random NEWS
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A Growing Hart

By Chris Juchau, President

When Fluke bought Hart Scientific almost six years ago, we told you that some things would change and some things wouldn't. People were wondering: would Hart go away, would we lose our personality, would we get lost in the Borg? Perhaps this is a good time to look back and see what's really changed. (And with DHI recently joining the Fluke family, perhaps these questions have added significance.)

The list of what has changed includes our logo (it's yellow now), our growth curve (it's steeper), our ability to provide local expert service at a half-dozen service centers around the world (it's better), the robustness of our new product designs (they're improved), and the timely delivery of our products (we're faster and more often on time than ever before).

Hart today is a better-performing, stronger organization than it's ever been. A lot of credit for that goes to our team here in American Fork, Utah. But a lot of it is also due to the professionalism and coaching of our friends at Fluke.

The list of what hasn't changed includes our pursuit of customer satisfaction, our commitment to the highest levels of metrological integrity, and the excellence of our team.

For example, when you call into Hart from the U.S., either for sales or service, you still get connected directly to the most helpful temperature experts anywhere; our most recent product introductions (the DewK Thermo-Hygrometer and Metrology Wells) include breakthroughs in metrology; and of the last 100 people who sent me a completed service reply card, 99 of them said they would return to Hart for future service (and we haven't given up on the last one).

One thing about Hart that I hope never changes is our down-to-earth attitude—our ability to be honest and treat people the same way we'd want them to treat us. A little common sense can go a long way, particularly in customer-supplier relationships. That's one reason why rutabagas are an important part of Hart's history.

A customer once asked me if being a part of a much larger corporation was going to make us "arrogant." I certainly hope not!

Yes, there are things we're proud of. But we stay in close touch with our shortcomings, too, and that keeps us continually striving to get better—particularly in the eyes of our customers. One of the things we've done better in recent years is solicit input from our customers. "Voice of the Customer" studies now have a direct impact on our product development plans as well as our service and manufacturing operations. (By the way, if you haven't joined the Hart Scientific Advisory Board, you can do so at our website at www.hartscientific.com. Please do.)

Take these two recent comments from customers as examples. One wrote: "The time it takes to receive equipment back is longer than I would like." That's a motivating comment! Turnaround time is critical for people who rely on their instruments—we understand that. That's

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Inside

Metrology Wells versus dry-wells: do vertical gradients really matter?

By Mingjian Zhao, Director of Primary Standard Engineering

Dry-well calibrators are widely used as temperature standards in many calibration laboratories and in various industrial fields. It's well known that the axial temperature uniformity of a dry-well calibrator is generally worse (usually much worse) than that of a liquid bath. How much do these vertical temperature gradients really affect your calibration? Why would you consider Metrology Wells as an alternative to both dry-wells and fluid baths?

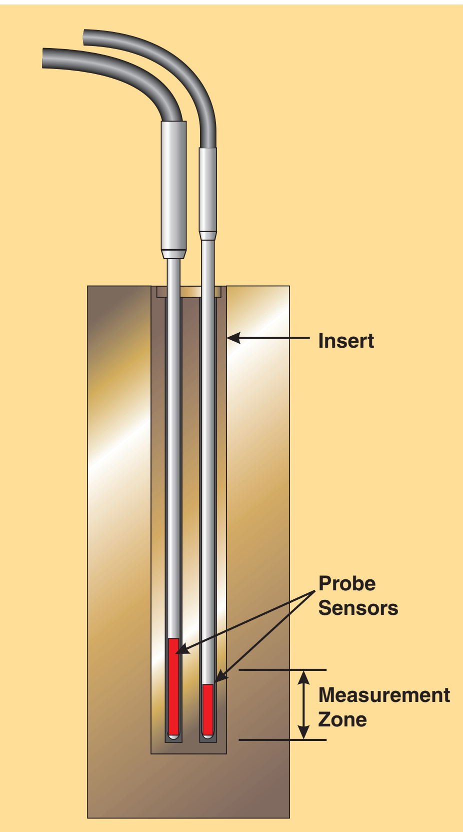


Figure 1 Probe sensors location in the block

Axial temperature uniformity and its contribution to calibration errors

The top and bottom of a dry-well lose heat at different rates than at the center. This occurs because the bottom end is better insulated from ambient effects than is the top end. The result is a temperature gradient axially along the well. The design of the dry-well compensates for this gradient by attempting to distribute heat to varying optimal degrees along the length of the block. This is very difficult to do, however, because axial temperature uniformities vary at different temperatures, creating ever-changing profiles of needed heat distribution.

A thermometer's reading in a dry-well is the average value of the sensed temperatures along the sensor in the block of the dry-well. PRT sensors have varying lengths and may be located at slightly different positions within their sheaths. Comparing different types of sensors (for example short, sensitive thermocouples or thermistors to long PRT sensors, can create a significant axial location difference making these comparisons particularly susceptible to axial gradients. Therefore, axial temperature non-uniformity of a dry-well calibrator can be a significant contributor to calibration error.

What makes the difference in Metrology Wells?

In order to reduce calibration errors and improve the performance of field-usable calibrators, a new type of calibrator with dual-zone control, named "Metrology Wells," was developed at Fluke's Hart Scientific division. Many new technologies are applied in the Metrology Wells, and overall performance is improved dramatically over dry-wells. The biggest improvement comes from the excellent axial temperature uniformities across each Metrology Well's entire temperature range. This improvement comes from technology that automatically adjusts the temperature at the top zone to minimize the differential temperature between the two zones at any temperature setting.

Axial uniformity of Metrology Wells vs. dry-well calibrators

Tests show that measurement results vary significantly when using two different PRTs with different sensor dimensions in the same dry-well at the same temperature. Figure 2 illustrates the relatively poor axial uniformity of a typical dry-well; it also shows that the shorter the sensing element of the thermometer used to measure the uniformity, the worse the uniformity appears, since each element averages the temperatures sensed across its length. Figures 2 and 3 also indicate the significant difference in performance of a Metrology Well.

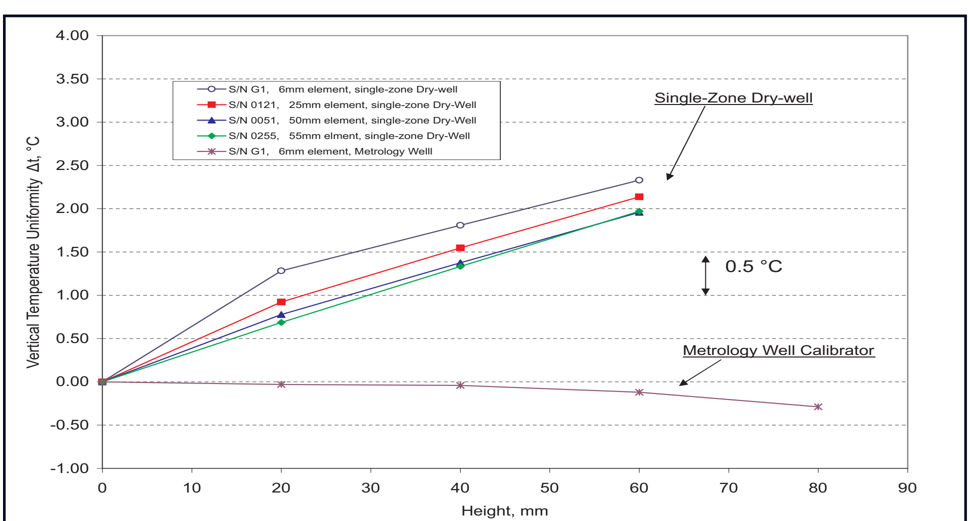


Figure 2 Axial temperature uniformity at 660 °C using different PRTs

Calibration using the single-zone dry-well calibrator

To see the typical magnitude of errors derived from a dry-well, including axial gradients, radial gradients, and stem conduction, several PRTs were calibrated using a dry-well and a reference thermometer. Four PRTs with identical element lengths were tested after they were first calibrated in fixed-point cells to ensure consistent results. Then the PRTs were measured in the dry-well calibrator at a temperature near 660 °C. The measured temperatures of the PRTs are shown in Figure 4. The maximum difference was slightly less than 0.1 °C. Since the PRTs were of similar construction, differences due to axial temperature non-uniformity and stem conduction would be negligible, leaving us to conclude that most of the error is due to radial temperature non-uniformity.

When using PRTs of varying element lengths, the errors were much larger. The results of comparing PRTs with different element lengths at 660 °C are shown in Figure 5. These also were previously calibrated in fixed-point cells for consistency. The differences between measurements were as large as nearly 2 °C. The tight fit of the probes in the wells and their adequate immersion depth precluded stem conduction from causing such large errors. We have to conclude that the large errors are primarily due to the effects of axial temperature gradients.

Calibration using the Metrology Well calibrator

Similar tests were performed with a Metrology Well. Eight precision PRTs with different element lengths were used in the experiment. All PRTs were calibrated by fixed-point cells from water to aluminum. The sensor element lengths of the probes are all less than 55 mm, but vary. Results of comparing each of seven of the PRTs against the eighth at three temperatures are shown in Table 1.

Verticle Gradients *continues next page*

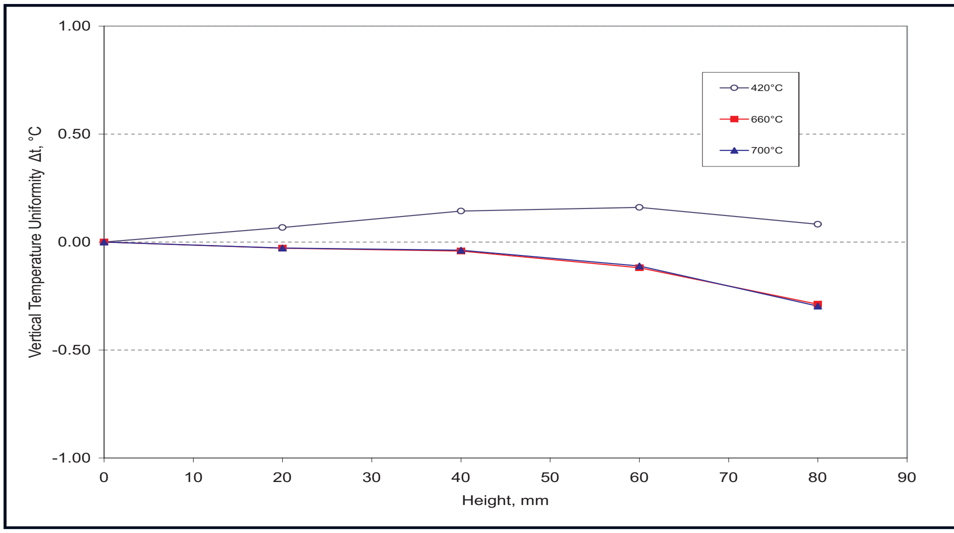


Figure 3 Axial temperature uniformity of a Metrology Well at different temperatures

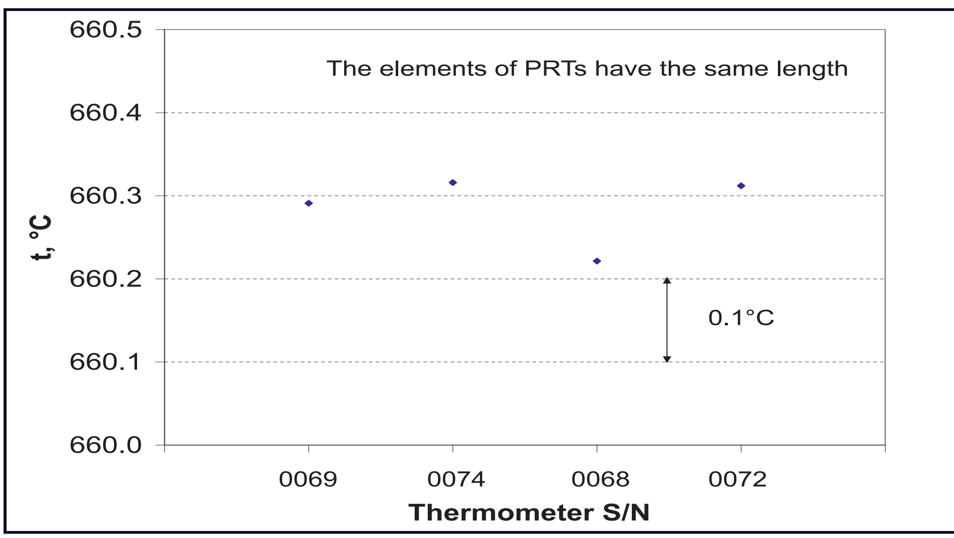


Figure 4 Comparison calibration of PRTs with identical element lengths at 660 °C in a dry-well

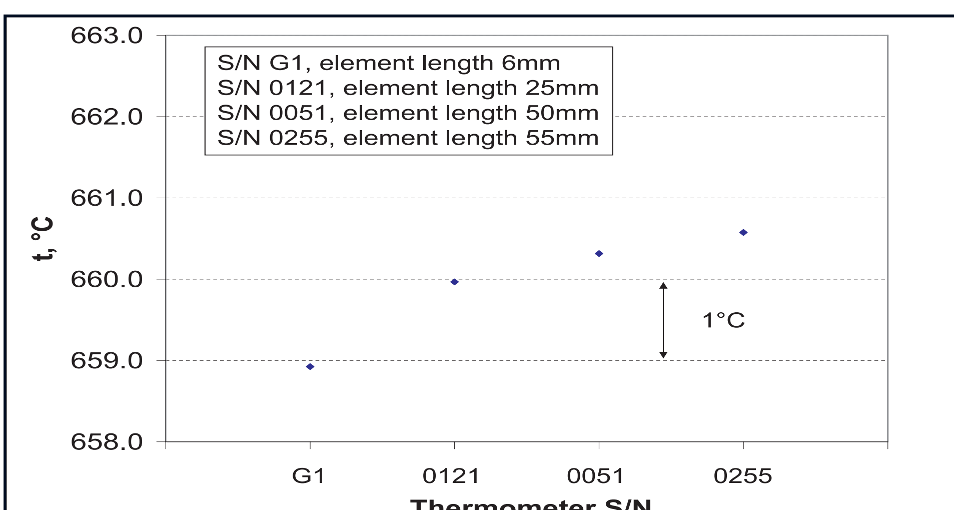


Figure 5 Comparison calibration results of PRTs with different element lengths at 660 °C

Verticle Gradients *continued from previous page*

Table 1. PRT Comparisons in a Metrology Well Calibrator (differences in °C)

Temperature Set Points	UUT #1	UUT #2	UUT #3	UUT #4	UUT #5	UUT #6	UUT #7
Element length	50 mm	6 mm	50 mm	25 mm	50 mm	55 mm	45 mm
660°C	+0.03	-0.01	+0.02	-0.01	+0.03	-0.08	-0.01
420°C	+0.02	-0.01	+0.01	-0.00	+0.02	+0.02	-0.02
232°C	+0.01	-0.01	+0.01	-0.01	+0.01	+0.02	+0.01

Conclusion

These simple tests illustrate that the axial uniformity of Metrology Wells can be 10–20 times better than the axial uniformity of a typical dry-well. This matters because in many cases axial uniformity is the largest single contributor to uncertainty when using a dry-well, and because axial uniformity can affect other components of uncertainty, such as radial uniformities, thermal loading effects, stem conduction heat loss, and control stability.

Does this mean that dry-wells are poor instruments? Of course not. Dry-wells are perfectly suited for many field applications with less rigorous performance requirements. They are fast, light, portable, inexpensive, and perform perfectly well for many applications. Does it mean that Metrology Wells can replace fluid baths? In some cases, yes; the performance of Metrology Wells is so good that their speed and absence of a fluid can be taken advantage of, in both field and lab applications. However, the very best temperature stability and uniformity over most commonly used temperatures are still found in a bath. And baths have that wonderful characteristic of being able to handle thermometers of many varied types, sizes, and sensor dimensions. ■

Crossword puzzle

Using Metrology Wells

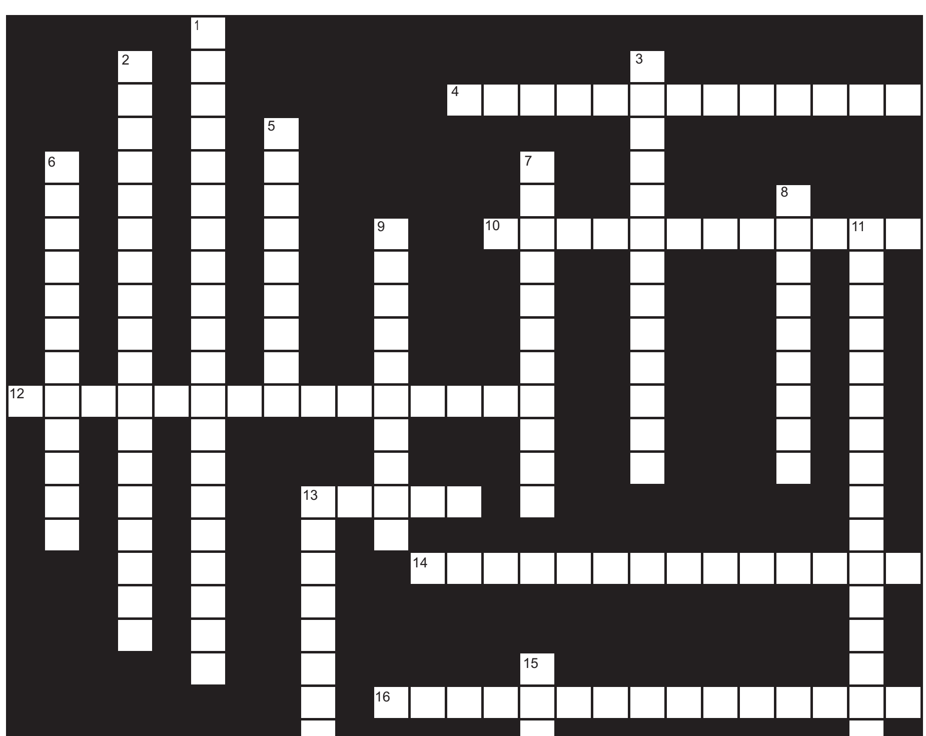
For help with this crossword, refer to "Understanding the uncertainties associated with the use of Metrology Wells," available at www.hartscientific.com/publications/articles.htm.

Across

4. Measures internal temperature (2 words)
10. Technique to reduce comparison errors from a vertical gradient (2 words)
12. What you want to characterize (3 words)
13. Change in value over time at a specific temperature
14. A heat flux along the length of the thermometer (2 words)
16. Vertical temperature gradient (2 words)

Down

1. Smaller uncertainties can be achieved using this (2 words).
2. Wherever you are, this is there too (2 words).
3. The name of an error that occurs when multiple probes are inserted into the block (2 words)
5. Measurement errors can exist without enough of this.
6. Rule of thumb to calculate immersion requirement: 20 x probe OD + this (2 words)
7. Error that results when current is passed through a sensor (2 words)
8. One of the most important specifications in any temperature source
9. A condition where measurement values depend on previous (historical) measurements
11. Temperature gradient between wells (2 words)
13. This type of control reduces the vertical gradient.
15. The number of heat sources that introduce at least some measurement error



New Product Announcements

1620A "DewK" and 9936A Log*Ware* III

The 1620A DewK Thermo-Hygrometer and 9936A Log*Ware* III run on your wireless or ethernet network and notify you if there's an environmental problem.

The 1620A is a dual-sensor, graphical data logger and analyzer that displays real-time and historical temperature and humidity data. It reads temperature to ± 0.125 °C and humidity to ± 1.5 % RH. Sensors are individually calibrated and can be interchanged between channels and units while retaining full calibration integrity. Although the DewK can be used alone, its best features are realized when it is used with Log*Ware* III.

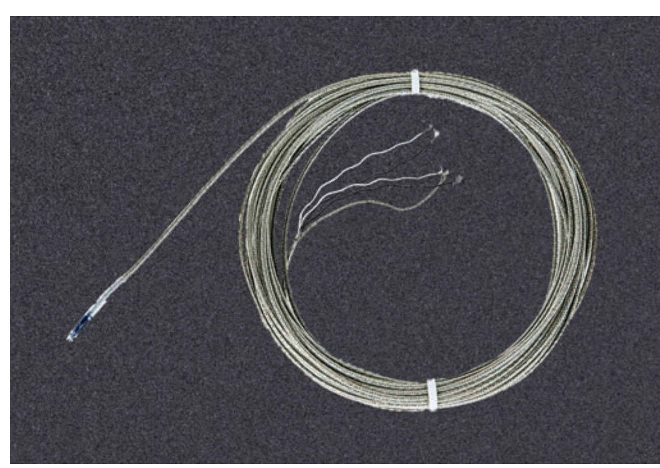
9936A Log*Ware* III is an optional client-server database program that retrieves, stores, and analyzes data from the DewK. This versatile application lets you store data from every DewK on your network in a single database, and then monitor live or recorded data from as many computers as you have licenses. It even sends notifications via email to PDAs and cell phones when user-defined events occur.

5947 Mini Metal-Cased Aluminum Cell

The 5947 Mini Metal-Cased Aluminum Cell completes Hart's set of metal-cased fixed-point cells that spans from 29.7646 °C to 660.323 °C. These cells meet the requirements of the ITS-90 and also overcome the fragility of the classic quartz fixed-point cells. If you're calibrating working SPRTs, PRTs, or thermocouples and want the most accurate calibration possible, these cells will give it to you.

These mini cells can achieve nearly the same uncertainty levels as Hart's traditional fixed-point cells, but Hart's 594X series of mini cells cost less, work faster, and are easier to use than traditionally sized cells because they can be used in our 9260 Mini Fixed-Point Cell Furnace. The 5947's immersion depth is 156 mm (6.14 in), and the diameter of its reentrant well is 7.8 mm (0.31 in).

5611T Teflon Probe



The 5611T Teflon Probe's unique construction makes it an especially versatile thermistor. With a tip that is just 3 mm (0.120 in) in diameter and a Teflon coating that makes it impervious to most liquids, the Teflon Probe is handy for measuring in a wide variety of applications, including bio-pharmaceuticals. It's even immersible to nearly 20 feet and very flexible.

The 5611T's thermistor bead is encapsulated in a mylar sleeve that is encapsulated inside a Teflon sleeve. The Teflon sleeve is melted around the Teflon-insulated cable, forming a moisture-proof seal.

The 5611T's has low self heating, fast response times, and is less susceptible to mechanical shock than a PRT. ■

Myth Busters

Myth: I just got my probe recalibrated, so now I just hook it up to the readout, load the coefficients and start measuring. I don't have to worry about the probe's calibration until it's recalibrated.

By Mike Coleman, Cal Lab Manager

Surprisingly, this is exactly how many people handle their probes' calibrations. Following this practice saves a little time, but the cost can be severe. Recently, a company lost over a million dollars of product and six months of calibration work. The culprit was simply a PRT probe that shifted, probably during shipping, and wasn't checked before being returned to service.

I hope this article will give you some ideas on how to make your temperature measurement program bulletproof by closing the loop on your probe calibrations.

What does "closing the loop" mean?

"Closing the loop" is completing the series of steps a probe should pass through as it is calibrated and used. In other words, there is more involved in managing a probe's calibration than just sending the probe out for calibration every year.

The first step is a measurement taken to capture the status of the probe before it is boxed up and sent into shipping. This measurement closes the loop on the work the probe has done. When the probe is received back from calibration, another measurement is taken to verify that the probe didn't shift during return shipment. Both the send-off measurement and return measurement are compared with the calibration report. This enables you to monitor the status of the probe, and it also provides a crosscheck between the calibration lab and your lab.

Measuring a probe before and after shipment may be the most important measurements in the overall calibration loop. Many probes and instruments are damaged beyond repair while in shipping. Make sure your work is closed out before shipping a probe.

How do I know if the probe is in tolerance?

Just because the probe was calibrated and given a calibration certificate doesn't mean it was in tolerance. This might sound obvious, but I have had this conversation with enough customers to know that it is a common misconception. Someone who is surprised by this always follows up with the question "How do I know if the probe is in tolerance?"

Basically, the tolerance status of a probe is calculated by comparing the new calibration with the previous calibration. We answered this question in more detail in a previous Random News. Please refer to *Random News* Number 8.

How can "out of tolerance" be avoided?

The goal of all measurement programs is to make sure that everything always works and nothing is out of tolerance. Of course, the better the measurement program, the less often instruments are out of tolerance. Measuring a probe as it is sent out for calibration and when it is received from calibration is good, but the probe also needs to be monitored as it is being used.

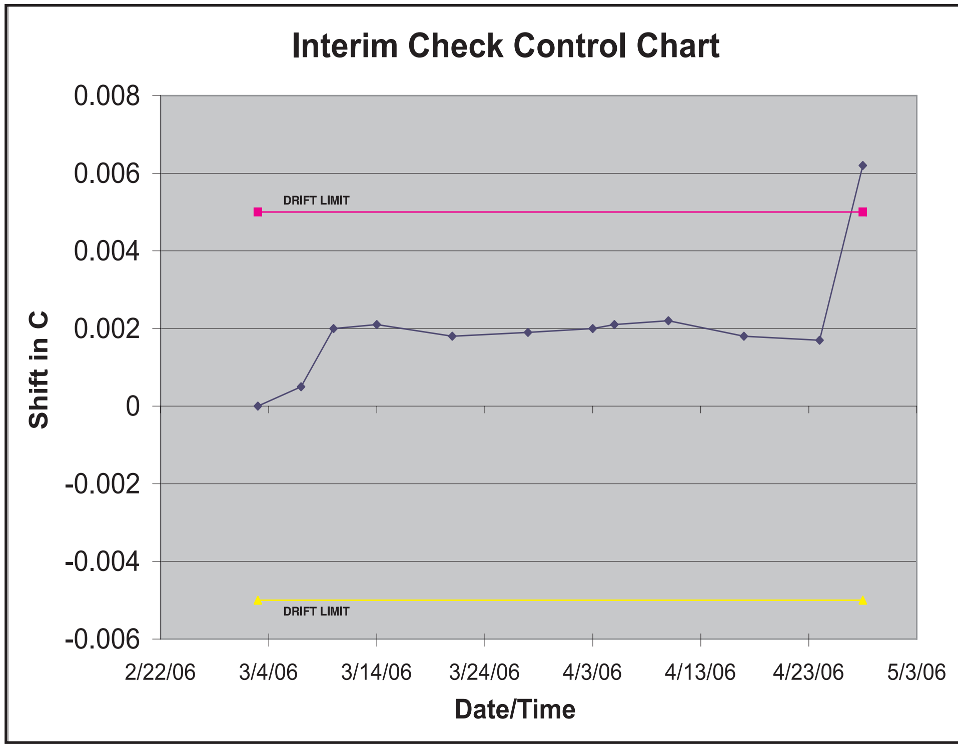
One of the difficulties in measuring temperature is that probes are typically very fragile so their performance is very dependent on care and handling. Manufacturers may spec a probe's long-term drift, but the only sure way to know the performance of a probe is by implementing interim checks and control charts (see the sample control chart in Figure 1).

Whenever interim checks are mentioned, someone always says "Who has the time?" My answer is "Who has the time to recall six months or a year's worth of work?" In the situation mentioned earlier, a 30-minute check every week would have saved the company over a million dollars and six months of work.

How often should the probe be checked?

There are no established rules that define how often an interim check should be done. One approach to establishing an interval is to decide the largest recall interval you are comfortable with and set the interim check interval accordingly. For example, if you calibrate 10 instruments a week with your temperature probe, then a weekly interim check may be sufficient. The largest risk would be the recall of 10 instruments. A daily interim check would limit the risk to recalibration of two instruments.

At each interim check, record the data on a spreadsheet or in a lab book. Graph the data. This is the beginning of a control chart. Add control lines to the chart to indicate how much the probe can drift before it exceeds the limits set in the calibration program (see Figure 1). The sample control chart shows the data of a probe measured about every seven days. On 4/28/06 the probe's shift was verified to be about 0.006 °C, which exceeds the process limit. Only four days of cal work may have to be recalled due to the shift.



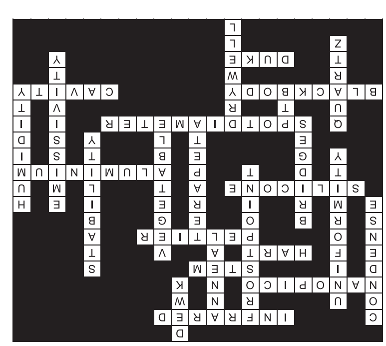
Figue 1 Sample of Interim Check Control Chart

What temperature points should be measured?

This is an essential question to ask because, depending on the situation, many different temperatures can be used. Mainly, the temperature point(s) should be fairly simple to achieve and, importantly, the temperature point(s) must be repeatable. Let's go over a few options.

The triple-point of water (TPW), 0.010 °C, is most often used for closing the loop in probe calibrations. At Fluke 's Hart Scientific division, the TPW is measured multiple times in every platinum resistance thermometer (PRT) calibration to monitor the probe as it is calibrated.

The TPW is very important in PRT calibrations because it can be used to troubleshoot several types of problems that affect PRT performance. Not only is the TPW included in every ITS-90 calibration, it is used in every ITS-90 measurement as well. The ITS-90 was designed to allow the user to update the probe's RTPW (resistance at the triple-point of water). Updating the RTPW coefficient can also help reduce errors due to probe drift. For these reasons, the TPW is the first choice for a quick check to verify and close the loop on a PRT. ■



Random News 10 crossword solution.

Q and A

with Steve Iman

Question: Why did my temperature sensor fail calibration?

By Steve Iman, Consultant

Temperature is the most commonly measured parameter in the world. Temperature sensors are used in instruments designed for measuring temperature. To be accurate, all temperature sensors must be calibrated against a known standard. Only short-term stability is checked during calibration. Long term stability should be monitored and determined by the user.

Occasionally, a temperature sensor might fail during calibration. This can happen even though the temperature sensor seemed to be functioning properly prior to sending it in for calibration. This article gives some basic reasons for temperature sensor failures and offers some suggestions to ensure their accuracy and maximize their useable life. In addition, some background knowledge is given on each temperature sensor type, including basic characteristics and their limitations.

Common temperature sensor types

Thermistors, platinum resistance thermometers (PRTs), and thermocouples are the instruments of choice for most temperature measurement applications. Each has specific characteristics and limitations. Normally, these instruments are reliable and give years of trouble-free service. Mistreating them, however, greatly affects their accuracy and useful life. Therefore, it's imperative that they be handled and used properly. To do so, you must understand how they operate and what their limitations are.

Thermistors

Thermistors are among the most robust of all temperature sensors. They are constructed of a solid state device that acts like a variable resistor. As the temperature changes, so does its resistance. These devices have excellent sensitivity and accuracy. They come in a wide range of resistance values. They have excellent long term drift characteristics and are not shock sensitive, nor do they suffer from other concerns that other thermometer types may have. Because they are not shock sensitive, their calibrations generally are not affected by minor vibration, being bumped or dropped. However, their temperature ranges are usually limited to a 100 °C span.

Platinum resistance thermometers (PRTs)

PRTs are perhaps the most versatile of all temperature sensors because of their wide temperature range and high accuracy. Most are usable from -196 °C to 420 °C, with a few exceptions that reach up to 500 °C or even higher. This, of course, depends on individual model specifications and their respective calibrations.

Even though PRTs are highly accurate and cover a wide temperature range, they do have limitations. Unlike thermistors, PRTs are subject to changes in calibration if the platinum wire is contaminated, exposed to vibration, bumped or dropped. Changes in calibration through these processes are cumulative. Therefore, great care must be taken when handling and using PRTs.

Thermocouples

Base metal thermocouples have advantages in that they have a very broad temperature range and are low in cost. Their disadvantages include relatively low accuracy and, at very high temperatures, they are susceptible to inhomogeneity. Noble metal thermocouples have a very broad temperature range with higher accuracy, but they cost more. Like base metal thermocouples, they are also susceptible to inhomogeneity.

Causes of failure during calibration

Self-heating in thermistors and PRTs

When thermistors and PRTs are calibrated, a nominal excitation current is applied. The amount of current that's required is generally stated on the calibration report or manufacturer's specifications.

We learn from Ohm's Law that when a current flows through a resistor, power is dissipated (I^2R). This power causes the sensor to heat which is known as "self-heating." When the temperature sensor is calibrated, its self-heating has been accounted for.

When using either sensor type, be sure to set the readout for the proper excitation current. Too little or too much current will cause measurement errors. These sensors can even be damaged if too much current is applied.

Some readouts will automatically choose the proper current when either "thermistor" or "PRT" is selected. Others may need to be set manually. The settings are generally in the probe setup menu. If you select the current manually, always refer to the thermometer's specifications or calibration report for the proper current.

Low insulation resistance and leakage currents

Low insulation resistance is sometimes referred to as shunt resistance, because current is allowed to flow outside of the measurement circuit. Electrically, it is like putting another resistance in parallel with the sensor. When low insulation resistance occurs, too often the transition junction temperature has become too hot. (Generally, the hub should not be so hot that it is painful to touch.)

Additionally, low insulation resistance may result if the sheath has been bent, or if the seal has been compromised, allowing moisture to reach the sensor and lead wires. This problem usually can be avoided through proper use and handling.

Transition junctions

Thermistors and PRTs generally have transition junctions. The transition junction is where the cable lead wires connect to the sensor lead wires. The lead wires will either be soldered or spot welded. If they are soldered and the junction gets too hot, the solder will melt, causing an open or intermittent condition.

Usually, the junction is sealed with epoxy to keep out moisture and other contaminants. If the seal is subjected to temperatures that are beyond what the epoxy can handle, the seal may crack. This allows moisture and other contaminants to penetrate the seal and reach the lead wires and sensor. Moisture accumulation is most noticeable when the temperature sensor is left to soak at temperatures below ambient or if the ambient humidity is high.

PRTs are often packed with powdered insulative material. This material makes the PRT less susceptible to stress caused by mechanical shock. Unless a good seal exists, at low temperatures the insulation absorbs moisture from the air. Moisture or other contaminants create errors in the measurements and cause the temperature sensor to fail calibration. Trapped moisture can also present a safety concern. If the insulation has absorbed a lot of moisture and the temperature sensor is put into a high temperature heat source, the moisture will turn to steam, possibly causing the seal to blow or rupture the sheath.

Broken or intermittent lead wires

If the temperature sensor cable is pulled, overworked or stressed, the lead wires may break, causing an open or intermittent connection. Some intermittent events are not noticeable until the temperature sensor is heated, causing the wire to expand and separate.

Even if great care has been taken to prevent broken or intermittent connections, they still may occur given enough time and use. The repeated expansion and contraction of the lead and sensor wires may eventually take its toll, causing the wire to break.

Contamination

Contamination can be caused by chemicals, metal ions or oxidation. Chemical contamination can occur in PRTs if a liquid reaches the lead or sensor wires. This can change the purity of the platinum, which alters its electrical characteristics. Any changes in the purity will be permanent.

Metal ion contamination of platinum wire usually occurs at 600 °C and higher. Because PRT sensors are manufactured using high purity platinum wire, they are the most susceptible to this type of contamination. Metal ion contamination is not reversible and will cause a PRT to constantly drift upward in temperature. This is particularly noticeable in a triple-point-of-water cell, where the reference temperature is extremely stable. When a PRT is manufactured for extremely high temperatures, it's constructed in such a way that the sensor is protected from ion contamination.

Temperature sensor sheaths are usually sealed to guard against contamination. Both industrial and secondary temperature sensors are not evacuated before being sealed. Generally, therefore, there will be some dry air inside them. When they are exposed to various temperatures, oxidation can form on the surface of the wire. Oxidation primarily affects temperature sensors whose sensing elements contain platinum wire. Oxidation causes an increase in RTPW (resistance at the water triple point) in metallic RTDs. Fortunately, oxidation can be removed by annealing the RTD, using the manufacturer's recommended temperature and procedure. Before and after annealing, compare the temperature sensor with a standard of superior accuracy such as a triple point of water cell. This

Q and A *continues next page*

allows you to determine whether the procedure was successful, and it helps you keep a history of the temperature sensor's performance.

Hysteresis and non-repeatability

Hysteresis is a condition in which a temperature sensor's readings lag behind or appear to have a "memory" effect as the thermometer is moved through a sequential range of temperatures. Measured values depend on the previous temperature in which the sensor or wire was exposed. If a temperature sensor is taken through a range of temperatures for the first time—let's say, from cold to hot—it will follow a particular curve. If the measurements are repeated in the reverse order, (hot to cold in our example), a thermometer that has a hysteresis problem will have an offset from the previous set of measurements. If repeated, the amount of offset may not always be the same.

Hysteresis does not occur with undamaged standard platinum resistance thermometers (SPRTs), because SPRTs are designed to be strain free. PRTs that are designed to be rugged, however, do not have a strain-free design and have at least some hysteresis. Additionally, moisture ingress, or moisture penetrating inside the temperature sensor, causes hysteresis in RTDs of any type.

Inhomogeneity

When a thermocouple is used at high temperatures, its wire may become contaminated. This causes the local Seebeck coefficient of the wire to change from its initial state. In other words, this alters the sensitivity of the wire to changes in temperature. However, the temperature exposure and contamination may not be uniform along the length of the thermocouple. The Seebeck coefficient then becomes a function of position along the thermocouple. This leads to measurement errors that depend on the temperature profile the thermocouple is exposed to all along the length of the thermocouple, and not just the temperature at the measurement junction.

Short term stability

Measurement repeatability is a term than can be used many different ways. It should be defined by the person using the term. It often refers to the RTPW repeatability during a segment of thermal cycling or a calibration process.

When a temperature sensor fails to meet its short term stability specification, it means the deviation between measurements at a particular temperature is outside its specification. This could be caused by a large standard deviation or by readings that continually drift in one direction. Potential causes for short-term stability problems include moisture, contamination, strain, leakage current, mechanical shock and inhomogeneity.

Ways to help prevent temperature sensor failure

To avoid contamination, take proper precautions when using temperature sensors in harsh environments. Do not subject the transition junction to higher or lower temperatures than the epoxy seal or transition junction can handle. Refer to the temperature sensor's specifications or contact the temperature sensor manufacturer for the transition junction temperature specification. If there is a possibility that the transition junction could be exposed to high or even marginally high temperatures, a heat shield or heat sink is recommended.

Other ways to help prevent failure:

- Do not drop, bump, or vibrate a PRT.
- Never bend a sheath that isn't designed to be bent. Even slight bends may adversely affect the calibration or temperature sensor life.
- Never submerge the transition junction into a liquid unless it was designed to be submerged.
- Never exceed the temperature specification of the temperature sensor.
- Do not soak temperature sensors for long periods of time, particularly at temperatures where oxidation is likely to occur.
- Do not pull or overly strain the temperature sensor cable.
- If a temperature sensor requires annealing, use recommended temperatures and techniques. Afterwards, always verify the temperature sensor's accuracy by comparing it against a primary standard.
- Periodically compare the temperature sensor's accuracy to a primary standard, such as a water-triple-point cell or a calibrated SPRT (standard platinum resistance thermometer). ■

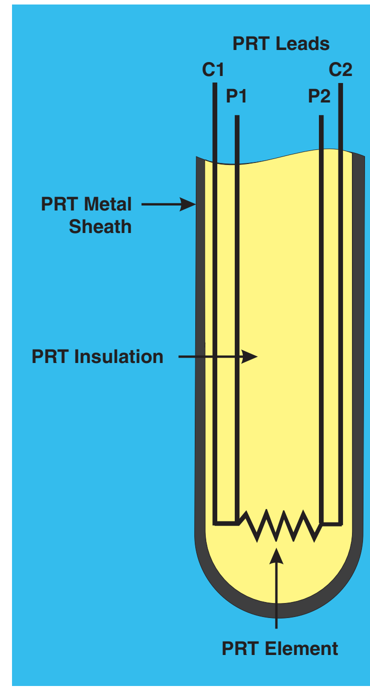
The importance of good insulation resistance in metal platinum resistance thermometers

By Tom Kolat, Senior Metrologist

Good insulation resistance in a metal sheathed platinum resistance thermometer (PRT) probe is important for obtaining accurate and stable temperature measurements. If a probe is cycled frequently between hot and cold temperatures, its components become fatigued over time, and moisture can leak through the sheath seal at the probe handle. This is a common cause of decreased insulation resistance and noisy measurements.

Cold temperatures allow moisture to leak through the sheath seal into the probe's insulation. This leakage corrupts the dielectric property of the probe, and resistance shifts occur. A probe can be taken to high temperatures to dry the insulation and temporarily correct the dielectric property. However, this does not repair the broken seal, and the problem can be expected to return when the probe is reintroduced to cold temperatures.

The diagram at right is an amplified, cutaway view of a typical 4-wire PRT that illustrates the key components: PRT element, sheath, insulation, and leads.



The resistance of the insulation between the metal sheath and any of the four PRT leads should be greater than 500 MΩ at room temperature for most 25 Ω metal sheathed PRTs.

Testing PRT insulation resistance

Insulation resistance should be checked with a multimeter or insulation tester with resistance or insulation test ranges of 0 to 500 MΩ or more. Be sure to abide by the manufacturer's recommended safety and operating procedures for any equipment chosen.

As a sample test, I examined a Hart Scientific 5628, 25-ohm PRT, at room temperature using a Fluke 189 DMM, which can check resistance in the "ohms" function up to 500 MΩ. Please see the photo for the setup connections and tester indications.

Conclusion

Low insulation resistance can inject errors in your temperature measurements because the insulation can act as a parallel resistance to the actual element resistance. If, for instance, the insulation resistance is a mere 1 kΩ at room temperature (25 °C), then this resistance, when acting in parallel with a 27.5 Ω PRT element resistance, yields the following equivalent resistance:

$$R_{equivalent} \approx \left[\frac{(27.5\ \Omega) \times (1\ k\Omega)}{(27.5\ \Omega) + (1\ k\Omega)} \right] \text{ or } 26.76\ \Omega$$

Considering the sensitivity of a 25 Ω PRT is 0.1 Ω per °C,the decrease in element resistance from 27.5 Ω to 26.76 Ω corresponds to about a 7.4 °C lower measured value at room temperature.

Therefore, when you observe noisy readings or shifts in readings from your metal sheathed PRT, refer to the PRT manufacturer's specifications and measure the PRT insulation resistance to determine whether it is causing the problem. ■

Using a Fluke 189 DMM, one lead is clipped to one of the probe leads, and the other lead is clipped to the sheath near the handle. The 189 indicates "OL" on the Ohms Range at room temperature. This signifies an insulation resistance greater than 500 MΩ and is considered good.

Expanded Training Course Offerings

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We've just introduced a new series of temperature calibration courses that will be available during 2007. The new courses include:

Principles of Temperature Metrology. This practical metrology course covers the fundamentals of temperature calibration. Topics range from the nuts and bolts of choosing and using calibration equipment to the theory behind good calibrations.

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Infrared Temperature Metrology. This course covers the basics of using infrared thermometers, performing radiometric (IR) calibrations, and determining measurement uncertainties. It is a must for professionals involved with IR thermometer measurements.

Each course lasts two full days. More details about these and other temperature calibration courses in American Fork, Utah, are available online at www.hartscientific.com/seminars.

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We now offer free web seminars. These seminars are part of the Fluke Precision Measurement Webinar series, a series of free seminars on topics of interest to calibration professionals. Courses range from the basic "Introduction to Temperature Calibration" to the more in-depth "Temperature Uncertainty Budgets and How to Use Them." Most courses are about ninety minutes in length. To sign up for a web-based seminar, visit http://us.fluke.com/usen/apps/PM/WhatsNew/default.htm. ■

A Growing Hart *continued from page 1*

why our continued pursuit of speed is not going to let up.

Another customer wrote: "Thanks so much for following up on this. The service from Hart Scientific continues to remain the best in the industry." Those are exactly the words we want to hear. They're possibly even more motivating than the first! After all, our customers have high expectations and we want to make sure we're living up to them.

So however high your expectations—and particularly if you think you ever see us slipping—keep us humble and give us a call. We'll smile when you're smiling and we'll roll up our sleeves further when you're not. ■

Calendar of events

TEMPMEKO	Lake Louise, Canada	May 21-25, 2007
13th International Metrology Congress	Lille, France	June 18-21, 2007
NCSLi	St. Paul, MN	July 29–August 2, 2007
Hart Principles of Temperature Metrology	American Fork, UT	August 6-7, 2007
Hart Advanced Topics in Temperature Metrology	American Fork, UT	August 8-9, 2007
ISA Expo	Houston, TX	October 2-4, 2007
Hart Infrared Temperature Metrology	American Fork, UT	October 15-16, 2007
Hart Product Training	American Fork, UT	October 17-18, 2007

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