Westinghouse Electric Corporation **Energy Systems**

Nuclear Services Division

Box 355
Pittsburgh Pennsylvania 15230-0355

Document Control Desk
U.S. Nuclear Regulatory Commission
Washington, D. C. 20555

CAW-97-1140

July 17, 1997

Attention: Mr. Samuel L. Collins

APPLICATION FOR WITHHOLDING PROPRIETARY INFORMATION FROM PUBLIC DISCLOSURE

Subject: "Response to NRC Questions on Indian Point Unit 2, P-T Limit Curves" (Proprietary)

Dear Mr. Collins

The proprietary information for which withholding is being requested in the above referenced report is further identified in Affidavit CAW-97-1140 signed by the owner of the proprietary information, Westinghouse Electric Corporation. The affidavit, which accompanies this letter, sets forth the basis on which the information may be withheld from public disclosure by the Commission and addresses with specificity the considerations listed in paragraph (b)(4) of 10 CFR Section 2.790 of the Commission's regulations.

Accordingly, this letter authorizes the utilization of the accompanying Affidavit by Consolidated Edison Company of New York, Inc.

Correspondence with respect to the proprietary aspects of the application for withholding or the Westinghouse affidavit should reference this letter, CAW-97-1140, and should be addressed to the undersigned.

Very truly yours,

N.J. Liparulo, Manager
Equipment Design and Regulatory Engineering

JWF:bbp

Attachment

cc: Kevin Bohrer/NRC(12H5)

AFFIDAVIT

COMMONWEALTH OF PENNSYLVANIA:

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COUNTY OF ALLEGHENY:

Before me, the undersigned authority, personally appeared James M. Brennan, 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 Corporation ("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:

James M. Brennan, Manager
Design Basis Programs

Sworn to and subscribed
before me this 17 day
of July, 1997

Notary Public

Notarial Seal
Rose Marie Payne, Notary Public
Monroeville Boro, Allegheny County
My Commission Expires Nov. 4, 2000
Member, Pennsylvania Association of Notaries

(1) I am Manager, Design Basis Programs, in the Nuclear Services Division, of the Westinghouse Electric Corporation 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 Energy Systems Business Unit.

(2) I am making this Affidavit in conformance with the provisions of 10CFR 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 Energy Systems Business Unit 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 10CFR 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 in "Response to NRC Questions on Indian Point Unit 2 P-T Limit Curves," (Proprietary), May, 1997 for Indian Point Unit 2, being transmitted by Consolidated Edison Company of New York, Inc. letter and Application for Withholding Proprietary Information from Public Disclosure, to Document Control Desk, Attention Mr. Samuel L. Collins. The proprietary information as submitted for use by Consolidated Edison Company of New York, Inc. for Indian Point Unit 2 is expected to be applicable in other licensee submittals to demonstrate compliance with 10CFR50 Appendix G and related NRC requirements.

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 requirements for licensing documentation.

(b) Westinghouse can sell support and defense of the technology to its customers in the licensing process.

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 methodologies 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 testing and analytical methods and performing testing.

Further the deponent sayeth not.

W NON-PROPRIETARY CLASS 3

Response to NRC Questions on Indian Point Unit 2
P-T Limit Curves

Request for Additional Information
Indian Point Unit 2 Pressure-Temperature (P-T) Limit Curves

I. THERMAL STRESS INTENSITY FACTORS

A. Provide a detailed, step-by-step, sample calculation of the thermal stress intensity factors (K_{IT}) tabulated in Tables A-2 and A-3 for cooldown and heatup. The sample calculation should include the coefficients C_0, C_1, C_2, and C_3 of the polynomial equation used to simulate the reactor vessel wall thermal stress distribution.

K_I for radial thermal gradient for any thermal stress distribution and at any specified time during *cooldown* for a 1/4-thickness inside surface defect:

$$K_{It} = (1.0359C_0 + 0.6322C_1 + 0.4753C_2 + 0.3855C_3) * \sqrt{\pi a}$$

and, similarly, K_{It} during *heatup* for a 1/4-thickness outside surface defect:

$$K_{It} = (1.079C_0 + 0.630C_1 + 0.481C_2 + 0.401C_3) * \sqrt{\pi a}$$

where coefficients C_0, C_1, C_2 and C_3 are determined from the thermal stress distribution at any specified time during the heatup or cooldown:

$$\sigma(x) = C_0 + C_1(x/a) + C_2(x/a)^2 + C_3(x/a)^3$$

x - variable representing radial distance from inside/outside surface to any point on the crack front

a - maximum crack depth = t/4 = 8.625/4 = 2.156 for Indian Point Unit 2

The following tables provide the details needed to perform hand calculations. The first eight values were obtained from the Westinghouse OPERLIM code output. The final column is the hand-calculated number using the above K_{IT} equations for cooldown and heatup.

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As can be seen from the bolded values in the above tables, the hand calculated K_{IT} values are very close to the K_{IT} values which were generated by the OPERLIM code.

B. *Sample problems were provided by the ASME Section XI Working Group on Operating Plant Criteria (using the new Appendix G methodology), which also included results from Westinghouse. The staff has noted large differences in the* K_{IT} *between the generic ASME results and the results for IP2 at low pressures. To resolve these differences, the staff requests the following:*

1. *For the cooldown and heatup transient finite element model:*
   a. *Confirm that the analysis used the plant-specific data for the IP2 vessel and flaw geometry and for an axial semi-elliptical surface flaw, and provide the data that was used.*

   The analysis did use the Indian Point Unit 2 plant-specific data. Also, the Westinghouse OPERLIM code does use an axial semi-elliptical surface flaw 1/4T in depth and 1.5T in length.

   The following vessel geometry data was input into the OPERLIM code:
   - Pressure vessel inner radius = 86.719 inches
   - Pressure vessel outer radius = 95.344 inches
   - Beltline region wall thickness = 8.625 inches
   - 1/4T location = 88.875 inches
   - 3/4T location = 93.188 inches

   The following cooldown rates were generated: 0, 20, 40, 60, 100°F/hr.
   The following heatup rates were generated: 60, 100°F/hr.

   b. *Provide the following ferritic base metal properties:*
   Thermal conductivity, k
   Heat transfer coefficient, h
   Specific heat, C_p
   Density, ρ
   Young's modulus, E
   Poisson's ratio, ν
   Thermal expansion coefficient, α

   As documented in Westinghouse Proprietary Class 2 letter MSE-REME-0112, the following material properties are used in the OPERLIM code. This data was originally documented in WCAP-9186, *Documentation and Verification of the OPERLIM Computer Code*. Note that these material properties are dependent upon temperature.

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c. *Provide the inputs, initial conditions, and boundary conditions used on the stress analysis and the heat transfer analysis for the 100°F/Hr cooldown transient.*

The following is documented in Section 2.6, *Pressure-Temperature Curve generation Methodology*, in WCAP-14040-NP-A, *Methodology Used to Develop Cold Overpressure Mitigating system Setpoints and RCS Heatup and Cooldown Limit Curves.*

The time-dependent temperature solution utilized in both the heatup and cooldown analysis is based on the one-dimensional transient heat conduction equation:

$$\rho C * \frac{\partial T}{\partial t} = K * [\frac{\partial^2 T}{\partial r^2} + \frac{1}{r}\frac{\partial T}{\partial r}]$$

with the following boundary conditions applied to the inner and outer radii of the reactor vessel, at $r = r_i$, $$-K\frac{\partial T}{\partial r} = h(T - T_c)$$

at $r = r_o$, $$\frac{\partial T}{\partial r} = 0(insulated)$$

where,
r_i = reactor vessel inner radius
r_o = reactor vessel outer radius
ρ = material density
C = material specific heat
K = material thermal conductivity
T = local temperature
r = radial location
t = time
h = heat transfer coefficient between the coolant and the vessel wall
T_c = coolant temperature

INDIAN POINT UNIT 2 INPUTS:

A	- PRESSURE VESSEL INNER RADIUS (IN)	8.67190E+01
B	- PRESSURE VESSEL OUTER RADIUS (IN)	9.53440E+01
TIN	- INITIAL WATER AND WALL TEMPERATURE (DEG.F)	5.50000E+02
TFIN	- FINAL WATER TEMPERATURE (DEG.F)	7.00000E+01
AOWIN	- FRACTIONAL CRACK DEPTH (a/t)	2.50000E-01

d. *Provide a sample calculation and the equation used to obtain reactor coolant system water temperature from the calculated metal temperature.*

OPERLIM does not calculate the water temperature from the metal temperature. Rather, the code first picks a time and water temperature. The metal temperature is then calculated. Then, the K_{IR} and K_{IT} are determined from the following equation.

$$K_{IR} = 2K_{IP} + K_{IT}$$

From this equation, K_{IP} is then calculated. Finally, the allowable pressure is determined.

2. *K_{IT} data presented in Table A-2 from MSE-REME-0076*
   a. *It is noted that the magnitude of the K_{IT} becomes smaller as the reactor vessel water temperature decreases. This trend is contrary to the trend from sample calculations provided by the ASME. Provide clarification.*

   There are no fundamental methodology differences between the ASME sample calculations and Westinghouse calculations that generated the Indian Point Unit 2 P-T limit curves. However, the following explains the reasons why the ASME data *appears* to be increasing and the Westinghouse data to be decreasing.

The calculations provided to ASME used constant material property values. On the other hand, the Westinghouse code (OPERLIM) uses temperature-dependent material properties (as provided in the earlier Summary of Material Properties table).

As can be seen on the plots presented on the following pages, the ASME problem K_{IT} values increase *very slightly* after a water temperature of 350F. The Westinghouse K_{IT} values, as a function of water temperature, decrease slightly after 350F, then begin to level off around 150F.

These differences are due to the temperature-dependent material properties utilized in the Indian Point Unit 2 P-T limit curves.

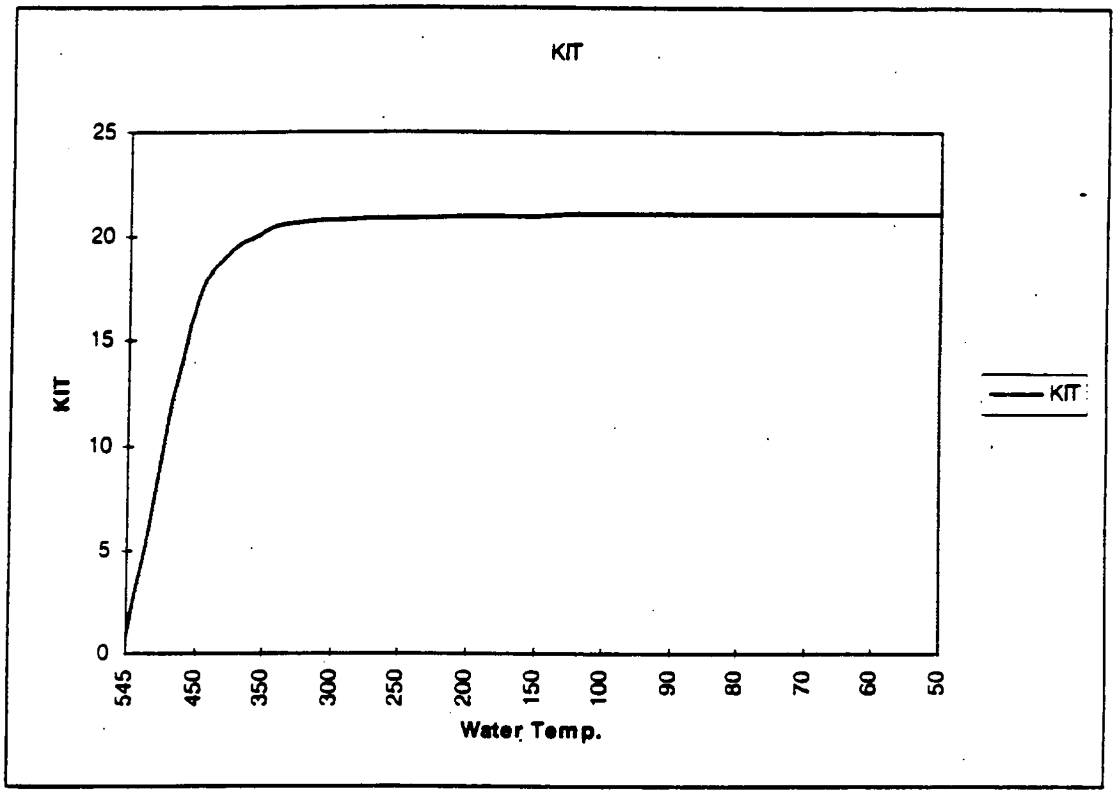
Further, both calculations (ASME sample problem and IP2) use the same computer code (OPERLIM). And, the ASME constant property case generated by Westinghouse compared well with the three other industry approaches. Therefore, we are confident that the calculational approach of OPERLIM is correct. See the following table from the ASME sample problem.

100F/hr. cooldown transient K_{IT} as a function of time:

t (min.)	**0**	**60**	**120**	**180**	**240**	**300**	**Organiz.**
K_{IT}	0.0	17.29	20.34	20.93	21.03	21.05	ATI
K_{IT}	0.0	17.06	20.34	20.93	21.03	21.08	W
K_{IT}	0.0	17.04	20.34	20.93	21.03	21.05	BG&E
K_{IT}	0.0	17.05	20.34	20.92	21.03	21.05	SIA

ASME Example Problem

Water Temp.	KIT
545	0.8719
450	17.07
350	20.34
300	20.7563
250	20.93
200	21.0032
150	21.03
100	21.0472
90	21.0487
80	21.05
70	21.051
60	21.0519
50	21.0527



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b. *At the 1/4T and 3/4T locations, provide K_{IT} and thermal stress time history curves for the 100°F/Hr cooldown transient.*

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ATTACHMENT V

SUPPLEMENTARY INFORMATION ON P-T LIMITS
ITEMS II AND III
(CON EDISON NON-PROPRIETARY)

CONSOLIDATED EDISON COMPANY OF NEW YORK, INC.
INDIAN POINT UNIT NO. 2
DOCKET NO. 50-247
JULY, 1997

II. TECHNICAL SPECIFICATIONS

The licensee request approval of the P-T curves using the new ASME methodology. However, in the technical specification bases the licensee continues to refer to Appendix G of ASME Section III, 1974 Edition. Provide clarification.

Response:

When the original submittal was made by Con Edison, we expected that the 1974 edition would be modified. Since that time, the 1995 Edition was released and was amended (A96) to include the new ASME methodology. In addition, the ASME has moved Appendix G from Section III to section XI. Therefore, we have enclosed with this supplemental information a revised bases page to reference the 1995 Edition as amended in 1996.

III. HEATUP AND COOLDOWN PRESSURE-TEMPERATURE LIMIT CURVES

A. Page 3.1B-5 (basis for the Heatup and Cooldown curves) describes that adjustments are made to account for pressure and temperature instrumentation errors. However, this subject is not addressed in the licensee's submittal. How is the licensee addressing the subject of instumentation error?

Response:

The calculation of heatup and cooldown limits for PWRs is governed by 10 CFR 50 Appendix G, which requires that the limits be established to comply with the specified margins of Appendix G, Section XI of the ASME Code. The procedure for establishing the pressure-temperature limits is entirely deterministic. The conservatism included in the limits are (but not limited to):

- An assumed flaw in the wall of the vessel with a depth equal to 1/4 of the thickness of the vessel wall and a length equal to 1-1/2 times the vessel wall thickness.

- A factor of 2 is applied to the membrane stress intensity factor (K_{IM}).

- The reference stress intensity factors (K_{IR}) specified in Appendix G to Section XI of the ASME B&PV Code is identical to the crack arrest stress intensity factor (K_{IA}) specified in Appendix A to Section XI of the ASME B&PV Code.

- There are margins applied in determining the Adjusted Reference Temperature (ART).

The regulations governing the pressure-temperature limits (10 CFR 50 - Appendix G and Appendix G to Section III of the ASME B&PV Code) do not require the inclusion of instrument uncertainties. The inclusion of instrument uncertainties in the limits, in addition to the other conservatism, is not required to prevent vessel damage nor are they required by the regulations. Therefore, plant operation can be based on heatup and cooldown curves without instrumentation errors.

The non-inclusion of uncertainties to calculated heatup and cooldown limits is consistent with your approval of our current curves. Therefore, we believe it is acceptable not to include additional uncertainties.

The bases for Heatup and Cooldown curves contain generic wording from the original licensing of IP2 which do not apply to current methodology as described above. To clarify this, attached are revised bases pages deleting the reference to adjustments for instrumentation errors.

It should be noted that instrument errors <u>are</u> included in generating the setpoints for the automatic Overpressurization Protection System (OPS) from Figure 3.1.A-1, "PORV Opening Pressure For Operation Less Than or Equal To 305°".

B. Was the pressure difference between the wide-range pressure transmitter and the limiting beltline location accounted for in the development of the P-T curves? If so, how? If the differential pressure (DP) was not included in the development of the curves, where is the DP addressed?

Response:

The calculated pressure difference between wide range pressure transmitter and the limiting beltline location is less than 5 psi. For the same reasons as above, this is not included in the heatup and cooldown curves, but is accounted for in the development of the OPS curves.