Number 9
Summer 2002

random NEWS

An occasional publication of
HART SCIENTIFIC
A Fluke Company

New Hart Temperature Lab Coming to Europe

When we announced the new accredited status of our temperature calibration laboratory in American Fork, Utah two years ago, we got quite a reaction! For one thing, orders flooded our lab faster than we were sometimes prepared to deal with—proving the need for accredited temperature labs in the U.S. and reminding us of our commitment to provide excellent service to our customers.

For another, some skeptics announced their doubts about the unusually low uncertainties included in our scope of accreditation. Many audits, published papers, and data-sharing sessions later, we hear much more of praise and much less of criticism.

Now, thanks to a sizable investment (nearly $500K) from our parent company, Fluke, we're bringing the same capabilities and excellent service to our customers across the pond. Based in Norwich, England, Hart's new European laboratory will serve users of precision temperature standards in Europe, the Middle East, and Africa.

A special preview of the lab was held for customers July 30. Over the next few months, the calibration equipment and standards used in the lab will undergo extensive testing and data analysis, with full services expected to be offered by late 2002. Full accredited services will become available during 2003.

Virtually all the equipment used in Hart labs was designed and built by Hart including ITS-90 fixed-point cells, maintenance furnaces, SPRTs, thermometer readouts, and fluid baths. Additional electrical standards for the Norwich lab are being supplied by Fluke and a DC resistance bridge is being used as an SPRT readout standard.

Services supplied in Norwich, as in American Fork, will include calibrations of SPRTs by fixed-point and by comparison, PRTs and thermistors by comparison, thermocouples by fixed point, and calibrations of resistance- and voltage-based readout standards. Calibrations will be available from –200°C to 1000°C. As with our American Fork lab, we expect the Norwich lab to achieve uncertainties that approach those of many national temperature laboratories.

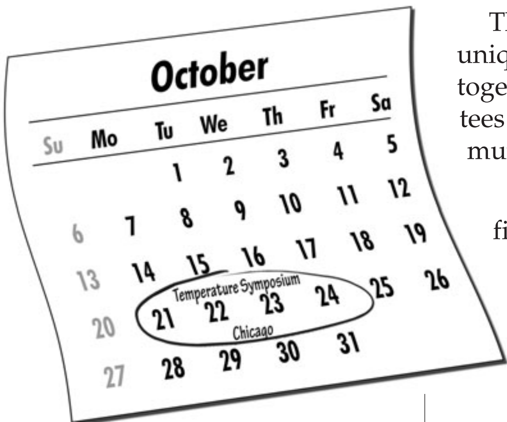
Peter Crisp will be running the Norwich lab. Having worked the last

see Lab on page 12

With a full line of temperature baths and fixed-point cells, Hart's new UK lab will aim to deliver the best commercial uncertainties in Europe.

Temperature Symposium Coming to Chicago in October

It only comes around about once every ten years and you don't want to miss it! "The 8th Symposium on Temperature: It's Measurement and Control in Science and Industry" is being held in conjunction with ISA 2002 October 21–24, at McCormick Place South in Chicago.



This rare event is being cosponsored by NIST and ISA and creates a unique forum for the world's leading temperature metrologists to come together, present their work, and exchange ideas. The program committees are comprised of a virtual "Who's Who" from the temperature community, including experts from many national labs and industry.

Topics covered at the symposium will include temperature scales, fixed points, thermocouple thermometry, calibration methods, resistance thermometry, temperature control and automation, instrumentation, radiation and optical thermometry, uncertainties and statistics, thermometry for specific industries, and many, many more. For the latest information on the symposium and its complete program, visit www.cstl.nist.gov/div836/836.05/thermometry/symposium.

Among the papers being presented at the symposium, will be a number by Hart's own technical staff. Our papers will address developments and research in fixed-point cells, SPRTs, gold-platinum thermocouples, and calibration of PRTs. Arrange your travel plans to join us and the rest of the world's temperature community in Chicago this October.

Xumo Li Receives Woodington Award

The metrology community recently honored Xumo Li at the 2002 Measurement Science Conference (MSC) by presenting him with the distinguished Woodington Award.

Xumo Li, Hart Scientific Vice President of Technology Development and Metrology

Named in honor of the late Andrew J. Woodington, this award is given each year as a career achievement tribute to a member of the measurement science community who "represents the highest level of professionalism and dedication to the metrology profession." Nominees for the award are to have received national or international recognition as metrology professionals who conduct themselves with dedication, competence, and commitment, and who inspire the professional status of other members of the metrology community.

Professor Li has been at Hart Scientific since 1994, where he is now Hart's Vice President of Technology Development and Metrology. Before joining Hart, Xumo served as the director of the temperature laboratory at NIM, the Chinese national laboratory. He has worked as a guest researcher in the German, Japanese, and Italian national labs, published numerous papers, played an active role in the development of the current international temperature scale (ITS-90), and developed a broad variety of instruments used in realizing and transferring the ITS-90.

We might add as a personal note from the folks at Hart Scientific that Xumo's resume completely understates the fact that he is an absolute pleasure to work with. (By the way, we pronounce his name "shoo-mo lee.")

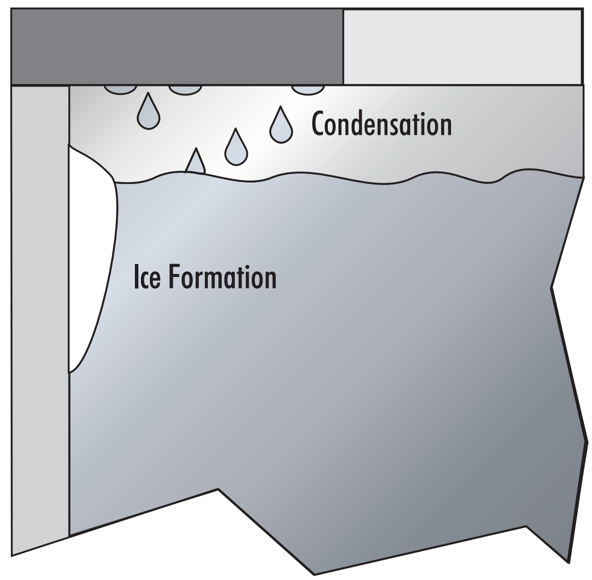
Avoid Water Problems in Cold Baths

By Steve Iman, Manager, Product Support

Halocarbon, methanol, ethanol, silicone oils, ethylene glycol, and Fluorinert are common bath fluids used at cold temperatures. Under ideal conditions, they make excellent heat transfer fluids for calibrations. But how are their heat transfer characteristics affected by water and how does this occur?

When a bath is operated at low temperatures, moisture condenses on exposed cold metal surfaces. This moisture accumulates until gravity causes it to run or drip into the bath fluid. Water may also be absorbed directly into the fluid from the surrounding air, particularly when ambient conditions are high in humidity.

Small amounts of water in most bath fluids will usually not affect the bath's performance in any noticeable way. However, as more water accumulates, the bath's performance will deteriorate. The water converts to small ice crystals, the viscosity of the fluid increases, and the result is a degradation in the stability and uniformity characteristics of the bath. Obviously, this is a bigger problem in areas with higher humidity.



Cutaway of inside bath tank showing condensation formation, condensation dripping into bath fluid, and ice formation on bath walls.

Condensed moisture affects various fluids in different ways. For example, ethylene glycol (mixed in a 1:1 ratio with water) is the least affected by an increase in water content. Alcohols such as ethanol or methanol absorb water and have a high tolerance for moisture in the short term, but will exhibit poorer performance as water content continues to increase.

Silicone oils, on the other hand, do not absorb water at all, which can allow excessive water to freeze on exposed cold metal surfaces. When this occurs, the oil is somewhat protected, but a new problem arises when the ice formations act as a thermal barrier or insulator and the conductive characteristics of the bath's walls are compromised. This can result in a bath failing to reach its lowest rated temperatures and, in severe cases, can impede or even completely stop the stirring of the fluid.

So, what to do? Here are a few suggestions:

1. Always keep the bath's access cover in place, especially when operating the bath below room temperature. The idea here is to prevent the wet room air from circulating throughout the tank area and depositing its moisture in the bath.
2. If the bath is equipped with a rubber fill-hole stopper, a hole may be drilled through the stopper through which a metal tube can be inserted to supply dry air or nitrogen. The pressure should be adjusted just enough to maintain a positive pressure flow.
3. With oils, the water can be boiled off periodically at 100°C.
4. Alcohols must simply be replaced when they become saturated with water.

Maintaining the bath fluid (by keeping it as dry and clean as possible) and following moisture prevention techniques will help ensure your bath keeps running at top performance.

Q and A

Question: Thermometric Fixed-Point Cells... Intrinsic Standards or Certified Artifacts?

by Thomas Wiandt, Director of Metrology

What is an Intrinsic Standard?

Intrinsic standards are defined by the NCSL as “standard(s) recognized as having or realizing, under prescribed conditions of use and intended application, an assigned value the basis of which is an inherent physical constant or an inherent and stable physical property.” Thermometric fixed-point cells are included in the NCSL “Catalog of Intrinsic and Derived Standards.” Some other well-known intrinsic standards include the Josephson-array voltage standard, the Quantum Hall resistance standard, and the Cesium atomic frequency standard.

The definitions themselves do not directly address the issues of uncertainty, traceability, or accreditation. However, in the case of thermometric fixed points, these issues are covered in the notes to the definition. The notes indicate that the value is assigned by consensus and need not be established through calibration. The uncertainty is said to have two fundamental components: (a) that associated with its consensus value, and (b) that associated with its construction and application. Traceability and stability are said to be established through verification at appropriate intervals. Verification can either be based upon application of a consensus approved test method or through intercomparison. Furthermore, the intercomparison may be accomplished with standards in a local quality control system or external standards including national and international standards.

Do Fixed-Point Cells Fit The Definition?

The basic parameter of the cell, the phase transition, is believed to be an inherent and stable physical property of the cell when used under prescribed conditions. The generally accepted values for the temperatures of the phase transitions along with corrections due to pressure and hydrostatic head are assigned by the ITS-90, the current temperature scale adopted by the BIPM. From the values given and by taking a few measurements, the theoretical temperature of the phase transition can be calculated. Also defined by the ITS-90 is the intended application, namely, as defining thermometric fixed points to be used in conjunction with an appropriate interpolation instrument and associated equations. Finally, the conditions of use are described by supplementary information to the ITS-90 as well as a significant body of literature. Although not everyone agrees on the exact procedures, for the most part they are quite well understood and accepted. It appears, then, that fixed-point cells can indeed be considered intrinsic standards.

However, several issues arise: First, the ITS-90 discusses fixed points based on phase transitions of pure substances. An ideal substance behaves differently than the real materials that we are able to obtain. The departure depends on the impurity content of the sample once it is assembled into a cell. For very highly pure materials, the slope of the plateau can be used to approximately determine the purity but the absolute temperature remains difficult to predict. Second, the ITS-90 does not directly specify an optimum cell design, furnace or cryostat design, or minimum purity requirements. Quite the contrary, many designs and options are presented in the literature. Although experiment results may suggest one design over another, the conclusions regarding uncertainty are not always clear. Third, the measurement results obtained from a cell are highly dependent upon experimental conditions. Having a good cell is only part of the exercise. Fourth, since a thermometer always measures its own temperature, the thermometer must be able to come to thermal equilibrium with the cell. This is affected by the cell, its apparatus, the thermometer, and the technique used to realize the phase transition. Finally, since we wish to perform traceable calibrations, knowing only the theoretical temperature is not adequate.

To Certify or Not To Certify?

So, how do we demonstrate that our cells embody the ITS-90 definitions and how do we establish traceability? Before we tackle those points, there are three issues that we must consider. First, whatever method we choose, we must perform a robust uncertainty analysis on our measurements. The uncertainty associated with the temperature of the phase transition is only one component among many that should be considered. Second, statistical process control (SPC) is critical whenever the measurement relies upon physical processes (such as the realization of a phase transition). Through SPC, we can quantify the repeatability of our process and show that the test experiment represents the process. Third, although SPRTs and sealed cells can be used as transfer standards, intercomparison of fixed-point cells over long distances is problematic.


Sealed metal freeze-point cells.

That having been said, the simplest method is to perform measurements in your cells using a calibrated SPRT. If the uncertainty of the measurement is sufficiently small, the temperature can then be shown to be within the estimated uncertainty based upon the theoretical considerations of the cell construction. In the case of low purity cells (five 9s or lower), it may be appropriate to "assign" a temperature and uncertainty to the realization obtained from the cell. These methods may be considered the least robust and typically will result in the largest uncertainties, but they can be shown to be traceable determinations.

A similar but more complicated method is to intercompare calibration results with peer laboratories or a reference laboratory using a suitable transfer standard. Although this type of analysis cannot directly "certify" the performance of a fixed-point cell, it will show your laboratory's capability to calibrate SPRTs using them. In many cases, this is what you are attempting to illustrate. A well-designed intercomparison will evaluate the results of the calibration, the raw and intermediate data, and the computations. Much insight can be obtained from such scrutiny. NIST offers a measurement assurance program (MAP) to satisfy this need.

Finally, the cells can be tested by an experienced laboratory that has the capability to provide traceable results with uncertainties in the neighborhood of your requirements. If the laboratory performing the test is using its own equipment and apparatus, this type of test will show the performance of the cell only. Additional experiment and uncertainty evaluation may be required for use in your laboratory. Also, this method will not illustrate your laboratory's ability to use the cells properly. The major advantage of this method is that it can provide the lowest overall uncertainty. Often, this is referred to as "direct comparison."

Issue	Verification via SPRT	Verification via Industry Intercomparison	NIST MAP	Cell Certification
Uncertainty for Cells	maybe	no	maybe	yes
Traceability for Cells	maybe	no	maybe	yes
Laboratory Apparatus	yes	yes	yes	maybe
Laboratory Equipment	yes	yes	yes	maybe
SPRT Calibration	no	maybe	yes	no
Procedure Evaluation	maybe	maybe	yes	no
Computation Evaluation	no	maybe	yes	no

So, What Should We Do?

Only a few years ago, it was considered acceptable to use a fixed-point cell with plateau analysis to show that the cell was behaving itself. This approach has proven to be inadequate as our understanding evolves and we try to improve our laboratories. Moreover, laboratory accreditation requires that we follow rigorous procedures in evaluating our uncertainties. If our uncertainties approach National Metrology Institute level, our data and analysis must justify this. And, the fixed-point cell is a critical component in the uncertainty evaluation. The intrinsic standard argument provided by the NCSL does state that some level of intercomparison is necessary. Presumably, the NCSL expects the intercomparison to be appropriate to the uncertainty claimed and based on the most current practices.

Triple point of water cells.

We must choose the method that makes economic sense and that satisfies our requirements. For example, if we are calibrating secondary PRTs using mini fixed-point cells, we may be justified in using a calibrated SPRT to verify the performance of our cells. Many laboratories (several accredited) use this method with success. Traceability can easily be demonstrated and the uncertainty analysis is straightforward. On the other hand, if we have spent tens of thousands of dollars on a system to calibrate SPRTs and these SPRTs are used for critical measurements, the NIST MAP program is a very good option, provided we qualify. Finally, if we wish to provide cell certifications, we will require a set of certified reference cells along with a robust uncertainty evaluation. At Hart, we use a combination of all three methods.

Conclusion and Recommendations

So, are fixed point cells intrinsic standards or certified artifacts? It really doesn't matter. Both viewpoints require testing and traceability. Both approaches require rigorous uncertainty analysis that must satisfy the scrutiny of our accreditation assessors, our customers, and our peers. And each perspective can be logically justified. At Hart, we treat some as intrinsic standards and others as certified artifacts. Our uncertainty analyses are as rigorous as we can make them and we welcome comment from our peers. Additionally, the NIST thermometry staff is available to assist in the development of uncertainty budgets, meeting traceability and accreditation requirements, as well as unique testing requirements. Finally, we use the approach that will result in the lowest uncertainties for a given set of equipment and techniques. After all, isn't that what it's all about?

New Product Announcements

9011 Dual-Well Calibrator

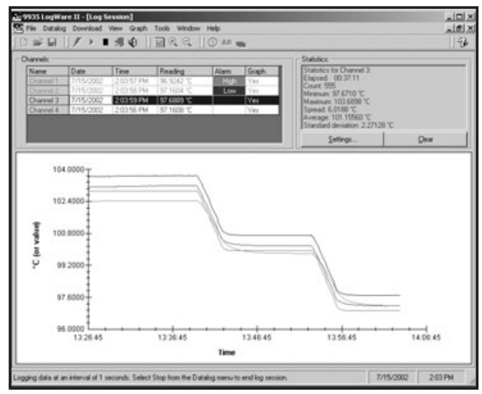
Heating and cooling technologies don't allow for extremely hot and cold temperatures in the same temperature block, but with Hart's new Model 9011 Dual-Well Calibrator you get two extreme-temperature wells in one convenient package.

The 9011's "cold block" covers temperatures from –30°C to 140°C. Four fixed wells provide for a variety of probe sizes. A fifth well accepts multi-well inserts for additional probe sizing. Calibrated accuracy in the removable insert is ±0.25°C and stability at –30°C is ±0.02°C.

The "hot block" also accepts multi-well inserts (up to 8 wells) and generates stable temperatures (±0.01°C to ±0.06°C) from 50°C to 670°C.

The 9011 features a Hart temperature controller and includes RS-232, Hart Interface-*it* software, and six-inch depth in both blocks.

9935 Log*Ware* II



Need a great data acquisition package for temperatue data? Hart's new Model 9935 Log*Ware* II works with any multi-channel Hart thermometer readout (*Black Stack,* Chub-E4, Super-Thermometer) to collect and analyze data from up to 96 thermometers simultaneously.

Log*Ware* II lets you set alarm conditions, delay start times, select an acquisition interval and much more. Raw data can be collected in ohms, millivolts, ratios, or multiple temperature scales. It even lets you configure your readout using its Windows interface.

Whether used to monitor data in real time, store data to individual text files, or analyze data collected in the memory of the ChubE-4, this program offers tremendous power, flexibility, and ease of use.

9100S and 9102S Handheld Dry-Wells

Handheld dry-wells were first introduced to the world by Hart Scientific in 1994. By incorporating Hart's newest proprietary temperature controller, our latest handheld calibrators offer broader temperatures, better performance, and automation capabilities—yet still fit into the world's smallest packages.

The Model 9100S covers temperatures from 35°C to 375°C with calibrated accuracy ranging from ±0.25°C to ±0.5°C. Stability is ±0.07°C at 50°C and ±0.3°C at 375°C. Small enough to fit in your hand, the 9100S comes with any of four block options, each including a different variety of well sizes.

The Model 9102S features stability of ±0.05°C over its entire range of –10°C to 122°C. Calibrated accuracy is ±0.25°C at all temperatures. Like the 9100S, the 9102S changes temperatures and stabilizes quickly. The 9102S includes two wells for matching removable sleeves with specific probes.

Both calibrators include a serial port for an RS-232 interface and ship with Hart's own Interface-*it* software. This easy-to-run software allows users to monitor heat source temperatures and to access all the control features found in these great little dry-wells.

Thermocouples 101... or, Maybe... 401!

By Ron Ainsworth, Metrologist

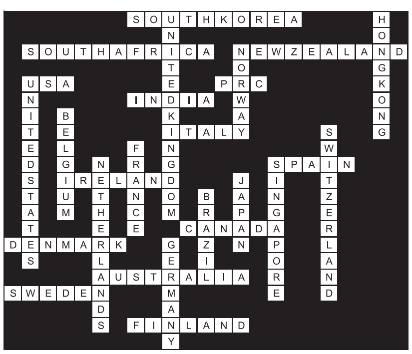
Thermocouples are the most commonly used temperature sensors in the world. If you're a thermocouple user, particularly of reference thermocouples, there are a few things you should know. It is easy to be led into believing that accurate measurements with a thermocouple (two dissimilar pieces of wire joined together at a common junction) are as simple to get as reading a number off a digital display.

Thermocouples react to temperature gradients by generating a voltage. The accuracy of converting that voltage into a temperature is determined by the condition of the thermocouple, the measurement technique used, the characteristics (or "type") of the thermocouple, and its calibration.

If you don't know how a thermocouple senses temperature, you probably make mistakes in using them.

The junction between the two dissimilar metals of a thermocouple does not produce the voltage that is measured across the ends of its lead wires. Thermocouples use the relationship between temperature and electricity that was first observed in 1821 by Thomas Seebeck. The so-called "Seebeck effect," which describes how thermal energy is converted into electrical energy, does not require two dissimilar metals to be joined together.

Consider two wires, one made of platinum and the other from a platinum-rhodium alloy. If both wires are placed separately with one end at Temperature A and the other end at Temperature B, a voltmeter will be able to measure a voltage between the ends of each individual wire, but the voltage will be different for the alloy than it will be for the pure metal. In a perfect world, the voltages measured depend only on the composition of the wire and the difference between temperatures A and B. For a single wire, we call this voltage the absolute Seebeck emf. If we want to know the difference between the absolute Seebeck emfs of the two wires, then all we need to do is join the two together at one end and measure the voltage at the other end. That's a thermocouple. If we know the thermocouple voltage and the temperature at one end (a reference temperature), then we can calculate a temperature at the other end. However, without an accurate reference temperature, making huge measurement errors is as easy as reading numbers off a digital display!



Answers to Random News 8 crossword puzzle.

If you don't know what a reference junction is, you need to find out.

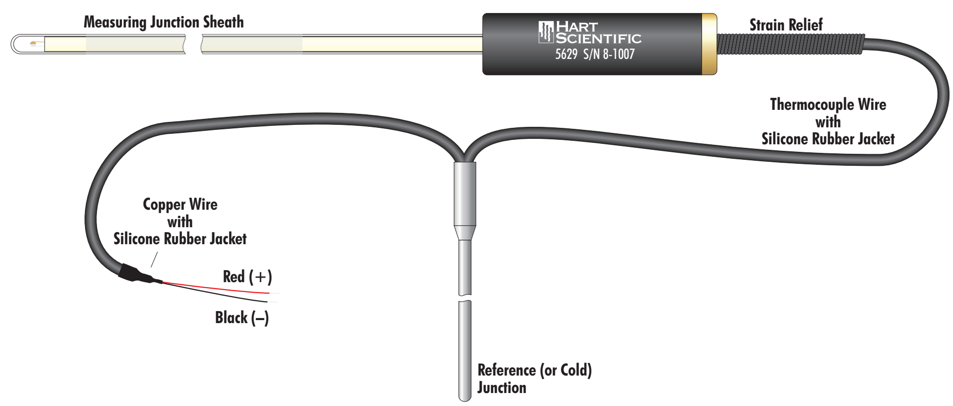
There are a number of ways to obtain an accurate reference temperature. The exact manner chosen depends on the desired accuracy, budget, available equipment, and expertise of the user.

On one end of the thermocouple is the measurement junction; the reference junction (if there is one) is on the other end. Generally, a reference junction consists of two copper or platinum wires (with very similar absolute Seebeck emfs) that are electrically connected to the thermocouple. The reference junction is usually placed in an ice bath, which keeps it at a constant known temperature of 0.000 ± 0.002°C if you're following the ASTM procedure E 563-97 for constructing a proper ice bath. Voltage measurements are then taken across the copper wires, which now reside at a known temperature, rather than at the thermocouple wires.

If a thermocouple does not have a reference junction, it is necessary to use some sort of electronic reference junction compensation (RJC—or "CJC" for "cold junction compensation"). The meter measures the temperature at the "cold" end of the thermocouple. From this temperature, a voltage offset is calculated. The voltage offset is then added to the voltage measured by the meter and the total voltage is used to calculate the temperature. You may have to choose how the readout or simulator device generates this offset. The wrong choice could mean an error as large as 25°C.

Isn't "homogeneity" a property of milk?

Imperfections in thermocouple wire may produce undesired results in temperature measurements. Thermocouple wires that are free from these imperfections are deemed homogenous. This means that the composition of the wire is the same from end to end. A new thermocouple ought to be homogenous. An old thermocouple may not be. Thermocouples attached to extension wires are not homogenous and the practice of adding extension wires should be avoided. Thermocouple wire that has been kinked or exposed to temperatures, pressures, or chemical environments for which they are not designed may also behave unpredictably because of reductions in homogeneity. However, if a thermocouple is not homogenous (i.e. where a reference junction has been soldered to it) and the temperature is kept constant along the heterogeneous section (i.e. the reference junction is placed in an ice bath), then the previously described errors will be minimized.



Gold-platinum thermocouple with a cold reference junction.

Manufacturers of thermocouples usually anneal new thermocouple wire electrically to relieve the mechanical strain introduced during manufacturing. Also, it is not unusual for laboratories to anneal thermocouples before attempting an accurate calibration. No one knows for sure whether annealing will help when other factors such as contamination have affected homogeneity.

If annealing cannot restore a thermocouple to a homogeneous state, then it should be replaced rather than recalibrated. The lifetime of a thermocouple is affected by its exposure to such things as vacuum, extreme temperatures, quenching, harsh chemical environments, and time at elevated temperatures. Be sure to use the correct type and gauge of thermocouple for your application to avoid damaging your thermocouple.

To sheath or not to sheath?

Some thermocouples come with a sheath. Sheaths may be ceramic, glass, or metal. The purpose of a sheath is to protect the thermocouple from its environment. Sheaths do not improve performance and, in fact,

see Thermocouple on page 12

Jon Sanders, Hart Scientific Applications Specialist

Application Notes…

At Hart, our applications specialists are always interested in finding new temperature applications—and we thought you might find them interesting as well. This one comes from Jon Sanders who joined Hart Scientific about a year ago.

High-volume water providers use large turbines to pump water along their pipelines. These turbines cost millions of dollars and their efficiency can be measured through thermodynamics. Recent regulations from the IEC (standard 6004-1) require measuring the temperature change of the water flowing through these turbines to within one thousandth of a degree, or ±0.001°C! This is done not only to ensure the correct operation of the turbines but also to save additional millions of dollars that could be lost due to misunderstood pumping volumes.

To solve this problem, one water provider is now using a Hart Model 1590 Super-Thermometer II along with ten standard thermistors with extended leads. The department takes measurements at the intake end of the pump and compares them against measurements taken at the discharge end. The 1590 can read thermistors to within fifty micro-Kelvin, or ±0.00005°C and standard thermistors have long proven themselves stable enough for such applications.

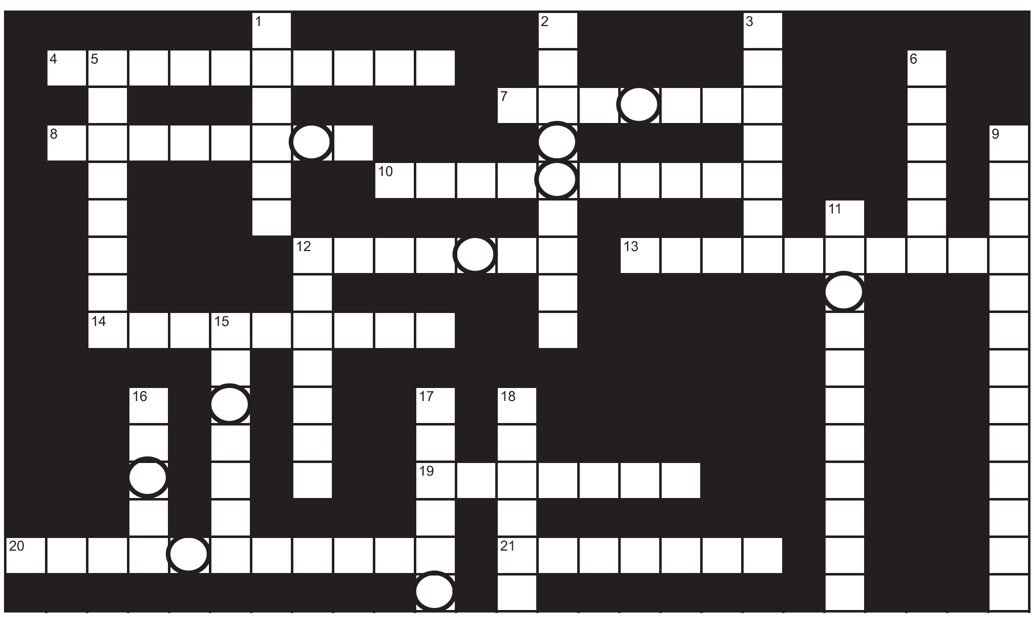
Crossword Puzzle & Contest – Win a Triple Point of Water Cell!

Across

- 4 Temperature scale
- 7 Temperature scale
- 8 Thermodynamic property
- 10 William Thomson
- 12 Site of 2002 International Temperature Symposium
- 13 High-sensitivity resistance thermometer
- 14 The science of measurement
- 19 Opposite of the "thermocouple effect"
- 20 Hart Scientific cal automation software
- 21 Noble metal

Down

- 1 156.5985°C
- 2 Target used for pyrometer calibrations
- 3 Hart Scientific one-channel thermometer readout
- 5 660.323°C
- 6 Calibration output
- 9 Offered by UKAS (UK) or DKAS (Germany)
- 11 Common bath fluid
- 12 Temperature scale
- 15 Temperature scale
- 16 Organization for standards laboratories
- 17 Gold-platinum thermocouple (abbr.)
- 18 Temperature scale



Win a Triple Point of Water Cell

Unscramble the circled letters. Then go to Hart Scientific's web site (www.hartscientific.com) and under "Fun Stuff" register to win a free triple point of water cell. Two registrants with the correct answer will be selected at random.

New Working Standard SPRT

Recently, Hart's primary standards development team introduced an exciting new SPRT designed to deliver high-quality SPRT performance at a very affordable price.

The new Model 5698 Working Standard SPRT is a true SPRT. It meets the ITS-90 ratio requirements for SPRTs and includes a Hart-designed, completely strain-free platinum sensor. With a 485-mm quartz sheath, this 25-ohm SPRT covers a temperature range from –200°C to 661°C. Long-term drift, which we define as the change in output resistance at the triple point of water after 100 hours at 661°C, is (after converting to temperature) less than 6 mK—typically less than 3 mK.

The 5698 makes a great companion to a Hart Super-Thermometer such as the Model 1590, which reads 25-ohm SPRTs to within 1 mK at 0°C and includes a number of convenient features for working with SPRTs. Requiring 1 mA of excitation current, the 5698 can also be used easily with a Hart *Black Stack,* or even a Chub-E4 Thermometer.

For those needing their SPRTs calibrated by a reputable calibration lab, Hart Scientific offers appropriate calibration options by fixed-point or by comparison in our NVLAP-accredited lab. Our calibration prices are as reasonable as our instrument prices, so you get maximum value from your SPRT.

Tell us More!

There are few things more valuable to us at Hart than feedback from our customers! During our training seminars in Utah, at tradeshows around the world, and often just through the phone or email, we get quite a bit of valuable feedback. Often it consists of praise or "thank-yous," but not always, and we value the criticism and suggestions as well as the positive strokes.

That's why we've decided to become a little more formal (not too formal—we have an image to maintain!) about gathering feedback from our customers. So if you get a phone call or a little piece of mail from us asking for your opinion, we hope you'll help us out.

Our goal is to become your preferred supplier of temperature calibration instruments. We want to make sure we understand what that means to you and how we can best deliver. Of course, if you can't wait for a phone call or piece of mail, call us toll-free (800-438-4278) or e-mail us (info@hartscientific.com) any time. The better we understand your needs, the better we can deliver the best possible solutions.

To The Point

News on fixed points and primary standards development

Calendar of Events

NCSLI
San Diego, CA
Aug. 4–8

Sensors Expo
Boston, MA
Sept. 24–26

Industrial Temperature Calibration Seminar
American Fork, Ut
Oct 7–9

ISA & Temperature Symposium
Chicago, IL
Oct. 22–24

BIAS
Italy
Nov. 19–23

Temperature Metrology Seminar
American Fork, UT
Dec. 2–6

Measurement Science Conference
Anaheim, CA
Jan. 13–17, 2003

Random News is published at random intervals by Hart Scientific, Inc.
All correspondence should be addressed to:

Hart Scientific
799 E. Utah Valley Drive
American Fork, UT
84003-9775

Tel: 801-763-1600
Fax: 801-763-1010

www.hartscientific.com

Printed in U.S.A. 1778988 B-ENG-N A

***Lab** continued from page 1*

twenty-three years for Fluke (formerly Wavetek and Datron), including positions as head of metrology and head of UKAS accredited standards and cal labs, Peter is a widely published metrologist and an accomplished trainer. He has served on committees with NPL, UKAS, and NAMAS, is an expert in all major international quality standards, and has served as Chairman of the British Measurement and Testing Association.

Peter Crisp, Fluke-Hart Manager, Norwich Primary Temperature Laboratory

Additionally, Hart now has a very strong product service center in Eindhoven in the Netherlands. This accredited Fluke facility is being used to service Hart baths and industrial calibrators such as dry-wells.

But there's more! Through Fluke subsidiaries in Asia, we have recently begun service operations in China and have begun commissioning a secondary laboratory in Singapore. The Singapore lab includes a full line of fluid baths, SPRTs, and readout standards for comparison calibrations of all thermometer types from –200°C to 550°C. This facility will support customers needing calibrations throughout the Asia-Pacific region and is expected to become accredited during 2003.

In our Utah lab, we have added two technicians in the past year and are beginning a $100,000 expansion project to add capacity and shorten the lead-times experienced by our customers. We are also continuing to grow our customer service team. If you have a need for thermometer calibrations services or service of Hart-manufactured products, please contact our customer service group at service@hartscientific.com and they can steer you to the best help available—and that's no longer just in Utah!

***Thermocouple** continued from page 9*

thermocouples with sheaths are less responsive and require more immersion than do similar unsheathed thermocouples. However, using a sheath is preferred to contaminating or mechanically damaging a thermocouple and is therefore a good choice for many applications.

To calibrate or replace?

Thermocouple types are defined by a particular emf-temperature relationship within a specified limit of error. However, they can be calibrated to achieve results that are more accurate. When a manufacturer makes a set of thermocouples from a particular batch of wire, a sample from that group may be calibrated as representative of the entire group. Individual thermocouple calibrations may achieve more accurate results than a batch calibration. Thermocouples may be calibrated by comparison or, for the most accurate results, by fixed point.

Accurate results however will depend on factors other than the calibration. Again, one of these factors is homogeneity. Of course taking everything into consideration, the decision to replace or recalibrate a thermocouple (and how often to recalibrate) is ultimately yours—you being most familiar with its behavior during actual usage conditions.