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August 6, 2002

U. S. Nuclear Regulatory Commission
Washington, DC 20555

ATTENTION: Document Control Desk

SUBJECT: Calvert Cliffs Nuclear Power Plant
Unit No. 2; Docket No. 50-318
Framatome Lead Fuel Assemblies – Temporary Exemption Request and License Amendment Request

REFERENCES:

(a) Letter from Mr. S. A. Richards (NRC) to Mr. T. A. Coleman (FCF), dated February 4, 2000, "Revised Safety Evaluation (SE) for Topical Report BAW-10227P: Evaluation of Advanced Cladding and Structural Material (M5) in PWR Reactor Fuel (TAC No. M99903)"

(b) WCAP-15604, Revision 1, November 2001, "Limited Scope High Burnup Lead Test Assemblies"

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 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 No. DPR-69 to incorporate the changes described below into the Technical Specifications for Calvert Cliffs Unit 2.

This exemption will allow up to four lead fuel assemblies (LFAs) manufactured by Framatome ANP, Inc. (FRA-ANP) with fuel rods clad with M5™ alloy 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 fuel rods clad with an advanced alloy that is not zircaloy or ZIRLO.

Calvert Cliffs is in the process of transitioning to ZIRLO as the standard cladding material, with the first ZIRLO cladding inserted during the spring 2002 refueling outage in Unit 1 (Cycle 16). The FRA-ANP LFA program is intended to provide data to support the use of new and improved fuel cladding material and fuel evaluation codes and methods. As described below, this temporary exemption is necessary to

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conduct representative testing of LFAs in Calvert Cliffs Unit 2 during Cycles 15 and 16. We will provide the NRC with the inspection results to assist them in their continuing evaluations of fuel performance of the LFAs.

Calvert Cliffs reviewed Reference (b) in the preparation of the attached LFA report. The intent of Reference (b) 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 Reference (b) [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.

The FRA-ANP 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 or the reload batch will be evaluated under 10 CFR 50.59.

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 FRA-ANP LFAs into the Unit 2 Cycles 15 and 16 cores. 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.

The purpose of the FRA-ANP LFA program is to utilize M5™ alloy in order to evaluate its ability to possess greater fuel reliability, improved thermal margin and increased fuel discharge burnup in order to 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 Westinghouse 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 Westinghouse 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 a zirconium-based alloy that does 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 a zirconium-based alloy that does not conform to either of these two designations requires an exemption from this section of the Code.

We plan to insert up to four FRA-ANP LFAs in Calvert Cliffs Unit 2 containing the advanced cladding material M5™ that does 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.

Since the LFAs will reside in non-limiting locations (see Attachment 2) the list of approved methodologies in Technical Specification 5.6.5 (Core Operating Limits Report) does not require updating to include FRA-ANP methodologies. Attachment 2 discusses the analytical approaches that each vendor (FRA-ANP for the LFAs and Westinghouse for the remainder of the fuel batch) will use in the analysis of the reload core. As detailed in Attachment 2, FRA-ANP will utilize approved methodologies in the analysis of the LFAs.

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 Topical Report submitted by FRA-ANP and approved by the Nuclear Regulatory Commission (Reference a) demonstrates that the predicted chemical, mechanical, and material performance of the M5™ cladding is acceptable under all anticipated operational occurrences and postulated accidents. Attachment (2) describes the analyses that will be completed in order to ensure the acceptability of the FRA-ANP LFAs in the Calvert Cliffs Unit 2 Core. Furthermore, the LFAs will be placed in non-limiting core locations.

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 Westinghouse assemblies. 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 M5™ alloy to Zircaloy-4 or ZIRLO and the location of the LFAs in non-limiting locations, the FRA-ANP M5™ topical concluded that the ECCS performance would not be adversely affected. Thus, the FRA-ANP safety evaluation demonstrates the acceptability of the M5™ cladding material under LOCA conditions.

The intent of 10 CFR 50.44 is to ensure that there is an adequate means of controlling generated hydrogen. The hydrogen produced in a post-LOCA scenario comes from a metal-water reaction. The supporting documentation for the FRA-ANP M5™ topical (Reference a) also shows that the use of the Baker-Just equation to determine the metal-water reaction rate is conservative for the M5™ 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 supporting documentation for the FRA-ANP M5™ topical shows that due to the similarities in the composition of the M5™ 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 M5™ cladding, even though the FRA-ANP M5™ topical 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 FRA-ANP fuel assemblies with the advanced cladding material M5™ to be inserted in Unit 2 Cycle 15 and 16 cores.

The FRA-ANP M5™ topical demonstrates that the predicted chemical, mechanical, and material performance of the M5™ 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, 10 CFR 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 Framatome ANP, Inc. (FRA-ANP) fuel assemblies into Calvert Cliffs Unit 2 that have fuel rods clad in an alloy that does 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 material, 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. The addition of what will be an approved temporary exemption for Unit 2 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 alloy to zircaloy will assure that the behavior of the fuel rods with this alloy are bounded by the fuel performance and safety analyses performed for the ZIRLO clad fuel rods in the Unit 2 Core. The similarity of ZIRLO to zircaloy was previously approved by the Nuclear Regulatory Commission. Therefore, the addition of the advanced cladding M5™ 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 alloy to zircaloy will assure that the behavior of the fuel rods with this alloy 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 the advanced cladding M5™ 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 FRA-ANP LFAs. The assemblies use the advanced cladding material M5™ that is 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.

   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)
- Letter from Mr. P. E. Katz (CCNPP) to Document Control Desk (NRC), dated July 17, 2002, Westinghouse Lead Fuel Assemblies – Temporary Exemption Request and License Amendment Request

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 6th day of August, 2002.

WITNESS my Hand and Notarial Seal: Denise D. [illegible]
Notary Public

My Commission Expires: 02/01/06
Date

PEK/DJM/bjd

Attachments: (1) Technical Specifications Marked-Up Page
(2) Analysis for Use of M5™ Cladding Materials in Calvert Cliffs Unit 2 Batch T Lead Fuel Assemblies

cc: 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 Framatome-ANP may be used in up to four lead test assemblies as described in approved temporary exemption dated XX/XX/XX.

ATTACHMENT (2)

ANALYSIS FOR USE OF M5™ CLADDING MATERIALS

IN CALVERT CLIFFS UNIT 2

BATCH T LEAD FUEL ASSEMBLIES

ATTACHMENT (2)

ANALYSIS FOR USE OF M5™ CLADDING MATERIALS IN CALVERT CLIFFS UNIT 2 BATCH T LEAD FUEL ASSEMBLIES

INTRODUCTION

Calvert Cliffs Nuclear Power Plant intends to utilize up to four Lead Fuel Assemblies (LFAs) manufactured by Framatome ANP, Inc. (FRA-ANP) in the Calvert Cliffs Unit 2 reactor during Cycles 15 and 16 operation. The analyses and evaluations to be performed by FRA-ANP and Westinghouse Electric Company (Westinghouse) in support of these LFAs are described below. A complete mechanical analysis will be performed by FRA-ANP using a combination of U.S. Nuclear Regulatory Commission (NRC)-approved methodologies. The NRC-approved FRA-ANP mechanical design methodology in References 1, 3, and 12 will be modified by the inclusion of the approved M5™[1] methodology in Reference 2.

Framatome-ANP, Inc. will perform a qualitative/semi-quantitative evaluation of the performance of the LFAs with respect to the safety analysis, including thermal-hydraulic compatibility, the loss-of-coolant accident (LOCA) and non-LOCA criteria. The qualitative/semi-quantitative evaluations will make use of the fact that the LFAs will be operated in non-limiting locations.

Westinghouse will perform evaluations and assessments to verify that the insertion of the FRA-ANP LFAs:

- do not adversely impact the fuel performance and mechanical integrity of the co-resident Westinghouse fuel and
- do not adversely impact the Calvert Cliffs Unit 2 Safety and Setpoint Analyses.

The evaluations and assessments will entail the development of neutronic and thermal-hydraulic models that explicitly model the FRA-ANP LFAs in the Unit 2 Calvert Cliff's core. Explicit calculations will be performed to model the impact of such on the power and flow distributions.

The FRA-ANP mechanical design for the Calvert Cliffs LFAs is very similar to the standard FRA-ANP designed Combustion Engineering (CE) 14x14 reload fuel. The primary change in the fuel design is the use of M5 cladding. The mechanical design evaluations for the LFAs will be performed with the standard reload mechanical design methods, augmented with the M5 cladding properties. The NRC has reviewed and approved the M5 properties (Reference 2). The design criteria for the mechanical analyses will be the same as used for standard reload fuel (Reference 1) with the exception that the cladding stress criteria will be those used previously with M5 (Reference 2). Qualitative evaluations will be performed for the LOCA, non-LOCA and thermal-hydraulic areas. The qualitative evaluations will make use of the fact that the LFAs will be operated in non-limiting locations. It is fully anticipated that the FRA-ANP LFAs will satisfy all applicable design criteria.

Program Description

Up to four LFAs 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). The design burnup for the LFAs is a peak rod burnup of 70 MWd/kgU. The burnup achieved after two cycles of irradiation will be below the Calvert Cliffs plant burnup limit of 60 MWd/kgU and therefore less than the current approved FRA-ANP methodology peak rod limit of 62 MWd/kgU

[1] M5 is a trademark of Framatome ANP, Inc.

(Reference 12). After two cycles of irradiation, poolside inspections and examinations will be conducted. The LFA performance data obtained from these poolside inspections will be used in conjunction with the design evaluations to assure that the design criteria are met for the higher burnups. Then, it is planned to irradiate the LFAs for an additional cycle. An explicit submittal will be made prior to a third cycle of irradiation.

The fuel management places the LFAs in non-limiting power locations. That is, their predicted peak pin power is equal to or less than 0.95 of the predicted maximum peak pin power in the core. Since these assemblies will not be in the highest core power density locations, the placement scheme will assure that the behavior of the LFAs is bounded by the safety analyses performed for the standard fuel rods.

Fuel Design Description

The LFAs for the Calvert Cliffs Unit 2 reactor will be the FRA-ANP CE 14x14 design. The bundle uses nine Zircaloy-4 grid spacers of the high thermal performance (HTP) design. The lower tie plate is the FUELGUARD™[2] design, and the upper tie plate is the standard, reconstitutable FRA-ANP design for CE 14x14 fuel. The HTP spacer was generically reviewed and accepted by the NRC and has been used for reload designs for CE, Westinghouse, and Kraftwork Union reactors since 1991. The FUELGUARD lower tie plate has also been used in reload designs for CE, Westinghouse, and General Electric designs. The reconstitutable upper tie plate design has been in use for reloads for CE plants since the early 1980's. Except for the changes to the fuel rod described in the following paragraphs, the LFA fuel bundle design has been used in reloads for other CE 14x14 plants. An illustration of this design is shown in Figure 1.

Each fuel bundle contains 4 corner guide tubes, 1 center guide tube/instrument tube, and 176 fuel rods. The corner guide tubes in the LFAs have the same nominal inside diameter/outside diameter (ID/OD) and dashpot design as used for the standard CE 14x14 reload fuel supplied by FRA-ANP to other CE designed reactors. The elevations of the features (e.g., weep holes, upper sleeve attachment, etc.), except for the total length, are the same as have been used on other CE 14x14 reload designs. Similarly, the center guide tube has the same nominal ID/OD as has been used on other CE 14x14 designs and as the co-resident fuel. The height and elevations are established to be compatible with the Calvert Cliffs' core plate separation distance, the co-resident fuel and the FRA-ANP manufacturing processes.

The fuel rod design for Calvert Cliffs uses a 136.7-inch fuel column of uranium dioxide pellets. The rod consists of cladding, an upper-end cap, a lower-end cap, fuel pellets, and a plenum spring. The differences between the Calvert Cliffs lead assemblies and the standard FRA-ANP designed fuel for CE 14x14 plants are changes to the fuel rod design. Specifically, the rod changes are:

- Cladding material used for the fuel rod is M5 instead of Zircaloy-4
- Cladding inner diameter is increased by 0.003 inches to 0.387 inches
- Pellet diameter is increased by 0.0035 inches to 0.3805 inches
- Pellet density is 96% theoretical density instead of 95.35% theoretical density
- Initial rod internal pressure will be increased from 315 psig to 375 psig
- Cladding length is increased by about 0.2 inches

[2] FUELGUARD is a trademark of Framatome ANP, Inc.

The increased length provides more plenum volume but requires the plenum spring to be modified to accommodate the longer plenum. The cladding OD is unchanged and is the same as the standard CE 14x14 reload fuel supplied by FRA-ANP and the same as the co-resident fuel. For approximately 168 rods in each of the four lead assemblies, the end caps are Zircaloy-4, with the only change being the diameter of the inserted portion of the end cap at the cladding interface. The lengths of the end caps will be the same as used for the standard CE 14x14 reload design with nine Zircaloy-4 HTPs.

For up to 32 fuel rods (nominally 8 rods in each of the four lead assemblies), a different process for welding the end caps will be used, which requires a modification to the end caps, the plenum spring, and the cladding length. This different welding process has successfully been used for Boiling Water Reactor and Pressurized Water Reactor reload designs in Europe. The pellet column and radial rod geometry are unchanged; the end cap modifications result from the interface differences required by the welding process. The end caps for up to 32 fuel rods are made from M5.

The cladding (and, as noted above, some end caps) for the LFAs are fabricated from the FRA-ANP M5 alloy. Use of the M5 alloy has previously been reviewed and accepted by the NRC for other reload applications. However, its use for the CE 14x14 design will require modifications to the design methodology to incorporate the M5 properties. These modifications are described in the next section. The geometry changes to the cladding and the resulting modifications to the other components, along with the appropriate initial rod internal pressure, are explicitly included in the input to the rod and assembly evaluations.

Mechanical Design Methodology

The mechanical design evaluations for the LFAs are the same as those performed for reloads. The evaluations will be performed for the assembly and the rod components using the generically approved NRC design criteria described in Reference 1. These approved criteria address the issues identified in Chapter 4 of the NRC Standard Review Plan, NUREG-0800. The approved codes and methods (References 3 and 12) will be used, except that the RODEX2 code will have to be augmented to include the M5 material properties (Reference 2), and the stress criteria approved in Reference 2 for M5 will be used in place of the stress criteria for Zircaloy-4 in Reference 1.

The M5 properties being incorporated into RODEX2 are:

- Thermal Conductivity
- Thermal Expansion
- Poisson's Ratio
- Young's Modulus
- Emissivity
- Corrosion
- Hydriding
- Thermal Conductivity of the zirconium oxide on the M5 cladding
- Stress-Free Irradiation Growth
- Creep

The first five properties are very similar between the Zircaloy-4 and the M5 material. The specific M5 properties, as reported in Reference 2, are being included because they are available, and it is not necessary to maintain the Zircaloy-4 values.

The corrosion and hydriding performance of the M5 are improved over Zircaloy-4. These properties are being included in the RODEX2 code. The hydrogen uptake rate for M5 is also reduced when compared with Zircaloy-4. With the reduced corrosion and the reduced uptake rate, the hydriding performance of the M5 cladding is improved.

The methodology for calculating the corrosion continues to use a 95/95 upper prediction of the corrosion, based on the peak local oxide, and apply this uniformly over the node. Also maintained is the inclusion of the impact of the oxide thickness on the temperature when calculating the corrosion rate so that the rate will not be underpredicted. Therefore, the thermal conductivity of zirconium oxide (the same conductivity model as used with the Zircaloy-4) was included for the M5 cladding. Use of the oxide conductivity also results in higher rod temperatures and the resulting higher fission gas release due to the higher temperatures.

The irradiation-induced growth of M5 is less than the irradiation-induced growth of Zircaloy-4. The M5 cladding is in the fully annealed condition. Based on irradiation data, a growth rate correlation was created. Again, the methodology of using a 95/95 upper tolerance limit growth with the worst-case tolerances is maintained.

Using the cladding creep data for M5 cladding, the appropriate creep coefficients were determined and are used as input in COLAPX and RODEX2 when analyzing the M5 rods. Because the M5 creep behavior is modeled with input changes, the feedback of the creep deformation on the thermal and fission gas behavior of the rod is maintained.

The cladding stresses (including wall thinning at end-of-life) are calculated using the approved methods with the appropriate M5 properties. The stress criteria are the same as used previously with M5 cladding that was reviewed and accepted by the NRC (Reference 2). These criteria are different than those approved for use with Zircaloy-4 in Reference 1.

The cladding fatigue is assessed by determining the cumulative usage factor using conservative power cycling estimates and the O'Donnel and Langer fatigue curves with the "2 and 20" conservatism. This is the same method as used for normal reload designs. The applicability of the O'Donnel and Langer fatigue curves for M5 was reviewed by the NRC in Reference 2.

Mechanical Design Evaluation

The LFAs are designed to support a peak rod exposure of 70 MWd/kgU, which is beyond the approved burnup limit of 62 MWd/kgU for the FRA-ANP mechanical design methodology. As noted in the Program Description, the burnup achieved after two cycles of irradiation will be below the Calvert Cliffs approved peak rod limit of 60 MWd/kgU and below the FRA-ANP approved methodology peak rod limit of 62 MWd/kgU. After two cycles of irradiation, poolside inspections and examinations will be conducted. The LFA performance data obtained from these poolside inspections will be used to verify that the assemblies will satisfy the design criteria at the higher burnups. If the inspection results support additional burnup, the LFAs will then be irradiated for an additional cycle. An explicit submittal will be made prior to a third cycle of irradiation.

It should be noted that the M5 cladding has not been previously approved by the NRC for use in CE plants. The scope of the mechanical design for the LFA fuel rod and assembly is the same as performed for reloads. The fuel rod analyses use the design power histories in RODEX2 to calculate the irradiation performance of the rod. The results of these analyses are the internal rod pressure, the fission gas release, the corrosion, the cladding strain (creepdown and creepout), and the pellet densification and swelling. Additional rod calculations include the determination of the cladding stresses and the cumulative usage factor for the fatigue evaluation. The fuel assembly is designed to be mechanically compatible with the reactor and co-resident fuel.

The cage design (e.g., tie plates, guide tubes, spacers) is the same as has been used on other CE 14x14 designs. Therefore, the previous fuel handling evaluations will be examined to verify that they continue to be applicable.

The fuel rod and the fuel assembly growth calculations will be performed. The growth model for the M5 cladding will be used for the rod growth, and the approved FRA-ANP growth model for the CE bundle type designs will be used for the assembly growth. The differential growth between the bundle and the rod and the total assembly growth will be assessed.

The lift-off of the LFAs will be determined using the standard FRA-ANP methods. The loss coefficients for the bundle have been established based on testing and are the same as used in other CE 14x14 reloads (appropriate because of the similar components). The plant conditions are used for the worst-case conditions for lift-off (typically beginning-of-life at four pump startup temperatures). The assemblies are designed not to lift-off in normal operation.

Westinghouse will perform a bounding assessment of the fuel mechanical design analysis that verifies that the FRA-ANP LFAs do not damage the co-resident Westinghouse fuel. Grid strength measurements supplied by FRA-ANP along with grid impact loads determined in the seismic analysis will be used.

<u>Seismic</u>

Framatome ANP, Inc. will analyze the seismic performance of the lead fuel assemblies by evaluating the seismic/LOCA time history supplied by Westinghouse with respect to the strength of the FRA-ANP Calvert Cliffs spacer. This spacer strength was determined through testing. The comparison will demonstrate that the design loads are not sufficient to result in spacer deformation.

Westinghouse will perform a bounding structural analysis to determine the grid impact loads on the co-resident fuel resulting from the use of up to four FRA-ANP LFAs. This information will be used in the Westinghouse Mechanical Design Evaluation described above.

<u>Core Physics</u>

All of the Westinghouse core physics models were explicitly set up to model the FRA-ANP LFAs. ROCS/DIT cross sections were generated for the FRA-ANP LFAs using standard Westinghouse methodology as described in References 13 and 14. Since the core physics models explicitly incorporated the FRA-ANP LFAs, any physics data generated (e.g., scram worth, moderator temperature coefficients, inverse boron worth's, etc.), for Unit 2 Cycles 15 and 16 will inherently incorporate the LFAs. The FRA-ANP LFAs are not expected to adversely impact any of the calculated core physics data.

In addition, the Westinghouse neutronic analysis will generate and provide the data required by FRA-ANP to both confirm the compatibility of the LFAs with co-resident fuel and to execute the performance analysis for the FRA-ANP LFAs.

Loss-of-Coolant Accidents

To support the licensing of the FRA-ANP LFAs, a qualitative disposition will be performed for both large and small break LOCAs. The disposition will consider the reduced power of the LFAs relative to the peak-powered assemblies in the core. The disposition will be based on a comparison of key LOCA parameters between Calvert Cliffs and similarly designed plants for which detailed LOCA analyses have been performed using the generically approved FRA-ANP methodologies (References 4, 5, and 6). The key parameters that will be compared include core operating conditions (e.g., core power level, LFA power levels, and radial and axial peaking factors) and fuel rod geometry (e.g., cladding and pellet characteristics). The M5 cladding will not significantly impact the LOCA performance of the LFAs; and it is expected that, based on the comparison of key LOCA parameters, 10 CFR 50.46 criteria will be met for the LFAs.

Non-LOCA Events

Thermal margin calculations will be performed to evaluate the relative departure from nucleate boiling (DNB) performance for the HTP spacers for the LFAs compared to the spacer performance for the co-resident fuel. Framatome ANP, Inc. will perform "closed channel" thermal margin calculations using a given set of core boundary conditions, radial peaking distributions and axial shapes over a defined range of core pressures, inlet temperatures and vessel flow rates. The core power that results in a minimum DNB ratio (DNBR) equivalent to the 95/95 limit of the critical heat flux correlation will be determined. Framatome ANP, Inc. will provide the overpower results for each case, and these results will be evaluated relative to those from Westinghouse at the same state points. It is expected that the DNB performance of the low power LFAs will be shown to be non-limiting relative to the co-resident fuel design; thus, the FRA-ANP LFAs can be conservatively modeled as the co-resident fuel type in Westinghouse's detailed thermal margin analyses.

The FRA-ANP thermal margin calculations will use the generically approved XCOBRA-IIIC thermal-hydraulics computer code (Reference 7) with the HTP critical heat flux correlation (Reference 8). The Reference 9 methodology will be used in a revised manner in that cross-flow at the inter-assembly boundary for detailed assembly model will not be modeled (i.e., "closed channel"). This modeling approach is considered acceptable since the purpose of these calculations is to quantify the relative DNB performance of the HTP spacers for the LFAs versus the spacers for the co-resident fuel design.

The explicit core physics information described above (including the ROCS modeled FRA-ANP LFAs) will be evaluated by Westinghouse against the bounding information contained in the Calvert Cliffs safety analysis. Again, the FRA-ANP LFAs are not expected to adversely impact any of the calculated core physics parameters supported by the bounding analysis. Consistent with the standard reload practice, the bounding analysis parameters, along with any plant parameter groundrule changes, will be explicitly evaluated in the Westinghouse LOCA, non-LOCA transient and, setpoint analyses.

Thermal-Hydraulic

Thermal-hydraulic calculations will be performed for the LFAs to assess the effect of fuel rod bowing, guide tube heating, core bypass flow, and fuel centerline melting. Fuel rod bowing that results from differential strains of adjacent fuel rods can impact local power peaking for LOCA and the DNB performance. The effect of fuel rod bow will be assessed for the LFAs using the approved methodology given in Reference 10. It is expected that fuel rod bowing will not adversely impact the DNB or LOCA performance of the LFAs.

An analysis will be performed to assess the performance of the FRA-ANP guide tube design with respect to cooling of the control element assemblies (CEAs). Specifically, flow through the guide tube will be calculated by standard fluid flow equations using the core pressure drop and form loss and friction resistances for the guide tube. A heat balance will be performed using the calculated guide tube flow rate and the heat deposition from the CEAs. It is expected that sufficient CEA cooling will be demonstrated by showing that bulk boiling in the guide tube is prevented.

An evaluation will be performed to assess the change in core bypass flow due to the presence of the LFAs. The change in core bypass flow will be determined by comparing the core pressure drop with and without the LFAs. Since only a maximum of four FRA-ANP LFAs will be loaded in the core, it is expected that they will not impact the amount of flow that bypasses the core.

An analysis will be performed to define the linear heat rate (LHR) at which fuel melting occurs for the LFAs. The analysis of the fuel melt LHR will use the fuel thermal-mechanical computer code RODEX2, as described in the Reference 11 methodology. The RODEX2 code will be updated with the mechanical properties for M5 cladding. The effect of cladding properties on the fuel centerline melt temperature (and equivalent LHR) is negligible. The performance of the LFAs relative to the fuel centerline melt acceptance criterion will be assessed by comparing the fuel melt LHR for Calvert Cliffs to that for other similarly designed plants for which detailed fuel melt analyses have been performed using approved FRA-ANP methodology (Reference 11). This comparison will take into consideration the non-limiting power location of the LFAs. Based on this comparison to similar plants, conclusions will be drawn to show that fuel centerline melt criterion is met for the LFAs.

A thermal-hydraulics evaluation will be performed to assess the potential impact of implementing the FRA-ANP LFAs on the core thermal-hydraulics. This analysis is expected to show the FRA-ANP LFAs are non-limiting with respect to DNB.

In the thermal-hydraulics compatibility evaluation, detailed thermal-hydraulic models of the mixed core will be developed to calculate potential perturbations in the core flow distributions due to the FRA-ANP LFAs. This evaluation will include performing a bounding reload DNB analysis for implementing the four FRA-ANP LFAs. The ABB-NV DNB correlation (Reference 16) will be used in the TORC code (Reference 15) to perform the DNB analysis.

Both FRA-ANP and Westinghouse will perform a separate DNB assessment with their own thermal-hydraulic code and DNB correlation in order to determine the difference in DNB margin relative to the ABB-NV correlation used in the reload DNB analysis. The thermal-hydraulic model in the DNB assessment will utilize the same geometry and radial power distribution. Cases will be performed for a bounding range of operating conditions and axial power shapes. The cases will iterate on power to the 95/95 DNBR limit, including applicable uncertainties. Westinghouse will use the 95/95 DNBR limit and associated uncertainties for the ABB-NV correlation and FRA-ANP shall use the 95/95 DNBR limit and uncertainties for their DNB correlation. The overpower values for these cases from both vendors will be used to determine the difference in DNB margin relative to the ABB-NV correlation used in the reload DNB analysis. This difference in DNB margin will be used in the reload DNB analysis to confirm that the FRA-ANP LFAs are always non-limiting.

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14 x 14 PWR FUEL BUNDLE

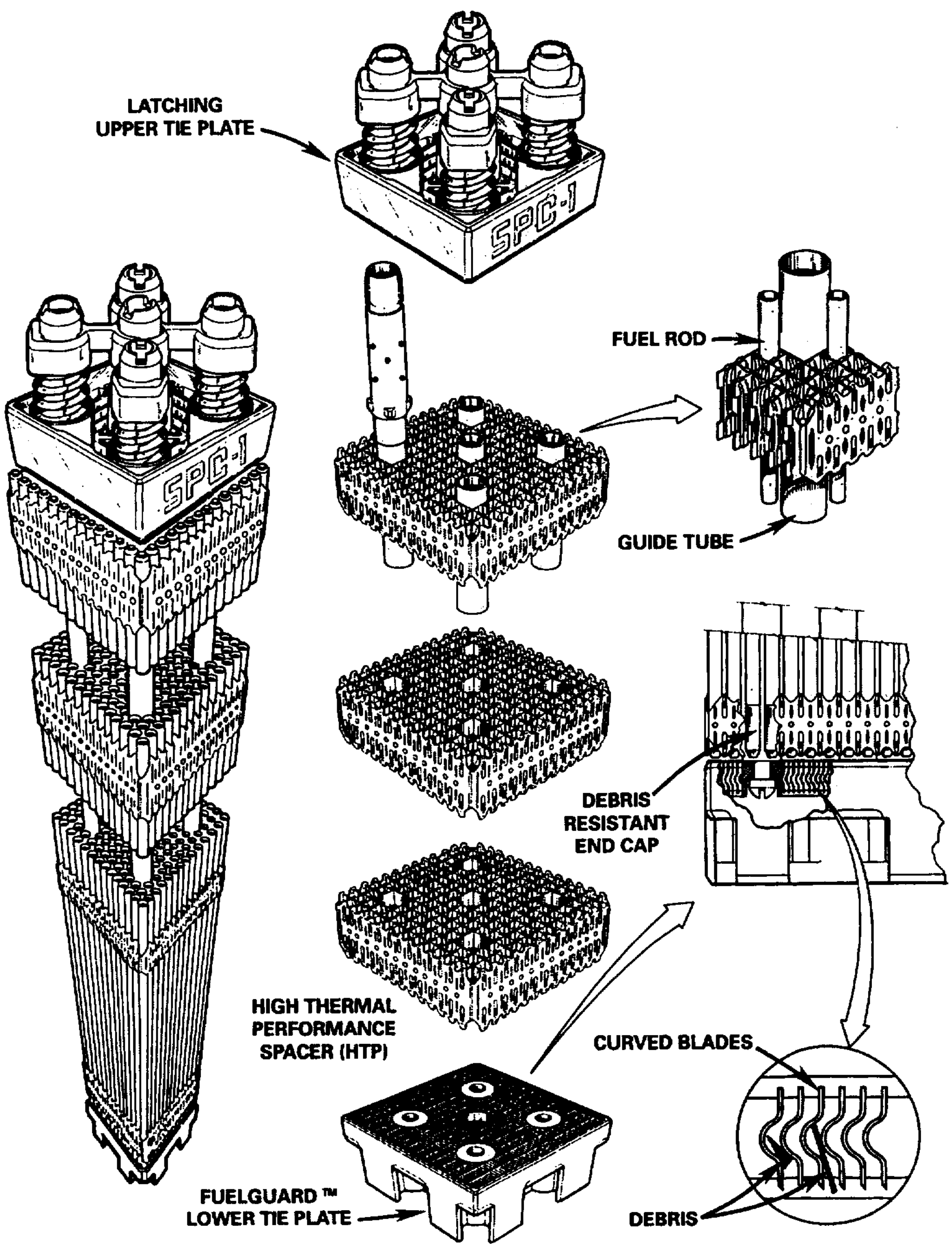

Figure 1