January 28, 2000

MEMORANDUM FOR: Stuart A. Richards, Chief
Project Directorate IV and Decommissioning
Division of Licensing Project Management
Office of Nuclear Reactor Regulation

FROM: Steven D. Bloom, Project Manager, Section 2
Project Directorate IV and Decommissioning
Division of Licensing Project Management /RA/
Office of Nuclear Reactor Regulation

SUBJECT: SUMMARY OF MEETING HELD ON DECEMBER 7, 1999 WITH WESTINGHOUSE ELECTRIC COMPANY TO DISCUSS THE WESTINGHOUSE FUEL PERFORMANCE UPDATE

The NRC staff met with representatives of Westinghouse Electric Company on December 7, 1999, at One White Flint North in Rockville, Maryland for a Westinghouse Fuel Performance Update. Attachment 1 contains the list of attendees at this meeting. The handouts used by Westinghouse during their presentation were proprietary. Attachment 2 is the nonproprietary version of the slides.

Westinghouse's presentation contained four major topics of discussion. The first topic was lead test assembly (LTA)/lead use assembly (LUA) programs and fuel inspection plans. Westinghouse provided a summary of ongoing LTA programs and ongoing or planned fuel inspections. Next, Westinghouse gave an update on the top nozzle holdown spring fracture issue. The update included a root cause analysis, and immediate and long-term corrective actions. Westinghouse discussed the top nozzle holddown spring screw licensing option which they are developing. This option would allow re-insertion of assemblies with fractured screws, provided design and safety criteria are met. The NRC staff indicated that this approach may be appropriate providing all the necessary justification and documentation is provided. The last portion of the presentation dealt with the Westinghouse improved performance analysis and design model (PAD 4.0). The presentation included a brief chronology and overview of their final submittal, a review of the last outstanding request for additional information, question number 9, a review of instrument fuel assembly (IFA) - 432 modeling, overall PAD 4.0 conclusions, and potential impact on the legacy fuel. Westinghouse emphasized the importance of this review and requested that the NRC provide dedicated resources to ensure that this review was completed in a timely manner.

Project No. 694

Attachments: 1. Attendance List
2. Nonproprietary Slides

cc w/atts: See next page

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UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

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cc:
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MEETING WITH WESTINGHOUSE ELECTRIC COMPANY

WESTINGHOUSE FUEL PERFORMANCE UPDATE

ATTENDANCE LIST

December 7, 1999

Name	Organization
S. Wu	NRR/DSSA/SRXB
M. Chatterton	NRR/DSSA/SRXB
R. Caruso	NRR/DSSA/SRXB
S. Dembek	NRR/DLPM/PD42
K. Hoskins	Westinghouse Nuc Fuel Business Unit
B. Hommerson	Southern Nuclear
D. Koontz	Duke Power
D. Rowland	Westinghouse
S. Ray	Westinghouse
D. Colburn	Westinghouse
S. Ferguson	Wolf Creek Nuclear
P. Larouere	Virginia Power
B. Herwig	SCE&G/VC Summer

Attachment 1

Westinghouse Fuel Performance Update Meeting

December 7, 1999

Presented by:
William H. Slagle

Attachment 2

Westinghouse Fuel Performance Update Meeting

This is the second Fuel Performance Update Meeting held between Westinghouse and the NRC in 1999. It had been requested by the NRC to hold the meeting semi-annually vs annually and to focus on selected topics.

The NRC views this meeting as a valuable information exchange. Thus, it was viewed that if fewer topics were addressed each meeting, then more questions could be asked and a better understanding of the information would exist.

Westinghouse Fuel Performance Update Meeting

The major topics of discussion for this meeting are:

- LTA Programs and Fuel Inspection Plans
- Top Nozzle Holddown Spring Screws Root Cause Analysis
- Top Nozzle Holddown Spring Screws Licensing Option
- Westinghouse Improved Performance Analysis and Design Model (PAD 4.0)

Westinghouse Fuel Performance Update Meeting

- LTA/LUA Programs and Fuel Inspection Plans (Proprietary Briefing):
  - Provide a summary of on-going LTA programs.
  - Provide a summary of on-going or planned Fuel Inspections.

Westinghouse Fuel Performance Update Meeting

- Top Nozzle Holddown Spring Screws Root Cause Analysis (Proprietary Briefing):
  - To address status of the root cause investigation.
  - To discuss immediate and long-term corrective actions being taken.

Westinghouse Fuel Performance Update Meeting

- Top Nozzle Holddown Spring Screws Licensing Option (Proprietary Briefing):
  - To address a possible licensing option associated with this issue.
  - To get feedback from the NRC with regards to this option.

Westinghouse Fuel Performance Update Meeting

- Westinghouse Improved Performance Analysis and Design Model (PAD 4.0) (Proprietary Briefing):
  - Brief Chronological Update
  - Brief Overview of Final Submittal
  - Review of RAI #9 (Typical Plots)
  - Review of IFA-432 Modeling
  - Conclusions
  - Implementation and Legacy Fuel
  - Schedules

Westinghouse Fuel Performance Update Meeting

This ends the non-proprietary part of the briefing.

The remaining briefings are all proprietary.

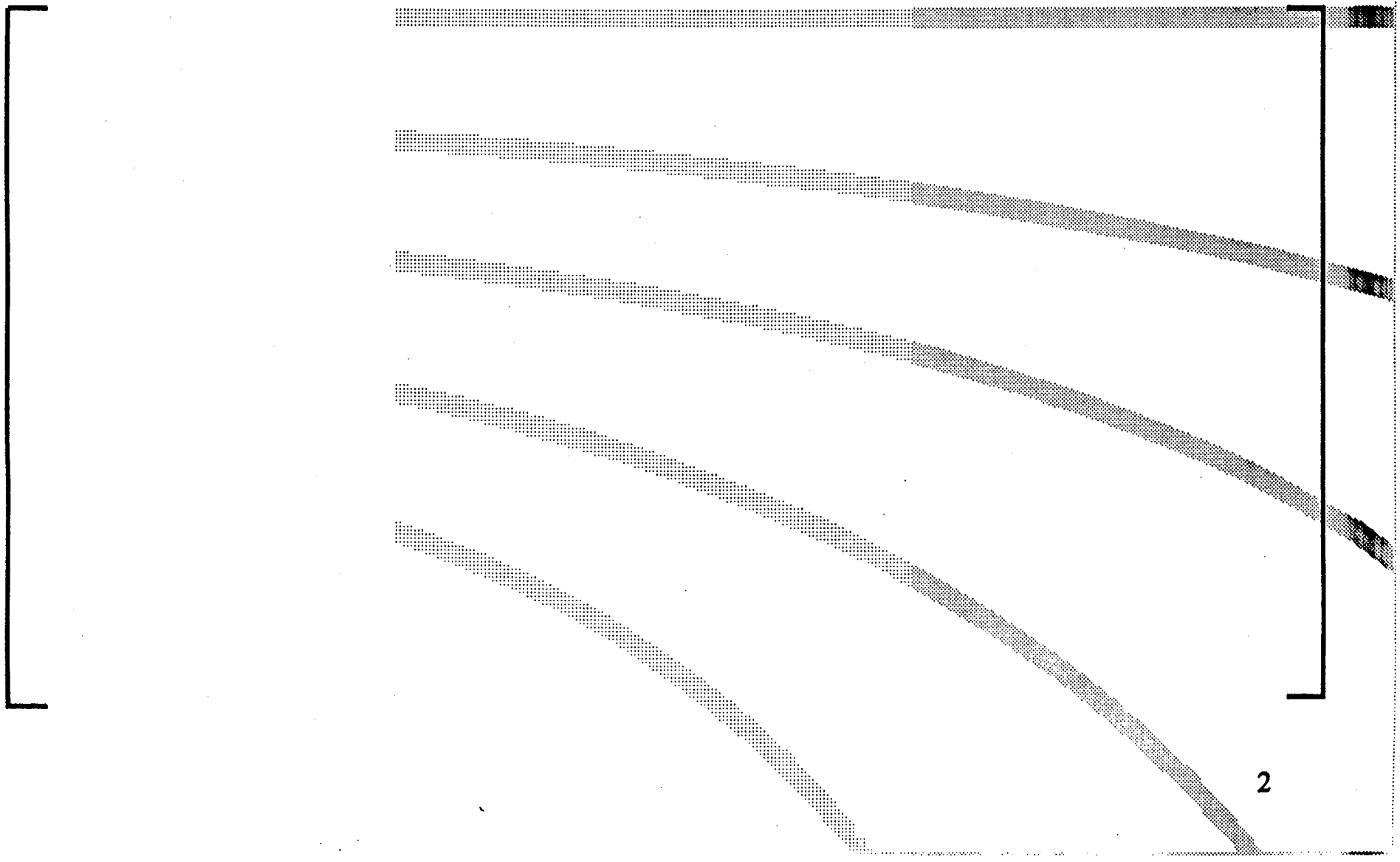
LTA/LUA Programs and Fuel Inspection Plans

Fuel Performance Meeting
with USNRC
December 7, 1999

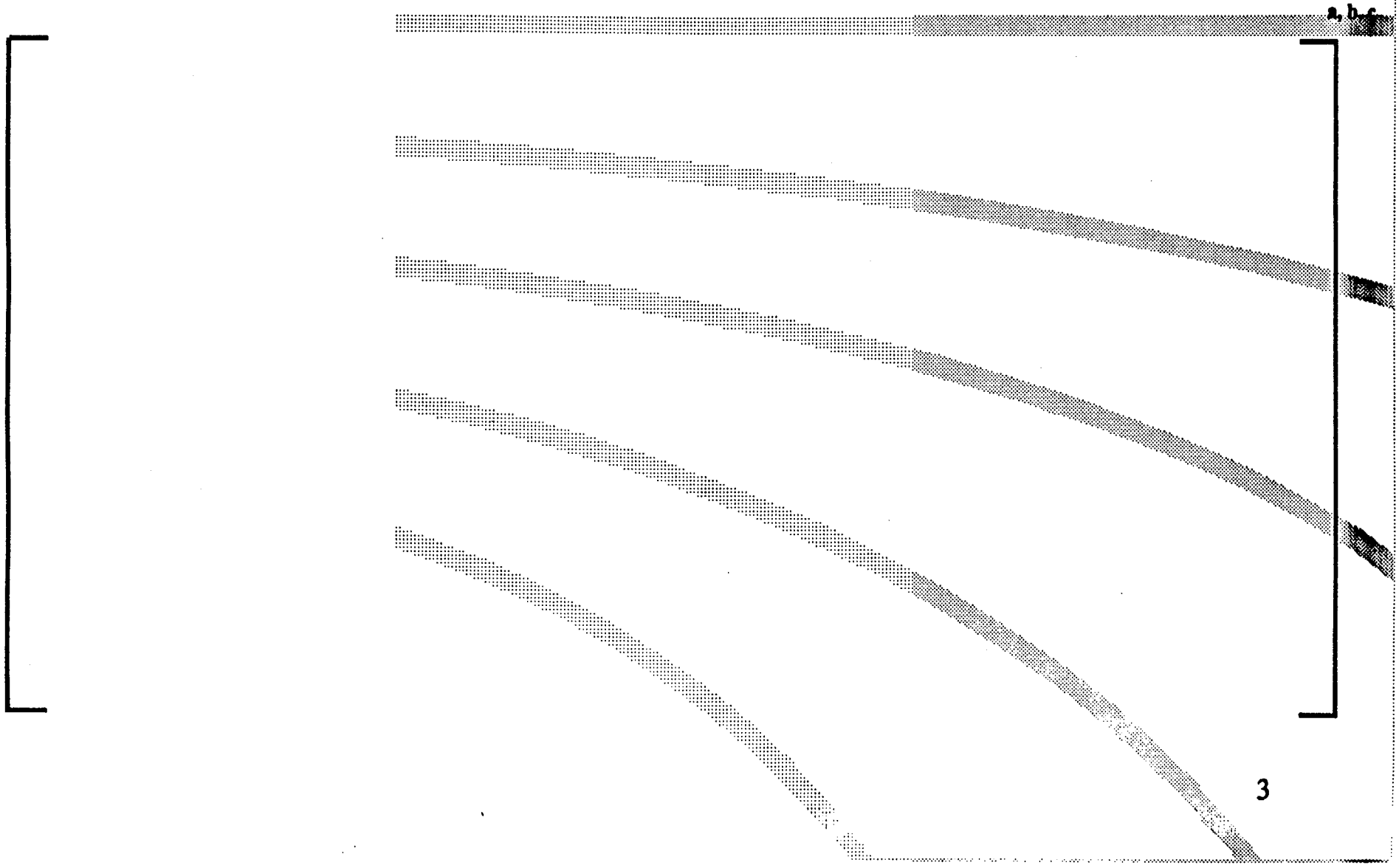
Presented by
William H. Slagle

High Burnup ZIRLO™ LTA Programs

a, b, c

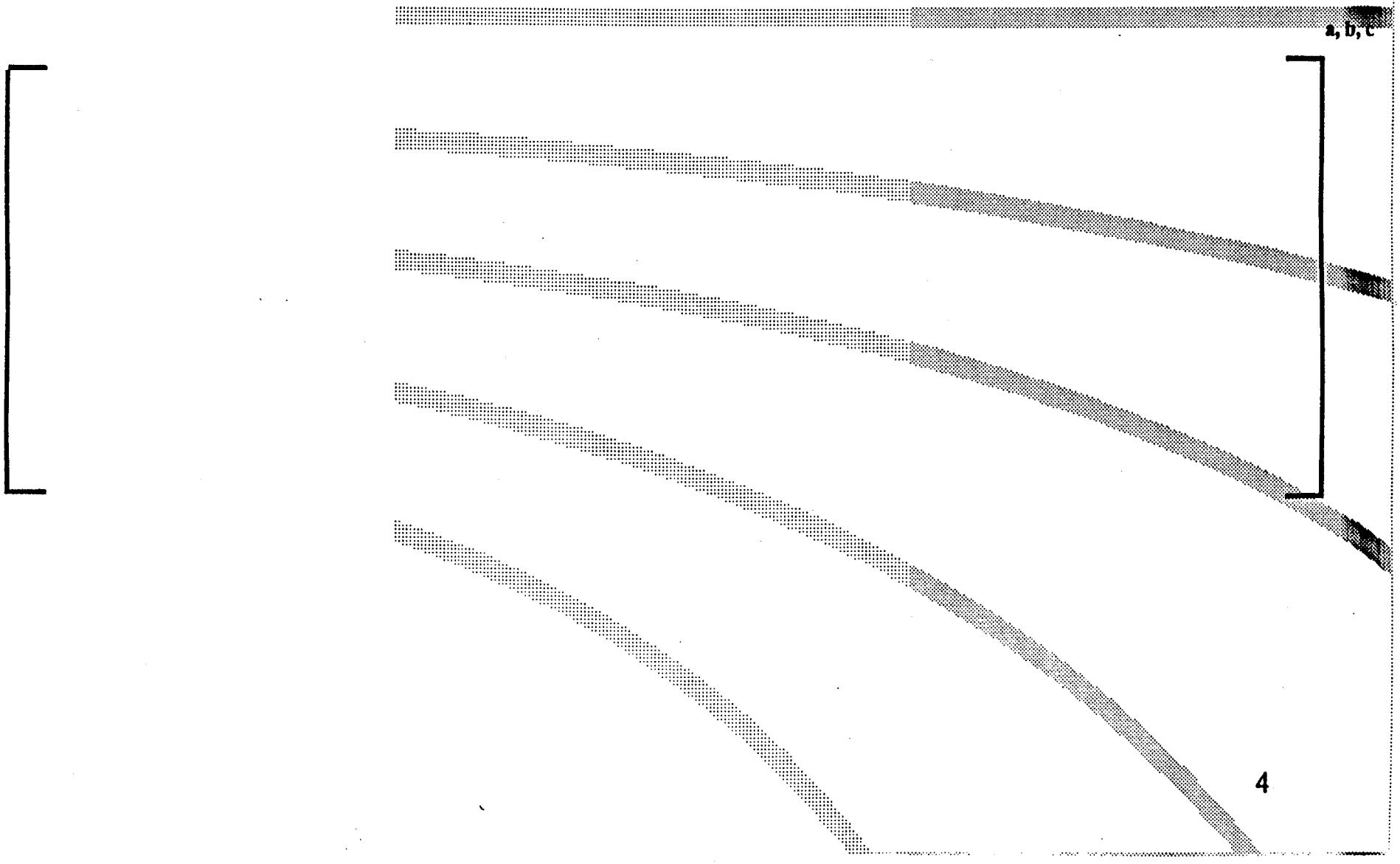


Other LTA/LUA Programs



Other Test Programs to Obtain Fuel Performance Data

a, b, c

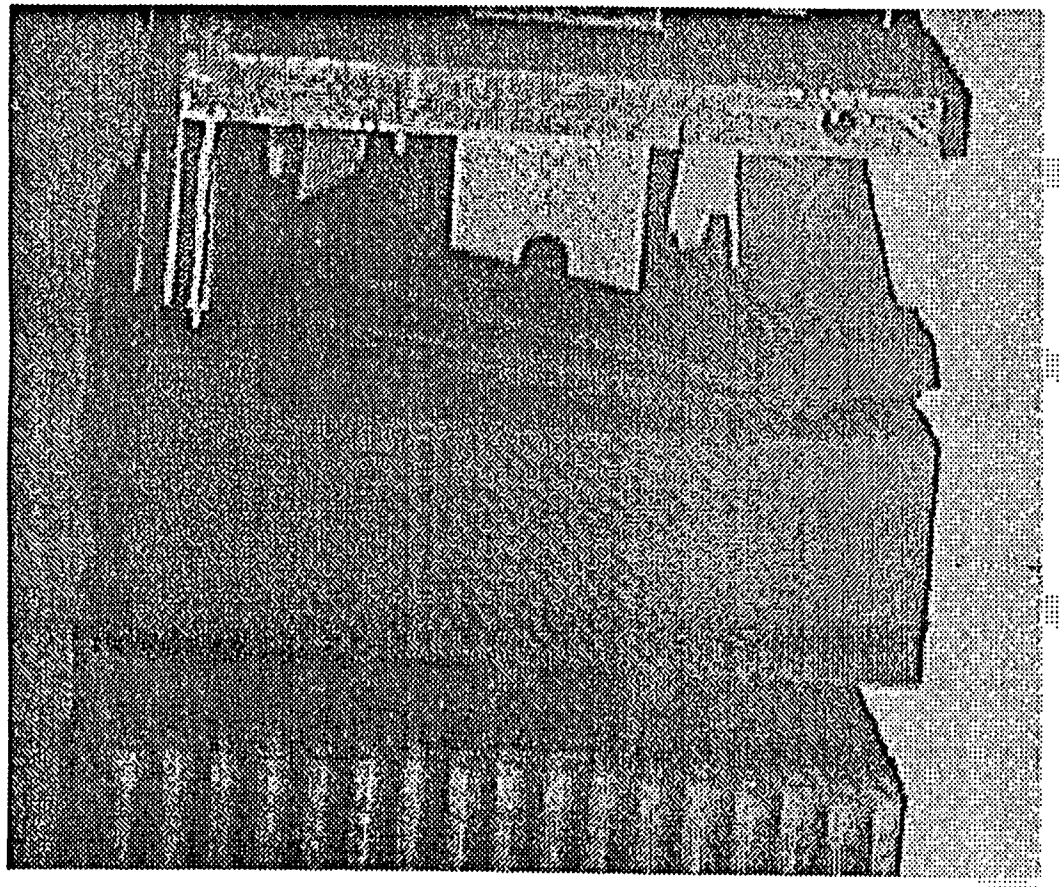


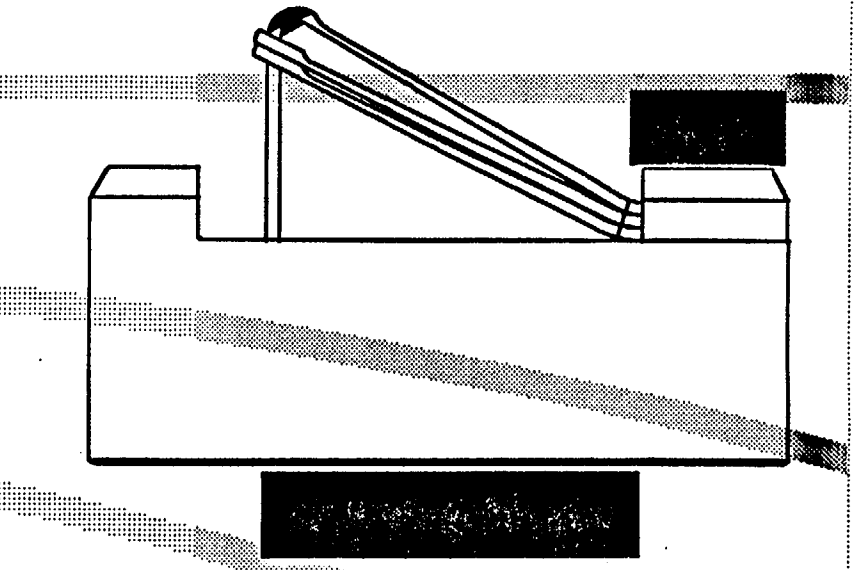
Top Nozzle Screw Fracture Update

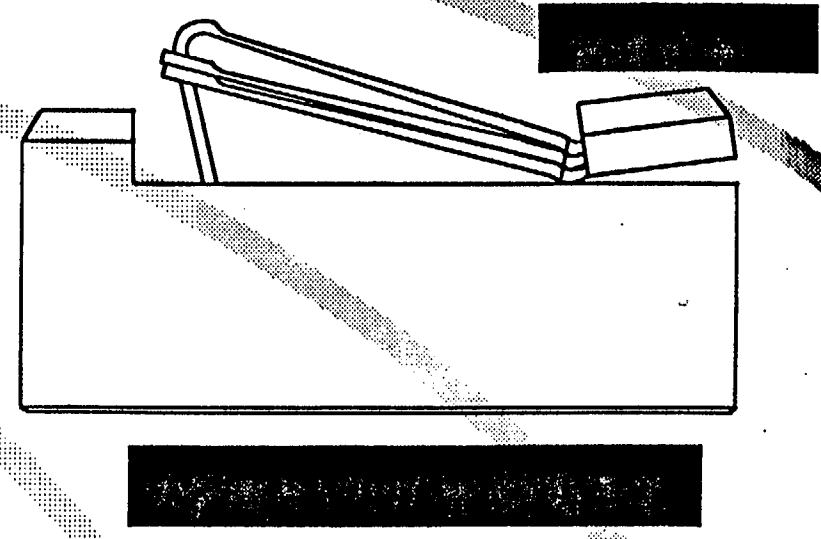
Fuel Performance Meeting
With USNRC
December 7, 1999

Presented by:
Don Rowland

Description







Background

- Joint Material/Mechanical Design in use since late 1970's (17x17).
- Early 1980s - [ ]^{a,c} fuel assemblies with fractures in [ ]^{a,c} fuel:
  - Improved and standardized screw design for all 12 foot fuel assemblies.
  - No design changes or issues since 1984.
- Mid-1998 - [ ]^{a,c} fuel assemblies (foreign plant, licensee fabricated) with fractures observed:
  - Assemblies re-nozzled.
  - Presumed root cause was over-torque [ ]^{a,c}
- Late 1998 - [ ]^{a,c} fuel assembly (14 foot design) with fractures observed:
  - Assembly discharged.
  - Root cause indeterminate.
- Early 1999 - Significant fracture rate found during outage inspections.

Background

- Status Prior to Fall 1999 Inspections:
  - Inspections based largely on visual exams.
  - Suspect population of fuel identified:
    - [ ]a, c.
    - May be limited by:
      - [ ]a, b, c,
      - [ ]a, b, c, and
      - [ ]a, b, c.
        - [ ]a, c.

Fall Inspection Results

- Approximately 1200 fuel assemblies were inspected during the fall outages for this condition.
- New spring screw inspection technique:
  - Provides greater discrimination of fractures compared to visual exams.
  - Uses a [ ]a, c.
- Repair activities have not affected critical path, to date.
- Fractures identified in fuel built prior to window:
  - Single fuel assemblies at [ ]a, b, c.
  - Multiple fuel assemblies at [ ]a, b, c.

Fall Inspection Results (cont.)

- Fractures observed in a 14x14 region:
  - Manufactured within window of susceptibility.
  - [ ]$^{a, b, c}$ to 17x17 fuel within window.
- No fractures detected in susceptible region at a 17x17 plant:
  - Screws used different [ ]$^{a, b, c}$.
- No fractures observed in 1X fuel [ ]$^{a, b, c}$.
- No fractures observed in 1X, 2X, or 3X fuel at a 14 foot design plant [ ]$^{a, c}$.

Root Cause Status

- Outage information and current tests provide sufficient information to complete root cause report.

- Schedule:
  - Customer summary letter on root cause: November 30
  - Final root cause report: December 30

Root Cause

Root Cause Assessment Results:

- Operator/Manufacturing factors less significant than previously believed.

- Material [ ]$^{a, b, c}$ susceptibility identified as the key root cause; associated with change in [ ]$^{a, b, c}$:
  - Design does not accommodate variability of [ ]$^{a, b, c}$.
  - Material specification needed improvement.
  - Secondary factors include use of [ ]$^{a, b, c}$ and the need for more focused PIE exams.

Margin Improvements

- Improvements implemented since April 1999:
  - Manufacturing Operations:
    - Operator sensitivity.
    - QC over-check of [ ]$^{a, b, c}$.
    - [ ]$^{a, b, c}$.
    - Area practices.
  - Material Improvements:
    - [ ]$^{a, b, c}$ screws:
      - In place for all fuel manufactured since September 1999.
      - Planned tightening of process specifications & change of supplier.

Margin Improvements (cont)

- [ ]a, b, c screw change:
  - Key Issues that need to be addressed.
    - Design changes to improve screw performance.
    - [ ]a, b, c vary widely according to [ ]a, b, c.
    - Additional testing and analysis needed prior to implementation.
  - Design Team and Review Team working out plan to address issues.

Outage Support

- Continue anticipation and active support of Spring 2000 outages:
  - Expect fractures in several plants.
  - Plant-by-Plant inspection, repair/replacement, and contingency plans being developed.

- Working with WOG to develop contingency option to reinsert fuel assemblies with fractured screws provided that design & safety criteria are met.

Top Nozzle Screw Summary

- Root cause completed on schedule:
  - Customer Summary Letter — November 1999
  - Final Report — December 1999
- Fall outage inspections completed.
- Spring 2000 outage plans underway.
- Improvements with current material in place.
  - Next step modified [ ]$^{a, b, c}$ screw.

Top Nozzle Holddown Spring Screw Licensing Option

Fuel Performance Meeting

With USNRC

December 7, 1999

Presented by:
Sumit Ray

Licensing Option

- Two options currently available for assemblies with fractured screws:
  - Discharge from the core.
  - Re-nozzle and reuse.
- Westinghouse is developing another option that can be used:
  - Would permit re-insertion of assemblies with fractured screws, provided design and safety criteria are met.
- Utilities have expressed interest in this option.
- Westinghouse is in dialog with the WOG PI core team to seek guidance to further develop this position.

Licensing Option

- Westinghouse believes this option is needed to provide additional flexibility:
  - Expects to be applied on a plant specific basis depending on the situation.

Key Design/Safety Criteria to Support Licensing Option

- Detailed visual inspection of [ ]$^{a, c}$.
- No clamp gaps [ ]$^{a, b, c}$ allowed for re-inserted assemblies:
  - Ensures all parts are secured to the top nozzle.
  - Ensures no operations or handling concerns.
- A plant specific loose parts assessment will be performed to ensure that the specific nozzle design has been evaluated.
- A plant specific reactor internals holddown capability evaluation is performed to address loss of holddown force for the affected assemblies.
- Licensee tracks non-conforming condition in its internal deficiency tracking system as per Generic Letter 91-18, Revision 1.

Licensing Option Approach

- Use of Generic Letter 91-18 Revision 1 to support start-up.
- Will be subjected to a 10 CFR 50.59 evaluation:
  - Demonstrate that no USQ exists.

Westinghouse Improved Performance Analysis and Design Model (PAD 4.0)

Fuel Performance Meeting
with USNRC
December 7, 1999

Presented by:
William H. Slagle

The PAD topical report review and approval is currently viewed as the most critical topical report on Westinghouse's review agenda.

Agenda for Presentation

- Brief Chronological Overview
- Brief Overview of Final Submittal Package
- Review of RAI #9 (Typical Plots)
- Review of IFA-432 Modeling
- Conclusions
- Implementation & Legacy Fuel
- Schedules

Brief Chronological Overview

- 01/96: Hot Cell data indicates [
  ]a, b, c.
  - [
    ]a, b, c.
  - [ ]a, c.
- 12/96: Higher corrosion measurements led to a new Zirc-4 corrosion model (ZrBA) which was presented to the NRC.
  - New corrosion model is incorporated into an interim PAD 3.4 version and tested during the period of 01/97 to 11/97.

Brief Chronological Overview

- 11/97: Incorporation of ZrBA into PAD 3.4 and its associated feedback affects result in further reduction to RIP margins, leading to projections of "Gap Re-Opening".
  - Westinghouse issues an Industry JCO to the NRC that addresses Gap Re-Opening.
  - Westinghouse's assessment states that the Safety Significance is considered low.
  - All reload analyses are done with the interim PAD model that incorporates ZrBA and gap re-opening methodology.
  - Westinghouse commits to update PAD to resolve gap reopening.

Brief Chronological Overview

- 01/98: NRC accepts Westinghouse's approach for Gap Re-Opening.
  - NRC accepts low safety significance position specified in the JCO.
  - Compliance with 10 CFR 50.46 must be demonstrated.
- 06/98: Westinghouse submits WCAP-15063-P, "Westinghouse In-Reactor Creep Model".
  - Revised In-reactor irradiation creep model.
  - [ ]a, c.
  - [ ]a, c.

Brief Chronological Overview

- 09/98: Westinghouse submits Calibration and V&V data package for the revised PAD model. A meeting is held with the Staff to present "Other Model Changes" that were made to PAD since the June submittal.

- 09/98: NRC issues RAIs for WCAP-15063-P and RAIs for the "Other Model Changes".

- 11/98: Westinghouse provides initial response to RAIs.

Brief Chronological Overview

- 01/99: Westinghouse provides supplemental response to RAIs.

- 06/99: Westinghouse provides a detailed presentation to the NRC on Westinghouse's [

  ]$^{a, c}$.

  - NRC requests that Westinghouse submits a re-write of the WCAP to include the original submittal and the other model changes.
  - NRC requests that Westinghouse propose [

    ]$^{a, c}$.

Brief Chronological Overview

- 08/99: Westinghouse proposes [ ]a, c.
- 09/99: Conference call with the NRC regarding [ ]a, c.
  - Reached agreement that all data for [ ]a, b, c be combined into a single [ ]a, b, c.
  - Concurrence was not obtained on the Westinghouse [ ]a, b, c. The NRC requested [ ]a, b, c to demonstrate overall model conservatism.

Brief Chronological Overview

- 11/99: Westinghouse submits final package for PAD 4.0 according to agreement established during 9/99 phone call.
  - Westinghouse complies with request to incorporate all the [ ]a, b, c into a single [ ]a, b, c.
  - Westinghouse complies with request to provide [ ]a, b, c.

- 12/99: Follow-up meeting with NRC to review final submittal package, discuss the review schedule and requested SER language with regards to "Legacy Fuel".

Brief Overview of Final Submittal Package

The final submittal package includes five attachments:

Attachment 1: Re-write of WCAP-15063-P, "Westinghouse In-Reactor Creep Model" to include "Other Model Changes".

Attachment 2: WCAP-15063-P Errata for corrections noted to the NRC in responses to other RAIs.

Attachment 3: Response to last outstanding question (RAI #9) on PAD Model Revisions submittal. Also included are five external independent assessments of Westinghouse's creep model by industry experts.

Brief Overview of Final Submittal Package

Attachment 4: Final PAD 4.0 Calibration and V&V Data Package based on the latest model revisions requested during the review process. Also included is the IFA-432 modeling comparison requested by the NRC reviewer.

Attachment 5: Discussion of PAD 4.0 implementation and approach on "Legacy Fuel".

Review of RAI #9

- Original request (9/98) covered typical performance areas: plots of corrosion vs burnup, clad OD vs burnup, centerline temperature vs power and burnup, rod pressure vs burnup, and power vs burnup.

- Significant additional information requested and transmitted:
  - Equivalent PAD 3.4 typical comparison plots (6/99);
  - Upper bound rod pressure vs burnup of (IFBA and Non-IFBA fuel) (6/99);
  - Typical fuel centerline temperatures used for nuclear safety analyses (6/99);
  - Input parameters used in the modeling of the typical plots that will be used to conduct an audit calculation with FRAPCON-3 (6/99); and
  - Overall swelling rate and creep rate model uncertainties (9/99).

Review of RAI #9

- Conclusions:
  - As demonstrated in the submittal, the PAD 4.0 results for RAI #9 are [

    ]a, c.
  - The interim PAD version would demonstrate overly conservative results.
  - PAD 4.0 has accomplished margin recovery.

[

]a, c

Review of IFA-432 Modeling

- Original request (11/98) for informal PAD 4.0 modeling of the IFA-432 fuel assembly, rods 1, 2, 3 and 5.
  - Used to help evaluate conservatism of fuel performance thermal models (fuel temperatures vs burnup).
  - These fuel rods have been modeled in the past by Westinghouse.
  - Generated a special version of PAD 4.0 for IFA-432 modeling and provided informal results (3/99).
  - In response to request to assume no fission gas leakage, and incorporate an alternate approach to creep model [ ]$^{a, b, c}$, IFA-432 analysis re-performed and presented to the NRC (6/99).
  - Final re-analysis provided in submittal to incorporate all PAD 4.0 model changes (11/99).

Review of IFA-432 Modeling

- Conclusions:
  - As expected, the PAD 4.0 modeling results are [ ]$^{a, b, c}$ with the previous licensed PAD versions (e.g,. the thermal model is unchanged).
  - Thus PAD 4.0 behaves in a [ ]$^{a, c}$ to the previous versions of PAD that were found to be conservative and bounding by the NRC.

Conclusions

- PAD 4.0 upgrade better reflects in-reactor performance and fuel material behavior.
  - The revised models have been calibrated to both the previous databases and new data.
  - The unchanged models have been re-calibrated to the previous databases (and revised IFA-432 data) and remain applicable.
  - Rod internal pressure margins improved as expected [ ]$^{a, b, c}$.
  - Unchanged models (i.e., fission gas and thermal) produce results consistent with previously licensed versions, as expected.

Conclusions

- The final submittal is the culmination of significant levels of information exchange/dialogue and numerous iterations with the NRC to ensure all requests were addressed.

- PAD 4.0 fulfills the commitment to the NRC to update the fuel performance analytic models.

Implementation & Legacy Fuel

- Proceed with implementation of PAD 4.0 on a forward-fit basis consistent with the plans being developed between Westinghouse and the WOG.
  - Establishing appropriate documentation and training.

- As noted in previous meetings with the NRC, PAD 4.0 may still predict some gap re-opening in "Legacy Fuel". Westinghouse will demonstrate that these assemblies will continue to meet all safety limits as well as 10 CFR 50.46 oxidation limits. Gap re-opening Legacy Fuel will continue to be covered by the JCO methodology until permanently discharged.

Schedules

11/19/99: Westinghouse's final submittal to NRC.

Based on previous verbal commitments, it was stated that the NRC's reviewer would be able to complete his review and issue a TER within 30 days after receiving the final submittal. It was further stated that the NRC should be able to issue an SER within 30 days after receiving the TER from the reviewer. It is extremely important to Westinghouse and our customers that the following schedules are met:

01/15/00: NRC reviewer issues Technical Evaluation Report (TER)

02/15/00: NRC issues Safety Evaluation Report (SER)

The PAD topical report review and approval is currently viewed as the most critical topical report on Westinghouse's review agenda.