July 1, 2009

Mr. James A. Gresham, Manager
Regulatory Compliance and Plant Licensing
Westinghouse Electric Company
P.O. Box 355
Pittsburgh, PA 15230-0355

SUBJECT: WESTINGHOUSE ELECTRIC COMPANY REQUEST FOR ADDITIONAL INFORMATION RE: TOPICAL REPORT WCAP-16498-P "17 x 17 NEXT GENERATION FUEL REFERENCE CORE REPORT" (TAC NO. MD8540)

Dear Mr. Gresham:

By letter dated April 3, 2008 (Agencywide Documents Access and Management System Accession No. ML081010602), Westinghouse Electric Company (Westinghouse) submitted for U.S. Nuclear Regulatory Commission (NRC) staff review Topical Report (TR) WCAP-16498-P entitled "17 x 17 Next Generation Fuel (17x17 NGF [Next Generation Fuel]) Reference Core Report". Upon review of the information provided, the NRC staff has determined that a Request for Additional Information (RAI) is needed to complete the review. On June 22, 2009, Mr. William Slagel, Westinghouse Licensing Engineer, and I agreed that the NRC staff should receive your responses to the enclosed RAI questions by August 28, 2009. If you have any questions regarding the enclosed RAI questions, please contact me at 301-415-1970.

Sincerely,

/RA/

George C. Bacuta, Project Manager
Special Projects Branch
Division of Policy and Rulemaking
Office of Nuclear Reactor Regulation

Project No. 700

Enclosure:
RAI questions

cc w/encl: Anthony Nowinowski, Manager

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REQUEST FOR ADDITIONAL INFORMATION

BY THE OFFICE OF NUCLEAR REACTOR REGULATION FOR

WESTINGHOUSE ELECTRIC COMPANY TOPICAL REPORT

WCAP-16498-P "17 x 17 NEXT GENERATION FUEL REFERENCE CORE REPORT"

TAC NO. MD8540

WESTINGHOUSE ELECTRIC COMPANY (WESTINGHOUSE)

PROJECT NO. 700

PART 1

Westinghouse states that the 17X17 Next Generation Fuel (NGF) design results in very small differences in nuclear design characteristics compared to those of the 17X17 Robust Fuel Assembly (RFA) fuel design. This statement only makes sense in the context of two reference cores, wherein only the fuel assembly designs differ. The following Request for Additional Information (RAI) request a one-to-one comparison between methodologies, computer codes and specific performance characteristics as they relate to the fuel performance analysis of 17X17 RFA and 17X17 NGF fuel designs described in Table 2-1 in WCAP–16498–P *in the context of the same reference core*.

RAI-1: Core Nuclear Design

In the analyses of the neutronic performance of the two designs, (i.e. 17X17 RFA vs. 17X17 NGF) what is used for the following analyses. If they differ between the two designs, describe the differences and their consequences.

Cross section generation:

1. What were the basic cross section data? (For example, ENDF/B – Version?) If they differ what are the key isotopes that introduce differences in the results?

2. Were the same cell codes and homogenization techniques used for the two designs?

3. What and how were the assembly design differences taken in account in the generation of the cross sections?

Neutrionic analysis:

1. Westinghouse states the differences in the nuclear design characteristics between the two assembly designs are very small. What is the reference core which allows you to come to that conclusion? How is small defined?

2. What neutronic codes were used for steady-state, transient and burnup neutronic analyses to generate the required input for fuel performance and system accident analyses?

3. Compare the axial nodal mesh in the neutronic analysis of the two assemblies? How does it relate to Span # in Fig. 2-1 of the Topical Report (TR)?

4. What are the material volume fractions within each axial node? How is the difference in the structural material between the two designs taken into account?

5. What are the limiting power peaking factors: Core - axial and total, Peak assembly - axial and total? Do these peaking factors occur in the same assembly at the same fuel pin in the reference core for the two designs? When in the residence time of the assembly do they occur?

6. What are the peak and average discharge burnups? Do they occur in the same assembly and fuel pin?

7. What is the beginning of life (BOL), end of life (EOL) and limiting moderator coefficient for each design?

8. What is the BOL, EOL and limiting rod worth for N-1 shutdown (i.e. stuck rod) for each design?

RAI-2: Fuel Assembly Thermal-Hydraulic Design

1. Briefly describe the thermal-hydraulic codes, methods that based on the neutronic analyses outputs are used to compute the necessary inputs for the fuel assembly and fuel pin mechanical performance analyses.

2. Compare the axial ΔP distribution in the peak channel for the two designs in steady-state operation.

3. Compare the axial peak cladding temperature distribution of the peak pins in the cores in steady state operation. Are they the same pin in the two cores?

4. Compare the peak sub-channel axial coolant temperature distributions in steady state operation.

5. What are the maximum net upward forces on the fuel assemblies due to axial flow at steady state operation?

6. What is the figure of merit for assessing the margin to the density wave instability? What are the thermal-hydraulic variables that are used to compute this figure of merit? Which one is the dominant contributor to this particular analysis? What are the values of this figure of merit in the case of the two cores under consideration?

7. What is the limiting predicted channel closure due to rod bowing for the two cores in steady state? What is the estimate for the limiting transient?

RAI-3: Fuel Assembly Mechanical Design

Fuel assembly growth:

1. Describe the codes that compute the required axial clearance between the core plates and nozzle end plates that are used to demonstrate sufficient margin for fuel assembly and fuel pin growth to design burnup in steady state operation. What physical phenomena are taken into account in computing growth? What is the dominant phenomenon in steady state operation?

2. At what point in the residence time of the fuel are the transient contributions computed? Why are they limiting at that point? What is the dominant phenomenon that contributes to axial growth during the transient at this point in the residence time?

Fuel assembly hydraulic stability:

1. The basis for demonstrating that fuel rod wear due to contact with mid-grids and IFM- grids is well within the Westinghouse guideline for limiting wear is demonstrated by flow tests at the VIPER Loop and at the FACTS Loop. Are the test assemblies at each loop BOL assemblies. If so, how are the radiation and the variation in the thermal-hydraulic environment taken into account. If some or all are neglected, what is the rational and how does this still justify the claim that the test represents the limiting conditions?

2. What are the margins to the Westinghouse guideline value for the two cores?

Fuel assembly structural integrity, and shipping and handling loads:

1. What are the Westinghouse figures of merit with regard to seismic and loss-of-coolant accident (LOCA) loads in the case of fuel assembly structural integrity loads, and to what fuel assembly components are they applied?

2. Are the margins determined purely by testing; or are some based on computation?

3. What are the margins for each core?

4. Are the radiation history and the evolution of the thermal-hydraulic environment taken into account in the test and analysis results?

Structural components:

For the structural components listed in section 2.4 of the TR:

1. What are the Westinghouse figures of merit with regard to each component?

2. Are the margins determined purely by testing; or are some based on computation?

3. What are the margins for each core?

4. Are the radiation history and the evolution of the thermal-hydraulic environment taken into account in the test and analysis results?

RAI-4: Lead Test Assembly Program

1. What is measured and what are Westinghouse's limits on these measured values? How do you arrive at the limits for EOL conditions and those for inspections before EOL?

2. What is the physical basis for the limiting values, in particular how do you account for the time-dependent irradiation and temperature environment of the fuel assembly in computing the margin?

3. How do you assess the uncertainty in the figures of merit that are compared to the limits?

4. Are the lead test fuel assemblies periodically disassembled for inspection and measurement and reconstituted for further irradiation?

5. For the test fuel how do you quantify gas pressure and fuel-cladding mechanical interaction? How do you determine the uncertainty in these quantities?

PART 2

RAI-1: Provide the Fuel Rod Design Calc Note.

RAI-2: Provide the Thermal-Hydraulic Design Calc Note.

RAI-3: Provide the Core Design Calc Note.

RAI-4: Fill in the following table for 17x17 NGF Fuel providing the appropriate units (sample units are given).

Rod Size		(units)
Outer Diameter		in
Inner Diameter		in
Pellet Diameter		in
Stack Length		in
Plenum Length		in
Spring Dimensions		

spring outer diameter		in
spring wire diameter		in
number of spring turns		
Pellet Shape		
Pellet Height		in
Central Hole Radius		in
Dish Radius		in
Dish Depth		in
Pellet Isotopics		
Fuel U-235 Enrichment		%
Gadolinia content		wt fraction
water in pellet		ppm
nitrogen in pellet		ppm
percent IFBA rods in core		%
Boron-10 enrichment in ZrB_2		atom%
ZrB_2 layer thickness		in
Density of ZrB_2		% T.D.
Pellet Fabrication		
pellet density		%
open porosity		%
pellet surface roughness		in
expected density increase		g/cm^3
sintering temperature		°F
Cladding Fabrication		
Cladding type		
Cladding cold work		
Cladding surface roughness		in
cladding texture factor		
Hydrogen in cladding		ppm
Rod Fill Conditions		
Fill gas pressure		psi
Fill Gas		
Reactor Conditions		
rod pitch		in
Coolant Conditions		
coolant pressure		psi
coolant inlet temperature		°F
coolant mass flux		$lb/hr\text{-}ft^2$

Cladding cold work – Cold-work of the cladding (fractional reduction in cross-section area due to processing).

Cladding texture factor – defined as the fraction of cladding cells with basal poles parallel to the longitudinal axis of the cladding tube.

1. The above table will be used to generate the FRAPCON input deck. Currently, FRAPCON does not have Optimized-ZIRLO as a 'cladding type'. Therefore, discuss any differences between ZIRLO and Optimized-ZIRLO for any relevant input parameters (such as 'Cladding cold work').

2. Provide the Radial Fall Off Curve as well as the associated axial power distributions.

3. Provide the Radial Fall Off Curve for 5 peak rods as well as the associated axial power distributions.

4. What is the crud deposition rate?

5. What is the initial crud thickness?