Westinghouse Electric Corporation

Energy Systems

Box 355
Pittsburgh Pennsylvania 15230-0355

AW-97-1116

June 4, 1997

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

ATTENTION: MR. T. R. QUAY

APPLICATION FOR WITHHOLDING PROPRIETARY INFORMATION FROM PUBLIC DISCLOSURE

SUBJECT: WESTINGHOUSE RESPONSES TO NRC REQUESTS FOR ADDITIONAL INFORMATION ON THE AP600

Dear Mr. Quay:

The application for withholding is submitted by Westinghouse Electric Corporation ("Westinghouse") pursuant to the provisions of paragraph (b)(1) of Section 2.790 of the Commission's regulations. It contains commercial strategic information proprietary to Westinghouse and customarily held in confidence.

The proprietary material for which withholding is being requested is identified in the proprietary version of the subject report. In conformance with 10CFR Section 2.790, Affidavit AW-97-1116 accompanies this application for withholding setting forth the basis on which the identified proprietary information may be withheld from public disclosure.

Accordingly, it is respectfully requested that the subject information which is proprietary to Westinghouse be withheld from public disclosure in accordance with 10CFR Section 2.790 of the Commission's regulations.

Correspondence with respect to this application for withholding or the accompanying affidavit should reference AW-97-1116 and should be addressed to the undersigned.

Very truly yours,

Brian A. McIntyre, Manager
Advanced Plant Safety and Licensing

jml

cc: Kevin Bohrer NRC OWFN - MS 12E20

AFFIDAVIT

COMMONWEALTH OF PENNSYLVANIA:

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COUNTY OF ALLEGHENY:

Before me, the undersigned authority, personally appeared Brian A. McIntyre, 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:

Brian A. McIntyre

Brian A. McIntyre, Manager
Advanced Plant Safety and Licensing

Sworn to and subscribed
before me this 5th day
of June, 1997

Janet A. Schwab
Notary Public

Notarial Seal
Janet A. Schwab, Notary Public
Monroeville Boro, Allegheny County
My Commission Expires May 22, 2000
Member, Pennsylvania Association of Notaries

(1) I am Manager, Advanced Plant Safety And Licensing, in the Advanced Technology Business Area, 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 th 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) Enclosed is Letter NSD-NRC-97-5163, June 4, 1997 being transmitted by Westinghouse Electric Corporation (W) letter and Application for Withholding Proprietary Information from Public Disclosure, Brian A. McIntyre (W), to Mr. T. R. Quay, Office of NRR. The proprietary information as submitted for use by Westinghouse Electric Corporation is in response to questions concerning the AP600 plant and the associated design certification application and is expected to be applicable in other licensee submittals in response to certain NRC requirements for justification of licensing advanced nuclear power plant designs.

This information is part of that which will enable Westinghouse to:

(a) Demonstrate the design and safety of the AP600 Passive Safety Systems.

(b) Establish applicable verification testing methods.

(c) Design Advanced Nuclear Power Plants that meet NRC requirements.

(d) Establish technical and licensing approaches for the AP600 that will ultimately result in a certified design.

(e) Assist customers in obtaining NRC approval for future plants.

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 advanced plant licenses.

(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 advanced nuclear power designs 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 analytical methods and receiving NRC approval for those methods.

Further the deponent sayeth not.

ENCLOSURE 2 TO WESTINGHOUSE

LETTER NSD-NRC-97-5163

NON-PROPRIETARY

Question 440.584 Rev. 1

Re: OI-3276

Staff analysis of data from Westinghouse OSU Test SB05 has revealed an apparent anomaly in the break flow. The integrated flow from the break, as determined from the instrumentation on the primary sump tank, appears to be approximately twice as large as would be expected, based on comparison to a similar NRC confirmatory test using the same nominal break size (1") as well as comparison to other Westinghouse tests of different sizes. For instance, Test SB19, with a 2" break (4 times SB05 nominal break area), appears to show about twice the break flow of SB5, rather than 4 times the flow. Please review the data from SB05 and explain the apparent anomalous flow data.

Response:

The break separator flow on SB05 was reviewed and summarized in the following:

The break orifice fixtures were inspected and diameters determined to be as specified. No anomalies were observed in the test record and the design of the orifice installation precludes installation of the orifice in an incorrect orientation.

The liquid mass changes in the reactor vessel head, steam generator, CMT and pressurizer are consistent with the integrated flow measured through the break separator. Thus the measured flow is real.

There is no evidence of an alternate leak path in the test documentation and the installation design eliminates the possibility of inserting the orifice incorrectly or inserting an orifice from another location. The SB05 break separator data is correct and can be used as such, however, the specific cause of the higher flows cannot be conclusively determined. A leak path around the orifice maybe the source of higher flows into the break separator.

Analysis:

Figure 1 shows the integrated flow through the BAMs system during the first 800 seconds of Test Run SB5 (reference 3) as calculated in the test analysis report. For comparison, the combined integrated flow from sensors FMM-905 and FVM-905 are presented in Figure 2; this calculation excludes changes in level of the break separator and possible reverse flow between the sump tank and the break separator tank. Still Figure 2 is in general agreement with Reference 3's calculation of break flow.

Figure 3 presents the INEL analysis of SB05, SB18, NRC tests 5001 and 5007, and the RELAP analysis of a 0.1604 inch break diameter. The presentation of SB05 results is in reasonable agreement with the results from Reference 3 (Figure 1). NRC-5001 was run at the same conditions and same orifice size as SB05 (0.1604 inch diameter) but measured a much smaller break flow. The results from NRC-5001 are in good agreement with a RELAP calculation with the break orifice diameter used.

Reference 1 shows an alternate method of calculating the flow rate through the break by calculating the rate of level change in the pressurizer (Figure 4) which is only valid until the pressurizer empties at approximately 200 seconds when the pressurizer is emptied. This analysis shows similar results for both SB05 and NRC-5001 over the first 140 seconds of the transient and concludes that BAM's liquid FMM-905 is in error.

If FMM-905 were correct, there would be additional evidence of liquid level changes around the system that would result from local temperatures at or above the saturation temperature of the fluid. Figure 5 shows the reactor vessel head reaches saturated conditions approximately 50 seconds from the start of the transient and would indicate that other volumes could also produce vapor liquid interfaces.

The ADS does not open until 634 seconds after the break and therefore only one flow path out of the system is available throughout this period. Only the first 600 seconds of the transient are considered below.

The following sensors were investigated for evidence of level changes:

- CLDP-601 Pressurizer Level
- CLDP-127 Reactor Vessel Level
- CLDP-115 Reactor Vessel Upper Head
- CLDP-113 Reactor Vessel Upper Plenum
- CLDP-502 CMT #2 Level
- CLDP-507 CMT #1 Level
- CLDP-207 Steam Generator #1 HT Level
- CLDP-208 Steam Generator #2 HT Level

CLDP's are levels corrected for density differences in the DP cell reference legs as calculated from reference 3.

FIRST 200 SECONDS

No significant level changes were noted in the steam generators or CMT's over the first 200 seconds but significant changes were noted in the reactor vessel level as shown in Figure 6. The primary reactor vessel level indication LDP-127 was inoperative during the first 8600 seconds of the test.

Estimating the mass lost during the first 200 seconds results in approximately a 200 lb loss from the pressurizer and a 300 lb loss from the reactor vessel (based on CLDP-115). This is consistent with the integrated mass measured at the break separator for 200 seconds as calculated in Reference 3.

600 SECONDS

After 200 seconds the pressurizer surge line continues to drain prior to starting to refill after 600 seconds (Figure 7) contributing approximately 80 lb to the discharge.

After 200 seconds the steam generator tubes begin to drain (Figure 8) and after 400 seconds the steam generator plenums start to drain(Figure 9). Complete draining of the steam generators adds approximately 600 lb to the break inventory before 800 seconds. The mass inventory in steam generator 2 inlet plenum seems to be giving inconsistent results and was not included in the summary mass balance.

The mass inventory in the CMT's starts to decrease rapidly (Figure 10) after approximately 400 seconds with a net loss of approximately 500 pounds by 800 seconds.

Very little additional change in the level of the reactor vessel (Figure 11) after 200 seconds is noted since the reactor vessel level had reached the level of the cold leg. The cold leg would have started draining with no additions from the CMT's or accumulators until after 500 seconds. Table 1 presents a summary of the mass balance throughout the system for SB05 at 200 and 600 seconds. No estimate was made of the amount of inventory that may have been lost from the cold leg.

CONCLUSION

The data consistently supports that the break separator flow meter, FMM-905, output is reading correctly and therefore more fluid must be coming through the break than would be predicted for the orifice size used.

The cold leg fluid (between the break and the reactor vessel) is approximately 20°F subcooled for the first 600 seconds of the transient which would equate to approximately 20% steam quality in the break separator line with a constant enthalpy or entropy model. Fauske critical flow models (Reference 6) for a 0.1% steam quality through the 0.1604 inch orifice would produce a flow similar to the NRC test but not the flow rate recorded during SB05. The maximum single phase flow calculated is:

$$\mathbf{w} = \mathbf{CA}\sqrt{2\mathbf{g}_c \Delta \mathbf{P} \rho}$$

where:

w	=	mass flow rate (lbm/sec)
C	=	flow coefficient (~1)
A	=	nozzle flow area (ft^2)
$\mathbf{g_c}$	=	gravitational constant (32.2 lbm•ft/(lbf•sec^2)
ΔP	=	Pressure drop (lbf/ft^2)
ρ	=	density (lbm/ft^3)

or approximately 1.9 lbm/sec for 380 psig system pressure or about 1500 lbm if held constant over 800 seconds which would be less than the observed flow using the area of the orifice.

The orifices were inspected and verified to be within the design tolerances with no cracks, damage or other irregularities. The orifice assembly was installed with some gasket material in the sealing groove. The orifice design eliminates any chance that the orifice could be installed in the wrong direction or that an orifice from another location could be substituted at the break location. No other cold leg break orifices could have given the same flow characteristics as the flow measured, since a 2 inch break size would have produced almost double the flow. Estimates of the additional area (3 times) required to provide the indicated flows cannot be accounted for by a leak path around the orifice assembly due to the clearances of the components. No anomalies were observed in the test documentation.

Given that the flow measurement is correct and that the correct size orifice was installed; it may be concluded that a leak around the flow orifice or of an undetermined location into the break separator line may be responsible for the high flows recorded during SB05 relative to the other tests.

References:

1. Pimentel, David Alan, "Two-Phase Fluid Break Flow Measurements and Scaling in the Advanced Plant Experiment (APEX)," Thesis, University of Oregon, May 9, 1996
2. Modro, Mike, "RELAP5 Calculated Break Flow - SMM-38-96," INEL, Augeust 14, 1996
3. AP600 Low-Pressure Integral Systems Test at Oregon State University Test Analysis Report, Revision 1, WCAP 14292, September 1995.
4. Megyesy, Eugene F., Pressure Vessel Handbook, Eighth Edition, 1989
5. AP600 Low-Pressure Integral Systems Test at Oregon State University Final Daata Report, WCAP 14252, May 1995
6. El-Wakil, M.M., "Nuclear Heat Transport," International Textbook Company, 1971 pages 359 to 365

Table 1
Initial OSU System Volume Changes

Time	Pressurizer		Reactor Vessel	Steam Generators	CMT	Totals	Break Separator Discharge
	Tank	Surge Line					
(sec)	(lb)	(lb)	(lb)	(lb)	(lb)	(lb)	(lb)

a,c

a,c

Figure 1

Integrated Break Flow SB5

a,c

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Figure 2

Comparison of TAR Value for Break Flow and Simple Sensor Outputs

a,c

Figure 3

INEL Break Separator Flows

a,c

Figure 4
OSU Pressurizer Flow Analysis

a,c

Figure 5

Various System Temperatures

Figure 6

Change in Water Height in Reactor Vessel and Pressurizer

a,c

Figure 7

Pressurizer Surge Line Level

a,c

Figure 8

Steam Generator Tube Inventory

a,c

Figure 9

Steam Generator Plenum Inventory

a,c

Figure 10

SB5 CMT Mass

a,c

Figure 11

Change in Water Height in Reactor Vessel

SSAR Revision: NONE