Public Service
Electric and Gas
Company

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United States Nuclear Regulatory Commission
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Washington, DC 20555

Gentlemen:

REQUEST FOR APPROVAL OF INCORPORATION OF WRB-2 CHF CORRELATION INTO THE SALEM LICENSING BASIS
SALEM GENERATING STATION UNITS NOS. 1 AND 2
FACILITY OPERATING LICENSES DPR-70 AND DPR-75
DOCKET NOS. 50-272 AND 50-311

REF:

1. Letter from L. Storz (PSE&G) to NRC, "Request for Change to Technical Specifications Margin Recovery Program", LCR 94-41, May 10, 1996

2. WCAP-10444-P-A, Reference Core Report VANTAGE 5 Fuel Assembly, September 1985

3. PSE&G/NRC April 7, 1998, Meeting Regarding Fuel Design Changes, NRC Headquarters, Rockville Maryland.

The purpose of the attached submittal is to obtain NRC approval for the use of the Westinghouse WRB-2 Critical Heat Flux Correlation (CHF) for Salem Units 1 and 2. Application of the specific CHF correlation is dependent on the fuel design features incorporated with the reload batch. The WRB-2 correlation is required for fuel with the Intermediate Flow Mixing (IFM) grids. This feature has not yet been used at either Salem unit. Salem reloads currently use Westinghouse VANTAGE 5H (V5H) fuel, incorporating some VANTAGE+ and PERFORMANCE+ features, without IFM grids. The current licensed CHF correlation used for thermal-hydraulic analysis is WRB-1, which is not applicable for use with IFM grids. Public Service Electric and Gas (PSE&G) plans to load fuel with IFM grids into both Salem units starting with the next refueling for Salem Unit 2 (fuel fabrication scheduled for early September 1998).

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The analyses supporting the Salem Margin Recovery Program (MRP) license change submittal (Reference 1) were originally performed to support the use of IFM grids with

the WRB-2 CHF Correlation (Reference 2). Prior to the time that the MRP license change request was submitted, flow induced vibration fretting problems were occurring in VANTAGE 5H fuel assemblies. The fix, at that time, significantly reduced the potential DNBR margin gained with the V5H assembly with IFM grids. Thus, PSE&G decided to delay loading any reload cores containing IFMs, until this industry issue was resolved. As a result, the MRP submittal was modified to remove all descriptions of any analyses supporting IFMs and the WRB-2 correlation.

Recently, Westinghouse has developed an improved fuel product, which eliminates the flow induced vibration with no reduction in any DNBR margins. This fuel design referred to as the Robust Fuel Assembly (RFA), maintains most of the VANTAGE+/PERFORMANCE+ design features but incorporates a modified low pressure drop (LPD) grid and modified IFM grid along with a thicker guide thimble. These two design features concurrently address flow induced vibration (LPD and IFM grid modifications) and incomplete rod insertion in high burnup fuel (thicker guide thimble). The RFA has undergone a thorough test program, independent design reviews, and is currently operating.

PSE&G plans to use this design in the upcoming reload for Salem Unit 2. This reload batch will be the first Salem cycle to transition to the IFM grids. Use of the improved fuel design makes it necessary for Salem to incorporate the WRB-2 CHF correlation into its licensing basis.

As part of the discussion supporting this submittal, a description of the fuel design, to which WRB-2 is to be applied, is provided. The attachment demonstrates that WRB-2 is applicable to the fuel assembly PSE&G intends to load. Transition mixed core effects and impacts to the Chapter 15 accident analysis are briefly discussed, but are aspects considered as part of the normal reload design process, handled under 10CFR50.59.

Note that no changes to the current Technical Specifications will be required for either Salem unit assuming that an amendment is issued for Salem Unit 2 in response to LCR 94-41 (Reference 1).

These subjects were discussed at a meeting with your staff conducted on April 7, 1998, at the U. S. Nuclear Regulatory Commission (NRC) office in Rockville Maryland (Reference 3).

The next refueling outage for Salem Unit 2 is scheduled to start early in 1999. However, the fuel manufacturing schedule is set for mid-September 1998. In order to support this fuel manufacturing schedule, we request your approval by August 31, 1998.

This submittal contains no proprietary information.

Should you have any questions regarding this request, please contact us.

Sincerely,

E C Simpson

Attachment

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ATTACHMENT

Request for NRC Approval for Incorporation of WRB-2 CHF Correlation into Salem Licensing Basis

Purpose

The purpose of this submittal is to obtain NRC approval for the use of the Westinghouse WRB-2 Critical Heat Flux Correlation (CHF) for Salem. Application of the specific CHF correlation is dependent on the fuel design features incorporated with the reload batch. The WRB-2 correlation is required for fuel with the Intermediate Flow Mixing (IFM) grids. This feature has not yet been utilized at either Salem unit. Salem reloads currently use Westinghouse VANTAGE 5H (V5H) fuel, incorporating some VANTAGE+ and PERFORMANCE+ features, without IFM grids. The current licensed CHF correlation used for thermal-hydraulic analysis is WRB-1, which is not applicable for use with IFM grids. PSE&G plans to load fuel with IFM grids starting with the next refueling for Salem Unit 2 (fuel fabrication scheduled for early September 1998).

A description of the fuel design, to which WRB-2 is to be applied, is provided in this submittal. The intent here is only to demonstrate that WRB-2 is applicable to the fuel assembly PSE&G intends to load. Transition mixed core effects and impacts to the Chapter 15 accident analysis are briefly discussed, but are aspects considered as part of the normal reload design process, handled under 10CFR50.59.

This submittal requires no changes to the current Technical Specifications for either Salem unit assuming that a Unit 2 amendment is issued in response to LCR 94-41 (Reference 1).

Introduction

The analyses supporting the Salem Margin Recovery Program (MRP) license change submittal (Reference 1) were originally performed to support the use of IFM grids with the WRB-2 CHF Correlation (Reference 2). Prior to the time that the MRP license change request was submitted, flow induced vibration fretting problems were occurring in VANTAGE 5H fuel assemblies. The fix, at that time, significantly reduced the potential DNBR margin gained with the V5H assembly with IFM grids. Thus, PSE&G decided to delay loading any reload cores containing IFMs, until this industry issue was resolved. As a result, the MRP submittal was modified to remove all descriptions of any analyses supporting IFMs and the WRB-2 correlation.

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Recently, Westinghouse has developed an improved fuel product, which eliminates the flow induced vibration with no reduction in any DNBR margins. This fuel design referred to as the "Robust Fuel Assembly" (RFA), maintains most of the VANTAGE+/PERFORMANCE+ design features but incorporates a modified low pressure drop (LPD) grid and modified IFM grid along with a thicker guide thimble (Reference 3). These two design features concurrently address flow induced vibration (LPD and IFM grid modifications) and incomplete rod insertion in high burnup fuel (thicker guide thimble). The RFA has undergone a thorough test program, independent design reviews, and is currently operating.

PSE&G plans to utilize this design in the upcoming reload for Salem Unit 2. This reload batch will be the first Salem cycle to transition to the IFM grids. Thus, it is necessary for Salem to incorporate the WRB-2 CHF correlation into its licensing basis. The generic application of the IFM grid design and WRB-2 was under WCAP-10444 (Reference 2) for the VANTAGE 5 (V5) assembly design with the later WCAP-10444 Addendum 2 (Reference 4) addressing the application to the VANTAGE 5H design.

The NRC's Safety Evaluation Report (SER) for the Salem V5H fuel change (Reference 5) was based on prior NRC approval of WCAP-10444-P-A and WCAP-10444-P-A Addendum 2. The SER to the VANTAGE 5 WCAP identified 13 conditions to be addressed for licensees using this fuel design. Note that a number of these conditions involve the V5 assembly in general and are not specifically related to IFMs or application of the WRB-2 CHF correlation. Those conditions that affected only the Salem V5H application were previously addressed in the Salem V5H SER.

At the time of the Salem V5H submittal, PSE&G did not consider the Intermediate Flow Mixing grid in the fuel assembly design configuration. Those sections of WCAP-10444-P-A covering IFMs and the WRB-2 Critical Heat Flux correlation were not applicable, hence were not addressed in the submittal nor in the SER. The Salem V5H submittal was, instead, the first application of the WRB-1 CHF correlation (Reference 6) for Salem fuel.

Therefore, this request to incorporate the WRB-2 CHF correlation will first address those conditions identified in the V5 fuel assembly SER which apply to WRB-2. This application of the WRB-2 correlation will not be for a V5 or V5H assembly with IFM grids, but for the Salem RFA. The second action is to address the applicability of the WRB-2 correlation to the new RFA design. The third and final action is to review the WRB-2 range of variables to ensure that use of this CHF correlation for the intended fuel changes (in conjunction with the margin recovery amendment changes) does not result in any variables falling outside the WRB-2 applicability range.

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Response to Prior VANTAGE 5 Fuel Assembly SER Conditions and Limitations

From WCAP-10444-P-A SER, 4 of the 13 conditions involve the DNBR design bases (numbers 4,5,7 and 9) and are addressed as follows:

4. "For those plants using ITDP, the restrictions enumerated in Section 4.1 of this report must be addressed and information regarding measurement uncertainty must be provided"

   Response:

   At the time V5H fuel was introduced, along with the WRB-1 correlation, ITDP was not used at Salem, therefore specific restrictions were not applicable. Subsequently, Revised Thermal Design Procedure (RTDP) was presented as part of the Margin Recovery Program submittal. As described in the SER (Reference 7) to the MRP (Salem Unit 1 only, Unit 2 amendment is to be issued at the time of the next refueling outage), the RTDP methodology and supporting instrument uncertainties were found to be acceptable for use at Salem.

   The instrument uncertainties incorporated with the approval of RTDP remain applicable with use of the RFA. The Overtemperature/Overpower ΔT trip setpoints were recalculated for the Margin Recovery license change request based on the most conservative core thermal limits. The most conservative core thermal limits were based in non-IFM grids using the RTDP safety limits. These core limits were used to bound mixed cores and full cores with the VANTAGE+ and PERFORMANCE+ fuel design features and are applicable and bounding with the intended RFA design features.

   The safety analysis DNBR limit is established as a function of the applicable CHF correlation and RTDP uncertainties. Impacts to the correlation limit or RTDP parameters are assessed, as described in the Salem Technical Specification Bases to Section 2.1.1, as part of the normal reload design and safety evaluation process. The Bases change made as part of the MRP remains applicable to the RFA design and reads as follows:

   > "The DNB design basis is as follows: uncertainties in the WRB-1 and WRB-2 correlations, plant operating parameters, nuclear and thermal parameters, fuel fabrication parameters, and computer codes are

considered statistically such that there is a 95 percent probability with a 95 percent confidence level that DNB will not occur on the most limiting fuel rod during Condition I and II events. This establishes a design DNBR value which must be met in plant safety analyses using values of input parameters without uncertainties."

5. "The WRB-2 correlation with a DNBR limit of 1.17 is acceptable for application to 17x17 VANTAGE 5 fuel. Additional data and analysis are required when applied to 14x14 or 15x15 fuel with an appropriate DNBR limit. The applicability range of WRB-2 is specified in Section 4.2"

Response:

As further described and approved in WCAP-10444-P-A, Addendum 2, the WRB series critical heat flux correlations with a 95/95 limit DNBR of 1.17 are appropriate for the VANTAGE 5H fuel assembly. Salem does not use, or plan to use 14x14 or 15x15 fuel designs. As described below, the WRB-2 correlation with a 95/95 limit DNBR of 1.17 is applicable to the proposed RFA design with IFMs.

As further described below, neither the changes implemented with the MRP (core thermal design flow and allowed Tavg range), nor the assembly geometry changes with the RFA will result in the use of the WRB-2 correlation outside the range of applicability for any correlation parameter.

7. "Plant specific analysis should be performed to show that the DNBR limit will not be violated with the higher value of $F\Delta H$."

Response:

As stated in the SER for the MRP, "The increase in the DNB margin gained through the RTDP with the WRB-1 correlation led to the request for the increase in the full power radial peaking factor $F\Delta H$, from 1.55 to 1.65." Those accidents affected by the increased peaking factors were reanalyzed as part of the MRP. As part of the MRP effort, accidents were also analyzed assuming implementation of IFM grids using the WRB-2 correlation (though for reasons stated earlier, these were not included with the submittal). In all cases, with the increased radial peaking factor, the resulting DNBR remained above the DNBR safety limit. Note that the radial peaking factor limit is one of the parameters assessed every reload as to impacts to the safety analyses of record.

9. "With regard to the RCS pump shaft seizure accident, the fuel failure criterion should be the 95/95 DNBR limit. The mechanistic method mentioned in WCAP-10444 is not acceptable."

Response:

This had been addressed in the V5H SER in which the fuel failure criteria was to be changed to the 95/95 DNBR limit. For the proposed fuel design change, this accident was reanalyzed with IFMs and remains bounded by the assumption of 5% of the rods going into DNB limit.

Section 3.3 of the SER for WCAP-10444-P-A, Addendum 2 contains the following additional limitation, "The WCAP-10444PA Addendum 2, provides an acceptable method for the application of the WCAP-10444PA information in the use of the VANTAGE 5H fuel assemblies in complete and transition core configurations. For transition cores, the transition core configuration penalty specified in WCAP-10444PA will apply for the estimation of the peak clad temperature in large break LOCA analyses".

Response:

Transition cores penalties are a function of the types of fuel assemblies in the core. The appropriate large break LOCA transition effects for a reload batch of the intended RFA with IFM grids will be assessed as part of the normal reload safety evaluation process. Any PCT penalty, if required, will be tracked and reported in accordance with 10CFR50.46 Section (a)(3)(i).

With respect to DNB performance, the additional grids will introduce localized flow redistribution from the RFA into the V5H assembly at axial zones near the IFM grid positions in a transition core. A bounding transition core penalty will be determined for each Salem transition cycle utilizing the RFA design with IFM grids and tracked relative to available DNBR margin as part of the reload safety evaluation process.

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Applicability of WRB-2 Correlation to Robust Fuel Assembly Design

The proposed RFA design utilizes the Modified 17x17 VANTAGE 5H Low Pressure Drop grid and Modified 17x17 V5H/IFM grid designs with a 0.482 inch outer diameter thimble and instrument tube. This design is identical to that recently utilized at Wolf Creek as described in previous transmittals to the NRC (References 3,8).

As previously documented, DNB testing performed on the Modified V5H/LPD and Modified V5H/IFM grids has demonstrated that WRB-2 provides a conservative prediction of the DNB performance of the modified design. The geometry for the slightly thicker guide thimble/instrument tube has been shown to be bracketed by the geometric parameter range of the WRB-2 correlation. The bracketing method of DNB correlation parameter range is described in the NRC approved Westinghouse FCEP topical report (Reference 9). Therefore, the 95/95 correlation limit of 1.17 remains applicable to the RFA design with IFM grids intended for Salem.

Assessment of Impacts of Margin Recovery Program and Proposed Fuel Design Changes on WRB-2 Range of Variables

For the V5H fuel assembly with IFMs (as described in WCAP-10444-P-A, Addendum 2), the WRB-2 correlation with a 95/95 limit DNBR of 1.17 is acceptable with the following range of applicability:

	WRB-2 Range	Salem RFA
Pressure	$1440 \leq P \leq 2490$ psia	Verified on a reload basis
Local Mass Velocity	$0.9 \leq G_{loc}/10^6 \leq 3.7$ lb/ft^{2}hr	Verified on a reload basis
Local Quality	$-0.1 \leq X_{loc} \leq 0.3$	Verified on a reload basis
Heated Length	$L_h \leq 14$ feet	≤ 12 feet
Grid Spacing	$10 \leq g_{sp} \leq 26$ inches	10 to 20.55 inches
Equivalent Hydraulic Diameter	$0.37 \leq d_e \leq 0.51$ inches	Typical and Thimble cell range 0.37 to 0.46 inches
Equivalent Heated Hydraulic Diameter	$0.46 \leq d_h \leq 0.59$ inches	Typical and Thimble cell range 0.46 to 0.54 inches

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The variables describing the local fluid conditions (pressure, local mass velocity and local quality) are functions of the core nominal coolant conditions and thermal hydraulic design parameters, thus are reload dependent. As such, these variables are verified for every reload design to ensure the CHF correlation is being used within the applicable range.

The remaining correlation variables are a function of the fuel design parameters only. The proposed RFA has the same 12 foot active fuel region as the current V5H design, thus is bounded by the correlation's heated length range. The grid spacing parameter for WRB-2 specifically considered the IFM on a V5 assembly, with 10 inch spacing (IFM to LPD grid). The axial grid spacing is identical on the RFA, thus remains applicable to the correlation. RFA design changes to the V5H LPD grid and guide thimble/instrument tube remain bracketed by the remaining WRB-2 correlation parameters for hydraulic and heated diameters.

Conclusions

1) The application of WRB-2 Critical Heat Flux correlation to the Salem Robust Fuel Assembly design with IFM grids can be implemented with no changes to the current Technical Specifications.

2) The Westinghouse Fuel Criteria Evaluation Process has been used to demonstrate that the WRB-2 correlation with a limit of 1.17 can be conservatively applied to the Robust Fuel Assembly with IFM design for Salem.

3) Transition core effects and safety analysis impact assessment will be performed as part of the normal reload design and safety evaluation process under 10CFR50.59.

4) There are no outstanding issues with respect to the original conditions identified for WRB-2 as part of the V5 and V5H Fuel Assesmbly Safety Evaluation Reports.

5) Necessary UFSAR changes with respect to Chapters 4 and 15, as a result of incorporation of the WRB-2 correlation will be performed under 10CFR50.59 upon approval of this submittal.

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Requested Schedule for Review and Approval

The next refueling outage for Salem Unit 2 is scheduled to start early in 1999. However, the fuel manufacturing schedule is set for mid-September 1998. PSE&G is requesting that the NRC's review be completed prior to the start of fuel fabrication.

References

1. Letter from L. Storz (PSE&G) to NRC, "Request for Change to Technical Specifications Margin Recovery Program", LCR 94-41, May 10, 1996

2. WCAP-10444-P-A, Reference Core Report VANTAGE 5 Fuel Assembly, September 1985

3. Letter from N. J. Liparulo (Westinghouse) to J. E. Lyons (NRC),"Transmittal of Response to NRC Request for Information on Wolf Creek Fuel Design Modifications", NSD-NRC-97-5189, dated June 30, 1997

4. WCAP-10444-P-A Addendum 2, VANTAGE 5H Fuel Assembly, April 1988

5. J. Stone (NRC) to S. Miltenberger (PSE&G), "Use of VANTAGE 5 Hybrid Fuel (TAC NOS. 71836/71837)", Amendment Nos. 96 and 72, May 1989

6. WCAP-8762-P-A, New Westinghouse Correlation WRB-1 for Predicting Critical Heat Flux in Rod Bundles with Mixing Vane Grids, July 1984

7. Letter from L. Olshan (NRC) to L. Eliason (PSE&G), "Salem Nuclear Generating Station, Unit No. 1 (TAC NO. M95383)", Amendment 201, November 26, 1997

8. Letter from N. J. Liparulo (Westinghouse) to R. C. Jones (NRC), "Transmittal of Presentation Material from NRC/Westinghouse Fuel Design Change Meeting on April 15, 1996", NSD-NRC-96-4964, dated April 22, 1996

9. WCAP-12488-A, Westinghouse Fuel Criteria Evaluation Process, October 1994