Westinghouse Electric Corporation

Energy Systems

Nuclear Services Division

Box 355
Pittsburgh Pennsylvania 15230-0355

CAW-97-1187

November 24, 1997

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

Attention: Mr. Samuel J. Collins

APPLICATION FOR WITHHOLDING PROPRIETARY
INFORMATION FROM PUBLIC DISCLOSURE

Subject: "Responses to Second Round NRC Request For Additional Information (RAIs) on South Texas Project Elbow Tap Submittal"

Dear Mr. Collins:

The Proprietary information for which withholding is being requested in the above referenced report is further identified in Affidavit CAW-97-1187 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 South Texas Project Nuclear Operating Company.

Correspondence with respect to the proprietary aspects of the application for withholding or the Westinghouse affidavit should reference this letter, CAW-97-1187 and should be addressed to the undersigned.

Very truly yours,

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

Enclosures

cc: Kevin Bohrer/NRC (12H5)

CAW-97-1187

AFFIDAVIT

COMMONWEALTH OF PENNSYLVANIA:

ss

COUNTY OF ALLEGHENY:

Before me, the undersigned authority, personally appeared Henry A. Sepp, 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:

Henry A. Sepp

Henry A. Sepp, Manager
Regulatory and Licensing Engineering

Sworn to and subscribed
before me this 24 day
of November, 1997

Rose Marie Payne

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, Regulatory and Licensing Engineering, 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 "Responses to Second Round NRC Request for Additional Information (RAIs) on South Texas Project Elbow Tap Submittal," (Proprietary), November, 1997 for South Texas Project, being transmitted South Texas Project Nuclear Operating Company letter and Application for Withholding Proprietary Information from Public Disclosure, to the Document Control Desk, Attention Mr. Samuel J. Collins. The proprietary information as submitted for use by South Texas Project Nuclear Operating Company for South Texas Project Nuclear Power Plants is expected to be applicable in other licensee submittals in response to certain NRC requirements for justification of use of RCS flow verification using elbow taps.

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

(a) Provide elbow tap methodology.

(b) Establish appropriate instrument uncertainties associated with elbow tap measurements.

(c) Assist the customer to obtain NRC approval.

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 RCS flow verification methodology using elbow taps 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 licensing support documentation 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 tests.

Further the deponent sayeth not.

ATTACHMENT 4

Response to Request for Additional Information (October 21, 1997)

NON-PROPRIETARY

NON-PROPRIETARY

SOUTH TEXAS PROJECT

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

PROPOSED AMENDMENT TO ALLOW USE OF ELBOW TAP ΔPs TO MEASURE

REACTOR COOLANT SYSTEM FLOW RATE

1. Provide the analytical model used including nodalization diagram, equations used, etc.

RESPONSE: The RCS hydraulic network diagram for the best estimate flow analysis applied to the South Texas Project is shown on Figure 1. The network consists of two major parts: reactor internals and reactor coolant loops. These flow paths and flow resistances are described below.

Reactor Internals

The major flow path through the reactor internals from the vessel inlet nozzles to the vessel outlet nozzles, shown on Figure 1, is through the downcomer, lower plenum, reactor core and upper plenum. Figure 1 also shows small flow paths which bypass the reactor core: the core bypass flow through the control rod drive thimbles and the gap between the internals barrel and core baffle, the bypass flow through the vessel upper head, and the bypass flows through the vessel outlet nozzle gaps. These bypass flows for the South Texas Project units are conservatively estimated to be 4.5% of total flow, so 95.5% of the total flow is the effective heat transfer flow through the reactor core.

The reactor internals flow resistance consists of three parts.

a. The reactor core flow resistance is calculated for the specific core configuration, power level and coolant temperatures and pressure, using a flow coefficient based on a full size fuel assembly hydraulic test, and modified by an iteration to account for the effect of the calculated core flow velocity on the friction factor.

b. The vessel internals flow resistance accounts for the Δps at the calculated flow through the downcomer, lower plenum, and upper plenum. The flow resistances are determined from hydraulic model test data and analysis for the specific reactor internals design, based on Δp measurements within the model.

c. The small bypass flows are determined by applying a conservative margin to a best estimate of the flow fraction bypassing the main flow path. The effect of the bypass flows is applied by reducing the main flows by the appropriate bypass flow fraction and defining the main flow path flow resistance for the Δp at the slightly lower flow.

Reactor Coolant Loops

The reactor coolant loop flow passes through the reactor vessel outlet nozzle, hot leg pipe, steam generator, pump suction pipe, pump and reactor vessel inlet nozzle. There are no bypass flows in the South Texas Project reactor coolant loops. The loop flow resistance is defined in three parts.

a. The reactor vessel nozzles are considered to be part of the coolant loops since the flow through the nozzles is at loop flow. Separate nozzle Δps are calculated for the inlet and outlet nozzles to account for differences in coolant density and volumetric flow at the hot leg and cold leg temperatures. The best estimate flow analysis combines the Δps and converts them into a single flow resistance at the pump operating (cold leg) temperature.

b. The steam generator flow resistance is defined in five parts: inlet nozzle, tube inlet, tubes, tube outlet, and outlet nozzle. The tube flow resistance is over [ ]$^{+a,c}$ of the total. The analysis accounts for the number of plugged or sleeved tubes in each steam generator, so loop specific flows can be calculated when different numbers of tubes are plugged or sleeved in each loop. The tube flow resistance is calculated for the specific power level and coolant temperatures and pressure, using a flow coefficient modified by an iteration to account for the effect of the calculated tube velocity on the friction factor. The analysis was confirmed by the flow and Δp measurements at Prairie Island Unit 2, obtained over the full range of temperatures, from [ ]$^{+a,c}$

c. The reactor coolant piping flow resistance consists of the flow resistances for the hot leg, pump suction and cold leg piping. The hot leg flow resistance is adjusted to account for the higher volumetric flow at the hot leg temperature existing at full power. The flow resistance for each section is based on an analysis of the effect of upstream and downstream components on elbow loss coefficients, using the results of industry hydraulics tests. The total piping flow resistance, which is less than [ ]$^{+a,c}$ of the system flow resistance, is consistent with the Δp measurements at Prairie Island Unit 2.

Reactor Coolant Pump Performance

The reactor coolant pump head-flow performance is based on a model test of the pump impeller, modified by an analysis of as-built impeller dimensions. The methodology was confirmed by the flow, Δp, speed and motor power measurements at Prairie Island Unit 2. Full flow tests of each impeller provide an approximate confirmation of pump performance. A polynomial equation is fit to the predicted pump head-flow performance and input to the best estimate flow analysis.

Best Estimate RCS Flow Calculations

The best estimate RCS flow analysis defines the Best Estimate Flow (BEF) and Future Cycle Estimated Flow (FEF) for the elbow tap flow measurement procedure. The calculation combines component flow resistances and pump performance predictions, and defines RCS loop flows at the desired power or temperature with any combination of pumps operating, with any fuel assembly design, and with different tube plugging in each steam generator. The calculated best estimate flows are in good agreement with calorimetric flow measurements from many plants before lower leakage loading patterns were implemented. For the many plants where the comparisons have been made, the calculated best estimate changes in flow from cycle to cycle have been in good agreement with changes measured by elbow taps.

Component head losses are calculated using the following form of the Bernoulli equation:

$$\Delta h = [K + f\, L / D] * [v^2 / 2g]$$

where Δh = head loss, feet
K = form loss coefficient, e.g., entrance loss, elbow bend loss, etc.
f = friction factor from Moody diagram
L = length of flow path, feet
D = diameter of flow path, feet
v = fluid velocity in flow path, feet / second
g = acceleration of gravity, 32.18 feet / second ^{2}

The [K + f L / D] terms for a component are combined into a flow resistance term and converted for application in the following equation:

$$\Delta h = K_X * Q^2$$

where K_X = flow resistance for a component, E-10 feet / (gpm) ^{2}
Q = volumetric flow through component, gpm

The South Texas Project flows and flow resistances, provided previously, are summarized below.

Flow resistances (E-10 feet / (gpm) [2]	Unit 1	Unit 2

[ ]+a,c

2. Does the 0.4% repeatability include repeatability of loop instruments?

RESPONSE: The repeatability term magnitude was determined by a combination of the instrument uncertainties considered appropriate for two different cycle measurements of RCS flow at 100% RTP by all of the cold leg elbow tap channels. Therefore, the term does include the repeatability of the instrument loop components. The generic uncertainties considered appropriate are:

[ ]+a,c

Because the South Texas Project instrument loop includes a digital processing system (QDPS) the repeatability terms are slightly different. The following terms were added to the generic list:

[ ]+a,c

Within the accuracy of roundoff, the South Texas Project specific magnitudes of these terms are defined in Table A-4 of reference 2. These terms are combined as follows:

[

]$^{+a,c}$

The generic magnitude for the repeatability term (for both three and four loop plants) is conservatively set at 0.4 % flow. The repeatability term is used as an acceptance criterion for predicted vs measured RCS flow comparisons. Therefore, the conservative direction for the magnitude of this term is smaller than actual, i.e., results in smaller tolerances. The South Texas Project specific magnitude for the equivalent repeatability term is conservatively estimated at 0.4 % flow.

3. Is the 0.4% repeatability accounted for in the uncertainty calculations?

   RESPONSE: None of the tables of the "RCS Flow Measurement Using Elbow Tap Methodology Licensing Submittal" note or explicitly use the repeatability term in the uncertainty calculations. However, all of the repeatability term components are common with the uncertainty calculations. Therefore, it is concluded that the basic components of the repeatability term are accounted for in the uncertainty calculations.

4. Is the elbow tap method (and its uncertainties) included in the revised thermal design procedure (RTDP)?

   RESPONSE: No. However, the RCS Flow uncertainty associated with the use of the elbow tap methodology is bounded by the current RCS Flow uncertainty utilized in the RTDP calculations.

5. Justify not including a 0.1% fouling factor in the venturi uncertainty calculations.

   RESPONSE: The elbow tap methodology does not use calorimetric power or feedwater flow to determine RCS flow for future cycles. Therefore, feedwater venturi fouling can not have an impact on future cycle RCS flow measurements using the elbow tap methodology.

   The Baseline RCS flow uses all previous cycle RCS flow measurements which are based on precision calorimetrics. All calorimetric measurements used to calculate Baseline RCS flow were performed at the beginning of each cycle. Thermal performance data and inspections at STP indicate that the process of a plant shutdown, secondary plant cooldown, and feedwater line draindown removes the magnetite which causes feedwater venturi fouling. Since all previous cycle calorimetric measurements were performed at the beginning of the cycle, feedwater venturi fouling was considered negligible.

   No feedwater venturi fouling factor uncertainty was included because of negligible feedwater venturi fouling during previous cycle RCS flow measurements and no possible impact of feedwater venturi fouling on future cycle RCS flow measurements using elbow taps.

6. Is the analytical model controlled by your 10 CFR Part 50, Appendix B Quality Assurance program?

   RESPONSE: Yes, the Westinghouse analytical model is controlled by their 10 CFR Part 50, Appendix B Quality Assurance program.

7. Regarding verification that the flow coefficients for each elbow tap remain constant, explain the statement, "a change to K will not be considered unless a trend were defined by more than a single measurement."

   RESPONSE: Given that the elbow tap Δp instrument channel remains within the repeatability allowance, and considering that the flow element (elbow) is not subject to erosion or fouling, there is no mechanism that would require a change to the elbow tap flow coefficient. A measured flow that differs from the best estimate flow is most likely due to instrument calibration differences (considered in the measurement uncertainty), but is unlikely to be the result of a change in the elbow tap flow coefficient. An evaluation of the flow coefficient would be justified only if the comparison with other cycle measurements defined a trend, indicating that the difference between the elbow tap flow ratio R and the best estimate flow ratio R' was increasing. The increasing trend could also be due to overpredicting a flow reduction caused by a hydraulics change. In any case, the elbow tap flow measurement procedure requires that the lower, more conservative best estimate flow based on the best estimate flow ratio (increased by 0.4%) be used if the elbow tap measured flow ratio R exceeds the best estimate flow ratio R' by more than the 0.4% flow repeatability allowance (considered in the measurement uncertainty).

8. Provide the following in your proposed Technical Specification (TS) change :

a. equation: $$\text{Future Cycle Flow} = \text{BCF} * \frac{\sqrt{(v * \text{delta-P})_f}}{\sqrt{(v * \text{delta-P})_b}}$$

and the following fixed constants for each elbow tap:

Baseline Calorimetric Flow (BCF)
Specific Volume (v_b)
delta-P_b

b. A periodic surveillance to verify that the individual correlation coefficients for each of the elbow taps remain constant. Explain how your proposed method would verify this assumption and provide the criteria that would be used to detect changes in this coefficient. Provide the individual elbow tap flow coefficients.

c. A statement requiring a 100% calorimetric heat balance flow measurement at the beginning of each cycle.

d. A commitment to: (1) notify the NRC of any known changes to the hydraulic flow model; and (2) contact the NRC for further review of the methodology if the correlation coefficients change or if the elbow tap flow rate exceeds the best estimate flow rate.

RESPONSE:

a. This formula alone does not present all information required to determine future cycle flow. The RCS flow determined for the cycle will also depend on the Best Estimate Flow Confirmation. Providing all the necessary information in the specification to determine RCS flow using elbow tap methodology is not practical.

Including this equation in the Technical Specifications does not contribute to the intended function of the Technical Specifications to provide direct assistance to plant personnel in operating the facility. The equation is stated in reference 3 which is to be included in the revised Technical Specification Bases page (see the response to question 10). The incorporation of this reference in the Bases is an effective alternative to assure the methodology is applied for the elbow tap determination.

b. There are no individual correlation coefficients for each of the elbow taps. The baseline elbow tap flow coefficient is based on the average Δp from all elbow taps. Repeatability and accuracy are improved when all elbow tap Δp measurements are used.

The method to verify that the correlation coefficient remains constant is through a Best Estimate Flow Confirmation which is already included in the RCS flow procedure for the proposed elbow tap methodology. The Best Estimate Flow Confirmation compares the expected change in RCS flow, based on an analytical model, to the measured change based on elbow tap data. If this confirmation shows that the measured flow change is outside the repeatability allowance, then an engineering evaluation will be performed to evaluate any potential changes to the correlation coefficient.

Other industry approved elbow tap RCS flow methodologies have Best Estimate Flow Confirmations which compare magnitude instead of expected changes. A comparison of magnitude (i.e., is the elbow tap flow less than the best estimate flow?) is a less effective method of verifying continued validity of correlation coefficients.

c. The South Texas Project committed in reference 3 to continue to obtain 100% calorimetric data at the beginning of cycle to be used in re-evaluating the elbow tap methodology if required. However, the South Texas Project does not intend to use the calorimetric data to calculate a calorimetric-based RCS flow each cycle. Inclusion of this activity as a commitment in the Technical Specifications is not consistent with the intended function of the Technical Specifications. The activity does not provide direct assistance to plant personnel in operating the facility. The correspondence containing the commitment is to be included in the revised Technical Specification Bases page (see the response to question 10). Station procedures and incorporation of this reference in the Bases will assure the required calorimetric data are obtained.

d. The South Texas Project committed in reference 3 to: 1) notify the NRC of any known changes to the hydraulic flow model methodology; and 2) contact the NRC if the measured absolute elbow tap flow rate exceeds the absolute best estimate flow rate when the measured flow change exceeds the predicted flow change by more that the repeatability allowance. Inclusion of these activities as commitments in the Technical Specifications is not consistent with the intended function of the Technical Specifications. These activities do not provide direct assistance to plant personnel in operating the facility. The correspondence containing the commitment is to be included in the revised Technical Specification Bases page (see the response to question 10). Station procedures and incorporation of this reference in the Bases will assure the required notifications are made.

The second commitment by STP is slightly different than that requested by the NRC. If the measured change and the best estimate change are within the repeatability allowance, then there is no reason to question the correlation coefficient or the methodology, and notification to the NRC would not be required.

9. Provide the entire derivation of the proposed methodology (above equation) from the fundamental equation Q = K*√(delta-P*v) in the TS Bases.

RESPONSE: The derivation of the subject equation is given in correspondence ST-HL-AE-5707 (page 13) (reference 2). This correspondence will be listed in the Technical Specification Bases as a reference for the elbow tap Δp methodology. (See response to Question 10.) Consequently, providing the entire derivation in the Bases is not needed.

10. The Westinghouse report SAE/FSE-TGX/THX-0152 ... tly referenced in the proposed TS Bases, has not been submitted to the NRC for review a... should be deleted from the Bases.

The revised Technical Specification Bases page B 3/4 2-6 is attached. The revision replaces the reference to Westinghouse report SAE/FSE-TGX/THX-0152. The new reference is to South Texas Project correspondence ST-HL-AE-5707. "Proposed Amendment to Technical Specification 2.2-1 and 3/4.2.5 for Reactor Coolant System Flow Monitoring - Revised," which describes the elbow tap Δp methodology. This correspondence was submitted to the Nuclear Regulatory Commission on August 6, 1997. Also included is a reference to ST-HL-AE-5752, "Amended Response to Request for Additional Information on the Proposed Elbow Tap Technical Specification Change (Table 2.2-1 and Section 3/4.2.5)," dated September 18, 1997.

11. Provide further justification of the use of an average of the delta-Ps from all elbow taps instead of individual elbow tap delta-Ps (i.e., individual flow measurements from each elbow tap). Provide this by starting with the summation of the flows from all elbow taps (as if you were to use individual elbow tap measurements of flow) and deriving the equation using an average delta-P.

RESPONSE: Table 1 presents the comparison of total flow calculated from individual elbow tap transmitter Δps and total flow calculated from the average of the elbow tap transmitter Δps. The individual elbow tap flows are determined by multiplying the loop baseline calorimetric flow by the flow ratio R, where R is the elbow tap flow ratio determined from the following equation:

$$R=\sqrt{(\Delta p_1 * v_1)/(\Delta p_0 * v_0)}$$

where Δp = elbow tap transmitter differential pressure, inches of water,
v = cold leg specific volume, cubic feet/lb,
1 = (subscript) current cycle
0 = (subscript) baseline cycle

The three flows defined by the three elbow taps in a loop are averaged, and the total flow is the sum of the loop flow averages. The flow calculation based on the average elbow tap Δp uses the same equation, with the Δps based on the average of the 12 Δp measurements, and specific volumes based on the average of the four cold leg temperature measurements. The total flow is determined by multiplying the total baseline calorimetric flow by the flow ratio R defined from the average Δps.

Elbow tap data from baseline Cycle 1 and Cycle 6 at South Texas Project Unit 2 was used in this comparison. The data covers a flow change of about 1% and has a typical spread in loop cold leg specific volumes. The total calorimetric flow defined for cycle 1 is the baseline flow, defined by averaging the six cycle calorimetric flows. The cycle 1 loop flows are ¼ of the total baseline calorimetric flow.

As shown on the table, the difference between total flow based on individual elbow taps and flow based on the average elbow tap Δp is negligible (0.01%). Although each elbow tap measures a slightly different change in flow, these differences are the expected effect of instrument channel calibration differences or repeatability variations. The average of the measurements within a loop or for the plant provides the most accurate indication of the change in flow. The conclusion that an average elbow tap Δp defines a sufficiently accurate flow, based on several other plant elbow tap data evaluations, is further confirmed by the evaluation shown on Table 1.

12. Explain your conclusion that the analytic model can predict flow to a 2% accuracy but can predict changes in flow to a 0.2% accuracy.

    RESPONSE: The uncertainty in the flow resistance of a component is responsible for only a fraction of the 2% uncertainty on the prediction of absolute flow, so the uncertainty in the change in flow resistance has a proportionally smaller impact on predicting a flow change. For example, the best estimate analysis would predict a flow decrease of about 1% for an increase of 5% in steam generator tube plugging. It is conservatively assumed that the uncertainty in predicting a flow resistance change is equal to or less than the flow resistance uncertainty for the component (10% for the steam generator), so the uncertainty on the flow change would be no more than 10% of the change, or 0.1% flow for the 5% increase in tube plugging. The accuracy of 0.2% flow for predicting a flow change is considered to be a maximum or bounding value for changes from cycle to cycle.

13. Justify your use of the analytic ratio R' from the perspective that this would lead to reliance on an analytically derived flow versus measured flow. The staff believes that while the analytic model can be used for verification, it should not be used for flow measurement to meet the TS requirement.

RESPONSE: The best estimate flow ratio R' is used mainly as a check on the measured elbow tap flow, and is applied only if the elbow tap flow ratio R exceeds R' by more than the conservatively defined repeatability allowance of 0.4% flow. If such a difference occurs, it could be due either to larger instrument channel calibration uncertainties than considered in the 0.4% allowance (but considered in the flow measurement uncertainty) or to an underprediction of best estimate flow. In this situation, although the elbow tap flow measurement is most likely still a valid flow measurement (see response to Question 7), the conservative approach used in the procedure is to apply the lower best estimate flow based on the best estimate flow ratio (increased by the 0.4% repeatability allowance). For this application, the limited use of the best estimate analysis is considered to be appropriate.

14. In response to Question 5 of the staff's August 11, 1997, RAI, you stated that use of an average delta-P simplifies the process while imposing no penalty or loss of flow measurement accuracy. Specify and quantify all benefits that would be gained from the averaging approach.

RESPONSE: As noted in the response to Question 7, the difference between flows based on the average elbow tap Δp and individual elbow tap Δps is negligible. The benefit resulting from using the average elbow tap Δp is simplification of the procedure and avoiding unnecessary complexity that could increase the possibility of errors in the calculations.

15. Provide the basis (including calculations) for your conclusion that the elbow tap measurement is a 95/95 value.

RESPONSE: No specific calculations were performed; however, the following provides the basis to conclude that the elbow tap measurement is a 95/95 value.

The typical components of an uncertainty calculation are:

Calibration Accuracy - sensors and racks,
Reference Accuracy - sensors,
Pressure Effects - Δp sensors,
Temperature Effects - sensors and racks,
Drift - sensors and racks and
Measurement & Test Equipment - sensors and racks.

The reference accuracy, pressure effects and temperature effects are values provided by the vendors/manufacturers of the hardware. When questioned concerning the probability/confidence levels of the hardware specifications, vendors identify that these three parameters are 2σ values. With respect to Westinghouse supplied sensors and rack modules, type testing determined that these parameter values were satisfied by design and qualification testing. For sensors provided by Westinghouse, each device is verified to satisfy the required temperature tolerance at [ ]$^{+a,c}$ as part of the temperature compensation process.

The calibration accuracy is controlled by plant procedure. The outer limit is used in the uncertainty calculations. Westinghouse has evaluated a large amount of plant specific data as part of 24 month fuel cycle justification efforts. Included in the evaluation process is a determination of the calibration accuracy for sensors and racks on a rigorous statistical basis. The data supports the conclusion that the outer limit specified in the procedures for the plants evaluated is [ ]$^{+a,c}$

Included in the Westinghouse 24 month fuel cycle evaluation process is a determination of the sensor and rack drift magnitudes on a rigorous statistical basis. The data for the plants evaluated supports the conclusion that the drift magnitude utilized in the South Texas Project uncertainty calculations for Westinghouse supplied process racks is significantly greater than expected and easily supports the conclusion that the rack drift is at least a 2σ value. While there is some plant variability in the sensor drift, [ ]$^{+a,c}$

Measurement and Test Equipment uncertainty magnitudes are based on vendor/manufacturer specifications. Westinghouse has reviewed calibration sheets for pressure gauges and digitial multimeters at different plants. In all cases, the as left data confirms the satisfaction of the accuracy specification.

In addition, the [ ]$^{+a,c}$ With respect to the instrument channel uncertainty calculations, Westinghouse utilizes a conservative algorithm that accounts for potential interactive effects between appropriate parameters that is consistent with NRC approved uncertainty calculations for RPS/ESFAS protection function trip setpoints. Finally, Westinghouse utilizes conservative assumptions for process noise and cold leg density effects, e.g., larger than expected magnitudes for signal noise and a conservative treatment of temperature variation in the cold leg for the density effect on the elbow tap transmitter measurement of Δp.

Therefore, based on the uncertainty input values being 2σ or better, the utilization of a conservative baseline RCS Flow Calorimetric measurement uncertainty, the utilization of a conservative algorithm for the determination of instrument channel uncertainties and the inclusion of conservative assumptions for systemic and process effects, Westinghouse concludes that the overall uncertainty for RCS Flow utilizing the cold leg elbow tap methodology and used for the RTDP analyses is a 95/95 value.

16. Provide an evaluation of the effects that crud deposits would have if they were to get into the taps and how this was addressed in your methodology. Should this occur, how will it be detected at South Texas?

    RESPONSE: Since the elbow tap Δp is a static pressure measurement, crud deposits in the taps would have no impact on the measured Δp. Therefore, the issue has not been addressed in the methodology or in surveillance programs.

17. Explain the increase in calorimetric heat balance flow measured for cycles 2 and 3 for Unit 1 and justify, for both units, the use of calorimetric data that were higher than the best estimate flow predictions in your baseline cycle flow average.

    RESPONSE: Since the calorimetric flow measurement uncertainty is ±2.8% at South Texas Project Units 1 and 2, the spread in flows measured in the first four cycles, although large, is well within the uncertainty range. These flow measurements cannot be considered to be in error by more than the stated uncertainty. Similarly, both the calorimetric flows and best estimate flows have uncertainties, and it is not inconceivable for the calorimetric flow or the actual flow to exceed the best estimate flow.

    STP used the average of all cycles to define baseline calorimetric flow. The average baseline flow used measurements that were higher than best estimate flow (measurement uncertainty) and measurements that were lower than best estimate flow (measurement uncertainty and streaming bias). The net effect in both Unit 1 and Unit 2 is that the baseline calorimetric flow determined by averaging all cycles is less than what is considered to be a true baseline flow based on early cycles before significant hot leg streaming biases.

FIGURE 1

RCS HYDRAULIC NETWORK DIAGRAM

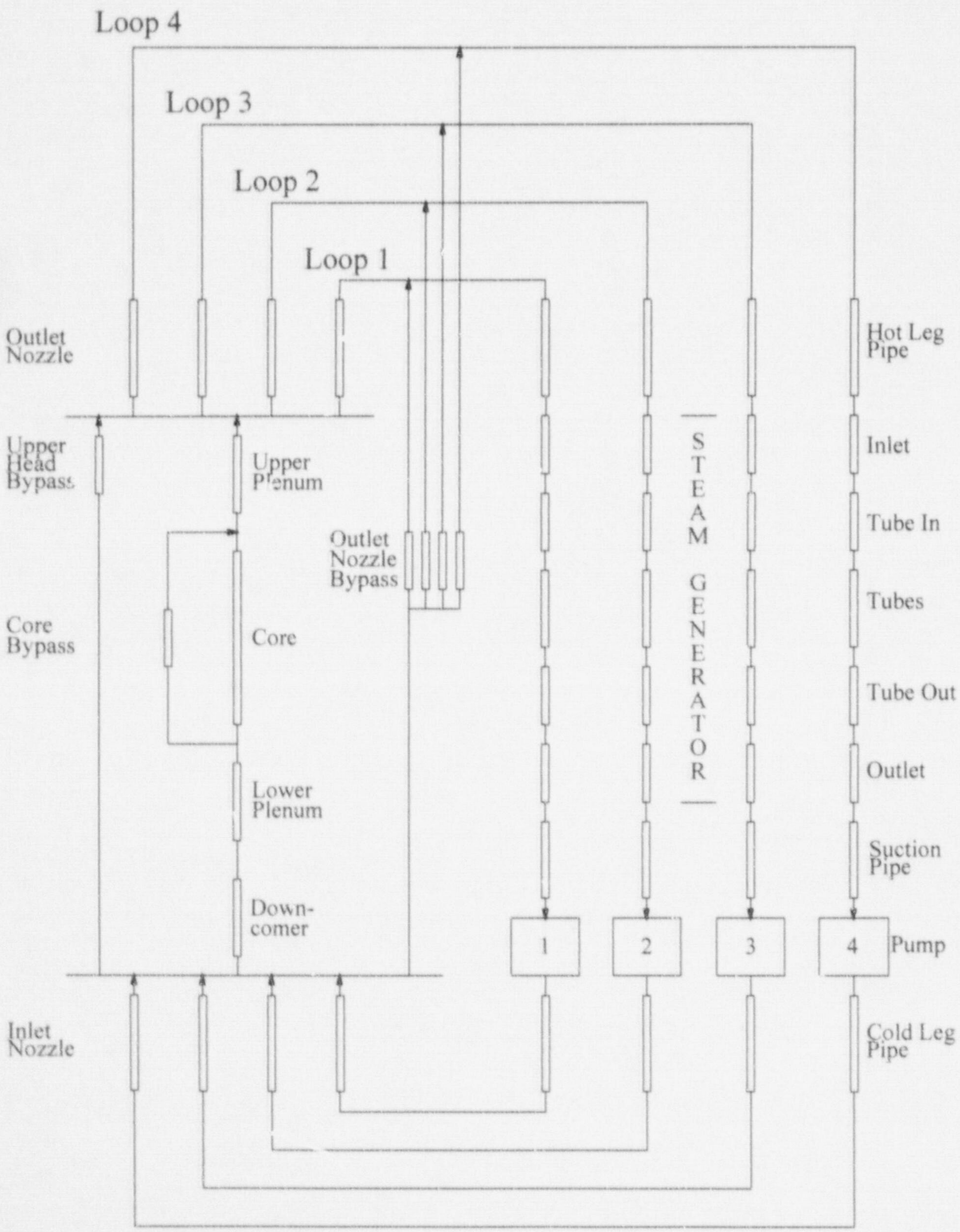

TABLE 1

SOUTH TEXAS PROJECT UNIT 2

ELBOW TAP FLOW CALCULATION COMPARISON

	Cycle 1			Cycle 6			
Transmitter	Δp (inches)	Δp * v (in·ft³/lb)	Cal Flow (gpm)	Δp (inches)	Δp * v (in·ft³/lb)	R	Flow (gpm)

+a,c

ATTACHMENT 5

Response to Request for Additional Information (October 21, 1997)

PROPRIETARY CLASS 2C