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August 13, 1984

Mr. Harold R. Denton, Director
Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
Washington, DC 20555

Subject: Byron Generating Station Units 1 and 2
Braidwood Generating Station Units 1 and 2
Improved Thermal Design Procedure
NRC Docket Nos. 50-454/455 and 50-456/457

Reference (a): December 19, 1983 letter from B. J. Youngblood to D. L. Farrar.

Dear Mr. Denton:

This letter provides additional information regarding the improved thermal design procedure (ITDP) to be used at Byron and Braidwood stations. NRC review of this information should permit closure of Outstanding Item 8 in the Byron SER.

Attached to this letter are the responses to NRC questions contained in reference (a). Attachment A to this letter contains the responses to questions 1, 5, 6, 7, and 8. These responses contain information considered proprietary by Westinghouse so withholding from public disclosure is requested pursuant to 10 CFR 2.790. An application for withholding from public disclosure and the supporting affidavit are provided in Attachment B. Attachment C is a non-proprietary version of Attachment A which can be placed in the public document room. Attachment D contains the responses to NRC questions 2, 3 and 4 which are not proprietary.

Please direct any questions you may have regarding this matter to this office.

One signed original and fifteen copies of this letter and the attachments C and D are provided for NRC review. Five copies of attachments A and B are provided.

Very truly yours,

T. R. Tramm

T. R. Tramm
Nuclear Licensing Administrator

lm

Limited Dist on Prop

Attachments

B001
1/5-Prop
5-NP

Change: BNL
DMB/DSS
FEMA
LPDR

PDR
NSIC
NTIS } Non Prop Only

9073N

ATTACHMENT C

Response to Questions 1, 5, 6, 7 and 8

Non-Proprietary Version

9073N

Question 1

[redacted]

The instrumentation uncertainties provided in Table 1 of the attachment to NS-EPR-2577 for Westinghouse supplied equipment are based on the same equipment being used for protection functions. The transmitters for pressurizer pressure and steamline pressure and the RTDs for T_H and T_c are the same sensors supplying input to the associated protection functions. The rack components used for indication and control are the same type of components used for the protection functions. The uncertainties for PMA, PEA, SCA, SPE, STE, SD, RCA, RTE, and RD are the same values noted in setpoint studies performed by Westinghouse for D. C. Cook II and V. C. Summer which were reviewed and approved by the NRC via NRC letter, S. A. Varga to J. Dolan, Indiana and Michigan Electric Company, dated 2/12/81, and NUREG-0717 Supplement No. 4, Safety Evaluation Report related to the operation of Virgil C. Summer Nuclear Station Unit No. 1, dated August, 1982. The uncertainties for ID, A/D, and CA do not pertain to protection functions but are based, as are the other parameters, on equipment manufacture and design specifications. It should also be noted that the uncertainties used are essentially the same as used to justify the RCS Flow Calorimetric Measurement uncertainty for McGuire. The NRC approved the McGuire submittal via NRC letter E. G. Adensam to H. B. Tucker, Duke Power Company, dated June 28, 1983.

Question 5

[redacted]

The rack drift error for feedwater temperature in Table 2 is in error, the correct value is [$]^{+a,c}$. The calculated value for the temperature error is correct.

Question 6

As noted in the generic response:

> "Technically, the feedwater temperature and pressure uncertainties are common to several of the error components. However, they are treated as independent quantities because of the conservatism assumed and the arithmetic summation of their uncertainties before squaring them has no significant effect on the final result."

Tables 1 and 2 demonstrate through a progression of calculational steps that the above statement is indeed true. Table 1 provides 3 steps noting the correct treatment of dependent effects for the Secondary Power Calorimetric Measurement. Calculation 1 is the uncertainty calculation noted in the generic response and assumes a feedwater temperature error of [$]^{+a,c}$ and feedwater pressure error of [$]^{+a,c}$. Calculation 2 notes the uncertainty with the feedwater temperature dependency correctly treated. However some of the conservatism in the feedwater temperature has been removed to compensate for this treatment, i.e., a feedwater temperature error of [$]^{+a,c}$ is used. As can be seen, no significant change results in the final uncertainty. Calculation 3 notes the uncertainty with the feedwater temperature and pressure dependencies correctly treated. As can be seen, this treatment has no impact on the final uncertainty either. Therefore, the statement as written in the generic response is correct for Secondary Power Calorimetric Measurements as presented.

Table 2 provides 4 steps for the correct treament of the RCS Flow Calorimetric Measurement. Calculation 1 is the uncertainty calculation provided in the generic response and assumes a feedwater temperature error of [or $]^{+a,c}$ depending on its use, a feedwater pressure error of [

$]^{+a,c}$, and a pressurizer pressure error of [$]^{+a,c}$. Calculation 2 notes the uncertainty with the feedwater temperature dependency correctly treated. However, the error assumed is consistently [$]^{+a,c}$, thus removing some of the conservatism. Please note that in this calculation, and the previous calculations, for dependent effects credit is taken for differences in sign, i.e., direction of impact of the errors. As can be seen by comparison with Calculation 1, no impact is noted on the final uncertainty. Calculation 3 treats the dependencies in feedwater temperature and pressure correctly. Again no effect is seen. Finally Calculation 4 treats the dependent effects for feedwater temperature and pressure and pressurizer presssure. It should be noted that four pressurizer pressure channels are provided for protection functions. It is therefore possible, and strongly recommended by Westinghouse, that a separate channel be used for each loop. This eliminates any dependency between loops. However, there is a dependency between the [$]^{+a,c}$. This dependency is correctly treated by summing the [hot $]^{+a,c}$ prior to squaring. While treating this effect correctly, conservatism was removed by using a pressure error of [$]^{+a,c}$ which is still larger than that substantiated in the generic response. Comparison with Calculation 1 again demonstrates no effect, therefore the statement is also true for RCS Flow Calorimetric Measurement.

As a final note, Table 3 is a calculation of the RCS Flow Calorimetric Measurement using the Byron/Braidwood plant specific input. Since this plant can measure feedwater pressure directly, the treatment of the feedwater pressure dependency is somewhat different than that for Table 2. However, in comparison with Table 2, Calculation 1 results there can be noted a small deviation. This deviation was conservatively treated by using a combined uncertainty for RCS Flow Calorimetric plus elbow taps of ±2.1% flow. It should be recognized that this deviation was not caused by correct treatment of dependent effects, but rather from the use of plant specific input, i.e., [$]^{+a,c}$.

TABLE 1

SECONDARY POWER CALORIMETRIC MEASUREMENT

Calculation 1 - Table 2 as presented.

+a,c

Venturi
Expansion Coefficient
Material
Density - Temperature
Electronics - Δp
Feedwater - Temperature
Steam - Pressure
Moisture
Pump Heat

Σ =

$(\Sigma)^{1/2}$ =

4 loop plant =

Calculation 2 - Table 2 with Feedwater Temperature Dependency [
]$^{+a,c}$

$[\quad]^{+a,c}$

Venturi

[

]$^{+a,c}$

Material

Electronics - Δp

Steam - Pressure

Moisture

Pump Heat

Σ =

$(\Sigma)^{1/2}$ =

4 loop plant =

Calculation 3 - Table 2 with Feedwater Temperature Dependency [
]$^{+a,c}$ and Steamline Pressure [ ]$^{+a,c}$/Feedwater Pressure Dependency [ ]$^{+a,c}$

$[\quad]^{+a,c}$

Venturi

[

]$^{+a,c}$

Material

Electronics - Δp

[

]$^{+a,c}$

Moisture

Pump Heat

Σ =

$(\Sigma)^{1/2}$ =

4 loop plant =

TABLE 2
RCS FLOW CALORIMETRIC MEASUREMENT

Calculation 1 - Table 3 as presented.

+a,c

Venturi
Expansion Coefficient
Material
Density - Temperature
Density - Pressure
Instrumentation - Δp
Feedwater h - Temperature
Feedwater h - Pressure
Steam - Pressure
Moisture
Pump Heat
T_H
T_H streaming
T_c
T_H h - pressure
T_c h - pressure

Σ =
$(\Sigma)^{1/2}$ =
4 loop plant =

Calculation 2 - Table 3 with Feedwater Temperature Dependency [$]^{+a,c}$

$^{+a,c}$

Venturi

[$]^{+a,c}$

Material

Density - Pressure

Instrumentation - Δp

Feedwater h - Pressure

Steam - Pressure

Moisture

Pump Heat

T_H

T_H streaming

T_c

T_H h - Pressure

T_c h - Pressure

Σ =

$(\Sigma)^{1/2}$ =

4 loop plant =

Calculation 3 - Table 3 with Feedwater Temperature Dependency [$]^{+a,c}$ and Steamline Pressure [$]^{+a,c}$/Feedwater Pressure [$]^{+a,c}$ Dependency

$^{+a,c}$

Venturi

[$]^{+a,c}$

Material

[$]^{+a,c}$

Instrumentation - Δp

Moisture

Pump Heat

T_H

T_H Streaming

T_c

T_H h - Pressure

T_c h - Pressure

Σ =

$(\Sigma)^{1/2}$ =

4 loop plant =

Calculation 4 - Table 3 with Feedwater Temperature Dependency [ ]$^{+a,c}$, Steamline Pressure [ ]$^{+a,c}$/Feedwater Pressure [ ]$^{+a,c}$ Dependency and Pressurizer Pressure Dependency [ ]$^{+a,c}$

+a,c

Venturi

[ ]$^{+a,c}$

Material

[ ]$^{+a,c}$

Instrumentation - Δp

Moisture

Pump Heat

T_H

T_H Streaming

T_c

[ ]$^{+a,c}$

Σ =

$(\Sigma)^{1/2}$ =

4 loop plant =

TABLE 3

BYRON/BRAIDWOOD RCS FLOW CALORIMETRIC MEASUREMENT

Table 3 with Byron/Braidwood input, Feedwater Temperature Dependency (3.2 degrees-F), Feedwater Pressure Dependency [ ]$^{+a,c}$ and Pressurizer Pressure Dependency [ ]$^{+a,c}$

[ ]$^{+a,c}$

Venturi

[Expansion Coefficient + Density]$^{+a,c}$

Material

[ ]$^{+a,c}$

Instrumentation - Δp

Steam - Pressure

Moisture

Pump Heat

T_H

T_H Streaming

T_C

[ ]$^{+a,c}$

Σ =

$(\Sigma)^{1/2}$ =

4 loop plant =

RESPONSE TO QUESTION #7:

The sensitivity factors of DNBR, with respect to core power, for the typical cell (-2.13) and the thimble cell (-1.98) are correct as applied to the Byron/Braidwood Units. The table given in WCAP 9500 reflects the opposite, incorrect values (-1.98 for typical cell and -2.13 for thimble cell). However, please note that the use of the incorrect sensitivity factors (for core power only) in the determination of the WCAP 9500 limit DNBR's has no effect on the final calculated DNBR limit values since there is only a small change in the third decimal place.

RESPONSE TO QUESTION #8:

Attached is a table of values of percent DNBR rod bow penalties for low flow and full flow conditions which were used to establish the penalties for 17x17 Optimized fuel when the WRB-1 DNB correlation is used in Thermal Hydraulic DNB safety analysis. The attached figure represents the results of using the new methodology and results in maximum DNBR rod bow penalties of [ ]$^{+a,c}$ at low flow conditions and [ ]$^{+a,c}$ at full flow conditions for assembly average burnups of 33000 MWD/MTU. Appropriate changes to FSAR sections 4.2.3.1(g) and 4.4.2.2.5 ans Q 221.5 were made in Amendment 44. The Bases for Technical Specification limits on power distribution will contain an appropriate reference to WCAP-8691, Rev. 1.

TABLE OF % DNBR PENALTY VS. ASSEMBLY AVERAGE BURNUP FOR WRB-1 DNB CORRELATION APPLICABLE TO 17x17 OPTIMIZED FUEL

ASSEMBLY AVERAGE	PERCENT DNBR BOW PENALTY	
BURNUP (MWD/MTU)	LOW FLOW	FULL FLOW

+a,c

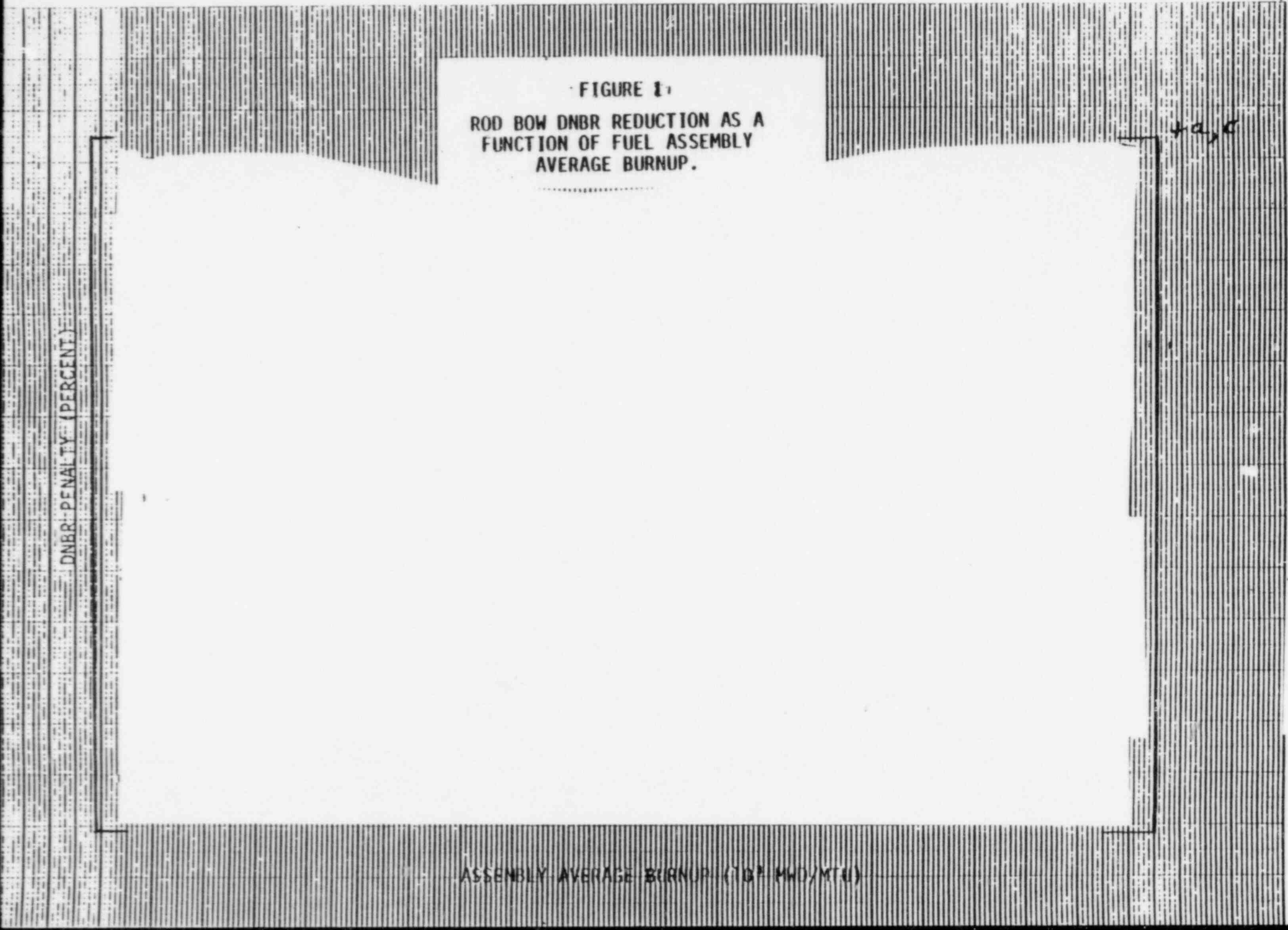

FIGURE 1

ROD BOW DNBR REDUCTION AS A FUNCTION OF FUEL ASSEMBLY AVERAGE BURNUP.

WESTINGHOUSE PROPRIETARY CLASS 3

ATTACHMENT D

Response to Questions 2, 3, and 4

(Contains no proprietary information)

2. Plant procedures will include provisions to ensure that performance of RCS flow measurements will require calibrations within seven days of the flow measurement for instruments used in determining the RCS flow. A verification of calibration may be used in lieu of an actual calibration and would check the accuracy of the instrument as opposed to making adjustments to the instrument or instrument loop. If the results of the verification of calibration indicate that the instrument in question is not within the calibration tolerance, the instrument will be recalibrated.

3(a) How do you assure that the venturi is clean at the beginning of a cycle? Is the venturi cleaned at the beginning of every cycle?

Response: Feedwater venturies are not inspected or cleaned at the beginning of every cycle. If performance data obtained during the previous cycle indicates that fouling has occurred, access will be obtained and the venturi cleaned or the degree of fouling will be assessed and included as a penalty on determining the RCS flowrate.

3(b) How do you detect the venturi fouling and to what extent of uncertainty can you detect fouling?

Response: Secondary plant performance data will be trended at a specified frequency of not less than once per month. A decrease in electrical output which cannot be accounted for by cycle variables is evidence of probable feedwater venturi fouling.

Data will be collected commencing with initial startup testing and the accuracy of that data will be determined to establish an uncertainty for nondetectable feedwater venturi fouling. Flow measurement uncertainties of 2.1% have been calculated by Westinghouse for Byron and a .1% penalty for undetected feedwater venturi fouling will be assumed until a specific value is determined (these values are stated in proposed Technical Specification 3/4.2.3). If the penalty determined exceeds .1% appropriate revisions will be made to the Technical Specifications and they will be submitted for NRC review. A further description of the performance monitoring program will be submitted for NRC review prior to obtaining full power. We feel this schedule in finalizing the program is justified for the following reasons:

1) The venturis will be clean at the start of the first cycle when the precision secondary plant calorimetric measurements will be performed as a basis for calculating RCS flow so that negligible uncertainty will be introduced into the RCS flow calculation at this time.

2) Negligible fouling is expected to occur to the feedwater venturis during cycle 1 and subsequent cycles due to the absence of copper or copper alloys in the secondary plant systems.

3) An all volatile chemical treatment program will be utilized in the secondary plant. Strict chemical control is required and, no phosphates will be used. This will help prevent fouling.

3(c) Describe the design provisions and procedures to clean the venturi if fouling is detected.

Response: There are currently no procedures or design provisions for cleaning the venturis. However, if trending of plant performance data indicates potential venturi fouling, existing openings to the feedwater piping would be utilized to inspect the venturis or access ports would be installed and examinations of the affected venturis would be performed at the next outage. If these examinations indicate fouling has occurred, measures would then be taken to clean the affected venturis. Hydrolasing has been used successfully in other plants.

3(d) How do you determine the error on feedwater flow measurement due to the fouling effect if the venturi is not cleaned or if the venturi fouling is not detected? (and)

3(e) If the venturi is not cleaned prior to the calorimetric flow measurement because no fouling is detected an error component should be added. The magnitude of the error component should depend on the minimum detectable value of fouling.

Response: The error on feedwater flow measurements due to the fouling effect if the venturi is not cleaned or if venturi fouling is not detected will be determined as discussed in the response to part (b) above. An error component will be determined to be included as an uncertainty when calculating RCS flow. Until the program is established, a penalty for a minimum undetected value of .1% will be assumed.

4(a) feedwater flow transmitter span = 4.80 10^6 PPH (Pounds mass per hour)

nominal feedwater flow = 3.78 x 10^6 PPH (Pounds mass per hour)

$$\frac{\text{span}}{\text{nominal}} = \frac{4.80 \times 10^6 \text{ PPH}}{8.78 \times 10^6 \text{ PPH}} \times 100\% = 127\%$$

Therefore, feedwater flow transmitter span is approximately 125% of nominal flow.

(b) 100-ohm platinum RTD's will be used to determine feedwater temperature. RTD output will be monitored by a digital voltmeter for thermal power measurements for initial plant startup. RTD output will be monitored by the plant process computer for daily calorimetrics.

(c) Feedwater temperature is scaled to span approximately 60°F to 460°F. The span is approximately 400°F.

(d) 3-tap scoops are used to sample RCS hot leg flow to feed the hot leg RTD bypass loop. The temperature stream error of 1.2 °F is Westinghouse supplied (page 34 of Westinghouse generic response letter NS-EPR-2577, Rahe to Berlinger, March 31, 1982).

All assumptions are therefore applicable to Byron.

ATTACHMENT B

Application for Withholding Proprietary Information

from

Public Disclosure and Supporting Affidavit