard deviation as well as maximum and minimum measured values.

Describe the method of measuring that was used, the frequency of measuring samples, and the production step at which the measurements are performed in the production process of the fuel assembly. If any of these parameters is measured at different times in the production process, e.g., at the fuel pellet manufacturer and at B&W, with identical or different measuring techniques compare the results and discuss any differences.

2. In order to assess the B&W evaluation model, TAFY, for stored energy, fuel pellet to clad gap conductance, and clad temperature of a fuel pin for Oconee Unit 1, a detailed description of the following items is required. Where applicable, equations and empirical formulations should be provided.

a. The amount and composition of the sorbed gases assumed to be present in the fuel including the analytical methods used to describe the release rate of the sorbed gases.

b. The amount and content of the gas in the gap between fuel pellet and clad.

c. Description of the gas mixture conductivity model for the gas in the fuel pellet-clad gap, and the thermal expansion model for the fuel pellet and the clad. Discuss how the fuel cracking is treated.

d. A listing of input values used for the TAFY code, including fuel and clad surface roughness and the fuel pin plenum volume.

e. A listing of the following parameters calculated with TAFY: hot gap size, fuel pellet diameter, conductivity of gas mixture, temperature jump distance, gap conductance and the contribution of each of the additive terms in the gap conductance. The information should be provided as a function of linear heat generation rate (kw/ft) and as a function of fuel burnup.

f. A comparison of TAFY calculated gap conductance (see item e) with app.icable fuel performance data.

3. Provide additional information on the fuel cladding creep tests that were performed in the BAWTR and that form the basis for the B&W clad creep model, CRECOL, which is used to calculate the expected collapse time for the Oconee Unit 1 fuel cladding. The requested information should include:

a. Physical properties of samples including yield stress, Young's modulus, Poisson's ratio and cold work.

b. Physical dimensions of samples including measured outside diameter, ovality, and thickness.

c. Three profilometer measurements of the pellet diameter (one typical and two extremes).

4. In order to assess the B&W collapse model, CRECOL, that is used to calculate expected collapse time for the fuel pins in Oconee Unit 1, the following additional information is required:

a. The equation used to calculate collapse ovality and a justification for not using the creeprate of irradiated fuel in that calculation.

b. A detailed description and justification for the extrapolation of BAWTR test data to the collapse time by use of the Larson Miller Parameter (LMP) including specific literature references to this method of extrapolation.

c. A justification for not including in the cladding stress analysis such axial forces as caused by pellet hangup, rod interference on the grid plates, and rod bending at the spacer grids.

d. A comparison of CRECOL calculated critical ovality and collapse time with experimental clad performance data.

e. A discussion of how flow induced fuel pin vibrations could affect the fuel pin collapse time.

f. A discussion of the clad temperature used in the CRECOL calculation.

g. A comparison of the B&W CRECOL code and the CRECOL code described in USAEC Report GAMD 9623, GGA, 1969. The comparison should identify any changes made to result in the present B&W version.

5. In order to perform an independent staff evaluation of the clad integrity for Oconee Unit 1, the following information is requested:

a. Detailed discussion of the 0.9 value for the usage factor and of the damage catagories included in the analysis.

b. Collapse time calculated with CRECOL with a comparison to one cycle and three cycle operating times.

c. A list of operating conditions and physical properties including:

    maximum operating time
    maximum external fuel pin pressure
    clad temperature
    clad outside diameter
    clad thickness
    initial ovality
    yield stress vs temperature and fast flux
    elastic modulus vs temperature
    Poisson ratio vs temperature
    internal fuel pin pressure vs time
    fast flux

d. Discussion of the assumptions for the internal fuel pin pressure vs time, including the cold and hot BOL pressure with and without fuel densification.

6. In order to assess the B&W evaluation of transients and accidents, provide a complete and consistent set of design values and operating parameters for conditions with and without fuel densification. Where applicable, appropriate information in the Final Safety Evaluation Report, FSAR, for Oconee Unit 1 should be referenced. The information requested should include:

   a. core wide radial power map
   b. radial local peak for hot assembly
   c. axial flux shape
   d. local flux distribution in hot assembly
   e. mass inlet velocity to hot assembly (with and without one vent valve assumed open)
   f. loss coefficients for spacer grids and upper and lower end fittings.

7. Provide an analysis of the (1) loss of flow transient and (2) Locked rotor accident for Oconee Unit 1 without and with the assumption of densified fuel. The information provided should include the following:

   a. nuclear power decay
   b. core coolant flow decay
   c. core inlet pressure
   d. DNBR vs time
   e. peak clad temperature vs time
   f. peak fuel centerline temperature vs time
   g. average heat flux vs time
   h. gap conductance vs time
   i. clad to coolant heat transfer coefficient

8. Provide the technical bases and supporting analyses for your conclusion that the 8.55 ft^2 split break would remain the worst break for a loss of coolant accident within the break spectrum considering the effects of fuel densification. For the worst break size provide curves showing:

a. Hot rod axial flux distribution for the steady state condition

b. Maximum clad temperature and local hot rod heat transfer coefficient as a function of time

c. Hot channel flowrate as a function of time.

9. Provide details of the assumptions and justification for establishing the design transient 100% - 30% - 100% power as the limiting transient. Discuss the axial xenon oscillations that are included in the design transient analysis.

10. Discuss, in detail, and justify how the effects of fuel densification are included in the rod ejection accident analysis and compare this analysis to the one in the FSAR without fuel densification. In particular, for full power cases, provide the initial peaking factors and their relationship to the power spike model and to design limits in the Technical Specifications for Oconee Unit 1. Describe how the initial pellet density variation has been accounted for if other than by a 2σ variation on heat flux and gap increase. Provide the peak fuel temperature (average and centerline) and clad temperature as a function of time during the accident. Indicate the number of fuel rods that experience DNB and will fail during the course of the accident.