STP Units 3 & 4
Spent Fuel Storage Rack
Baseline Design Structural Analysis

NRC Audit

January 17-20, 2012

Rockville, MD

Agenda

- Introductions / Attendees
- Objective, Desired Outcomes & Wrap-up Plan
- Licensing Basis
- Overview of design
- Overview of analyses
- Fuel Design, Modeling & Integrity
- Audit logistics

Attendees

NINA

- Scott Head
- Steve Thomas
- Tom Daley
- Jim Agles

TANE

- Jim Fisicaro

Toshiba

- (available via telephone or email)

Westinghouse

- Brad Maurer
- Joel Stevens
- Brian Albert
- Brian VanLuik
- Matt Coble
- Robert Quinn
- Russell Breed
- Others on call

Objective & Desired Outcomes

- Objective: Review detailed reports and supporting calculations to aid in resolving technical issues concerning New and Spent Fuel Storage

- Provide clear overview of the SFR design and the analyses that support it
- Provide support for review of documents that are the basis for WCAP-17331-P and responses to recently received RAIs
- Answer questions
- Establish agreement on next step(s) and action items

Last Day Wrap-up & Summary

- Summary of Audit Findings
- Action Items
- Schedule
- Next Step(s)
  - Staff's preparation of the SER

Licensing Basis

- Licensing Basis
  - ABWR DCD, Part 2, Tier 1, Section 2.5.6 "Fuel Storage Facility"
  - ABWR DCD, Part 2, Tier 2*, Section 4.2 "Fuel System Design"
  - ABWR DCD, Part 2, Tier 2, Section 9.1 "Fuel Storage and Handling"
  - NUREG 1503, "Final Safety Evaluation Report
  - STP 3&4 COLA Part 2, Tier 2, Section 9.1
    - STD DEP 9.1-1 (revised)
    - COL Items 9.1.6.4 (load drop) & 9.1.6.7 (structural evaluation)

- Elimination of New Fuel Racks (STP DEP T1 2.5-1 & STD DEP 9.1-1)
  - No racks in New Fuel Vault
  - All new fuel stored in Spent Fuel Pool

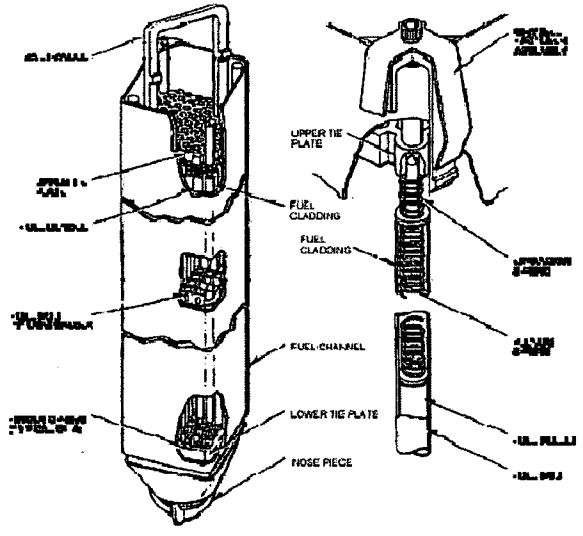
Overview of Design

- Key Design Features
- Modeling techniques & assumptions
- Mechanical and Structural Baseline Design

Top loading, with fuel bail extended above the rack. (T1 2.5.6)

[ ] a,c

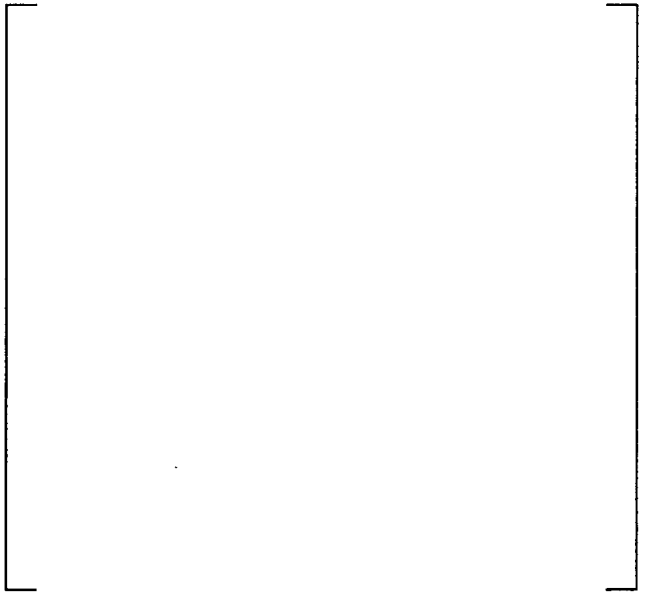
Spent Fuel Rack (WCAP-17331-P Fig 3-3)



DCD Fuel Assembly

Overview of Design *(continued)*

- Key Design Features
  - 26 racks (All are 10 x 10, total capacity = 2600 fuel elements)
  - Two independent groups of racks (separated by approx. a 12" gap)
  - Racks in each group tied together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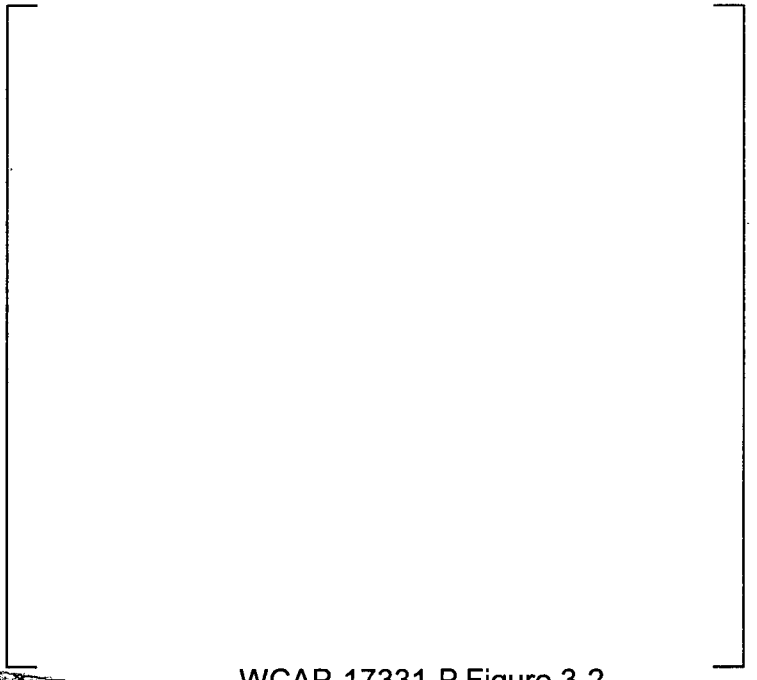
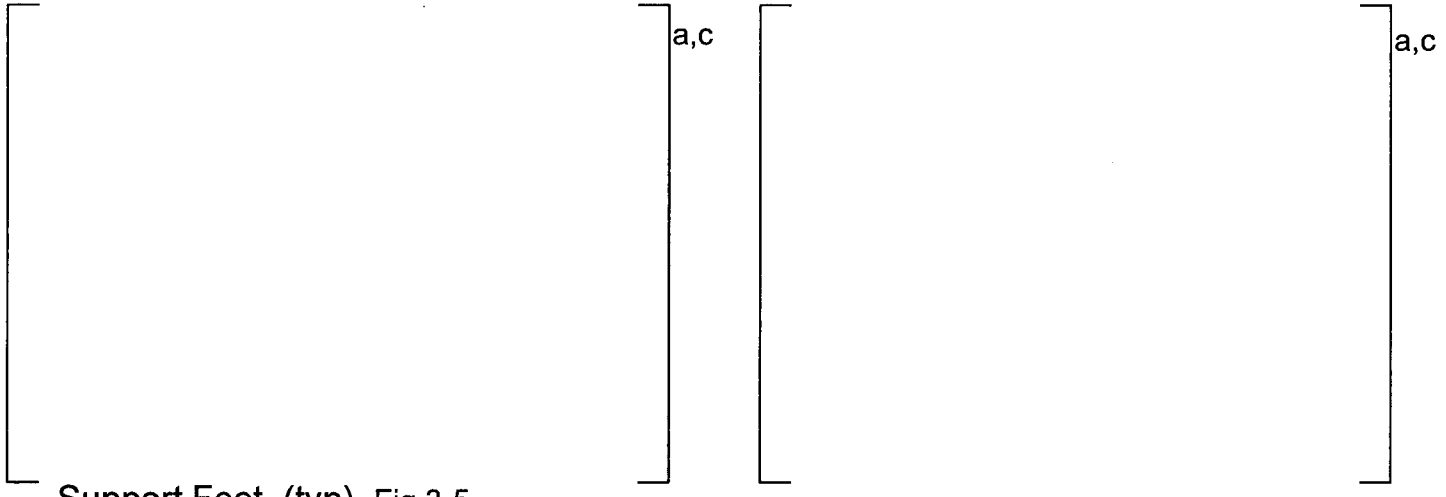
WCAP-17331-P Sketch A-2


a,c

WCAP-17331-P Figure 3-2

Overview of Design *(continued)*

- Key Design Features *(continued)*
  - Free Standing (no floor anchors or bracing off walls)
  - Eight support feet per rack (leveling pad, leveling screw & support plate)
  - Neutron absorber between all adjacent cells & on outside perimeter
  - Neutron absorber (non-structural member) contained within a SS wrapper



Overview of Analyses

- Seismic Analysis
  - [6] **CN-RVHP-10-21, Rev 0**, "Generation of Artificial Seismic Time Histories for Design Basis Ground Motion"
  - [3] **CN-MRCDA-11-23, Rev 0**, "Spent Fuel Storage Rack Structural Analysis with DCD Fuel" (Revision pending)
- Fuel Drop Analysis
  - [4] **CN-RVHP-10-33, Rev 2**, "Fuel Storage Rack Fuel Assembly Drop Evaluation"

WCAP 17331-P reference numbers are provided in [ ].

Overview of Analyses

- Modeling Techniques & Assumptions
  - Individual Rack Model
  - Whole Pool Model
  - Assumptions

Overview of Analyses *(continued)*

- Modeling Techniques & Assumptions
  - *Racks*
    - Superelement representation developed from detailed finite element model
    - Mode frequencies of the superelement matched to detailed model within [ ] [a,c]
    - Detailed single rack models developed to evaluate localized stresses and secondary thermal stresses

Overview of Analyses *(continued)*

- Modeling Techniques & Assumptions
  - *Whole Pool Model*
    - All 26 spent fuel racks modeled as two independent freestanding groups
      - » Racks internal to each group interconnected at top and bottom
    - Includes hydrodynamic mass effects and buoyancy
    - Non-linear contact is considered between:
      - » Each rack and the pool floor
      - » adjacent racks
      - » fuel assembly and the rack
      - » racks and the pool wall boundary

Overview of Analyses *(continued)*

- Modeling Techniques & Assumptions
  - *Whole Pool Model (continued)*
    - Considers a range of friction coefficients and a partially loaded case
  - *Assumptions*
    - Fluid damping is not included
    - To avoid small element sizes, the weld spacers were not modeled.
    - Weld tensile strength is equal to the base metal tensile strength

Summary of Models
Seismic Analysis CN-MRCDA-11-23

a,c

Model Flow Chart
Seismic Analysis CN-MRCDA-11-23

a,c

Calculation Note Model Locations

a,c

Seismic Analysis

- 6 load scenarios for full pool model
  - Full pool model, simplified racks, μ = 0.2
    - [ ]^{a,c}
  - Full pool model
    - Contains [ ]^{a,c}
    - Friction coefficient, μ = 0.2, 0.5, and 0.8
  - Partial loaded pool, μ = 0.2 and 0.8

Seismic Analysis *(continued)*

- Applied Seismic Time Histories
  - Satisfies the criteria of NUREG-0800, SRP 3.7.1
  - 3 statistically independent synthetic time histories
  - Envelopes target response spectra
  - Actual PSD satisfies the criteria
  - Synthesized displacement time histories are baseline corrected
    - Eliminate drift
    - Provide zero velocity at the beginning and end of time history.

Seismic Analysis *(continued)*

- Summary of Results
  - Meets all requirements
  - Initial design changed in WCAP Rev 2 to address high stress locations
    - [ ]^{a,c}
    - [ ]^{a,c}
  - Cell wall structure meets buckling requirements

Fuel Drop Analysis

- Three Orientations (a total of 10 cases were run)
  - Shallow Drop - Vertical drop on top of rack
  - Inclined Orientation – on top of rack
  - Deep Drop - Through to Bottom of Rack
- Drop Locations - considered limiting impact locations
- Acceptance Criteria (SRP 3.8.4, App D, Sect I.4, "Loads & Load Combinations"). "The functional capability of the fuel racks should be demonstrated."
- Results
  - Functional capability of the fuel rack is maintained

WCAP-17331-P, Rev 2 – Content Summary

- Design Details updated and expanded in Rev 2
- Method of Analyses
- Modeling Assumptions & Input Data
- Key Evaluations & Results
  - Seismic Impact Loads & Displacement
  - Rack Structural Evaluation (Seismic plus Deadweight)
  - Dropped Fuel Assembly
  - Stuck Fuel Assembly
- Supporting Calculations & References

Fuel Design

- DCD fuel is GE P8x8R (DCD Tier 2 Ch 4.2)
- Parameters summarized in DCD T2 Table 1.3-1
  - 8 x 8 array of rods
  - 176" overall length
  - Active fuel length 146"
  - 435 lb UO2, 62 fuel rods
  - 0.483 inch cladding diameter, Zircaloy-2
  - 675 lb assembly weight with channel
  - Channel Zircaloy-4, 5.48" sq, 0.100" thick
- Other parameters are proprietary but can be deduced and obtained from available literature

Fuel Modeling

- Rack Analyses – Fuel Dynamic Properties
  - Detailed analytical model for Optima2 used as baseline case
  - BWR 8x8 assembly weight and fundamental frequency information available from Westinghouse report CENPD-288

[a,c]

  - Dynamic characteristics of detailed Optima2 model modified to match weight and fundamental frequency of GE 8x8 modeled fuel
  - Modeled fuel selected (vs. DCD fuel) to maximize g-load

Fuel Modeling *(continued)*

- Rack Analyses – Fuel Lateral Stiffness
  - Fuel lateral stiffness is simply a modeling means for transferring load from the fuel assembly to the rack cell
  - The analysis looked at lower and upper bound values for [ ]^{a,c}
  - Comparable data for 8x8 BWR grids are not readily available
    - Available data on other BWR grids suggests 8x8 grid stiffness comparable
    - [ ]^{a,c}
    - [ ]^{a,c}
  - The lateral stiffness does not effect the modal behavior of the fuel or rack
    - Fundamental frequency change is negligible (<1%)

Fuel Modeling *(continued)*

- A sensitivity analysis of fuel loads on the rack was done for the [ ]^{a,c}
  - [ ]^{a,c}
- Fuel lateral stiffness has minimal effect on fuel impact load on rack
  - Suggests that further studies / permutations are not warranted

Fuel Integrity Evaluation

- Capacity
  - DCD defines design basis seismic load on fuel in core – 2.4g at fuel fundamental frequency
  - DCD Ch 19 evaluates fuel capacity
    - Median capacity 4.72 times design basis = 11.3g
    - HCLPF capacity > 2 times design basis = >4.8g
  - [ ]a,c

Fuel Integrity Evaluation *(continued)*

- Loads ("Demand")
  - In-phase – From rack analyses maximum load case
    - [

      ]a,c
  - Out-of-phase – used SRP kinetic energy method for bounding load
    - [

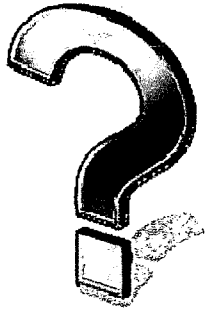
      ]a,c
    - [

      ]a,c

Audit Logistics

- Calculations
- Drawings
- Draft RAI Responses
- Points of Contact
  - Structural – Brian Albert
  - Load Drop – Brian VanLuik
  - Seismic – Joel Stevens / Matt Coble
  - Fuel Integrity – Brad Maurer / Bob Quinn

Questions and Discussion



Supplemental Presentations

- Summary of Peer Review and Technical Review
- Comparison of STP and Crystal River Methodologies

Peer Review

- Based on Revision 1 of the technical report
- Presentation and results discussed in peer review minutes [ ]a,c

Peer Review (Continued)

- Peer Review Committee Members in attendance
  - Jeff Himler (Chairman), Westinghouse Fellow Engineer, performed Crystal River technical review
  - Brandon Schoonmaker, Westinghouse Senior Engineer, worked on AP1000® submittal
  - Frank Marx, Westinghouse Fellow Engineer, ANSYS® technical expert, previously employed by ANSYS®
  - Robert Condrac, Westinghouse Principal Engineer
  - Tom Hammel, Westinghouse Principal Engineer, worked on CE SFR seismic analysis submittals
  - Dave Faulstich, GE retired

Peer Review (Continued)

- Performed extensive review of:
  - model technical aspects
    - Development of superelements
    - Methods for calculating hydrodynamic mass
    - Whole pool model
    - Methods for submodel analysis
- Reviewed seismic input
- Provided 16 recommendations for model investigation and improvement of modeling techniques
- The recommendations were tracked using an internal punch list and all 16 recommendations were completed
- Detailed discussion on the large displacements that occurred in Revision 1 of the technical report. The peer review team determined that the largest contributor to these displacements was the magnitude of the input.

Technical Review Overview

- Peer checks performed by Steve Austin (developed hydrodynamic mass calculation methodology)
  - Created simplified models to confirm hydrodynamic mass calculations
- Byounghoan Choi performed technical review of the revision 1 technical report model according to Westinghouse 3-pass verification method
- Tom Hammel, Earnest Shen, and Ya Tao Wu performed technical review of seismic analysis calculation according to Westinghouse 3-pass verification method

Comparison of STP and Crystal River Methodologies and Results

- See following summary slides

Modeling Methodology

[a,c]

Results Discussion

- The Crystal River input is much less than STP input
- [ ]a,c
- [ ]a,c
- [ ]a,c

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WEC-NINA-2012-0003

CAW-12-3356

January 13, 2012

APPLICATION FOR WITHHOLDING PROPRIETARY INFORMATION FROM PUBLIC DISCLOSURE

Subject: Spent Fuel Rack Audit Presentation Material entitled: "STP Units 3 & 4 Spent Fuel Storage Rack Baseline Design Structural Analysis" (Proprietary)

The proprietary information for which withholding is being requested in the above-referenced document is further identified in Affidavit CAW-12-3356 signed by the owner of the proprietary information, Westinghouse Electric Company LLC. The affidavit, which accompanies this letter, sets forth the basis on which the information may be withheld from public disclosure by the Commission and addresses with specificity the considerations listed in paragraph (b)(4) of 10 CFR Section 2.390 of the Commission's regulations.

Accordingly, this letter authorizes the utilization of the accompanying affidavit by Nuclear Innovation North America (NINA).

Correspondence with respect to the proprietary aspects of this application for withholding or the accompanying affidavit should reference CAW-12-3356 and should be addressed to J. A. Gresham, Manager, Regulatory Compliance, Westinghouse Electric Company, Suite 428, 1000 Westinghouse Drive, Cranberry Township, Pennsylvania 16066.

Very truly yours,

B. F. Maurer, Manager
ABWR Licensing

Enclosures

cc: R. Foster (NRC TWFN 6 D38M)

AFFIDAVIT

COMMONWEALTH OF PENNSYLVANIA:

ss

COUNTY OF BUTLER:

Before me, the undersigned authority, personally appeared B. F. Maurer, 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:

B. F. Maurer, Manager
ABWR Licensing

Sworn to and subscribed before me
this 13th day of January 2012

Notary Public

COMMONWEALTH OF PENNSYLVANIA
Notarial Seal
Cynthia Olesky, Notary Public
Manor Boro, Westmoreland County
My Commission Expires July 16, 2014
Member, Pennsylvania Association of Notaries

(1) I am Manager, ABWR 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 Proprietary Information from Public Disclosure 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 Spent Fuel Rack Audit Presentation Material entitled: "STP Units 3 & 4 Spent Fuel Storage Rack Baseline Design Structural Analysis" (Proprietary) for submittal to the Commission, being transmitted by Nuclear Innovation North America (NINA) letter and Application for Withholding Proprietary Information from Public Disclosure, to the Document Control Desk. The proprietary information as submitted by Westinghouse is that associated with NRC review of the ABWR spent fuel rack structural analysis methodology for South Texas Project Units 3&4.

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

(a) Assist the customer in obtaining NRC review of the spent fuel rack structural analysis for South Texas Project 3&4.

Further this information has substantial commercial value as follows:

(a) Westinghouse plans to sell the use of this information to its customers for purposes of plant specific spent fuel rack structural analysis and methodology development for ABWR licensing basis applications.

(b) Its use by a competitor would improve their competitive position in the design and licensing of a similar product for ABWR spent fuel racks.

(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 technical evaluations 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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