Number 6
Summer 2000

random NEWS

An occasional publication of
HART SCIENTIFIC

Jim Triplett,
Chairman and CEO

The Devil's in the Machine

By Jim Triplett, Chairman and CEO

Y2K has passed us quietly in the night, and now we're safe for another 1,000 years or so... Well, maybe not!

Now it looks like we have a new problem to contend with. According to an upcoming book, *The Devil in the Machine*, by Rev. Jim Peasboro, approximately 1 out of every 10 computers is host to some type of evil spirit. Occasionally, the evil spirit is Satan himself.

Dealing with Satan alone is enough of a problem, but when you throw in computers and employees, the whole thing becomes very complex. If the Rev. Peasboro is correct, this issue could spawn a whole new reason to store up food, move to the woods, buy a generator, and stop downloading software upgrades.

We have at least 50 computers in our building, so this means at least five of them are possessed by an evil spirit—or maybe just an evil em-

see JIM on back page

Cooperation Initiatives Create Worldwide Acceptance of Cal Labs

By Bernard Morris, Vice President of Metrology Products and Applications

Since metrologists around the world rely on temperature calibration equipment from Hart, it is important that the quality of our testing and calibration work be recognized in virtually every country. After reviewing various accreditation options, we chose the National Voluntary Laboratory Accreditation Program (NVLAP), a program operated under the auspices of the National Institute of Standards and Technology (NIST). Hart is now in the final stages of NVLAP accreditation.

NVLAP

Calibration laboratory accreditation is "a program to assess the competence of a calibration laboratory." The assessment process examines a lab's quality program and validates its capability to perform calibrations within its stated uncertainties. All aspects of calibration are evaluated, including facilities and environment, calibration and tests methods, certificates and reports, complaints, handling of calibration items, measurement traceability, quality organization, and management.

NVLAP is not a new program to the testing community. In 1976 a Laboratory Accreditation Program was conceived at NBS (now NIST) under procedures of the National Voluntary Accreditation Program. These procedures were further developed in 1994 in the following key ways:

1. Expansion of accreditation procedures from testing labs to include accreditation of calibration labs.

2. Updating of procedures to ensure compatibility with industry standard assurance programs.

3. Incorporation of international changes, especially new ISO documents (e.g., ISO Guides 25, 38, 43 and 58, and ISO 9000).

4. A charge to facilitate and promote acceptance of calibration and test results between countries to help reduce trade barriers.

Mutual Recognition of Accreditation Bodies

One reason Hart chose NVLAP was because of increased international acceptance of NVLAP as an accrediting body. Currently NVLAP has Mutual Recognition Arrangements (MRA) with the Asia Pacific Laboratory Accreditation Cooperation (APLAC), which means that NVLAP calibrations and results are accepted by accreditation programs from Australia (NATA), New Zealand (IANZ), Hong Kong (HOKLAS), Singapore (SAC-SINGLAS), Taiwan (CNLA), Japan (JAB, JNLA), and Korea (KOLAS). NVLAP also has MRAs with Mexican (DGN) and Canadian (CLAS) programs via the North American Calibration Cooperative.

Recently the European Co-operation for Accreditation (EA) voted to accept NVLAP into an MRA. Details are still being worked out, but the U.S. is expected to sign the agreement very soon. This means acceptance for NVLAP calibrations and test results by accreditation programs all over Europe including the United Kingdom (UKAS), Germany (DKD), and France (COFRAC).

Mutual Recognition of National Laboratories

Another area of great activity is MRAs between the various National Measurement Institutes (NMIs). In October 1999, 38 nations (including the U.S.) agreed to launch a system for assessing the accuracy and reliability of measurements made by the world's NMIs to further reduce trade barriers.

This arrangement establishes a formal system for "key" measurement comparisons among NMIs through carefully controlled "round-robin" exercises. These comparisons establish how closely a particular measurement performed by one NMI agrees with the results of another NMI.

Levels of agreement establish the basis for linking measurements across international borders. Measurement traceability is critical to many exporters and companies that recognize quality system registration.

Key comparisons are coordinated by the Bureau International des Poids et Mesures (BIPM) and performed by a series of consultative committees (mainly NMIs) for the various measurement parameters. The comparisons can take several years to complete. When done, the data is stored in a database accessible by anyone interested.

For temperature, five key comparisons are currently in progress covering various sections of the ITS-90. Hart Scientific has been actively supporting these key comparisons. A Hart 5681 SPRT is currently being used as an artifact for the CCT-K3 long-stem SPRT key comparison. *End*

Temperature Calibration Training Schedule

Industrial Temperature Calibration	August 7–9, 2000
Temperature Metrology	September 25–27, 2000
Realizing and Approximating ITS-90	November 29–December 1, 2000
Industrial Temperature Calibration	January 29–31, 2001
ITS-90 Realization Workshop	February 27–March 2, 2001
Temperature Metrology	March 26–28, 2001

To the Point

News on fixed points and primary standards development

NIST Tests Four Hart Fixed-Point Cells

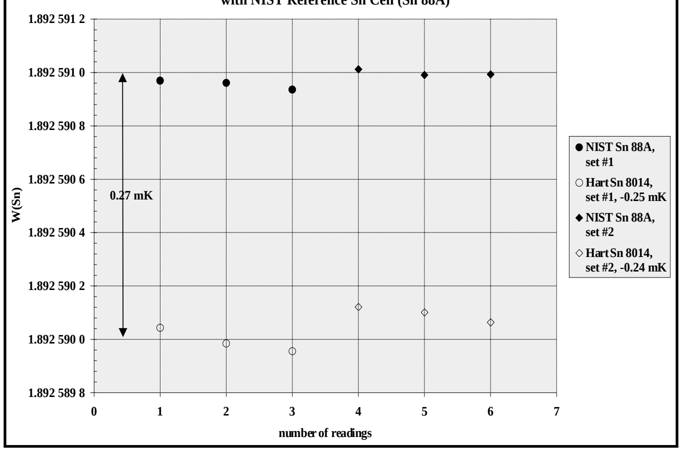
As part of its NVLAP accreditation process, Hart recently submitted four metal fixed-point cells (gallium, indium, tin, and zinc) to NIST for intercomparison with corresponding reference cells maintained by NIST.

For each cell, six sets of alternating measurements were made between the Hart cell and the NIST cell. All measurements were made using the same freezing curve (or melting curve, in the case of gallium).

The largest differences between the Hart cells and the NIST cells were as follows: gallium, -0.07 mK; indium, -0.22 mK; tin, -0.25 mK; and zinc, -0.65 mK.

Complete copies of the four test reports are available from Hart and are published at www.hartscientific.com. Data from the tin cell report is also shown here. In a few weeks, NIST is expected to complete testing on two additional cells submitted by Hart (aluminum and silver). These results will also be posted on Hart's web site when available. *End*

Figure 1: Direct Comparison of Hart Scientific Sn Cell (s/n Sn-8014) with NIST Reference Sn Cell (Sn 88A)

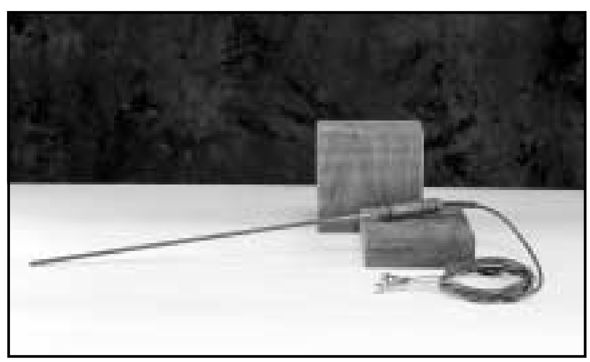


New SPRT Designs

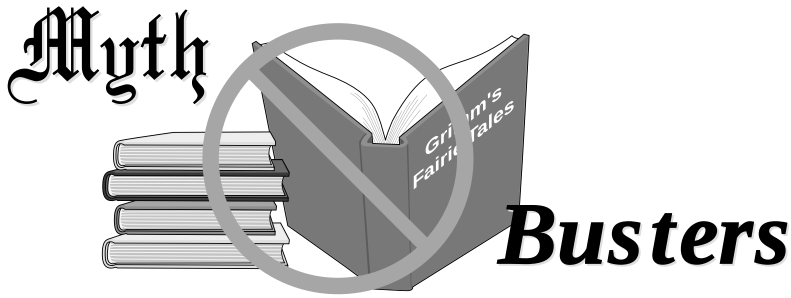
Metrologists at Hart Scientific, led by Xumo Li, have completed the design and prototype testing of two new SPRTs and are now beginning to manufacture both models.

The Model 5699 Metal-Sheath SPRT meets all the ITS-90 requirements for SPRTs and covers the temperature range –200°C to 660°C. Special design aspects of the 5699, including a platinum sheath around the sensor assembly, help protect against the contamination that typically occurs to metal-sheathed probes during use at high temperatures. Drift after one year of typical usage is within 2–3 mK.

The Model 5683 Ultra-Stable SPRT addresses the need for extremely stable standards over the commonly used range –200 to 450°C. With a proprietary gas mixture sealed inside its quartz sheath and manufacturing techniques carefully designed to retain the integrity of the seal, the 5683 drifts less than 0.5 mk after 100 hours at 450°C. Both SPRTs have a nominal resistance of 25.5 ohms at the triple point of water.



Each of these models may now be purchased from Hart, with or without calibration. Calibrations are done in Hart's temperature laboratory either by fixed point or by comparison. The Model 5699 can be calibrated from the boiling point of liquid nitrogen (LN_2) at approximately –197°C to the aluminum point (660.323°C); the Model 5683 may be calibrated from LN_2 to the zinc point (419.527°C). *End*



Myth: Built-in Dry-Well Indicators are Good for Reading Reference Thermometers and Probes Under Test

By J. Randall Owen, President

Some dry-well, or "block," calibrators on the market offer the option of a second digital display to indicate the temperature of a thermocouple or RTD under test and / or a reference RTD. While at face value this seems like a convenient feature, the design most manufacturers use to implement this option presents some serious limitations that are not explained to many users.

Presently, the dry-well makers that offer this option use off-the-shelf controls and indicators. To give you the option of a built-in indicator, they simply add an industrial panel meter to the dry-well package. Some of these panel meters offer the ability to switch between thermocouple types and RTDs.

If you're going to read the sensor under test with one of these built-in indicators, you should understand the following limitations:

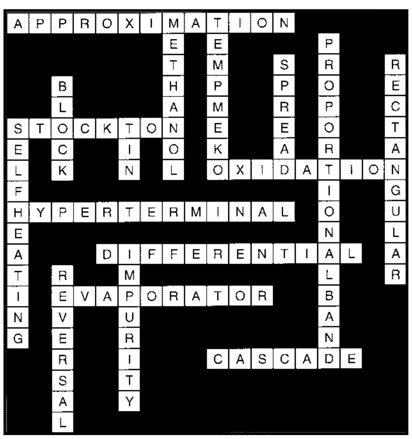
Reference-Junction Compensation

These panel meters use electronic reference-junction compensation, which requires a temperature sensor mounted at the connection of the thermocouple wire to the copper inputs of the measuring circuit in the panel meter. As seen in Figure 1, this sensor is packaged at the back of the panel meter housing. Some dry-wells have actually been manufactured with copper wire extending from this point to the front panel connections of the dry-well. Users are led to believe that they can connect any thermocouple type to these connections and simply program the meter from the front panel to read the new type. As temperature fluctuates along the copper wire inside the dry-well housing, unacceptable errors are introduced to the thermocouple reading.

A correct design would provide compensated, or type-specific, thermocouple wire and connector from the dry-well front panel to the back of the panel meter. This prevents the error mentioned above, but it limits the use of your built-in indicator to reading only that specific thermocouple type.

Accuracy

Because these are industrial panel meters, their accuracy specification is not generally adequate. Remember that the error of the panel meter



Solution to previous Random News *crossword puzzle.*

must be included in the calculation of the total uncertainty for the calibration you're performing.

Readout Capability

As mentioned earlier, if correct reference-junction compensation is provided, the built-in indicator won't be able to read a variety of thermocouple types. Also, ask if it can read 2-wire, 3-wire, and 4-wire RTDs and thermistors. The more sensors it reads, the better. Additionally, ask if it can read in ohms (for RTDs) or millivolts (for thermocouples). Some panel meters only read in temperature units. Unfortunately, none of the built-in indicators we've seen are very versatile.

If you plan to connect a calibrated RTD to the built-in indicator for use as a reference during calibration, consider these points:

System Calibration Capability

Can the indicator be programmed to match an individually calibrated RTD, or is it designed to just read the normal industrial curve? All the built-in panel meters we've seen are set up to read the DIN- or IEC-type interchangeable industrial RTD and cannot receive the calibration constants of a properly calibrated reference probe. This means you will have the error of the panel meter plus the conformance error of the RTD (make sure the RTD is calibrated for conformance). If this is your reference, you're pretty far removed from compliance to any ITS-90-based methodology.

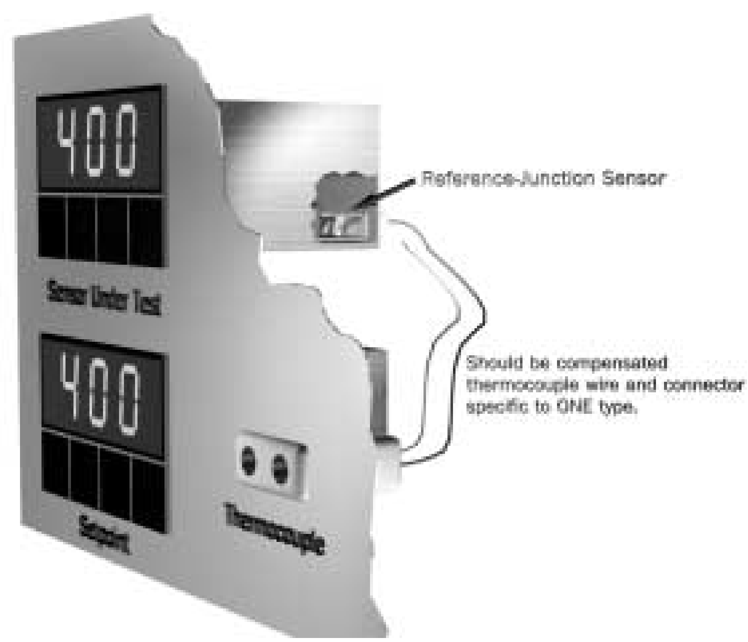


Figure 1

Accuracy

As mentioned, the typical panel meter is designed for use in industrial process monitoring, not calibration work. Look at the specifications for the panel meter and compare them to real calibration or metrology readouts.

One Thing at a Time

If you think you'll use the built-in indicator to read both the sensor under test and an external reference probe (as some manufacturers boast), then remember that it can only display one at a time. First you'll read the reference. Then you'll disconnect it and connect the sensor you're testing. You'll reprogram the meter for the new sensor type, and then you'll take its reading. A few moments will have passed since you took the reference temperature. Because the dry-well probably uses an industrial panel-mount controller, it isn't as stable as it could be and the actual temperature has changed a bit since you took the reference reading. Unless you're using a very stable dry-well, you should read both sensors at the same time or within a couple of seconds.

See MYTH on back page

NVLAP Update

Hart is now well on its way to achieving NVLAP accreditation for its calibration laboratory. In April NVLAP auditors performed their site evaluation of the lab's QA policies and procedures. They also reviewed data and uncertainty calculations for the areas in which Hart seeks accreditation. A certificate of accreditation is expected within three months. (Watch for our announcement!)

Hart's accreditation will include the calibrations of SPRTs, PRTs, thermistors, and thermocouples; the calibration of Hart-manufactured thermometer readouts such as the Super Thermometer and *Black Stack*; the calibration of standard DC resistors; and the testing of ITS-90 fixed-point cells.

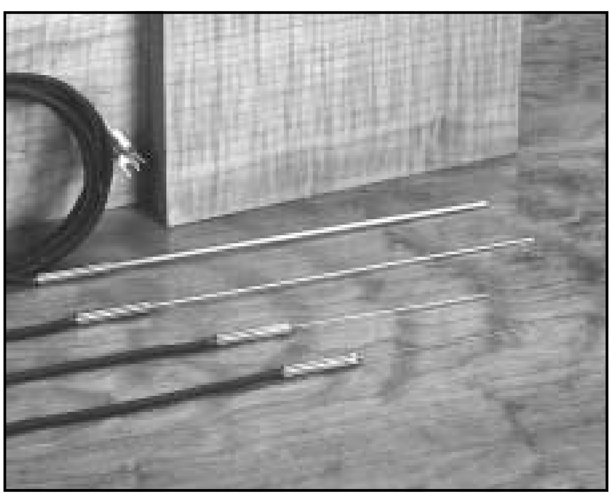
Accreditation continues to become a critical issue both overseas as well as within the United States. Hart's accreditation will embody compliance with ISO Guide 25 and ISO 9002. NVLAP (National Voluntary Laboratory Accreditation Program, which operates under NIST) and A2LA are the two leading accreditation bodies in the U.S. *End*

Probe Handling

By Steve Iman, Product Support Manager

Practicing good handling procedures helps retain a thermometer's calibration accuracy and long life. This is especially true for PRTs and SPRTs, which are particularly susceptible to mishandling. Keep the following do's and don'ts in mind:

- Don't subject a platinum thermometer to any physical shock or vibration. While some of the damage from such shock can be "annealed out," frequent annealing is also not desirable.
- Don't bend a probe sheath that is not designed for bending.
- Don't install compression fittings on a probe sheath.
- Don't subject a thermometer to sudden extreme temperature changes. SPRTs should not be removed from temperatures above 480°C directly into room temperatures. Generally, they should be cooled from high temperatures at a rate of about 100°C per hour.
- Don't subject a thermometer to temperatures outside its range—either too hot or too cold.
- Don't subject a thermometer's transition junction, handle, or lead wires to temperatures above their rated temperatures, which can be as low as 60°C. Likewise, do not subject the handle or cable to temperatures below ambient, as moisture can then condense inside the probe.
- Don't immerse a thermometer's handle in liquid.
- Do immerse a probe to its minimum immersion depth. Each thermometer has different requirements. When in doubt, consult the manufacturer.
- Do allow the thermometer time to stabilize. This time will vary with the probe's construction, the temperature, and the application.
- Do use the proper current to prevent self-heating errors. *End*



New Product Announcements

Model 1529 Chub-E4 Thermometer Readout

Hart's newest lab-quality thermometer readout sets a new world standard for thermometer versatility. The Model 1529 Chub-E4 comes with four input channels and can read PRTs, thermistors, and nine types of thermocouples. Basic accuracy includes ±0.006°C for PRTs, ±0.0025°C for thermistors, and ±0.35°C for a type K thermocouple.

The Chub-E4 includes a front-panel display that offers many viewing options. Measurements may be displayed in any of five different units with user-selectable resolution. Readings from all four channels may be displayed simultaneously, and users may view any eight statistical data fields involving any combination of channels. Screen set-ups may even be stored for simple recall.

With a built-in rechargeable battery and the ability to store up to 8,000 time- and date-stamped measurements, the Chub-E4 is completely portable. Windows software is also available for analyzing stored data, logging data in real time, and automating calibrations using the Chub-E4 to read a reference thermometer as well as units under test.

Model 9009 Industrial Dual-Block Calibrator

Need a portable temperature calibrator that covers both hot and cold temperatures? The new Model 9009 Industrial Dual-Block Calibrator includes a two-well hot block ranging from 35°C to 350°C and a two-well cold block that provides temperatures from –15°C to 110°C.

A precision Hart Scientific temperature controller powers both blocks, achieving stability as good as ±0.1°C for the cold block and ±0.2°C for the hot block. Each unit comes with a NIST-traceable calibration of each block. Calibrated accuracy is ±0.2°C on the cold side and ±0.6°C on the hot side.

The Model 9009 is housed in a rugged Pelican™ case that carries a power cord, manual, and up to eight removable inserts of various sizes. Everything you need to provide accurate, stable temperatures from –15°C to 350°C now comes in one convenient package.

Model 1522 Little Lord Logger Handheld Thermometer

When we unveiled the Little Lord Kelvin last year, we introduced the world's first handheld thermometer with true temperature standards performance. Now we've added data-logging capabilities and appropriately named our Model 1522 the Little Lord Logger.

With the ability to read PRTs (to ±0.025°C) and thermistors (to ±0.005°C) and to read calibrated and uncalibrated probes interchangeably without programming, the Little Lord Logger can also store 10,000 readings at user-definable intervals. Batches of readings may be stored in user-labeled data sets, and up to 100 readings may be individually stored "on demand."

With Hart's Log*Ware* software, data may be downloaded, saved, and graphically analyzed. Data may also be logged in real-time with delayed start / stop features and user-definable alarms. *End*

Question: How Do I Compute Total Uncertainty When Using a Dry-Well Calibrator?

By Chris Juchau, Vice President

The calibration of a temperature sensor involves placing the sensor into a stable temperature environment, measuring the temperature of that environment with a reference thermometer, and comparing the reading from the reference thermometer to the reading of the sensor under test.

Due to imperfect measurements of the reference thermometer and temperature gradients between the reference thermometer and the sensor under test, the actual temperature at the location of the test sensor can be estimated only within a stated uncertainty. The lower this uncertainty, the better the quality of the calibration.

How we estimate our uncertainty depends on how the heat source is used. For dry-well calibrators, two methods are common—using an external reference thermometer or relying on the dry-well's internal control sensor. Each system offers a different set of uncertainty sources to consider, though many sources are common to both methods. What follows is a list of the key sources of uncertainty for each system.

Using an External Reference

Reference Thermometer and Its Readout - No matter how good a reference thermometer we use or the device that reads it, no system yields perfect measurements. Thermometers drift, uncertainty exists in their own calibrations, readouts rely on unstable electronic components, and the references used by readout devices (such as standard resistors) change with time. Uncertainties should be estimated for the reference thermometer, its readout, and any references used by the readout.

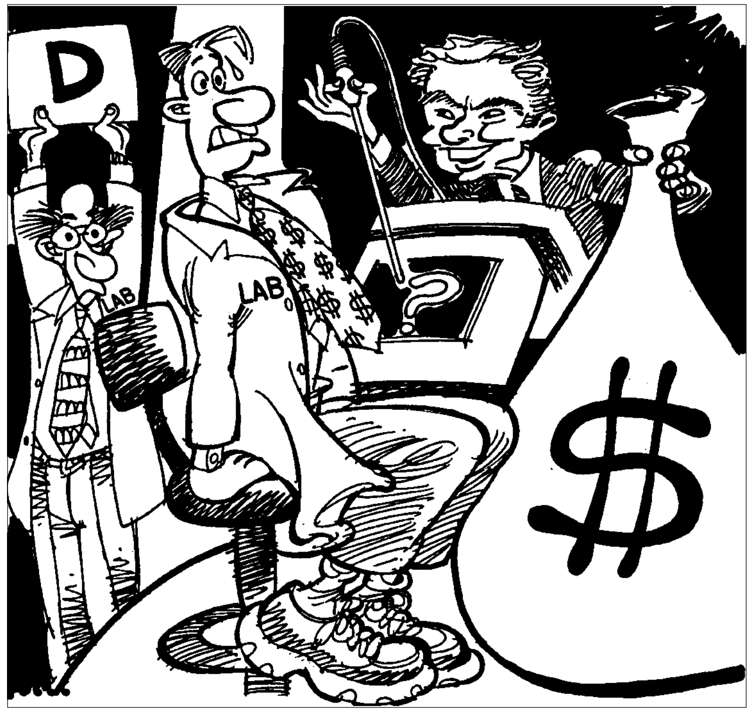
Temperature Gradients between Thermometers - Having accounted for the uncertainty in the reference thermometer, the fact remains that the reference thermometer and the test sensor are not in the exact same place at the same time. Likely they are in two different wells, with a slight temperature difference between the wells. Further, unless both sensors have identical construction and are inserted to exactly the same depth, vertical gradients must be accounted for. Even the heat-sinking effect that results from the construction of certain test sensors or from loading a dry-well with many test sensors simultaneously can alter the temperature within portions of the block. The magnitude of these types of uncertainties can be estimated by the manufacturer, but is best ascertained within a user's own lab under conditions typical for that user.

Using an External Reference

Dry-Well Stability - The quantification of a heat source's stability is simple and does not even require a calibrated thermometer. Two things should be mentioned here, however. First, temperature blocks often require more time to reach optimum stability than their built-in displays indicate. And second, the length of time that should be considered in a stability test varies with the length of time required by a particular user to complete a measurement cycle and with the time constant of the dry-well.

Using an Internal Reference

Dry-Well Display Accuracy - In concept, an internal reference is the same as an external reference. Both a thermometer and readout device are still involved. The difference exists in how they're calibrated and in the fact that internal systems are not as accurate as good external systems. Most dry-wells come factory calibrated (and can be recalibrated periodically using an external thermometer to calibrate the internal thermometer) with a quantified uncertainty value, which should take into account the resolution of the dry-well's display.



"For $1M, who invented the rectal thermometer? A) Gabriel Fahrenheit, B) Lord Kelvin, C) Anders Celsius, D) Ben Dover?"

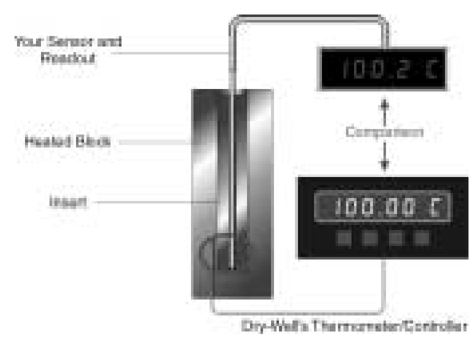
Temperature Gradients between Thermometers - The display accuracy of the dry-well includes the temperature difference between the location of the control sensor and the location of the external thermometer that was used to calibrate the dry-well. But unless the construction of the sensor you're testing is identical to that of the thermometer used to calibrate the dry-well and unless it's placed in the same well at the same depth as the calibrating thermometer, the same types of gradient issues are involved as with an external reference.

Dry-Well Stability - Short-term stability issues (typically 30 minutes or less) are the same as with external references. However, long-term drift issues that can occur to the control sensor between calibrations must now be considered. This is most easily quantified by recalibrating the dry-well periodically and charting its drift patterns under typical usage conditions.

Dry-Well Hysteresis - Without a reference thermometer, the hysteresis of the dry-well must be considered, though in many cases it will already be factored into the calibration uncertainty of the dry-well's display.

Conclusion

The largest errors in calibrations using dry-wells often come from misuse. Poor fit of test thermometers in wells, insufficient thermometer immersion, inadequate stabilization time, and a host of other blunders can render an uncertainty analysis of a dry-well calibration virtually meaningless. It's important to use a dry-well as specified by its manufacturer. It's also important to recognize the limitations of dry-wells and to use fluid baths or other heat sources when they are more appropriate and yield much better results.

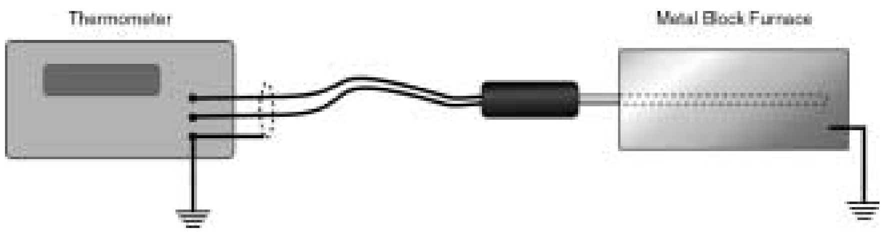


Using an Internal Reference

Recently the EA (European Co-operation for Accreditation) published their reference EA-10/13, "EA Guidelines on the Calibration of Temperature Block Calibrators," which discusses the testing and calibration of dry-well calibrators and the major sources of uncertainty that should be considered when so doing. Likewise, an ASTM subcommittee chaired by Thomas Wiandt of Hart Scientific has been commissioned to evaluate the calibration and proper use of dry-wells. Their work is expected to be completed within two years. *End*

Solve the Measurement Mystery

What is wrong with the following picture?



The circuit shielding is grounded in multiple locations. This connection creates the possibility of a ground loop. When sensitive circuits are connected in such a way that more than one ground connection is provided and the multiple ground locations are at different potentials, current will flow from one ground location to the other. This current can induce a voltage in the signal circuit, which causes a measurement error. The measurement error is larger when the signal circuit is not isolated from ground.

For best results, the probe's shield should generally be attached to

ground at one and only one point. In this case, since the probe is grounded through the furnace block, there will be less likelihood of ground loop interference if the shield wire is disconnected from the ground of the thermometer readout. *End*

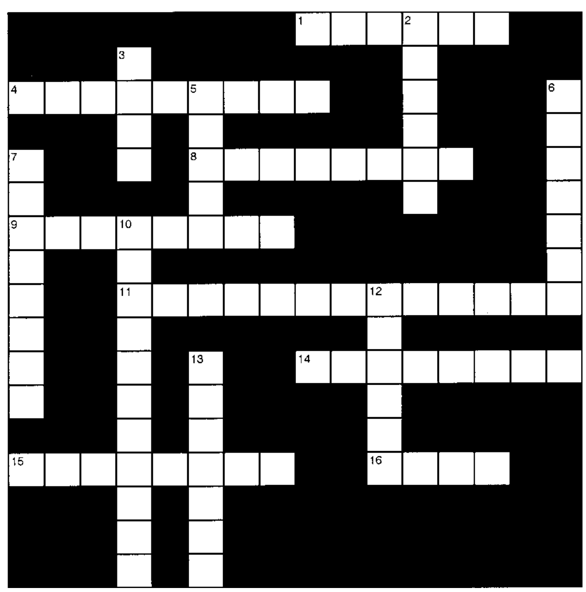
Crossword Puzzle

Across

1. "W" is the ratio of an SPRT's resistance at a temperature to its resistance at the __________ point of water.
4. __________ depth affects the accuracy of a PRT.
8. Fixed-point measurements may be adversely affected by a temperature _________ in the furnace.
9. Calibration uncertainty is only one factor in determining total __________.
11. The effect that results from removing a probe directly from a very high temperature to ambient. (two words)
14. Moisture can alter a probe's accuracy when its __________ seal breaks.
15. Because SPRTs are so __________, they must be handled carefully.
16. __________ is uncertain.

Down

2. Quartz sheaths may be sandblasted to prevent light __________.
3. Average (or not very nice).
5. Greek letter used to represent standard deviations.
6. Atmospheric pressure affects the __________ point of liquid nitrogen.
7. More information is obtained through a rigorous uncertainty __________ than through a TUR.
10. Standard deviations are often used to quantify aspects of __________.
12. Gaussian distribution.
13. Root sum __________.



Reference Documents Available at NCSL

From time to time we are asked to provide information on topics such as uncertainty analysis, designing a laboratory, calculating recalibration intervals, etc. We have found the National Conference of Standards Laboratories (NCSL) to be a great resource for such topics. Below is a partial list of the resources available from the NCSL.

Acronym List - A compilation of commonly used acronyms and their various definitions collated by the acronym and the acronym definition.

Calibration Lab Manager's Guidebook - Strategic and tactical information for assessing your laboratory situation and identifying sources of detailed and technical information on specific topics peculiar to calibration laboratory management.

ANSI/NCSL Z540-1-1994 (Calibration & Measurement & Test Equipment General Requirements) - A combination of MIL-STD-45662A and ISO Guide 25 to ensure calibration laboratory competence.

ANSI/NCSL Z540-2-1997 (U.S. Guide to the Expression of Uncertainty in Measurement) - An adaptation of the ISO "Guide to the Expression of Uncertainty in Measurement."

RP-1: Establishment & Adjustment of Calibration Intervals - This Recommended Practice (RP) provides information needed to design, implement, and manage calibration interval determination, adjustment, and evaluation.

RP-3: Calibration Procedures - Technical guidelines for calibration procedures as far as contents needed and format preferred for measuring and test equipment, general measurement/test systems, and measurement standards.

RP-4: Calibration System Specification - Gives the minimum essential requirements of a calibration system for control of measuring equipment and standards.

RP-9: Calibration Laboratory Capability Documentation Guideline - To establish a uniform method for identifying and publishing a document indicating the capability of a calibration laboratory, thereby improving the communication of capabilities within the metrology community.

RP-11: Reports & Certificates of Calibration - Preparation guidelines for the content and format of Reports of Calibration and Certificates of Calibration. The intent of this document is to improve communication through standardization and clarification of information provided to requestors and users.

RP-12: Determining and Reporting Measurement Uncertainties - Further discussion and examples to augment the ISO "Guide to the Expression of Uncertainty in Measurement." Practical methods are given so that determining, calculating, and reporting measurement uncertainties are made clearer.

RP-14: Guide to Selecting Standards-Laboratory Environments - Provides guidance in the selection of laboratory environments suitable for standards maintenance and calibration operations. It is not intended to mandate a specific environment for a specific calibration, but to direct selection of the environment and to suggest how to extend precision in an existing or achievable environment. *End*

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Calendar of Events

NCSL Workshop and Symposium
Westin Harbour Castle, Toronto, Canada
July 16–19

Hart Scientific Seminar
Industrial Temperature Calibration *Aug. 7–9*

ISA Expo 2000
Morial Convention Center, New Orleans, LA
Aug. 21–24

Oceans 2000 MTS/IEEE Conference and Exhibition
Rhode Island Convention Center, Providence, RI
Sept. 11–14

Hart Scientific Seminar
Temperature Metrology
Sept. 25–27

NCSL Region 8 Meeting
Hart Scientific
American Fork, UT *Oct. 4*

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***JIM** continued from page 1*

ployee. We are looking into the problem now. To this point, we are pretty sure that for an evil spirit to invade a computer, the computer must have significant free space on the hard drive, and possibly extra RAM.

Some of you may be skeptical, but I have seen direct evidence of this type of demonic force. For one thing, I've received e-mails that I thought might have been written by the devil.

In addition, I've caught employees using banned Internet sites while at work. I'm not sure the sites were exactly wallowing in filth, but when I asked, "What the hell are you doing?" the employee said, "I don't know what happened. It was as if something took me over and just made me do it." According to our employee handbook, possession by some types of evil spirits is a reasonable explanation for occasional really stupid behavior.

We are still trying to figure out the implications that this may have for temperature calibration. It might work its way into calculations of system error somehow, but ITS-90 doesn't address this—not yet anyway.

I'm sure someone out in cyber space is developing some kind of Satan purging software that not only manages your cookie files, but also takes care of any unwanted evil spirits that have gotten twisted up in your bios chip, CPU, or I/O bus. If CDs suddenly start shooting out of your computer without any provocation on your part, call Rev. Peasboro—he seems to know what to do. You can probably reach him through the *Weekly World News*, the paper where I first read about this problem.

The devil's in the machine, and I have seen him. *End*

***MYTH** continued from page 5*

Busting the Myth

Generally speaking, you're much better off using a separate instrument to read the sensors you're testing as well as a reference probe. The Hart 1560 *Black Stack* or the 1529 Chub-E4 can be configured to read virtually any combination of thermocouples, RTDs, or thermistors. You can easily use one channel as a properly calibrated reference channel with a properly calibrated reference probe. One or more other channels can then be used to read any sensor you are testing.

With these instruments, the error added by the readout is well within calibration-level uncertainty norms. Also, a separate readout instrument makes it easier to maintain the readout's calibration for proper control of total uncertainty and traceability. You can also read raw resistance or millivolts, and you can even use an external traditional ice bath. If you use the on-board reference-junction compensation, it is properly designed and placed in the correct location! You can use these instruments with any dry-well on the market. Finally, if you want an automated calibration solution, these readouts all work with Hart's Calibrate-*it* software. *End*