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March 28, 1983

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

Attention: Ms. E. G. Adensam, Chief
Licensing Branch No. 4

Re: McGuire Nuclear Station
Docket No. 50-369

Dear Mr. Denton:

Attached are responses to the questions included in the March 17, 1983 letter by Elinor G. Adensam. The questions concerned the proposed Technical Specification change for McGuire Unit 1 to reduce the measurement uncertainty for RCS flow rate. Please note that these responses were discussed with the NRC staff on March 23, 1983. We will be available to meet with the NRC staff to discuss this further, if necessary.

Very truly yours,

H.B. Tucker / BU

Hal B. Tucker

REH:jfw
Attachment

cc: Mr. James P. O'Reilly, Regional Administrator
U. S. Nuclear Regulatory Commission
Region II
101 Marietta Street, NW, Suite 2900
Atlanta, Georgia 30303

Mr. W. T. Orders
Senior Resident Inspector
McGuire Nuclear Station

B021

1. Question

Table 1 provides the equation for calculating flow. Table 2 provides the uncertainties associated with calculation of loop flow. Since Table 2 does not include any uncertainty associated with primary syst‹m net heat losses, please confirm that this term is neglected and results in a conservative determination of loop flow.

Response

Increasing primary side heat losses results in a less conservative determination of RCS flow. Primary side heat loss uncertainties were assessed to be zero due to the negligible effect of this parameter on the total RCS flow uncertainty.

2. Question

Does the assessment of uncertainty in the measurement of feedwater flow agree with any published industry standard or publication or was it developed based on physical equations for flow? It is expected that the uncertainty in feedwater flow measurement has been the subject of previous investigations. The staff would like to know if such data was used and if not, what expertise was used for this evaluation.

Response

The assessment of uncertainty in the measurement of feedwater flow was developed from the physical equations. Feedwater flow measurement has not been the subject of any Duke Power Company studies. We have no knowledge of any existing industry studies. The expertise used in developing the feedwater flow uncertainty was Duke Power Company staff using standard uncertainty techniques. The assessment of feedwater flow uncertainty has been discussed with Westinghouse personnel and they are in aggreement with the techniques used in determining it.

3. Question

The component error in differential pressure measurement made to determine feedwater flow is a very low number. Please provide the basis for the value used and how it is measured.

Response

The differential pressure measurement made to determine feedwater flow is indeed a low number. The instrument specified was designed to yield a very low uncertainty number. The differential pressure cell uses a fused quartz bourdon tube. The fused quartz crystal exhibits the lowest hysteresis creep and is one of the most perfectly elastic materials known. The feedwater differential pressure is measured by a Ruska DDR-6000 direct reading differential pressure gauge which uses a quartz tube cell. Manufacturer's specifications are as follows:

A) Standard Accuracy =±0.008% RDG
B) 90 Day Stability =±0.004% FS
C) DVM Repeatability ±0.001% RDG

For full scale range of 50 PSID and a differential pressure of 8.9 PSID

Response (con't)

at 75% power level, the differential pressure uncertainty is ±0.033%. Attachment 1 contains the specifications of the Ruska DDR-6000.

4. *Question*

Please further clarify how the feedwater temperature is measured and the basis for its component error.

Response

Each feedwater temperature is measured by precision instrumentation consisting of a continuous-lead type J thermocouple and an icebath reference junction. The feedwater thermocouple output is measured by a Leeds and Northrup 914 Numatron DVM with a 0-40 millivolt range. Refer to Figure 1 for a comparison between process feedwater temperature measurement and precision feedwater temperature measurement. Component uncertainties are as follows:

Thermocouple Calibration ± 0.25°F
Readout Calibration ± 0.03°F

Standards Lab Calibration Uncertainty - (USL)

$$USL = \sqrt{\Sigma U_i^2} = \sqrt{(\pm .25)^2 + (\pm .03)^2} = \pm 0.25°F$$

Additional conservatism is added to this measurement uncertainty:
2 X USL = 2 X 0.25°F = 0.5°F

5. *Question*

The dominant consideration in the total steam enthalpy error is moisture carryover, which is an estimated value. Also, the net pump heat addition uncertainty is an estimated value. Since these factors are onesided, i.e., not negative values, what is the basis for using the RSS method for their consideration in flow measurement uncertainty?

Response

The dominant consideration in the total steam enthalpy error is moisture carryover. As the estimated moisture carryover increases, it results in a more conservative determination of RCS flow. The estimated moisture carryover used in the RCS flow uncertainty analysis was the Westinghouse guaranteed value at the steam generator outlet, i.e., 0.25%. The expected moisture carryover per Westinghouse is 0.10% at full power, with less moisture carryover at lower power levels. Previous industry experience with this type steam generator indicate the moisture carryover may exceed the guarantee value at initial startup. In view of this, the ±.25% assessed for the moisture carryover is a two sided figure and can be combined using the RSS method. Pump power uncertainty has been conservatively estimated to be ±2%. In the actual test, pump power is a measured parameter with uncertainty contributed from the process instrumentation used to measure pump motor current and voltage. The uncertainty of these measurements are two-sided, thus the RCS pump power can be combined in the precision calorimetric RCS flow measurement uncertainty using the RSS method.

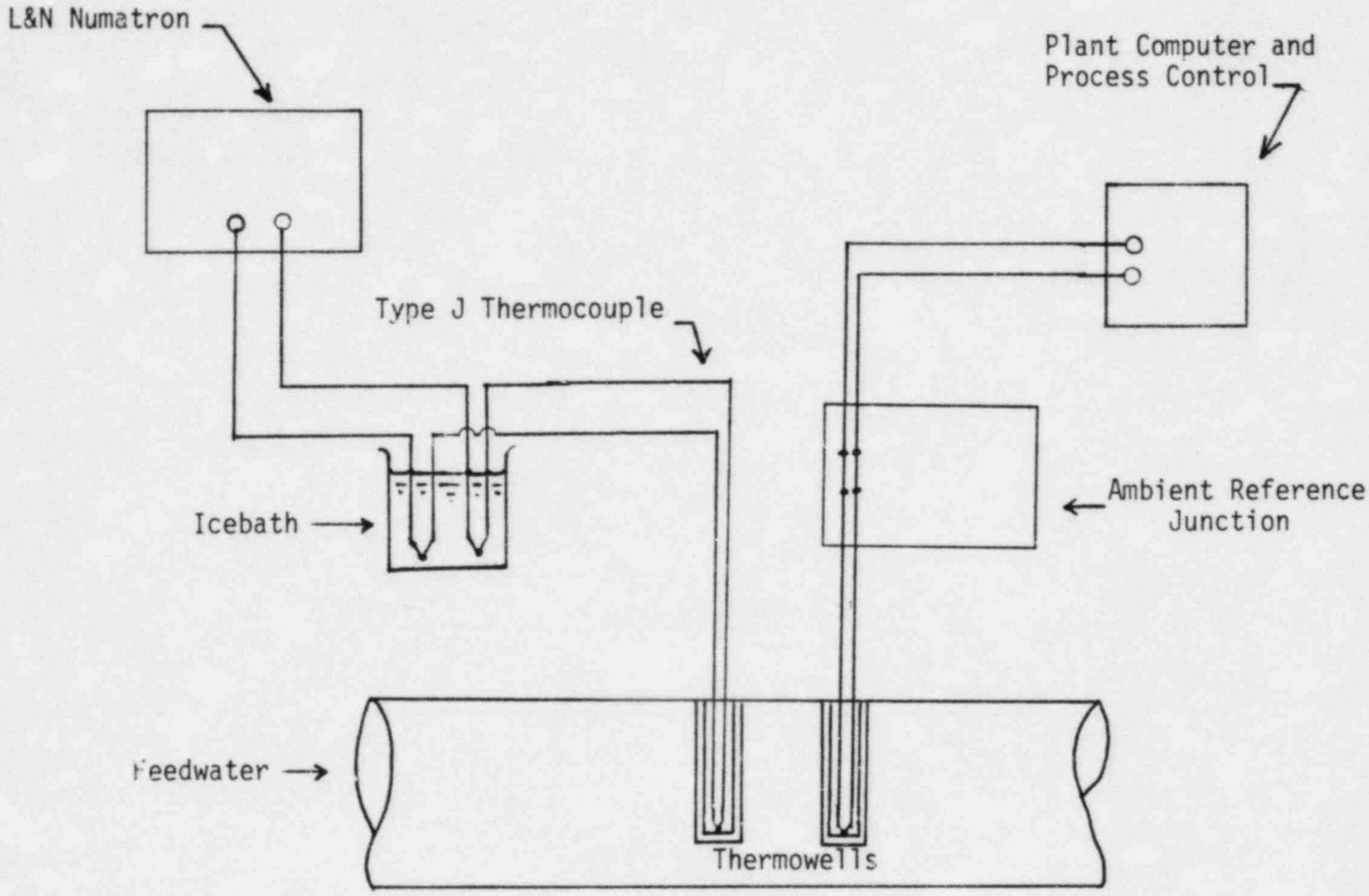

Figure 1

Final Feedwater Temperature Measurement Schematic
Process Versus Precision Comparison

6. *Question*

Please provide further clarification of the measurement errors associated with hot and cold leg temperature measurements. How is DVM used to measure resistance and how did you get the measurement span in °F and RTD calibration in % ? Be explicit how this measurement is made.

Response

The reactor coolant hot and cold legs temperature measurements are performed utilizing a digital resistance bridge and four lead resistance temperature detectors. Two of the leads are used to pass a current through the RTD while the other two leads measure the emf across the RTD. A three point calibration is performed at the factory on each RTD to determine the coefficients of the third-order polynomial curve which characterizes each specific RTD. The RTD resistances are then utilized in the characteristic equations for the different RTD's to iteratively calculate RCS temperature. The RTD's used for the precision calorimetric are narrow range RTD's with calibrations spans as follows: hot legs = 530°-650°F, cold legs = 510°-630°F. The accuracy of this calibration guaranteed by Westinghouse is ±0.2% of the measured span, i.e., ±0.2% X 120°F = 0.24°F. The DVM accuracy is ±0.15% of range, i.e., ±0.15% X 120°F = 0.18°F.

7. *Question*

Please provide a copy of the interface requirements established by Westinghouse that would be used by Duke Power Co., to assure that measurements would be made in a manner as assumed in the analysis and with the required accuracy.

Response

In this matter, no interface requirements established by Westinghouse were utilized by Duke Power Company. Duke Power Company staff engineers have developed the techniques utilized in this test during the previous twenty-five years in similar testing applications. The uncertainty analysis reflects actual test measurement instrumentation uncertainties. The test procedure defines the test techniques and instrumentation utilized in this test and provides assurance that future measurements will be made in the manner presented in the subject uncertainty analysis. All instrument and measurement uncertainties are conservative and consistent with the Improved Thermal Design Procedure (ITDP) study performed by Westinghouse.

ATTACHMENT 1

Ruska DDR-6000 Specifications

SPECIFICATIONS*

For full scale ranges to 2500 PSI

REPEATABILITY:	0.002% F.S.
STABILITY:	0.004% F.S.
LINEARITY:	0.001% F.S. (Included above)
RESOLUTION:	0.001% F.S.
HYSTERESIS:	Not Detectable
SLEW RATE:	5 Sec. Maximum Full Scale
ANALOG OUTPUT:	Differential 0-11.5 Volts DC Max. Impedance, less than 5000 ohms
TEMPERATURE RANGE:	Operate: 10 to 36°C Storage: 0 to 60°C
BOURDON TUBE VOLUME:	1 cc Plus Fittings
CASE VOLUME:	180 cc Plus Fittings
TILT SENSITIVITY:	0.002% F.S. per Degree Tilt
MATERIALS IN CONTACT WITH PRESSURE MEDIA:	Quartz, Teflon, 416 Stainless Steel, Polyethylene, Aluminum, Brass, Buna N
MATERIALS IN CONTACT WITH REFERENCE MEDIA:	Aluminum, Brass, Copper, Buna N, Polyethylene, Teflon, Quartz, Sapphire, Epoxy, 416 Stainless Steel, Alnico and Carbon Steel
PRESSURE MEDIA:	Clean, Dry Gas Compatible with Materials of Construction. (Liquid — Special Order)
SHOCK TOLERANCE:	5 g/10 m.s. with No Resets, or 15 g/8 m.s. Resetting Offsets
WARM-UP TIME:	2 Hours. Instrument can be "ON" indefinitely.
BOURDON TUBE PROOF PRESSURE:	150% Full Scale to 1000 PSI 125% Full Scale over 1000 PSI
CASE WORKING PRESSURE:	Aluminum 1000 PSI Steel 5000 PSI
CASE PROOF PRESSURE:	Aluminum 2000 PSI Steel 20000 PSI
CASE VACUUM EFFECT:	Negligible
FITTINGS:	¼" NPTF Rear Bulkhead
STANDARD OVERPRESSURE PROTECTION:	Bourdon Tube Relief Valve set at 110% F.S. Case Relief Se. at 10 PSI
STANDARD FILTERS:	On Tube and Case
MOUNTING:	Standard 19" Relay Rack. Cabinets Optional
SIZE:	19" Wide x 7" High Panel, 16" Deep
WEIGHT:	27 Pounds Net, 45 Pounds Gross
POWER REQUIREMENT:	115/230 VAC, 50/60 Hz. 15 Watts

(Specifications based on 100,000 count full scale instruments. Other models differ slightly.)

For full scale ranges above 2500 PSI, if different from above

REPEATABILITY:	0.015% F.S.
STABILITY:	0.030% F.S.
LINEARITY:	0.020% F.S.
SLEW RATE:	Consult Factory
MATERIALS IN CONTACT WITH PRESSURE MEDIA:	Copper, Buna N, Polyethylene, Teflon, Quartz, Sapphire, Epoxy, 416 SS, Alnico, Carbon Steel
MATERIALS IN CONTACT WITH REFERENCE MEDIA:	Quartz, Teflon, 416 SS, Polyethylene, Buna N
SIZE:	14"x12¼"x16" For Cabinet 19"x12¼"x16" For Rack Type
PRESSURE MEDIA:	Clean Dry Nitrogen or Gas Compatible with Materials of Construction. For Liquid Ser. ice, Pressure Medium is Silicone Oil.
WARM-UP TIME:	5 Hours (Can be left on indefinitely).
PROOF PRESSURE:	15,000 PSI Case, 125% F.S. Quartz
FITTINGS:	NBS Female for ¼" Tubing
WEIGHT:	55 Pounds Net For Cabinet 65 Pounds Net For Rack Type

MODEL NUMBERS

For Full Scales to 2500 PSI (Indicate Range and Units)

- **6000-801** — Aluminum Body
- **6000-802** — Steel Body

For Full Scales over 2500 PSI (Indicate Range and Units)

- **6000-803** — Gas Service-Cabinet Type
- **6000-804** — Gas Service-Rack Mount
- **6000-805** — Gas Service-Rack Mount with Manual Controller Manifold
- **6000-806** — Liquid Filled-Pressure Side
- **6001-21-1** — Panel Blank-For Cabinet Mounting when DVM is not ordered.

Note: For 230 V, use -861, -862, etc. See page 5 for DVM Readout Model Numbers.

*Note: See "Definitions and Accuracy" page 23, for explanation of terms and discussion of accuracy.

DEFINITIONS AND ACCURACY

DIRECT READING REPEATABILITY

The ability of the instrument to reproduce outputs when the same known pressure is applied to it under the same conditions from either direction. This term includes linearity on instruments up to 2500 psi and is valid for a 24-hour period.

DIRECT READING STABILITY

The same as Direct Reading Repeatability, but extended to a 90-day period.

LINEARITY

The maximum deviation of any output reading from the corresponding point on a straight line drawn through the calibrated end points and mid-point based on a 90-day period.

SLEW RATE

The nominal time to traverse from zero to full scale, or from full scale to zero.

System volume, vacuum pumping time, and temperature will affect slew time in either measure or control modes.

Stated values are average estimates.

NOTE: The foregoing definitions and the following stated values are valid in accordance with the following conditions:

a. Normal warm-up of instrument
b. Zero setting daily
c. Based on 100,000 counts Full Scale with Full Scale pressure not exceeding 2500 psi
d. Applied within the context of all other specifications

TOTAL ACCURACY

To determine the total 24-hour accuracy of a measure mode reading, the following terms must be added algebraically:

Term:	Value, as Supplied by RUSKA
a. Direct Reading Repeatability	±0.002% of Full Scale
b. Digital Voltmeter Repeatability	±0.001% of Reading
c. Calibration Standard Accuracy	±0.0055% of Reading to 50 psi ±0.008% of Reading above 50 psi

After 90 days, the values of terms b. and c. will depend on the means of recertification employed by the user.

For 90-day accuracy, substitute stability specifications for repeatability.