



**Westinghouse  
Electric Company**

4350 Northern Pike  
Monroeville Pennsylvania 15146-2886

October 17, 2000

AW-00-1427

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

Attention: J. S. Wermiel, Chief,  
Reactor Systems Branch  
Division of Systems Safety and Analysis

APPLICATION FOR WITHHOLDING PROPRIETARY  
INFORMATION FROM PUBLIC DISCLOSURE

Subject: Westinghouse Updated Fuel Licensing Criteria (Slide Presentation of October 17, 2000),  
(Proprietary)

Reference: Letter from H. A. Sepp to J. S. Wermiel, NSBU-NRC-00-5981, dated October 17, 2000

Dear Mr. Wermiel:

The application for withholding is submitted by Westinghouse Electric Company LLC, a Delaware limited liability company ("Westinghouse"), pursuant to the provisions of paragraph (b)(1) of Section 2.790 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 2.790, Affidavit AW-00-1427 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 2.790 of the Commission's regulations.

Correspondence with respect to this application for withholding or the accompanying affidavit should reference AW-00-1427 and should be addressed to the undersigned.

Very truly yours,

A handwritten signature in black ink, appearing to read "H. A. Sepp". The signature is fluid and cursive, with a large loop at the end.

Henry A. Sepp, Manager  
Regulatory and Licensing Engineering

### **Proprietary Information Notice**

Transmitted herewith are proprietary and non-proprietary versions of documents furnished to the NRC. In order to conform to the requirements of 10 CFR 2.790 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 2.790(b)(1).

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AFFIDAVIT

COMMONWEALTH OF PENNSYLVANIA:

SS

COUNTY OF ALLEGHENY:

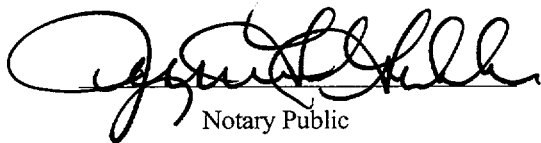
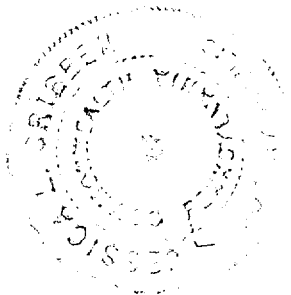
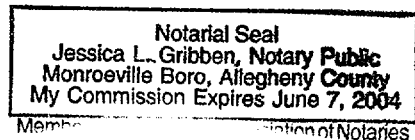
Before me, the undersigned authority, personally appeared Henry A. Sepp, who, being by me duly sworn according to law, deposes and says that he is authorized to execute this Affidavit on behalf of Westinghouse Electric Company LLC, a Delaware limited liability company ("Westinghouse") and that the averments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



Henry A. Sepp, Manager

Regulatory and Licensing Engineering

Sworn to and subscribed  
before me this 13<sup>th</sup> day  
of October, 2000.

  
Notary Public

- (1) I am Manager, Regulatory and Licensing Engineering, in the Nuclear Services Division, of the Westinghouse Electric Company LLC, a Delaware limited liability company ("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 rulemaking proceedings, and am authorized to apply for its withholding on behalf of the Westinghouse Electric Company.
- (2) I am making this Affidavit in conformance with the provisions of 10 CFR Section 2.790 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 the Westinghouse Electric Company 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 2.790 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 which 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 2.790, 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 "Westinghouse Updated Fuel Licensing Criteria (Slide Presentation of October 17, 2000), (Proprietary)," October 17, 2000, for submittal to the Commission, being transmitted by Westinghouse Electric Company (W) letter (NSBU-NRC-00-5981) and Application for Withholding Proprietary Information from Public Disclosure, Henry A. Sepp, Westinghouse, Manager Regulatory and Licensing Engineering to the attention of J. S. Wermiel, Chief, Reactor Systems Branch, Division of Systems Safety and Analysis. The proprietary information as submitted by Westinghouse Electric Company is to provide the material as presented to the NRC staff at the Updated Fuel Licensing Criteria meeting on October 17, 2000.

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

- (a) Correct any problems associated with fuel failures and ensure proper fuel performance of fuel operating in reactors.
- (b) Assist customers in improving their fuel performance (zero defects).

Further this information has substantial commercial value as follows:

- (a) Westinghouse plans to continue to implement corrective actions to ensure the highest quality of fuel in order to meet the customer needs.

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 evaluation justifications 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 for developing the enclosed improved core thermal performance methodology.

Further the deponent sayeth not.



**Westinghouse  
Updated Fuel Licensing Criteria  
(Slide Presentation of October 17, 2000)**

**October 2000**

# Updated Fuel Licensing Criteria

Westinghouse Electric Company

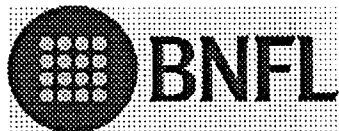
Presentation to the  
Nuclear Regulatory Commission

October 17, 2000



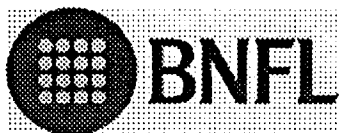
# Updated Fuel Licensing Criteria

- **Agenda**
  - Purpose
  - Criteria Review
  - Structural Hydrogen Criterion
  - Updated Transient Fuel Rod Design Criteria
  - Summary
  - Proposed Approach



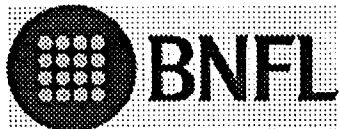
## Updated Fuel Licensing Criteria

- **Purpose: Present Updated Fuel Licensing Criteria**
- **Reasons:**
  - Current criteria Pre-NUREG 0800,
  - Convergence in methods between Westinghouse, Westinghouse/CE and Westinghouse/ATOM,
  - Make new criteria consistent with Industry Guidelines (Robust Fuel Program),
  - New criteria replace indirect performance correlations with direct performance correlations that are more readily measured and thus provide direct feedback to design, and
  - New criteria focus of industry analysis methods and testing.



## Current and Proposed Criteria

<u>Parameter</u>	<u>Current Criteria</u>	<u>Proposed Criteria</u>
Fuel Assembly Structural Hydrogen	Structural Zircaloy Hydrogen [ ] <sup>a,c</sup>	Stresses consistent with ASME Code Section III requirements after accounting for wall thinning
Fuel Cladding Transient Strain	Transient strain < 1 % No fuel centerline melt	Same as current criteria
Fuel Rod Stress	Transient Stress [ ] <sup>a,c</sup>	Stresses consistent with ASME Code Section III requirements

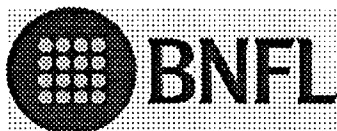


## Current Cladding and Structural Hydrogen Criteria

- The Westinghouse imposed hydrogen criteria for both cladding and structural components is

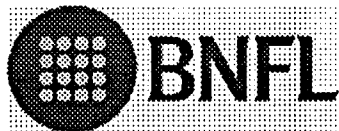
“The clad and structural component hydrogen pickup is limited to [ ]<sup>a,c</sup> at end of life to preclude loss of ductility due to hydrogen embrittlement by the formation of zirconium hydride platelets.”

- The criteria are based on data for unirradiated zircaloy which showed levels of [ ]<sup>a,c</sup> ppm were acceptable.
- No differentiation is made between heated and unheated surfaces.



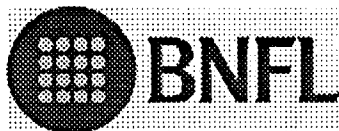
## Evaluation of Hydrogen Content Criteria

- Reviewed Westinghouse and industry data on the effects of hydrogen content on material properties.
  - Ductility
  - Strength
- Evaluated the impacts of corrosion hydrogen pickup on Fuel Assembly Structures.
  - Spacer grids
  - Thimble tubes



## The Effects of Hydrogen Content on Zircaloy Material Properties

- The ductility of unirradiated zircaloy at room temperature does not abruptly decrease above [ ]<sup>a,b,c</sup> There is a gradual decrease and some ductility remains at hydrogen levels of [ ]<sup>a,b,c</sup>
- The ductility of irradiated zircaloy is primarily affected by irradiation.
- While hydrides contribute to the embrittlement of irradiated zircaloy, the [ ]<sup>a,b,c</sup> up to hydrogen contents in excess of [ ]<sup>a,c</sup>

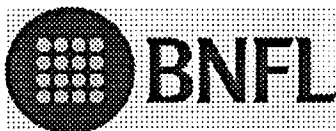




## The Effects of Hydrogen Content on Zircaloy Material Properties

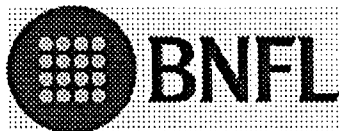
- Hydrogen has little effect on the tensile strength of irradiated zircaloy at either room or operating temperatures.
- The yield strength of irradiated recrystallized zircaloy at operating temperatures is about [ ]<sup>a,b,c</sup> the value for unirradiated material. The value is about [ ]<sup>a,b,c</sup> at room temperature.
- Westinghouse experience with handling assemblies with hydrogen contents in excess of [ ]<sup>a,b,c</sup> has not resulted in any fuel damage.

The strength and ductility of irradiated zircaloy are primarily affected by irradiation. Hydrogen effects are negligible by comparison



## Impact of Hydrogen Content on Grids

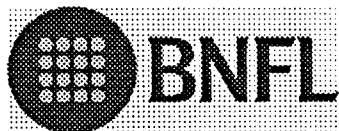
- NUREG 0800 specifies that grid crush tests should be performed on unirradiated production grids at, or corrected to, operating temperature.
- Tests were conducted to verify that unirradiated production grids would continue to demonstrate minimum LOCA/seismic capability when accounting for corrosion, wall thinning due to corrosion, hydrogen uptake, and enlargement of the grid cell size.
- Tests were conducted on unirradiated [ ]<sup>a,b,c</sup> grid sections with simultaneous oxidation, wall thinning, hydrogen pickup, and enlargement of grid cell size.
  - One sided oxide thickness ranged from [ ]<sup>a,b,c</sup>
  - Hydrogen content was up to [ ]<sup>a,b,c</sup>
  - Wall thinning varied from [ ]<sup>a,b,c</sup>
  - grid spring to rod gaps varied from [ ]<sup>a,b,c</sup>



## Impact of Hydrogen Content on Grids

- The [ ]<sup>a,b,c</sup> tests indicated that grid crush strength and the seismic capability factor  $P/(K)^{1/2}$  [ ]<sup>a,b,c</sup>
- Tests were conducted on production grids that were [ ]<sup>a,b,c</sup>
- There was [ ]<sup>a,b,c</sup>

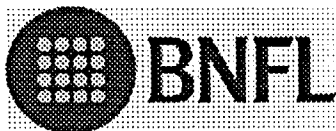
The use of crush test data from production grids to perform LOCA/Seismic analysis was validated for Westinghouse grids.



# Hydrogen Impact on Thimble Tube Stresses

- Thimble tube stresses are evaluated using Westinghouse design procedures that follow ASME Code Section III guidelines per NUREG 0800.
- An evaluation was performed for a limiting design and considered Conditions I, II, III, and IV events and shipping/handling loads.
- Wall thinning was accounted for in this standard procedure.
- It was concluded that the thimble tube stresses would not exceed the yield stresses for wall thinning values predicted for currently licensed burnups.
- Since the yield stress is not exceeded; therefore, thimble tube ductility is not a concern.

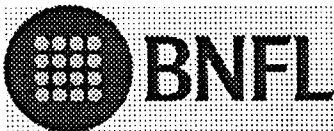
Westinghouse will account for thimble tube wall thinning as described in NUREG 0800.



## Revised Westinghouse Criteria

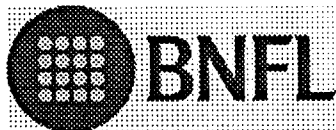
- Desirable characteristics of a design criterion:
  - Related to a physical limit
  - Basis for quantifying the limit
  - Can be verified by measurement.
- The [ ]<sup>a,c</sup> criterion does not have the desired characteristics.
- A wall thinning criteria applied in design, meets all the desired characteristics for design criteria.

Westinghouse will account for wall thinning in determining stress, strain, and loading limits on zircaloy alloy fuel structural components.



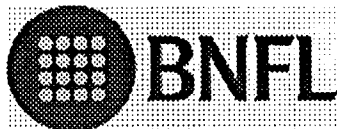
# Updated Fuel Licensing Criteria

Elimination of Transient Fuel Rod Design Criteria  
(No change in conformance to NUREG 0800)



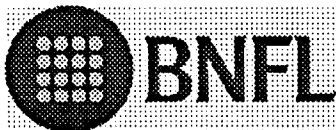
# Updated Fuel Licensing Criteria Fuel Rod Design

- Existing Criteria
  - No centerline fuel melt
  - Cladding transient strain  $< 1\%$
  - [ $\sigma_{a,c}$ ]
- Revised Criteria
  - No centerline fuel melt
  - Cladding transient strain  $< 1\%$
  - ASME Code Section III based stress limits



## Updated Fuel Licensing Criteria Fuel Rod Design

- Updated Criteria - Conform to NUREG 0800 and Industry Robust Fuel Program (RFP) guidelines
  - Transient Strain: The design limit for the fuel rod cladding transient strain during AOOs is that the total tensile strain due to uniform cylindrical pellet thermal expansion during the transient is less than 1% of the pre-transient value.
  - No Centerline Fuel Melt: The design limit for fuel temperature analysis during Condition I and II is that there is at least a 95% probability that the peak kw/ft fuel rods will not exceed the  $\text{UO}_2$  melting temperature.
  - Fuel Rod Cladding Stress: Cladding stresses will be evaluated using ASME Code Section III pressure vessel guidelines.





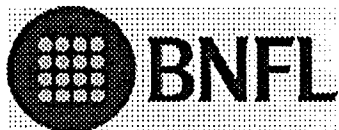
# Updated Fuel Licensing Criteria

## Fuel Rod Design

- Cladding Transient Strain Criterion
  - Cladding integrity is assured by limiting linear heat generation rates below centerline fuel melt and 1% cladding transient strain.
    - Both Westinghouse and industry testing demonstrate cladding ductility of  $> 1\%$  for appropriate test methods.
    - Cladding strain capability is focus of industry efforts in development of testing methods and analysis.
    - Reload analysis continues to show that [

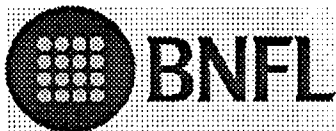
] <sup>a,c</sup> Not a specific high burnup concern up to the current licensed limits.

Transient strain criteria of 1% combined with no fuel centerline melt are sufficient to prevent fuel failure and meet NUREG 0800 requirements and RFP guidelines.



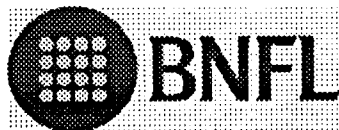
## Updated Fuel Licensing Criteria

- Summary
  - Current criteria pre-dates NUREG 0800
  - Updated criteria conforms to:
    - NUREG 0800
    - Industry RFP Guidelines
  - Updated criteria promote convergence between Westinghouse Business Units
  - Updated criteria are sufficient to ensure fuel integrity



## **Updated Fuel Licensing Criteria (for both structural hydrogen content and cladding stress)**

- Present Criterion listed in:
  - WCAP-12610-P-A, Vantage+ Fuel Assembly Core Report, April 1995.
  - WCAP-12488-A, Westinghouse Fuel Criteria Evaluation Process, October 1994.
  - WCAP-10125-P-A, Extended Burnup Evaluation of Westinghouse Fuel, December 1985.



## Proposed Licensing Approach

- Revised Criteria will be submitted as:
  - Letter addendum to WCAP-10125-P-A, Extended Burnup Evaluation of Westinghouse Fuel.
- Changes are considered globally applicable to all other references.
- Request:
  - NRC formally respond with acceptance of letter
- Westinghouse will then
  - Update WCAP-12488-A, Westinghouse Fuel Criteria Evaluation Process

