October 6, 2003
WOG-03-511

WCAP-15973
Project Number 694

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

Attention: Chief, Information Management Branch
Division of Program Management

Subject: **Westinghouse Owners Group Response to Staff Request for Additional Information regarding WCAP-15973-P, "Low Alloy Steel Component Corrosion Analysis Supporting Alloy 600/690 Nozzle Repair Programs" (TAC No. MB6805)**

Topical report WCAP-15973, "Low Alloy Steel Component Corrosion Analysis Supporting Alloy 600/690 Nozzle Repair Programs," was submitted for staff review and approval on November 11, 2002 via letter CEOG-02-243. The purpose of this letter is to provide responses to the staff RAIs issued on July 2, 2003.

Certain information contained in this response is proprietary to Westinghouse Electric Co. and is requested to be withheld from public disclosure pursuant to 10 CFR 2.790. The reasons for withholding this proprietary information are defined in the enclosed affidavit CAW-03-1711.

Proprietary responses to the staff's RAIs are contained in Enclosure 2. Enclosure 3 provides a non-proprietary version of these responses.

The Westinghouse Owners Group is prepared to discuss these responses, if needed, in order to facilitate the staff's review of WCAP-15973. If you require further information, please feel free to contact Mr. Steve Lurie, Owners Group Project Office at 860-731-6241.

Very truly yours,

Robert H Bryan

Robert H. Bryan, Chairman
Westinghouse Owners Group

D048

Enclosure:

cc: D. G. Holland, USNRC
Management Committee
Materials Subcommittee Chairman
Project Management Office
H. A. Sepp, Westinghouse
K. J. Vavrek, Westinghouse
S. J. Lurie, Westinghouse
B. Hinton, Westinghouse
J. F. Hall, Westinghouse
J. Ghergurovich, Westinghouse

Enclosure 1

Westinghouse Request for Withholding Proprietary Information

CAW-03-1711

Westinghouse

Westinghouse Electric Company
Nuclear Services
P.O. Box 500
Windsor, Connecticut 06095-0500
USA

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

Direct tel: 860-731-6289
Direct fax: 860-731-6238
e-mail: ian.c.rickard@us.westinghouse.com

Our ref: CAW-03-1711
September 24, 2003

APPLICATION FOR WITHHOLDING PROPRIETARY INFORMATION FROM PUBLIC DISCLOSURE

Subject: **Westinghouse Response to Staff RAIs on WCAP-15973-P, R00, "Low Alloy Steel Component Corrosion Analysis Supporting Alloy 600/690 Repair Program," (Proprietary), dated September 2003**

Westinghouse hereby transmits responses to a staff request for additional information (RAI) concerning the subject topical report. Portions of these responses contain proprietary information for which withholding from public disclosure is requested. Affidavit CAW-03-1711, signed by Westinghouse Electric Company LLC, the owner of the information, sets forth the basis on which the proprietary information is requested to be withheld from public disclosure by the Commission and addresses the considerations listed in paragraph (b)(4) of 10 CFR 2.790 of the Commission's regulations.

For identification purposes and in conformance with the requirements of 10 CFR 2.790, Westinghouse has enclosed within brackets the proprietary information contained within the subject presentation. The justification for claiming the information designated as proprietary is indicated by means of superscript letters immediately following the brackets. These superscript designators refer to the types of information Westinghouse customarily holds in confidence as identified in Sections (4)(ii)(a) through (4)(ii)(f) of the enclosed affidavit.

Correspondence with respect to the proprietary aspects of the application for withholding or the Westinghouse affidavit should reference this letter, CAW-03-1711, and should be addressed to the undersigned.

Very truly yours,

Ian C. Rickard
Licensing Project Manager
Regulatory Compliance and Plant Licensing

Enclosure:

cc: D. G. Holland / NRR

AFFIDAVIT

STATE OF CONNECTICUT)
) ss: WINDSOR, CT
COUNTY OF HARTFORD)

Before me, the undersigned authority, personally appeared Ian C. Rickard, 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 ("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:

Ian C. Rickard,
Licensing Project Manager
Regulatory Compliance and Plant Licensing

Sworn to and subscribed before me
this 24th day of September 2003.

Notary Public

My commission expires May 31, 2008.

(1) I, Ian C. Rickard, depose and say that I am the Licensing Project Manager, Regulatory Compliance and Plant Licensing, in Nuclear Services, Westinghouse Electric Company LLC ("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 rule making proceedings, and am authorized to apply for its withholding on behalf of the Westinghouse Electric Company LLC.

(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 LLC 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.

(iii) There are sound policy reasons behind the Westinghouse system for classification of proprietary information, 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 that 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.

(iv) The information is being transmitted to the Commission in confidence and, under the provisions of 10 CFR 2.790, it is to be received in confidence by the Commission.

(v) 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.

(vi) The proprietary information sought to be withheld in this submittal is that which is appropriately marked in the responses to the staff's request for additional information concerning WCAP-15973-P, "Low Alloy Steel Component Corrosion Analysis Supporting Alloy 600/690 Nozzle Repair Program," dated September 2003.

This information is part of that which will enable Westinghouse to repair or replace Alloy 600 / 690 nozzles, and in particular to support utilities in the application of such, including:

(a) The identification of important phenomena relevant to corrosion of base metals associated with Alloy 600 / 690 nozzles,

(b) An assessment of industry data as applied to primary materials corrosion,

(c) The incorporation of replacement nozzles in plant-specific inspection program applications.

Further this information has substantial commercial value as follows:

(a) Westinghouse plans to sell the use of similar information to its customers for purposes of meeting NRC requirements for licensing documentation.

(b) Westinghouse can sell support and defense of Alloy 600/690 nozzle repair.

(c) The information requested to be withheld reveals the technical aspects of a methodology that was developed by Westinghouse.

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 advanced nuclear power plant designs and to provide 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.

Further the deponent sayeth not.

PROPRIETARY INFORMATION NOTICE

Transmitted herewith are proprietary and/or non-proprietary versions of documents furnished to the NRC in connection with requests for generic and/or plant-specific review and approval.

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 as identified in Sections (4)(ii)(a) through (4)(ii)(f) of the affidavit accompanying this transmittal.

Enclosure 3

Non-Proprietary Response to Request for Additional Information

WCAP-15973-NP

WCAP-15973-P, Revision 00, "Low Alloy Steel Component Corrosion Analysis Supporting Alloy 600/690 Nozzle Repair Programs,"

Response to NRC Request for Additional Information dated July 2, 2003

Question 1:

Section 2.6 of the topical report (TR) provides previous field experience of the half-nozzle repairs, including a pressurizer vapor space instrumentation nozzle repair performed in 1990 at Arkansas Nuclear One, Unit 1 (ANO-1). The repair was ultrasonic test (UT) inspected at the 1st and 2nd refueling outages and is currently UT inspected on an every-other-cycle basis. The repair is exposed to a high temperature steam environment which contains some boron, but not the same level as a pipe nozzle. This repair was approved provided that the licensee implements a monitoring program with a nondestructive examination technique demonstrated to be effective in evaluating base metal corrosion. A UT inspection method was developed and implemented. The monitoring plan was considered to be an essential part of the repair to provide assurance of continued safe operation, since laboratory data may not necessarily duplicate field conditions. Also, since there is limited experience with the behavior of the repair and different conditions such as potential extended outages or chemistry control fluctuations, periodic UT inspections performed every other outage of the repairs will provide the necessary data to understand the behavior of the repair and its continued safe operation. Why is a monitoring program not specified to evaluate repairs in nozzles with borated water that may be susceptible to primary water stress corrosion cracking? Please provide justification for omitting a volumetric monitoring program (such as UT inspection).

Response 1:

There is more than limited experience with the half-nozzle replacement and similar small diameter nozzle repairs in which carbon or low alloy steels are exposed to nominal primary coolant conditions. Approximately 200 such replacements/repairs have been completed on pressurizers, hot and cold leg piping, and reactor vessels. Approximately 60 of these have been in service for 5 or more years. These nozzle locations continue to be inspected as part of existing monitoring programs. Several plants are, or will be, performing periodic volumetric inspections of nozzle repairs. In addition, as noted in the topical report, one plant removed a half-nozzle repair after 5 years of service in a hot leg location (where it was exposed to primary water, not steam) to address boric acid corrosion concerns. Only minor pitting of the carbon steel was present.

Based on the satisfactory experience with the large number of half-nozzle repairs completed to date, experience with other locations in which the cladding was removed, and the analyses performed in the topical report and similar documents, additional volumetric inspections are not required.

Question 2:

Sections 3.1 and 3.3 of the TR specify stress intensity factor ranges of KI (?KI) and crack growth (?a). These seem to be typographical errors. Please correct these errors.

Response 2:
This is a typographical error that sometimes occurs during printing. The intended symbol where this occurred in these sections is the delta symbol, "**Δ**;" this error will be corrected in the approved report.

Questions 3 and 11:

Question 3: Section 4.0 of CN-CI-02-71 (Summary of Fatigue Crack Growth Evaluation Associated with Small Diameter Nozzles in CEOG Plants) states that the elastic-plastic fracture mechanics (EPFM) evaluation is based on the Appendix K (ASME Section XI) approach. The Appendix K methodology is for the evaluation of flaws in reactor vessels when the vessel temperature is in the upper-shelf range. Justify the use of the Appendix K methodology in the current evaluation of crack stability for flaws originated from small diameter nozzle holes in pressurizers.

Question 11: Provide justification for using the J-material curve of NUREG/CR-5729 in your evaluation.

Responses 3 and 11:

The Appendix K methodology was developed for application to the beltline regions of a Reactor Vessel, and in Section 4.0 of the calculation it is implied that Appendix K was used in the analysis. The elastic-plastic fracture mechanics evaluation found in Section 6.3.2.2.2 of the subject calculation was consistent with Appendix K but was tailored to the application and conditions evaluated. The methodology was actually based on Regulatory Guide (RG) 1.161, which is very similar to the non-mandatory rules given in Appendix K of Section XI of the1992 ASME Code Edition. Specific aspects of Appendix K unique to reactor vessels were therefore not applicable and were not used. For example, for reactor vessel analyses, K-1200(a) requires that flaws be postulated with the criteria of K-2000. For the Pressurizer nozzle, the postulated flaw was determined in step 14 of the procedure described in section 6.1 of the subject calculation, rather than in accordance with K-2000. Therefore, both Appendix K and RG 1.161 represent industry-accepted methodologies for evaluating crack stability, and were used as guidance for establishing the methodology used in this calculation.

Table 11 of NUREG CR5729 provides a J-R curve meeting the K-3300(b) requirements for the Pressurizer lower shell material (SA-533A or SA-533B material.) This reference provides an industry-accepted source for this data.

Questions 4 and 5:

Question 4: Section 6.1 of CN-CI-02-71 states that fatigue crack growth of the flaw is calculated over the remaining plant life and the final flaw size is used to confirm flaw stability at the end-of-plant life. However, plant life is not defined for these calculations. Please provide the length of time these calculations address. In addition, revise Tables 2.1, 2-3, and 2-5, by including in the tables the remaining plant life for each limiting plant selected for the fatigue crack growth calculation for the three locations. Further, report the RT_{NDT} values for the materials at the three locations being evaluated.

Question 5: Section 6.2.2 of CN-CI-02-71 states that the specified design operating transients pertinent to this evaluation are similar for all plants. Confirm that the occurrences of transients specified in this section are for 40 years and the fatigue crack growth calculation was based on the portion of the occurrences corresponding to the remaining plant life for specific limiting plants.

Responses 4 and 5:

The plant life used in all calculations is the original design life of 40 years. The "remaining plant life" in all cases equates to 40 years because it was assumed that the flaw originates on the first day of operation. The term "remaining" was inadvertently used, as the discussion was borrowed from a similar analysis that focused on a portion of the plant life. The implied meaning of the word "remaining" therefore does not belong in this context and can be deleted everywhere it appears; it will also be deleted in the approved report. This information does not belong in Tables 2-1, 2-3 or 2-5.

The RT_{NDT} values are as follows:

[ ] a,c

Question 6:

Section 6.2.2.1 of CN-CI-02-71 discusses the establishment of the pressure curve based on "P_{SAT} + 200°F." Please clarify how you shift the saturation curve.

Response 6:

The "PSAT + 200°F" expression contains a typographical error. The correct expression should read "PSAT + 200 psi." The report provides a discussion regarding the basis for developing this modification to the saturation curve.

Question 7:

Section 6.3.1 of CN-CI-02-71 indicates that both the hand calculations and ANSYS results for stresses are presented in Appendix B, Reference 7.1.18. Provide a discussion on these two sets of results as related to the validation of your ANSYS results.

Response 7:

Hand calculations were performed to determine pressure stresses. The ANSYS calculations were performed to calculate thermal stresses. As such, the hand calculations are not used to validate the ANSYS calculations.

Question 8:

Section 6.3.2 of CN-CI-02-71 states that the fracture mechanics evaluation used "the guidance outlined in ASME Code Section XI Appendix A for a double-sided crack that has propagated through the J-Weld..." Provide the figure number for the crack growth rate of Appendix A and the Edition of the ASME Code that you referenced.

Response 8:

Figure A-4300-2 of the 1992 Edition of the ASME Code Section XI was used to obtain the fatigue crack growth rate. This curve applies to carbon and low alloy ferritic steels exposed to a water environment.

Question 9:

Discuss the differences between the relative hole size and crack geometry of your issue and those of Raju-Newman's - address the need to use an additional margin to account for the concern for applying Raju-Newman's analytical results directly.

Response 9:

As stated in the subject calculation, the fracture mechanics evaluation is performed using the guidance found in ASME Code, Section XI, Appendix A (Code). This guidance outlines a process to assess a flaw left in service considering postulated operating conditions over the life of the plant. As part of this guidance, the Code offers material limits and suggested methods of analysis. In this evaluation, the Code aspects associated with material properties specified in Article A-4000 were used as directed, as was the analysis guidance specified in Article A-5000. The only modification to the Code guidance was to use a more technically appropriate formulation to calculate the Stress Intensity Factor (SIF) as is allowed by Article A-3000.

The technique used to calculate SIF in the subject calculation is based on a Newman-Raju paper "Stress Intensity Factor Equations for Cracks in Three-Dimensional Finite Bodies Subjected to Tension and Bending Loads," NASA Technical Memorandum 85793, April 1984. Specifically, this paper presents solutions for several flaw configurations including flaws adjacent to holes such as the one presented for a "Corner Elliptical Corner Crack at a Hole." Considering the actual geometry of the problem under evaluation, which is essentially a hole through a specified thickness, it was concluded that the formulation offered by this paper was more applicable to the problem than that presented in Article A-3000.

From the discussion presented in the paper, the "Corner Elliptical Corner Crack at a Hole" formulation is based on results from a three-dimensional finite element model subjected to remote tension and bending loads. It indicates an applicability range for crack depth to crack length ratios from 0.2 to 2. The paper further states that for ratios of crack depth to plate thickness less than 0.80, the equations are generally within 5% of the finite element results, except where the crack front intersects a free surface, where the equations give higher SIF than the finite element results. The paper concludes that the equations provided should be useful for correlating and predicting fatigue crack growth rate as well as in computing fracture toughness and fracture loads for these types of crack configurations.

In conclusion, based on our study of this paper, Westinghouse believes that this is an appropriate alternative to calculating the stress intensity factor for this problem than what is provided in ASME Code, Section XI, Appendix A and can be applied without adding any additional margin.

Question 10:

The last paragraph of Section 6.3.2 of CN-CI-02-71 indicates that thermal stresses are dominant in the pressurizer lower head due to its thick cladding. Was cladding with an appropriate thermal expansion coefficient modeled in your heat transfer analysis? Discuss the appropriateness of your heat transfer analysis.

Response 10:

The thermal analysis of the Pressurizer was performed for the effects of the modified design basis transient identified in Figure 6-3 of Section 6.2.2.1. In general, the temperature distribution through the wall was characterized by a partial differential equation defined for the applicable boundary conditions and geometry, and solved numerically using the finite element model to determine wall temperature as a function of radius, time, and thermal rate. The thermal time histories were input to the ANSYS finite element models as a series of discrete (time, temperature) points, and a time history thermal analysis was performed for each transient.

The models were sufficiently detailed to provide an accurate distribution of temperature as a function of radial location and transient time. Cladding was modeled as part of the thermal analysis. Variation of material properties is modeled, allowing for the change in material thermal properties between the cladding and the base metal. The appropriate thermal conductivities and thermal diffusivities for the base and clad materials were obtained from the ASME Code.