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

February 2, 2010

LICENSEE: Southern Nuclear Operating Company, Inc.,

FACILITY: Vogtle Electric Generating Plant, Units 1 and 2

SUBJECT: SUMMARY OF JANUARY 20, 2010, PUBLIC MEETING WITH SOUTHERN NUCLEAR OPERATING COMPANY, INC. (SNC), ON THE UNRESOLVED ISSUES REGARDING THE PERMANENT ALTERNATE REPAIR CRITERIA FOR STEAM GENERATORS (TAC NOS. ME3003 AND ME3004)

On January 20, 2010, a Category 1 public meeting was held between the U.S. Nuclear Regulatory Commission (NRC) staff and representatives of SNC at NRC Headquarters, One White Flint North, 11555 Rockville Pike, Rockville, Maryland. The purpose of the pre-application meeting was to discuss the unresolved issues regarding the permanent alternate repair criteria for steam generator tubes as transmitted by NRC letter dated November 23, 2009 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML093030490) for Vogtle Electric Generating Plant, Units 1 and 2. A list of attendees is provided as Enclosure 1.

The licensee along with staff from Westinghouse, presented information (see Enclosure 2) that explained the proposed path to resolution of the unresolved issues. The licensee proposed that they would utilize a second model (known as the Square Cell [C^2] model) to demonstrate the currently referenced model (known as the Scale Factor model) is conservative and valid. Complete descriptions of how the two models were developed will be provided in an effort to fully answer the questions in the NRC letter dated November 23, 2009. The licensee also discussed modifications that will be made to the Scale Factor model to address some of the unresolved issues.

The licensee's presentation also included a discussion regarding the proposed schedule for submission of the permanent alternate repair criteria license amendment request (LAR). Additionally, the licensee discussed the content of the LAR, e.g., the licensee would not resubmit reports already on the docket, but reference the documents as necessary. The NRC staff noted that due to the compressed schedule, the licensee should include as much information as possible from the original submittals in the LAR and when responding to the unresolved issues, to allow for a more efficient review by the NRC staff.

After the licensee's presentation, the NRC staff provided the licensee with clarifications on the scope and basis for the unresolved issues. Each question was discussed by the NRC staff, the licensee, and Westinghouse to ensure the licensee had a clear understanding of the issue. Consequently, the NRC staff gained a clearer perspective on the existing models and the licensee's approach to addressing the questions. The NRC staff did not provide concurrence with the licensee's approach but stated that the proposed approach could be a possible resolution to the concerns.

The NRC staff expressed concern about the proposed 5-month review schedule and cautioned the licensee that for this schedule to be viable, all of the unresolved issues must have a clear resolution strategy that will be part of the LAR. The NRC staff also informed the licensee that any substantive changes to the previously submitted methodologies or assumptions, could adversely impact the proposed schedule. In addition, the NRC staff encouraged the licensee to develop a contingency plan in the event that the proposed schedule is not met.

Finally, the NRC staff and the licensee agreed that frequent and effective communication is needed to ensure the unresolved issues are addressed and the proposed schedule is met.

Other nuclear industry representatives were in attendance. No members of the general public were in attendance. Public Meeting Feedback forms were not received. One attendee dialed in via telephone.

Please direct any inquiries to me at 301-415-1864, or donna.wright@nrc.gov.

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Plant Licensing Branch II-1
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Docket Nos. 50-424 and 50-425

Enclosures:
1. List of Attendees
2. Licensee Presentation

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LIST OF ATTENDEES

JANUARY 20, 2010, MEETING WITH

SOUTHERN NUCLEAR OPERATING COMPANY, INC. (SNC),

VOGTLE ELECTRIC GENERATING PLANT, UNITS 1 AND 2

UNRESOLVED ISSUES REGARDING PERMANENT ALTERNATE REPAIR CRITERIA

FOR STEAM GENERATORS

NRC
Patrick Boyle, NRR
Marshall David, NRR
Dennis Egan, NRR
Andrew Johnson, NRR
Ken Karwoski, NRR
John Lubinski, NRR
Robert Martin, NRR
Emmett Murphy, NRR
Balwant Singal, NRR
Robert Taylor, NRR
Donna Wright, NRR

SNC
Tom Hess
Rick Mullins

Westinghouse
Chris Cassino
Herm Lagally
Damian Testa
Gary Whiteman

Other
Gary Boyers, Florida Power and Light
Patrick Fabion, PSEG Nuclear, LLC
Don Gerber, Dominion
Greg Gerzen, Exelon
Jack Hicks, Luminant Power
Russell Lieder, NextEra Energy
Dan Mayes, Duke Energy
Jim Riley, Nuclear Energy Institute
Jay Smith, Exelon
Chung Tran, Luminant Power
Steve Wideman, Wolf Creek Nuclear Operating Corporation
Lisa Schofield, Exelon (via telephone)

SNC/NRC/W Pre-Submittal Meeting on H*: Unresolved Issue on Eccentricity

January 20, 2010

Enclosure 2

Objectives

- Assure alignment on outstanding unresolved issue and path to resolution
- Provide plan to resolve NRC questions and show that current licensing basis is acceptable
- Provide proposed schedule for submission of TS Amendment for SG H* Permanent Alternate Repair Criteria
- Provide proposed content of LAR

H* History/Background

- From 2002 to present, resources expended to license a SG Tube Alternate Repair Criteria have been substantial for both the industry and the NRC

- Multiple License Amendment Requests have been submitted after technical resolution of issues was believed to have been achieved; new questions continue to explore the validity of the H* approach

- Assure alignment on outstanding unresolved issue and path to resolution

H* History/Background

- October 28, 2005 – 17 inch B* repair criteria for Unit 2 SG inspections during Fall 2005
- September 12, 2006 - 17 inch B* for Fall 2006 (Unit 1) and Spring 2007 (Unit 2)
- November 9, 2007 - Southern Nuclear Company (SNC) submitted a License Amendment Request (LAR) for permanent alternate repair criteria for Vogtle
- April 9, 2008 – IARC for Spring 2008 (Unit 1)
- April 18, 2008 – SNC submitted a request to withdraw the LAR for a permanent alternate repair criteria

H* History/Background

- September 16, 2008 - IARC for Fall 2008 (Unit 2)
- May 19, 2009 – SNC submitted an LAR for a permanent alternate repair criteria
- September 11, 2009 – SNC submitted a request to revise the May 19, 2009 LAR to one time alternate repair criteria
- September 24, 2009 – one cycle alternate repair criteria for Fall 2009 (Unit 1) and Spring 2010 (Unit 2)
- November 23, 2009 – SNC received NRC letter containing the unresolved issues regarding a permanent alternate repair criteria

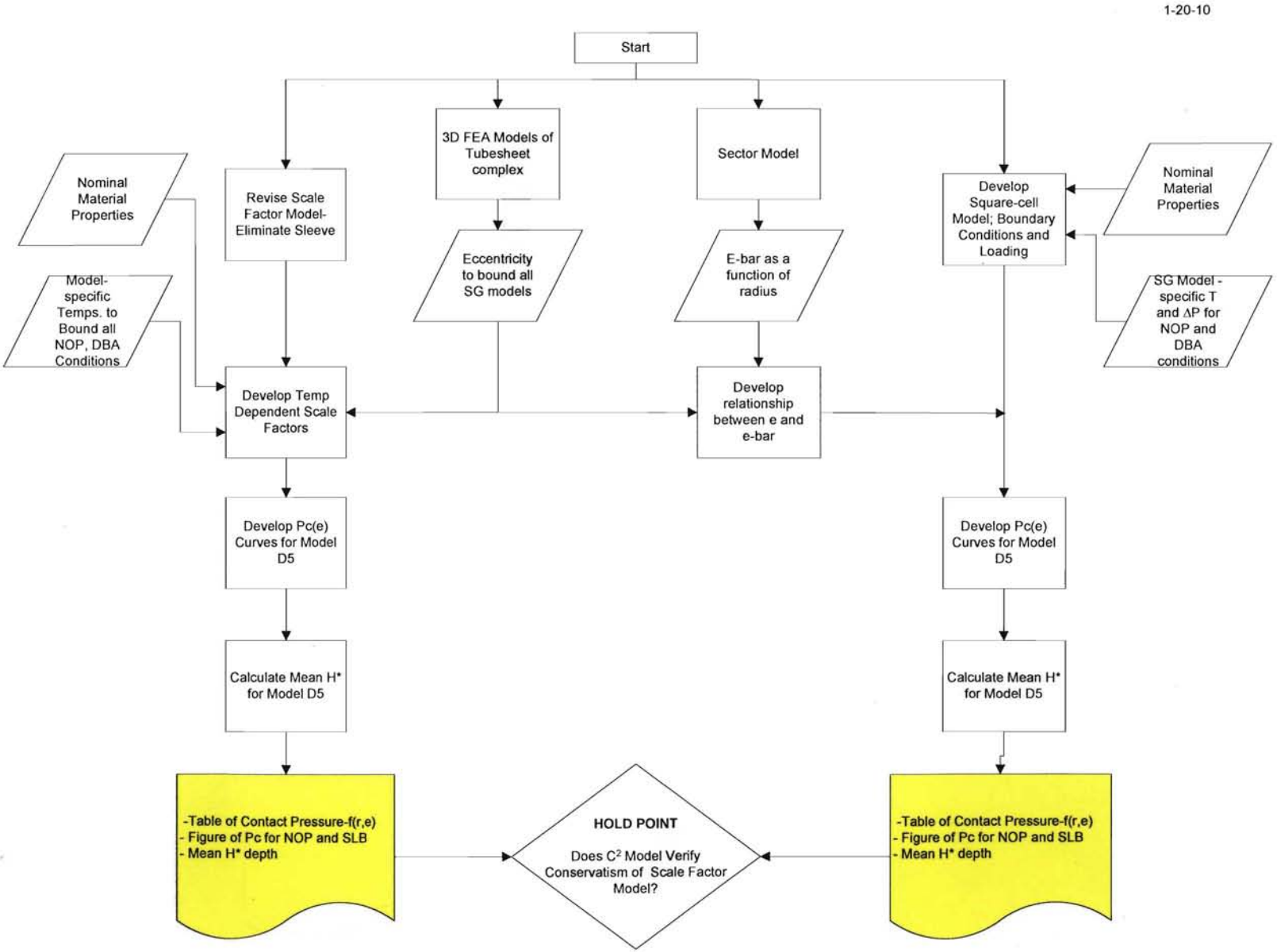
Technical Discussion Agenda

- W/Industry summary of NRC questions
- Proposed approach to resolving issue
- Discussion of eccentricity structural models
- Square Cell Model needed to show PcSLB>PcNOP for Model D5 SG
- Summary and roadmap of response to NRC questions

Summary of Unresolved Issue

- For the Model D5, two models (Scale Factor [SF] and Square Cell [C^2]) are used to calculate contact pressure as a function of eccentricity
  - "Slice Model", "Scale Factor Model", "Old Model" are synonymous
- The NRC has expressed concern that differences between the outputs of the two models challenge the validity of the H* contact pressure results
- The NRC questions request an explanation why the differences between the two models are acceptable.

Proposed Approach



W Position on Eccentricity Models

- C^2 model is considered to be more accurate than SF model
  - Straightforward structural analysis
  - Currently best representation of physical conditions
  - Considered to be the benchmark analysis
- Expect to show that SF model is conservative relative to C^2 model
  - SF model is a good engineering approach to estimating contact pressure reduction as a function of tubesheet bore eccentricities
- Detailed results from the C^2 and SF models are not expected to be directly comparable
  - The models are entirely different approaches

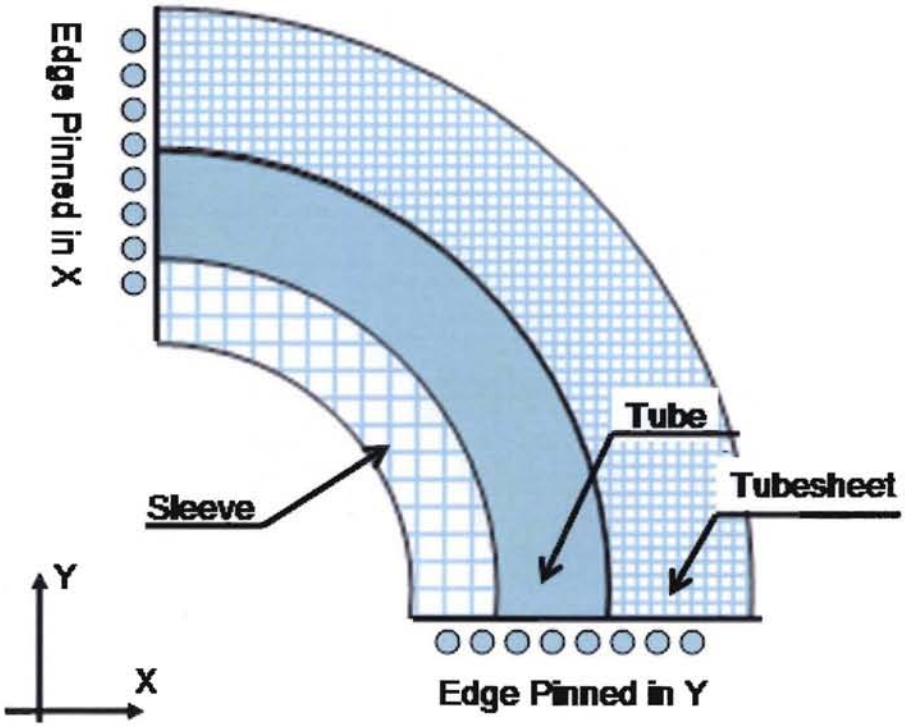
Scale Factor Model

(WCAP-17071-P, Section 6.3 and Reference 15 [SM-94-08, Rev. 1]

- The purpose of the model is to predict the reduction in contact pressure ratio as a function of tube bore eccentricity.
  - Contact pressure ratio (ovalized : non-ovalized)
- Developed during a 1994 sleeving campaign to address reduction of contact pressure due to tubesheet (TS) bore ovalization.
  - As currently used for H*, model includes a sleeve
- Applied in H* to address TS bore eccentricity due to TS rotation (see 6.3 of WCAPs)
- Current licensing basis of H* for Models F, 44F and 51F and D5 for NOP conditions.
  - Only exceptions are D5 and 44F 2-loop SLB condition

Summary of Scale Factor Model Assumptions

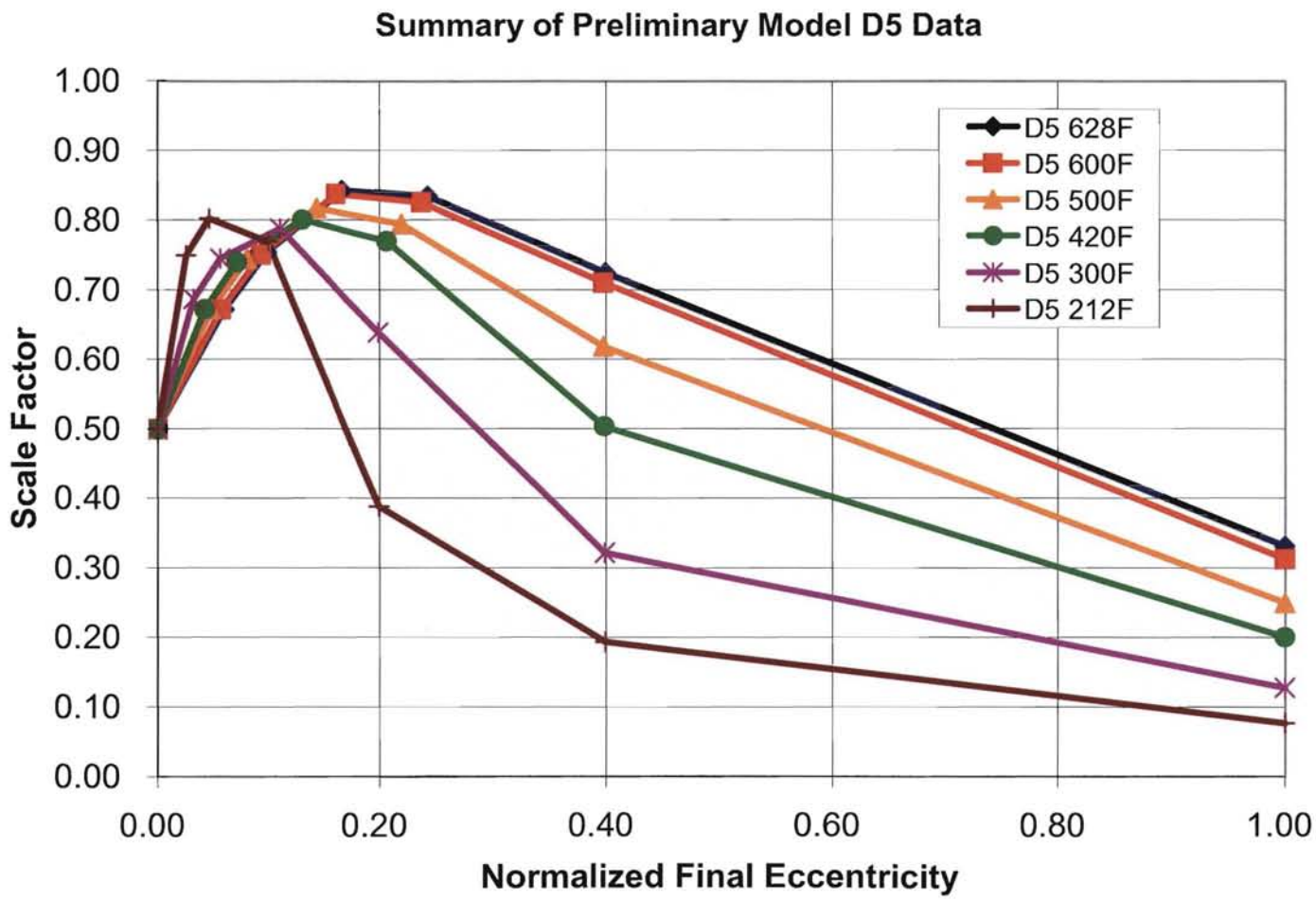
- Model includes ovality; multiple models required to represent a range of ovalities that represent TS deformation
- Tubesheet is modeled as an ellipse prior to loading
- Tube is circular prior to loading
- Tube and tubesheet are **not** rigid; can deform when loaded. Change in TS displacement is expected.
- Tube is not forced to remain in contact with the tubesheet.
- Load is applied by application of ΔT = 500°F in current H* analysis
    - TS has no CTE value
- No ΔP is applied to sleeve, tube or tubesheet.



Scale Factor Model Load Steps

- Step 0: Initialize Model (geometry definition); includes TS bore ovality (assumed d_{max}-d_{min}).
- Step 1: Apply temperature to model.
  - TS (collar) coefficient of thermal expansion set to zero
  - TS (collar) elastic modulus changes with temperature.
  - Tube (and currently, sleeve) expand with temperature
- Step 2: Calculate contact pressure and record data.
  - Average, Maximum and Minimum results.
- Step 3: Set new Tube and TS geometry (different d_{max}-d_{min}).
- Step 4: Repeat 0-3 for all ΔT and (d_{max}-d_{min}) of interest.
- Step 5: Determine SF vs. eccentricity relationship based on contact pressure ratio reductions matching results from thick-shell equations using ΔD equation in LTR-SGMP-09-109 P-Attachment

SF Model Results Cannot Be Linearly Scaled for Temperature



Modifications to Scale Factor Model to Address NRC Questions

- Remove sleeve from model
- Increase range of eccentricities to bound predicted TS deformations from 3D FEA model
- Add multiple temperature loading conditions to represent NOP and transient operating conditions for each eccentricity

Square Cell (C^2) Model

- Developed to address September 2008 question (EP and NRC) regarding potential for flow channeling in eccentric TS bore (see WCAP, section 6.2.5)
- Utilized to check application of SF model; shows SF model to be conservative (see WCAP, section 6.4.6)
- Applied in "White Paper" on Model D5 SLB Contact Pressure (Westinghouse Letter LTR-NRC-09-26, 5/13/09)

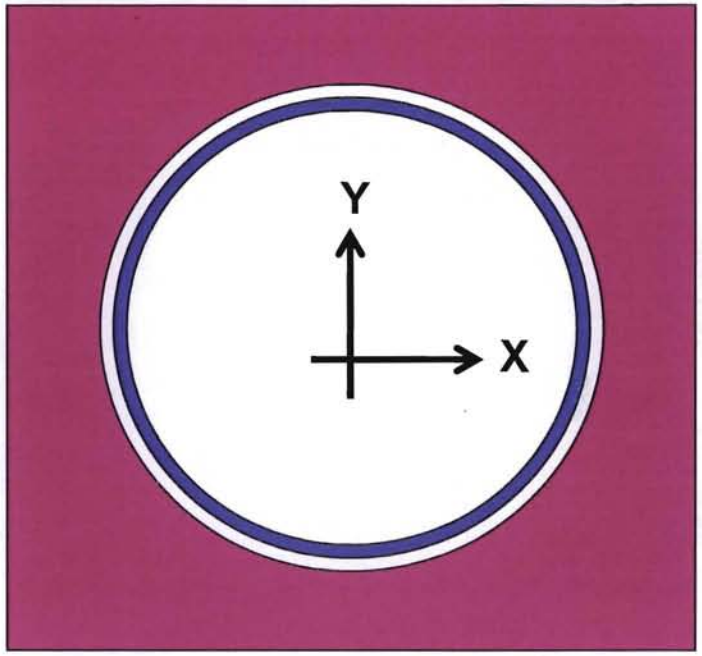
Model D5 White Paper

(Westinghouse Letter LTR-NRC-09-26, 5/13/09)

- SF model predicted PcSLB<PcNOP for some elevations in TS
  - NRC had requested notification if such a case was found
  - Based on ANL (November 2008) meeting discussions
  - Available data shows no correlation between contact pressure and leak rate coefficient
- Further review showed that SF model provided physically impossible results for only D5 SLB conditions
  - Assumed linear scaling for temperature; later shown not appropriate
- Application of C^2 model showed SF model to be conservative and resolved the contact pressure issue
  - This application of C^2 model did not include temperature effects; therefore conservative

Square Cell (C^2) Model Description

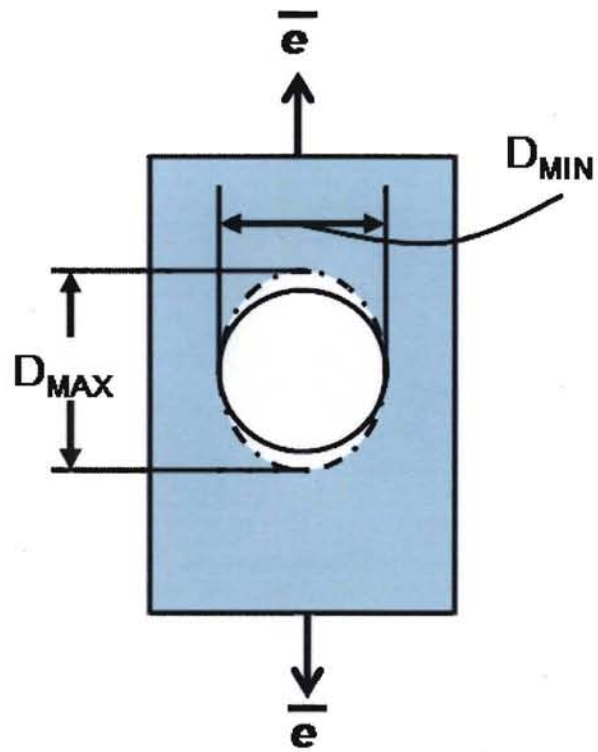
1. 2D-FEA plane strain model of an equivalent cell in the TS based on Model F geometry. Model F geometry gives lowest residual contact pressure results in the fleet.
2. Mean material properties used for Tube and TS (E, S_y, Tangent E, ν, etc.)
3. Mean geometry used
4. Mesh converged to within 2% difference.
5. Contact model adjusted to prevent node interpenetration.
6. Expansion pressure less than mfg. process spec for conservatism (~2 ksi below min spec)



Ref: Figure 6-48
WCAP-17072; p6-73

Square Cell Model Assumptions

- The purpose of the model is to predict the reduction in contact pressure as a function of tubesheet bore displacement (dilation and eccentricity)
- TS is displaced, which creates tubesheet bore eccentricity. Source of displacement is 3D FEA H* model. The displacement represents the potential TS deformation due to TS "bow" only.
- Tube and tubesheet are **<u>not</u>** rigid.
- Tube and tubesheet can deform independently.
- Both TS and tube are permitted to expand with temperature.
- Tube and tubesheet ΔT is condition specific.
- Tube ΔP is condition specific.



See figure RAI 4-9 and 4-10 response LTR-SGMP-09-109-P Attmt.

"Square Cell" Load Steps

- Step 0: Initialize Model
- Step 1: Initial gap (permits study of no-concentricity)
- Step 2: Pressurize tube to approx. half of spec. expansion pressure
- Step 3: Pressurize tube to 2 ksi less than minimum spec. expansion pressure
- Step 4: Release pressure on Tube
- Step 5: Apply ΔT
- Step 6: Apply "e bar"
- Steps 7- 9: Apply condition-specific ΔP (Ref. pg 28, LTR-SGMP-09-109 P attmt.)

Application of C^2 Model

- Start with geometry of unexpanded tube in undistorted tubesheet bore (steps 0 and 1)
- Analytically simulate expansion to establish reference condition for subsequent steps (steps 2, 3 and 4)
- Apply temperature condition to represent SG operating condition (step 5)
- Apply force to achieve displacement conditions – displacement determined from 3D FEA lower tubesheet complex model for selected operating condition (step 6)
- Apply tube internal pressure for selected operating condition (step 7 or 8 or 9)

Square Cell Boundary Conditions

- Steps 0-4: Initialize Model and Expand Tube
  - Tube is radially "pinned" so it cannot rotate.
  - TS displacement edge is currently constrained so that all corners remain square.
- Step 5: Apply ΔT
  - All displacement based boundary conditions released.
  - Tube is free to pull away from TS.
  - TS is currently constrained <u>with applied forces</u> to maintain square corners and prevent beneficial Poisson contraction.
- Step 6: Apply force to generate "e bar" (displacement)
  - Displace upper and lower edges of Square Cell using applied forces in addition to growth from ΔT and expansion process. Force iterations are performed to achieve desired displacement.
- Steps 7-9: Apply Internal Tube ΔP
  - Square Cell model is free to expand with increasing ΔP.

Typical Output from C^2 Model

- Prediction of contact pressure for combinations of radius and elevations in the tubesheet
  - Currently only one data point provided
  - Results for 10 elevations at 6 radii will be provided
- Applied directly as a factor in the contact pressure calculation (adjusts contact pressure calculation for TS rotation effects; see Eqn. p6-95 of WCAP-17072-P)

Comparing the Models

C^2 Model

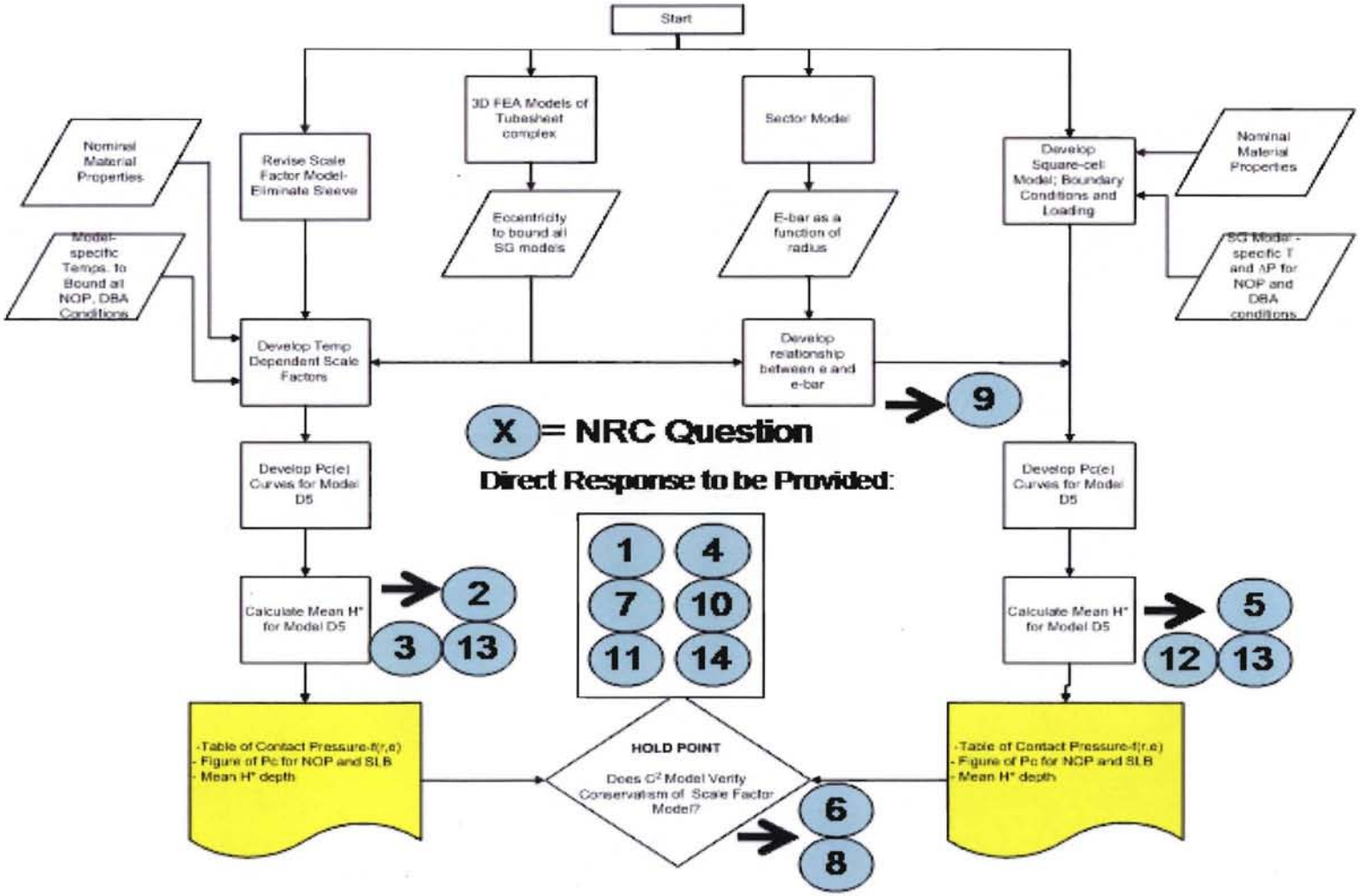
- Includes pressure and temperature effects for all plant conditions (including crevice pressure effects)
- Includes both dilation and eccentricity effects directly
- Includes tube expansion procedure to simulate baseline SG conditions
- Uses a strain hardened tube

SF Model

- Does not include pressure loading or crevice pressure effects
- Model is driven by input eccentricity which is set
- Tube is initially assumed to be circular (i.e., gap exists on major axis); no tube hydraulic expansion is simulated; tube strain hardening is not included

✓ Both models are good engineering models
✓ C^2 utilizes up-to-date computation methods
✓ C^2 model best represents physical reality
✓ C^2 model is **not** expected to directly match SF model results
✓ C^2 model **is** expected to demonstrate the conservatism of the SF model, the current licensing basis

Resolution of NRC Questions



Model Results Comparison

- Final contact pressure table α(radius, elevation, operating condition)
  - H* value

Licensing

- Include reference to previous LAR support documentation as appropriate
- Include updated No Significant Hazards Determination
- BET Commitment will be eliminated for plants which have measurement
- Westinghouse documentation
  - Will address unresolved issues
  - If necessary, will reconcile any changes from the previous LAR support documentation

Industry Status

Plant	Current Status	LAR Required
Braidwood 2	One-time Approved 10-16-2009 for Fall 2009	Spring 2011
Byron 2	One-time Approved 10-16-2009 for Spring 2010	Fall 2011
Catawba 2	Preparing One-time for Fall 2010	Fall 2010 / Spring 2012
Comanche Peak 2	One-time Approved 10-09-2009 for Fall 2009	Spring 2011
Millstone 3	One-time submitted 11-23-2009 for Spring 2010	Spring 2010 / Fall 2011
Point Beach 1	No inspection in Spring 2010	Fall 2011
Salem 1	One-time submitted 10-08-2009 for Spring 2010	Spring 2010 / Spring 2013 (plan to skip inspection Fall 2011)
Seabrook 1	One-time Approved 10-13-2009 for Fall 2009	Spring 2011
Surry 1	One-time Approved 11-05-2009 for Fall 2010	Spring 2012
Surry 2	One-time Approved 11-05-2009 for Fall 2009	Spring 2011
Turkey Point 3	One-time Approved 10-30-2009 for Fall 2010	Spring 2012
Turkey Point 4	One-time Approved 10-30-2009 for Fall 2009	Fall 2012 (plan to skip inspection Spring 2011)
Vogtle 1	One-time Approved 9-24-2009 for Fall 2009	Spring 2011
Vogtle 2	One-time Approved 9-24-2009 for Spring 2010	Fall 2011
Wolf Creek	One-time Approved 10-19-2009 for Fall 2009	Spring 2011

Preliminary Schedule

Activity	Date
• NRC Concur with Approach	late January 2010
• Achieve HOLD POINT on Flow Chart (D5)	late May 2010
• Review Meeting with NRC - Assume agreement reached on approach	early June 2010
• Complete D5 Analysis (Probabilistic, etc.)	late July 2010
• Westinghouse Report	mid August 2010
• Prepare LAR Package	August 2010
• Complete Site Review Process	September 2010
• Submit LAR to NRC	end of September 2010
• LAR Approval needed	February 2011

Summary

- Proposed approach addresses NRC questions
- Comparison of significant H* parameters (Pc) adequately addresses concerns regarding the issue of Pc vs. eccentricity
- No data to support functional relationship between contact pressure and leakage loss coefficient
  - PcSLB>PcNOP not necessary for success
- Follow-up Meeting in June 2010
- License Amendment needed to support Spring 2011 Inspections
- Regular technical interaction with NRC recommended

The NRC staff expressed concern about the proposed 5-month review schedule and cautioned the licensee that for this schedule to be viable, all of the unresolved issues must have a clear resolution strategy that will be part of the LAR. The NRC staff also informed the licensee that any substantive changes to the previously submitted methodologies or assumptions, could adversely impact the proposed schedule. In addition, the NRC staff encouraged the licensee to develop a contingency plan in the event that the proposed schedule is not met.

Finally, the NRC staff and the licensee agreed that frequent and effective communication is needed to ensure the unresolved issues are addressed and the proposed schedule is met.

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/RA/

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Docket Nos. 50-424 and 50-425

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