WEIGHTS & MEASURES
CONNECTION
NIST
National Institute of Standards and Technology
U.S. Department of Commerce
Volume 4 Issue 2
April 1, 2013

Inside this Issue

This Month in History

April 2, 1513 - Spanish explorer Ponce De Leon discovered Florida and claimed it for Spain. He came ashore in what is now known as St. Augustine, which is the oldest city in the United States.

April 4, 1887 - On this day, the first woman mayor was elected in the United States. Ms. Susanna Salter was elected mayor of Argonia, Kansas.

April 13, 1743 - Thomas Jefferson's birthday (1743 - 1826). He was a native of Virginia and a respected author, inventor, lawyer, politican, architect, and considered one of the finest minds of the 1700s.

April 19, 1775 - The historic "shot heard around the world" occured on this day at Lexington Green, Massachusetts. This event began the American Revolution.

April 22, 1864 - On this day, established by an Act of of Congress "In God We Trust" was added to all newly minted U.S. coins.

April 24, 1880 - The Library of Congress was established in Washington, DC.

Field Standards for Weights and Measures

Byline: Georgia L. Harris

A number of questions and issues have recently been raised that caused me to pause – and think – about field standards related to the entire weights and measures system. Normally, I would focus on just the laboratory applications and considerations, but I think it's time for some integrated thinking about field standards, their acceptance, and use. A number of key questions are presented here related to manufacturing, calibration, and use of field standards, such as: Are the field standards "fit for purpose"? Do the field standards comply with a documentary standard or other specifications *and* tolerances? What legal authority and responsibility do jurisdictions have regarding choice and purchase of field standards, compliance, metrological traceability, and acceptance of assessments or calibration reports? What should laboratories provide "the customer"?

Fit for Purpose

One of the big questions that should be asked in the measurement community is whether [field] standards are "fit for purpose". The concept of fit for purpose is common in method validation practices to ensure that adequate quality and suitability is designed into procedures. The concept can also be applied to field standards. Two quick examples might be: Class F field standard weights (NIST Handbook 105-1, *Specifications and Tolerances for Field Standard Weights*) are not suitable for evaluating a Class II weighing device (balance). They are not fit for purpose. Small Volume Provers (NIST Handbook 105-7, *Specifications and Tolerances for Dynamic Small Volume Provers*) are not suitable for evaluating Liquid Petroleum Gas (LPG) meters. They are not fit for purpose. While these statements could be debated, if one reviews the calibration uncertainty and tolerances for the field standards, it will quickly become obvious that Class F weights will not meet the Fundamental Considerations for evaluating a Class II device. The Fundamental Considerations require that the uncertainties in the standards be less than one third of the applicable tolerances. The tolerances on the mass standards are just too big. One could also argue that Small Volume Provers could be used for LPG meters; however, during the initial evaluation and development of the NIST Handbook 105-7, there was NO data collected or evaluated that demonstrated that Small Volume Provers could successfully be used to evaluate LPG meters. Thus, data are required to demonstrate suitability.

An additional question that might be asked in this section is whether the field standard allows for replication of the use of the weighing or measuring instrument. An example here is whether or not it is suitable to remove the nozzle from a retail motor fuel dispenser to evaluate a meter – and whether

there are sufficient steps in the evaluation process to ensure that the verification of the device complies with NIST Handbook 44, *Specifications, Tolerances, and Other Technical Requirements for Weighing and Measuring Devices*, and is fit for purpose (i.e., for consumers to use a meter tested this way to fill their vehicles with adequate accuracy). This entire concept goes back to an article I wrote in June 2005 on the Calibration of Rocks (http://www.nist.gov/pml/wmd/labmetrology/upload/h-006.pdf). A laboratory can provide a perfectly valid mass value and uncertainty for a rock, but that does not mean the rock is suitable for use as a mass standard in testing a scale.

Compliance Assessments

A common practice among calibration laboratories is to evaluate compliance of the measurement result and the uncertainties against published tolerances only. In fact, many calibration certificates say something along the lines of "the measurement results comply with the tolerances of XYZ Handbook." A key aspect of this practice to consider is that the calibration uncertainties must always be smaller than the applicable field standard tolerances to claim any level of compliance. If a situation occurs such as is shown in Figure 1, in Case A, the measurement uncertainty is bigger than the tolerance and a statement of compliance cannot be made with the usual confidence, in spite of the value being at nominal! In Case B or Case C, there is doubt about the measurement result – which is why most metrologists will also adjust a field standard and you may see "as found" and "as left" calibration results reported on a calibration certificate.

What is also critical for weights and measures officials to know is that many laboratories do NOT evaluate field standards for compliance to all of the specifications in a documentary standard. It is important to make sure you know this when covering any of the subsequent sections in this article! For example, cast iron 1 lb weights are manufactured, used by service companies, and calibrated by laboratories – yet they do not comply with NIST Handbook 105-1 for field standard weights because of the material requirements for weights between 0.01 lb – 10 lb (5 g – 5 kg). A volumetric prover or LPG prover may or may not be evaluated against NIST Handbook 105-3, *Specifications and Tolerances for Graduated Neck Type Volumetric Field Standards*, or 105-4, *Specifications and Tolerances for Liquefied Petroleum Gas and Anhydrous Ammonia Liquid Volumentric Provers*, even if new and just being put into service – unless the evaluation was requested.

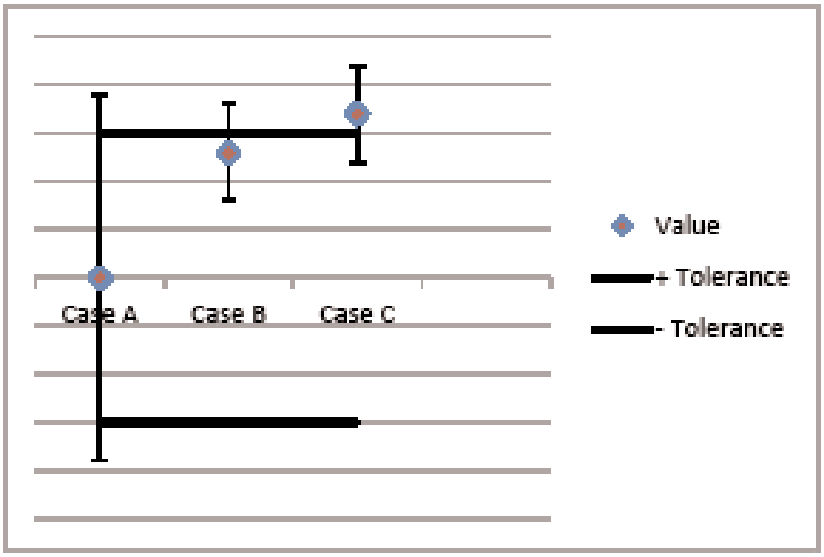

Figure 1. Example Values, Uncertainties and Tolerances.

Weights and measures jurisdictions may require compliance to NIST Handbook 105-series standards, or an ASTM standard (e.g., proving rings used for wheel load weigher testing), or OIML R 120 for volumetric standards. It is important to specifically request an evaluation of compliance to a standard for a weights and measures program when evaluating the standards field staff use, when designating suitable field standards for service companies, or when accepting calibration reports from other calibration laboratories. NIST recommends full compliance evaluations whenever possible – yet, we have no regulatory authority to ensure that laboratories perform this function. It is up to the jurisdiction to mandate compliance evaluations. ISO/IEC 17025, Section 5.10.4.2 indicates that when compliance statements are included on a calibration report, they must specifically include what was or was not assessed: "If a statement of compliance with a specification is made, this shall identify which clauses of the specification are met or not met." So, if a field standard was only evaluated for measurement results to tolerances, the report should specifically state that "no evaluation for compliance against the specifications was made" in addition to "all standards were found/left in tolerance according to this handbook." An example here might be a volumetric prover made from aluminum. Aluminum is not allowed according to NIST Handbook 105-3 due to the excessively large cubical coefficient of expansion. Yet, a laboratory could perform a valid calibration and find the prover in tolerance and produce an acceptable calibration certificate, as long as the report indicated no evaluation was done. In this case, not only would the prover NOT comply with the standard, it would also not be fit for purpose.

There is an ongoing challenge when no documentary standard exists that includes both specifications and tolerances. In the scheme of the NIST Handbook 105-series standards, Handbook 105-8, *Specifications and Tolerances for Field Standard Weight Carts*, for weight carts used to evaluate scales, is relatively new. Prior to this handbook being published, there were many weight carts already in use throughout the country by both weights and measures jurisdictions as well as by service

companies. No one was able to assess weight carts for compliance, because no standard existed.

Legal Responsibilities

Most jurisdictions in the United States have adopted into law language similar to the model laws provided in NIST Handbook 130, *Uniform Laws and Regulations in the Areas of Metrology and Engine Fuel Quality*. In the current version (in fact going back to 2005 when some key changes were adopted), the model law and the registered service persons program designate some key responsibilities and authorities to the weights and measures director. The director has the authority to accept calibration reports from other calibration laboratories and retains the right to inspect and evaluate the standards that will be used. This right is especially critical if the laboratory performing the calibration did not evaluate the field standards for compliance to a documentary standard that is required in your jurisdiction. When a calibration report is submitted which states that the standards were not evaluated for compliance, a weights and measures jurisdiction should conduct an inspection or evaluation of the field standard when specific documentary standards are required.

The model laws also allow for specific calibration intervals or variable calibration intervals based on statistical analysis of stability of the standards. According to ISO/IEC 17025 for the laboratories, no calibration intervals are to be included on a calibration certificate unless requested by the customer or unless there is a legal requirement. Service companies may not be aware of legally required calibration intervals when requesting calibration services, so it is a good idea for laboratories to ask customers where or how they intend to use the standards and if there are required calibration intervals. We have previously published some baseline calibration intervals for a variety of field standards, where local authority allows for variable intervals based on data. See: http://www.nist.gov/pml/wmd/labmetrology/upload/h-009.pdf.

Supplier Evaluations – Calibration Laboratories

When accepting calibration certificates from a laboratory, there are some concepts from the ISO/IEC 17025 standard (as applied to calibration laboratories through recognition and/or accreditation), that are useful. Compliance with ISO/IEC 17025 requires assessment of the evidence for metrological traceability of the measurement results. This is also defined in NIST Handbook 143, *Weights and Meaures Laboratories Program Handbook*, Program Handbook for Laboratory Recognition, and in NIST Handbook 130, which indicates that evidence of metrological traceability may be assessed through laboratory recognition or accreditation.

However, even if a laboratory is or was recognized or accredited, it is important to ensure that they still are recognized or accredited at the time of calibration when accepting the calibration certificate AND that the measurements in question are actually on the laboratory's measurement Scope. The Scope defines the measurement areas for which the laboratory has been recognized or accredited. For example, a laboratory only recognized or accredited for mass has not demonstrated metrological traceability and proficiency for volume. It is also important to ensure that the laboratory has the capability of providing measurement uncertainties that are sufficiently small for your applications. Otherwise, a calibration might have uncertainty bars similar to Case A (Figure 1). Laboratories have a responsibility to consider the needs and requirements of the user, so the example in Case A should never occur, but again, there is not a regulatory body that enforces this.

Calendar 2013

Registration for training in the NIST Office of Weights and Measures is handled by Yvonne Branden at yvonne.branden@nist.gov.

Course descriptions can be viewed on the Office of Weights and Measures website by clicking on the name of the course. http://www.nist.gov/pml/wmd/calendar.cfm

April 8 - 11 (4 days)
SEMAP*
Class No. 5209
Tifton, GA

April 9 - 11 (3 days)
Packaging and Labeling Seminar
Class No. 5224
NIST/Gaithersburg, MD

April 15 - 19 (5 days)
Fundamentals of Metrology
Class No. 5208
NIST/Gaithersburg, MD

April 22 - 26 (5 days)
Vehicle-Tank and Loading-Rack Meters
Class No. 5268
Olympia, WA

April 23 - 25 (3 days)
Grain Moisture Meter Technical Training
Class No. 5264
Kansas City, MO

April 25
Conducting an Effective Management Review
Webinar, 2:00 p.m. to 4:00 p.m.
Class No. 5253

May 2
Internal Auditing Best Practices
Webinar, 2:00 p.m. - 4:00 p.m.
Class No. 5234

May 6 - 10 (5 days)
WRAP*
Class No. 5216 , Helena, MT

May 6 - 9 (4 days)
Northeast Weights and Measures Association (NEWMA)
Saratoga Springs, NY
Contact: James Cassidy at jcassidy@cambridgema.gov

May 13 - 24 (2 weeks)
Mass Metrology Seminar
Class No. 5217
NIST/Gaithersburg, MD

May 20 - 23
Central Weights and Measures Association (CWMA)
Overland Park, KS

(*con'd pg 4)*

Contract Review and Customer Service

Another concept applied in the laboratories for ISO/IEC 17025 is that of contract review. We often hear the argument that, "we are a government laboratory and don't have authority to sign contracts; therefore, this section is not applicable for us." Not true!

When a laboratory accepts a standard and provides a calibration, they have "agreed" to perform a calibration and provide a calibration report. The key questions that must be considered at every level are, "What does the customer need?" and "Are we recognized or accredited to provide that calibration service – is it on our Scope?" NIST OWM has responded to a number of recent inquiries where a standard was calibrated by an accredited calibration laboratory in a jurisdiction, without a full compliance assessment. When the service company receiving that calibration submitted the calibration report to another jurisdiction, assumptions were made about compliance assessments of the field standards during the calibration. As noted before, unless the calibration report specifically claims that the standards were fully evaluated for compliance to a documentary standard, one should NOT assume this to be the case. Also, as noted before, service companies may not be aware of legally required assessments and/or calibration intervals.

Suitability of Field Standards – in Use

I would like to conclude with some challenging thoughts and questions. Calibrations of field standards may or may not involve a compliance assessment. However, calibrations are also done at one point in time, under controlled laboratory conditions, using laboratory procedures. Yet, field standards are used in a wide variety of conditions for various applications, sometimes deviating from the specific examination procedure outlines. How do we know that the field standards are actually suitable for a wide variety of conditions in use? How confident are we in our measurement results when field standards knowingly do not comply with standards? How can we be sure a calibrated value can be replicated in field use? How can we be sure deviations from the field procedures produce reliable results? And finally, how can we responsibly take enforcement action with all of these questions and doubt?

Some steps taken to provide assurance are to define specifications and tolerances that are intended to allow for or account for these various conditions and deviations. Every effort is made to consider suitable specifications and tolerances to ensure that when field standards are used, good quality measurements are possible in a variety of conditions. However, additional factors often need to be considered. Yet, even a good specification and full compliance along with a good calibration is not the full answer and can leave a sense of doubt. Here are some specific examples and questions about standards used in the weights and measures system that should be considered, the impact should be evaluated, and procedures should be followed.

Selection of weights that comply with NIST Handbook 105-1 and a current calibration might not address all of the user requirements.

- Laboratories have observed Class F weights being out of tolerance on the day they are brought into the laboratory for calibration, only to find that they are in tolerance once they have properly equilibrated with laboratory conditions (according to the standard operating practice [SOP]). How often do laboratories calibrate field weights without allowing suitable equilibration? How often are weights used outside of normal laboratory operating conditions in the field?

Contact: Maureen Henzler at maureen.henzler@kda.ks.gov

June 17
Webinar Week - NIST IR 6969, SOP 8, Part I
10:00 a.m. to 12:00 p.m.
Class No. 5239

June 17
Webinar Week - Uncertainty Budgets for SOP 4
2:00 p.m. to 4:00 p.m.
Class No. 5257

June 18
Webinar Week - Conducting an Effective Management Review
10:00 a.m. to 12:00 p.m.
Class No. 5240

June 18
Webinar Week - NIST IR 6969, SOP 8, Part II
2:00 p.m. to 4:00 p.m.
Class No. 5241

June 19
Webinar Week - NIST IR 7383, SOP 18, Part I
10:00 a.m. to 12:00 p.m.
Class No. 5242

June 19
Webinar Week - Uncertainty Budgets for SOP 5
2:00 p.m. to 4: 00 p.m.
Class No. 5258

June 20
Webinar - Uncertainty Budgets for SOP 19
10:00 a.m. to 12:00 p.m.
Class No. 5259

June 20
Webinar Week - NIST IR 7383, SOP 18, Part II
2:00 p.m. to 4:00 p.m.
Class 5243

June 21
Webinar Week - Calibration Report Evaluation
10:00 a.m. to 12:00 p.m.
Class No. 5244

June 21
Webinar Week - Uncertainty Budgets for SOP 14
2:00 p.m. to 4:00 p.m.
Class No. 5254

July 14 - 18
NCSL International
Nashville, TN
Contact: info@ncsli.org

July 14 - 18
NCWM Annual Conference
Louisville, KY (con'd pg 5)

- Laboratories have observed errors on precision weight values that were over 300 times the reported uncertainty of the calibration, due only to a 2 °C gradient in the calibration laboratory. This would be observable when evaluating a Class II balance. How often are the environmental conditions measured when evaluating a Class II balance? Are the weights allowed to equilibrate?

- Weights and measures officials or service agents have reported that they use Class F weights for evaluating Class II balances. How often is this done? Should a laboratory provide calibrations for weights to meet the required weight classification (e.g., OIML Class F2) if they are recognized for Mass Echelon III only (the answer is "no")?

- Most state calibration laboratories do not have the ability to evaluate density, surface finish, or magnetism requirements in some mass specifications to determine compliance. Therefore, that laboratory is not able to perform a full compliance assessment. However, most manufacturers are able to perform these additional assessments.

Selection of glassware that is marked Class A might not meet all of your needs.

- Laboratories have reported that up to 50 % of the volumetric glassware purchased for use in package checking is out of tolerance when purchased. How often is the glassware used without calibration because it is purchased or marked as Class A by the manufacturer?

Selection of a test measure or prover that complies with NIST Handbook 105-3 with a calibration might not address all of the user requirements.

- Laboratories hear reports from service agents and field officials that they do not correct the volume of large volume provers (certainly not test measures) for the actual volume at time of test based on temperature. Most provers and test measures are calibrated to a reference temperature 60 °F in the United States. Are field officials correcting the volume of the prover real-time? Are they using calibrated thermometers with evidence of metrological traceability?

- In some recent instances, the standards were being exported and needed to comply with OIML R 120. Are laboratory staff familiar enough with the additional documentary standards that might be requested to assess compliance?

- How many large volume provers are grandfathered in because they don't meet specifications and/or are calibrated in the field without suitable environmental controls?

Selection of a prover that complies with NIST Handbook 105-4 with a calibration might not address all of the user requirements.

- Laboratories observe that pressure gauges on LPG provers have been changed between calibrations. Provers are often calibrated without evaluation of the pressure gauge calibration. Are the replacement pressure gauges calibrated, and do they agree with the previous gauge? Again, are provers being used with calibrated thermometers with evidence of metrological traceability?

Selection of a timing device or thermometer that complies with NIST Handbook 105-5, *Specifications and Tolerances for Field Standard Stopwatches,* or 105-6, *Specifications and Tolerances for Thermometers,* with a calibration

Contact: info@ncwm.net

August 1
Webinar - Calibration Report Evaluation
2:00 p.m. to 4:00 p.m.
Class No. 5245

August 8
Webinar - Contract Review
2:00 p.m. - 4:00 p.m.
Class No. 5246

August 12 - 16
Handbook 133, *Checking the Net Contents of Packaged Goods*
Class No. 5261
Scramento, CA

August 15
Webinar - Document Control and Recordkeeping
2:00 p.m. to 4:00 p.m.
Class No. 5247

August 19 - 23 (5 days)
Fundamentals of Metrology
Class No. 5248
NIST/Gaithersburg, MD

September 9 - 13
NEMAP*
Class No. 5218
Harrisburg, PA

September 16 - 20
MidMAP*
Class No. 5219
Springfield, IL

September 22 - 26
Western Weights and Measures Association (WWMA)
Kalispell, MT
Contact: Doug Deiman at doug.deiman@alaska.gov

September 23 - 27
SWAP*
Class No. 5220
Phoenix, AZ

October 7 - 9
Southern Weights and Measures Association (SWMA)
Charleston, WV
Contact: Steve Benjamin at steve.benjamin@ncagr.gov

October 10
Webinar - State Laboratory Annual Submission Process*
2:00 p.m. to 4:00 p.m.
Class No. 5249

October 21 - November 1 (2 weeks)
Mass Metrology Seminar
Class No. 5250 *(con'd pg 6)*

might not address all of the user requirements.

- Many laboratories are not recognized or accredited to evaluate timing devices and to calibrate thermometers or to assess these standards for compliance. How many are in use without evaluation or calibration?

Use of a Small Volume Prover that complies with NIST Handbook 105-7 with a calibration might not address all of the user requirements.

- Small Volume Provers were only assessed during development of Handbook 105-7 for refined fuel and fuel oil (and not LPG). The integral pressure sensors and thermometers are often not calibrated by the same laboratory when the volume is calibrated.

- Small Volume Provers are calibrated under laboratory conditions with controlled flow, pressure, and temperatures, but we don't have data for their accuracy under a wide variety of flow rates and field conditions. When initial assessments were done, performing the slow flow test identified a leak in the system that was not obvious during the fast flow test. How often do short cuts take place when evaluating a meter to save time?

- An industry laboratory was accredited to perform calibrations of a Small Volume Prover gravimetrically and inappropriately demonstrated their proficiency by calibrating a Class F mass standard.

Use of a weight cart that complies with NIST Handbook 105-8 with a calibration might not address all of the user requirements.

- Weight carts are often used without the associated checklist in Handbook 105-8. Weight carts are often calibrated without evaluating them for compliance with the standard and have been grandfathered. What is the impact of deviations? Laboratories have data to show the impact of water on the surface that is wiped off and appears dry, with the cart being out of tolerance. Are weight carts ever used on days with precipitation? Handbook 105-8 instituted a smaller gas tank with the use of correction weights to account for the mass of fuel lost during use. Field staff often do not account for these mass changes and many weight carts found in service have not been modified to comply with Handbook 105-8.

The examples provided here are just the tip of the iceberg and only cover those situations where a NIST Handbook currently exists. As you read this article, you may have had additional questions – and even examples! Feel free to contact me with additional examples and questions at gharris@nist.gov.

NIST/Gaithersburg, MD

October 31
Webinar - Internal Auditing Best Practices
2:00 p.m. to 4:00 p.m.
Class No. 5251

November 18 - 22 (5 days)
Volume Metrology Seminar
Class No. 5252
NIST/Gaithersburg, MD

2014

January 13 - 17 (5 days)
Fundamentals of Metrology Seminar
Class No. not available
NIST/Gaithersburg, MD

January 19 - 22 (4 days)
National Conference on Weights and Measures (NCWM) Interim Meeting
Albuquerque, NM
info@ncwm.net

February 6
Webinar - Conducting an Effective Management Review
2:00 p.m. to 4:00 p.m.
Class No. 5255

*Invitation Only
**Limited to State Laboratory Program Participants

The Office of Weights and Measures

will glady include your weights and measures related events in our calendar.
Contact the Editor:
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Weights and Measures in the News

Pennsylvania - witf.org
As counties shed weights and measures services, Ag. Dept. picks up slack
http://www.witf.org/news/2013/03/as-counties-shed-weights-and-measures-services-ag-dept-picks-up-slack.php