

TEMPERATURE CALIBRATION TRAINING

How about a little education? Hart Scientific can provide it for you through our courses in temperature calibration.

Each one of these classes has been specifically designed for the work you do. You'll hear from some of the best metrologists in the world, as well as from applications specialists, metrology scientists, and equipment designers. You'll get hands-on experience and demonstrations to support many of the techniques taught in each class. You'll also get a chance to tour our calibration laboratory and primary standards lab, and you'll have chances to get all your questions answered by any of our world-class instructors.

Our courses have become known as the standard for temperature calibration training. Most classes sell out long before the registration deadline. Attendees tell us they like our classes more than any others they've attended. Our casual atmosphere makes learning these challenging concepts enjoyable.

We absolutely guarantee that if you come to one of our classes we'll make it one of the most memorable experiences that you have ever had in continuing education! And these classes meet your lab accreditation needs.

Courses

Industrial Temperature Calibration

- Course length: 2½ days
- Cost: \$895
- Class size: 25

This one is about fundamentals. We'll explore the theory and practice of temperature measurement and calibration across an accuracy range of 1°C to 0.1°C. In this class we go directly to the center of industrial temperature calibration and accuracy issues. We focus on

"Temperature measurement is one of my weak areas, where I have a tendency to question my techniques. I have greater confidence now since the seminar."



Xumo, Kay, Mike, Tom, and Rick share their seminar notes.

practical applications and hands-on experience with classroom discussion of the theory behind the technique.

We'll show you how to calibrate thermocouples, thermistors, PRTs, and anything else you can think of. We'll explain how to properly use heat sources such as dry-wells and portable baths to achieve the accuracy you need with the least amount of anxiety over your technique.

Whether you're new to temperature calibration or you've been performing field calibrations for years, you'll go home more confident and ready to expand your role in calibration.

Temperature Metrology

- Course length: 2½ days
- Cost: \$895
- Class size: 25

This is an intermediate course in practical lab skills for comparison calibrations of various sensor types, along with other calibration techniques for greater accuracy. You'll leave knowing how to use SPRTs and other high-accuracy standards to keep your working standards performing at their highest levels.

Comparison calibration labs need practical information on how to implement ITS-90, and you'll get it from this course. Come and talk with people who know the theory and practice of calibrating everything you see on a daily basis. Not only will they teach you technique, they'll explain the logic behind what they're teaching. You'll learn more than you thought possible in only a couple of days. We'll address the world of accuracy from 0.1°C to 0.01°C.

Not only will we cover actual calibration techniques, we'll show you how various instruments such as readouts, dry-wells, and calibration baths work and why they work the way they do. You'll learn how to pick the right equipment for

"The course was very informative, with enough technical content—yet not overbearing."

any calibration, how to verify the uncertainty of what you are doing, and the most cost-effective approach for specific jobs. Bring your questions; we'll answer them better than anybody ever has.

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Course	Industrial Calibration	Temperature Metrology	ITS-90 Seminar	ITS-90 Workshop
Qualifications and Prerequisites	None	Some experience in sensor calibrations	Some experience with comparison calibration techniques; some familiarity with the ITS-90	Understanding of the ITS-90; experience with fixed-point cells or plans to work with them; experience working with SPRTs
Typical Uncertainties Discussed	$\pm 5^{\circ}\text{C}$ to $\pm 0.1^{\circ}\text{C}$	$\pm 0.5^{\circ}\text{C}$ to $\pm 0.005^{\circ}\text{C}$	$\pm 0.1^{\circ}\text{C}$ to $\pm 0.001^{\circ}\text{C}$	Minimal uncertainty from fixed points
Coverage of Fixed Points	Brief introduction to water triple point cells; demonstration of mini WTP cells.	Theory, demonstrations, and hands-on experience with water triple point cells.	Theory of all ITS-90 fixed points; demonstrations of WTP freeze and tin and gallium realizations.	Extensive hands-on experience with many ITS-90 fixed points.
Who Should Come	Anyone new to temperature metrology and anyone performing in-field calibrations of working sensors—typically using portable calibrators—with or without reference thermometers.	Those responsible for calibrating in-field standards. Metrologists who do not work heavily with ITS-90 fixed points, but who seek lower uncertainties through comparison calibrations.	Metrologists responsible for calibrating SPRTs or other laboratory standards. Those seeking the lowest possible uncertainties through comparison or fixed-point calibrations.	Those who work in a primary temperature laboratory with fixed points and want to increase their skills and knowledge; and anyone who anticipates using fixed points in a primary lab in the future.

“I liked the detail of technical information without much of a sales pitch. It gave me many ideas to use. I also enjoyed the light, casual attitude.”

Realizing and Approximating ITS-90

- Course length: 2½ days
- Cost: \$895
- Class size: 25

Buckle up because this is the big one. This is the only course of its kind that is this thorough on realizing and approximating ITS-90. We cover it all!

In this class we’re going to take you on an adventure from 0.01°C all the way to 0.001°C , and beyond. We’ll explore SPRT calibrations using fixed-point cells; we’ll teach you the proper way to use a water triple point cell and how often to use it to verify the calibration of your working standards. We’ll show you everything that impacts SPRTs and other laboratory standards down to 0.1 mK. You’ll learn how SPRTs get contaminated and how to stop it. We’ll demonstrate the usage of fixed-point cells and explain all the alternative methods for using fixed points in your lab.

Don’t just bring your questions; bring the hardest, most unusual temperature calibration questions you can think of.

We’ll answer them. Nobody explains the problems, theories, and techniques of 1 mK work better than we do! Previous attendees from some of the best labs in the world tell us that what we’re promising you is what we delivered to them. It’s two and a half days of temperature calibration camp at its best!

ITS-90 Realization Workshop

- Course length: 4 days
- Cost: \$1,595
- Class size: 5

This is a one-on-one fixed-point realization training course for temperature metrologists. If you work with fixed-point cells or plan to, this experience is for you. The class takes place in our lab and focuses on calibrations of SPRTs and noble-metal thermocouples through fixed-point calibrations.

All of the points from -196°C to 961°C are realized, including LN_2 , Mercury, TPW, Gallium, Tin, Zinc, Aluminum, and Silver (-196°C is achieved by comparison). Each participant gets plenty of hands-on experience with the cells and does the necessary math calculations associated with the calibrations.

Metrologists and scientists provide personalized teaching of calibration procedures and little-known facts and information about the dynamics of the fixed points. Participants learn the physics of

what is going on inside the cells and why it is occurring.

Operation of 0.1 ppm AC and DC bridges is also included in the course. Attendees should have a thorough knowledge of ITS-90 and may want to take our ITS-90 course as a prerequisite.

Registration

Call us, write us, fax us, e-mail us, go through our Web site, or use carrier pigeons, but get your registration in. We’re supposed to close registration two weeks before the class date, but we often sell out only weeks after we announce the date of the next class. Once you register, we’ll send you the necessary visitor information on where to stay and how to get here. We’re located just 40 minutes

“I learned enough to more than justify the cost of the seminar. I’ve got a start now for implementing changes for the better in our lab.”

from Salt Lake City International Airport with plenty of inexpensive hotels nearby.

When registering, ask about extending your visit with a two-day, one-night stay at Falcon’s Ledge (additional fees apply). Guided fly-fishing and hunting packages are available. Space is limited.

TEMPERATURE CALIBRATION TRAINING

Industrial Temperature Calibration, Course Outline

An introduction to the basic principles and techniques for testing or calibrating common sensors and thermometers.

Overview

- ITS-90, international agreements
- Terminology review
- Traceability & hierarchy

Unit Under Test Fundamentals

- Types, characteristics, and limitations
- Thermometer configurations

Calibration Methods

- Simulators
- Reference heat sources
- Reference thermometers
- Introduction to accuracy
- How accuracy is determined
- Error sources
- Special cases and challenges

Calibration Equipment

- Learn the characteristics and applications
- Heat sources
- Thermometers and readouts
- Standards—what is suitable as a reference

Case Studies

Other Issues

- Quality issues—ISO 17025, Z540, reports, record keeping
- Math applications
- Introduction to high-precision equipment
- Q&A with the experts

Demonstrations

Temperature Metrology, Course Outline

An intermediate course in practical lab skills for comparison calibration of thermistors, RTDs, thermocouples, and other thermometers.

Introduction to Temperature Metrology

- Scales, ITS-90, and fixed points
- Uncertainty and traceability

Thermometer Types

- SPRTs, PRTs, RTDs, and thermistors
- Thermocouples—noble vs. base metal
- Liquid-in-Glass—procedures for accuracy
- Reference thermometers

Components of Uncertainty

- Heat sources
- Readouts

Common Calibration Techniques

- Thermistors & PRTs
- Thermocouples—ASTM, spool testing
- LIG—ASTM—specific requirements

Optimizing Your Measurement

- Test uncertainty ratio
- Error budgeting
- Profiling a heat source
- Mathematics

Maintaining Your Standards

- Frequency of calibration
- Uncertainty analysis and SPC

Compliance Issues

- Z540, reports, tables—pleasing the auditor

Demonstrations

Realizing and Approximating ITS-90, Course Outline

An advanced seminar in temperature metrology.

Realizing ITS-90 Introduction

- History of ITS-90
- Learn how and why the scale changed

Fixed-Point Fundamentals

- Fixed-point vs. thermodynamic scale
- Uncertainties

Practical Fixed-Point Realization

- In-depth review of each fixed point
- Equipment: cells, apparatus, bridges
- Methodology, procedures, and demos

Resistance Thermometers

- SPRTs and HTPRTs
- Annealing procedures

Approximating the Scale

- Choosing to do comparison calibrations

Techniques

- Getting the most accuracy
- How to select calibration points
- Choosing a technique and demos

Equipment

- PRTs and thermistors
- Heat sources: LN₂, furnaces, baths
- Readouts: DMMs, "thermometers"

Uncertainty

- Error analysis and uncertainty
- Statistical process control

Demonstrations

How Do I Register?

Call us at...
800-438-4278

Fax us at...
801-763-1010

E-mail us at...
seminars@hartscientific.com

or register online at...
www.hartscientific.com

ITS-90 Realization Workshop, Course Outline

An advanced workshop in fixed-point realization and calibration of SPRTs, HTPRTs, and noble-metal thermocouples.

Calibrate the Following Thermometers:

- 25-ohm SPRT
- 2.5-ohm HTPRT
- Noble-metal thermocouple

Hands-on Procedures

- Annealing

- Realizing fixed-points (TPHg, TPW, Zn, Sn, Al, Ag)
- LN₂ comparison calibration at -196°C
- Check-standard procedures for each point
- Calibration calculations
- Documentation

Lectures

- ITS-90 overview
- Cell dynamics
- Thermometer characteristics
- Bridges
- Mathematics of SPRT calibrations
- Freezing points vs. melting points



Want to learn how to use Hart products? Would you like to learn how they work and how you can get the most out of them? Would you like to send your staff to be trained on Hart instruments?

While our seminars offer two and a half days of theory, demonstrations, hands-on exercises, and panel discussions, our Product Training Sessions give you up to two full days of additional hands-on experience.

These post-seminar classes are broken into four half-day sessions covering thermometers, baths, dry-wells, and software. Product Training Sessions are held in our Temperature Calibration School in Utah during the same week as our seminars, so they provide the perfect follow-up to our regular seminar course work. The \$400 enrollment fee includes all four of the half-day sessions.

These sessions offer the perfect opportunity to learn to maximize the advantages you get from Hart products. You'll leave knowing exactly how to use your favorite temperature calibration products, how to achieve the best results from them, and how to get the most productivity out of your calibration work.

An experienced product group expert at Hart Scientific guides each Product

Training Session. Enrollment is limited so everyone gets plenty of time with the equipment and no one lacks individual attention. You're guaranteed to get all your questions answered.

Each session includes experience with a large number of products that represent Hart's entire line for that particular product group. In the thermometer session, for example, you'll get to work (and play) with a Little Lord Logger, a Chub-E4, a *Black Stack*, and a Super-Thermometer. Likewise for the other sessions.

To register, just visit our Web site at www.hartscientific.com. Fill out the registration form for the seminar you'd like to attend, and check the box to include the post-seminar Product Training Sessions. Or call us at 1-800-438-4278 and we'll take care of it over the phone.

Watch our Web site for exact dates and times of all our seminars and Product Training Sessions. We provide the equipment, the instructors, a fun place to work and learn, and we even throw in lunch. You just need to register and enjoy using the best temperature calibration products in the world. Try them out and you'll understand what we mean.

Software Training

You'll learn how to...

- automate control of your heat sources
- automate calibrations entirely
- generate probe data easily
- log temperature data and analyze it

You'll use...

- 9930 *Interface-it*
- 9932 *Calibrate-it*
- 9933 *TableWare*
- 9935 *LogWare II*

Thermometer Training

You'll learn how to...

- use the menu systems for each readout
- match a probe to a readout
- select the best probe and handle it correctly
- get the most productivity from your readout

You'll use...

- 1522 *Little Lord Logger*
- 1529 *Chub-E4*
- 1560 *Black Stack*
- 1590 *Super-Thermometer II*

Dry-Well Training

You'll learn how to...

- use all dry-well controller functions
- recalibrate your own dry-well
- use a reference thermometer
- maximize dry-well productivity

You'll use...

- Lab Dry-Wells
- Field Dry-Wells
- Handheld Dry-Wells
- Micro-Baths

Bath Training

You'll learn how to...

- profile a bath to minimize uncertainty
- use different types of bath fluids
- use Hart bath controllers
- get the most from a reference thermometer

You'll use...

- Model 7380 -80°C Bath
- Model 6022 Oil Bath
- Model 1590 *Super-Thermometer II*