

Misconceptions of Metrology and Calibration

Abstract

In today's world of manufacturing, R&D, and testing across diverse industries, the definition of Metrology and calibration has taken on new meanings, whether it is right or wrong. With the evolving requirements for defining traceability, which is impacted through ISO/IEC 17025: 2017 as well as the NIST's definition of Metrological Traceability, we must step back and truly understand what the differences are between these 2 terms. In this paper, we will evaluate the definitions of Metrology and calibration. We will also look at the importance of each and how one affects the other. While both terms are important, as liaisons within the Science of Measurement, we need to be able to articulate the differences between both terms to assist in bringing the representatives working in various industries to a clear understanding of how calibration is an action within the world of Metrology.

Introduction

Have you ever been asked what do you do for a living and have answered that you are a Metrologist? I am sure many of us have, which leads to the people following up with the question of "You're a weatherman?", "How can you be 50% correct in your forecast and still have a job?", or "What is a metrologist?". The first 2 questions are absurd, but the general population of individuals do not know what Metrology is. The last question provides us the opportunity to educate and spread the word of our extraordinary career field of Metrology.

Defining Metrology vs. Calibration

So, what is Metrology? Metrology is defined by the International Bureau of Weights and Measures (BIPM) as "the science of measurement, embracing both experimental and theoretical determinations at any level of uncertainty in any field of science and technology"¹. It establishes a common understanding of units, crucial to human activity.

In today's world of manufacturing, R&D, and testing across diverse industries, the definition of Metrology and calibration has taken on new meanings, whether it is right or wrong. You are probably asking yourself, why is it important to not cross the two terms with each other since they have completely different meanings.

Consider the definition of calibration, which is an "operation performed on a measuring instrument or a measuring system that, under specified conditions 1. establishes a relation between the values with measurement uncertainties provided by measurement standards and corresponding indications with associated measurement uncertainties and 2. uses this information to establish

¹ "What is metrology?". BIPM. Accessed 6 April 2021. <https://www.bipm.org/en/worldwide-metrology/>

a relation for obtaining a measurement result from an indication”². In layman’s terms, it is the comparison of an unknown value of a device under test to a known reference value. There is more to this since the definition of metrological traceability has been updated and redefined, but that is another topic of discussion.

While we are discussing these definitions and how they are applied, there are many individuals, service manuals, and printed literature where additional actions get referenced as calibration. These terms which are incorrectly used in the various industries are: adjustment, trimming, tweaking, and guard banding. Even though these actions are extremely important in determining and/or correcting measurement values that have been compared to a known value, they are not included in the definition of calibration within the Metrology industry.

Am I a Calibration Technician or Metrologist?

As the metrology industry continues to evolve, so has the continuous debate on how we represent our employees working in the industry. I have heard many calibration technicians refer to themselves as a metrologist and vice versa. We must ask ourselves and rely on our industry subject matter experts to define what the differences are between the 2. Back in 2005, there was a team of industry leaders, which included multiple Woodington Award recipients, established to develop an initiative thru ASQ to solicit the Department of Labor, Bureau of Lab Statistics to add calibration technician, calibration engineer, and metrologist to the Standard Occupational Classification list. The jobs are defined as:

Calibration Technician

Apply knowledge of measurement science, mathematics, physics, and electronics to calibrate inspection, measurement, and test equipment (IM&TE) in the electrical, dimensional, optical, physical, mechanical, environmental, and/or chemical disciplines to ensure measurement accuracy. Identify and utilize appropriate measurement procedures. Perform corrective actions to address identified measurement problems. Adapt equipment, standards, and procedures to accomplish unique measurements. Maintain calibration standards. Perform laboratory and/or departmental housekeeping.

Calibration Engineer

Apply measurement science, mathematics, physics, and engineering to design and develop systems, equipment, and methods for calibrating electrical, dimensional, optical, physical, mechanical, environmental, and/or chemical inspection, measurement, and test equipment (IM&TE). Analyze and solve calibration problems using advanced mathematical and engineering knowledge. Use statistics to analyze measurement standards and processes. May develop software to assist in calibration laboratory and/or departmental processes. Recommend calibration standards and IM&TE. Maintain calibration laboratory and/or quality systems. Perform laboratory and/or departmental administration and management.

² VIM4. BIPM. Accessed 19 May 2021 https://www.bipm.org/documents/20126/54295284/VIM4_CD_210111c.pdf/a57419b7-790f-2cca-f7c9-2/5d54d049bf6

Metrologist

Apply measurement science, mathematics, and physics to develop, document, and maintain calibration systems, procedures, and methods for electrical, dimensional, optical, physical, mechanical, environmental, and/or chemical inspection, measurement, and test equipment (IM&TE) based on analysis of measurement problems, and accuracy and precision requirements. Evaluate new calibration methods and procedures. Use statistics to analyze measurement standards and processes. Recommend calibration standards and IM&TE. Maintain calibration laboratory and/or departmental accreditation, and quality systems. Perform laboratory and/or departmental administration and management.³

You can see, based on the definitions that were included in the submission to the Department of Labor, the roles are specific to the various roles in the industry. Whether you are working for the military, civil service, or 3rd party calibration companies, you have distinct responsibilities that fall into one of these roles.

Finally, in 2018, the SOC was updated to include Calibration Technologists and Technicians. This job description in the SOC is defined as: “Execute or adapt procedures and techniques for calibrating measurement devices, by applying knowledge of measurement science, mathematics, physics, chemistry, and electronics, sometimes under the direction of engineering staff. Determine measurement standard suitability for calibrating measurement devices. May perform preventive maintenance on equipment. May perform corrective actions to address identified calibration problems.”⁴

This was the first step in recognizing the metrology industry by the Department of Labor, however it did not account for the various roles that perform the calibrations vs the development of processes and/or procedures that are used in today’s industry. This leaves the industry wide open to interpretation since the SOC only added 1 defined role for calibration.

The second part of the debate is around the education for a metrologist vs. calibration technician. When you investigate the ASQ’s submittal for the definitions, the calibration engineer and metrologist definitions speak to the use of statistical analysis, advanced mathematics and/or engineering skills. Many of these advanced skills require advanced education which can be obtained in various ways. Individuals can obtain their knowledge thru colleges and universities, while other could obtain the skills from OJT and working with individuals who have obtained degrees thru other resources.

Metrology is really the all-encompassing global traceability network whose purpose is to standardize product/service measurements in the name of good commerce. This starts with the definitions of each base unit of measure (SI units) created by the BIPM and extends from the realization of these SI units at each National Metrology Institute (NMI) through every level in the chain of traceability to the measurements made on products and in services provided to consumers and businesses – including the uncertainty of each measurement. Calibration is the action taken at each step in the Metrology network. Therefore, a Calibration Technician is a person who performs the comparisons

³ Job Description Initiative, March 2006, <http://rube.asq.org/measure/initiatives/pdf/finalized-metrology-job-description.pdf>

⁴ Standard Occupational Classification Manual. BLS.GOV https://www.bls.gov/soc/2018/soc_2018_manual.pdf

and notes their differences while a Metrologist has their eye on keeping the whole system aligned to minimize Quality Blind Spots introduced along the way to achieve consistency in measurements throughout the Metrology network.

Summary

We need to educate and groom our next generation of calibration technicians and metrologists today. Work with our employees and teams to identify the individuals who will be leading the industry in the next 20-30 years. Our roles and responsibilities by working in the metrology industry while supporting calibrations across various industries is to minimize risk. By staying consistent on how we discuss and educate equipment owners and industry liaisons, articulating that there is a significant differentiation in these roles, and to be clear on what equipment owners need for their calibration program. Calibration programs need to be developed and managed by metrologists and not by calibration technicians that are only executing the processes and procedures for the equipment under test. We must not lose sight of the purpose of Metrology as well as the different roles within Metrology and their respective responsibilities in order to continue to minimize measurement risk, also known as Consumer risk, for products and services across all industries.