Calculation 98-ENG-02405D2, Revision 2

Attachment 1

Calculation 98-ENG-02405D2, Rev. 2
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Dominion®

Item Equivalency Evaluation Signature Page

Item Equivalency Evaluation Title/Station/Unit		IEE Number	Version
MINCO S7927 RTD, BURNS MODEL WSP / Millstone / Unit 2		10000008752	V00
Approvals (N/A blocks not required)			
Preparer Procurement Engineer (Print) P. Wynn	Signature [signature]		Date 9/28/09
Independent Procurement Engineer (Print) R. Malinowsky	Signature [signature]		Date 9/29/09
Peer Review/Design Authority (Print) DVCLEMONS	Signature [signature]		Date 10/6/09
Other/Reviewer/Affiliation (Print)	Signature		Date
Other/Reviewer/Affiliation (Print)	Signature		Date
Other/Reviewer/Affiliation (Print)	Signature		Date
Other/Reviewer/Affiliation (Print)	Signature		Date

Notes:
Backlog Item

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Packing Slip Report

12/14/2009 12:20:28PM

From:

Packing Slip: 34182

Order No.: S000425772

Page: 1

Burns Engineering, Inc.
10201 Bren Road East
Minnetonka MN 55343
United States

Toll Free: 1-800-328-3871
Tel: 952-935-4400 **Fax:** 952-935-8782

Bill To: C000834

Dominion Nuclear Connecticut, Inc
Accounts Payable
PO Box 25459
Richmond VA 23260-5459

Ship To: (1)
Attn:
Dominion Nuclear Connecticut, Inc
Rope Ferry Road (Route 156)
Waterford CT 06385

Order Contact: Bonnie Guelbart

Ref PO:
Proj No:

Order#	Cust PO	Ship Via	Weight	Packages#
S000425772	45711234	UPS N/C		

Line/Release:	Item	UM	Qty Ordered	Qty To Pack
1	WSP2C2-4-5A/CI25 RTD MO Type C OAL=8.5 200 Ohm 4-Wire 42142388 Model: WSP2C2-4-5A/CI25	ea	1.00	1.00

S000308794
MATERIAL RECEIPT VERIFICATION
DATE REC'D 12-21-09
CARRIER
P.O. NO. 45711234
STKHDL INIT. [illegible]

Returned merchandise must have a return material authorization(RMA). Non-stocked, made-to-order items are not returnable. Stocked parts returned are subject to a restocking fee and must be returned within one year of purchase

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BURNS ENGINEERING

10201 Bren Road East Minnetonka, Minnesota 55343

Report of Calibration

NVLAP®
For the Scope of Accreditation Under NVLAP Lab Code 200706-0

Model:	WSP2C2-4-5A/CI25		
Serial Number:	838621		
PO Number:	45711234		
Description:	Platinum Resistance Thermometer, Secondary Standard		
Calibration Procedure Numbers:	SOPC3 Rev D		
Calibration Method:	Comparison to SPRT	Calibration Range:	-38°C to 100°C
Customer:	Dominion Nuclear Connecticut, Inc.	Calibration Date:	12/11/2009
	Rope Ferry Road (Route 156)	As-Found Condition:	New
	Waterford, CT 06385	As-Left Condition:	Calibrated

This platinum resistance thermometer (PRT) was calibrated using an AC bridge at a current of 1mA, at the temperatures reported below by comparison to Standard Platinum Resistance Thermometers (SPRTs). These SPRTs are calibrated to the International Temperature Scale of 1990 (ITS-90) and their calibration is traceable to the National Institute of Standards and Technology.

The combined standard uncertainty of this calibration includes all known sources present at the time of calibration. The uncertainties are reported at the calibration temperatures only, the uncertainties at intermediate temperatures can be computed from these values and the ITS-90 propagation of error curves. The combined standard uncertainty is multiplied by a coverage factor of 2 to give an expanded uncertainty, which defines the interval having a level of confidence of approximately 95 percent. The expanded uncertainty presented in this report is consistent with the 1993 ISO Guide to the Expression of Uncertainty in Measurement. The expanded uncertainty is not to be confused with a tolerance limit for the user during application.

Calibration Results		
Temperature (deg C)	Resistance (ohms)	Uncertainty (mK)
-38.000	169.7716	± 25 mk
0.000	199.9705	± 25 mk
50.000	239.1699	± 25 mk
100.000	277.7691	± 25 mk

Callendar-Van Dusen Calibration Coefficients			
R0 = 199.9705	Alpha = 0.0038905	Delta = 1.5430	Beta = 0.0997
	A = 3.950536e-03	B = -6.003035e-07	C = -3.877400e-12

Comments and Limitations: None

The temperature calibration system used by Burns Engineering complies with the requirements of ANSI/NCSL Z540-1-1994, Part 1, and ISO/IEC 17025:2005. This calibration report applies only to the item calibrated. This report shall not be used to claim certification, approval, or endorsement by NVLAP, NIST, or any agency of the federal government.

Environmental conditions:
The ambient conditions of the laboratory are controlled to 21 ± 4 degrees C and 80% maximum relative humidity.

The following measuring and test equipment were used in this calibration:

Item	Model	Serial Number	Recall Date
SPRT	8163QB	1873681	5/25/2010
SPRT	8163Q	J96S4772	7/2/2012
Bridge	F700	1337-006-446	4/14/2010
Standard Resistor	5685A-100	8738/14	1/9/2010

The attached resistance vs temperature table was generated for this sensor using the Callendar-Van Dusen interpolation equations and the results of this calibration.

Calibration performed and Approved by:

Terry Walsh Date of Issue: 12-11-2009
Metrology Technician: Terry Walsh

Resistance vs. Temperature table using Callendar-Van Dusen coefficients for RTD Serial Number: 838621
Coefficients used: Ro: 199.9705 Alpha: 0.0038905 Delta: 1.5430 Beta: 0.0997
Temperatures are in deg Celcius

	-0	-1	-2	-3	-4	-5	-6	-7	-8	-9	
-40											-40
-30	176.1600	175.3623	174.5645	173.7663	172.9679	172.1692	171.3703	170.5711	169.7716		-30
-20	184.1219	183.3268	182.5315	181.7360	180.9402	180.1441	179.3478	178.5513	177.7544	176.9573	-20
-10	192.0585	191.2659	190.4731	189.6801	188.8868	188.0933	187.2995	186.5055	185.7112	184.9167	-10
0	199.9705	199.1804	198.3900	197.5994	196.8086	196.0175	195.2262	194.4346	193.6428	192.8508	0
	-0	-1	-2	-3	-4	-5	-6	-7	-8	-9	

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Resistance vs. Temperature table using Callendar-Van Dusen coefficients for RTD Serial Number: 838621
Coefficients used: Ro: 199.9705 Alpha: 0.0038905 Delta: 1.5430 Beta: 0.0997
Temperatures are in deg Celcius

	0	1	2	3	4	5	6	7	8	9	
0	199.9705	200.7603	201.5500	202.3394	203.1285	203.9174	204.7061	205.4945	206.2827	207.0707	0
10	207.8584	208.6459	209.4331	210.2201	211.0068	211.7933	212.5796	213.3656	214.1514	214.9370	10
20	215.7223	216.5074	217.2922	218.0768	218.8611	219.6452	220.4291	221.2127	221.9961	222.7793	20
30	223.5622	224.3448	225.1273	225.9095	226.6914	227.4731	228.2546	229.0358	229.8168	230.5976	30
40	231.3781	232.1583	232.9384	233.7181	234.4977	235.2770	236.0561	236.8349	237.6135	238.3918	40
50	239.1699	239.9478	240.7254	241.5028	242.2800	243.0569	243.8335	244.6100	245.3861	246.1621	50
60	246.9378	247.7133	248.4885	249.2635	250.0382	250.8127	251.5870	252.3610	253.1348	253.9084	60
70	254.6817	255.4547	256.2275	257.0001	257.7725	258.5446	259.3164	260.0881	260.8595	261.6306	70
80	262.4015	263.1722	263.9426	264.7128	265.4827	266.2524	267.0219	267.7911	268.5601	269.3288	80
90	270.0973	270.8656	271.6336	272.4014	273.1690	273.9363	274.7033	275.4702	276.2367	277.0031	90
100	277.7692										100
	0	1	2	3	4	5	6	7	8	9	

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Item Equivalency Evaluation Title/Station/Unit	IEE Number	Version
MINCO S7927 RTD, BURNS MODEL WSP / Millstone / Unit 2	10000008752	00

Attachments (Each page of the IEE shall have IEE#, Revision, & pagination including attachments):
Drawing 25203-31147 Sheet R
Drawing 25203-28408 SH. 312, MP2 HUD Piping Thermowell
MINCO Drawing S7927
Fax from MINCO dated May 10, 2000
Comparison Table from DCN DM2-04-0524-98
Page from Calculation No. 98-ENG-02405D2, Rev 01
BURNS Engineering Quote WQ13270 Dated 9/9/2009
Pages from BURNS Engineering catalog for Model WSP Resistance Thermometers (Bulletin 973A)
BURNS Engineering Curve 2
BURNS Engineering Technical Paper on Stability

	ORIGINAL	REPLACEMENT
Material Master Number	M365721R	42142388
Item Description	Precision Platinum Resistance Thermometer (Resistance Temperature Detector (RTD))	Precision Platinum Resistance Thermometer (Resistance Temperature Detector (RTD))
Manufacturer	MINCO	BURNS Engineering
Part Number	XS7927PK1L76S	WSP2C2-4-5A/CI25
Model Number	S7927	WSP
Specifications	200 Ω Platinum wire Accuracy +/- 0.025 degrees C Stainless steel case 4-wire ¼ in diameter 1 inch temp sensitive zone 7.6 in case length	200 Ω Platinum wire Accuracy +/- 0.025 degrees C Stainless steel case 4-wire ¼ in diameter Maximum 1 inch temp sensitive zone 7.0 in probe length
Vendor Manuals	N/A	BURNS Bulletin 973A
Other	The 'X' in the original item part number means 200 ohm platinum, no 2.25 inch spring, and variable case length. For the MINCO design, the spring is used for strain relief. (See MINCO fax attached to this IEE)	-

Item Equivalency Evaluation Title/Station/Unit	IEE Number	Version
MINCO S7927 RTD, BURNS MODEL WSP / Millstone / Unit 2	10000008752	00

Part II Identification of Technical Requirements/Critical Characteristics

Note 1: If any end use locations have form, fit, functional, qualification or design requirements more restrictive than those required for the original item include the requirements below.

Note 2: If code reconciliation is required for any item location subject to ASME/ANSI/IEEE or original construction code ensure the reconciliation is documented below (e.g., NDE or testing changes).

Characteristic	Original	Replacement	Same/Different	Acceptable
Form	Precision Platinum Resistance Thermometer	Precision Platinum Resistance Thermometer	Same	Yes
Fit	Fits in 4 ¼ inch bore depth thermowell, contains nipple and connection head ½ inch NPT threads ¼ in diameter 7.6 inch case length Cable and sensor leads terminated at connection head No spring	Fits in 4 ¼ inch bore depth thermowell, contains nipple and connection head ½ inch NPT threads ¼ in diameter 7 inch probe length (length below spring). 8 ½ inch overall length. Cable and sensor leads terminated at connection head Spring Loaded	Different	Yes
Function	Provide a resistance value that changes with service water temperature	Provide a resistance value that changes with service water temperature	Same	Yes
Element	200 Ω Platinum 4-wire lead construction	200 Ω Platinum 4-wire lead construction	Same	Yes
Temperature Coefficient	0.00392 (Ω/Ω/°C min.)	0.003902 (Ω/Ω/°C min.), BURNS Engineering Curve No. 2	Different	Yes
Temperature Range	-180 to 260 Degrees C	-38 to 100 Degrees C (Range calibrated by vendor)	Different	Yes
Case Material	Stainless steel with copper alloy tip	Stainless steel case and tip	Different	Yes
Pressure Rating (psi)	100	3000	Different	Yes
Accuracy	+/- 0.025 degrees C	+/- 0.025 degrees C	Same	Yes
Stability (degrees C/yr)	+/- 0.05 at 0 degrees C	Unspecified	Different	Yes
Self-Heating	0.015 degrees C/mW	0.02 degrees C/mW	Different	Yes
Repeatability (degrees C)	+/- 0.01 at 0 degrees C	Maximum +/- 0.047 at 0 degrees C	Different	Yes

Item Equivalency Evaluation Title/Station/Unit	IEE Number	Version
MINCO S7927 RTD, BURNS MODEL WSP / Millstone / Unit 2	10000008752	00

Part III Evaluation of Acceptability of Replacement Item

IEE Basis -- Engineering justification for the acceptability of the differences in the critical characteristics:

Fit: The original item has a 7.6 inch case length and fits in a 4 ¼ inch bore depth thermowell. Walkdown of the original item showed that a nipple is used in the installation to accommodate the difference between RTD case length and bore depth. The replacement item will also be provided with a nipple to allow installing it, with its 7.0 inch probe length, into the existing 4 ½ inch bore depth. The replacement item installation configuration will be similar to that of the original item. The replacement item is spring loaded so that the element and thermowell are kept in contact firm contact. This item is acceptable.

Temperature Coefficient: The replacement item has a slightly different temperature coefficient than the original. However, the replacement item is still a 200 ohm platinum precision RTD and will be provided with full calibration data. Procedure MP-PROC-MP-IC 2429B will need to be updated with the replacement item's calibration data. This item is acceptable.

Temperature Range: The replacement item will be calibrated by the vendor over the range of -38 to 100 degrees C. This is acceptable since the system fluid is service water and in-service calibration of service water system temperature sensors is performed over a range of 0 to 100 degrees F.

Case Material: Both items have a stainless steel case. The original item has a copper alloy tip to improve sensor time response. The material for the replacement item tip is stainless steel. This may slow the replacement item's response time slightly, Burns Bulletin states a 5 ½ second time constant for the replacement item, but the critical performance characteristic of the replacement item is accuracy. Accuracy of the replacement item is the same as that of the original item. This is acceptable.

Pressure rating: The RTD is inserted into a dry thermowell. Additionally, the system fluid is low pressure service water. Pressure ratings for the original and replacement items are of no concern for the component locations evaluated. This is acceptable.

Stability: The stability of the replacement item is not specified. A review of Burns Engineering Technical Paper on stability, attached to this IEE, shows that the stability of a platinum resistance thermometer (PRT) at the service water system temperatures can be ignored as a potential error source. This item is acceptable.

Self-Heating: The self-heating effect for the original item is stated as negligible in calculation No. 98-ENG-02405D2. The replacement item's self-heating is approximately the same as that of the original item and would also be negligible in the calculation. This is acceptable.

Repeatability: The repeatability of the replacement item is conservatively high since it is specified over a temperature range that cycles up to 900 degrees F. The actual temperature conditions of the service water system where the replacement items will be installed provide a small range of temperature cycling so the replacement item repeatability will be much better than 0.047 and should be close to that stated on the MINCO drawing for the original item. Additionally, repeatability is not a source of error considered in calculation No. 98-ENG-02405D2. This is acceptable.

The replacement item will be provided with a full vendor calibration with calibration report and temperature verses resistance tables from -38 degrees C to 100 degrees C resulting in an accuracy of +/- 0.025 degrees C.

The replacement item has different wire lead colors, red and black, than the original item's colors which are red and white. This will require drawing updates upon installation of the replacement item.

☒ The Design Effects Table (DET) was reviewed and no programs were impacted.

☐ The DET is attached to this IEE.

Calculation 98-ENG-02405D2, Rev. 2
Attachment 1, Page 9 of 13 BULLETIN
REPLACEMENT ITEM 973 A

Burns Eng. 800-328-3871

SPECIFICATIONS
For Standard Length ¼" OD Type A, B, C, D, & G Elements

P. Wynn

ELEMENT RESISTANCE

Resistance at 32°F	Resistance Change at 32°F
100 ohm platinum	.22 ohms per °F
200 ohm platinum	.44 ohms per °F
500 ohm platinum	1.10 ohms per °F

The 100 ohm platinum element is most standard and least expensive. When the total resistance change for the 100 ohm element for a narrow temperature span does not meet the minimum resistance change for the instrument it is to be connected to, then a 200 ohm or a 500 ohm element should be selected. Example: If the temperature span is 50°F a 100 ohm element will have a total resistance change of 50 x .22 = 11.0 ohms. If the instrument requires a 20 ohm minimum span, then a 200 ohm element should be used, which has a resistance change of 50 x .44 = 22.0 ohms.

ACCURACY

All elements will follow the Resistance vs Temperature Tables shown on pages 8 and 9 within the interchangeability limits shown. Note that there are two classes of Precision Accuracy Elements as well as one class of Standard Accuracy Elements. These classes are identified by the resistance tolerance at the ice point (0°C).

PRECISION ACCURACY PLATINUM ELEMENTS

±0.02% of Resistance at 0°C. For stock sensors only.
±0.05% of Resistance at 0°C for all dual element and most non-standard sensors.

STANDARD ACCURACY PLATINUM ELEMENTS

±0.10% of Resistance at 0°C.
For all sensors.

The available accuracies are listed in the ordering information tables on the following pages.

REPEATABILITY

±0.1°F over range 32°F to 900°F. → 0.047 °C

MATCHED PAIRS

When two unmatched elements are used to measure temperature difference, one of the elements could be off by +1/2°F and the other, off by -1/2°F. This would result in a 1°F error in temperature difference. Matched pairs are selected to assure that the two elements are matched to each other to minimize errors. Thus, the error is not greater than 1/2°F at 32°F. (For the standard accuracy platinum elements.)

PRESSURE RATING

3000 psi at 700°F standard for all stainless steel sheath elements.

TIME CONSTANT

2½ seconds for 63.2% reponse in water moving at three feet per second for the type "D" sheath (1/8" diameter fast response tip).

5½ seconds for the type "A" sheath (1/4" diameter).

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SELF HEATING

Self heating is caused by electric current used to determine element resistance. The error is typically 50 milliwatts per degree centigrade for 1/4 inch diameter resistance thermometers in water moving at three feet per second.

0.02 °C/mW

Example:
Water moving at 3 feet per second.
Current of 2 milliamps.
Element resistance of 110 ohms

$$Power = I^2R$$
$$= (2 \times 10^{-3}\ Amps)^2\ (110\ ohms) = 0.44\ milliwatts$$

$$\text{Self heating error} = \frac{\text{Power}}{\text{Self-heating coefficient}}$$

$$= \frac{0.44\ \text{milliwatts}}{50\ \text{milliwatts}/^\circ C} = .0088^\circ C = .0158^\circ F$$

Example:
Same conditions except current is 5 milliamps

$$Power = (5 \times 10^{-3}\ AMPS)^2\ (110\ ohms)$$

$$\text{Self heating error} = \frac{2.75\ \text{milliwatts}}{50\ \text{milliwatts}/^\circ C} = .055^\circ C = .099^\circ F$$

Factors that affect self heating error are thermal conductivity and velocity of the process medium being measured. These are the same factors that affect time response.

For most applications self-heating error is negligible and can be ignored.

INSULATION RESISTANCE

With dry external surfaces the insulation resistance between any lead wire and the metal sheath will be as follows:

Sheath Temperature (°C)	Insulation Resistance, Minimum
20	200 Megohms at 100 VDC
225	100 Megohms at 100 VDC
500	10 Megohms at 100 VDC
650	5 Megohms at 100 VDC

TEMPERATURE LIMITS

PLATINUM ELEMENTS

Standard Limits -325°F to 900°F (element enclosed in type 316 stainless steel sheath).

Extended Limits -325°F to 1200°F (element enclosed in inconel sheath).

END SEAL AND LEAD WIRES

This portion of the element assembly is rated from -50°F to 200°F for the waterproof construction and -50°F to 400°F for the nonwaterproof construction with the No. 1 head (higher ratings available).

P. Wynn
MWW

BURNS
ENGINEERING

Error Sources
That Effect Platinum Resistance Thermometer Accuracy
Part 3 - Stability

Introduction

There are many sources of error that affect the performance of Platinum Resistance Thermometers (PRTs). These error sources are inherent in the design and manufacture of all PRTs, but the magnitude of the resulting error can vary greatly depending on the specific PRT design and environment that it is used in. It is important for users of PRTs to know and understand what these error sources are so they can make intelligent decisions related to PRT selection and use. The most common error sources fall within the following categories: Interchangeability, Insulation Resistance, Stability, Repeatability, Stem Conduction, Hysteresis, Calibration and Interpolation, Lead Wire Resistance, Self-Heating, Time Response, and Thermal EMF. This paper will discuss the topic of Stability.

Stability

Stability refers to the ability of a PRT to maintain its' Resistance vs. Temperature (R vs. T) relationship over time as a result of thermal exposure. Both ASTM E1137 and IEC 60751 address resistance change due to thermal exposure, however the criteria are somewhat different. ASTM E1137 essentially states that the PRT must meet the resistance tolerance for a Grade A or Grade B sensor as applicable, after 4 weeks (672 hours) of exposure to the maximum rated temperature. While this is a well defined criteria, it essentially does not permit any change in the resistance unless the manufacturer held a tighter tolerance to account for the change. IEC 60751 states that the PRT can change at 0°C by the equivalent of 0.15°C for a Class A sensor and 0.30°C for a Class B sensor after 250 hours at maximum rated temperature. While this standard allows for an R vs. T shift outside of the original tolerance, the 250 hour duration may be quite short for estimating longer term effects. Both of these standards leave something to be desired with respect to stability. Many manufacturers state stability specifications more like the IEC 60751 standard, stating a maximum change at 0°C as a result of exposure to maximum rated temperature for a given period of time. These specifications typically do not require the PRT to remain within the original R vs. T tolerance after the exposure.

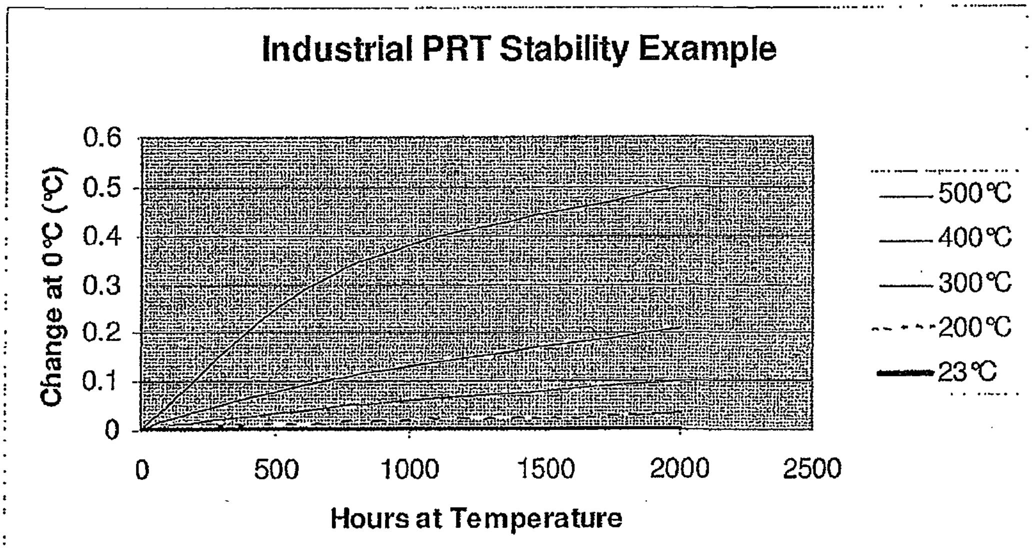
Given the information contained above, it may be possible to perform a comparison between PRTs, but it is likely insufficient for determining how a PRT will perform in actual use. In the case where the PRT is used continuously for one year (~9000 hours) at 350°C, what estimation of performance can be made if stability information of .15°C per

P. Wynn

250 hours at 500°C is the only detail provided? Additional information regarding stability would certainly be beneficial.

The additional information that would be valuable for estimating stability error would be a set of specifications that state the change due to exposure to varying temperatures over varying intervals of time. Typically three or four temperatures including the maximum rated temperature, would be adequate to estimate stability. The graph in Figure 3-1 below gives a realistic representation of the stability of a typical industrial PRT at 5 different exposure temperatures.

Figure 3-1



By examining Figure 3-1, a few generalizations can be made about the stability of this industrial PRT. These generalizations hold true for the behavior of most industrial PRTs, however the numbers, maximum temperatures, etc., will all be unique based on the specific PRT design. If a better understanding is needed regarding a specific PRT, the manufacturer of that PRT should be consulted.

1) The resistance change due to exposure to room temperature and below can be considered negligible. Test results on several industrial PRTs have shown that the ice point resistance shift following 25,000+ hours at 23°C is less than .01°C. This is a very small change in comparison to other potential error sources. 73.4°F
2) The magnitude of the change increases with increasing exposure temperature and is a maximum at maximum rated temperature. For example, the change after 1000 hours will be larger for an exposure temperature of 500°C than an exposure temperature of 400°C.

Service water temperature < 25°C

3) The magnitude of the change is not linear with temperature and cannot be extrapolated beyond the upper temperature limit. For example, the change caused by exposure to 550°C cannot be reliably predicted based on the changes observed due to 500°C or 400°C exposure.
4) The rate of change over time is fairly linear and remains fairly constant. For example, the change after 2000 hours can be approximated as twice the amount of change as was present after 1000 hours for the same exposure temperature.

Given the generalizations above along with the information illustrated in Figure 3-1, a reasonably accurate estimation of stability can be made for the hypothetical example of a PRT at 350°C for one year. The stability can be estimated by looking at the graph and estimating a change after 1000 hours for a 350°C exposure. According to the graph, this would be approximately 0.1°C. Multiplying this number by 9 to determine the cumulative effect over 9000 hours gives a result of .9°C maximum change at 0°C after one year of exposure to 350°C. This is likely to be a more accurate estimate than extrapolating the IEC 60751 requirement of .15°C (or .30°C) per 250 hours out to 9000 hours which would result in an estimated value of 5.4°C (or 10.8°C)

Causes of Stability Error

Many factors can contribute to the instability of a PRT, but the most prominent source of instability is contamination of the platinum in the sensing element. Contamination can come from a variety of sources, such as metals that alloy with platinum at elevated temperatures, and very small amounts of these contaminants can have large effects on resistance. The materials and processes used to manufacture the sensor must be carefully selected and/or developed such that they have minimal affect on the platinum at temperatures up to the maximum rated temperature of the PRT. Cleanliness during manufacture is also critical as any foreign substance may become a source of contamination. In general, the materials, processes, and cleanliness become more critical as the maximum rated temperature of the PRT increases.

How to Reduce Stability Error

Since stability is controlled almost exclusively by the design and manufacture of the PRT, the best way to reduce stability error is to select a high quality PRT that has a low specified stability. When selecting a PRT, the stability must be considered for the maximum temperature of use, not necessarily the maximum rated temperature of the PRT itself since many PRTs are not used to maximum rated temperatures. Never expose PRTs to temperatures in excess of their maximum rated temperature without consulting the manufacturer first to determine the effect on stability. Also, avoid unnecessary exposure to elevated temperature, the less time the sensor is exposed to elevated temperature the smaller the cumulative effect.

As mentioned in Part 1 on Interchangeability, using a transmitter with "matching" capabilities can nearly eliminate interchangeability error and the same is true with stability error. Periodic calibration of the PRT and transmitter system can allow a transmitter to be matched to the newly characterized R vs. T relationship of the PRT. This can "calibrate out" the change of the PRT due to stability, and significantly reduce the cumulative effect of this error source.

Summary

There are many sources of error that affect the performance of a PRT. One of these sources is Stability, the ability of a PRT to maintain its R vs. T relationship over time as a result of thermal exposure. The most prominent source of instability is contamination of the platinum sensing element which can come from the materials, build processes, and foreign substances introduced during manufacture. The best way to reduce stability error is to select a high quality PRT that has a low specified stability and to minimize the PRTs exposure to elevated temperatures. Matching a transmitter to a PRT and periodically calibrating the system to adjust for changes can significantly reduce the cumulative effect of this error source.

John Zwak
Metrology Engineer
jzwak@burnsengineering.com

www.burnsengineering.com
www.burnsengineering.com/BEblog/

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Attachment 2