ATTACHMENT 2

SAFETY EVALUATION
FOR THE
VIRGIL C. SUMMER NUCLEAR STATION
UPGRADE TO WESTINGHOUSE 17x17 VANTAGE+ FUEL

SOUTH CAROLINA ELECTRIC & GAS COMPANY
VIRGIL C. SUMMER NUCLEAR STATION
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SAFETY EVALUATION

1.0 INTRODUCTION

The Virgil C. Summer Nuclear Station (VCSNS) is currently operating in Cycle 6 in its second transition core consisting of Westinghouse 17x17 low-parasitic (LOPAR) fuel assemblies and VANTAGE 5 fuel assemblies which have Zircaloy-4 clad fuel rods. The fuel region of LOPAR fuel assemblies will be discharged at the end of Cycle 6. For subsequent cycles, the fresh fuel will be upgraded to VANTAGE+ assemblies. As presently planned, Cycle 7 will operate with approximately 50%-60% VANTAGE 5 and 40%-50% VANTAGE+ fuel assemblies. The most significant difference between the VANTAGE 5 and VANTAGE+ fuel designs is the use of ZIRLO™ clad fuel rods (Reference 2).

The VCSNS VANTAGE+ fuel includes the following advanced fuel features:

- o ZIRLO clad fuel rods
- o ZIRLO guide thimbles (including instrumentation tubes)
- o The option to use annular Axial Blanket pellets
- o An optimized fuel stack coil spring to provide added rod internal pressure margin
- o Small assembly dimensional modifications

VANTAGE+ is a modification of the NRC-approved VANTAGE 5 fuel assembly design and thus also includes the following VANTAGE 5 fuel product features (Reference 3):

- o Reconstitutable Top Nozzle (RTN)
- o Intermediate Flow Mixing (IFM) Grids
- o Axial Blankets
- o Integral Fuel Burnable Absorbers (IFBA)

The VCSNS VANTAGE+ fuel assembly will continue to use the Debris Filter Bottom Nozzle (DFBN) which is present in VCSNS Regions 7 and 8 VANTAGE 5 fuel assemblies.

These added features will result in several operational benefits to VCSNS. The advanced fuel assembly design provides improved corrosion resistance (allowing for increased flexibility in coolant chemistry operations), enhanced fuel reliability, and the capability to provide VCSNS fuel design with increased fuel performance margin. To achieve these fuel performance improvements, Westinghouse has developed a new zirconium-based fuel rod clad and guide thimble alloy, known as ZIRLO, for VANTAGE+ fuel. This alloy provides a significant improvement in clad and guide thimble corrosion resistance and dimensional stability under irradiation. Fuel rods clad with ZIRLO alloy have been irradiated in a test reactor (BR-3) at linear power levels up to 17 kw/ft and to burnup levels much greater than those contemplated for VCSNS. Comparative data show that corrosion and hydriding of the rods clad with ZIRLO alloy is significantly less than that of comparable Zircaloy-4 clad rods. Irradiation test results also show lower irradiation growth and creepdown for ZIRLO clad rods compared to Zircaloy-4 clad rods (Reference 8).

Two demonstration assemblies using ZIRLO fuel clad have completed their first cycle of operation at North Anna. On-site examinations show that the ZIRLO clad fuel rods have performed to expectations and achieved 21,000 MWD/MTU burnup. One of these assemblies is presently in its second cycle of irradiation.

VANTAGE+ core evaluations for VCSNS have been performed to support the same operating limits as are supported for a VANTAGE 5 fueled core (Reference 9) including:

- Core thermal power level of 2,775 MWt,
- $F(\Delta H)$ of 1.62,
- Maximum $F(Q)$ of 2.45,
- Positive moderator temperature coefficient (PMTC) of +7 pcm/°F from 0 to 70% power and then decreasing linearly to 0 pcm/°F between 70 to 100% power.

The licensed axial offset strategy is RAOC. Base Load Technical Specifications are an optional strategy used during operation at or near steady-state equilibrium conditions. An F(Q) Surveillance Technical Specification has been implemented. RAOC and F(Q) surveillance have been approved by the NRC.

Consistent with the Westinghouse standard reload methodology, (Reference 1) conservative evaluation parameters have been selected to maximize the applicability of the safety evaluations to future cycles. This VANTAGE+ report will act as a basic reference document in support of future VCSNS Reload Safety Evaluations (RSE) for VANTAGE+ fuel reloads. The specific cycle 7 RSE and subsequent cycle specific RSEs will verify that applicable safety limits are satisfied based on evaluations and analyses described herein.

2.0 MECHANICAL EVALUATION

VANTAGE+ fuel assemblies are mechanically compatible with the presently-used VANTAGE 5 and LOPAR fuel assemblies.

VANTAGE+ FUEL ASSEMBLIES

VANTAGE+ fuel assemblies have been designed to be compatible with the VANTAGE 5 and LOPAR fuel assemblies, reactor internals interfaces, fuel handling equipment and the refueling equipment. The VCSNS VANTAGE+ fuel assembly is nearly identical in design to the VANTAGE 5 fuel assembly with the exception of the use of ZIRLO fuel clad and guide thimbles and the slight assembly dimensional adjustm[illegible]. The assemblies are interchangeable from the standpoint of the exterior [illegible]y envelope and reactor internals interfaces.

The design bases and limits for the VANTAGE+ fuel assembly are the same as those for the VANTAGE 5 fuel design, except for those instances where they have been modified to consider the use of the ZIRLO alloy. Compliance with the "Acceptance Criteria" of the Standard Review Plan (SRP, NUREG 0800) Section 4.2, Fuel System Design, has already been demonstrated for VANTAGE 5 fuel. The changes due to the use of the ZIRLO alloy are discussed in Reference 2, and are outlined in the following sections.

VANTAGE+ ASSEMBLY SKELETON DIMENSION MODIFICATION

The VCSNS VANTAGE+ assembly skeleton is identical to the VANTAGE 5 fuel assembly skeleton except for modifications which enhance fuel design and corrosion performance margin. These modifications consist of guide thimbles fabricated of the ZIRLO alloy and small changes in the skeleton and associated hardware dimensions. It is otherwise identical to the presently-used VANTAGE 5 hardware, materials, and features.

The VANTAGE+ fuel assembly exterior envelope has the same dimensions as that of the VANTAGE 5 assembly. The functional interface with the reactor internals is also the same as in previous Westinghouse fuel designs.

VANTAGE+ FUEL ROD

The basic difference between VANTAGE+ fuel and VANTAGE 5 fuel assemblies is the use of ZIRLO clad fuel rods and ZIRLO guide thimbles instead of Zircaloy-4 clad fuel rods and Zircaloy-4 guide thimbles. The ZIRLO alloy is zirconium-based, similar in composition and physical and mechanical properties to Zircaloy-4. However, it has been specifically developed for enhanced corrosion resistance. In-reactor performance data has been used to establish the ZIRLO clad irradiation-dependent behavior. These data have been used to establish the fuel performance analysis models. Reference 2 details the effects of the difference in alloy composition. A fuel rod design has been established which will satisfy both the fuel rod design bases and the design and licensing criteria.

Both the VANTAGE+ and VANTAGE 5 fuel rods contain enriched uranium dioxide fuel pellets, axial blanket (natural uranium dioxide) pellets at the top and bottom of the fuel stack and may include an Integral Fuel Burnable Absorber (IFBA) coating on some of the enriched fuel pellets. The plenum coil spring has been optimized in the VANTAGE+ design to provide additional plenum volume.

As an option, the axial blanket pellets in the VCSNS VANTAGE+ fuel rods may be annular to provide additional effective plenum volume for increased fuel rod internal pressure margin.

VANTAGE+ FUEL ROD PERFORMANCE

Fuel rod performance for all fuel rod designs is shown by cycle specific analyses and evaluations to satisfy the Westinghouse fuel rod design bases on a region by region basis. The ZIRLO alloy used as clad in the VANTAGE+ fuel assembly allows fuel rod design criteria to be met with increased margin to design limits.

Performance is unaffected by using more than one type of fuel rod design or clad alloy in the core during the upgrade cycle. The fuel rod performance evaluation for each region addresses all appropriate design features of the region, including any changes to the fuel rod or pellet geometry from that of previous fuel regions. The analysis of the VANTAGE+ fuel rod takes into consideration the use of the ZIRLO alloy as fuel clad and related geometry changes of the fuel rod. Fuel performance evaluations are conducted for each region in order to demonstrate that the design criteria will be satisfied for all fuel rod types in the core under the planned operating conditions.

Reference VANTAGE+ fuel rod design evaluations will be performed using NRC-approved models supplemented by evaluations for ZIRLO alloy (References 2, 7 and 11). The VCSNS VANTAGE+ fuel rods will also be shown to satisfy Westinghouse fuel rod design criteria, including the rod's internal pressure design basis for lead rod average burnups to currently-approved burnup levels (Reference 4). For initial application of the VCSNS VANTAGE+ fuel design, the burnup is limited to this value, which is supported by currently-approved methods (Reference 11).

FUEL ROD AND GUIDE THIMBLE WEAR

Fuel rod wear and guide thimble wear depends on both the support conditions and the flow environment to which the affected components are subjected. Where pertinent, the wear characteristics between Zircaloy-4 and ZIRLO are comparable considering the alloys are alike in composition as well as material and mechanical properties. Since VANTAGE+ and VANTAGE 5 fuel assembly designs use the same components which could potentially influence either the support conditions or flow environment, no additional wear will occur with the introduction of VANTAGE+ fuel in VCSNS (Reference 2).

3.0 NUCLEAR EVALUATION

The two features in VANTAGE+ fuel not present in VANTAGE 5 fuel that affect nuclear design are: 1) use of the ZIRLO alloy for the fuel clad and guide thimbles and 2) the option to use annular axial blanket pellets at the ends of the fuel stack of the VCSNS VANTAGE+ fuel rod.

The effect of the use of the ZIRLO alloy as fuel clad and guide thimbles on the nuclear design is a slight neutronic difference due to the presence of niobium. The effect of the use of an annular pellet design in the axial blanket zones is a small reduction in total uranium loading in the fuel rod. The overall fuel stack height remains the same as that of current VCSNS VANTAGE 5 fuel.

The evaluation of the upgrade and equilibrium cycle for cores containing VANTAGE+ fuel is presented in Reference 2. The design and predicted nuclear characteristics of VANTAGE+ fuel are similar to those of VANTAGE 5 fuel as described in Reference 3. The evaluation discussed in Reference 2 has shown that the VANTAGE+ fuel nuclear design bases are satisfied and that the safety limit characteristics of the VANTAGE 5 fuel design nuclear evaluations also apply to the VANTAGE+ design, and will be adequately satisfied. Standard nuclear design methods will be used to predict the neutronic behavior of VANTAGE+ fuel.

As the core transitions to an all-VANTAGE+ fuel design, the key safety parameters evaluated for the VCSNS reactor will be the same as for an all-VANTAGE 5 fueled core. Any changes in values of the key safety parameters would be typical of the normal cycle-to-cycle variations experienced as loading patterns change. As is current practice, each reload core design will be evaluated to assure that design and safety limits are satisfied according to the reload methodology (Reference 1). The design and safety limits will be documented in each cycle specific reload safety evaluation (RSE) report.

4.0 THERMAL AND HYDRAULIC EVALUATION

The thermal hydraulic analyses to support the introduction of VANTAGE+ into VCSNS are identical to the currently approved analyses for VANTAGE 5 since all pertinent thermal parameters and hydraulic characteristics are identical.

No DNB transition effects between VANTAGE+ and VANTAGE 5 need be considered inasmuch as the assemblies are hydraulically equivalent. Previously defined transition effects between VANTAGE 5 and other 17x17 fuel are directly applicable to VANTAGE+ and other 17x17 fuel (Reference 10).

5.0 SAFETY ANALYSIS EVALUATION

5.1 NON-LOCA PERFORMANCE

The methods and computer codes currently used in the analysis of the non-LOCA licensing basis events are valid for use in the evaluation of the VANTAGE+ design. These evaluations show that all licensing basis criteria will continue to be met for the VANTAGE+ fuel design.

The unique design features of VANTAGE+ fuel that are considered in the non-LOCA evaluation are the use of ZIRLO alloy fuel clad and the adjustments to the assembly dimensions. The optional use of annular axial blanket pellets will also be considered.

EFFECT OF USE OF ZIRLO ALLOY FUEL CLAD

For non-LOCA accident analyses in which the cladding temperature does not reach or exceed the ZIRLO alloy phase change temperature, the use of ZIRLO alloy as fuel cladding has no effect on the analysis results in comparisons to those results obtained for Zircaloy-4 clad fuel rods (Reference 2).

Based on a review conducted of all non-LOCA licensing basis accident analyses, only two non-LOCA licensing basis analyses result in cladding temperatures which are predicted to reach the ZIRLO alloy phase change temperature. These analyses are: (1) Locked Rotor/ Shaft Break peak cladding temperature analysis and (2) Rupture of a Control Rod Drive Mechanism (RCCA Ejection). Each of these analyses have been evaluated to determine the effect of the use of ZIRLO alloy clad material on the analyses results, and to compare the results to acceptance criteria.

EFFECT OF ADDITIONAL MODIFICATIONS TO THE FUEL ASSEMBLY DESIGN

Reference 4 evaluates the effect of extended burnup on the design and operation of Westinghouse fuel, and is applicable to the use of VANTAGE+ at VCSNS since this initial application introduces no changes in the burnup level.

Core flow areas and loss coefficients have been preserved in the dimensional adjustments made in the design of the VANTAGE+ fuel assembly. Therefore, no other parameters important to non-LOCA safety analyses, beside consideration of the use of ZIRLO clad, have been affected.

NON-LOCA RELOAD SAFETY EVALUATION METHODOLOGY

The non-LOCA safety evaluation process is described in Reference 1 and Chapter 18 of Reference 5. The process determines if a core configuration is bounded by existing safety analyses in order to confirm that applicable safety criteria are satisfied. The methodology systematically identifies parameter changes on a cycle-to-cycle basis which may invalidate existing safety analysis assumptions and identifies the transients which require re-evaluation. This methodology is also applicable to the evaluation of VANTAGE+ fuel upgrade and full cores.

Any necessary re-evaluation identified by the reload methodology is one of two types. If the identified parameter is only slightly out of bounds, or the transient is relatively insensitive to that parameter, a simple evaluation may be made which conservatively estimates the magnitude of the effect and explains why the actual analysis of the event does not have to be repeated. If the deviation is large and/or expected to have a significant or not easily quantifiable effect on the transients, re-analyses are required. The re-analysis approach will typically use the analytical methods used in previous submittals to the NRC, which are presented in Final Safety Analysis Reports (FSARs). Subsequent submittals to the NRC for a specific plant will continue to reference the FSARs, or an NRC-approved topical report.

The key safety parameters for the VANTAGE 5 Safety Analysis in Reference 9 and Chapter 15 of the FSAR are applicable to VANTAGE+ fuel, since the values of these parameters bound both fuel types. For subsequent fuel reloads, the key safety parameters will be evaluated to determine if there are any violations of the bounding values. Re-evaluation of the affected transients would then take place if necessary and would be documented for the cycle specific reload design.

RESULTS AND CONCLUSIONS: VCSNS NON-LOCA EVALUATION

Analyses performed for the Locked Rotor/Shaft Break event, to determine the effect of the ZIRLO fuel clad on the peak cladding temperature and metal-to-water reaction rates, have demonstrated that the use of the ZIRLO alloy results in a minor increase in the peak clad temperature compared to that temperature resulting from the use of Zircaloy-4 clad. This has a negligible effect on the metal-to-water reaction rate (Reference 2).

Analyses for the Rupture of a Control Rod Drive Mechanism event -- at hot full power and hot zero power conditions -- take into consideration the particular physical property versus temperature relationship of ZIRLO alloy clad material. These analyses demonstrate that the use of ZIRLO alloy results in a small reduction in both the fraction of fuel melted at the hot spot as well as the peak fuel stored energy when compared to Zircaloy-4 clad. The peak RCS pressure analysis is unaffected by the use of ZIRLO alloy fuel clad material (Reference 2).

The appropriate safety criteria as discussed in References 2 and 12 are met for each of the two accidents re-evaluated; the current FSAR analysis for RCCA Ejection remains bounding; and, because of the negligible increase in peak clad temperature for the Locked Rotor event, no changes to the non-LOCA Section of Chapter 15 of the FSAR are required.

5.2 LOCA EVALUATION

ANALYSIS AND ASSUMPTIONS FOR 17x17 VANTAGE+ FUEL

All VANTAGE+ fuel design features can be modeled with existing Evaluation Models by appropriate selection of code inputs, with the exception of the ZIRLO clad material. As described in Reference 2, a series of test programs has been performed in order to determine the behavior of ZIRLO clad during a LOCA. These tests indicate that many of the ZIRLO alloy physical and mechanical properties are similar to those of Zircaloy-4 when the two materials are in the same metallurgical phase. However, the phase changes occur at different temperatures for the two alloys, and this difference results in differences in several clad thermophysical properties as detailed in Reference 2. New clad models have been developed from these test data and have been submitted for NRC review and approval, on a generic basis, in Reference 2. Supporting LOCA sensitivity studies will be based on VCSNS.

CURRENT LARGE BREAK LOCA LICENSING BASIS

VCSNS Large Break LOCA analysis is based on the approved Westinghouse 1981 Evaluation Model with BASH (Reference 6). The Double Ended Cold Leg Guillotine (CD = 0.4) produces the most limiting consequences.

CURRENT SMALL BREAK LICENSING BASIS

The VCSNS Small Break LOCA analysis (Reference 9) is based on the currently-approved NOTRUMP Evaluation Model. The 3.0 inch diameter cold leg break produces the most limiting consequences.

METHOD OF ANALYSIS AND LOCA RESULTS WITH ZIRLO

To support the use of VANTAGE+ fuel, Reference 2 proposes clad model changes for the Large and Small Break LOCA Evaluation Models. The effect of the annular blanket pellets will be evaluated to confirm that the fuel assembly PCT remains within the acceptance limits of 10CFR50.46. Sample LOCA sensitivity studies are currently being performed using the ZIRLO alloy version of the computer codes. These calculations are based on VCSNS and are anticipated to show that the effect of the proposed model revisions on the LOCA transients is relatively small. Results will be incorporated into Reference 2.

Following NRC approval of the proposed revisions (Reference 2) to the LOCA Evaluation Model, plant-specific LOCA calculations for VCSNS will be utilized as a part of the normal reload design process for Cycle 7 to assure continued conformance to 10CRF50.46. Existing LOCA margins are believed to be sufficient to cover the effect of ZIRLO clad fuel. However, if required, core operating limits will be adjusted to offset unanticipated increases in event results. These adjustments would be reported to the NRC through issuance of the VCSNS Core Operating Limits Report in accordance with the Technical Specification 6.9.1.11.

CONCLUSIONS OF THE LOCA EVALUATION

For the upgrade of VCSNS fuel to the VANTAGE+ fuel design, continued conformance to the acceptance criteria of 10CFR50.46 is assured through the following:

1. NRC approval of proposed LOCA Evaluation Model changes for ZIRLO clad.

2. Utilization of plant specific analyses using the approved LOCA Evaluation Models for ZIRLO clad as a part of the Cycle 7 reload design process. For VCSNS, these analyses use the Baker - Just correlation to calculate the metal-water reaction rate.

3. Adjustments in core operating limits, within the scope of the Core Operating Limits Report, to offset increases in LOCA results.

5.3 CONTAINMENT INTEGRITY MASS AND ENERGY RELEASES

The effect of fuel changes on containment mass and energy releases and, therefore, containment peak pressure, depends on changes to the core fluid volume, stored energy and hydraulic resistance.

The VANTAGE+ and VANTAGE 5 fuel rods have the same diameter. However, both fuel designs contain rods of smaller diameter than the original 17x17 LOPAR (standard) fuel that was used within the VCSNS core. The smaller fuel rod diameter reduces the core stored energy. This reduces the mass and energy releases calculated for a hypothetical LOCA. The smaller diameter VANTAGE 5 and VANTAGE+ fuel rods also result in a slight increase in core fluid volume and the use of Intermediate Flow Mixing grids in both VANTAGE 5 and VANTAGE+ fuel increases hydraulic resistance. These changes are offset by the reduction in core stored energy. Because of this offset, a re-analysis of containment mass and energy releases was not necessary for the implementation of VANTAGE 5 fuel at VCSNS, nor is it needed for the implementation of VANTAGE+ fuel. The implementation of VANTAGE+ fuel at VCSNS will not result in an increase in the containment peak pressure reported in the VCSNS FSAR or an increase the offsite radiological consequences associated with high containment pressures resulting from a hypothetical LOCA.

5.4 STEAM GENERATOR TUBE RUPTURE

The consequences of a Steam Generator Tube Rupture (SGTR) are analyzed in the VCSNS FSAR. These consequences depend on the initial reactor and steam generator power, pressure, and temperature conditions. No changes in initial operating conditions will occur as a result of implementation of VANTAGE+ fuel at VCSNS; thus, the consequences of a SGTR will not be increased by the implementation of VANTAGE+ fuel, and the conclusions in the FSAR SGTR analysis remain applicable

5.5 BLOWDOWN REACTOR VESSEL AND LOOP FORCES

The forces created by a hypothetical break in the Reactor Coolant System (RCS) piping are principally caused by the motion of the decompression wave through the RCS. The strength of the decompression wave is primarily a result of the assumed break opening time, break area, and RCS operating power, temperature and pressure conditions. These parameters will not be affected by a change in VCSNS fuel from VANTAGE 5 to VANTAGE+. Thus the implementation of VANTAGE+ fuel at VCSNS will not result in an increase of the calculated consequences of a hypothetical LOCA on the reactor vessel internals or RCS loop piping. The current FSAR analysis for forces on the reactor internals and RCS piping resulting from a hypothesized LOCA remains applicable.

5.6 POST-LOCA LONG-TERM CORE COOLING (ECCS FLOWS, CORE SUBCRITICALITY AND SWITCHOVER OF THE ECCS TO HOT LEG RECIRCULATION)

The implementation of VANTAGE+ fuel at VCSNS does not affect the assumptions for decay heat, core reactivity or boron concentration for sources of water residing in the containment sump post-LOCA. These licensing requirements associated with LOCA are thus not affected by the implementation of VANTAGE+ fuel. Westinghouse performs an independent check on core subcriticality for each fuel cycle of Westinghouse fuel utilized at VCSNS.

5.7 RADIOLOGICAL ASSESSMENT

The effect of VANTAGE+ fuel on radiological source terms has been shown to be small and due to the extension of the average fuel burnup levels beyond those currently-approved (Reference 2). Since no burnup increase beyond currently-approved levels is planned for the initial VCSNS upgrade to VANTAGE+ fuel, the current source terms remain bounding for this application and the radiological consequences of all accidents evaluated in the FSAR are unaffected.

6.0 TECHNICAL SPECIFICATION CHANGE

Section 5.3.1 of the VCSNS Technical Specifications currently allows only the use of Zircaloy-4 to clad fuel rods. To allow the use of the ZIRLO alloy, this section needs to be modified. The requested changes are given in Attachment 1 to the license amendment request.

7.0 SUMMARY AND CONCLUSIONS

Consistent with the Westinghouse Standard Reload Methodology for analyzing cycle specific reloads, the operating limits supported for the VCSNS VANTAGE+ reload fuel will remain the same as those supported for the VCSNS VANTAGE 5 reload fuel (Reference 9). The evaluation parameters conservatively bound the values for subsequent reload cycles and facilitate the determination of the applicability of 10CFR50.59. The future cycle-specific reload safety evaluations will verify that applicable safety limits are satisfied based on the reference evaluation/analyses described in this report and the supporting Reference 2. The mechanical, thermal and hydraulic, nuclear, and accident evaluations performed to date, and those currently being performed, take into consideration the upgrade and full VANTAGE+ cores.

The results of these evaluations and analyses lead to the following conclusions:

- The VANTAGE+ fuel assemblies for VCSNS are mechanically compatible with the current VANTAGE 5 and LOPAR fuel assemblies, control rods, secondary source rods and reactor internals interfaces. The VANTAGE+, VANTAGE 5 and LOPAR fuel assemblies will satisfy the current design bases for VCSNS.

- Changes in the nuclear characteristics due to the upgrade from VANTAGE 5 to VANTAGE+ fuel will be within the range normally seen from cycle to cycle due to normal changes in fuel management.

- The VANTAGE+ fuel assemblies are hydraulically compatible with previously irradiated VANTAGE 5 fuel assemblies (and with Westinghouse LOPAR assemblies).

- Cycle-Specific Reload Safety Evaluations will confirm the core's capability to operate safely at rated thermal power within the bounds of the plant's Safety Analysis.

- The fuel rod design analyses using appropriate model modifications for ZIRLO and dimensional changes will show that all applicable design limits are met for specific application of VANTAGE+ at VCSNS.

- The radiological consequences for the FSAR accidents remain valid for VANTAGE+ fuel.

- Plant operating limitations given in the Technical Specifications (T.S.) will be satisfied with the proposed change to T.S. Section 5.3.1 to allow the use of ZIRLO alloy clad and guide thimbles.

8.0 REFERENCES

1. Bordelon, F. M. et al., "Westinghouse Reload Safety Evaluation Methodology," WCAP-9272-P-A, July 1985.

2. Davidson, S. L. and Nuhfer, D. L., "VANTAGE+ Fuel Assembly Reference Core Report," WCAP-12610, June 1990.

3. Davidson, S. L. and Kramer, W.R.; "Reference Core Report VANTAGE 5 Fuel Assembly," WCAP-10444-P-A, September 1985.

4. Davidson, S. L., and Kramer, W. R., "Extended Burnup Evaluation of Westinghouse Fuel," WCAP-10125-P-A, December 1985.

5. Davidson, S. L., and Iorii, J. A., "Reference Core Report - 17x17 Optimized Fuel Assembly," WCAP-9500-P-A, May 1982.

6. Kabadi, J. N. et. al., "The 1981 Version of the Westinghouse ECCS Evaluation Model Using the BASH Code," WCAP-10266-P-A, March 1987.

7. Miller, J. V.. "Improved Analytical Models Used in Westinghouse Fuel Rod Design Computations," WCAP-8720 (Proprietary), October 1976.

8. Sabol, G. P., Kilp, G. R, et. al., "Development of Cladding Alloy for High Burnup," ASTM STP 1023, 1989 pp. 227-244.

9. Letters from SCE&G (D. A. Nauman) to USNRC dated May 20 1988, and June 20 1988, Subject: VCSNS Nuclear Station, Docket 50/395, "Technical Specification Change" and "Change Addendum" - VANTAGE 5 Reload.

10. Schueren, P. and McAtee, B. "Extension of Methodology for Calculation of Transition Core DNBR," WCAP-11837-P-A, May 1988.

REFERENCES (Cont)

11. Weiner, R. A., et. al., "Improved Fuel Rod Performance Models for Westinghouse Fuel Rod Design and Safety Evaluation," WCAP-10851-P-A, August 1988.

12. Letter from Westinghouse (W. J. Johnson) to USNRC dated October 23, 1989, Subject: Use of 2700°F PCT Acceptance Limit in Non-LOCA Accidents.

ATTACHMENT 3

SIGNIFICANT HAZARDS EVALUATION FOR THE VIRGIL C. SUMMER NUCLEAR STATION TRANSITION TO WESTINGHOUSE VANTAGE+ FUEL

Description of Amendment Request:

Virgil C. Summer Nuclear Station (VCSNS) Technical Specification 5.3, "Reactor Core," currently requires Zircaloy-4 to be the material used for fuel rod cladding. VCSNS Specification 5.3 also requires that any filler rods (used as substitutions for fuel rods) be composed of stainless steel or Zircaloy-4. The zirconium based alloy (Zircaloy-4) and stainless steel are specified because their mechanical, chemical, and nuclear properties have been evaluated and determined to be sufficient to support the licensing basis for VCSNS.

With this Technical Specifications Change Request, South Carolina Electric & Gas Company (SCE&G) is proposing to revise the wording of Specification 5.3 to allow utilization of an advanced material, ZIRLO, for both cladding and filler rods. VCSNS is requesting this revision because ZIRLO is the cladding material used in the Westinghouse VANTAGE+ fuel design, which VCSNS intends to utilize during Cycle 7. Use of VANTAGE+ fuel is expected to allow higher fuel burnups, offer an increased resistance to cladding corrosion, and reduce fuel cycle costs. Other unique design features of VANTAGE+ fuel include ZIRLO guide thimbles, the option to use annular axial blanket pellets, and modified fuel assembly dimensions.

SCE&G intends for this revision to be a permanent change in the VCSNS Technical Specifications. The change in cladding and filler rod material does not affect the purpose of Specification 5.3; only the composition of the two components has been changed. The safety evaluation for this proposed change shows that all current design and safety criteria will be satisfied with the use of VANTAGE+ fuel assemblies in the Cycle 7 core and subsequent reload cores.

Basis for Proposed No Significant Hazards Consideration Determination:

SCE&G has evaluated the proposed changes associated with the implementation of VANTAGE+ fuel against the Significant Hazards Criteria of 10CFR50.92 and against the Commission Guidance concerning application of this standard. VCSNS's proposed license amendment is closely related to an example (51FR7751) of action not likely to involve a significant hazard. Specifically, example (iii) of the Guidance states:

"For a nuclear power reactor, a change resulting from a nuclear reactor core reloading, if no fuel assemblies significantly different from those found previously acceptable to the NRC for a previous core at the facility in question are involved. This assumes that no significant changes are made to the acceptance criteria for the technical specifications, that the analytical methods used to demonstrate conformance with the technical specifications and regulations are not significantly changed, and that NRC has previously found such methods acceptable."

The VCSNS proposed licensing amendment is directly related to the above example in that the core reload uses VANTAGE+ fuel that is not significantly different from previous cores at VCSNS; the changes to the Technical Specifications are as a result of the core reload and not because of any significant change made to the acceptance criteria for Technical Specifications; and the analytical methods to be used in the required reload analysis will have been found acceptable by the NRC prior to their use by VCSNS. Therefore, based on the above, SCE&G concludes that the proposed Technical Specification 5.3.1 changes do not involve a significant hazard consideration.

SCE&G has evaluated the proposed changes in design, analytical methodologies and Technical Specifications associated with the implementation of VANTAGE+ fuel against the Significant Hazards Criteria of 10CFR50.92. The results of SCE&G evaluations demonstrate that the changes do not involve any significant hazard as described below.

a. The probability or consequences of an accident previously evaluated is not significantly increased.

The VANTAGE+ reload fuel assemblies are mechanically, thermally, and hydraulically compatible with the current VANTAGE 5 and LOPAR fuel assemblies, control rods, and reactor internals interfaces. Also, implementation of VANTAGE+ fuel does not cause a significant change in the physical characteristics of the VCSNS cores. The three fuel assembly types satisfy the design basis for VCSNS as proposed for this amendment.

The proposed change has been assessed from a core design and safety analysis standpoint. The use of ZIRLO, modified assembly dimensions, and annular axial blanket fuel pellets are explicitly modeled using NRC approved nuclear design models and methods. No increase in the probability of occurrence of any accident was identified, and only evaluations of Loss of Coolant, Rod Ejection, and Locked Rotor Accidents were required to assure compliance to the VCSNS Technical Specifications. The non-LOCA evaluations utilized methods and models that have been conservatively modified for the use of ZIRLO. The results are all clearly within the design and safety acceptance criteria and demonstrate the plant's capability to operate safely at 100% power.

From a LOCA standpoint, ECCS Evaluation Model changes have been developed and submitted for approval in WCAP-12610. Following NRC approval of the proposed changes, plant specific LOCA calculations for VCSNS will be utilized as a part of the normal reload design process for Cycle 7 to assure continued conformance to 10CFR50.46. Although a small increase in peak clad temperature is expected, existing margins will be checked to assure they are adequate to cover the impact of VANTAGE+. However, if required, core operating limits will be adjusted in accordance with Specification 6.9.1.11 to offset any decreases in margins to acceptance limits. Since the acceptance limits will be met, there is no increase in event consequences.

Based on the above, it is concluded that there will be no significant increase in the probability or consequences of an accident previously evaluated.

b. The possibility of an accident or malfunction of a different type than any evaluated previously in the safety analysis reports is not created.

The possibility of an accident or malfunction of a different type than any evaluated previously in the safety analysis reports is not created because the proposed Technical Specifications change to allow use of ZIRLO in the VCSNS core does not significantly affect the overall method of operation at VCSNS, and can be accommodated without compromising the performance or qualification of safety-related equipment. The VANTAGE+ reload fuel assemblies are mechanically, thermally, and hydraulically compatible with the fuel assemblies, control rods, and reactor internals currently used in the core. The design basis for VCSNS will be satisfied when VANTAGE+ fuel assemblies are introduced into the core, and will be satisfied for the transition cycles during which the core may contain a mixture of VANTAGE+, VANTAGE 5, and LOPAR fuel assemblies.

For these reasons, the use of ZIRLO in the VCSNS core does not create the possibility of an accident or malfunction of a different type than any previously evaluated.

c. The margins of safety as defined in the basis of the Technical Specifications is not significantly reduced.

The margins of safety as defined in the basis of the Technical Specifications are not significantly reduced as a result of the proposed amendment. Small changes in the margin to the safety limit of some previously analyzed accidents are anticipated to result from the use of VANTAGE+ fuel in the VCSNS core. In all accident cases, however, the results of the changes will be within the bounds of the approved design and safety acceptance criteria. The use of VANTAGE+ assemblies containing the ZIRLO cladded fuel rods will continue to ensure conformance with all current fuel design bases and will not change the existing reload design safety analysis limits. There is, therefore, no significant reduction in the margin of safety as a result of this proposed change.

In view of the preceding, SCE&G has determined that the proposed license amendment does not involve any significant hazards considerations.