Westinghouse
Electric Company

Box 355
Pittsburgh Pennsylvania 15230-0355

February 15, 2002
LTR-NRC-02-7

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

Subject: Westinghouse Presentation on Creep/Growth Test (Slide Presentation of March 7, 2002), (Proprietary)

Dear Mr. Wermiel:

Enclosed are copies of the Proprietary and Non-Proprietary versions of the presentation material from the NRC/Westinghouse/SNOC meeting on Creep/Growth Test to be held at the NRC in Rockville, Maryland on March 7, 2002.

Also enclosed are:

1. One (1) copy of the Application for Withholding, AW-02-1511 with Proprietary Information Notice and Copyright Notice.

2. One (1) copy of Affidavit, AW-02-1511.

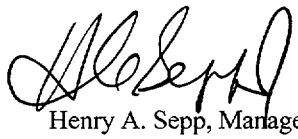
This submittal contains Westinghouse proprietary information of trade secrets, commercial or financial information which we consider privileged or confidential pursuant to 10 CFR 9.17(a)(4). Therefore, it is requested that the Westinghouse proprietary information attached hereto be handled on a confidential basis and be withheld from public disclosure.

This material is for your internal use only and may be used solely for the purpose for which it is submitted. It should not be otherwise used, disclosed, duplicated, or disseminated, in whole or in part, to any other person or organization outside the Office of Nuclear Reactor Regulation without the expressed prior written approval of Westinghouse.

T007.

Correspondence with respect to any Application for Withholding should reference AW-02-1511 and should be addressed to H. A. Sepp, Manager of Regulatory and Licensing Engineering, Westinghouse Electric Company, P. O. Box 355, Pittsburgh, Pennsylvania 15230-0355.

Very truly yours,



Henry A. Sepp, Manager
Regulatory and Licensing Engineering

Copy to:
S. L. Wu, NRR
R. Caruso, NRR
U. Shoop, NRR
D. Holland, NRR

Westinghouse
Electric Company

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AW-02-1511

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

APPLICATION FOR WITHHOLDING PROPRIETARY
INFORMATION FROM PUBLIC DISCLOSURE

Subject: Westinghouse Presentation on Creep/Growth Test (Slide Presentation of March 7, 2002), (Proprietary)

Reference: Letter from H. A. Sepp to J. S. Wermiel, LTR-NRC-02-7, dated February 15, 2002

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-02-1511 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-02-1511 and should be addressed to the undersigned.

Very truly yours,

Henry A. Sepp, Manager
Regulatory and Licensing Engineering

AFFIDAVIT

COMMONWEALTH OF PENNSYLVANIA:

ss

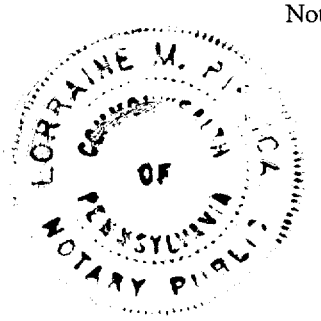
COUNTY OF ALLEGHENY:

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 15th day
of February, 2002.

Notary Public



Notarial Seal
Lorraine M. Piplica, Notary Public
Monroeville Boro, Allegheny County
My Commission Expires Dec. 14, 2003
Member, Pennsylvania Association of Notaries

(1) I am Manager, Regulatory and Licensing Engineering, in Nuclear Services, 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 Presentation on Creep/Growth Test (Slide Presentation of March 7, 2002), (Proprietary)," February 15, 2002, for submittal to the Commission, being transmitted by Westinghouse Electric Company (W) letter (LTR-NRC-02-7) 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 March 7, 2002 meeting.

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

(a) Justify technical and licensing positions on assumption used in the fuel performance model.

(b) Assist customers in improving their fuel performance (zero defects).

Further this information has substantial commercial value as follows:

(a) Westinghouse plans to use information obtained from the test for future fuel product licensing.

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.

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).

Copyright Notice

The documents transmitted herewith each bear a Westinghouse copyright notice. The NRC is permitted to make the number of copies for the information contained in these reports which are necessary for its internal use in connection with generic and plant-specific reviews and approvals as well as the issuance, denial, amendment, transfer, renewal, modification, suspension, revocation, or violation of a license, permit, order, or regulation subject to the requirements of 10 CFR 2.790 regarding restrictions on public disclosure to the extent such information has been identified as proprietary by Westinghouse, copyright protection not withstanding. With respect to the non-proprietary versions of these reports, the NRC is permitted to make the number of copies beyond these necessary for its internal use which are necessary in order to have one copy available for public viewing in the appropriate docket files in the public document room in Washington, DC and in local public document rooms as may be required by NRC regulations if the number of copies submitted is insufficient for this purpose. Copies made by the NRC must include the copyright notice in all instances and the proprietary notice if the original was identified as proprietary.

Westinghouse
Presentation on Creep/Growth Test
(Slide Presentation of March 7, 2002)

March 2002

Creep/Growth Test

John Foster

Jack Killimayer

Tom Smentek

Meeting with the NRC on March 7, 2002

Westinghouse Electric Company

Outline

- Review Test
- Update Schedule and Test Matrix
- Show Measurement Methods
  - In response to questions during the W/NRC Meeting on 2/21/01
- Present Statistical Analysis
  - Westinghouse action from the W/NRC Meeting on 2/21/01
- Show Licensing Approach

Test Objectives

- Generate ZIRLO™ tensile/compressive in-reactor creep data
- Determine the effects of [ ]a,c
- Evaluate Low Sn ZIRLO™ [ ]a,c
- Screen [ ]a,c

Test Overview

- Test samples will be irradiated in [

  ]^{a,c}
  - Test samples do not contain fuel
- Four assemblies irradiated for 1, 2, 3 & 4 cycles
  - Additional test assembly is being considered
- Samples discharged for measurement will not be reinserted
- Disassemble samples by shearing after the refueling outage in the pool and ship to AECL for examination
- Similar method to EPRI/B&W Oconee-2 test
  - Considered the best available PWR in-reactor creep test

Test Environment

- Parameters:

  Fluences: ~5×10^{21} n/cm^2 E>1 MeV/cycle

  (associated with cycles 1, 2, 3 & 4)

  4-cycle fluence is associated with a burnup >75,000 MWd/MTU

  Constant flux: typically ~1.06×10^{14} n/cm^2-sec E>1 MeV

  Temperatures: in the range of ~576 - 607°F

Irradiation Schedule

- Initiate irradiation in Vogtle 2 cycle 10

Cycle:	10	11	12	13	14
	Fall 02	Spring 04	Fall 05	Spring 07	Fall 08

a, c

[ ]

Test Matrix Key Features

- Replicate samples for all key tests will provide verification of the measurements
  - [ ]a, c
  - [ ]a, c
- [ ]a, c
- Two sample designs to evaluate gamma heating effects
  - Confirmation of the actual sample stresses
- [ ]a, c.
  - [ ]a, c
  - [ ]a, c

Test Matrix

Number of Test Samples

Alloy	Cycles	Hoop Stress (ksi)							
		-13.1	-8.7	-5.8	-2.9	0	2.9	5.8	8.7
[									] a, b, c
			-9.7	-5.1	-0.53	1.1	2.7	7.3	11.9
[									] a, b, c

Test Matrix (continued)

Number of Test Samples

Alloy	Cycles	Hoop Stress (ksi)				
		-9.0	-6.2	0	5.0	
[						a, b, c]
		-8.7		0		
[						a, b, c]

Test Matrix (continued)

Number of Test Samples

Alloy	Cycles	Hoop Stress (ksi)		
		-8.7	-5.8	0
[				] a, b, c

Test Matrix (continued)

Number of Test Samples

Alloy	Cycles	Hoop Stress (ksi)		
		-8.7	-5.8	0
[				] a, b, c

Alloy Compositions/Initial Phase

Alloy	Nb	Sn	Fe	Cr
ZIRLO (current)	[			] a, b, c
Low Tin ZIRLO, Byron & Vandellos LTAs				
Low Tin ZIRLO (new ingot)				
Alloy A				

Mechanical Design Key Features

- Most samples are internally pressurized with helium
  - Some reference (unstressed) samples are open to the coolant
- Internal mandrels (inside the pressurized samples) will support the tubing in case of collapse
- Screw threads connect the test samples and spacers
  - Locking Heli-Coils fix the test samples and spacers in position
  - Heli-Coils were successfully used in the W/BWR Fitzpatrick demo assemblies
- Spacers between the samples will be shear cut in the pool and shipped to AECL for examination

Core Design Key Features

- Irradiate the inserts in 1-cycle burned fuel assemblies
  - New host fuel assembly for each irradiation cycle
- Place four assemblies in symmetric locations
  - Use dummy insert(s) and assembly(ies) for core flux symmetry
  - Approximately the same flux for all assemblies
  - Approximately constant cycle-to-cycle flux
- Total fluence greater than the value associated with a burnup of 75,000 MWD/MTU
- Reload design and analysis methods are applicable

Temperature Evaluation

- Analytically calculate the coolant temperatures using the measured inlet and mixed mean outlet temperatures and post-cycle fuel assembly powers
  - EPRI/B&W Program calculated all temperatures
- Irradiation effects (creep & growth) not strongly temperature dependent over the test temperatures

Fluence Measurements

- Experimentally measure the flux/fluence using PNNL dosimetry capsules
  - PNNL/laboratory in the USA with this expertise
  - Include different wire segments with cross-sections sensitive to different neutron energies (Fe, Ti, Nb & Cu)
  - EPRI/B&W Program relied on calculated flux/fluence values

Post Irradiation Examination/AECL

- Measure the sample oxide thickness, diameter change and length change
  - –Samples designed with the AECL measurement methods
- Perform metallography on selected samples for oxide thickness
- Perform hydrogen pickup analysis on selected samples

Assembly A1, A2 & A3 Pretest Diameter and Length Measurements/AECL

[a, b, c]

Assembly A1, A2 & A3 Pretest Diameter and Length Measurements/AECL

- 140 diameter measurements per sample per measurement data set

[ ] a, b, c

- 25 length measurements per sample per data set

[ ] a, b, c

Major Milestones

	Date
Technical Feasibility	Complete
Design Review	Complete
Fabricate Hardware	5/02
Initiate Irradiation	11/02
Continue Irradiation/1-cycle assembly discharged	Spring 04
Continue Irradiation/2-cycle assembly discharged	Fall 05
Complete Irradiation	Fall 08
Discharge & PIE	Spring 09
Final Report	Fall 10

Statistical Evaluation of 1-Cycle Creep/Growth Test Data

- Performed a statistical evaluation of expected 1-cycle test data
  - Action item from the W/NRC Meeting on 2/21/01
- Used CWSR Zr-2.5Nb data reported by Causey et al (ASTM STP 1245, 1994, 202-220) (for the first inspection)
  - Similar irradiation creep and growth expected for [ ]^{a,c} ZIRLO^{TM} based on texture and c-component dislocation density

Tubing	Texture			c-component Dislocation Density
	f_r	f_θ	f_z	(10^{14} /m^2)
ZIRLO^{TM}	[			]^{a,b,c}
CANDU	0.57	0.37	0.07	0.6

Statistical Evaluation of 1-Cycle Creep/Growth Test Data (continued)

- ZIRLO™ 1-cycle predicted strains are similar to the strains reported by Causey et al on the highest stress samples
  - ZIRLO™: $\Delta D/D = 0.24\%$ (for 8.7 ksi at 605 °F)
  - Causey et al (samples irradiated in Osiris at 536 °F for 1.0×10^{21} n/cm^2 E>1):

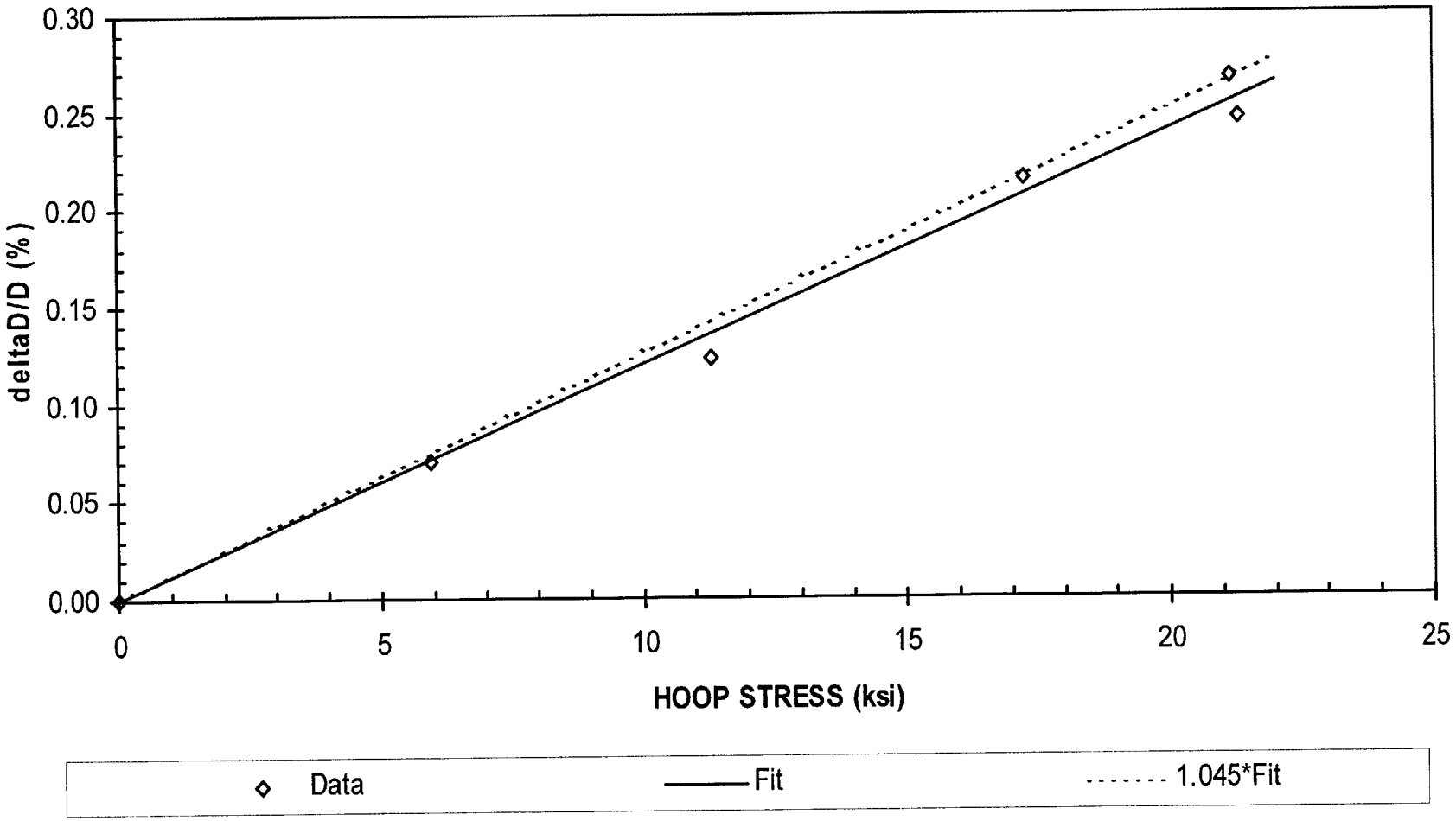
Sample	Hoop Stress (ksi)	$\Delta D/D$ (%)
F	17.3	0.213
J	21.2	0.276
K	21.3	0.228
	average =	0.239

Statistical Evaluation of 1-Cycle Creep/Growth Test Data (continued)

- Adjusted the Causey et al data for flux variations and irradiation growth
  - 14% flux variation - linearly normalized $\Delta D/D$ data to the average flux (fluence)
  - Converted the total strain to irradiation creep by subtracting the average irradiation growth

$$\Delta D/D(\text{creep}) = \Delta D/D(\text{total}) - \Delta D/D(\text{growth})$$

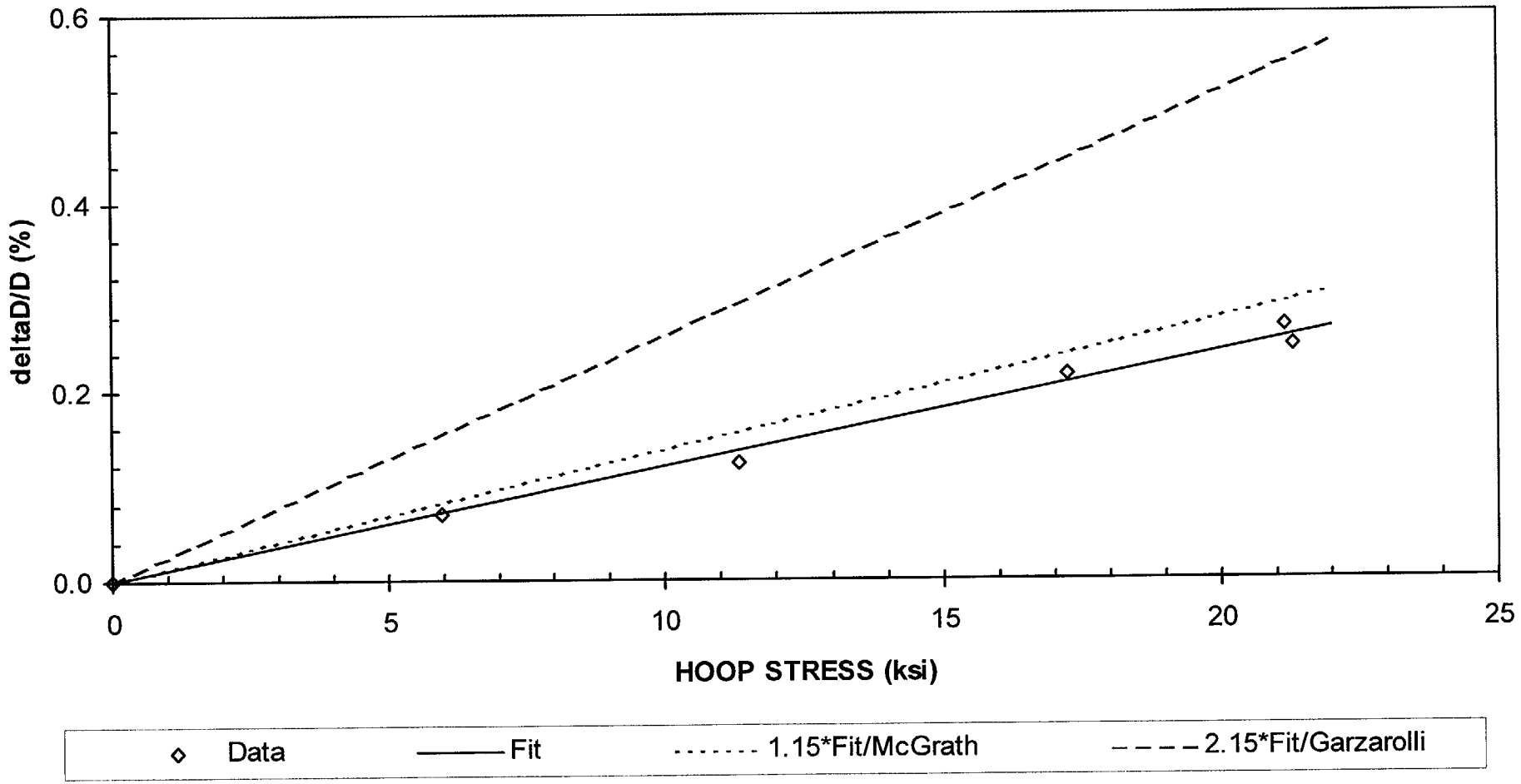
Statistical Evaluation of 1-Cycle Creep/Growth Test Data (continued)



Statistical Evaluation of 1-Cycle Creep/Growth Test Data (continued)

- Largest uncertainty due to sample-to-sample scatter
  - Sample-to-sample scatter ~4.5%
  - Precision of measurement for each datum ~$\pm 2 \times 10^{-4}$% (reported by Causey et al)
- Evaluation consisted of comparing the Causey et al data with the reported tensile irradiation creep factors
  - McGrath reported a factor of 1.15 (ANS Conference at Park City)
  - A factor of 2.15 is consistent with the data reported by Garzarolli et al (ASTM STP 1295) if the 0 stress datum has no uncertainty

Statistical Evaluation of 1-Cycle Creep/Growth Test Data (continued)



Statistical Evaluation of 1-Cycle Creep/Growth Test Data (continued)

- 1-cycle Creep/Growth test data will statistically show whether the reported tensile creep factors of 1.15 and 2.15 are consistent with with W ZIRLO™
  - Sample-to-sample scatter is less than either 1.15xFit or 2.15xFit
- 1-cycle Creep/Growth test data will discriminate a tensile creep factor ⇩1.045
  - Sample-to-sample upper uncertainty bound is ~1.045

Licensing

- Creep/Growth test will be licensed under 10 CFR 50.59
  - No change to the Technical Specifications required
  - Creep/Growth test not controlled by a higher precedence regulation
  - Design function of the host fuel assemblies and the reload core not adversely affected by the Creep/Growth test
  - No methodology changes needed to evaluate test
  - "Screen in" as a test or experiment not described in the UFSAR
- Creep/Growth test rodlets do not contain fuel pellets
  - No impact on radiological consequences
- No exemptions to 10 CFR 50.44 and 50.46 are required for the advanced test material.
  - Advanced test material does not surround fuel

Licensing

- Formal Design Review was completed for Creep/Growth test
  - Design Review functional requirements were consistent with ANS Standard ANSI/ANS-57.5-1996, "Light Water Reactors Fuel Assembly Mechanical Design and Evaluation," as applicable to the Creep/Growth test
  - Results demonstrated that all applicable design criteria were met
  - Host fuel assemblies and reload core not adversely affected by test
  - All materials in the test are compatible with RCS materials
  - Standard ZIRLO™ properties are expected to envelope advanced alloys based on comparisons of out-of-reactor and existing in-reactor data
  - Current mechanical and neutronic methods of evaluation are applicable for evaluation of the test

Licensing

- Formal integrated 10 CFR 50.59 evaluation will be completed in March
- 10 CFR 50.59 Evaluation for Creep/Growth Test will be referenced in the Vogtle Unit 2 Cycle 10 Reload Evaluation

Summary

- Creep/Growth Test represents the most comprehensive program undertaken to evaluate irradiation creep and growth
  - Characterize standard ZIRLO™ with high accuracy
  - Evaluate hydrogen strengthening, fabrication processing and gamma heating
  - Evaluate advanced alloys
- [ ]^{a,c} ZIRLO™ tension and compression data for 7 stress levels at ~590 °F up to ~20x10^{21} n/cm^2 E>1 MeV
- Creep/Growth test samples do not have fuel
  - Test samples are [ ]^{a,c} of the assembly
- SNC intends to license these inserts under 10 CFR 50.59