Domestic Members
AmerenUE
Callaway
American Electric Power Co.
D.C. Cook 1 & 2
Arizona Public Service Co.
Palo Verde 1, 2 & 3
Constellation Energy Group
Calvert Cliffs 1 & 2
R. E. Ginna
Dominion Kewaunee
Dominion Nuclear Connecticut
Millstone 2 & 3
Dominion Virginia Power
North Anna 1 & 2
Surry 1 & 2
Duke Energy
Catawba 1 & 2
McGuire 1 & 2
Entergy Nuclear Northeast
Indian Point 2 & 3
Entergy Nuclear South
ANO 2
Waterford 3
Exelon Generation Company LLC
Braidwood 1 & 2
Byron 1 & 2
FirstEnergy Nuclear Operating Co.
Beaver Valley 1 & 2
FPL Group
St. Lucie 1 & 2
Seabrook
Turkey Point 3 & 4
Nuclear Management Co.
Palisades
Point Beach 1 & 2
Prairie Island 1 & 2
Omaha Public Power District
Fort Calhoun
Pacific Gas & Electric Co.
Diablo Canyon 1 & 2
Progress Energy
H. B. Robinson 2
Shearon Harris
PSEG – Nuclear
Salem 1 & 2
South Carolina Electric & Gas Co.
V. C. Summer
Southern California Edison
SONGS 2 & 3
STP Nuclear Operating Co.
South Texas Project 1 & 2
Southern Nuclear Operating Co.
J. M. Farley 1 & 2
A. W. Vogtle 1 & 2
Tennessee Valley Authority
Sequoyah 1 & 2
Watts Bar 1
TXU Power
Comanche Peak 1 & 2
Wolf Creek Nuclear Operating Corp.
Wolf Creek

International Members
British Energy plc
Sizewell B
Electrabel
Doel 1, 2, 4
Tihange 1 & 3
Electricité de France
Kansai Electric Power Co.
Mihama 1
Takahama 1
Ohi 1 & 2
Korea Hydro & Nuclear Power Co.
Kori 1 – 4
Ulchin 3 - 6
Yonggwang 1 - 6
NEK
Krško
NOK
Kernkraftwerk Beznau
Ringhals AB
Ringhals 2 – 4
Spanish Utilities
Asco 1 & 2
Vandellos 2
Almaraz 1 & 2
Taiwan Power Co.
Maanshan 1 & 2

Project Number 694
WCAP-16180-NP, Rev. 0

August 17, 2005

WOG-05-371

U.S. Nuclear Regulatory Commission
Document Control Desk
Washington, DC 20555-0001

Subject: **Westinghouse Owners Group Transmittal of Responses to NRC Requests for Clarification Regarding WCAP-16180-NP, Revision 0, "Operability Assessment for Combustion Engineering Plants with Hypothetical Circumferential Flaw Indications in Pressurizer Heater Sleeves" (PA-MSC-0143)**

References:

1. WOG-03-643, "WOG CE Fleet Operability Assessment Regarding Pressurizer Heater Sleeves," December 23, 2003.
2. NRC Letter (D. Holland) to the Westinghouse Owners Group Program Management Office (G. Bischoff), "Request for Additional Information Concerning WCAP-16180-NP, Revision 0, "Operability Assessment for Combustion Engineering Plants with Hypothetical Circumferential Flaw Indications in Pressurizer Heater Sleeves" (TAC No. MC1751)," February 18, 2004.
3. WOG-04-404, Westinghouse Owners Group Transmittal of Partial Response to NRC Request for Additional Information Concerning WCAP-16180-NP, Revision 0, "Operability Assessment for Combustion Engineering Plants with Hypothetical Circumferential Flaw Indications in Pressurizer Heater Sleeves" (PA-MSC-0143), August 12, 2004
4. WOG-04-540, Westinghouse Owners Group Transmittal of Remaining Responses to NRC Request for Additional Information Concerning WCAP-16180-NP, Revision 0, "Operability Assessment for Combustion Engineering Plants with Hypothetical Circumferential Flaw Indications in Pressurizer Heater Sleeves" (PA-MSC-0143), October 19, 2004

The WOG has provided to the NRC, via Reference 1, the Operability Assessment performed by the WOG in support of the CE fleet regarding the potential for circumferential cracks in pressurizer heater sleeves, as well as the inspection activities planned at that time by the CE utilities to address the heater sleeve issue.

After review of WCAP-16180-NP, the NRC issued a Request for Additional Information (Reference 2). The WOG provided responses to this RAI via References 3 and 4.

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Subsequent to the submittal of responses by the WOG to the RAI questions, the NRC Staff has issued several requests for clarification regarding those responses. The WOG has provided responses to these requests for clarification both verbally and via email. The following information formally documents the WOG responses.

1. Request for clarification received from NRC via email (November 1, 2004) regarding the WOG response to RAI Question #2. The NRC request for clarification and the WOG response (initially provided via email from Steve DiTommaso (Westinghouse) to Mr. Girija Shukla of NRC Staff on November 8, 2004) are provided in Attachment 1.

2. Request for clarification received from NRC via email (April 6, 2005) regarding the WOG responses to RAI Questions #4 and #7. The NRC requests for clarification and the WOG responses (initially provided via email from Steve DiTommaso (Westinghouse) to Mr. Girija Shukla of NRC Staff on June 30, 2005) are provided in Attachment 2.

3. A follow-up question to the responses provided in Attachment 2 was received from NRC via email (July 18, 2005) regarding a comparison between the EMCC fracture mechanics modeling methodology and the methodology used in WCAP-16180-NP. The response was provided via telecon discussion between Mr. Warren Bamford of Westinghouse and Mr. Simon Sheng of NRC Staff. The request for clarification and the WOG response as discussed in the telecon are provided in Attachment 3.

With this formal submittal of responses to the NRC's requests for clarification regarding WCAP-16180-NP, the WOG considers the review of WCAP-16180-NP to be complete. The WOG respectfully requests NRC Staff's concurrence. As always, the WOG is prepared to discuss, at your convenience, the responses provided herein. Please contact Mr. Brad Maurer (Westinghouse) at 412-374-4419 with any questions or comments regarding this information.

Sincerely yours,

Frederick P. "Ted" Schiffley, II
Chairman, Westinghouse Owners Group

Attachments (3)

FPS:PJH.las

cc: Dr. Brian Sheron, NRC
Steve Dembek, NRC
Girija Shukla, NRC
Alex Marion, NEI
Dave Mauldin, APS
Executive Committee
Steering Committee
Materials Subcommittee
Licensing Subcommittee
B. Maurer (W) Pittsburgh
PMO

Responses to NRC Requests for Clarification
Regarding
WCAP-16180-NP, "Operability Assessment for Combustion Engineering Plants with Hypothetical Circumferential Flaw Indications in Pressurizer Heater Sleeves"

Attachment 1

Request for clarification received from NRC via email, November 1, 2004. The response was initially provided via email from Steve DiTommaso (Westinghouse) to Mr. Girija Shukla of NRC Staff on November 8, 2004.

Question

Table 2-1 on page 5 has a heading labeled "Number of Circumferential Cracks/Leaks." Using the information available to the staff, it is not understood how the number "16" at the bottom of that column corresponds to the heading of the column. For instance, the staff is aware of many more than 16 leaks, but not 16 leaking circumferential cracks. The staff would like to have a brief telephone call with the cognizant WOG analyst to better understand what data they are using for the operability assessment.

Response

The column in Table 2-1 entitled "Number of Circumferential Cracks/Leaks" represents the number of pressurizer heater sleeve cracks that are considered to have the potential for progressing to a small break LOCA. Only (16) currently identified cracks have this potential, even though the data base for heater sleeve cracks consists of a much larger population. The following criteria were used in filtering this database to conservatively arrive at this number.

1. Only circumferential cracks have the potential for progressing to a small break LOCA.

2. Cracks should be in or adjacent to the Alloy 600 penetration welds for them to have the potential to lead to a small break LOCA.

3. Cracks that were not tested or inspected by ultrasonic or eddy current methods were conservatively included in the group of cracks with the potential for progressing to a small break LOCA. The inspection data available thus far have not shown any circumferential cracks in the pressurizer pressure boundary. The uncharacterized (due to a lack of test or inspection) cracks that have been included with the known circumferential cracks are expected to be axial cracks, based on the inspection of numerous leaking sleeves. However, for conservatism in the PRA assessment, these cracks were assumed to have the potential for progressing to a small break LOCA.

In summary, the (16) cracks that were assumed to have the potential for leading to a small break LOCA conservatively consisted of uncharacterized leakage cracks, as well as known circumferential cracks.

Responses to NRC Requests for Clarification
Regarding
WCAP-16180-NP, "Operability Assessment for Combustion Engineering Plants with Hypothetical Circumferential Flaw Indications in Pressurizer Heater Sleeves"

Attachment 2

Request for clarification received from NRC via email, April 6, 2005. The response was initially provided via email from Steve DiTommaso (Westinghouse) to Mr. Girija Shukla of NRC Staff on June 30, 2005.

Question 1:

Regarding the response to Question # 4: In your letter dated October 19, 2004, you provided modeling details of a new FEM model to explain "stress relaxation" due to the presence of a circumferential through-wall crack with different lengths. The staff understands that this new model is similar to the EMC approach using pinning and unpinning of nodes along the crack faces. However, you did not provide information regarding the original stress-relaxation modeling reported in WCAP-16180. Without using unpinning, as you indicated in the response, how did you simulate the appropriate surface traction on the crack faces in your original stress and fracture mechanics analyses?

Response 1:

In the original models used for the WCAP-16180 analyses, unpinning was used to obtain the stress intensity factor for each of the flaw lengths. The model used for the response to question 4 was set up for the purpose of demonstrating that the stresses decrease when the crack is allowed to open. The goal of the model was to actually determine the stresses as the crack opened, so a slightly different approach was used, but the model was essentially the same one used for the calculations shown in the WCAP.

Question 2:

Regarding response to Question # 7: Provide the structural factors that you used in the crack stability analysis in determining the critical flaw size.

Response 2:

The structural factor, or safety factor used in the calculations of the critical flaw length was set equal to 1.0. The definition of critical flaw size is that flaw which would fail the structure, so no safety factor or structural factor is necessary.

Attachment 3

Follow-up question to the responses provided in Attachment 2, received from NRC via email, July 18, 2005. The response was initially provided via telecon discussion between Mr. Warren Bamford of Westinghouse and Mr. Simon Sheng of NRC Staff.

Question:

So far, the fracture mechanics modeling is described on Page 5-24 of the WCAP as, "the welding residual stresses were applied as secondary stresses, which redistribute in the presence of the crack. Only the operating pressure is applied as a primary load to the model, both at the model inside and outside diameter wetted surfaces and on the crack face. This is a more accurate approach to modeling the stress state of the cracked nozzle than methods such as superposition." Subsequent WOG responses did not clarify this statement. We are aware about the method using Principle of Superposition and the "node-release" method proposed by Engineering Mechanics Corporation of Columbus (EMCC).

The node-release methodology maps the full stress field and full plastic strain field from an FEM residual stress analysis to a new mesh with a pinned crack (much finer mesh is required for a fracture mechanics analysis). After the mapping is complete, the proper applied loads (temperature + pressure) will be applied, and the pinned crack nodes, two for each point along the crack, will then released simultaneously to solve for J/K.

Since your methodology may be different from EMCC's node-release method, please point out the differences between your methodology and what is described above. We need to know in detail before the NRC can endorse a new methodology.

Response:

The methodology used in the nodal release is essentially identical to that of EMCC. The stress state from the welding residual stress model is mapped into a new mesh that is appropriate for fracture mechanics analysis (i.e., with a crack front mesh). The crack face is "unpinned", and temperature and pressure are applied to the crack model with mapped residual stresses to complete the loading. The analysis results from the fracture mechanics model are then used to calculate J/K. There is nothing in the description of EMCC's methodology that is inconsistent with that of WCAP-16180, which probably explains the consistency in the two results, when compared.