NORTHEAST UTILITIES

THE CONNECTICUT LIGHT AND POWER COMPANY
WESTERN MASSACHUSETTS ELECTRIC COMPANY
HOLYOKE WATER POWER COMPANY
NORTHEAST UTILITIES SERVICE COMPANY
NORTHEAST NUCLEAR ENERGY COMPANY

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September 26, 1985

Docket No. 50-423

B11713

Director of Nuclear Reactor Regulation
Mr. B. J. Youngblood, Chief
Licensing Branch No. 1
Division of Licensing
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

Reference: (1) J. F. Opeka letter to B. J. Youngblood, Revised Response to Question 492.7, dated July 15, 1985.

Dear Sir:

Millstone Nuclear Power Station, Unit No. 3
Revised Response to Question 492.7

In Reference (1), Northeast Nuclear Energy Company (NNECO) submitted a revised response to Core Performance Branch Question #492.7 concerning reactor coolant system (RCS) flow measurement capability. In our Reference (1) response, we provided the results of an evaluation of the uncertainties associated with the instrumentation used to measure RCS flow.

As a result of a September 10, 1985 telephone conversation between your Mr. H. Balukjian and representatives of NNECO, it was discovered that the total RCS flow uncertainty for three loop operation was incorrect. This error resulted from an incorrect instrument uncertainty value which was used in calculating the total RCS flow uncertainty. As such, we have revised our instrument uncertainty analysis and have included the results in the attached response to Question #492.7.

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We believe that this information should resolve the Staff's concerns regarding this matter and should, therefore, close SER Open Item #8.

Very truly yours,

NORTHEAST NUCLEAR ENERGY COMPANY
et al.

BY NORTHEAST NUCLEAR ENERGY COMPANY
Their Agent

J. F. Opeka

J. F. Opeka
Senior Vice President

STATE OF CONNECTICUT)
) ss. Berlin
COUNTY OF HARTFORD)

Then personally appeared before me J. F. Opeka, who being duly sworn, did state that he is Senior Vice President of Northeast Nuclear Energy Company, an Applicant herein, that he is authorized to execute and file the foregoing information in the name and on behalf of the Applicants herein and that the statements contained in said information are true and correct to the best of his knowledge and belief.

Lorraine J. D'Amico

Notary Public

My Commission Expires March 31, 1988

NRC Letter May 25, 1984

Question 492.7

Q.492.4 mentioned Seabrook rather than Millstone 3 (page 4 of response to Q.492.4). We therefore do not have confidence that you performed the required review of the Westinghouse standard response on flow measurement to assure that it applies to your plant. In order to provide this assurance, please answer the following questions.

(1) The instrumentation uncertainties cited are the generic bounding values for Westinghouse instrumentation. Plant-specific instrumentation uncertainties exceeding the bounding values cited in the Westinghouse response should be identified and used for the plant-specific analysis. Identify any instrumentation which deviates from the Westinghouse instrumentation and provide the uncertainty value pertinent to this instrumentation and measurement arrangement with comparison to the Westinghouse generic value. The bases or sources for the uncertainty value should also be provided. The sources can be from purchase specifications, manufacturing specifications, calibration data provided by instrumentation vendor or obtained on site, published industry standard or other justifiable bases.

(2) For the RCS flow measurement, the Westinghouse generic response states: "It is assumed for this error analysis, that this flow measurement is performed within seven days of calibrating the measurement instrumentation, therefore, drift effects are not included (except where necessary due to sensor location)." Does your plant operating procedure have provisions that require the RCS flow measurement be performed within seven days of calibrating the measurement instrumentation? If not, what are the drift uncertainty values associated with each component such as Δ P Cell, local meter, RTD, thermocouple, process rack and sensors? What is the effect on the overall flow measurement uncertainty?

(3) The Westinghouse report states: "It is also assumed that the calorimetric flow measurement is performed at the beginning of a cycle, so no allowance has been made for feedwater venturi crud buildup;" and "If venturi fouling is detected by the plant, the venturi should be cleaned, prior to performance of the measurement. If the venturi is not cleaned, the effect of the fouling on the determination of the feedwater flow, and thus, the steam generator power and RCS flow, should be measured and treated as a bias, i.e., the error due to venturi fouling should be added to the statistical summation of the rest of the measurement errors."

   (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?

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

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

   (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?

(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 of the minimum detectable value of fouling.

Response:

1. The measurement of Reactor Coolant System (RCS) flow is based upon performing a precision heat balance flow measurement at the beginning of each fuel cycle and using the result to calibrate the RCS elbow tap flow indicators. The determination of error associated with RCS flow measurement is done by statistically combining the uncertainty associated with the instruments used in the RCS flow measurement. The instruments used in determining RCS flow are permanent plant instrumentation and are assumed to be read on the plant process computer with the exception of RCS Narrow Range T_{HOT} and T_{COLD} which are read on a precision three wire bridge.

   Major instrumentation used in the flow measurement include:

   1. Main Feedwater Flow (ΔP)
   2. Main Feedwater Pressure
   3. Main Feedwater Temperature
   4. Steam Generator (Line) Pressure
   5. Pressurizer Pressure
   6. Narrow Range T_{HOT} and T_{COLD}

   To reduce the amount of error in the determination of RCS flow it is assumed that the above instrumentation with the exception of Pressurizer Pressure has had a calibration check performed within seven days of the RCS flow measurement as required by Technical Specifications.

   The method used in determining error of an instrument loop is the statistical combination of the groups of components in an instrument loop which are statistically independent. Errors which are not statistically independent are combined arithmetically. Sources for instrument uncertainty are vendor technical manuals and drawings.

   Secondary Side Effects

	Instrumentation Error	% Flow Uncertainty
Feed Flow		
Feed Flow Indication	.363%	.873%
Venturi Effects		.28%
Total Feedwater Flow Error $\sqrt{(e)^2}$ x % of scale (.76)		.698%

	Instrumentation Error	% Flow Uncertainty
Feedwater Temperature		
Total Feedwater Temperature Enthalpy Error	.70% of reading	.60%
Feed Water Pressure		
Feed Water Pressure	±.91% of reading	
Total Feedwater Pressure Enthalpy Error		±.0017%
Steam Pressure Error		
Steam Pressure	±.88% of reading	
Total Steam Pressure Enthalpy Error		±.039%
System Losses		
Steam Generator Blowdown		±.037% of core power
Pump Heat Input		±.026% of core power
System Heat Losses (i.e. CVCS)		±.006% of core power
Component Conduction and Convection		±.02% of core power
Total System Heat Loss/Addition Uncertainty	$\sqrt{\Sigma(e)^2}$	.049%
Total Secondary Side Loop Power Uncertainty	$\sqrt{\Sigma(e)^2}$	±.92% of loop power
Power Uncertainty (Four Loops in Operation)	$\sqrt{\Sigma(e)^2/4}$	±.46%
Power Uncertainty (Three Loops in Operation)	$\sqrt{\Sigma(e)^2/3}$	±.53%

	Instrumentation Error	% Flow Uncertainty
<u>Primary Side Effects</u>		
<u>Hot Leg</u>		
T_h Instrumentation (includes streaming error recommended by Westinghouse)	$\pm 1.7^{o}F$	$\pm 3.14\%$
<u>Cold Leg</u>		
T_c Instrumentation	$\pm 1.2^{o}F$	$\pm 3.23\%$
<u>Pressurizer Pressure</u>		
Instrument Error	$\pm 2.34\%$	
Cold Leg Effects		$\pm .321\%$
Hot Leg Effects		$\pm .193\%$
<u>Total Primary Side Errors</u> $\sqrt{\Sigma(e)^2}$		$\pm 4.522\%$
Primary Side Errors (Four Loops in Operation) $\sqrt{\Sigma(e)^2/4}$		$\pm 2.261\%$
Primary Side Errors (Three Loops in Operation) $\sqrt{\Sigma(e)^2/3}$		$\pm 2.61\%$
Total RCS Flow Uncertainty with Four Loops in Operation Based on Heat Balance		$\pm 2.308\%$

$$\sqrt{\begin{bmatrix}\text{Secondary}\\ \text{error}\\ \text{4 loop}\end{bmatrix}^2 + \begin{bmatrix}\text{Primary}\\ \text{error}\\ \text{4 loop}\end{bmatrix}^2}$$

Total RCS Flow Uncertainty with Three Loops in Operation Based on a Heat Balance		$\pm 2.66\%$

$$\sqrt{\begin{bmatrix}\text{Secondary}\\ \text{error}\\ \text{3 loop}\end{bmatrix}^2 + \begin{bmatrix}\text{Primary}\\ \text{error}\\ \text{3 loop}\end{bmatrix}^2}$$

	Instrumentation Error	% Flow Uncertainty
Elbow Tap Flow Indicators	1.537% of span	
If Three Indicators per Loop are Used $\frac{(e)}{\sqrt{3}}$	.8874% of span per loop	
If Two Indicators per Loop are Used	1.086% of span per loop	
Four Loops in Operation Three Indicators per Loop	$\frac{.8874\%}{\sqrt{4}}$ x (span) 1.2	.532%
Four Loops in Operation Two Indicators per Loop	$\frac{1.086}{\sqrt{4}}$ x 1.2	.651%
Three Loops in Operation Three Indicators per Loop	$\frac{.8874}{\sqrt{3}}$ x 1.2	.61%
Three Loops in Operation Two Indicators per Loop	$\frac{1.086}{\sqrt{3}}$ x 1.2	.75%

<u>Total Indicated Four Loop Flow Uncertainty</u>

Three Indicators Per Loop

$$\sqrt{\begin{bmatrix}\text{elbow}\\\text{Tap}\\\text{error}\\\text{3/loop}\end{bmatrix}^2 + \begin{bmatrix}\text{Heat}\\\text{Balance}\\\text{error}\\\text{4 loop}\end{bmatrix}^2} \qquad \pm 2.37\%$$

Two Indicators Per Loop

$$\sqrt{\begin{bmatrix}\text{elbow}\\\text{Tap}\\\text{error}\\\text{2/loop}\end{bmatrix} + \begin{bmatrix}\text{Heat}\\\text{Balance}\\\text{error}\\\text{4 loop}\end{bmatrix}^2} \qquad \pm 2.4\%$$

	Instrumentation Error	% Flow Uncertainty
Total Indicated Three Loop Flow Uncertainty		
Three Indicators Per Loop		
$\sqrt{\begin{bmatrix}\text{elbow}\\ \text{Tap}\\ \text{error}\\ \text{3/loop}\end{bmatrix}^2 + \begin{bmatrix}\text{Heat}\\ \text{Balance}\\ \text{error}\\ \text{3 loop}\end{bmatrix}^2}$		$\pm$2.73%
Two Indicators Per Loop		
$\sqrt{\begin{bmatrix}\text{elbow}\\ \text{Tap}\\ \text{error}\\ \text{2/loop}\end{bmatrix}^2 + \begin{bmatrix}\text{Heat}\\ \text{Balance}\\ \text{error}\\ \text{3 loop}\end{bmatrix}^2}$		2.76%

Total Flow Uncertainty (Four Loops in Operation)

Two Indicators Per Loop	2.4%
Three Indicators Per Loop	2.37%

Total Flow Uncertainty (Three Loops in Operation)

Two Indicators Per Loop	2.76%
Three Indicators Per Loop	2.73%

The above numbers assume that feed flow venturies are clean. If the venturis are not verified to be clean, an additional 0.1% error will be included to increase the total flow error.

NNECO will ensure that the minimum RCS flow is met by incorporating appropriate surveillance requirements in the Millstone Unit No. 3 Technical Specifications.

2. As noted in the response to Item 1, above, all instrumentation used to determine RCS flow with the exception of pressurizer pressure which has been determined to have a negligible effect on the total instrument uncertainty will have a calibration check performed within seven days prior to the RCS flow measurement.

3. a. Prior to initial plant startup, main feedflow venturis were installed clean. In addition, the section of feedwater piping with the venturis will be flushed prior to initial plant startup. At the beginning of subsequent fuel cycles venturis will be inspected. If venturi fouling is discovered during inspection, the venturis will be cleaned.

b. Venturi fouling is detected using the performance monitoring program. Plant performance data is collected automatically on a daily basis and trended on a monthly basis. The plant parameters specifically reviewed for determination of venturi fouling are electrical output, feedwater flow, main steam flow, and first stage turbine pressure. The base relationship of these parameters will be established during startup testing and the first month of operation by review of the collected performance monitoring data. During this period, the venturi will be presumed to be clean. During the monthly performance review, the trended daily data for the mean electrical output, mean steam flow and mean turbine first stage pressure will be compared to the mean feedwater flow. If the trend of the monthly review indicates that the relationship has deviated, corrective action will be taken before performing the next precision heat balance RCS flow measurement. The corrective action will involve inspecting and cleaning the venturi when venturi fouling is indicated.

c. During the first refueling outage, inspection ports will be added upstream and downstream of the venturis. Cleaning will be done by hydrolasing when required.

d. The venturi fouling term is a bias that will result in a higher measured feedwater flow and, in turn, a higher determined RCS flow than actual value. Therefore, if the feedwater venturi is not cleaned, the effect of the fouling on the determination of the feedwater flow and thus the steam generator power and RCS flow is such that all values will be treated in a conservative manner. However, prior to performing the calorimetric flow measurement, the venturis will be verified to be clean by performing a visual inspection (borascope, photography, etc.) and cleaned, when necessary.

e. Prior to the start of each cycle, the venturis will normally be inspected and cleaned if necessary. If the venturis are not inspected, an additional 0.1% will be added to the total RCS flow measurement uncertainty.