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April 16, 1984

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: Catawba Nuclear Station
Docket Nos. 50-413 and 50-414

Dear Mr. Denton:

Ms. Elinor G. Adensam's letter of April 10, 1984 transmitted three questions (as Enclosure 4) which were related to Open Item 5 in the Catawba SER, Thermal Design Procedures and Flow Measurement Techniques. A response to each of these questions is attached.

As the response to question 1 contains information proprietary to Westinghouse Electric Corporation, it is supported by an affidavit signed by Westinghouse, the owner of the information. The affidavit 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 Section 2.790 of the Commission's regulations.

Accordingly, it is respectfully requested that the information which is proprietary to Westinghouse be withheld from public disclosure in accordance with 10 CFR Section 2.790 of the Commission's regulations. Correspondence with respect to the proprietary aspects of the Application for Withholding or the supporting Westinghouse affidavit should reference CAW-84-33 and should be addressed to R. A. Wiesemann, Manager, Regulatory and Legislative Affairs, Westinghouse Electric Corporation, P. O. Box 355, Pittsburgh, Pennsylvania 15230.

Very truly yours,

H.B. Tucker / HBT

Hal B. Tucker

ROS/php

Attachment

B001
1 | 5 Prop
| 5 Non Prop

Change: BNL
DMB/DSS
FEMA
LPDR
PDR
NSIC
NTIS
} Non Prop

cc: (w/o proprietary attachment)
Mr. James P. O'Reilly, Regional Administrator
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Question

1. *In response to staffquestion 492.2 regarding the Improved Thermal Design Procedure (ITDP), your letter of December 8, 1982 provides a Westinghouse response regarding the variances and distributions of some ITDP parameters, i.e., pressurizer pressure, core average temperature, reactor power and reactor coolant flow. Even though the Westinghouse response reflects the use of RdF RTD transmitters for Catawba, other 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. Please 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.*

Response

A summary of the Catawba plant specific instrumentation for the precision heat balance follows:

FLOW UNCERTAINTY

Component	Westinghouse Instrument Error	Catawba Specific Instrument Error	Reference Notes
Feedwater Flow	[ ]a,c		
Venturi, K		±0.25%	1
ΔP and Read Out		±0.88% of ΔP	2
Feedwater Density and Enthalpy			
a) Temperature		±0.63F	3
b) Pressure		±10 psi	4
Steam Enthalpy			
Steamline Pressure		±3.3 psi	5
Moisture Carryover		[ ]a,c	6
Primary Side Enthalpy			
T_H (Electronics)		[ ]a,c	
RTD Calibration			8
Sensor Drift			8
DVM		±0.13F	9

FLOW UNCERTAINTY

Component	Westinghouse Instrument Error	Catawba Specific Instrument Error	Reference Notes
T_C (Electronics)			
RTD Calibration	[ ]^{a,c}	[ ]^{a,c}	8
Senior Drift			8
DVM Accuracy			9

REFERENCE NOTES

1. Alden Research Laboratories statement of accuracy - ±0.25%

2. Instrument Error:

   Calibration Standard Accuracy = ±0.008% of Reading
   90-Day Stability (Drift) = ±0.004% Full Scale
   DVM Repeatability = ±0.001% of Reading

   For a full scale range of 50 psid and a differential pressure of 8.9 psid at ~75% power level, the differential pressure uncertainty is ±0.031%.

   ±0.031% 90-day total accuracy of Ruska DDR-6000
   ±0.800% Uncertainty for Process Fluctuation
   ±0.048% Uncertainty for Single Instrument Random Error
   Σ±0.88% of ΔP

3. Measurements will be performed using a continuous lead Type-J thermocouple with an icebath reference junction and a Fluke 2190A Thermocouple Thermometer.

   Duke Power Company Standards Lab Calibration Accuracy = ±0.25 F

   1-Year DVM Accuracy (Refer to Attachment 3) = ±0.58F
   Process Fluctuations = ±0.014F
   Total Feedwater Temperature Error $\sqrt{\Sigma(e)^2}$ = ±0.63F

4. Test pressure gauge accuracy of ±0.25% of span @ 2000 psi span

   ±0.25% x 2000 psi = ±5 psig

   Additional conservatism for Drift = <u>±5 psig</u>
   Σ ±10 psig

5. Dead Weight Gauge Accuracy: 0.10% x 1000 psi = ± 1.0 psi
   Process Fluctuation Error: ± 1.3 psi
   Additional Conservatism for Drift: ± <u>1.0 psi</u>
   Σ ± 3.3 psi

   NOTE: If a precision digital pressure gauge is used to perform this measurement, its accuracy will be as good or better than the DWG.

6. Same as the generic Westinghouse assumption.

7. Pump power during the Calorimetric RCS Flow Test is measured by the plant process computer and included in the calculations of RCS flow. The generic Westinghouse submital assumes pump power is an estimated value.

8. Same as the generic Westinghouse assumption. RTD's are specified by Westinghouse Design Specification Number 955322. Attachment 1.

9. The DVM used to measure hot and cold leg RTD's is a Fluke 8520A, refer to Attachment 2. The 90 day accuracy statement for this instrument is:

[(0.007% (Input, Ω) + 2 (digits)]
DVM Accuracy = [0.00007)(450Ω)+ 2 (.01Ω)] = ±0.0515Ω
The nominal output for the hot leg RTDs is 450 Ω.

The sensitivity of the RTD is the change in temperature with respect to a change in resistance or $\frac{\Delta T}{\Delta ohms}$. From the Westinghouse design specification (Attachment 1) at 525 F the nominal resistance is 410Ω; at 625 F resistance equals 450.42Ω. Therefore:

$$\frac{\Delta T}{\Delta \Omega} = \frac{T_1 - T_2}{\Omega_1 - \Omega_2} = \frac{625\,F - 525\,F}{450.42\Omega - 410\Omega} = \frac{100\,F}{40.42\Omega} \cong 2.5F/\Omega$$

The DVM error is:

±0.0515Ω x 2.5F/Ω = ±0.129F

The error of the DVM used to measure hot (T_h) and cold leg (Tc) temperature is the only plant specific component that exceeds the bounding value of the generic Westinghouse submittal. Its effect, however, is insignificant in the final determination of primary side enthalpy. The plant specific error in the determination of T_H and Tc is:

T_H and T (Electronics)
Calibration Accuracy [ ] a,c
Sensor Drift
DVM ±0.13F

T_H and Tc Total Error Σ(e) = ±1.207F ≅ ±1.2F

This compares to a generic bounding value of [ ] a,c

2. *Question*

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 instrumentation? If not, what are the drift uncertainty values associated with each component such as ΔP Cell, local meter, RTD, thermocouple, process rack and sensors? What is the effect on the overall flow measurement uncertainty?

Response

The following instrumentation is not calibrated within the specified seven (7)

day period due to sensor location:

Pressurizer Pressure
Hot and Cold Leg RTD's

Sensor drift error is included in the Westinghouse analysis for these measured parameters.

The other measured parameters that are required in the Westinghouse analysis to be calibrated within a specified (7) day period are:

Primary RTD Digital Voltmeter
Feedwater Temperature Process Components
ΔP Cell for Feedwater Flow

The Digital Voltmeter used to measure the primary RTDs will be calibrated within seven (7) days prior to the performance of the precision heat balance.

The feedwater temperature is measured by precision test Type - J thermocouples which are of higher quality than the process temperature sensors referenced in the generic submittal. These thermocouples are regularly calibrated and equipment histories indicate the ±0.25F calibration accuracy, providing the thermocouple is not physically abused, is good for the annual calibration cycle. The accuracy quoted for the Digital Thermocouple Thermometer includes an annual drift allowance.

The feedwater flow ΔP is read by the Ruska DDR-6000. The accuracy previously quoted in question 1 was a 90-day specification that included an allowance for instrument stability (drift). A calibration check on the Ruska DDR-6000 will be performed within 90 days of performing the precision heat balance.

Provisions will be included in the procedure for insuring the calibration of these instruments within the specified period.

3. *Question*

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 feedwater 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 on the minimum detectable value of fouling.*

Response

(a and c) The feedwater venturis will be assured to be clean by benchmarking trended parameters at the beginning of the first fuel cycle. Presently, no provisions exist for cleaning the feedwater venturi at the beginning of every cycle.

(b, d, and e) The Catawba Performance Monitoring Program includes a monthly review of trended data conducted for the purpose of detecting potential venturi fouling. The undetected development of venturi fouling during a power cycle would introduce a non-conservative bias into any subsequent efforts to normalize the RCS elbow tap flow indications. The monthly review includes analyzing trended data of electrical output, feedwater flow and 1st stage pressure.

The ratios of electrical output and 1st stage pressure to feedwater flow would shift in the event of venturi fouling and are, therefore, monitored to detect fouling. Indicated reactor thermal power is directly porportional to indicated feedwater flow. Venturi fouling would result in an increase in indicated feedwaer flow which would increase indicated reactor thermal power. Since the reactor thermal power is limited to the 100% licensed value, indicated feedwater flow is also limited and actual feedwater flow would be reduced. By reducing actual feedwater flow, electrical output and 1st stage pressure are reduced by the same degree. Therefore, by trending electrical output and 1st stage pressure with indicated feedwater flow, venturi fouling can be detected.

The normal relationship between electrical output, 1st stage pressure and indicated feedwater flow will be established during the first fuel cycle when the venturi is presumed to be clean. To avoid any significant effect of measurement uncertainties on the results, the monthly review will include analyzing data that is trended on a daily basis. The mean electrical output and mean 1st stage pressure will be compared to the mean feedwater flow. If the trend of the monthly reviews indicate that this ratio has deviated by 0.1%, corrective action will be taken before performing the next precision heat balance for RCS flow measurement. Corrective action will involve either (1) inspecting and cleaning the venturi or (2) quantifing the bias effect of the fouling and making an allowance for it in the RCS flow measurement.

The 0.1% value serves as an "alarm level" at which corrective action must be taken. This value was chosen because it is believed to be high enough to avoid spurious "alarms" yet low enough to avoid an unnecessarily excessive penalty for fouling.

Attachment 1

a,c

[ ] a,c

Attachment 2

Bias Current: ≤50 pA

Maximum Reading Rate

Operation	Line	Rate	Resolution
Local or Remote	50 Hz	200 rdgs/sec*	5½ digits
	60 Hz	240 rdgs/sec*	
Remote	50 Hz	> 500 rdgs/sec	4½ digits
	60 Hz	> 500 rdgs/sec	

For local operation, 8522A is limited to ½ this rate.

AC Voltage (True RMS)
Input Characteristics

Range	Full Scale	Resolution	Input Impedance
1V	1.99999	10 µV	1 MΩ, ≤ 100 pF
10V	16.0100	100 µV	
100V	130.100	1 mV	
650V	650.00	10 mV	

Accuracy: ±(% Input + % of Full Scale) ac or ac+dc*

Frequency	90 Days 18°C to 28°C			1 Year 18°C to 28°C		
	% of Input	+% FS AC	+% FS AC+DC	% of Input	+ % FS AC	+% FS AC+DC
10 Hz to 20 Hz**	3.0	0.6	0.7	3.5	0.6	0.7
20 Hz to 40 Hz**	0.5	0.5	0.6	0.6	0.6	0.7
40 Hz to 20 kHz	0.1	0.03	0.08	0.15	0.05	0.16
20 kHz to 100 kHz	1.0	0.3	0.4	2.0	0.6	0.8
100 kHz to 300 kHz	2.4	0.6	0.6	4.0	0.1	0.1
300 kHz to 1 MHz	8.0	2.5	2.5	15.0	5.0	5.0

From 0.1% of range to full scale
**With statistics program for smoothing*

Temp. Coefficient: 18°C to 0°C or 28°C to 50°C, to 20 kHz
AC Mode: ±(0.007% of input + 0.007% FS)/°C
AC+DC Mode: ±(0.007% of input + 0.014% FS)/°C
Maximum Input: ±1000V peak High to Low or Guard to Chassic terminals, and ±200 V peak Guard to Low terminals
Crest Factor: ≥4:1 at full scale, increasing down scale
Maximum Reading Rate: 10 readings per second
Maximum Slew Rate: 177V per µs
Maximum Volt-Hertz Product: 2 x 10^7

Resistance
Input Characteristics

Range	Full Scale	Resolution	Current Through Unknown	Open Circuit Voltage
10Ω	19.9999	100 µΩ	10 mA	7V
100Ω	199.999	1 mΩ	10 mA	
1000Ω	1999.99	10 mΩ	1.0 mA	
10 kΩ	19.9999	100 mΩ	0.1 mA	
100 kΩ	199.999	1Ω	14.5 µA (max)	
1 MΩ	1.99999	10Ω	1.5 µA (max)	
10 MΩ	19.999	1kΩ	1.5 µA (max)	

Maximum Input: ±400V peak for any range
Maximum Reading Rate: 100 kΩ range and higher, reading rate is 10 rdgs/second

10 kΩ Range and Lower

Operation	Resolution	Line	Reading Rate
Local or Remote	5½-digits	50 Hz	200 rdgs/sec*
		60 Hz	240 rdgs/sec*
Remote	4½-digits	50 Hz	>500 rdgs/sec
		60 Hz	>500 rdgs/sec

For local operation, 8522A is limited to ½ this rate.

→ Note: Should be 28°C

Accuracy: ±(% of Input + Digits)

Range	24 Hours 23°C ± 1°C	90 Days 18°C 328°C	1 Year 18°C 28°C	Plus Temp Coefficient per °C*
10Ω	0.0045 + 6	0.0080 + 7	0.0140 + 12	0.0007 + 2.0
100Ω	0.0035 + 2	0.0070 + 2	0.0125 + 3	0.0007 + 0.2
1000Ω	0.0035 + 2	0.0070 + 2	0.0125 + 3	0.0007 + 0.2
10 kΩ	0.0035 + 2	0.0070 + 2	0.0125 + 3	0.0007 + 0.2
100 kΩ	0.0040 + 2	0.0090 + 2	0.0140 + 3	0.0012 + 0.2
1 MΩ	0.0090 + 2	0.0160 + 2	0.0200 + 3	0.0020 + 0.2
10 MΩ	0.0300 + 1	0.0440 + 1	0.0450 + 3	0.0030 + 0.2

From 18°C to 0°C or 28°C to 50°C

Conductance
Range: 100 nS (10 MΩ)$^{-1}$
Full Scale: 199.99
Resolution: 0.01 nS (100,000 MΩ)$^{-1}$
Accuracy: ±(% of Input + Digits)

24 Hours 23°C ± 1°C	90 Days 18°C to 28°C	1 Year 18°C to 28°C	*Plus Temp Coefficient per °C
0.04 + 5	0.05 + 5	0.06 + 5	0.004 + 1

From 18°C to 0°C or 28°C to 50°C

Maximum Input: ±400V peak
Maximum Reading Rate: 10 readings per second

External Reference
Operating Range: ±0.5V dc to ±33V dc as long as external reference Low terminal is within ±16.5V of input Low terminal
Input Impedance: 10,000 MΩ between external reference High or Low terminals and input Low terminal
Accuracy

X-Ref Voltage	Accuracy
16.5V to 33V	±(A + B + 20 ppm)
0.5V to 16.5V	±[A + B + (400 ppm ÷ |Vref|)]

Note: A = DC 10 volt range accuracy
B = Input voltage or resistance range accuracy

Maximum Input: ±180V peak between external reference High or Low and input Low; ±360V peak between externa reference High and Low

Transfer Accuracy
The following accuracy specifications apply when:

- Reading rate is 2 readings per second
- Filter settling time is 500 ms
- Warm-up is at least 2 hours
- Quantity measured has same nominal value and frequency as transfer standard
- Measurements are made in one range
- Standard is checked at least every hour
- Ambient temperature remains within ±1°C

DC Voltage

Range	±(% of Input + digits)
100 mV	0.0020 + 4
1V	0.0020 + 1
10V	0.0010 + 1
100V	0.0020 + 1
1000V	0.0020 + 1

AC Voltage (all ranges)

Frequency	±(% of input + % of Full Scale)
10 Hz to 20 Hz	1.0 + 0.2
20 Hz to 40 Hz	0.1 + 0.1
40 Hz to 20 kHz	0.005 + 0.009
20 kHz to 100 kHz	0.100 + 0.030
100 kHz to 1 MHz	0.500 + 0.60

4

ATTACHMENT 3

DIGITAL THERMOMETERS
2180/2190 Series

Thermometer Specifications

2190A Thermocouple Thermometer Specifications

Thermocouple Types: Five, switch selectable. Which thermocouple types depends on your choice of microcomputer type. See Accuracy chart below
Resolution: 0.1°C or °F
Input Connection: 2 wires on screw terminal isothermal block
Max Source Impedance: 2 kΩ
Overrange Detection: Flashing display
Open Circuit Detection: Source impedance of 3 kΩ or more causes a flashing "OC"

2190A Accuracy*

Thermocouples		Maximum Error*					
		±Degrees C			±Degrees F		
Type	Applicable Portion of Temperature Range °C	At Cal	90 Days 20°C to 30°C	1 Year 15°C to 35°C	At Cal	90 Days 68°F to 86°F	1 Year 59°F to 95°F
Microcomputer Type 1							
J	-128 to 0 0 to 900	0.18 0.18	0.19 0.31	0.21 0.36	0.20 0.20	0.23 0.47	0.26 0.58
K	-132 to 0 0 to 1350	0.18 0.18	0.19 0.39	0.21 0.47	0.30 0.30	0.33 0.72	0.37 0.87
T	-243 to 0 0 to 400	0.18 0.18	0.20 0.22	0.22 0.25	0.30 0.30	0.35 0.41	0.39 0.46
R	0 to 1708	0.31	0.59	0.70	0.47	1.01	1.20
C**	0 to 2471	0.18	0.60	0.75	0.30	1.11	1.37
Microcomputer Type 2							
J	-128 to 0 0 to 900	0.18 0.18	0.19 0.31	0.21 0.36	0.20 0.20	0.23 0.47	0.26 0.58
K	-132 to 0 0 to 1350	0.18 0.18	0.19 0.39	0.21 0.47	0.30 0.30	0.33 0.72	0.37 0.87
E	-252 to 0 0 to 1000	0.18 0.18	0.20 0.33	0.22 0.39	0.30 0.30	0.35 0.61	0.40 0.72
R	0 to 1708	0.31	0.59	0.70	0.47	1.01	1.20
S	0 to 1685	0.22	0.50	0.60	0.38	0.92	1.10
Microcomputer Type 3							
J DIN***	-100 to 0 0 to 760	0.18 0.18	0.19 0.28	0.20 0.33	0.30 0.30	0.32 0.52	0.36 0.61
K	-50 to 0 0 to 1372	0.18 0.18	0.18 0.39	0.20 0.48	0.20 0.20	0.22 0.63	0.25 0.78
T DIN***	-200 to 0 0 to 400	0.18 0.18	0.20 0.22	0.21 0.25	0.30 0.30	0.34 0.41	0.38 0.46
B	420 to 1815	0.21	0.52	0.62	0.37	0.95	1.15
R	140 to 1700	0.18	0.46	0.46	0.20	0.74	0.93

*Total instrument accuracy. Does not include Thermocouple errors such as non-conformity to standard curve.
**C designates Tungsten-5% Rhenium vs. Tungsten-26% Rhenium.
***DIN is a European Standard.

2180A RTD Thermometer Specifications

RTD Types: 100Ω Pt, 385 (DIN), 390, 3916, or 392; 100Ω Ni (DIN); 10Ω Cu; 0 to 999Ω resistance — switch-selectable
Resolution: 100Ω Pt RTD's: 0.01°, autoranging to 0.1° above 204°C; 100Ω Ni RTD's: 0.01°, autoranging to 0.1° above 93°C; 10Ω Cu RTD's: 0.1°
Input Connection: 4-wire screw terminals. Terminals accept 3-wire and 2-wire RTD's at reduced accuracy
RTD Matching: User-performed potentiometer adjustment matches the 2180A to user's RTD to compensate for variations in lead length and resistance at 0°C
Lead Resistance: 4-wire: 200Ω max per lead for both 100Ω and 10Ω RTD's; 3-wire: 2Ω max per lead for 100Ω RTD's, 0.18Ω max per lead for 10Ω RTD's; 2-wire: 0.9Ω max per lead for 100Ω RTD's, 0.09Ω max per lead for 10Ω RTD's
Lead Resistance Error: 4-wire: no error; 3-wire 100Ω RTD's: 0.012° per degree per ohm; 3-wire 10Ω RTD's: 0.12° per degree per ohm; 2-wire 100Ω RTD's: 0.025° per degree per ohm; 2-wire 10Ω RTD's: 0.25° per degree per ohm

2180A Linearizations (Microcomputer Type 2)*

RTD Type	Linearization Coefficients
100Ω 385 Pt	DIN** 43760 Table
100Ω 390 Pt	ALPHA* = 0.0038994 DELTA* = 1.494 A4* = $-0.265668 \times 10^{-[illegible]}$ C4* = $-0.205984 \times 10^{-11}$
100Ω 3916 Pt	ALPHA* = 0.003916 DELTA* = 1.505 A4* = -0.099668×10^{-5} C4* = $-0.271142 \times 10^{-12}$
100Ω 392 Pt	ALPHA* = 0.00339221 DELTA* = 1.493 A4* = -0.38668×10^{-5} C4* = $+0.192912 \times 10^{-13}$
100Ω 617 Ni	DIN** 43760 Table
10Ω Cu	R0 = 9.042 Ohms R25 = 10.005 Ohms ALPHA = 0.004260

*See IPTS 68 equations in NBS Monograph 126. Microcomputer Type 1 no longer available.
**European Standard.

2180A Accuracy (Microcomputer Type 2)*

RTD's		Maximum Error*					
		±Degrees C			±Degrees F		
Type	Applicable Portion of Temperature Range °C	At Cal	90 Days 20°C to 30°C	1 Year 15°C to 35°C	At Cal	90 Days 68°F to 86°F	1 Year 59°F to 95°F
100Ω 385 Pt	-190 to 0 0 to 204	0.043 0.043	0.089 0.132	0.112 0.173	0.076 0.076	0.161 0.239	0.203 0.314
	-190 to 0 0 to 750	0.11 0.11	0.12 0.26	0.14 0.37	0.18 0.18	0.21 0.46	0.24 0.62
100Ω 390 Pt	-200 to 0 0 to 204	0.009 0.009	0.055 0.098	0.078 0.139	0.015 0.015	0.100 0.177	0.142 0.252
	-200 to 0 0 to 750	0.08 0.08	0.10 0.23	0.11 0.32	0.13 0.13	0.16 0.41	0.19 0.57
100Ω 3916 Pt	-200 to 0 0 to 204	0.040 0.040	0.086 0.13	0.109 0.171	0.071 0.071	0.156 0.234	0.198 0.309
	-200 to 0 0 to 750	0.11 0.10	0.12 0.26	0.14 0.34	0.17 0.17	0.21 0.46	0.24 0.62
100Ω 392 Pt	-200 to 0 0 to 204	0.008 0.009	0.055 0.098	0.078 0.139	0.014 0.014	0.099 0.177	0.141 0.252
	-200 to 0 0 to 750	0.08 0.08	0.10 0.23	0.11 0.32	0.12 0.12	0.16 0.41	0.19 0.57
100Ω 617 Ni	-60 to 0 0 to 93	0.129 0.129	0.157 0.176	0.172 0.199	0.230 0.231	0.282 0.317	0.308 0.359
	-60 to 0 0 to 177	0.19 0.19	0.20 0.22	0.21 0.25	0.33 0.33	0.35 0.39	0.35 0.44
10Ω Cu	-75 to 0 0 to 150	0.16 0.16	0.18 0.20	0.19 0.23	0.27 0.27	0.31 0.35	0.34 0.41
Ohms	0 to 196.99 0 to 999.99	0.005 0.05	0.042 0.22	0.059 0.31	All Units In Ohms		

NOTE: Shaded area is 0.01° resolution; unshaded area is 0.1° resolution
*Total instrument accuracy. Does not include RTD probe errors. Valid for 4-wire RTD's only. Microcomputer Type 1 no longer available.