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July 17, 2002

U. S. Nuclear Regulatory Commission
Washington, DC 20555

ATTENTION: Document Control Desk

SUBJECT: Calvert Cliffs Nuclear Power Plant
Unit Nos. 1 & 2; Docket Nos. 50-317 & 50-318
Westinghouse Lead Fuel Assemblies – Temporary Exemption Request and License Amendment Request

Pursuant to Title 10 of the Code of Federal Regulations (CFR) 50.12(a), Calvert Cliffs Nuclear Power Plant, Inc. requests a temporary exemption for Calvert Cliffs Unit No. 2 from the requirements of 10 CFR 50.46, 10 CFR 50.44, and 10 CFR Part 50, Appendix K. Pursuant to 10 CFR 50.90, Calvert Cliffs Nuclear Power Plant also requests an amendment to the Renewed Operating License Nos. DPR-53 and DPR-69 to incorporate the changes described below into the Technical Specifications for Calvert Cliffs Unit Nos. 1 and 2.

This exemption will allow up to four lead fuel assemblies (LFAs) manufactured by Westinghouse Electric Company (Westinghouse) with a limited number of fuel rods clad with advanced zirconium-based alloys to be inserted into the core during the next Unit 2 refueling outage, scheduled to begin in February 2003. The CFR specifies standards and acceptance criteria only for fuel rods clad with zircaloy or ZIRLO. Thus, a temporary exemption is requested to use a limited number of fuel rods clad with advanced zirconium-based alloys that are not zircaloy or ZIRLO.

As detailed below, this temporary exemption is necessary to conduct representative testing of LFAs in Calvert Cliffs Unit 2 during Cycles 15 and 16. This testing is intended to provide data to support the development of new and improved fuel cladding materials and fuel evaluation codes and methods. We will provide the Nuclear Regulatory Commission the inspection results to assist them in their continuing evaluations of fuel performance of the LFAs.

The Westinghouse LFAs may be reinserted for a third cycle if the inspections justify additional duty cycles. An explicit submittal for a third cycle will be provided at that time. Other changes associated with the LFAs (e.g., increased fuel rod length) or the reload batch will be evaluated under 10 CFR 50.59.

A001

Calvert Cliffs reviewed WCAP-15604-NP, Revision 1, "Limited Scope High Burnup Lead Test Assemblies" in the preparation of the attached LFA report. The intent of WCAP-15604 is to provide the basis for the operation of a number of fuel assemblies with rod burnups that are greater than the current licensed lead rod average burnup (up to 75 GWD/MTU). At this time, Calvert Cliffs is not pursuing an extension to the licensed burnup limit. Nevertheless, key elements of WCAP-15604 [e.g., review of mechanical properties, fuel rod design, impact on loss-of-coolant accident (LOCA) and non-LOCA] were assessed in the attached report.

A related change to the Technical Specifications is also required. Currently, Calvert Cliffs Technical Specification 4.2.1, Fuel Assemblies, only allows fuel that is clad with either zircaloy or ZIRLO. Pursuant to 10 CFR 50.90, we request an Amendment to the Calvert Cliffs Unit 2 Technical Specifications to allow the installation of up to four Westinghouse LFAs into the Unit 2 Cycles 15 and 16 cores. In addition, the statements currently in Technical Specification 4.2.1 concerning the lead test assemblies that were allowed to be inserted for Unit 1 Cycles 13, 14, and 15 have been deleted. Unit 1 completed Cycle 15 in February 2002 and therefore these statements are no longer applicable. The proposed change to Technical Specification 4.2.1 is shown in Attachment (1). The final Technical Specification pages will be renumbered to accommodate the insertion of this change, if necessary.

Calvert Cliffs is in the process of transitioning to ZIRLO as the standard cladding, with the first ZIRLO cladding inserted during the spring 2002 refueling outage in Unit 1 Cycle 16. The purpose of the Westinghouse LFA program is to utilize improved zirconium-based alloys in order to demonstrate that they possess greater fuel reliability, improved thermal margin, increased fuel discharge burnup and will provide for more favorable fuel economics.

Current plans at Calvert Cliffs involve replacement of the steam generators during the upcoming 2003 refueling outage. Consistent with Reactor Coolant System chemistry changes for replacement steam generators on Unit 1, the maximum lithium concentration on Unit 2 will be raised from 3.5 to 5.25 ppm. Prior to implementing this change, Calvert Cliffs will perform a technical review to ensure that there will be no adverse impacts on the fuel performance of the LFAs.

BACKGROUND

The Calvert Cliffs Unit 2 core consists of 217 fuel assemblies. Each fresh fuel assembly consists of 176 fuel rods, 5 guide tubes, a bottom Inconel and 8 zircaloy fuel rod spacer grids, upper and lower end fittings, and a hold-down device. The rods are arranged in a square 14x14 array. The guide tubes, spacer grids, and end fittings form the structural frame of the assembly. The four outer guide tubes are mechanically attached to the end fittings and the spacer grids are welded to all five guide tubes.

In a standard fresh fuel assembly, the fuel rods consist of slightly enriched uranium dioxide cylindrical ceramic pellets and a round wire stainless steel compression spring located at the top of the fuel column, all encapsulated within a seamless ZIRLO tube with a Zircaloy-4 cap welded at each end. The uranium dioxide pellets are dished and chamfered on both ends to accommodate thermal expansion and swelling.

Title 10 CFR 50.46(a)(1)(i) states, “Each boiling or pressurized light-water nuclear power reactor fueled with uranium oxide pellets within cylindrical zircaloy or ZIRLO cladding must be provided with an Emergency Core Cooling System (ECCS) that must be designed so that its calculated cooling performance following postulated loss-of-coolant accidents conforms to the criteria set forth in paragraph (b) of this section. Emergency Core Cooling System cooling performance must be calculated in accordance with an acceptable evaluation model and must be calculated for a number of postulated loss-of-coolant accidents of different sizes, locations, and other properties sufficient to provide assurance that the most severe postulated loss-of-coolant accidents are calculated." Section 10 CFR 50.46 goes on to delineate specifications for peak cladding temperature, maximum cladding oxidation, maximum hydrogen generation, coolable geometry, and long-term cooling.

In addition, 10 CFR 50.44(a) states, "Each boiling or pressurized light-water nuclear power reactor fueled with oxide pellets within cylindrical zircaloy or ZIRLO cladding, must, as provided in paragraphs (b) through (d) of this section, include means for control of hydrogen gas that may be generated, following a postulated loss-of-coolant accident (LOCA). . . ." Since 10 CFR 50.46 and 10 CFR 50.44 specifically refer to fuel with zircaloy or ZIRLO clad, the use of fuel clad with zirconium-based alloys that do not conform to either of these two designations requires an exemption from this section of the Code.

Finally, 10 CFR Part 50, Appendix K, paragraph I.A.5, states, "The rate of energy release, hydrogen generation, and cladding oxidation from the metal/water reaction shall be calculated using the Baker-Just equation." Since the Baker-Just equation presumes the use of zircaloy or ZIRLO cladding, the use of fuel with zirconium-based alloys that do not conform to either of these two designations requires an exemption from this section of the Code.

We plan to insert up to four Westinghouse LFAs in Calvert Cliffs Unit 2 containing advanced cladding materials that do not meet the definition of zircaloy or ZIRLO. The LFAs are scheduled to be inserted into the core at the next Unit 2 refueling outage, scheduled to begin in February 2003, and will remain in the Calvert Cliffs Unit 2 core for Cycles 15 and 16. Presently, Cycle 16 is scheduled to end on or about March 2007. We are requesting a temporary exemption to 10 CFR 50.46, 10 CFR 50.44, and 10 CFR Part 50, Appendix K, for the period when these LFAs reside in the core.

We believe that the standards of 10 CFR 50.12 are satisfied in this case. Special circumstances are present, as described in 10 CFR 50.12(a)(ii), to warrant granting the temporary exemption. They are described below.

10 CFR 50.12 REQUIREMENTS

The standards set forth in 10 CFR 50.12 provide that specific exemptions may be granted that:

- are authorized by law;
- are consistent with the common defense and security;
- will not present an undue risk to the public health and safety; and
- are accompanied by special circumstances.

We believe that the activities to be conducted under the temporary exemption are clearly authorized by law and are consistent with the common defense and security. The remaining standards for the temporary exemption are also satisfied, as described below.

No Undue Risk

The temporary exemption will not present an undue risk to the public health and safety. The attached safety evaluation performed by Westinghouse demonstrates that the predicted chemical, mechanical, and material performance of the advance zirconium-based cladding is within that approved for Zircaloy-4 or ZIRLO under all anticipated operational occurrences and postulated accidents. Furthermore, the LFAs will be placed in non-limiting core locations. Westinghouse considers information contained in the attached safety evaluation report (Attachment 4) proprietary. Accordingly, it is requested that the report be withheld from public disclosure in accordance with the provisions of 10 CFR 2.790 and that this material be appropriately controlled. The reasons for the classification of this material as proprietary are delineated in the affidavit provided in Attachment (3). A non-proprietary version of the Westinghouse safety evaluation report is included as Attachment (2).

In the unlikely event that cladding failures occur in the LFAs, environmental impact would be minimal and is bounded by previous environmental assessments. In addition, the insertion of the LFAs will not foreclose the option of reverting to the use of standard ZIRLO cladding. That is, the change is not irreversible. The long-term benefits expected from the LFA program include reduced incidence of fuel failure, longer operating cycles, higher fuel burnup, and improved thermal margin.

Special Circumstances

This request involves special circumstances as set forth in 10 CFR 50.12(a)(ii). The underlying purpose of 10 CFR 50.46 is to ensure that nuclear power facilities have adequate acceptance criteria for ECCS. The effectiveness of the ECCS in Calvert Cliffs Unit 2 will not be affected by the insertion of the LFAs. Due to the similarities in the material properties of the advanced zirconium-based alloys to Zircaloy-4 or ZIRLO and the location of the LFAs in non-limiting locations, the Westinghouse safety evaluation concluded that the ECCS performance would not be adversely affected. Thus, the Westinghouse safety evaluation demonstrates the acceptability of the advanced zirconium-based cladding material under LOCA conditions.

The intent of 10 CFR 50.44 is to ensure that there is an adequate means of controlling accident generated hydrogen. The hydrogen produced in a post-LOCA scenario comes from a metal-water reaction. The Westinghouse safety evaluation also shows that the use of the Baker-Just equation to determine the metal-water reaction rate is conservative for the advanced zirconium-based cladding material. Therefore, the amount of hydrogen generated by metal-water reaction in these materials will be within the design basis.

The intent of paragraph I.A.5 of Appendix K to 10 CFR Part 50 is to apply an equation for rates of energy release, hydrogen generation, and cladding oxidation from a metal-water reaction that conservatively bounds all post-LOCA scenarios. The Westinghouse safety evaluation shows that due to the similarities in the composition of the advanced zirconium-based cladding and Zircaloy-4 or ZIRLO, the application of the Baker-Just equation will continue to conservatively bound all post-LOCA scenarios.

The wording of the regulations renders the criteria of 10 CFR 50.46, 10 CFR 50.44, and 10 CFR Part 50 Appendix K inapplicable to the advanced zirconium-based cladding, even though the Westinghouse safety evaluation shows that the intent of the regulations are met. Application of these regulations in this particular circumstance would not meet the underlying purpose of the rule nor is it necessary to achieve the underlying purpose of the rule, and therefore special circumstances exist.

PROPOSED TECHNICAL SPECIFICATION CHANGES

This submittal proposes to change Technical Specification 4.2.1, Fuel Assemblies, as shown on the marked-up pages for Calvert Cliffs Unit 2 in Attachment (1). The change allows up to four Westinghouse fuel assemblies with advanced cladding material to be inserted in Unit 2 Cycle 15 and 16 cores. In addition, the statements concerning the lead test assemblies that were allowed to be inserted for Unit 1 Cycles 13, 14, and 15 have been deleted. Unit 1 completed Cycle 15 in February 2002 and therefore these statements are no longer applicable.

The Westinghouse safety evaluation demonstrates that the predicted chemical, mechanical, and material performance of the advanced zirconium-based cladding is within that approved for Zircaloy-4 or ZIRLO under all anticipated operational occurrences and postulated accidents. Furthermore, the LFAs will be placed in non-limiting core locations.

DETERMINATION OF SIGNIFICANT HAZARDS

The proposed change to the Technical Specifications has been evaluated against the standards in 10 CFR 50.92. Note that this determination is not required to address the requested temporary exemption, in accordance with 10 CFR 50.12. The proposed change has been determined to not involve a significant hazards consideration, in that operation of the facility in accordance with the proposed amendments:

1. *Would not involve a significant increase in the probability or consequences of an accident previously evaluated.*

   Calvert Cliffs Technical Specification 4.2.1, Fuel Assemblies, states that fuel rods are clad with either zircaloy or ZIRLO. This reflects the requirements of 10 CFR 50.44, 50.46, and 10 CFR Part 50, Appendix K, which also restricts fuel rod cladding materials to zircaloy or ZIRLO. Calvert Cliffs Nuclear Power Plant, Inc. proposes to insert up to four Westinghouse fuel assemblies into Calvert Cliffs Unit 2 that have some fuel rods clad in zirconium alloys that do not meet the definition of zircaloy or ZIRLO. An exemption to the regulations has also been requested to allow these fuel assemblies to be inserted into Unit 2. The proposed change to the Calvert Cliffs Technical Specifications will allow the use of cladding materials that are not zircaloy or ZIRLO for two fuel cycles once the exemption is approved. To obtain approval of new cladding materials, 10 CFR 50.12 requires that the applicant show that the proposed exemption is authorized by law, is consistent with the common defense and security, will not present an undue risk to the public health and safety, and is accompanied by special circumstances. The proposed change to the Technical Specification is effective only as long as the exemption is effective. In addition, the statements concerning the exemption for Unit 1 Cycles 13, 14, and 15 have been deleted, since Unit 1 Cycle 15 is completed, and therefore the exemption has expired. The addition of what will be an approved temporary exemption for Unit 2 and the deletion of an expired Unit 1 exception to Technical Specification 4.2.1 does not change the probability or consequences of an accident previously evaluated.

   Supporting analyses indicate that since the lead fuel assemblies (LFAs) will be placed in non-limiting locations, the placement scheme and the similarity of the advanced alloys to ZIRLO will assure that the behavior of the fuel rods with these alloys are bounded by the fuel performance and safety analyses performed for the ZIRLO clad fuel rods in the Unit 2 Core. Therefore, the addition of these advanced claddings does not involve a significant increase in the probability or consequences of an accident previously evaluated.

Therefore, the proposed change does not involve a significant increase in the probability or consequences of an accident previously evaluated.

2. *Would not create the possibility of a new or different type of accident from any accident previously evaluated.*

   The proposed change does not add any new equipment, modify any interfaces with existing equipment, change the equipment's function, or change the method of operating the equipment. The proposed change does not affect normal plant operations or configuration. Since the proposed change does not change the design, configuration, or operation, it could not become an accident initiator.

   Therefore, the proposed change does not create the possibility of a new or different type of accident from any previously evaluated.

3. *Would not involve a significant reduction in the margin of safety.*

   The margin of safety for the fuel cladding is to prevent the release of fission products. Supporting analyses indicate that since the LFAs will be placed in non-limiting locations, the placement scheme and the similarity of the advanced alloys to ZIRLO will assure that the behavior of the fuel rods with these alloys are bounded by the fuel performance and safety analyses performed for the ZIRLO clad fuel rods in the Unit 2 cores. Therefore, the addition of these advanced claddings does not involve a significant reduction in the margin of safety.

   The proposed change will add an approved temporary exemption to the Unit 2 Technical Specifications allowing the installation of up to four Westinghouse LFAs. The assemblies use advanced cladding materials that are not specifically permitted by existing regulations or Calvert Cliffs' Technical Specifications. A temporary exemption to allow the installation of these assemblies has been requested. The addition of an approved temporary exemption to Technical Specification 4.2.1 is simply intended to allow the installation of the LFAs under the provisions of the temporary exemption. The license amendment is effective only as long as the exemption is effective. This amendment does not change the margin of safety since it only adds a reference to an approved, temporary exemption to the Technical Specifications.

   In addition, the words concerning the exemption for Unit 1 Cycles 13, 14, and 15 will be deleted since Unit 1 Cycle 15 is completed, and therefore, the exemption has expired. This change does not change the margin of safety since it only deletes a reference to an expired exemption to the Technical Specifications.

   Therefore, the proposed change does not involve a significant reduction in the margin of safety.

ENVIRONMENTAL ASSESSMENT

We have determined that operation with the proposed amendment would not result in any significant change in the types, or significant increases in the amounts, of any effluents that may be released offsite, and no significant increases in individual or cumulative occupational radiation exposure. Therefore, the proposed amendment is eligible for categorical exclusion as set forth in 10 CFR 51.22(c)(9). Pursuant to 10 CFR 51.22(b), no environmental impact statement, or environmental assessment is needed in connection with the approval of the proposed amendment.

SAFETY COMMITTEE REVIEW

The Plant Operations and Safety Review Committee and Offsite Safety Review Committee have reviewed this proposed change and concur that operation with the proposed changes will not result in an undue risk to the health and safety of the public.

SCHEDULE

The insertion of the LFAs is currently scheduled to occur during the next Unit 2 refueling outage, which is expected to begin in February 2003. Should this request not be granted, we would need to insert substitute fuel assemblies in their place. Therefore, we request that this temporary exemption and license amendment be approved and issued by February 1, 2003.

PRECEDENT

The Nuclear Regulatory Commission has granted exemptions for similar LFAs in Calvert Cliffs Nuclear Power Plant Unit 1 for Cycles 13, 14, and 15 and for Unit 2 for Cycle 14.

- Letter from Mr. D. G. McDonald, Jr. (NRC) to Mr. R. E. Denton (BGE), dated November 28, 1995, Temporary Exemption from 10 CFR 50.44, 10 CFR 50.46, and Appendix K to 10 CFR Part 50, for Lead Fuel Assemblies – Calvert Cliffs Nuclear Power Plant, Unit No. 1 (TAC No. M93232)
- Letter from Mr. D. G. McDonald, Jr. (NRC) to Mr. R. E. Denton (BGE), dated February 21, 1996, Issuance of Amendment for Calvert Cliffs Nuclear Power Plant, Unit No. 1 (TAC No. M94365)
- Letter from Ms. D. M. Skay (NRC) to Mr. C. H. Cruse (CCNPP), dated March 6, 2001, Calvert Cliffs Nuclear Power Plant, Unit No. 2, Exemption from the Requirements of 10 CFR Part 50, Sections 50.46, 50.44, and Appendix K (TAC No. MB0008)
- Letter from Ms. D. M. Skay (NRC) to Mr. C. H. Cruse (CCNPP), dated April 5, 2001, Calvert Cliffs Nuclear Power Plant, Unit No. 2 – Amendment RE: Lead Test Fuel Assembly (TAC No. MB0007)

Should you have questions regarding this matter, we will be pleased to discuss them with you.

Very truly yours,

Peter E. Katz

STATE OF MARYLAND :
: **TO WIT:**
COUNTY OF CALVERT :

I, Peter E. Katz, being duly sworn, state that I am Vice President - Calvert Cliffs Nuclear Power Plant, Inc. (CCNPP), and that I am duly authorized to execute and file this License Amendment Request on behalf of CCNPP. To the best of my knowledge and belief, the statements contained in this document are true and correct. To the extent that these statements are not based on my personal knowledge, they are based upon information provided by other CCNPP employees and/or consultants. Such information has been reviewed in accordance with company practice and I believe it to be reliable.

Peter E. Katz

Subscribed and sworn before me, a Notary Public in and for the State of Maryland and County of Calvert, this 17 day of July, 2002.

WITNESS my Hand and Notarial Seal:

Denise D. Snider
Notary Public

My Commission Expires:

02/01/06
Date

PEK/DJM/bjd

Attachments:
(1) Technical Specification Marked-Up Pages
(2) Safety Analysis Report for Use of Improved Zirconium-Bases Cladding Materials in Calvert Cliffs Unit 2 Batch T Lead Fuel Assemblies, April 2002 (Non-Proprietary)
(3) Proprietary Affidavit for Attachment (4)
(4) Safety Analysis Report for Use of Improved Zirconium-Bases Cladding Materials in Calvert Cliffs Unit 2 Batch T Lead Fuel Assemblies, April 2002 (Proprietary)

cc: **(Without Attachment 4)**
R. S. Fleishman, Esquire
J. E. Silberg, Esquire
Director, Project Directorate I-1, NRC
D. M. Skay, NRC
H. J. Miller, NRC
Resident Inspector, NRC
R. I. McLean, DNR

ATTACHMENT (1)

TECHNICAL SPECIFICATIONS

MARKED-UP PAGE

4.0-1

4.0 DESIGN FEATURES

4.1 Site Location

The site for the Calvert Cliffs Nuclear Power Plant is located on the western shore of the Chesapeake Bay in Calvert County, Maryland, about 10-1/2 miles Southeast of Prince Frederick, Maryland. The site is approximately 45 miles southeast of Washington, DC, and 60 miles south of Baltimore, Maryland. The exclusion area boundary has a minimum radius of 1,150 meters from the center of the plant.

4.2 Reactor Core

4.2.1 Fuel Assemblies

The reactor shall contain 217 fuel assemblies. Each assembly shall consist of a matrix of Zircalloy or ZIRLO fuel rods with an initial composition of natural or slightly enriched uranium dioxide (UO_2) as fuel material. Limited substitutions of zirconium alloy or stainless steel filler rods for fuel rods, in accordance with approved applications of fuel rod configurations, may be used. Fuel assemblies shall be limited to those fuel designs that have been analyzed with applicable NRC staff approved codes and methods and shown by tests or analyses to comply with all fuel safety design bases. A limited number of lead test assemblies that have not completed representative testing may be placed in nonlimiting core regions. ~~For Unit 1 Cycles 13, 14, and 15 only, advanced cladding material may be used in four lead test assemblies as described in an approved temporary exemption dated November 28, 1995.~~ For Unit 2 Cycle 14 only, advanced cladding material may be used in one lead test assembly as described in an approved temporary exemption dated March 6, 2001.

INSERT (A)

4.2.2 Control Element Assemblies

The reactor core shall contain 77 control element assemblies.

INSERT A

For Unit 2 Cycles 15 and 16 only, advanced cladding material from Westinghouse may be used in up to four lead test assemblies as described in approved temporary exemption dated XX/XX/XX.

ATTACHMENT (2)

SAFETY ANALYSIS REPORT FOR USE OF IMPROVED ZIRCONIUM-BASED CLADDING MATERIALS IN CALVERT CLIFFS UNIT 2 BATCH T LEAD FUEL ASSEMBLIES

APRIL 2002

[NON-PROPRIETARY]

WESTINGHOUSE PROPRIETARY CLASS 2

WCAP-15874-P
REVISION 0

SAFETY ANALYSIS REPORT FOR USE OF IMPROVED ZIRCONIUM-BASED CLADDING MATERIALS IN CALVERT CLIFFS UNIT 2 BATCH T LEAD FUEL ASSEMBLIES

APRIL 2002

LEGAL NOTICE

This report was prepared as an account of work performed by Westinghouse Electric Company LLC (Westinghouse) for Calvert Cliffs Nuclear Power Plant Incorporated (Calvert Cliffs). Neither Calvert Cliffs nor Westinghouse, nor any person acting on their behalf:

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B. Assumes any liabilities with respect to the use of, or for damages resulting from the use of, any information, apparatus, method or process disclosed in this report.

WCAP-15874-NP, REVISION 0

SAFETY ANALYSIS REPORT FOR USE OF IMPROVED ZIRCONIUM-BASED CLADDING MATERIALS IN CALVERT CLIFFS UNIT 2 BATCH T LEAD FUEL ASSEMBLIES

April 2002

Author: Anand Garde

Approved: David W. Heyer

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Executive Summary

The purpose of this report is to describe the chemical, mechanical, and material properties of improved fuel rod cladding materials to be used for four fuel assemblies for Calvert Cliffs 2, Batch T. The impact of the improved fuel rod cladding materials on the safety analysis will also be described.

The predicted chemical, mechanical, and material properties of the improved zirconium-based fuel cladding alloys fall within the range of the properties for Zircaloy-4 or ZIRLO™ under all anticipated operating conditions, including those considered in the safety analysis. Therefore, it is concluded that the fuel rod design criteria currently used for the design and analysis of the Zircaloy-4 and ZIRLO™ clad rods will also be applicable to the fuel rods clad with the improved zirconium alloys for lead fuel assemblies (LFAs) to be included in the Calvert Cliffs Unit 2, Batch T fuel. Furthermore, these LFAs and the fuel rods clad with the improved alloy materials will be placed in non-limiting core locations that experience no more than 0.95 of the highest core power density through the irradiation periods. Thus, the nominal fuel performance characteristics of the improved alloys will be essentially the same as those observed for other fuel rods. Since the current fuel design criteria are applicable to the proposed cladding variants and the expected operating conditions are within those assumed for the standard clad rods currently licensed for Calvert Cliffs Unit 2, it is concluded that the licensing basis currently in effect will not be compromised by incorporating a limited number of fuel rods fabricated with improved zirconium alloy cladding.

SAFETY ANALYSIS REPORT FOR USE OF IMPROVED ZIRCONIUM-BASED CLADDING MATERIALS IN CALVERT CLIFFS UNIT 2, BATCH T LEAD FUEL ASSEMBLIES

1.0 INTRODUCTION

Westinghouse Electric Company LLC has developed improved cladding materials to meet the nuclear industry's continued need for greater fuel reliability, improved thermal margin, increased fuel discharge burnup, and more favorable fuel cycle economics. Four Lead Fuel Assemblies (LFAs) with improved cladding materials are planned for irradiation in Calvert Cliffs Unit 2 reactor, beginning with Batch T in Cycle 15 (CC2T). Currently these LFAs are scheduled for two cycles of irradiation in Unit 2 (Cycles 15 and 16) and a third cycle in Unit 1 Cycle 19. According to current plans, the burnup achieved after two cycles of irradiation will be below the current approved peak pin limit of 60 GWd/MTU (Ref. 1). After [ ] poolside inspections and examinations will be conducted. If the LFA performance data obtained from these poolside inspections justify higher burnups, the LFAs will be irradiated for an additional cycle. An explicit submittal will be made at that time to exceed the current 60 GWd/MTU burnup limit.

The primary feature of the LFA is the introduction of improved zirconium-based alloys for the fuel cladding with expected superior corrosion resistance. [ ]

1.1 Background

The corrosion performance requirements for nuclear fuel cladding are becoming more demanding with the continued trend in the nuclear industry towards increased fuel discharge burnups and longer exposure cycles. Under these more demanding operating conditions, the corrosion resistance of OPTIN Zircaloy-4, the most commonly used fuel cladding material for CE designed fuel, is not adequate to provide the necessary operational flexibility and performance margins. Although replacement of OPTIN by

ZIRLO™ (Ref. 2) is expected to improve the performance margins, the use of more improved cladding materials will provide additional margin for high burnup and high duty operation. Westinghouse has developed low-tin ZIRLO™ [

] Improved corrosion

performance of [

]

Superior corrosion performance of [

]

[

]

[

]

[

] Table 1 shows the planned number of fuel rods using the improved cladding variants in the proposed four lead fuel assemblies. It is planned that a mixture of these alloys will be used in each of the four LFAs. The total number of fuel rods with improved cladding will be no more than [ ]. The number of individual rods with improved alloy cladding may be interchanged for manufacturing flexibility, maintaining the total number of improved cladding rods within the maximum of [ ]. Fuel rods clad with ZIRLO™, which is the standard used for the rest of the Batch T fuel, are also included in these LFAs as controls. The cladding types to be used were chosen [

]

The fuel rods containing the special cladding alloys are identical in design and dimension to the ZIRLO™ fuel rods used in the LFAs. Specifically, all the rods will contain urania fuel pellets of the same enrichment as the ZIRLO™ fuel rods in the LFAs. All rods [ ] in the four LFAs will be of the same length. [

] The fuel rods in these LFAs are identical in other fuel rod design aspects as the fuel rods used in remaining fuel assemblies in CC2T [

]

[

]

[

] These assemblies will be placed in non-limiting locations in the core with predicted peak pin power not more than 0.95 of the predicted maximum peak pin power in the core. As a result, the behavior of the fuel rods clad with these alloys is bounded by the fuel performance and safety analyses performed for the ZIRLO™ clad fuel rods and will meet the performance criteria.

Visual examinations and eddy current oxide thickness measurements are planned to confirm continued satisfactory behavior. Moreover, [

] prior to the start of Cycle 15 of CC2. The reconstitutable upper end fitting feature of the Calvert Cliffs fuel assemblies will provide access to the fuel rods for reconstitution in the unlikely event that there is any indication of unsatisfactory performance following inter-cycle examinations and measurements.

1.2 Exemption From 10 CFR 50.46, 50.44 and Appendix K to 10 CFR Part 50 Requirements

The Code of Federal Regulations specifies standards and acceptance criteria only for fuel rods clad with Zircaloy or ZIRLO™. Because the chemical compositions of the [ ] improved cladding alloys used in the fuel rods included in the LFAs are outside the Zircaloy and ZIRLO™ specifications, an exemption is needed to use the fuel rods clad with these alloys. This report describes the composition and properties of the improved alloys and provides a safety evaluation for the fuel rods clad with these alloys.

2.0 EVALUATION

2.1 CHEMICAL, MECHANICAL, AND OTHER MATERIAL PROPERTIES

2.1.1 Chemical Properties

The chemical compositions of the improved cladding alloys are given in Table 2. The chemical compositions of the cladding alloys previously approved by the Nuclear Regulatory Commission (NRC) for the demonstration assemblies included in [ ] are also given for comparison (Refs. 5, 6 and 7).

All the cladding alloys used in the LFAs were selected on the basis of [ ] has been compared against OPTIN Zircaloy-4 and ZIRLO™. Optimized low-tin Zircaloy-4 (i.e., OPTIN) was used as the standard for comparison in the early Alloy A development since this cladding has been used for earlier batches of fuel used in Calvert Cliffs 2. ZIRLO™ is used as a standard for comparison as Westinghouse is transitioning from OPTIN to ZIRLO™ cladding starting with batchwide application for urania rods beginning with [ ]

Figure 1 shows [

] Figure 2 compares [

]

[

]

[

]

Available irradiation experience for the alloys of interest is summarized in Table 3. The table lists the maximum burnup for which in-reactor performance information is available for each of the improved alloys. For each alloy, the host reactors, the number of fuel rods irradiated (or continuing irradiation) in each reactor and the scope of the post-irradiation examination performed, if any, are also shown. In general, the post-irradiation examination results on corrosion behavior confirm the trend observed in ex-reactor testing. The corrosion results are addressed below in conjunction with the discussions on chemical compositions of each of the alloys. [

]

[

.] Supporting data demonstrating the beneficial effect of lowering tin content have also been reported by others (Refs. 10 and 11).

In reactor corrosion, creep and growth measurements made on fuel rods clad with [

] have recently been reported (Ref. 4). Data are available on burnups up to 69 GWd/MTU, and at the highest burnup showed approximately greater than 50% reduction in oxide thickness compared to low-tin Zircaloy-4 (OPTIN) that was used as a reference.

The corrosion resistance of [

]

[

]

2.1.2 Mechanical Properties

The main as-fabricated mechanical properties of the improved cladding alloys affecting the in-PWR fuel performance are the creep resistance, ductility and tensile yield strength. In the following sections, these three as-fabricated properties of the improved alloys are compared to those of standard ZIRLO™ and OPTIN.

2.1.2.1 Creep Resistance of the Improved Alloys

The cladding creep resistance depends [

]

[

]

Irradiation creep strains of [ ] and OPTIN cladding after 2-cycle exposure in PWR are plotted in Figure 6 (Reference 4). Creepdown strains for [ ] those for OPTIN.

As a result of these minor differences in the [

]

[

] compared to the ZIRLO™ clad rods.

2.1.2.2 Ductility of the Improved Alloys

[

]

2.1.2.3 Tensile Yield Strength of the Improved Alloys

[

]

The mechanical properties of the as-fabricated tubes of all improved alloys were measured to assure compliance with the minimum strength and ductility material specification requirements for room and elevated temperatures for each alloy.

Summarizing, the improved cladding materials listed in Table 2 are expected to show improvement in corrosion resistance compared to ZIRLO™ under PWR operating conditions. The mechanical properties of these alloys are comparable to ZIRLO™ and, therefore, their mechanical response is expected to be similar to that of ZIRLO™ cladding for all anticipated operating and postulated accident conditions. Fuel rods using similar types of cladding alloys have been successfully irradiated in several PWRs to [ ]

2.1.3 Other Material Properties

Other material properties of the improved cladding alloys which are relevant to the plant design bases are essentially the same as those of Zircaloy-4 or ZIRLO™. This is a [

] All cladding materials listed in Table 2 satisfy the requirements of the respective cladding specifications. The following properties of the improved alloys are similar to those of OPTIN or ZIRLO™: [

] In addition, the following properties are expected to be essentially the same as those of ZIRLO™ and OPTIN: [ ]

An examination of the in-reactor growth measured for fuel rods clad with [

] to the observed in-reactor growth behavior of ZIRLO™ clad fuel rods.

Irradiation growth of [ ] is compared to OPTIN growth curve in Figure 7. At a fluence of about 15 x 10^{21} n/cm^2 [ ] that of OPTIN.

[

]

[

]

[

]

2.2 SAFETY ANALYSIS

2.2.1 Cladding Behavior Under LOCA Conditions

The behavior of the new cladding materials under LOCA transient conditions was evaluated. [

]

[

]

In the following paragraphs, the expected behavior of [ ] during a postulated LOCA transient is compared to that of Zircaloy-4.

[

]

[

]

[

]

[

]

[

]

[

]

[

]

Summarizing, the behaviors of all the alloys proposed to be included in the CC2T LFAs are essentially the same as that of conventional Zircaloy-4 and ZIRLO™ under all conditions experienced during both normal operation and under the conditions existing during a LOCA transient. Therefore, the 10 CFR 50.44 and 50.46 criteria will be applicable and satisfied for these proposed alloys.

2.2.2 Cladding Behavior Under Non-LOCA Conditions

Consideration was also given to the behavior of the improved cladding materials under non-LOCA conditions. These conditions include normal operation, Anticipated Operational Occurrences, (AOOs), and postulated accidents other than LOCA. Cladding properties/features that impact fuel behavior during non-LOCA conditions are:

( )

These same features were evaluated for improved zirconium-based cladding materials to be inserted as LFAs for Unit 2 Cycle 15.

Based on statements mentioned in Section 2.1.3 and estimates presented in Reference 15, the aforementioned material properties of the improved cladding alloys which could impact the non-LOCA analyses are expected to be [ ] to the ZIRLO™ properties used to support the findings of Reference 2, Section 7.0. Reference 2 also addresses the impact of these material property changes on [

] and concludes that the [ ] Additionally, as noted in

Section 1.1, the LFAs will be placed in non-limiting locations in the core with [ ] in the core.

With respect to [ ] Since improved zirconium based cladding is expected to share [ ]

Therefore, based on the above considerations, cladding behavior under non-LOCA conditions is expected to [ ] from that described in Reference 2, Section 7.0, as a result of introducing a limited number of [ ] clad fuel rods into the Calvert Cliffs Unit 2 Cycle15 core.

3.0 EVALUATION CONCLUSIONS

The preceding discussions describe why the predicted chemical, mechanical, and material properties of the improved zirconium alloys [ ] Therefore, it is concluded that the fuel rod design criteria currently used for the design and analysis of the Zircaloy-4 and ZIRLO™ clad rods will also be applicable to the fuel rods clad with the improved zirconium alloys for LFAs to be included in the Calvert Cliffs Unit 2, Batch T. Furthermore, these LFAs and the fuel rods clad with the [ ] will be placed in non-limiting core locations which experience no more than 0.95 of the highest core power density through the irradiation periods, as indicated in Section 1. Thus, the nominal fuel performance characteristics of the improved alloys will be practically the same as those observed for other fuel rods. Since the current fuel design criteria are applicable to the proposed [ ] and the expected operating conditions are within those assumed for the standard clad rods currently licensed for Calvert Cliffs Unit 2, it is concluded that the licensing basis currently in effect will not be compromised by incorporating a limited number [ ] of fuel rods fabricated with [ ]

4.0 REFERENCES

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(15) [

]

Table 1

Improved Cladding Variants to be Used in Calvert Cliffs Unit 2 Batch T Lead Fuel Assemblies

Table 2

Comparison of Chemical Compositions of Cladding Alloys for Use in Calvert Cliffs Unit 2 Batch T LFAs With Other Previously-Approved Alloys

Table 3

Summary of Irradiation Experience of Improved Cladding

Table 4
Creep Test Results for Different Alloys

Figure 1
In-PWR Waterside Corrosion Oxide Thickness for Fuel Rods with Alloy A and Alloy E as a Function of Rod Average Burnup

Figure 2:
70-ppm Water autoclave Weight Gain as a Function of Autoclave Exposure Days

Figure 3
Comparison of Long Term Steam Autoclave Data for ZIRLO™ and Low Tin ZIRLO™

Figure 4
Waterside Oxide Profile: 1-Cycle Fuel Rods Clad with ZIRLO™ and Low Tin ZIRLO™

Figure 5
Long Term 360°C Water Autoclave Corrosion Test Data

Figure 6
Clad Creepdown After Two Irradiation Cycles Exposure as a Function Of Rod Axial Elevation for Fuel Rods

Figure 7
Fuel Rod Irradiation Growth Strain for Rods as a Function of Rod Average Burnup

ATTACHMENT (3)

PROPRIETARY AFFIDAVIT FOR

ATTACHMENT (4)

I, Norton L. Shapiro, depose and say that I am the Chief Consulting Engineer of Westinghouse Electric Company LLC (WEC), duly authorized to make this affidavit, and have reviewed or caused to have reviewed the information which is identified as proprietary and described below.

I am submitting this affidavit in conformance with the provisions of 10 CFR 2.790 of the Commission's regulations for withholding this information. I have personal knowledge of the criteria and procedures utilized by WEC in designating information as a trade secret, privileged, or as confidential commercial or financial information.

The information for which proprietary treatment is sought, and which document has been appropriately designated as proprietary, is contained in *WCAP-15874-P, "Safety Analysis Report for use of Improved Zirconium-Based Cladding Materials in Calvert Cliffs Unit 2 Batch T Lead Fuel Assemblies," April 2002*. Pursuant to Section 2.790(b)(4) of the Commission's regulations, the following is furnished for consideration by the Commission in determining whether the information included in this document should be withheld from public disclosure.

1. The information sought to be withheld from public disclosure is owned and has been held in confidence by WEC. It consists of an evaluation of the fuel cladding material properties and performance characteristics for use as a lead test assembly.
2. The information consists of analyses or other similar data concerning a process, method or component, the application of which results in substantial competitive advantage to WEC.
3. The information is of a type customarily held in confidence by WEC and not customarily disclosed to the public.
4. The information is being transmitted to the Commission in confidence under the provisions of 10 CFR 2.790 with the understanding that it is to be received in confidence by the Commission.
5. The information, to the best of my knowledge and belief, is not available in public sources, and any disclosure to third parties has been made pursuant to regulatory provisions or proprietary agreements that provide for maintenance of the information in confidence.
6. Public disclosure of the information is likely to cause substantial harm to the competitive position of WEC because:
   a. A similar product or service is provided by major competitors of Westinghouse.
   b. WEC has invested substantial funds and engineering resources in the development of this information. A competitor would have to undergo similar expense in generating equivalent information.
   c. The information consists of fuel cladding material properties and performance characteristics that qualify its use in lead test assemblies to be installed at Calvert Cliffs Unit 2; the application of which provides a competitive economic advantage. The availability of such information to competitors would enable them to design their product or service to better compete with WEC, take marketing or other actions to improve their product's position or impair the position of WEC's product, and avoid developing similar technical analysis in support of their processes, methods or apparatus.
   d. Significant research, development, engineering, analytical, manufacturing, licensing, quality assurance and other costs and expenses must be included in pricing WEC's products and services. The ability of WEC's competitors to utilize such information without similar expenditure of resources may enable them to sell at prices reflecting significantly lower costs.
   e. Use of the information by competitors in the international marketplace would increase their ability to market comparable products or services by reducing the costs associated with their technology development. In addition, disclosure would have an adverse economic impact on WEC's potential for obtaining or maintaining foreign licenses.

Norton Shapiro

Norton L. Shapiro, Chief Consulting Engineer
Westinghouse Electric Company LLC

Sworn to before me this 10th day of April 2002

Laurie J. White Notary Public

My commission expires: 8/31/04