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Our ref: LTR-NRC-04-31

May 19, 2004

TRANSMITTAL OF PROPRIETARY INFORMATION

Enclosed are:

1. 1 proprietary copy and 1 nonproprietary copy of Responses to RAIs on WCAP-16182-P & NP, "Westinghouse BWR Control Rod CR 99 Licensing Report"

Also enclosed is:

1. One (1) copy of the Application for Withholding, AW-04-1839 (Nonproprietary) with Proprietary Information Notice.
2. One (1) copy of Affidavit (Nonproprietary).

This information is being submitted by Westinghouse Electric Company LLC in response to the NRC's Request for Additional Information regarding WCAP-16182-P & NP.

This submittal contains proprietary information of Westinghouse Electric Company, LLC. In conformance with the requirements of 10 CFR Section 2.390, as amended, of the Commission's regulations, we are enclosing with this submittal an Application for Withholding from Public Disclosure and an affidavit. The affidavit sets forth the basis on which the information identified as proprietary may be withheld from public disclosure by the Commission.

Correspondence with respect to the affidavit or Application for Withholding should reference AW-04-1839 and should be addressed to J. A. Gresham, Manager, Regulatory Compliance and Plant Licensing, Westinghouse Electric Company LLC, P.O. Box 355, Pittsburgh, Pennsylvania 15230-0355.

Very truly yours,

J. A. Gresham, Manager
Regulatory Compliance and Plant Licensing

Enclosures

cc: W. Macon
E. Peyton

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Our ref: AW-04-1839

May 19, 2004

APPLICATION FOR WITHHOLDING PROPRIETARY
INFORMATION FROM PUBLIC DISCLOSURE

Subject: Responses to RAIs on WCAP-16182-P & NP, "Westinghouse BWR Control Rod CR 99 Licensing Report" (Proprietary)

Reference: Email from Mr. W. Macon (NRC) to Mr. R. Sisk (Westinghouse) "WCAP-16182 - CR 99 - RAIs," dated 4/19/04

The Application for Withholding is submitted by Westinghouse Electric Company LLC (Westinghouse), pursuant to the provisions of Paragraph (b) (1) of Section 2.390 of the Commission's regulations. It contains commercial strategic information proprietary to Westinghouse and customarily held in confidence.

The proprietary material for which withholding is being requested is identified in the proprietary version of the subject report. In conformance with 10 CFR Section 2.390, Affidavit AW-04-1839 accompanies this Application for Withholding, setting forth the basis on which the identified proprietary information may be withheld from public disclosure.

Accordingly, it is respectfully requested that the subject information which is proprietary to Westinghouse be withheld from public disclosure in accordance with 10 CFR Section 2.390 of the Commission's regulations.

Correspondence with respect to this Application for Withholding or the accompanying affidavit should reference AW-04-1839 and should be addressed to J. A. Gresham, Manager, Regulatory Compliance and Plant Licensing, Westinghouse Electric Company LLC, P.O. Box 355, Pittsburgh, Pennsylvania 15230-0355.

Very truly yours,

J. A. Gresham, Manager
Regulatory Compliance and Plant Licensing

Enclosures

cc: W. Macon
E. Peyton

AW-04-1839

AFFIDAVIT

COMMONWEALTH OF PENNSYLVANIA:

ss

COUNTY OF ALLEGHENY:

Before me, the undersigned authority, personally appeared J. A. Gresham, who, being by me duly sworn according to law, deposes and says that he is authorized to execute this Affidavit on behalf of Westinghouse Electric Company LLC (Westinghouse), and that the averments of fact set forth in this Affidavit are true and correct to the best of his knowledge, information, and belief:

J. A. Gresham

J. A. Gresham, Manager
Regulatory Compliance and Plant Licensing

Sworn to and subscribed
before me this 19th day
of May, 2004

Sharon L. Fiori
Notary Public

Notarial Seal
Sharon L. Fiori, Notary Public
Monroeville Boro, Allegheny County
My Commission Expires January 29, 2007
Member, Pennsylvania Association Of Notaries

(1) I am Manager, Regulatory Compliance and Plant Licensing, in Nuclear Services, Westinghouse Electric Company LLC (Westinghouse), and as such, I have been specifically delegated the function of reviewing the proprietary information sought to be withheld from public disclosure in connection with nuclear power plant licensing and rule making proceedings, and am authorized to apply for its withholding on behalf of Westinghouse.

(2) I am making this Affidavit in conformance with the provisions of 10 CFR Section 2.390 of the Commission's regulations and in conjunction with the Westinghouse "Application for Withholding" accompanying this Affidavit.

(3) I have personal knowledge of the criteria and procedures utilized by Westinghouse in designating information as a trade secret, privileged or as confidential commercial or financial information.

(4) Pursuant to the provisions of paragraph (b)(4) of Section 2.390 of the Commission's regulations, the following is furnished for consideration by the Commission in determining whether the information sought to be withheld from public disclosure should be withheld.

(i) The information sought to be withheld from public disclosure is owned and has been held in confidence by Westinghouse.

(ii) The information is of a type customarily held in confidence by Westinghouse and not customarily disclosed to the public. Westinghouse has a rational basis for determining the types of information customarily held in confidence by it and, in that connection, utilizes a system to determine when and whether to hold certain types of information in confidence. The application of that system and the substance of that system constitutes Westinghouse policy and provides the rational basis required.

Under that system, information is held in confidence if it falls in one or more of several types, the release of which might result in the loss of an existing or potential competitive advantage, as follows:

(a) The information reveals the distinguishing aspects of a process (or component, structure, tool, method, etc.) where prevention of its use by any of Westinghouse's competitors without license from Westinghouse constitutes a competitive economic advantage over other companies.

(b) It consists of supporting data, including test data, relative to a process (or component, structure, tool, method, etc.), the application of which data secures a competitive economic advantage, e.g., by optimization or improved marketability.

(c) Its use by a competitor would reduce his expenditure of resources or improve his competitive position in the design, manufacture, shipment, installation, assurance of quality, or licensing a similar product.

(d) It reveals cost or price information, production capacities, budget levels, or commercial strategies of Westinghouse, its customers or suppliers.

(e) It reveals aspects of past, present, or future Westinghouse or customer funded development plans and programs of potential commercial value to Westinghouse.

(f) It contains patentable ideas, for which patent protection may be desirable.

There are sound policy reasons behind the Westinghouse system which include the following:

(a) The use of such information by Westinghouse gives Westinghouse a competitive advantage over its competitors. It is, therefore, withheld from disclosure to protect the Westinghouse competitive position.

(b) It is information that is marketable in many ways. The extent to which such information is available to competitors diminishes the Westinghouse ability to sell products and services involving the use of the information.

(c) Use by our competitor would put Westinghouse at a competitive disadvantage by reducing his expenditure of resources at our expense.

(d) Each component of proprietary information pertinent to a particular competitive advantage is potentially as valuable as the total competitive advantage. If competitors acquire components of proprietary information, any one component may be the key to the entire puzzle, thereby depriving Westinghouse of a competitive advantage.

(e) Unrestricted disclosure would jeopardize the position of prominence of Westinghouse in the world market, and thereby give a market advantage to the competition of those countries.

(f) The Westinghouse capacity to invest corporate assets in research and development depends upon the success in obtaining and maintaining a competitive advantage.

(iii) The information is being transmitted to the Commission in confidence and, under the provisions of 10 CFR Section 2.390, it is to be received in confidence by the Commission.

(iv) The information sought to be protected is not available in public sources or available information has not been previously employed in the same original manner or method to the best of our knowledge and belief.

(v) The proprietary information sought to be withheld in this submittal is that which is appropriately marked in Responses to RAIs on WCAP-16182-P & NP, "Westinghouse BWR Control Rod CR 99 Licensing Report" (Proprietary), being transmitted by Westinghouse letter (LTR-NRC-04-31) and Application for Withholding Proprietary Information from Public Disclosure, to the Document Control Desk. The proprietary information as submitted for use by Westinghouse is expected to be applicable in other licensee submittals in response to certain NRC requirements for justification of the use of the CR 99 control rods.

This information is part of that which will enable Westinghouse to:

(a) Provide CR 99 control rods to Licensees.

(b) Meet NRC regulatory requirements in support of a Westinghouse product.

Further this information has substantial commercial value as follows:

(a) Westinghouse plans to sell the use of similar information to its customers for purposes of supplying CR 99 control rods to BWR Licensees.

(b) Westinghouse can sell support and defense of the use of CR 99 control rods.

(c) The information requested to be withheld reveals the distinguishing aspects of a methodology which was developed by Westinghouse.

Public disclosure of this proprietary information is likely to cause substantial harm to the competitive position of Westinghouse because it would enhance the ability of competitors to provide similar services and licensing defense services for commercial power reactors without commensurate expenses. Also, public disclosure of the information would enable others to use the information to meet NRC requirements for licensing documentation without purchasing the right to use the information.

The development of the technology described in part by the information is the result of applying the results of many years of experience in an intensive Westinghouse effort and the expenditure of a considerable sum of money.

In order for competitors of Westinghouse to duplicate this information, similar technical programs would have to be performed and a significant manpower effort, having the requisite talent and experience, would have to be expended.

Further the deponent sayeth not.

PROPRIETARY INFORMATION NOTICE

Transmitted herewith are proprietary and/or non-proprietary versions of documents furnished to the NRC in connection with requests for generic and/or plant-specific review and approval.

In order to conform to the requirements of 10 CFR 2.390 of the Commission's regulations concerning the protection of proprietary information so submitted to the NRC, the information which is proprietary in the proprietary versions is contained within brackets, and where the proprietary information has been deleted in the non-proprietary versions, only the brackets remain (the information that was contained within the brackets in the proprietary versions having been deleted). The justification for claiming the information so designated as proprietary is indicated in both versions by means of lower case letters (a) through (f) located as a superscript immediately following the brackets enclosing each item of information being identified as proprietary or in the margin opposite such information. These lower case letters refer to the types of information Westinghouse customarily holds in confidence identified in Sections (4)(ii)(a) through (4)(ii)(f) of the affidavit accompanying this transmittal pursuant to 10 CFR 2.390(b)(1).

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Request for Additional Information
WCAP-16182-P/NP
Westinghouse BWR Control Rod CR 99 Licensing Report

1. **LTR Table 4-1 lists a matrix of the Design Requirements versus the Applicable Criteria used for the CR 99 evaluation. How do these requirements/criteria relate to the licensing requirements of SRP Section 4.2 and to the design requirements used for the approved CR 82 design?**

According to SRP Section 4.2.I, the review is to cover the following specific areas: (A) Design Bases, (B) Description and Design Drawings, (C) Design Evaluation, and (D) Testing, Inspection, and Surveillance Plans. In addition, Appendix A to the SRP requires control rod insertability following a Safe Shutdown Earthquake. Each of these, as required in Section 4.2.II generically for control rods, is discussed separately below as they apply to the CR 99 Westinghouse BWR Control Rod design.

Design Bases (SRP 4.2.II.A)
<u>General Design Criteria 27 (and 28)</u> – [

]^{a,c} This ensures (1) that there is sufficient reactivity throughout its lifetime to meet Criteria 27 in the same way as the OEM rods do and (2) reactivity limits associated with the OEM rod worth are met (Criteria 28). This holds for both the CR 99 and CR 82 designs. Specifically: see LTR Sections 4.1.1, 4.1.2, 4.1.3, 4.1.4, 7.2.1 through 7.2.4, 7.3.1 through 7.3.4, 8.2.5, 8.2.7, 8.3.5, and 8.3.6.

The CR 99 design meets the specified criteria for D, C, and S Lattice in US GE BWR's.

<u>Stress, strain, and loading limits for the CR 99 control rods (SRP 4.2.II.A.1(a)) and cumulative number of strain fatigue cycles (SRP 4.2.II.A.1(b))</u> - Chapter 6 in the LTR discusses these items. The control rod is evaluated according to ASME Section III. Specifically: see LTR Sections 4.1.6, 5.2.1, 5.3.2, and 6.3.

The CR 99 design meets the requirements of these sections of the SRP for D, C, and S Lattice in US GE BWR's.

<u>Dimensional changes regarding control rods (SRP 4.2.II.A.1(e))</u> - The same basic design has been operated for more than 30 years, including the approved CR 82. The control rods have been shown not to undergo any dimensional changes under operation. The CR 99 has this same basic design with the stainless steel sheets mounted together to form a cruciform shaped rod. From the outside, the CR 99 looks identical to the approved CR 82. This experience base is directly applicable to the CR 99. Specifically: see LTR Sections 4.1.1, 4.1.2, 4.1.3 5.3.3, 6.3.5, 8.2, and 8.3.1 through 8.3.7.

The CR 99 design meets the requirements of this section of the SRP for D, C, and S Lattice in US GE BWR's.

<u>Control rod reactivity must be maintained (SRP 4.2.II.A.1(h))</u> - The control rods are designed such that rod worth is consistent with the plant safety analysis. [

]^{a,c} Surveillance that reactivity loss does not occur due to B_4C wash out has been performed by visual inspections and neutron radiography measurements. It has been shown that the basic concept of the Westinghouse BWR control rods, with the horizontally drilled absorber holes, retains boron carbide powder even in the case of cracking.

Regarding CR 99, the performance is considered to be even better since the [ ]^{a,c} are more inert than the powder. [ ]^{a,c}. Specifically: see LTR Sections 4.1.2, 4.1.4, 5.2.3, 7.2.1, 7.2.4, 7.3.1, 7.3.4, and 8.3.8. Also see the response to Question 16.

The CR 99 design meets the requirements of this section of the SRP for D, C, and S Lattice US GE BWR's.

Description and Design Drawings (SRP 4.2.II.B)

Outline drawings of CR 99 for D, C, and S Lattices are enclosed.

Design Evaluation (SRP 4.2.II.C)
<u>Prototype Testing - Control Rod Structural and Performance Test (SRP 4.2.II.C.2)</u> - The basic design of Westinghouse BWR control rods has been operated for more than 30 years, including the approved CR 82. The CR 99 has this same basic design with the stainless steel sheets mounted together to form an cruciform shaped rod. From the outside, the CR 99 looks identical to the approved CR 82. The absorber material is contained in horizontally drilled absorber holes – B_4C powder for the CR 82 and [ ]^{a,c} for the CR 99. A CR 99 has already been operated to the NEOL in the Oskarshamn 3 BWR in Sweden, with additional CR 99's currently in operation in the BWR6 Leibstadt, Forsmark 3, Isar, Oskarshamn 3, and KRB-II. The operational evaluation of the CR 99 is discussed in LTR Chapter 8.

The CR 99 design meets the requirements of this section of the SRP for D, C, and S Lattice in US GE BWR's.

Testing, Inspection, and Surveillance Plans (SRP 4.2.II.D)
<u>Surveillance of control rods containing B_4C should be performed to ensure against reactivity loss</u> - Since the early 1980's, surveillances (visual inspections and neutron radiography measurements), have been conducted which have demonstrated that reactivity loss does not occur due to B_4C wash out. It has been shown that the basic concept of the Westinghouse BWR control rods, with the horizontally drilled absorber holes, retains boron carbide powder even in the case of cracking. Regarding CR 99, the performance is considered to be even better since the [ ]^{a,c} are more inert than the powder. [ ]^{a,c}

A CR 99 has already been operated to the NEOL in the Oskarshamn 3 BWR in Sweden, with other CR 99's currently in operation in Leibstadt, Forsmark 3, Isar, Oskarshamn 3, and KRB-II. Lead control rods of this design have been, and will continue to be inspected to ensure that no cracking occurs prior to NEOL.

It is expected that the European experience will continue to lead the US in terms of burn-up, with all lead rod inspections there. In particular, a set of CR 99's delivered to Leibstadt are undergoing an extensive surveillance program, consisting of:

- Pre-characterization of the control rods, including blade profile measurements - completed
- Multi-cycle burn-up to reach moderate exposure (2-3 cycles) – on-going
- Visual and blade profile measurements to NEOL
- The blade profile measurements will allow us to verify that there is no hard contact between the [ ] a, c and the wing material at NEOL. No hard contact means no swelling induced stresses are created, which is historically what leads to cracking in Westinghouse BWR control rods prior to NEOL.
- This verification will confirm that Operational Criteria 8 (LTR Section 8.3.8), mechanical end of life greater than nuclear end of life, is met.

The CR 99 design meets the requirements of this section of the SRP for D, C, and S Lattice US GE BWR's. Thus, there is no expectation of Westinghouse recommended inspections (lead use or normal operation) for US BWR's.

Appendix A

<u>Control Rod insertability must be assured following a Safe Shutdown Earthquake (SSE) (SRP 4.2, Appendix A, section D.2(b))</u> – This section was written to ensure that any new fuel design would retain sufficient integrity following a SSE to allow control rod insertability. Nevertheless, when a new control rod design is introduced, this issue needs to be addressed going the other way, i.e., can the new control rod design survive the SSE with the existing fuel design?

This is discussed in Section 6.3.5 of the LTR and the response to Question 8.

The CR 99 design meets the requirements of this section of the SRP for D, C, and S Lattice in US GE BWR's.

<u>Design Requirements relative to the approved CR 82</u> – The design requirements for the CR 99 are identical to the approved CR 82, although some of the methods and methodologies to show how they are met are not identical. See the answer to this question, as well as the other questions contained in this RIA for more insight into this. It should be noted here that Westinghouse plans to submit a LTR in the near future which updates and collates the information for the licensed CR 82 (which we now call the CR 82M-1) in a format identical to that presented in this LTR for the CR 99.

2. **In LTR Section 5.2.3 and Table 5-1, it is stated that the [proprietary] absorber material provides a higher effective density of the absorber. What is the nominal absorber "stack" density and the tolerances, or lower limit, to be achieved?**

The nominal density of the absorber material is [ ] a, c There is no specified lower value for density. This is not necessary in that:

- [

  ] a, c
- There is also a requirement on total absorber weight in a wing (weight after absorber is added – weight before added) which ensures that the correct amount of B_4C is added.

Additionally, the density is monitored to control the manufacturing process by our sub-supplier.

3. **In LTR Table 5-1, values are given for materials related critical attributes for the CR 99 design. What are the equivalent values for the approved CR 82 materials?**

To make the comparison clear the materials of the approved CR 82 is inserted in this modification of table 5.1 in the LTR.

a, c

[ ]

4. **In LTR Table 5-2, materials criteria are provided, along with the conformance method and the evaluation results for the CR 99 design. What are the equivalent criteria/results for the approved CR 82 design?**

To make the comparison clear the approved CR 82 is inserted in this modification of table 5.2 in the LTR.

a, c

[ ]

5. **LTR Table 6-1 provides the critical mechanical evaluation attributes/values for the CR 99 design. What are the equivalent values for the approved CR 82 design?**

The equivalent values of the approved CR 82 are shown in this modification of table 6.1 from the LTR. For this comparison, values for D-lattice CR 99 and CR 82 are shown to demonstrate the similarity of the rods. Results from comparison of C- and S-lattice rods lead to the same conclusions. D-lattice is chosen since the initial licensing work of the CR 82 describes rods for D-lattice.

a, c

a, c

[

]

6. **LTR Section 6 provides an extensive overview of the mechanical evaluation process used for the CR 99 design. It would be helpful to the staff if a summary of the significant differences between this process and the mechanical evaluation analyses performed for the approved CR 82 design could be provided. Changes in methodology should be flagged, with citations to the appropriate references if not included in the LTR.**

There are no major changes in the structural part of the CR 99 control rod compared with the CR 82 control rod. The principle of a control rod with a cruciform absorber section, formed by four solid stainless steel sheets, which are welded together at the center, has been unchanged over the years. The absorber material resides in horizontally drilled holes in both types of rods. [ ]a,c

Since the 1980's, when the CR 82 was licensed by the NRC, fuel operation has generally underwent up-grading in power. Specific thermal loads have increased and demands on burn-up and life time have increased for both fuel and control rods. Despite the existence of these factors, Westinghouse has been able to continue to meet the additional demands by improvements in material, design and careful analysis.

In the course of applying to the Standard Review Plan (SRP), ASME III Code is employed for stress and fatigue evaluation. The basic underlying methodology concerning the use of ASME criteria in the evaluation has, in principle, been unchanged over the years. Nevertheless, the mechanical calculation methods used have been continuously improved. Finite Element Analyses (FEA) is now fully employed in the stress analyses as well as in thermal analyses of the absorber blade, with dimensional tolerances strictly implemented in the most conservative way.

Computer codes used for stress and temperature calculations have varied over the years. For CR 82 the 3D Finite Element (FE) code EUFEMI was used for the stress analysis and the 2D FE code ALEXANDER was used for temperature calculations. Today, ANSYS 7.1 is used for both thermal and stress analysis. [ ]a,c

The design pressure and temperature is set by the design of the plant reactor coolant system; whereas the internal pressure is determined by the He-gas release from the absorber and the system temperature effect on that gas. Design pressure, as it relates to control rod design, consists of (1) a maximum system pressure the control rod can be expected to experience and (2) a pressure difference across the holes (? P) used in the stress calculations.

The maximum system pressure expected during operation is specified as [ ]a,c The control rod can be expected to survive much higher absolute pressure[ ]a,c, but reactor vessel capability precludes this value from being reached. [ ]a,c

Total ? P and its use in stress calculations are described in Section 6.3.2.1 of the LTR. [

]^{a,c} See the table in the answer to Question 7.

As discussed in Section 6.3.2.1 of the LTR, the ? P varies over control rod lifetime and with reactor pressure/temperature. At BOL, external pressure exceeds internal pressure, while at EOL (the limiting case), internal pressure exceeds external pressure. [

]^{a,c}

It should be noted that an analysis of the load-case with internal overpressure only results in an allowable differential pressure on the order of [ ]^{a,c} However, dynamic (scram) loads must also be added to the stresses caused by the ? P, lowering the calculated margin to the stress limits at a design ? P of [ ]^{a,c}

In order to prevent any confusion regarding design pressure, we are submitting an Addendum to Table 6-1 (page 6-18) of the LTR to specify both design pressure values.

Experience shows (as can be expected from the above discussion) that premature failure of Westinghouse BWR Control Rods is caused by stress corrosion cracking ensuing from B_4C swelling rather than by the gas pressure. [

]^{a,c} The methodology for calculation of the design margins is discussed in LTR section 6.3.4.3.

7. **LTR Section 6 provides design and calculated values from the CR 99 mechanical design evaluation. Please provide, where possible, the equivalent values used for the approved CR 82 design, or explain why a direct comparison is not applicable.**

Calculated design values, that is stresses and strains ensuing from internal gas pressure build-up for the CR 99 design and CR 82 design in combination with operation (scram) induced loads, in both cases, comply with the ASME criteria cited in the LTR.

Stress analysis comparison of CR 99/CR 82

a, c

a, c

8. LTR Section 6.3.5 discusses seismic behavior for the Westinghouse CR 85 control rod design. Please provide a summary of the design differences between the approved CR 82 design and the tested CR 85 design.

a, c

[ ]

Seismic tests of CR 85 control rods in Japan has shown that the control rods behave satisfactory in terms of insertion time.

For the CR 82 a bending stiffness (N/mm) was reported whereas for the CR 99 the moment of inertia (mm^4) has been calculated. The moment of inertia for CR 85, based on old calculations, was also mentioned in the LTR. The bending stiffness in terms of moment of inertia for CR 82 and CR 99 is estimated to be equal due to almost identical geometry (blade thickness, pitch, hole diameter and depth).

9. **LTR Table 7-1 provides the critical physics related attributes for the CR 99 control rod. What are the equivalent values for the approved CR 82 design?**

The equivalent values of the approved CR 82 are shown in this modification of Table 7.1 from the LTR. For this comparison, values for D-lattice CR 99 and CR 82 are shown to demonstrate the similarity of the rods. Results from comparison of C- and S-lattice rods lead to the same conclusions. D-lattice is chosen since the initial licensing work of the CR 82 describes rods for D-lattice.

a, c

10. **LTR Section 7 discusses the use of the PHOENIX code for determining the control rod worth attributes and the effect on the LPRM detector signal for the CR 99 control rod. Please describe the code model used for the approved CR 82 control rod evaluation and the effect of using a different model.**

    PHOENIX (NRC reviewed and approved in NRC Topical Report BR 91-402-P-A) is a two-dimensional transport theory and depletion code used for evaluation of the neutronic behavior of individual pins as well as whole fuel assemblies with and without control rods. In addition quadruple assembly configurations may be treated by PHOENIX. PHOENIX is also Westinghouse standard computer program for BWR to calculate reactivity quantities, fuel assembly power distributions and homogenized neutron cross-sections for input to the Westinghouse 3D-core simulator.

    For CR 99 and CR 82, the same code model, PHOENIX, has been used for all nuclear physics calculation. New versions of PHOENIX and libraries have been introduced since the CR 82 was approved. However, this will not significantly influence the control rod calculations results.

11. **LTR Section 7.2.4 discusses the use of the PHOENIX/XYBDRY method (Ref. 27) for control rod nuclear lifetime calculations and cites three references (Refs. 28-30) to show the calculated nuclear end-of-life values (NEOL's) for the CR 99 rods. Please provide these references or a detailed discussion of the method and the calculated results. Also describe the methods and results used for the approved CR 82 rods.**

    References 27 – 30 are enclosed. As mentioned in the answer to Question 10, the same model (PHOENIX) was used for both CR 82 and CR 99. The BWR control rod worth and worth depletion calculations are handled with the Westinghouse code package XYBDRY/PHOENIX. It consists of the following:

    XYBDRY- Used for detailed depletion and resonance self-shielding calculation on the control rod and for detailed calculation of control rod boundary conditions and response properties with regard to interaction between absorber pins as well as surrounding materials.

    PHOENIX- Westinghouse standard code for BWR lattice calculations.

    For CR 99 and CR 82 the same code model, XYBDRY/PHOENIX, has also been used for the nuclear lifetime calculations. New versions of XYBDRY/PHOENIX and libraries have been introduced since the CR 82 was approved. However, this does not significantly influence the control rod calculations results.

    The nuclear end-of-lifes (NEOL) for both CR 82 and CR 99 are based on the historical limits for GE BWRs, [ ] [a,c] Thus the reactivity worth reduction for CR 99 or CR 82 will only decrease during control rod depletion to the level allowed for the OEM. This means that the criteria for the determination of the NEOL is consistent among CR 99, CR 82, and the OEM rods.

12. LTR Table 7-2 provides the physics criteria and evaluation results for the CR 99 rods. What are the equivalent criteria/results used for the approved CR 82 rods?

To make the comparison clear the approved CR 82 is inserted in this modification of Table 7.2 in the LTR.

a, c

13. **LTR Section 7.3.4 discusses the applicability of the "historical" value of 90% of the initial rod worth, due to absorber depletion, as the basis for the NEOL limit. Also discussed is the use of explicit control rod worth representation in reload and core monitoring codes to extend the use of Westinghouse control rods beyond the historical limit. The use of visual inspections to verify acceptable mechanical performance is listed.**

    How is the effect of using different reload methodologies and different core monitoring codes accounted for in determining the physics criterion conformance? How does this contrast with the methodology used for the approved CR 82 rod evaluations?

    Westinghouse BWR control rods of different types, including CR82 and CR 99, have been applied in several countries with different reload methodologies and different fuel types. They are inserted in GE and KWU D, C, S-lattice BWRs as well as Westinghouse BWRs. As shown by a number of nuclear design calculations, the reactivity worth and its decrease during control rod depletion is quite insensitive to fuel type, and fuel depletion for a certain reactor type. The combined experience for these reactors show that no special effect regarding different reload methodologies are needed for the Westinghouse control rods.

    With respect to core supervision, the concept of matching reactivity worth for CR82, CR 99 and OEM is sufficient to secure that the impact of the control rods on the core is treated sufficiently well, even regarding the aspect of depleting control rods. A separate set of lattice parameters for the different control rods in a reactor is therefore only necessary if the OEM are exchanged with control rods with more than 5% higher reactivity worth. Also the positive experiences for such high-worth control rods in different reactors with different core monitoring systems support the fact that OEM, CR 82 and CR99 can be treated well by different core monitoring systems.

14. LTR Table 8-1 gives the critical operational related attributes and values for the CR 99 control rod. What are the equivalent attributes/values for the approved CR 82 rod?

The equivalent values of the approved CR 82 are shown in this modification of Table 8.1 from the LTR. For this comparison, values for D-lattice CR 99 and CR 82 are shown to demonstrate the similarity of the rods. Results from comparison of C- and S-lattice rods lead to the same conclusions. D-lattice is chosen since the initial licensing work of the CR 82 describes rods for D-lattice.

a, c

15. LTR Table 8-2 shows the operational criteria and CR 99 evaluation results. What criteria/methods and evaluation results were used for the approved CR 82 rod evaluations?

The equivalent evaluation results of the approved CR 82 are shown in this modification of table 8.2 from the LTR. For this comparison, values for D-lattice CR 99 and CR 82 are shown to demonstrate the similarity of the rods. Results from comparison of C- and S-lattice rods lead to the same conclusions. D-lattice is chosen since the initial licensing work of the CR 82 describes rods for D-lattice.

a, c

15. Continued

a, c

15. Continued

a, c

16. **LTR Section 8.3.8 discusses the mechanical end-of-life (MEOL) design goal of greater than or equal to the NEOL for new control rod designs. Please discuss the formal Westinghouse policy to follow lead control rods of each design to high burnups by performing inspections. This is related to the Section 7.3.4 statement on use of visual inspections. What is the current process for formulating guidelines for operation and further inspections for the CR 99 rods and is this different from the approved CR 82 process?**

Westinghouse has always followed a policy regarding BWR control rod blades that states that operating guidelines are based on visual inspections on leading blades of each type. That strategy was used for the CR 82 and the same strategy is also used to formulate operating guidelines for the CR 99. As mentioned in the LTR a CR 99 was inspected in Oskarshamn 3 in the summer of 2003 at the NEOL and was found to be intact. This inspection has verified the potential of the CR 99 control rod.

Westinghouse, together with the BWR6 Kernkraftwerk Leibstadt (KKL) in Switzerland, will perform an extensive surveillance program on a set of CR 99's delivered to Leibstadt, consisting of:

- Pre-characterization of the control rods, including blade profile measurements - completed
- Multi-cycle burn-up to reach moderate exposure (2-3 cycles) – on-going
- Visual and blade profile measurements to NEOL
- [

]a,c

This verification will confirm that Operational Criteria 8 (LTR Section 8.3.8), mechanical end of life greater than nuclear end of life, is met. Thus, there is no expectation of Westinghouse recommended inspections (lead use or normal operation) for US BWR's. Nevertheless, should this program identify a need to do inspections prior to NEOL, this recommendation will be passed on to utilities, as has been done for previous designs.

The process described above for CR 99 is no different than used for the CR 82. Lead blades were monitored, crack thresholds were determined (when less than NEOL), and inspection recommendations provided to utilities.

The enclosures provided with the Class 2 RAIs are considered proprietary and are not included in this Class 3 version.