VIRGINIA ELECTRIC AND POWER COMPANY
RICHMOND, VIRGINIA 23261

October 4, 1993

U.S. Nuclear Regulatory Commission
Attention: Document Control Desk
Washington, DC. 20555

Serial No.	93-614
NL&P/MAE:	R0
Docket Nos.	50-338 50-339
License Nos.	NPF-4 NPF-7

Gentlemen:

VIRGINIA ELECTRIC AND POWER COMPANY
NORTH ANNA POWER STATION UNITS 1 and 2
PROPOSED TECHNICAL SPECIFICATIONS CHANGES
IMPLEMENTATION OF ZIRLO CLADDING

Pursuant to 10 CFR 50.90, the Virginia Electric and Power Company requests amendments, in the form of changes to the Technical Specifications, to Facility Operating License Nos. NPF-4 and NPF-7 for North Anna Power Station Units 1 and 2, respectively. The proposed changes will allow the use of ZIRLO for fuel cladding.

A discussion of the proposed Technical Specifications changes is provided in Attachment 1. The proposed Technical Specifications changes are provided in Attachment 2. It has been determined that the proposed Technical Specifications changes do not involve an unreviewed safety question as defined in 10 CFR 50.59 or a significant hazards consideration as defined in 10 CFR 50.92. The basis for our determination that these changes do not involve a significant hazards consideration is provided in Attachment 3. The proposed Technical Specifications changes have been reviewed and approved by the Station Nuclear Safety and Operating Committee and the Management Safety Review Committee.

Should you have any questions or require additional information, please contact us.

Very truly yours,

W. L. Stewart
Senior Vice President - Nuclear

Attachments

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NRC Senior Resident Inspector
North Anna Power Station

Commissioner
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COMMONWEALTH OF VIRGINIA)
)
COUNTY OF HENRICO)

The foregoing document was acknowledged before me, in and for the County and Commonwealth aforesaid, today by W. L. Stewart who is Senior Vice President - Nuclear, of Virginia Electric and Power Company. He is duly authorized to execute and file the foregoing document in behalf of that Company, and the statements in the document are true to the best of his knowledge and belief.

Acknowledged before me this 4TH day of October, 1993.

My Commission Expires: May 31, 1994.

Vicki L. Hull
Notary Public

(SEAL)

Attachment 1

Discussion of Changes

DISCUSSION OF CHANGES

INTRODUCTION

Virginia Electric and Power Company plans to insert fuel assemblies containing fuel rods, guide thimble tubes, instrumentation tubes, and mid-span grids fabricated with Westinghouse Electric Corporation's (Westinghouse's) advanced zirconium alloy material, ZIRLO, into the North Anna Units 1 and 2 reactors, beginning with the next refueling at each unit (late 1994 and early 1995, respectively). In the current fuel design, these components are fabricated from Zircaloy-4. Changing the material of these components from Zircaloy-4 to the ZIRLO alloy will provide operational benefit relative to the current fuel design due to the ZIRLO alloy's improved corrosion resistance and dimensional stability under irradiation.

Based both on evaluations and analyses, no unreviewed safety questions exist as a result of inserting ZIRLO cladding or ZIRLO fabricated skeleton components into the North Anna Units 1 and 2 reactor cores. However, the Technical Specifications define the fuel rod cladding material as Zircaloy-4, so implementation of this material change requires changes to the Technical Specifications. It should be noted that the only component for which Technical Specification changes are required are the ZIRLO clad fuel rods. Use of the ZIRLO fabricated guide thimble tubes, instrumentation tubes, and mid-span grids does not require changes to the Technical Specifications.

BACKGROUND

Westinghouse has developed a new zirconium based alloy, known as ZIRLO, to enhance fuel reliability and achieve extended burnup. This alloy provides a significant improvement over Zircaloy-4 in fuel rod, guide thimble tube, instrumentation tube, and mid-span grid corrosion resistance and dimensional stability under irradiation. ZIRLO corrosion resistance has been evaluated in long-term, out-of-pile tests over a wide range of temperatures (up to 680°F in water tests, up to 932°F in steam tests). Additional tests have been conducted in lithiated water environments at temperatures of 680°F. The improved corrosion resistance of ZIRLO cladding has also been demonstrated to very high burnups in the BR-3 test reactor (Mol, Belgium) and to burnups over 46,000 MWD/MTU in demonstration assemblies at North Anna Unit 1.

North Anna Units 1 and 2 are currently operating with North Anna Improved Fuel, which is a Westinghouse fuel design incorporating VANTAGE 5H features, as described in our submittal to the Nuclear Regulatory Commission (NRC) dated January 15, 1990 (Reference 1). A conditional licensing approval for the use of an advanced alloy (ZIRLO) for cladding in two demonstration assemblies in the North Anna Unit 1 reactor core was given in a NRC letter dated May 13, 1987. To allow the use of the demonstration fuel assemblies with some fuel rods with ZIRLO cladding, the NRC granted an exemption (Reference 3) from the provisions of 10 CFR 50.46 (acceptance criteria for emergency core cooling systems), 10 CFR 50.44 (standards for combustible gas control systems) and 10 CFR 51.52 (environmental aspects of fuel and waste transportation), all of which

specifically pertained to fuel with Zircaloy cladding.[1] The two demonstration assemblies have each completed two cycles of operation, and one is currently being irradiated for a third cycle. To date the results at North Anna Unit 1 support the data obtained in the test reactor, with ZIRLO exhibiting peak corrosion levels which are substantially lower than those observed in the current Zircaloy-4 cladding, as well as improved dimensional stability over Zircaloy-4.

Use of a full reload region of fuel assemblies containing ZIRLO fuel cladding and skeleton components is currently planned to begin at North Anna Unit 1 starting with Cycle 11, which is anticipated to start in the fourth quarter of 1994, and at North Anna Unit 2 starting with Cycle 11, currently scheduled for startup in the second quarter of 1995. The use of the ZIRLO alloy in place of Zircaloy-4 in these fuel assemblies represents the principal difference between the proposed fuel design and the fuel currently in use at both units.

The information required to support the licensing basis for the implementation of ZIRLO clad fuel rods in full reload regions of fuel in North Anna Units 1 and 2 cores is given in References 2, 4, and 5. The areas assessed during the safety evaluation process included: chemical/mechanical properties, neutronic performance, thermal and hydraulic performance, cladding performance under non-LOCA conditions, and cladding performance under LOCA conditions.

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[1]As a result of recent federal regulation changes (Reference 2), these exemptions are no longer required to implement ZIRLO fuel rod cladding.

The use of ZIRLO cladding does not alter the models and methods used for analyzing cycle specific reloads of North Anna Improved Fuel (References 6 and 7) with the exception of the LOCA model and methodology as noted in Section 6 of the Safety Significance evaluation. The revised LOCA model and methodology were used as the basis to evaluate the effects of the change in cladding material. These evaluations have shown that the present LOCA related design bases and limits remain valid. Where the reload design models and methods are not affected by ZIRLO cladding, plant and cycle specific evaluations and analyses will continue to be performed for North Anna Units 1 and 2 to demonstrate that the design bases and limits remain valid.

TECHNICAL SPECIFICATION CHANGES

General

The Technical Specification changes described herein apply to North Anna Units 1 and 2.

Technical Specification 5.3.1

The Design Features section (Technical Specification 5.3.1) will be changed to allow fuel rods clad with either Zircaloy-4 or ZIRLO.

Technical Specification 6.9.1.7.e

An additional reference is being added in the Administrative Controls section (Technical Specification 6.9.1.7.e) for the calculation of the heat flux hot channel factor for LOCA evaluations of fuel with ZIRLO cladding in the Core Operating Limits Report.

SAFETY SIGNIFICANCE

1. Previous Irradiation Experience

Fuel rods fabricated with ZIRLO cladding have been previously irradiated in the BR-3 test reactor (Mol, Belgium) at linear power levels up to 17 kw/ft, and burnups significantly greater than those planned for the North Anna fuel assemblies. Corrosion and hydriding data obtained on the ZIRLO cladding were compared with the reference Zircaloy-4 cladding of fuel rods irradiated as controls in the same test assemblies. Based on the irradiation results of the test assemblies in the foreign reactor, the North Anna ZIRLO cladding waterside corrosion and hydriding will be significantly less than that expected for the Zircaloy-4 clad fuel rods. The irradiation test results substantiate a lower clad irradiation growth ($\Delta L/L$) and creepdown for the ZIRLO cladding compared to Zircaloy-4 cladding.

Two demonstration fuel assemblies containing ZIRLO clad fuel rods also began irradiation in the North Anna Unit 1 reactor during June 1987. The ZIRLO clad fuel rods achieved over 21,000 MWD/MTU burnup in their first cycle, which was completed during February, 1989. Visual and dimensional

inspection during refueling showed no abnormalities. One demonstration assembly with ZIRLO clad fuel rods achieved over 37,000 MWD/MTU burnup in its second cycle of irradiation, completed in January, 1991. Visual and dimensional inspection of the two-cycle ZIRLO clad fuel rods in this assembly showed no abnormalities. Cladding corrosion measurements showed that the reduced corrosion obtained with two cycles of operation with the ZIRLO cladding was significantly better than that anticipated in the licensing basis evaluation. The second North Anna demonstration assembly with ZIRLO clad fuel rods achieved over 46,000 MWD/MTU burnup during its first two cycles of irradiation, with the second operating cycle being completed in January, 1993. Visual inspection of this assembly after the second operating cycle showed no abnormalities, and a third cycle of irradiation began in the second quarter of 1993. The present and future irradiation results are and will be considered in the design of the fuel rods with ZIRLO cladding to assure that all fuel rod design bases are satisfied for the planned irradiation life of the North Anna Units 1 and 2 fuel assemblies.

2. Chemical/Mechanical Properties

The nominal chemical composition (see Table 1) of the fuel rods, guide thimble tubes, instrumentation tubes, and mid-span grids fabricated with ZIRLO in the North Anna Units 1 and 2 fuel assemblies is similar to Zircaloy-4 except for slight reductions in the content of tin (Sn) and iron (Fe), and the elimination of chromium (Cr). ZIRLO alloy also contains a nominal amount of niobium (Nb). These small composition changes are responsible for the improved corrosion resistance compared to Zircaloy-4. The physical and mechanical properties of ZIRLO are very

similar to Zircaloy-4 alloy while in the same metallurgical phases. However, the temperatures at which the metallurgical phase changes occur are different for Zircaloy-4 and ZIRLO alloys (Appendix A of Reference 4). These differences are considered in the evaluation of cladding behavior under non-LOCA and LOCA conditions. Further aspects of the ZIRLO cladding performance under LOCA conditions are given in Reference 4. Evaluations are performed using the NRC approved fuel rod performance model (Reference 7) to verify that the fuel rod design bases and design criteria (References 8 and 9) are met for assemblies containing ZIRLO clad fuel rods. The fuel rod design bases, criteria and models which are affected by the use of ZIRLO cladding are described in Reference 4.

3. Neutronic Performance

The design and predicted nuclear characteristics of fuel rods, guide thimble tubes, instrumentation tubes and mid-span grids fabricated from ZIRLO alloy are similar to those of the currently used North Anna Improved Fuel (Reference 1), in which these fuel assembly components are fabricated from Zircaloy-4. Evaluations (Reference 4) have shown that the nuclear design bases are satisfied for fuel rods, guide thimble tubes, instrumentations tubes, and mid-span grids fabricated with ZIRLO alloy. Standard nuclear design analytical models and methods (Reference 6) can also be used to accurately describe the neutronic behavior of fuel assemblies with fuel rod cladding, guide thimble tubes, instrumentation tubes and mid-span grids fabricated from ZIRLO alloy. The safety limit characteristics of the North Anna Improved Fuel design (Reference 1) are not affected.

4. Thermal and Hydraulic Performance

The thermal and hydraulic design bases for fuel rods, guide thimble tubes, instrumentation tubes, and mid-span grids fabricated with ZIRLO alloy are identical to those of the North Anna Improved Fuel design (Reference 1). Since the use of the ZIRLO alloy does not cause changes affecting the parameters which are major contributors in this area (i.e., DNB, core flow, and rod bow), the design bases of the North Anna Improved Fuel design (Reference 1) remain valid.

5. Cladding Performance for Non-LOCA Events

Evaluations reported in Reference 4 concluded that the properties of Zircaloy-4 and ZIRLO are essentially the same with the exception of the differences in the phase change temperature and its related effect on the thermophysical properties. The phase change temperature shift affects the functional relationship between specific heat and temperature. The ZIRLO and Zircaloy-4 specific heats are essentially identical up to approximately 1380°F, at which the ZIRLO material undergoes an alpha-beta phase change and its specific heat rises to a plateau value. Zircaloy-4 has a similar behavior, except that the onset of the phase change occurs at a greater temperature (approximately 1500°F). This difference in specific heat-temperature relationship between the two clad materials potentially affects transient clad temperature response as the clad temperature approaches the ZIRLO phase change temperature of 1380°F.

To assess the impact of this property difference, Westinghouse conducted a review of non-LOCA licensing basis analysis results for various plant

and fuel design types. It was concluded that only two events have licensing basis results in which calculated clad temperatures reach 1380°F or greater. These analyses are: 1) the peak clad temperature assessment for a single reactor coolant pump Locked Rotor/Shaft Break and 2) Rupture of a Control Rod Drive Mechanism (RCCA Ejection). All other non-LOCA analyses have reported clad temperatures which remain below approximately 1000°F. Therefore, the use of ZIRLO cladding will have no effect upon these events. The evaluation for the two non-LOCA accidents potentially affected by the use of ZIRLO clad are described below.

It was determined in Reference 4 that assuming ZIRLO cladding in the analysis of the Locked Rotor event results in a very small increase in calculated peak clad temperature (approximately 2°F). This small increase in clad temperature results in a comparable small increase in zirconium/water reaction rate, as estimated with the Baker-Just model. During the course of a postulated Locked Rotor transient, this would have a negligible effect upon the total zirconium/water reaction when compared to Zircaloy-4. This validates the results of the peak clad temperature assessment for the North Anna Units 1 and 2 Locked Rotor analysis.

For the Rod Ejection event analysis, it was determined that the ZIRLO cladding results in a small reduction in both the fraction of fuel melting at the hot spot and the fuel peak stored energy when compared with the results for Zircaloy-4. The North Anna Unit 1 and 2 licensing basis analysis results will therefore be applicable to either clad material. The assessment from Reference 4 as summarized here thus confirms that the conclusions in the North Anna Updated Final Safety Analysis Report (UFSAR) for the two affected non-LOCA accidents remain valid (Reference 10).

6. Cladding Performance for LOCA Events

Reference 4 describes modifications necessary to model ZIRLO clad fuel in the large break 1981 Evaluation Model with the BART/BASH code and in the small break NOTRUMP Evaluation Model. For North Anna Units 1 and 2, these modified Evaluation Models were utilized to demonstrate continued conformance with 10 CFR 50.46 (acceptance criteria for emergency core cooling systems) for a postulated Large and Small Break LOCA with a core containing ZIRLO clad fuel.

6.1 Large Break LOCA Evaluation

The limiting case Large Break LOCA analysis for North Anna Units 1 and 2 has been shown to have a 0.4 break discharge coefficient (CD) as documented in the UFSAR. Since the hydraulic transient determines the most limiting peak clad temperature (PCT) and Reference 4 demonstrated that ZIRLO clad fuel did not result in a more severe hydraulic transient than Zircaloy-4 clad fuel, only the most limiting break size need be analyzed. In addition, the conclusions of Reference 4 indicated that since only the clad heatup portion of the transient is significantly affected by the ZIRLO clad fuel related changes, only the LOCBART computer code which incorporated the modifications described in Reference 4 was utilized for the North Anna Units 1 and 2 ZIRLO clad fuel analysis.

A reanalysis of the North Anna Units 1 and 2 Large Break LOCA transient was recently completed employing the 1981 Evaluation Model with the BASH

code, including changes previously reported to the NRC in compliance with 10 CFR 50.46. This analysis of record was used as the starting point for the assessment of ZIRLO clad behavior. A direct sensitivity for the effect of ZIRLO clad fuel was obtained by reanalyzing the limiting case LOCBART run with appropriate changes to model the revised cladding and fuel properties design characteristics.

Due to the differences in the strain characteristics between Zircaloy-4 and ZIRLO, a study of the effects of burnup on ZIRLO clad fuel for the Large Break LOCA transient was documented in Reference 4. The conclusion from the Reference 4 study was that the requirement of 10 CFR 50, Appendix K to determine the limiting time in fuel life will continue to be met by assuming beginning of cycle fuel properties. This conclusion has been judged to be applicable for North Anna Units 1 and 2 and was applied in the ZIRLO clad Large Break LOCA sensitivity analysis.

The sensitivity analysis of the North Anna Units 1 and 2 limiting CD=0.4 Large Break LOCA with ZIRLO cladding calculated that the peak clad temperature at the limiting time in life is 2066°F. The result for this case from the pending analysis of record as discussed above is 2044°F. For the ZIRLO analysis, the maximum local metal-water reaction is 6.28 percent and total core metal-water reaction is less than 1.0 percent. The temperature transient is terminated at a time when core geometry is still amenable to cooling. As a result, the core temperature will continue to decrease and the ability to remove decay heat generated in the fuel for an extended period of time will be provided. Therefore, the 10 CFR 50.46 acceptance criteria continue to be satisfied for North Anna Units 1 and 2 operation with ZIRLO clad fuel.

6.2 Small Break LOCA Evaluation

The limiting case Small Break LOCA analysis for North Anna Units 1 and 2 has been shown to have a 3 inch break size as documented in the UFSAR. As described in Section 6.1 for the Large Break LOCA event, the hydraulic transient determines the most limiting PCT for the Small Break LOCA event. It was judged in Reference 4 that the cladding differences between Zircaloy-4 and ZIRLO have a small effect on the core average fuel rod modelled in the Small Break LOCA calculation with the NOTRUMP model, and thus, the effect on the thermal-hydraulic response of the RCS would be insignificant. Therefore, only the LOCTA-IV computer code which incorporated the modifications described in Reference 4 was utilized for the limiting 3 inch break for the North Anna Units 1 and 2 ZIRLO clad fuel analysis.

The existing North Anna Units 1 and 2 Small Break LOCA analysis of record employed the NOTRUMP Evaluation Model which included changes previously reported to the NRC in compliance with 10 CFR 50.46. A direct sensitivity for the effect of ZIRLO clad fuel was obtained by reanalyzing the limiting case LOCTA-IV computer code run with appropriate changes to model the revised cladding and fuel properties design characteristics.

The North Anna analyses performed with the approved NOTRUMP Small Break LOCA Evaluation Model have assumed beginning of life fuel conditions. Both the existing Zircaloy-4 analysis of record and the ZIRLO sensitivity analysis incorporate this assumption. The reported results of each

analysis have been adjusted by addition of a temporary PCT penalty which accounts for the most limiting time in life. This penalty has been quantified employing an evaluation tool developed by Westinghouse to conservatively estimate the effects associated with clad burst and heatup during the Small Break LOCA transient.

The sensitivity analysis of the North Anna Units 1 and 2 limiting 3 inch Small Break LOCA with ZIRLO cladding calculated that the peak clad temperature at the limiting time in life is 1934°F. The analysis of record result for this case is 1916°F. For the ZIRLO analysis, the maximum local metal-water reaction is 2.46 percent and total core metal-water reaction is less than 1.0 percent. The temperature transient is terminated at a time when core geometry is still amenable to cooling. As a result, the core temperature will continue to decrease and the ability to remove decay heat generated in the fuel for an extended period of time will be provided. Therefore, the 10 CFR 50.46 acceptance criteria continue to be satisfied for operation of North Anna Units 1 and 2 with ZIRLO clad fuel.

6.3 Conclusions

The results of studies performed to assess the effects of ZIRLO clad fuel rods on the Large and Small Break LOCA for North Anna Units 1 and 2 have demonstrated continued conformance with the 10 CFR 50.46 acceptance criteria.

7. Assessment of Unreviewed Safety Question

From the previous evaluation, it is concluded that the use of fuel assemblies containing fuel rods, guide thimble tubes, instrumentation tubes and mid-span grids fabricated with ZIRLO alloy in North Anna Units 1 and 2 in Cycle 11 and subsequent cycles does not result in the acceptable safety limits for any incident being exceeded and does not result in any unreviewed safety questions as defined in 10 CFR 50.59. The basis for this determination is delineated below.

7.1 Probability of Previously Evaluated Accidents

This Safety Assessment documents that the probability of an accident previously evaluated in the North Anna Units 1 and 2 UFSAR is not increased. The designs for Cycle 11 and subsequent cycles at both units will meet all applicable design criteria and ensure that all pertinent licensing basis acceptance criteria are met. Though the fuel and core designs are not directly related to the probability of occurrence of any previously evaluated accident, the demonstrated adherence to applicable standards and acceptance criteria precludes new challenges to components and systems that could increase the probability of any previously evaluated accident. Specifically, the use of fuel rods, guide thimble tubes, instrumentation tubes and mid-span grids fabricated with ZIRLO alloy will not increase the probability of occurrence of an accident previously evaluated in the North Anna Units 1 and 2 UFSAR. The clad integrity is maintained and the structural integrity of the fuel rods, fuel assemblies, and core is not affected. The ZIRLO alloy improves corrosion performance and dimensional stability and will not cause the

core to operate in excess of pertinent design basis operating limits. Therefore, the probability of occurrence of an accident previously evaluated in the UFSAR has not increased.

7.2 Consequences of Previously Evaluated Accidents

This Safety Assessment documents that the consequences of an accident previously evaluated in the North Anna Units 1 and 2 UFSAR are not increased. The design of Cycle 11 and subsequent cycles for each unit does not have a direct role in mitigating the consequences of any accident, and does not affect any of the bases (assumptions, actions, etc.) for the current analyses as described in the North Anna Units 1 and 2 UFSAR. The reload core design for Cycle 11 and subsequent cycles at both units will meet all applicable design criteria and ensure that all pertinent licensing basis acceptance criteria are met. The demonstrated adherence to these standards and criteria precludes new challenges to components and systems that could (a) adversely affect the ability of existing components and systems to mitigate the consequences of any accident, and/or (b) adversely affect the integrity of the fuel rod cladding as a fission product barrier. Furthermore, adherence to applicable standards and criteria ensures that these fission product barriers maintain design margin to safety limits. Specifically, the use of fuel rods, guide thimble tubes, instrumentation tubes and mid-span grids fabricated with ZIRLO alloy will not increase the consequences of an accident previously evaluated in the North Anna Units 1 and 2 UFSAR. The ZIRLO alloy is similar in chemical composition to, and has physical and mechanical properties similar to, Zircaloy-4 and will not cause the core to operate in excess of pertinent design basis operating limits.

Thus, clad integrity is maintained. Since the dose predictions presented in the UFSAR are not sensitive to the fuel rod cladding material changes specified in this report, the radiological consequences of accidents previously evaluated in the North Anna Units 1 and 2 UFSAR have not increased.

7.3 Possibility of Accidents Not Previously Evaluated

This Safety Assessment documents that the possibility of an accident which is different from any already in the North Anna Units 1 and 2 UFSAR is not created. The design of Cycle 11 and subsequent cycles for each unit will meet all applicable design criteria and ensure that all pertinent licensing basis acceptance criteria are met. The demonstrated adherence to these standards and criteria precludes new challenges to components and systems that could introduce a new type of accident. Specifically, the use of fuel rods, guide thimble tubes, instrumentation tubes and mid-span grids fabricated with ZIRLO alloy will not create the possibility of an accident of a different type than any previously evaluated in the North Anna Units 1 and 2 UFSAR. The fuel assemblies containing the fuel rods, guide thimble tubes, instrumentation tubes and mid-span grids fabricated with ZIRLO alloy will satisfy the same design bases as those used for fuel assemblies in previous fuel regions (References 1, 4, and 6 through 9). All design and performance criteria will continue to be met and no new single failure mechanisms have been created, nor will they cause the core to operate in excess of pertinent design basis operating limits. Therefore, the possibility of an accident of a different type than any previously evaluated in the UFSAR has not been created.

7.4 Probability of Previously Evaluated Malfunction of Equipment Important to Safety

This Safety Assessment documents that the probability of a malfunction of equipment important to safety previously evaluated in the North Anna Units 1 and 2 UFSAR is not increased. The design of Cycle 11 and subsequent cycles at both units wi ˉ meet all applicable design criteria and ensure that all pertinent licensing basis acceptance criteria are met. Demonstrated adherence to applicable standards and acceptance criteria precludes new challenges to components and systems that could increase the probability of any previously evaluated malfunction of equipment important to safety. Specifically, the use of fuel rods, guide thimble tubes, instrumentation tubes and mid-span grids fabricated with ZIRLO alloy, in compliance with the methodology described in Reference 1, will not increase the probability of occurrence of a malfunction of equipment important to safety previously evaluated in the North Anna Units 1 and 2 UFSAR. No new performance requirements are being imposed on any system or component such that any design criteria will be exceeded nor will the core be operated in excess of pertinent design basis operating limits. No new modes or limiting single failures have been created with the ZIRLO alloy design. Therefore, the probability of occurrence of a malfunction of equipment important to safety previously evaluated in the UFSAR has not increased.

7.5 Consequences of Previously Evaluated Malfunction of Equipment Important to Safety

This Safety Assessment documents that the consequences of a malfunction of equipment important to safety previously evaluated in the North Anna

Units 1 and 2 UFSAR are not increased. The design of Cycle 11 and subsequent cycles at both units does not have a direct role in mitigating the consequences of any malfunction of equipment important to safety, and does not affect any of the bases (assumptions, actions, etc.) for the current analyses as described in the North Anna Units 1 and 2 UFSAR. The Cycle 11 designs for both units as well as subsequent cycle designs will meet all applicable design criteria and ensure that all pertinent licensing basis acceptance criteria are met. The demonstrated adherence to these standards and criteria precludes new challenges to components and systems that could (a) adversely affect the ability of existing components and systems to mitigate the consequences of any accident, and/or (b) adversely affect the integrity of the fuel rod cladding as a fission product barrier. Furthermore, adherence to applicable standards and criteria ensures that these fission product barriers maintain the design margin of safety. Specifically, the use of fuel rods, guide thimble tubes, instrumentation tubes and mid-span grids fabricated with ZIRLO alloy will not increase the consequences of a malfunction of equipment important to safety previously identified in the North Anna Units 1 and 2 UFSAR. The dose predictions presented in the UFSAR are not sensitive to the fuel rod cladding material. The use of ZIRLO alloy does not change the performance requirements on any system or component such that any design criteria will be exceeded and will not cause the core to operate in excess of pertinent design basis operating limits. No new modes or limiting single failures have been created with the ZIRLO alloy design. Therefore, the radiological consequences of a malfunction of equipment important to safety previously evaluated in the North Anna Units 1 and 2 UFSAR have not increased.

7.6 Possibility of Malfunction of Equipment Important to Safety Not Previously Evaluated

This Safety Assessment documents that the possibility of a malfunction of equipment important to safety different from any already evaluated in the North Anna Units 1 and 2 UFSAR is not created. The design for Cycle 11 at each unit and subsequent cycles will meet all applicable design criteria and ensure that all pertinent licensing basis acceptance criteria are met. The demonstrated adherence to these standards and criteria precludes new challenges to components and systems that could introduce a new type of malfunction of equipment important to safety. Specifically, the use of fuel rods, guide thimble tubes, instrumentation tubes and mid-span grids fabricated with ZIRLO alloy will not create the possibility of a malfunction of equipment important to safety of a different type than any previously evaluated in the North Anna Units 1 and 2 UFSAR. All original design and performance criteria continue to be met, and no new failure modes have been created for any system, component, or piece of equipment. No new single failure mechanisms have been introduced, nor will the core operate in excess of pertinent design basis operating limits. Therefore, the possibility of a malfunction of equipment important to safety of a different type than any previously evaluated in the UFSAR has not been created.

7.7 Margin of Safety

This Safety Assessment documents that the margin of safety as defined in the Bases to any Technical Specification is not reduced. The design for Cycle 11 and subsequent cycles at both units will meet all applicable

design criteria and ensure that all pertinent licensing basis acceptance criteria are met. It has been determined that the North Anna Units 1 and 2 current design and safety limits (Reference 1) remain applicable, and that these limits are supported by the applicable Technical Specifications for Cycle 11 and subsequent cycles. Specifically, the use of fuel assemblies containing fuel rods, guide thimble tubes, instrumentation tubes and mid-span grids fabricated with ZIRLO alloy will not reduce the margin of safety as defined in the basis for any Technical Specification. The use of these fuel assemblies will take into consideration the normal core operating conditions allowed in the Technical Specifications. For each cycle reload core, these fuel assemblies will be specifically evaluated using approved reload design methods (Reference 6) and approved fuel rod design models and methods (References 4, 8 and 9). This will include consideration of the core physics analysis peaking factors and core average linear heat rate effects. Therefore, the margin of safety as defined in the Bases to the Technical Specifications has not been reduced.

8. Conclusions

The Technical Specifications ensure that the plants operate in a manner that provides acceptable levels of protection for the health and safety of the public. The Technical Specifications are based upon assumptions made in the safety and accident analyses, including those relating to the core design. This ensures adequate margin to the regulated acceptance criteria for the accident analyses. Since it has been concluded that the core design parameters and assumptions utilized in the accident analyses are appropriate with consideration for the introduction of fuel rods,

guide thimble tubes, instrumentation tubes and mid-span grids fabricated with ZIRLO alloy, the conclusions in the North Anna Units 1 and 2 UFSAR are valid. Therefore the regulated margin of safety as defined in the Bases of the Technical Specifications is not affected by the use of ZIRLO alloy in North Anna Units 1 and 2.

Based on the acceptance criteria as specified in References 1 and 4, and on the evaluations and analysis results presented above, it can be concluded that fuel rods, guide thimble tubes, instrumentation tubes and mid-span grids fabricated with ZIRLO alloy will perform better than fuel rods, guide thimble tubes, instrumentation tubes and mid-span grids fabricated with Zircaloy-4, and therefore using ZIRLO alloy does not constitute an unreviewed safety question as defined by 10 CFR 50.59 (a)(2).

SUMMARY

The foregoing analyses and evaluations demonstrate that the conclusions of the accident analyses in the North Anna Units 1 and 2 UFSAR remain valid for the proposed material change from Zircaloy-4 to ZIRLO in the fuel assemblies. Each pertinent design and safety criterion was evaluated for the impact of implementing ZIRLO alloy fuel rod cladding, guide thimble tubes, instrumentation tubes, and mid-span grids, and all evaluation results were found to be acceptable. It has also been determined that the current core design parameters and methods will remain applicable for the design and analysis of fuel with fuel rod and fuel assembly components fabricated from the ZIRLO alloy.

TABLE 1

Nominal Compositions of
ZIRLO and Zircaloy-4 Alloys

Element	Zircaloy-4 (wt %)*	ZIRLO (wt %)
Sn	1.45	1.0
Fe	0.21	0.10
Cr	0.10	----
Nb	----	1.0
Zr	Balance	Balance

* Recent Zircaloy-4 cladding has been manufactured under a tighter specification on the concentration of tin to improve corrosion resistance. This low-tin material still falls within the nominal ranges for Zircaloy-4.

REFERENCES

1. Letter from W. L. Stewart (Virginia Electric and Power Company) to Leon B. Engle (NRC), "North Anna Power Station Units 1 and 2 - Proposed Technical Specifications Change - North Anna Fuel Assembly Design Change," Serial Number 89-795, January 15, 1990.

2. "Use of fuel with Zirconium-Based (Other than Zircaloy) Cladding (10 CFR 50.44, 50.46, and Appendix K to Part 50)," Federal Register, Vol. 57, No. 169, Rules and Regulations, Pages 39353 and 39355, August 31, 1992.

3. "Safety Evaluation by the Office of Nuclear Regulation Related to Amendment No. 94, Facility Operating License No. NPF-4, Virginia Electric and Power Company, Old Dominion Electric Cooperative, North Anna Power Station, Unit No. 1," Docket No. 50-338, May 13, 1987.

4. Davidson, S. L., and Nuhfer, D. L. (Eds.), "VANTAGE+ Fuel Assembly Reference Core Report," WCAP-12610, June 1990; and Davidson, S. L., and Nuhfer, D. L. (Eds.), "Westinghouse Responses to NRC Request for Additional Information on WCAP-12610, 'VANTAGE+ Fuel Assembly Reference Core Report'," WCAP-12610, Addendum 1, February 1991.

5. Letter from A. C. Thadani (NRC) to S. R. Tritch (Westinghouse), "Acceptance for Referencing of Topical Report WCAP-12610, 'VANTAGE+ Fuel Assembly Reference Core Report'," TAC.NO. 77258, July 1, 1991

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