THE PRACTITIONER'S TOOL KIT

An Introduction and Checking Field Thermometer Accuracy

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Editor's Note: The National Environmental Health Association (NEHA) strives to provide relevant and useful information for environmental health practitioners. In a recent membership survey, we heard your request for information in the *Journal* that is more applicable to your daily work. We listened and are pleased to feature this column from a cadre of environmental health luminaries with over 300 years of experience in the environmental health field. This group will share their tricks of the trade to help you create a tool kit of resources for your daily work.

The conclusions of this column are those of the authors and do not necessarily represent the official position of NEHA, nor does it imply endorsement of any products or services mentioned.

Introduction

Welcome to tricks of the trade. This column will look at the "what, why, and how" behind exercising our professional knowledge, skills, and attributes in the field. The information we will present is based on good science and uses a practical, commonsense approach.

We are all quite adept at interpreting codes, rules, regulations, and policies but unfortunately, applying this skill did not come with an owner's manual. Like most, we initially learned from a mentor, who learned from a mentor, and so on. It only becomes apparent that there might be a better way of doing things after we have been in practice for several years, or when we observe a colleague and wonder if there is something that can improve what we are doing. At best, we hone our skills. At worst, we become static and subsequently can be challenged when our work does not hold up to scientific or legal scrutiny.

This column is an extension of something we started approximately 30 years ago in the *Journal of Environmental Health*, albeit with a new perspective. We initially penned a column on field instrumentation and tools. Our approach was similar to that of *Consumer Reports* in reviewing household appliances, tires, and auto insurance. We put the tools into actual practice and gave an honest and critical accounting of our findings.

We learned much writing that column. We also learned new insights into our applied environmental health science. In particular, we learned how to sample, measure, and interpret findings to eliminate bias, ensure repeatability, and be responsive to developing scientific and technological trends, current public health needs, and the needs of our clients. We learned to use our field instruments and inspection, audit, or evaluation techniques to assess risk and help tailor corrective measures in a cost-effective and cost-efficient manner. We found that this approach encourages our clients to think of new ways to protect the public.

We learned to interpret data that conform with the sampling method and inherent error and limitations of the field instruments, as well as to structure our reports so that they cannot be easily assailed. And finally, we learned teaching and sales techniques along with professional deportment that results in improved communication and cooperation for the good of public health.

The idea for this column came from an experience working as a defendant's expert in a correctional conditions case. During field work, it became obvious—much to our own embarrassment because we were guilty of doing much of the same thing—that the sampling and measuring techniques of the plaintiff's expert were not defensible. Routine monitoring such as evaluating the temperature of food, as well as evaluating lighting, ventilation, and general sanitation practices, were without a good grounding in our applied science and industry accepted practices. Likewise, we are often called on to comment and defend (or critique) contentious sampling strategies, concise report preparation, and professional deportment in the performance of our duties. We are looking forward to sharing these experiences and the insights that go with them.

The authors of this column collectively have over 300 years of experience as environmental health professionals. We are all credentialed and worked as regulatory practitioners, academicians, industry consultants, and forensic technologists. Our careers were fraught with mistakes and successes, both large and small. We have embraced and learned from our mistakes and successes—and we are still learning. We do not know all the answers but realize it is now our turn to give to the best of our ability our version of an owner's manual for environmental health practitioners.

In so doing, we hope to introduce timely ideas and tips to make your field work easier and seamless. Most important, however, we welcome your questions and comments. We will try to respond in a way that is both useful and in keeping with our collective professional goals. We know there are emerging issues that affect our professional acumen and therefore, we welcome all your comments, opinions, and questions. Most of all, we are open to sharing novel approaches and techniques that you are using that make your job easier, safer, and more concise and understandable.

By way of introduction, here are the coauthors of this column:

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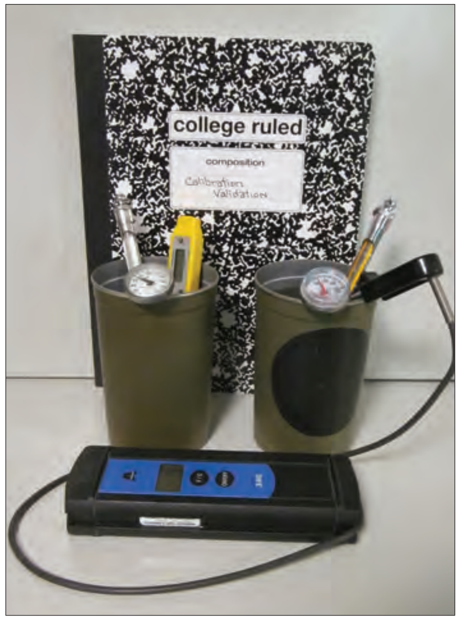
Checking Field Thermometer Accuracy

When conducting a retail food establishment inspection, one of the most critical and often observed violations is the failure to maintain safe temperatures, particularly hot and cold holding. Temperature readings above 41 °F (5 °C) and below 135 °F (57 °C), barring any time component, can result in immediate food destruction or a serious consequence in fines, sanctions, or even closure. On rare occasions, the restaurateur might challenge these findings that include questioning the thermometer accuracy and/or the conditions of sampling. When findings are questioned, it is our responsibility to justify inspection results in a way that cannot be challenged. In occasions when we have worked with a restaurateur to defend their claim, we found that failure to validate and record the thermometer(s) accuracy can and will invalidate inspection findings. We will deal with sampling strategies in another column.



Calibration and validation array that shows the "temperature standard" thermometer along with the thermometers to be validated (bimetallic dial, thermistor, and thermocouple thermometers), and record book. Note, the black dot on the container shown in the photo is used for validating our infrared thermometer, which will be discussed in a future column. Photo courtesy of Dr. Robert Powitz.

For this column, however, we will focus on ensuring accuracy of the temperature measuring devices that we regularly use in the field.

The need for validation—to confirm its accuracy or calibration, which is to precisely adjust the instrument in accordance with manufacturer recommendations—is inherent in the temperature measuring device itself. Most electronic thermometers are manufactured to an accuracy of ±0.2 °F (0.1 °C). Mechanical thermometers, such as bimetallic (dial) thermometers, have a tolerance of ±2 °F (1.1 °C). Thermometer accuracy can also be further compromised by external conditions encountered during transport, such as keeping them in a hot car, in freezing temperatures, or subjecting them to jarring before use.

Therefore, in the absence of a National Institute of Standards and Technology (NIST)-traceable dry-well thermometer calibrator, validating thermometer accuracy by some simple but traceable means is essential. Conventional wisdom recommends using an ice bath to validate electronic thermometers or calibrate mechanical ones. Presumably, the ice and water mixture will be 32 °F (0 °C) but that is not always the case. A water and ice mixture made from distilled, reverse osmosis, or deionized water will result in a 32 °F (0 °C) bath. A water and ice mixture made from surface, well, or bottled water can differ widely in total dissolved solids (TDS) content and affect the temperature of the mixture. The higher the concentration of dissolved salt, the lower its overall freezing point. The freezing temperature of "pure" versus highly mineralized water can vary as much as ±4.5 °F (2.5 °C). Along with the inherent accuracy of the thermometer, the variance of the ice and water mixture and thermometer together can result in an error as high as ±6.5 °F (3.6 °C). This high possibility for error does not instill a lot of confidence in verification of thermometer accuracy using an ice bath, particularly when a poorly functioning thermometer is used as an enforcement tool. There is a better way.

Here is the logic. If the thermometer is used to measure both hot and cold holding temperatures, would it not make more sense to do a two-point validation at some approximate temperature in the hot and cold range? Secondly, would it not make more sense to compare the temperatures of the thermometers to some temperature standard rather than worry about the TDS levels of the water and ice mixture and its freeze point conversion factor?

Let us begin by using a "temperature standard" thermometer, which is a liquid-in-glass general purpose laboratory thermometer, preferably built to NIST specifications but not necessarily essential. A convenient temperature range of the temperature standard thermometer is 0–220 °F (-20–110 °C). You will also need two containers of the same material type, such as inexpensive insulated travel mugs.

Fill one container with cold tap water and the other with hot tap water; immerse the temperature standard liquid-in-glass thermometer in either container along with the probe of the electronic thermometer or the mechanical thermometer to be tested. Let both thermometers equilibrate (a few minutes will do) and compare the temperature reading of the temperature-standard thermometer against that of the thermometer being validated. Repeat the process in the other container.

Always record your results. We use a bound composition book that is admissible in court and enter the time, date, and results that include the temperature of the temperature standard thermometer versus the field thermometer, along with your initial or signature. We use a separate column, marked in red ink, to list the correction factor (± variance from the standard) that we will apply in the field when taking temperatures. The results recorded in a bound composition book are a legal document that verifies due diligence in the performance of our duties as environmental health professionals. The process is simple, fast, accurate, inexpensive, defensible, and best of all, it cannot be challenged.

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