CAL LAB
THE INTERNATIONAL JOURNAL OF METROLOGY

2024
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Are You Measuring "Average Roughness" Correctly? There's More to It Than You May Think

Digitalization in the Quality Infrastructure - Perspectives from Novo Nordisk

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VOLUME 31, NUMBER 4

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FEATURES

DEPARTMENTS

ON THE COVER: Tovey Engineering provides Force Metrology training at their state-of-the-art facility in Phoenix, Arizona.

CALENDAR

UPCOMING CONFERENCES & MEETINGS

The following event dates are subject to change. Visit the event URL provided for the latest information.

Mar 11-14, 2025 International Metrology Congress (CIM). Lyon, France. Embark on a journey to uncover the latest trends and gain a sneak peek into future innovations worldwide. https://www.cim-metrology.org/

Apr 6-9, 2025 A2LA Annual Conference. Dallas, TX. Over the years, the A2LA Annual Conference has grown to become one of the largest, multidiscipline events in the accreditation industry, attracting attendees from over a dozen different sectors, including automotive, environmental, pharmaceutical, information technology, cannabis, food testing, biobanking, and calibration. https://a2la.org/annual_conference/

Apr 14-17, 2025 MSC Training Symposium. Anaheim, CA. Founded in 1970, the Measurement Science Conference (MSC) promotes education and professionalism in Measurement Technology. We serve the Metrology community by providing an annual conference to exchange ideas and techniques regarding Measurement. https://annualconf.msc-conf.com/

May 6-8, 2025 International Conference on Electronics, Energy and Measurement. Algiers, Algeria. The 3rd IC2EM covers: Electronics and electrical engineering systems, such as the following topics: Electronic Systems, Energy Systems, Measurements, Instrumentations, Telecommunications and Power electronics and drives. https://ic2em2025.usthb.dz/

May 6-8, 2025 SENSOR+TEST. Nuremberg, Germany. SENSOR+TEST is the world's leading forum for sensor, measurement and testing technology. https://www.sensor-test.de/en/

May 6-8, 2025 Sensor and Measurement Science International. Nuremberg, Germany. As the only major

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EDITOR'S DESK

150 Years of Measurement Progress

BIPM will be celebrating its 150th anniversary, May 20-22, 2025 in Paris, France. You can check out this special event by going online to thebipm150.org. Their theme, "From units to the universe - future revolutions in metrology," encompasses an exciting program of sessions. A quick peek on their website and I can see topics of digital transformation, as well as digitalization.

20 years ago, not many paid a whole lot of attention to what "going digital" would mean for the industry. Now, the hot topic of digitalization has spun off into sessions at conferences, workshops, and international meetings. Manual entry and paper transfer is giving way to automation as needs for quality and quantity increase.

Focused on making their data FAIR (Findable, Accessible, Interoperable, and Reusable), Novo Nordisk is piloting a transition from manual entry and handling to digital. Heidi Foldal writes about her company's journey towards automation and digitalization in "Digitalization in the Quality Infrastructure – Perspectives from Novo Nordisk."

But first, we have a Metrology 101 on measuring roughness by Mike Zecchino and Mark Malburg. I saw Digital Metrology Solution's video on LinkedIn and knew their material would make for an excellent article. They were happy to oblige our request with "Are You Measuring 'Average Roughness' Correctly? There's More to It Than You May Think."

This past couple of months, I've been loading up the print and online Google calendar (callabmag.com/calendar), so be sure to check them out for upcoming conferences and meetings. If you can get out to NCSLI's Technical Exchange or the MSC Training Symposium, our publisher will be handing out the remaining copies of "Cal-Toons by Ted Green" wall calendars. They are also still for sale from the website (callabmag.com/2025-calendar). This special BIPM 150th anniversary themed calendar also includes a number of metrology related conferences & meetings happening around the globe.

Happy Measuring,

Sita Schwartz

international sensor and metrology conference, SMSI brings together intelligent sensor technology and instrumentation, digitalization-oriented measurement science with cognitive features as well as modern quantum technology-based metrology including the secure digital exchange of certificates. https://www.smsi-conference.com/

Jun 18-20, 2025 IEEE 12th International Workshop on Metrology for AeroSpace. Naples, Italy. MetroAerospace aims to gather people who work in developing instrumentation and measurement methods for aerospace. Attention is paid, but not limited to, new technology for metrology-assisted production in aerospace industry, aircraft component measurement, sensors and associated signal conditioning for aerospace, and calibration methods for electronic test and measurement for aerospace. https://www.metroaerospace.org/

Jun 20, 2025 ARFTG Microwave Measurement Symposium. San Francisco, California. The 105th ARFTG Microwave Measurement Symposium will be co-located with IMS-2025. https://arftg.org/

Aug 25-28, 2025 MSA Conference. Sydney, Australia. Rapid-Tech MSA2025 will be the place to be to connect with the metrology community, hear about the latest trends, meet experts from National Metrology Institutes and regulatory bodies, find your next instrument investment and enjoy the company of many likeminded professionals. https://metrology.asn.au/events/

Sep 21-26, 2025 European Microwave Week. Utrecht, Netherlands. https://www.eumweek.com/

SEMINARS & WEBINARS: Dimensional

Feb 4, 2025 EDU-V111: Introduction to Dimensional Gage Calibration. Virtual Classroom. Mitutoyo. This course is taught in the Mitutoyo Institute of Metrology's Training Lab in Aurora, IL and broadcast live in a virtual session. The course combines modern calibration and quality management ideas with best practices and "how-to" calibration methods for common calibrations of micrometers and calipers. https://www.mitutoyo.com/training-education/

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Feb 13-14, 2025 Virtual Hands-On Precision Gage Calibration and Repair Training. IICT Enterprises. Enhance your career knowledge in Metrology with this in-depth Gage use, Calibration, and Repair course. Recommended for people interested in pursuing the ASQ CCT Exam. https://calibrationtraining.com/

Feb 18-20, 2025 Gage Calibration Methods Class. Cincinnati, OH. QC Training. This 3-day hands-on workshop offers specialized training in calibration and repair for the individual who has some knowledge of basic Metrology. https://qctraininginc.com/course/gage-calibration-methods/

Feb 19-20, 2025 EDU-113: Dimensional Gage Calibration. Aurora, IL. Mitutoyo. The course combines modern calibration and quality management ideas with best practices and "how-to" calibration methods for common calibrations. The course is ideal for those operating in ISO/IEC 17025 accredited laboratories or in gage labs supporting manufacturing operations. https://www.mitutoyo.com/training-education/

Feb 24-28, 2025 Advanced Dimensional Metrology. Pretoria, South Africa. NMISA. The course objective is to obtain an in-depth understanding of Dimensional Metrology. The course built on the Basic dimensional metrology course explaining the key principles and techniques used in dimensional metrology. https://store.nmisa.org/collections/face-to-face-courses

Mar 5-6, 2025 Hands-On Precision Gage Calibration and Repair Training. Blooomington, MN. IICT Enterprises. Enhance your career knowledge in Metrology with this in-depth Gage use, Calibration, and Repair course. Recommended for people interested in pursuing the ASQ CCT Exam. https://calibrationtraining.com/

Mar 18-20, 2025 Gage Calibration Method Class. Cincinnati, OH. QC Training. This 3-day hands-on workshop offers specialized training in calibration and repair for the individual who has some knowledge of basic Metrology. https://qctraininginc.com/course/gage-calibration-methods/

CALENDAR

Mar 18-19, 2025 Virtual Hands-On Precision Gage Calibration and Repair Training. IICT Enterprises. Enhance your career knowledge in Metrology with this in-depth Gage use, Calibration, and Repair course. Recommended for people interested in pursuing the ASQ CCT Exam. https://calibrationtraining.com/

Mar 25-26, 2025 EDU-113: Dimensional Gage Calibration. West Chester, OH. Mitutoyo. This course is taught at the one of Mitutoyo America's regional showrooms, with the class size intentionally small to ensure personalized and customized instruction to meet the needs of individual students. The course combines modern calibration and quality management ideas with best practices and "how-to" calibration methods for common calibrations. https://www.mitutoyo.com/training-education/

Apr 8-9, 2025 Hands-On Precision Gage Calibration and Repair Training. Cleveland, OH. IICT Enterprises. Enhance your career knowledge in Metrology with this in-depth Gage use, Calibration, and Repair course. Recommended for people interested in pursuing the ASQ CCT Exam. https://calibrationtraining.com/

Apr 10-11, 2025 Hands-On Precision Gage Calibration and Repair Training. Indianapolis, IN. IICT Enterprises. Enhance your career knowledge in Metrology with this in-depth Gage use, Calibration, and Repair course. Recommended for people interested in pursuing the ASQ CCT Exam. https://calibrationtraining.com/

Apr 16, 2025 EDU-111: Introduction to Dimensional Gage Calibration. Novi, MI. Mitutoyo. This 1-day classroom course is part of our dimensional metrology curriculum and is a blended learning opportunity to maximize the student's time in the classroom. Adapted from our popular 3-day Dimensional Gage Calibration course, this 1-day version utilizes Mitutoyo America's online video material, which is to be watched prior to attending the classroom course. https://www.mitutoyo.com/training-education/

Apr 21-23, 2025 Gage Calibration Methods Class. Greer, SC. QC Training. This 3-day hands-on workshop offers specialized training in calibration and repair for the individual who has some knowledge of basic Metrology. https://qctraininginc.com/course/gage-calibration-methods/

Apr 22, 2025 EDU-113: Dimensional Gage Calibration. Aurora, IL. Mitutoyo. This course is taught at the one of Mitutoyo America's regional showrooms, with the class size intentionally small to ensure personalized and customized instruction to meet the needs of individual students. The course combines modern calibration and quality management ideas with best practices and "how-to" calibration methods for common calibrations. https://www.mitutoyo.com/training-education/

Apr 23-24, 2025 Virtual Hands-On Precision Gage Calibration and Repair Training. IICT Enterprises. Enhance your career knowledge in Metrology with this in-depth Gage use, Calibration, and Repair course. Recommended for people interested in pursuing the ASQ CCT Exam. https://calibrationtraining.com/

May 13-15, 2025 EDU-114: Dimensional Gage Calibration and Repair. Aurora, IL. Mitutoyo. The course combines modern calibration and quality management ideas with best practices and "how-to" calibration methods for common calibrations. The course is ideal for those operating in ISO/IEC 17025 accredited laboratories or in gage labs supporting manufacturing operations. https://www.mitutoyo.com/training-education/

May 15-16, 2025 Hands-On Precision Gage Calibration and Repair Training. Houston, TX. IICT Enterprises. Enhance your career knowledge in Metrology with this in-depth Gage use, Calibration, and Repair course. Recommended for people interested in pursuing the ASQ CCT Exam. https://calibrationtraining.com/

May 20-21, 2025 Virtual Hands-On Precision Gage Calibration and Repair Training. IICT Enterprises. Enhance your career knowledge in Metrology with this in-depth Gage use, Calibration, and Repair course. Recommended for people interested in pursuing the ASQ CCT Exam. https://calibrationtraining.com/

Jun 5-6, 2025 Hands-On Precision Gage Calibration and Repair Training. Atlanta, GA. IICT Enterprises. Enhance your career knowledge in Metrology with this in-depth Gage use, Calibration, and Repair course. Recommended for people interested in pursuing the ASQ CCT Exam. https://calibrationtraining.com/

Jun 17-18, 2025 Virtual Hands-On Precision Gage Calibration and Repair Training. IICT Enterprises. Enhance your career knowledge in Metrology with this in-depth Gage use, Calibration, and Repair course. Recommended for people interested in pursuing the ASQ CCT Exam. https://calibrationtraining.com/

Jun 18-19, 2025 EDU-113: Dimensional Gage Calibration. Aurora, IL. Mitutoyo. The course combines modern calibration and quality management ideas with best practices and "how-to" calibration methods for common calibrations. The course is ideal for those operating in ISO/IEC 17025 accredited laboratories or in gage labs supporting manufacturing operations. https://www.mitutoyo.com/training-education/

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Jun 26-27, 2025 Hands-On Precision Gage Calibration and Repair Training. Bloomington, MN. IICT Enterprises. Enhance your career knowledge in Metrology with this in-depth Gage use, Calibration, and Repair course. Recommended for people interested in pursuing the ASQ CCT Exam. https://calibrationtraining.com/

SEMINARS & WEBINARS: Education

Feb 13, 2025 Metric System Education Resources. Online. NIST. This 1.5-hour session will explore NIST Metric Program education publications and other resources teachers, parents, and students can download and freely reproduce. https://www.nist.gov/pml/owm

SEMINARS & WEBINARS: Electrical

Mar 3-6, 2025 MET-101 Basic Hands-On Metrology. Everett, WA. Fluke Calibration. This Metrology 101 basic metrology training course introduces the student to basic measurement concepts, basic electronics related to measurement instruments and math used in calibration. https://www.fluke.com/

Apr 14-17, 2025 MET-301 Advanced Hands-On Metrology. Everett, WA. Fluke Calibration. This course introduces the student to advanced measurement concepts and math used in standards laboratories. https://www.fluke.com/

Apr 29-30, 2025 Electrical Measurement. Lindfield, NSW. Australian NMI. This course provides in-depth knowledge of the theory and practice of electrical measurement using digital multimeters and calibrators; special attention is given to important practical issues such as grounding, interference and thermal effects. https://shop.measurement.gov.au/

May 1, 2025 High-Voltage Test and Measurement. Lindfield, NSW. Australian NMI. This one-day workshop provides hands-on experience and practical techniques involved in performing high-voltage tests and measurements, and explains how to make such tests and measurements in accordance to relevant international and Australian standards. https://shop.measurement.gov.au/

Jun 9-12, 2025 MET-101 Basic Hands-On Metrology. Everett, WA. Fluke Calibration. This Metrology 101 basic metrology training course introduces the student to basic measurement concepts, basic electronics related to measurement instruments and math used in calibration. https://www.fluke.com/

SEMINARS & WEBINARS: Flow

Feb 5-6, 2025 Calibration of Liquid Hydrocarbon Flow Meters. Londonderry, NSW. Australian NMI. This two-day course provides training on the calibration of liquid-hydrocarbon LPG and petroleum flow meters. It is aimed at manufacturers, technicians and laboratory managers involved in the calibration and use of flowmeters. https://shop.measurement.gov.au/

Mar 25-28, 2025 Gas Flow Calibration Using molbloc/molbox. Phoenix, AZ. Fluke Calibration. This is a four day training course in the operation and maintenance of a Fluke Calibration molbloc/molbox system. https://www.fluke.com

SEMINARS & WEBINARS: General

Mar 6-7, 2025 Basics Principles of Metrology. Pretoria, South Africa. NMISA Training Center. https://www.nmisa.org/applied-metrology/Pages/Metrology-Training-Centre.aspx

Mar 12, 2025 Calibration and Measurement Fundamentals. Online Trainer-Delivered. Australian NMI. This course covers general metrological terms, definitions and explains practical concept applications involved in calibration and measurements. The course is recommended for technical officers and laboratory technicians working in all industry sectors who are involved in making measurements and calibration process. https://shop.measurement.gov.au/

Apr 2, 2025 Calibration and Measurement Fundamentals. Lindfield, NSW. Australian NMI. This course covers general metrological terms, definitions and explains practical concept applications involved in calibration and measurements. The course is recommended for technical officers and laboratory technicians who are involved in making measurements and calibration process. https://shop.measurement.gov.au/

Apr 7-11, 2025 Fundamentals of Metrology. Gaithersburg, MD. NIST. The 5-day Fundamentals of Metrology seminar is an intensive course that introduces participants to the concepts of measurement systems, units, good laboratory practices, data integrity, measurement uncertainty, measurement assurance, traceability, basic statistics and how they fit into a laboratory Quality Management System. https://www.nist.gov/pml/owm/owm-training-and-events

SEMINARS & WEBINARS: Industry Standards

Feb 11-12, 2025 Understanding the Requirements and Concepts of ISO/IEC17024:2012. Live Online Event. This course is designed to introduce organizations considering accreditation by ANAB to the international standard ISO/IEC 17024, General requirements for bodies operating certification schemes for persons. The standard is a globally accepted benchmark for bodies managing the certification of persons. https://anab.ansi.org/

Feb 18-19, 2025 Understanding ISO/IEC 17025:2017 for Testing & Calibration Labs. Virtual. A2LA WorkPlace Training. This course is a comprehensive review of the philosophies and requirements of ISO/IEC 17025:2017. https://a2lawpt.org/

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Feb 25-26, 2025 Understanding the Requirements and Concepts of ISO/IEC 17025:2017. Live Online. Understand requirements of ISO/IEC 17025:2017, including general, structural, resource, process, and management system requirements. Learn practical concepts, such as impartiality, documents control, ensuring validity of results and risk management. Gain an understanding of an ISO/IEC 17025:2017 laboratory management system. https://anab.ansi.org/find-training/

Mar 10-13, 2025 Understanding ISO/IEC 17025:2017 for Testing & Calibration Labs. Virtual. A2LA WorkPlace Training. This course is a comprehensive review of the philosophies and requirements of ISO/IEC 17025:2017. https://a2lawpt.org/

Mar 11-12, 2025 ISO/IEC 17043:2023 and Statistical Analysis for Proficiency Testing. Virtual. A2LA WorkPlace Training. This course provides the participant with a comprehensive look at Proficiency Testing (PT), including the design and operation of PT schemes, statistical methods, reporting, and interpretation. https://a2lawpt.org/

Mar 11-12, 2025 Auditing Your Laboratory to ISO/IEC 17025:2017. Virtual. A2LA WorkPlace Training. This ISO/IEC 17025 auditor training course will introduce participants to ISO/IEC 19011, the guideline for auditing management systems as applied to ISO/IEC 17025:2017. https://a2lawpt.org/

Apr 7-8, 2025 Understanding ISO/IEC 17025:2017. Pretoria, South Africa. NMISA Training Center. https://www.nmisa.org/applied-metrology/Pages/Metrology-Training-Centre.aspx

Apr 22-23, 2025 Understanding the Requirements and Concepts of ISO/IEC 17025:2017. Live Online. Understand requirements of ISO/IEC 17025:2017, including general, structural, resource, process, and management system requirements. Learn practical concepts, such as impartiality, documents control, ensuring validity of results and risk management. Gain an understanding of an ISO/IEC 17025:2017 laboratory management system. https://anab.ansi.org/find-training/

May 7-8, 2025 Understanding the Requirements and Concepts of ISO/IEC17024:2012. Live Online Event. This course is designed to introduce organizations considering accreditation by ANAB to the international standard ISO/IEC 17024, General requirements for bodies operating certification schemes for persons. The standard is a globally accepted benchmark for bodies managing the certification of persons and is being increasingly recognized by the U.S. federal government, the certification industry, and organized labor. https://anab.ansi.org/

May 12-15, 2025 Understanding ISO/IEC 17025:2017 for Testing & Calibration Labs. Virtual. A2LA WorkPlace Training. This course is a comprehensive review of the philosophies and requirements of ISO/IEC 17025:2017. https://a2lawpt.org/

May 12-15, 2025 Auditing Your Laboratory to ISO/IEC 17025:2017. Virtual. A2LA WorkPlace Training. This ISO/IEC 17025 auditor training course will introduce participants to ISO/IEC 19011, the guideline for auditing management systems as applied to ISO/IEC 17025:2017. https://a2lawpt.org/

May 15, 2025 Internal Auditing Best Practices. Online. NIST. This 2-hour webinar will consider internal auditing techniques and best practices that are used by a metrology laboratory to comply with ISO/IEC 17025:2017 criteria. https://www.nist.gov/pml/owm/owm-training-and-events

Jun 9-12, 2025 Understanding ISO/IEC 17025:2017 for Testing & Calibration Labs. Virtual. A2LA WorkPlace Training. This course is a comprehensive review of the philosophies and requirements of ISO/IEC 17025:2017. https://a2lawpt.org/

Jun 9-12, 2025 Auditing Your Laboratory to ISO/IEC 17025:2017. Virtual. A2LA WorkPlace Training. This ISO/IEC 17025 auditor training course will introduce participants to ISO/IEC 19011, the guideline for auditing management systems as applied to ISO/IEC 17025:2017. https://a2lawpt.org/

Jun 10-11, 2025 Understanding the Requirements and Concepts of ISO/IEC 17025:2017. Live Online. Understand requirements of ISO/IEC 17025:2017, including general, structural, resource, process, and management system requirements. Learn practical concepts, such as impartiality, documents control, ensuring validity of results and risk management. Gain an understanding of an ISO/IEC 17025:2017 laboratory management system. https://anab.ansi.org/find-training/

SEMINARS & WEBINARS: Mass

Mar 3-14, 2025 Mass Metrology Seminar. Gaithersburg, MD. NIST. The Mass Metrology Seminar is a two-week, "hands-on" seminar. It incorporates approximately 30 percent lectures and 70 percent demonstrations and laboratory work in which the participant performs measurements by applying procedures and equations discussed in the classroom. https://www.nist.gov/pml/owm/owm-training-and-events

Apr 16, 2025 Calibration of Weights and Balances. Lindfield, NSW. Australian NMI. This course covers the theory and practice of the calibration of weights and balances. It incorporates hands-on practical exercises to demonstrate adjustment features and the effects of static, magnetism, vibration and draughts on balance performance. https://shop.measurement.gov.au/

SEMINARS & WEBINARS:
Measurement Uncertainty

Feb 20-21, 2025 Measurement Uncertainty: Practical Applications. Live Online. ANAB. This class covers concepts and accreditation requirements associated with measurement traceability, measurement assurance, and measurement uncertainty. https://anab.ansi.org/

Mar 4-5, 2025 Introduction to Measurement Uncertainty. Virtual. A2LA WorkPlace Training. This course is suitable for both calibration and testing laboratory participants, focusing on the concepts and mathematics of the measurement uncertainty evaluation process. https://a2lawpt.org/

Apr 15, 2025 Introduction to Estimating Measurement Uncertainty. Lindfield, NSW. Australian NMI. This course will give you a clear step-by-step approach to uncertainty estimation with practical examples; you will learn techniques covering the whole process from identifying the sources of uncertainty in your measurements right through to completing the uncertainty budget. https://shop.measurement.gov.au/

Apr 16-17, 2025 Measurement Uncertainty: Practical Applications. Live Online. ANAB. This class covers concepts and accreditation requirements associated with measurement traceability, measurement assurance, and measurement uncertainty. https://anab.ansi.org/

May 6-7, 2025 Uncertainty, Sampling and Data Analysis: Understanding Statistical Calculations. Live Online. ANAB. This course provides an introduction to statistical concepts and techniques used for the collection, organization, analysis, and presentation of various types of data. https://anab.ansi.org/

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May 20-21, 2025 Introduction to Measurement Uncertainty. Virtual. A2LA WorkPlace Training. This course is a suitable introduction for both calibration and testing laboratory participants, focusing on the concepts and mathematics of the measurement uncertainty evaluation process. https://a2lawpt.org/

Jun 5-6, 2025 Measurement Uncertainty: Practical Applications. Live Online. ANAB. This class covers concepts and accreditation requirements associated with measurement traceability, measurement assurance, and measurement uncertainty. https://anab.ansi.org/

SEMINARS & WEBINARS: Photometry & Radiometry

Feb 26-27, 2025 Photometry and Radiometry. Lindfield, NSW. NMI of Australia. This two-day course (9 am to 5 pm) covers the broad range of equipment and techniques used to measure colour and light output, the basic operating principles involved in radiometry, working techniques, potential problems and their solutions. https://shop.measurement.gov.au/

SEMINARS & WEBINARS: Pressure

Mar 10-14, 2025 Principles of Pressure Calibration. Phoenix, AZ. Fluke Calibration. A five-day training course on the principles and practices of pressure calibration using digital pressure calibrators and piston gauges (pressure balances). https://www.fluke.com

Apr 21-25, 2025 TWB 1061 Principles of Pressure Calibration Web-Based Training (Online). Fluke Calibration. This is a short form of the regular five-day in-person Principles of Pressure Calibration class. https://www.fluke.com

Apr 28-May 2, 2025 Principles of Pressure Calibration. Phoenix, AZ. Fluke Calibration. A five-day training course on the principles and practices of pressure calibration using digital pressure calibrators and piston gauges (pressure balances). https://www.fluke.com

Jun 18-19, 2025 Pressure Measurement. Port Melbourne, VIC. NMI of Australia. This two-day course (9 am to 5 pm each day) covers essential knowledge of the calibration and use of a wide range of pressure measuring instruments, their principles of operation and potential sources of error — it incorporates extensive hands-on practical exercises. https://shop.measurement.gov.au/

SEMINARS & WEBINARS: Software

Mar 17-21, 2025 TWB 1071 Crystal Reports Web-Based Training. Online. Fluke Calibration. This course is designed for those who are involved with modifying or writing custom reports for use with MET/TEAM. https://www.fluke.com

Mar 24-28, 2025 MC-206 Basic MET/CAL® Procedure Writing. Everett, WA. Fluke Calibration. In this five-day Basic MET/CAL® Procedure Writing course, you will learn to configure MET/CAL® software to create, edit, and maintain calibration solutions, projects and procedures. https://www.fluke.com

Apr 28-May 2, 2025 MC-205 MET/TEAM® Asset Management. Everett, WA. Fluke Calibration. This five-day course presents a comprehensive overview of how to use MET/TEAM® Test Equipment and Asset Management Software in an Internet browser to develop your asset management system. https://www.fluke.com

May 5-9, 2025 MC-206 Basic MET/CAL® Procedure Writing. Everett, WA. Fluke Calibration. In this five-day Basic MET/CAL® Procedure Writing course, you will learn to configure MET/CAL® software to create, edit, and maintain calibration solutions, projects and procedures. https://www.fluke.com

May 6-9 2025 VNA Tools Training Course & VNA Expert Day. Wabern, Switzerland. METAS. VNA Tools is a free software developed by METAS for measurements with the Vector Network Analyzer (VNA). The software facilitates the tasks of evaluating measurement uncertainty in compliance with the ISO-GUM and justifying metrological traceability. The software is available for download at www.metas.ch/vnatools. The three day course provides a practical and hands-on lesson with this superior and versatile software. Day 4: State of the art primary S-parameter traceability and how VNA Tools can support. https://www.metas.ch

May 19-23, 2025 TWB 1051 MET/TEAM® Basic Web-Based Training. Online. Fluke Calibration. This web-based course presents an overview of how to use MET/TEAM® Test Equipment and Asset Management Software in an Internet browser to develop your asset management system. https://www.fluke.com

Jun 23-27, 2025 TWB 1031 MET/CAL® Procedure Development Web-Based. Online. Fluke Calibration. Learn to create procedures with the latest version of MET/CAL, without leaving your office. https://www.fluke.com

Jun 26, 2025 Software Verification and Validation, Part 1. Online. NIST. Session I (June 26, 2025) and Session II (July 17, 2025) are two 2-hour sessions that will focus on the use of Microsoft Excel in calibration laboratories and examine the ISO/IEC 17025:2017 requirements related to software. Part I will provide guidance and resources for ensuring software quality assurance, documenting evidence of verification and validation, and provide the tools for ongoing software evaluation. https://www.nist.gov/pml/owm/owm-training-and-events

SEMINARS & WEBINARS:
Temperature & Humidity

Feb 19-21, 2025 Practical Temperature Calibration. American Fork, UT. A three-day course loaded with valuable principles and hands-on training designed to help calibration technicians and engineers get a solid base of temperature calibration fundamentals. https://www.fluke.com

Mar 17-19, 2025 Practical Temperature Calibration. American Fork, UT. A three-day course loaded with valuable principles and hands-on training designed to help calibration technicians and engineers get a solid base of temperature calibration fundamentals. https://www.fluke.com

CALENDAR

Apr 3, 2025 Humidity Measurement. Lindfield NSW. National Measurement Institute, Australia. This one-day course provides information about the main concepts and practical techniques involved in measuring humidity in air and explains how to make such measurements accurately and consistently. https://shop.measurement.gov.au/

May 13-15, 2025 Advanced Topics in Temperature Metrology. American Fork, UT. Fluke Calibration. A three-day course for those who need to get into the details of temperature metrology. https://www.fluke.com

SEMINARS & WEBINARS: Time & Frequency

Mar 5-6, 2025 Time and Frequency Measurement. Lindfield, NSW. NMI of Australia. This two-day course covers the broad range of equipment and techniques used to measure time and frequency and to calibrate time and frequency instruments. https://shop.measurement.gov.au/

SEMINARS & WEBINARS: Validation & Verification

Feb 6, 2025 Validation and Verification of Analytical Methods. Live Online. ANAB. This course provides an introduction to validation and verification of analytical methods and ISO/IEC 17025 & ISO/IEC 17020 requirements. https://anab.ansi.org/

May 28, 2025 Validation and Verification of Analytical Methods. Live Online. ANAB. This course provides an introduction to validation and verification of analytical methods and ISO/IEC 17025 & ISO/IEC 17020 requirements. https://anab.ansi.org/

Jun 16-18, 2025 Method Validation. Pretoria, South Africa. NMISA Training Center. The objective of this course is to introduce analysts to the basic concepts of method validation and quality control. https://www.nmisa.org/

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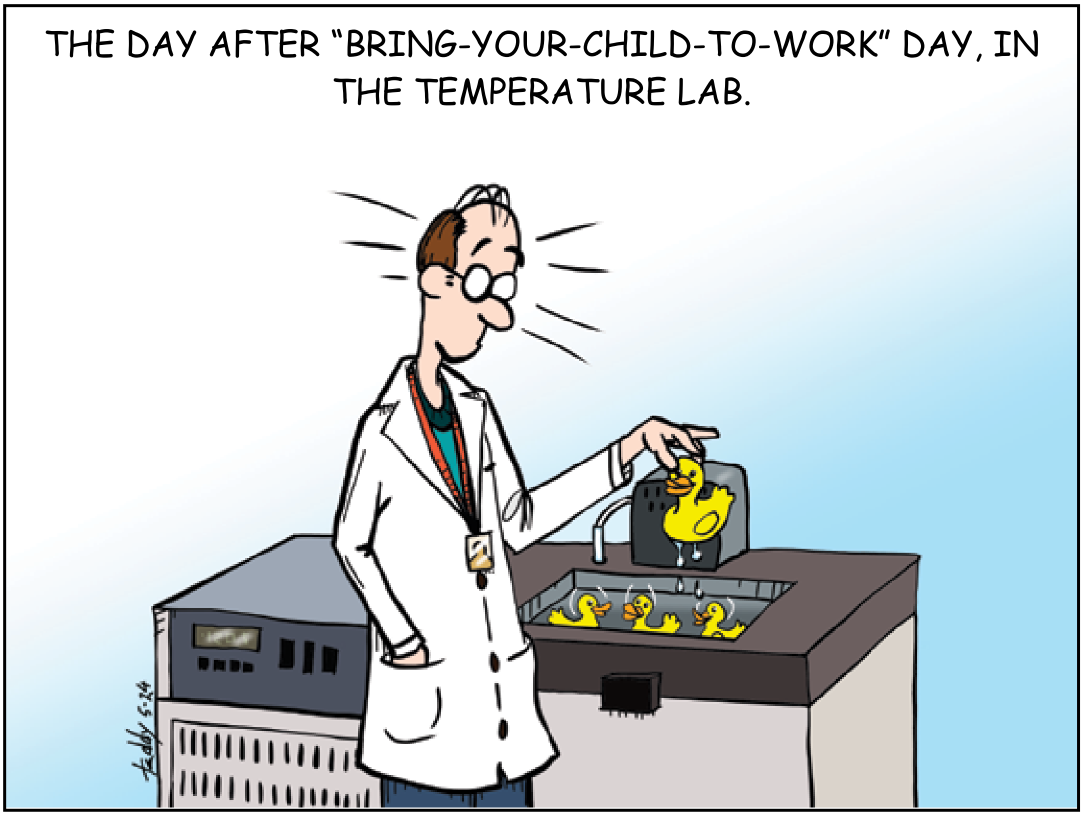
CAL-TOONS by Ted Green teddytoons@icloud.com



The Arctic research station in NY-Ålesund, Norway © The COAT project

EURAMET project performs a comparison of thermometer radiation shields in the Arctic

Polar regions are very sensitive to climate change – and monitoring these regions provides early indications of potential climate trends

The temperatures in the Arctic continue to rise at three times the global annual average. Not only does the melting of ice and snow contribute to rising sea levels, but it could also contribute to extreme temperatures in other parts of the world. To help combat global warming it is essential that measurements, such as air temperature, are rigorously monitored. Air temperature measurements are mainly performed by resistance thermometers protected by shields with the aim of avoiding the influence of solar radiation and rain on thermometer's readings.

Combinations of different models of thermometers and different models of radiation shields are used around the world since neither a specific thermometer, nor a radiation shield have been defined as a 'reference system' so far.

As each radiation shield creates a specific microclimate inside, air temperature measurements depend on the combination of both shield and thermometer – which makes comparability between different systems around the world limited and creates inconsistencies in climate measurements. The World Meteorological Organization (WMO) recognizes the field intercomparison of instruments as the most powerful tool for increasing the comparability of measurements taken at different times and in different places. The WMO, aware of the importance of air temperature measurements in the evaluation of climate change and the strong influence of external factors on air temperature measurements, recommended the organization of field comparisons of radiation shields in extreme climates. Comparisons of radiation shields have been performed in different climate conditions but an intercomparison of radiation shields in the polar climate was still required.

This problem has been addressed by the now completed EMPIR project "Increasing the comparability of extreme air temperature measurements for meteorology and climate studies" (19SIP06, COAT).

Building on the work performed in the earlier EMRP project MeteoMet2, members of the consortium, which included experts from metrology, meteorology and the artic environment, performed two measurement campaigns using 10 different models of radiation shields. The first campaign was laboratory based where all the instrumentation was calibrated just before and just after the second field campaign at the Arctic research station, in NY-Ålesund, Norway.

This second campaign was conducted at the Arctic station for over a year using 41 thermometers. As well as temperature, which was measured every 2 minutes, data was also recorded for wind speed and direction, solar radiation, humidity, and pressure. From the data, the consortium derived a reference shield that will allow more comparable measurements of temperatures in the polar climate.

The campaign results were published in a paper entitled "COAT Project: Intercomparison of Thermometer Radiation Shields in the Arctic" along with the data sets generated and the work has been shared with the primary supporter of the project, the WMO. The validated intercomparison protocol was submitted for consideration to WMO INFCOM/SC-MINT, WMO's Standing Committee on Measurements, Instrumentation and Traceability, as a reference document.

The comparison protocol, the results of the field comparison and the guidance developed in the project, will support the harmonisation of future measurements and intercomparisons. In turn, the resulting, more accurate air temperature data will help guide climate policymakers to implement more appropriate climate policies.

The coordinator of the project Carmen Garcia Izquierdo (CEM) said about the work:

"With this project, we wanted to create solutions to increase the comparability of Air Temperature Measurements. In addition, building a metrological facility in field and under extreme climate conditions (in the Arctic) was challenging and highly appreciated by the WMO, which requests and encourages the development of field experiments with the aim of increasing the knowledge about metrology and climate."

This EMPIR project was co-funded by the European Union's Horizon 2020 research and innovation programme and the EMPIR Participating States.

The EMRP joint research project was part of EURAMET's European Metrology Research Programme. The EMRP was jointly funded by the EMRP participating countries within EURAMET and the European Union.

Source: https://www.euramet.org/publications-media-centre/news/news/euramet-project-performs-a-comparison-of-thermometer-radiation-shields-in-the-arctic

Ball plate for the reduced three-rosette method with 12 irregularly arranged balls. Credit: PTB

In-Situ Rotary Table Calibration

PTB-News 3.2024 - The deviations of rotary tables can be directly measured on coordinate measuring machines (CMMs) in all six degrees of freedom by means of a self-calibrating procedure using a ball plate. A new concept at PTB is intended to significantly reduce the required number of ball measurements at the specified angular resolution. This enables economical measurements at a higher angular resolution and without noteworthy drifts. For angular resolutions of 5°, a novel ball plate that has been adapted to the method has been manufactured at PTB. The measurement uncertainty will increase only slightly in comparison with the previous method.

When rotationally symmetric workpieces, such as gears, are measured on coordinate measuring machines or machine tools, rotary tables are frequently used. Their rotary guides contribute to the uncertainty of the measurement result. For highly accurate measurements, it is therefore essential to determine these deviations and to subsequently correct them numerically. For this purpose, the so-called three-rosette method determines the deviations of the rotary table in all six degrees of freedom at angular grid points that are regularly distributed over a complete rotation of the rotary table. The resolution of the identified rotary table deviations is determined by the number of balls. Determining the deviations at smaller angular steps requires a ball plate with more balls, which would soon exceed the scope in which it makes sense to realize such ball plates. In addition, the measuring time increases quadratically with the number of balls, which not only makes the method uneconomical, but also unreliable due to drift effects.

Due to a reduced three-rosette method that has been recently developed at PTB, it is no longer necessary to attach balls to every position on the angular grid as specified by the desired resolution. To apply the patent-pending method, a novel ball plate with 12 balls was manufactured. This plate allows the deviations of the rotary table to be measured at 72 reference points, i.e., in 5° steps. The balls' positions have been optimized in terms of low measurement uncertainty. For this reason, the overall measurement uncertainty increases only slightly, by approximately 10 % to 20 %, in comparison with complete method.

Contact: Frank Keller, Fachbereich 5.3, Koordinatenmesstechnik, Telefon: (0531) 592-5215, frank.keller(at)ptb.de

Scientific publication: F Keller, M. Stein: A reduced self-calibrating method for rotary table error motions. Meas. Sci. Technol. 34, 065015 (2023), DOI: 10.1088/1361-6501/acc265

Source: https://www.ptb.de/cms/en/presseaktuelles/journals-magazines/ptb-news.html

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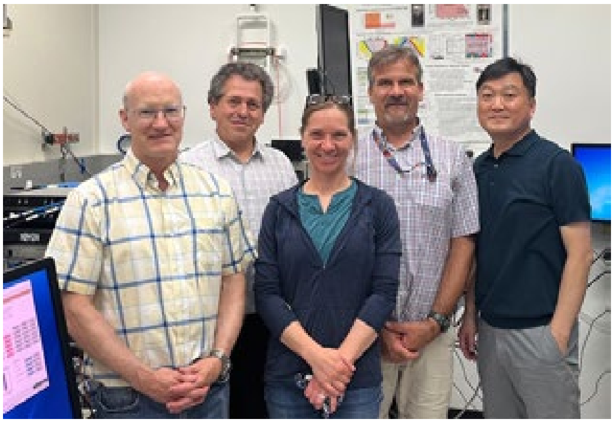
New Pilot Study Enhances Accuracy of AC Voltage Comparisons

The BIPM and NIST have successfully conducted a new pilot study, marking a significant advancement in the accuracy and reliability of ac voltage comparisons. This achievement represents a major step forward for on-site comparisons of ac voltages.

Background

Since 2016, the International Bureau of Weights and Measures (BIPM) has conducted multiple pilot studies to expand its on-site comparison programme from dc (direct current) Josephson voltage standards to ac (alternating current) voltages. These studies aim to decrease the uncertainties associated with the differential sampling technique applied to Programmable Josephson Voltage Standards (PJVSs) within the range of 10 Hz to 1 kHz, for root-mean-square (rms) voltages of 0.7 V and 7 V. This effort has been supported by several National Metrology Institutes (NMIs), including including NMIJ, CENAM, MIKES, KRISS, NIST, VNIIM, NMIA, and PTB.



From left to right: A. Rüfenacht (NIST), R. Chayramy (BIPM), R. Johnson (NIST), S. Solve (BIPM), M.-S. Kim (KRISS). Credit: BIPM

Key Results

In August 2024, Dr Stéphane Solve and Mr Régis Chayramy from the BIPM spent three weeks at the NIST Boulder laboratories, alongside a KRISS scientist, to carry out a new pilot study. The BIPM's transportable PJVS was directly compared to NIST's Josephson Arbitrary Waveforms Synthesizer (JAWS). As a primary standard, JAWS produces sinusoidal voltage signals in the hertz to megahertz range with very high spectral purity up to 2 V. Importantly, unlike other ac voltage sources, the JAWS does not exhibit any voltage drift, ensuring reliable results.

Key achievements of this study include:

- **Stability and reproducibility:** The NIST JAWS system allowed the BIPM PJVS to be tested under a wide variety of configurations, pushing the limits of reliability of the differential sampling setup.
- **Breakthrough in uncertainty:** For the first time, the study achieved a Type A uncertainty (a measure of statistical uncertainty) of a few parts in 10^9 for a 10 Hz sine wave at 2 V rms. At 1 kHz, a relative level of 2×10^{-7} was reached.

Future Implications

The technical protocol for this new BIPM comparison was validated by experts from the Consultative Committee for Electricity and Magnetism (CCEM) and released in June 2023. A follow-up questionnaire was sent to the NMIs of the BIPM's Member States to gauge interest in participating in the comparison. Out of 21 NMIs that expressed interest in participating, 16 requested the option for ac measurements.

These successful pilot comparison results confirm the high reliability of the BIPM's transportable system and pave the way for on-site comparison exercises for ac voltages in the coming years. This will help NMIs to demonstrate the performance of their ac voltage measurement systems and helps to underpin equivalence of ac voltage measurements worldwide.

The successful results of the pilot study at NIST confirm the high reliability of the BIPM transportable system. It represents the beginning of on-site comparison exercises for ac voltages.

Source: https://www.bipm.org/en/-/2024-10-24-pilot-study-ac-voltage.

Are You Measuring "Average Roughness" Correctly? There's More to It Than You May Think

Mike Zecchino and Mark Malburg
Digital Metrology Solutions

Introduction

Calibration labs frequently need to certify the average roughness (Ra) of calibration specimens or samples. This seemingly straightforward task, however, involves more than running a roughness gage across the surface and reading the Ra value. Variations in basic settings can result in Ra values that differ by orders of magnitude.

To properly measure and report average roughness, we need to establish measurement protocols to ensure that the value is measured accurately and that it is measured the same way every time, both in the calibration laboratory and by the customer.

Measuring Roughness

Stylus-based roughness gages are the most widely used instruments for measuring surface texture. These systems measure texture by moving a fine, diamond stylus across the surface. The stylus follows the surface texture, rising and falling to create a two-dimensional "profile" (Figure 1, left). Non-contact, optical measurement systems producing 3D texture data (Figure 1, right) are becoming more prevalent in industry and laboratories as well for these types of measurements.

While these systems are designed to accurately measure texture, there are many factors that go into calculating parameters such as Ra based on those measurements. Differences in these factors will dramatically influence the parameter values. In order to discuss these factors, however, we first have to go back to basics and discuss how we define "roughness."

Surface Texture Consists of Roughness, Waviness, and Form

As measurement equipment and software have advanced, our understanding of surface texture has developed as well. Rather than thinking of a surface as having a generalized "roughness," we now more properly describe a surface's "texture," and the range of features of varying sizes within that texture (as well as spacings, directionality, etc.). We

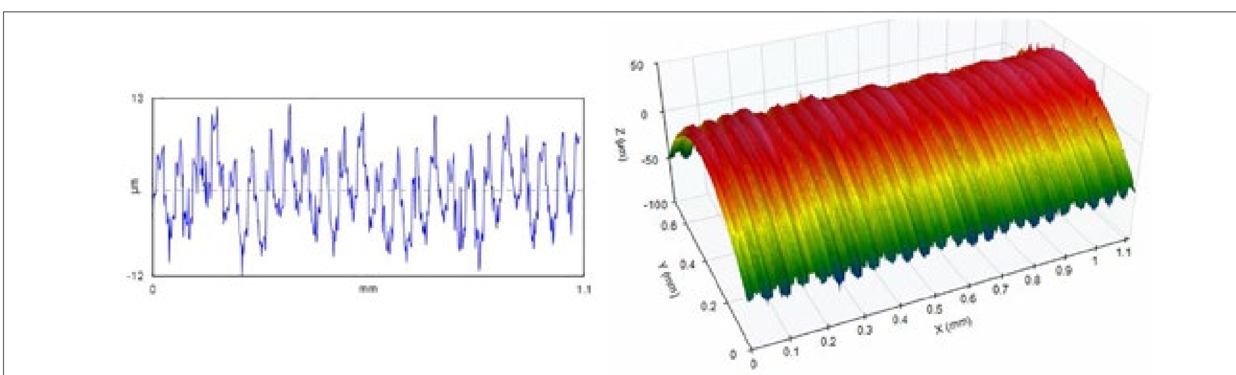


Figure 1. A stylus measurement of surface roughness on a shaft (left), and a 3D measurement of the surface texture (right).

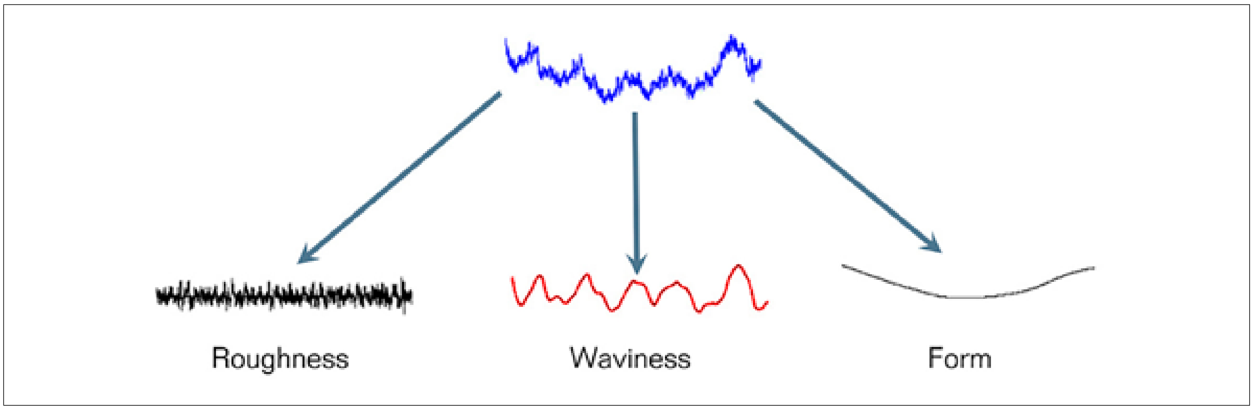


Figure 2. Surface texture consists of roughness (left), but also waviness (center) and form error (right). Depending on the application, it may be important to control all three bands. Image courtesy The Surface Texture Answer Book [1].

describe the size of the surface features in terms of "wavelengths," from short-wavelength roughness to longer-wavelength "waviness" and "form error" (Figure 2).

The raw measurement of a surface will contain the full spectrum of wavelengths extending from microscopic (even atomic) scales too small to be resolved by the instrument, to progressively larger roughness, waviness, and overall form (Figure 3).

"Roughness" Refers to a Band of Feature Sizes

The size of the features we call "roughness" is not based on standardized values. Instead, the range is determined by the size of features that matter for the application. On a polished mirror, we may define "roughness" as features that scatter light. Those feature sizes, however, would be orders of magnitude too small to matter for a machined surface. At even larger scales, we may define the roughness of a road based on the large features that make a car bounce via the shock absorbers.

Depending on the application, the longer wavelength waviness may be as important as the roughness for controlling noise, sealing, fit, appearance, etc.

To analyze texture, we use a series of "filters" to define a roughness band (and waviness band) for the particular surface. These filters attenuate smaller or larger wavelengths so that we can accurately assess the features we know matter for the application. These filters are not optional; they are required to provide a repeatable basis for the parameters (as we will see in the following, changing these filters can result in huge variations in measured values).

Defining the Roughness Band

To establish the roughness band of wavelengths, we first remove the overall, dominant shape of the surface (tilt, cylinder, etc.) from the measured data.

Next, we define a lower limit of the roughness band. The Short (or "S") Filter defines the smallest features we will consider to be "roughness" for the application (Figure 4). The Short Filter attenuates wavelengths smaller than the filter wavelength (λs); they will not be included when we calculate

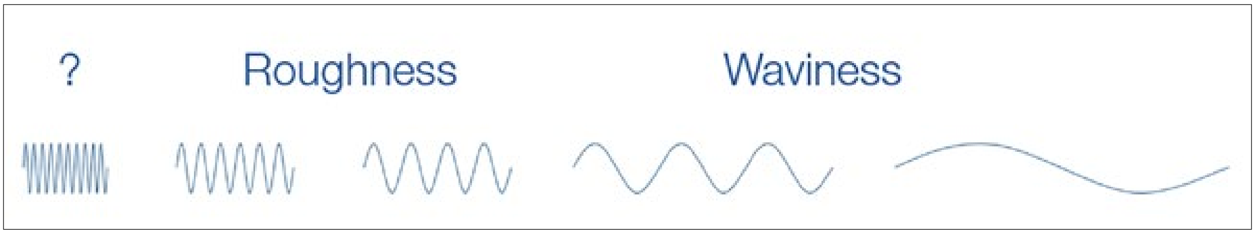


Figure 3. Surface texture consists of a spectrum of feature sizes and spacings.

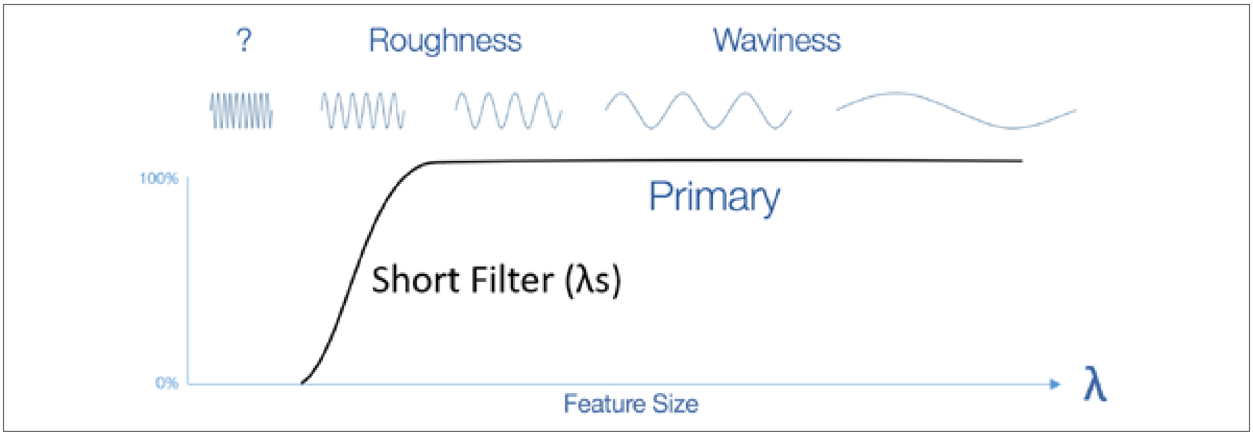


Figure 4. The Short Filter defines the smallest features to include when calculating roughness parameters. Image courtesy The Surface Texture Answer Book [1].

roughness parameters such as Ra. The remaining data is called the Primary Profile.

Next, we apply a Roughness Filter (also called the Long or "L" Filter) to define the largest features to be considered as roughness (Figure 5). Applying the Long Filter results in two profiles: the Roughness Profile (which includes the finer roughness features) and the Waviness Profile (consisting of the larger, "bumpier" features).

Roughness parameters, such as Ra, are calculated based on the Roughness Profile, while waviness parameters are based on the Waviness Profile.

Changing the Filtering Will Dramatically Impact Roughness Values

As we mentioned above, changing the roughness filter's cutoff wavelength will impact which feature sizes are included in the roughness and waviness profiles. This will, in turn, affect the roughness and waviness parameter values. Figure 6 shows the impact of changing the roughness filter's cutoff wavelength from 0.25 mm to 2.5 mm. With the larger cutoff value, more of the "lumpy" features are included in the Roughness Profile, resulting

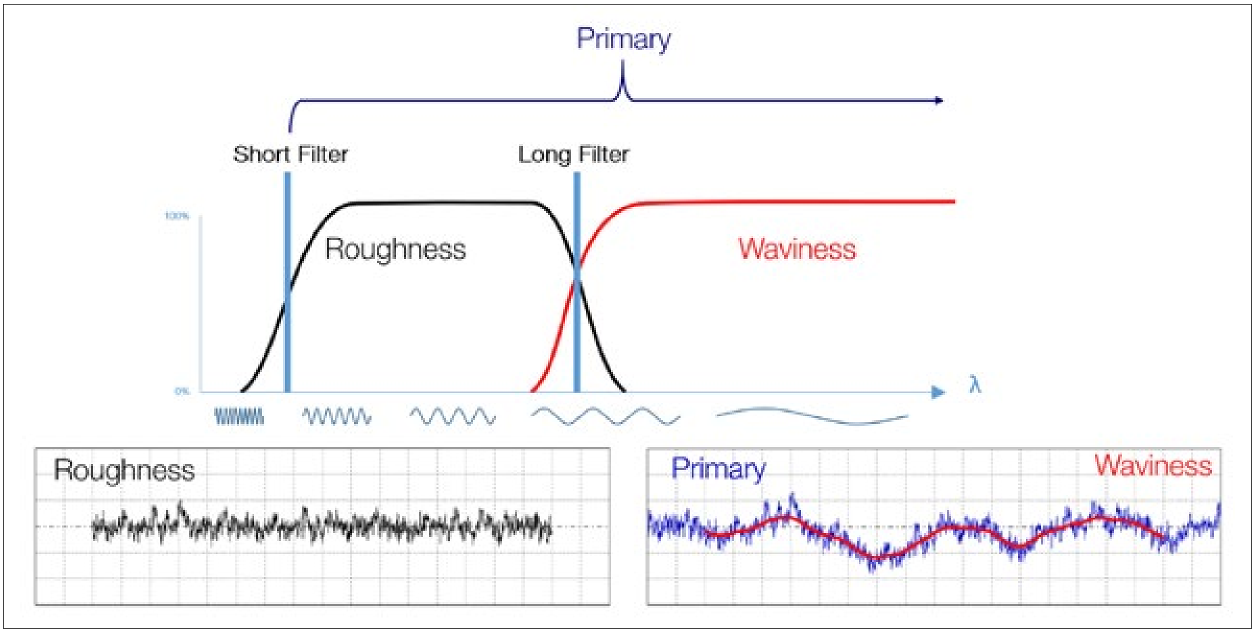


Figure 5.Filtering the Primary Profile into Roughness and Waviness. Image courtesy The Surface Texture Answer Book [1].

in an Ra value nearly 6 times larger! It's critical to know how to verify/adjust the filter settings for your instrument and analysis software in order to produce meaningful parameter values.

Specifying Filter Cutoffs

When roughness values are required, the filter cutoffs must also be specified. Despite this requirement, however, the values are not always stated, particularly on older drawings. Calibration patches, for example, may be marked with a target Ra value but may not indicate the roughness range that was used to reach that value.

When filter cutoffs are not specified, the best option is to contact the person responsible for the surface design. When this is not possible, the major standards that govern surface roughness provide tables. For random surfaces, we use the Ra value and Table 3-3.20.2-1 in the ASME B46.1-2019 standard. For periodic surfaces (sine wave, sawtooth, etc.), we use the Rsm value (the mean of the roughness profile feature widths) described in ASME B46.1-2019 Table 3-3.20.1-1. These filtering selections must appear on the certificate that the calibration lab provides with the results.

Considerations for Measuring Roughness

In addition to the filter settings, other aspects of texture measurement need to be specified in order to produce repeatable roughness parameter values.

Instrument Type

As we mentioned above, the most common instruments for measuring surface roughness are stylus-based instruments and 3D optical instruments. All measurement technologies have unique characteristics that may not correlate to other technologies. A measurement protocol should define the type of instrument to use, to ensure repeatable results.

Instrument Resolution

All measurement systems have a limit to the smallest features that can be resolved (Figure 7). The limits will be based on the measuring instrument itself, but also on the choice of stylus probe (on a

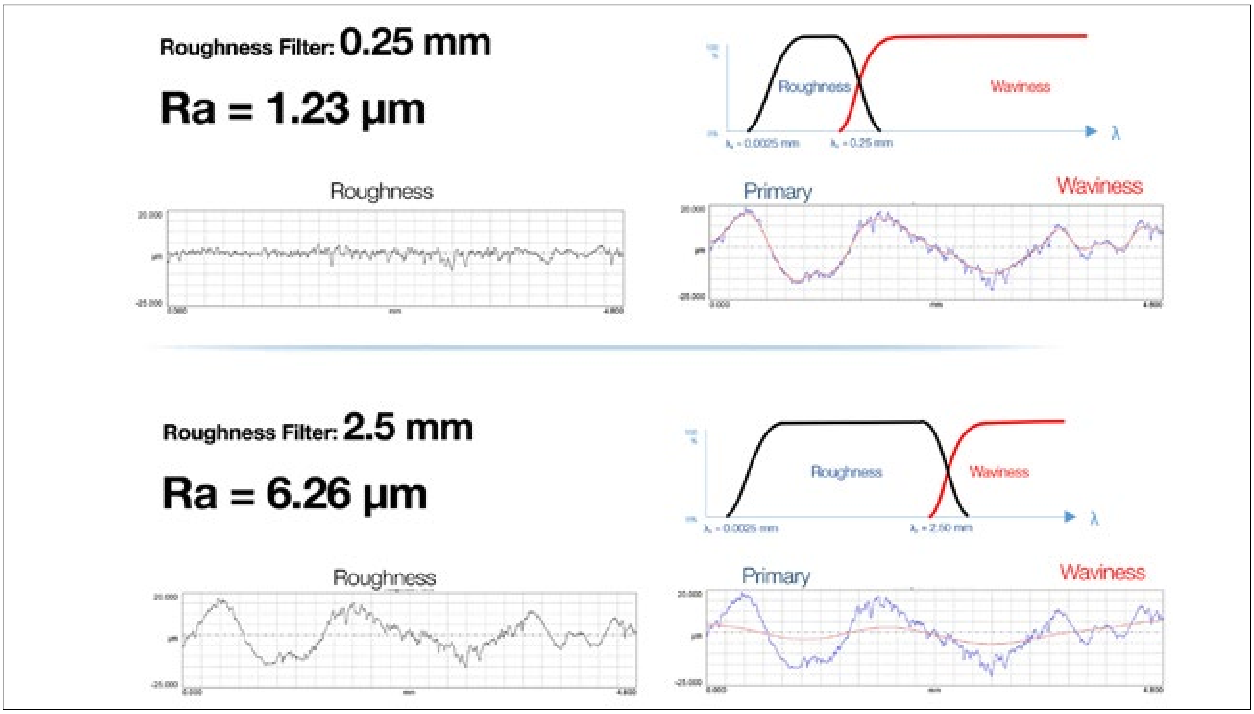


Figure 6. For this surface, changing the Roughness Filter cutoff from 0.25 mm to 2.5 mm results in a 6X change in the Ra value.

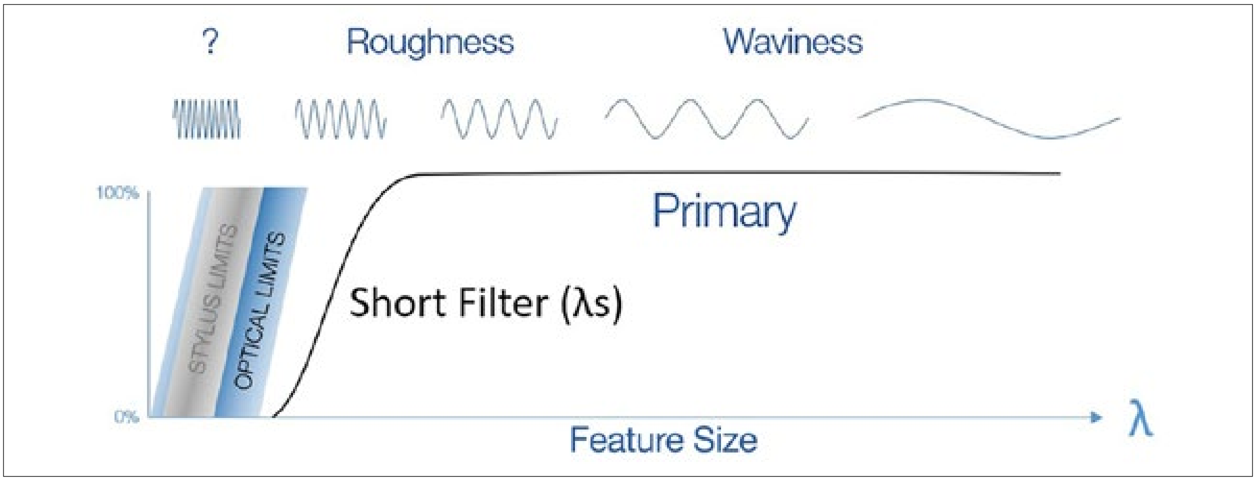


Figure 7. Choose a measurement system that can resolve the smallest feature sizes specified by the short filter.

profilometer) or objective (on an optical system). Be sure that the system as configured is able to measure beyond the features specified by the Short Filter. This way the wavelength band is defined mathematically, rather than by physical properties which can vary from system to system.

Probe size

A stylus profilometer can use different stylus probe tips, with 2 µm and 5 µm radius tips being the most common. The 2 µm tip, however, may resolve finer features, and therefore measure a different profile, than a 5 µm tip. The Short Filter must be selected with the stylus tip radius in mind. For example, a 2.5 µm Short Filter is meaningless if the data has already been mechanically "filtered" with a 5 µm stylus tip radius. ASME and ISO standards generally recommend a 2 µm tip radius for the majority of the surfaces we encounter.

Figure 8. The location and direction of measurement on this calibration patch can produce vastly different Ra values.

Measurement Speed

The speed at which the probe moves over the surface will also impact which features can be measured. A slower-moving tip can more accurately trace small valleys and sharp peaks. Again, the correct speed should be part of an established measurement protocol.

Sample Quality

On a scuffed or dirty calibration patch, measuring Ra in different locations and directions may produce very different results. Traversing deep scratches versus measuring parallel to the scratches will provide grossly different Ra values.

Analysis

Most surface texture analysis software will calculate basic surface parameters such as Average Roughness. Some software also shows the profile data or even allows the user to interact with the data to understand the effects of various settings (Figure 9). Seeing a surface often gives far more information about the texture than a list of parameter values.

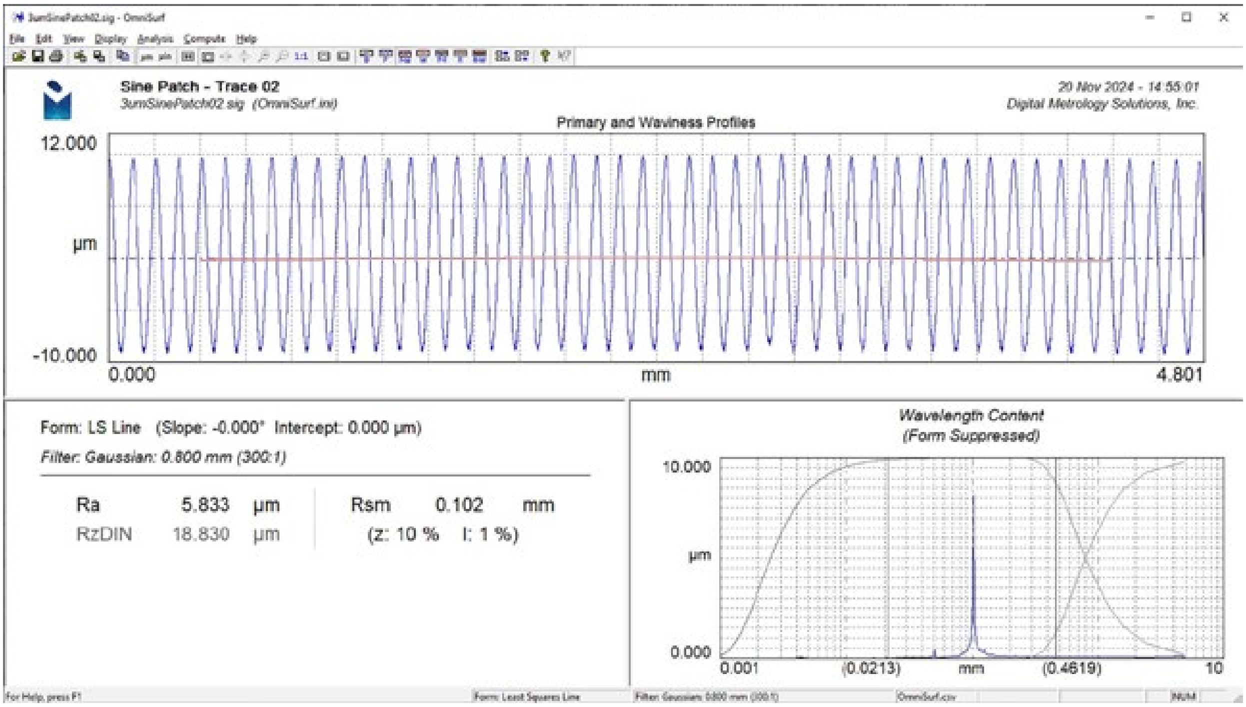


Figure 9. Analysis software that provides the ability to see surface texture provides greater understanding than a list of numerical values. OmniSurf software courtesy Digital Metrology Solutions.

Going Beyond the Certificate

The numerical value of Ra does not fully describe the shape of the measured surface. Thus, it is often preferred to provide the raw, measured data files along with the certificate. This allows the customer to load the data into analysis software to see the actual shape of the surface and visually track any changes over time. Various software tools are available for analyzing surface texture datasets, such as the OmniSurf software[1] shown in Figure 9.

Learning More about Surface Texture

The world of surface texture goes far beyond a single number definition. To produce quality surfaces, we need to be able to see and understand what matters about the texture for the application. Many resources are available to learn about surface roughness/texture, including short videos, tutorials, books, and sample data available through digitalmetrology.com.

1 https://digitalmetrology.com/solution/omnisurf/

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[1] Musolff, C. and Malburg, M. *The Surface Texture Answer Book*. June 2021. ISBN-10: 1736846825.

About the Authors

Mike Zecchino (mzecchino@digitalmetrology.com) has been creating resources and technical content related to measurement and surface texture for over 20 years. His articles have appeared in dozens of publications, and his training materials and videos support numerous measurement instruments and technologies.

Dr. Mark Malburg (mcmalburg@digitalmetrology.com) is the president of Digital Metrology Solutions. With over 30 years in surface metrology, he is the chief architect of a range of standard and custom software for surface texture and shape analysis. Dr. Malburg has consulted in numerous industries ranging from optics to aerospace. He is a frequent participant in standards committees and has helped shape many of the standards that govern surface specification and control.

Digitalization in the Quality Infrastructure – Perspectives from Novo Nordisk

Heidi Foldal
Novo Nordisk A/S

1. Introduction

Novo Nordisk, established in 1923 and headquartered in Denmark, is a global healthcare company dedicated to providing medication for chronic diseases. Our operations are managed through process management across the organizational structure, with the corporate metrology process ensuring reliable and traceable measurements for critical processes. This paper focuses on two strategic goals within our corporate metrology process: eliminating manual data transfer and ensuring that data is Findable, Accessible, Interoperable, and Reusable (FAIR) as well as relevant, thereby facilitating informed decision-making. To achieve these objectives, we are conducting pilots to implement Digital Calibration Certificates (DCC) and Digital Calibration Requests (DCR).

Our calibration program begins by defining the measurement parameters and identifying the requirements for these parameters. The calibration requirements for the measuring equipment are derived from the measurand requirements. Calibration intervals are determined based on a risk assessment, which considers:

- The impact on Novo Nordisk if measuring equipment does not meet calibration requirements.
- The likelihood of measuring equipment failing to meet calibration requirements.
- Mitigations such as intermediate checks, adjustment limits, and the length of the calibration interval.

A corporate IT system evaluates whether the calibration results pass or fail, with the final decision made by a qualified Novo Nordisk employee. If measuring equipment fails to comply with calibration requirements, an investigation is conducted to evaluate the potential impact on product quality and patient safety over the period since the last successful calibration. While Novo Nordisk can outsource the execution of calibrations, we retain ultimate responsibility; hence, conformity statements in calibration certificates are not required. All calibration certificates must be delivered to Novo Nordisk.

2. Digitalization and Automation Journey

We have been conducting a project aimed at digitizing calibration certificates from suppliers in the corporate metrology process. Each year, we handle approximately 20,000 external calibrations performed by various suppliers in different countries. Our digitization process began with creating a system for receiving digitally signed PDF certificates for manual handling. Subsequently, we automated the receipt and archiving of these digitally signed PDF certificates. This process is illustrated in Figure 1.

We are piloting a three-step process for implementing DCCs and DCRs:

- Manual handling
- Semi-automatic handling
- Fully automated handling

Achieving fully automated handling in our regulated industry is a challenging journey.

2.1 Digitally Signed PDF Certificates for Manual Handling

Our metrology process includes a document for receiving digitally signed PDF certificates, verifying data integrity, and archiving. Corporate requirements for exchanging these documents with external partners are managed by our records management

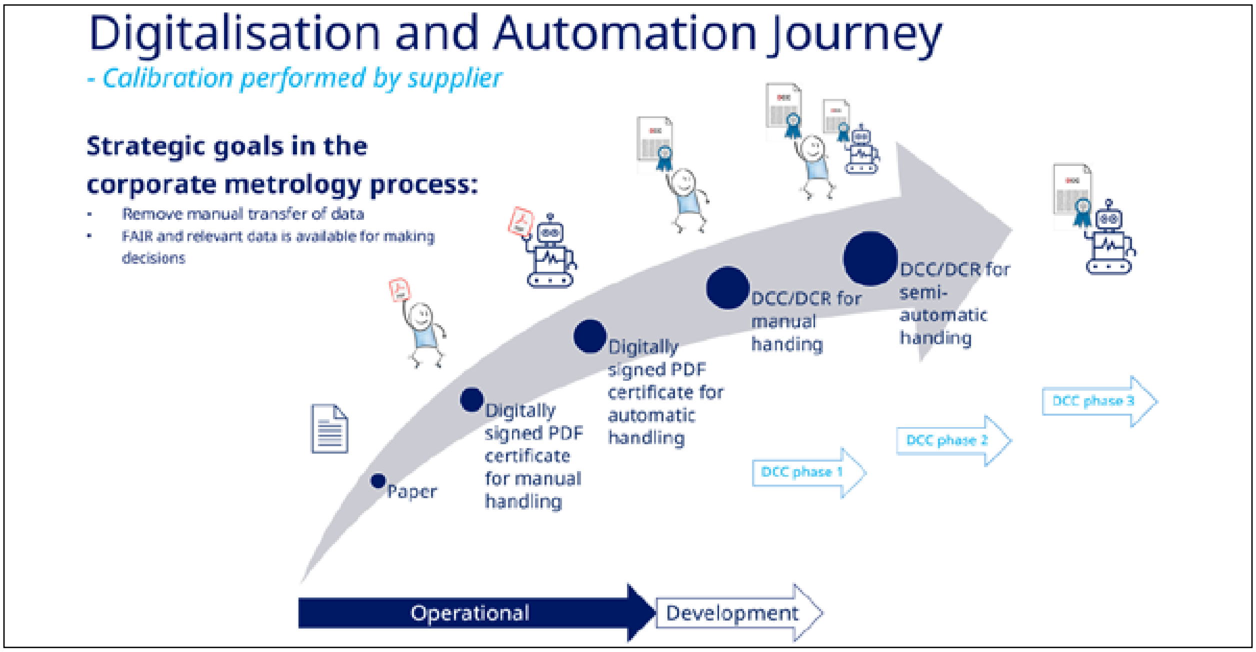

Figure 1. Digitalization and automation journey.

process. We have contracts with thirteen suppliers for delivery of digitally signed PDF certificates. A qualified Novo Nordisk employee checks the signatures against the root certificate using the Adobe Approved Trust List (AATL) program to ensure no modifications have been made since signing.

2.2 *Digitally Signed PDF Certificates for Automatic Handling*

Conducting data integrity verification presents challenges for some employees. While it is straightforward to train those who manage digitally signed PDF certificates daily, maintaining competence is more difficult for individuals who handle them infrequently.

In collaboration with the corporate automation department, the corporate metrology process has developed a Robotic Process Automation (RPA) solution for receiving and archiving digitally signed PDF certificates.

1. The process flow is as follows:
2. The supplier sends an email to the software application (BOT).
3. The BOT opens the email and reads the email body text, which must adhere to specific syntax requirements.
4. The BOT conducts data integrity verification before archiving the certificate(s) in Novo Nordisk's document database.
5. Once the certificate(s) are uploaded, the BOT sends a notification to the relevant Novo Nordisk employee with a hyperlink to the certificate in the document database.
6. The employee can then review and evaluate the calibration certificate(s) and decide to release or reject the measuring equipment for use.

The syntax requirements in step 2 are necessary due to the lack of machine readability of PDF certificates. Therefore, machine-readable metadata must be included in the email body to facilitate the processing of the PDF certificates.

2.3 *Manual Handling of DCCs/DCRs*

Manual handling of DCCs/DCRs involves an employee logging into the Novo Nordisk IT system, opening the calibration work order, and transferring requirements to the middleware that creates the DCR. After a supplier performs calibration and the DCC is received, the employee logs in again, extracts relevant data using middleware, and transfers it to the IT system. The employee then verifies the data transfer and signs off on the completion of the work order. A second person confirms the accuracy of the data transfer and signs for the work order review.

2.4 Semi-Automatic Handling of DCCs/DCRs

Semi-automatic handling involves an employee logging into the Novo Nordisk IT system and initiating a calibration work order. A DCR is generated and sent to the supplier. After the supplier performs the calibration and the DCC has been received, the relevant data is transferred to the Novo Nordisk IT system. An employee logs into the IT system to verify that the data transfer is accurate and signs for the work order review.

2.5 Fully Automated Handling of DCCs/DCRs

Fully automated handling operates similarly to semi-automatic handling as detailed in subsection 2.4, without the added feature of automating the work order review process.

3. Development – Phase 1: Manual Handling of DCC/DCR

In DCC pilot phase 1 (see Figure 1), we will use learnings from the digitally signed PDF calibration certificate. We will embed the DCC in XML format into the PDF while keeping the human-readable PDF for inspections and audits. The PDF will also serve as a manual fallback if automation fails. We are piloting this with Danish suppliers like DFM, TI, and FORCE.

3.1 Mapping of Data Flow from Novo Nordisk IT System to DCR

To generate a DCR, it is vital that the data in the Novo Nordisk IT system is FAIR data, as this ensures retrievability. When digitizing a process, it is important to analyze all aspects of the calibration request process, including the unwritten practices that have developed over a long period of cooperation between customer and supplier. The analysis identifies three groups of information that go into the DCR:

- Data that can be transferred from the Novo Nordisk IT System
- Standard text describing fundamental requirements
- Manually collected information

Examples of these types of information include:

Data that can be transferred from the Novo Nordisk IT System:

- Equipment ID number
- Calibration work order in the Novo Nordisk IT System
- Requirements for:
  - Calibration method
  - Environmental conditions
  - Which channel to connect the sensor to
  - The direction the calibration point should be approached (increasing or decreasing)
  - Units for the Device Under Test (DUT), standard, and expanded uncertainty
  - Adjustment if limit is exceeded

Standard text describing fundamental requirements:

- Calibration must be performed accredited according to ISO 17025 or according to a Metrology Quality Agreement between Novo Nordisk and the supplier
- Only one measuring equipment per calibration certificate
- As found calibration and as left calibration must be in two individual certificates

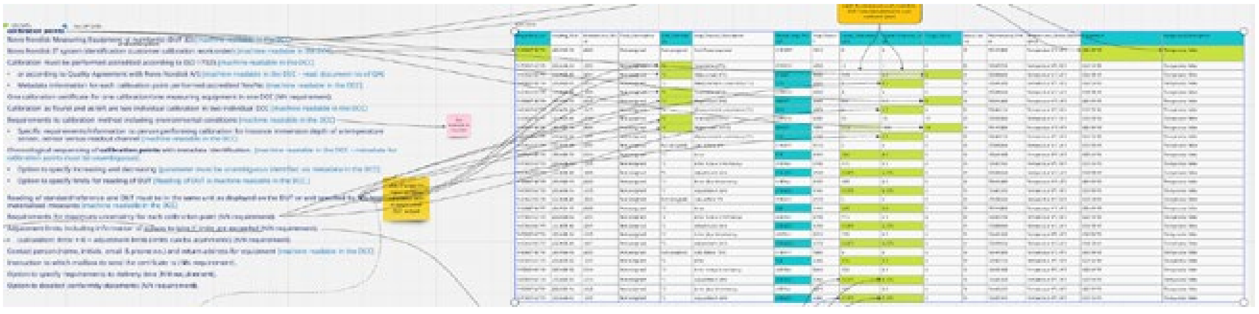

Figure 2. Illustration of mapping of data for TI system

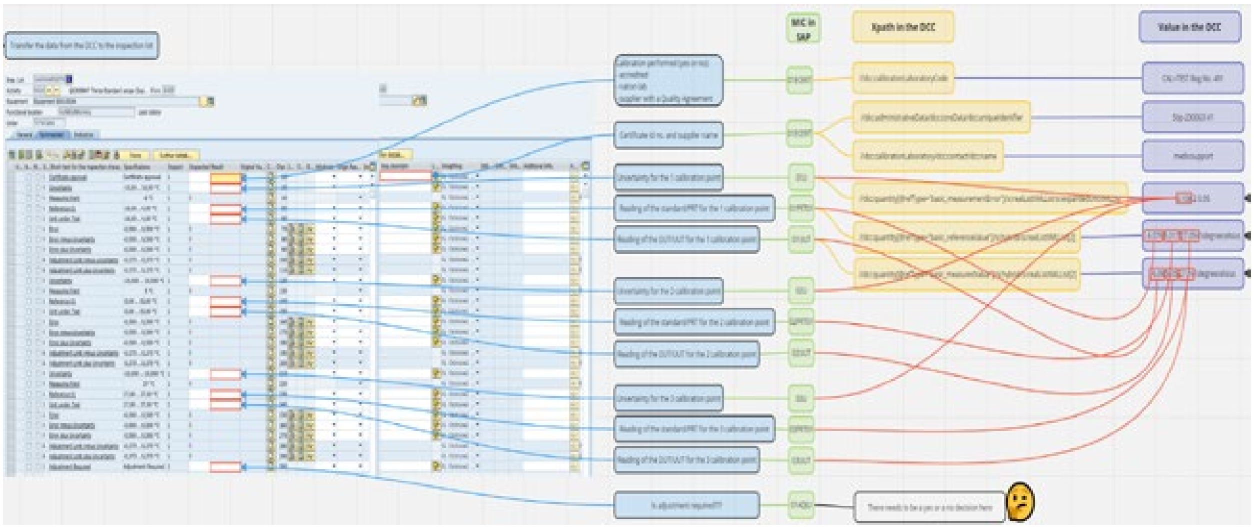

Figure 3. Illustration of unique data identification.

- The same units must be used for the DUT, standard, and uncertainty
- No conformity statements in the certificate

Manually collected information:

- Contact person (name, initials, email, and phone number)
- Return address for equipment
- Return address for certificate

Figure 2 shows an example of mapping the data flow from the Novo Nordisk IT System.

3.2 Mapping of Data Flow from DCC to Novo Nordisk IT System

When handling automatic data transfer, it is vital to ensure unique data identification in both systems. In the Novo Nordisk IT system, each calibration point has a unique ID, as shown in Figure 3. Here, a Device Under Test is called a Unit Under Test (UUT). The first calibration point is tagged 01UUT, the second 02UUT, and so on. Calibration standards used by suppliers are labeled similarly; for example, 01PRT01 indicates the first point reading, and 02PRT01 the second. Calibration result uncertainties are marked as 01U, 02U, etc.

Calibration results in the DCC must be uniquely identifiable to ensure correct data transfer and minimize transcription errors, as noted in section 9.4 of [1].

XPath is used to query XML files. Queries in DCCs need to be consistent, well-defined, and objective XPaths, as described in section 5.5.3 of [1]. XPaths yielding multiple results, as shown in Figure 4, increase middleware complexity and failure risk.

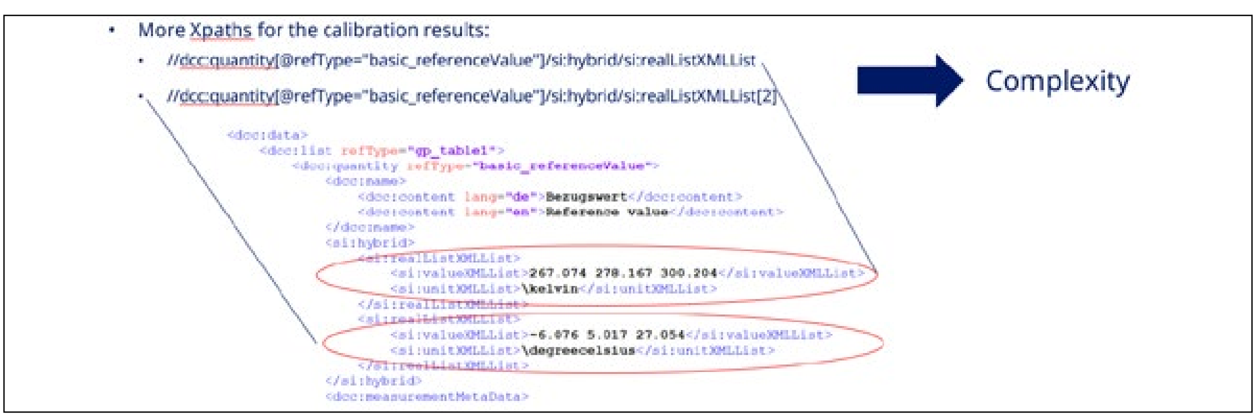

Figure 4. Illustration of an XPath resulting in multiple query results.

Humans can easily distinguish between temperature results given in Kelvin and Celsius, but developing middleware to handle this makes IT risk assessments more complex. The assessment must address and validate all potential data transfer issues. Robust XPaths in the middleware make the DCC more reliable, so the DCC should be designed to simplify the creation of robust XPaths.

3.3 Regulatory Requirements to a Record (ALCOA+)

In the healthcare industry, calibration certificates must meet various regulatory requirements. At Novo Nordisk, our corporate record management process ensures compliance with these standards. Whether electronic or paper, calibration certificates must adhere to the same rules. Following the ALCOA+ principles ensures we meet regulatory expectations.

Attributable

Attributable in [1] is ensured by having a clear identification of the individual performing a calibration task and the date or date range for when the calibration was performed. We expect the calibration certificate to be locked for editing with a trusted signature and in a way so it can be verified that the document has not been altered after the last signature was applied.

Legible

Legible in [1] covers the record being readable and unambiguous for it to be understandable and usable. This is where the unambiguous identification of calibration data described in section 3.1 becomes important.

Contemporaneous

Contemporaneous in [1] is covered by section 7.8.1.2 in [2] and is a requirement that specifies that recording of calibration data must be documented when the calibration takes place. By requesting an accredited calibration, the accreditation ensures that the result of the calibration is accurate, clear, unambiguous, and objective.

Original

Original in [1] is also covered by section 7.8.1.2 in [2] and is a requirement to ensure the first capture of calibration results.

Accurate

Accurate in [1] is a requirement to ensure that the calibration results are a truthful representation of fact which is the intent of [2].

Complete

Complete in [1] is a requirement to ensure that all critical information to understand the calibration is captured to ensure that all relevant metadata is available in the DCC and that the information is not deleted or lost.

Consistent

Consistent in [1] is requirement to help control or standardize the DCC. We need an international standard for the DCC.

Enduring

Enduring in [1] is a requirement to ensure that the calibration certificate is readable and reliable in the retention period. In Novo Nordisk the retention period for a calibration certificate is ten years. From our experience with digitally signed PDF calibration certificates, we know that the root certificate has an expiry date after typically three years. By uploading the certificates to the Novo Nordisk database upon receival and at the same time ensuring the data integrity, we protect the certificates in the entire retention period.

Available

Available in [1] is a requirement to ensure that the calibration certificate is available for Novo Nordisk employees.

Further Risk Reduction

Section 5.5.3 in [1] gives good practice guidance in reducing risk by having a simple process which is consistent, well defined, and objective. Complex or inconsistent processes with open ends and subjective outcomes lead to increased risk. At Novo Nordisk we prefer simplicity.

4. Why Digitalize

At Novo Nordisk, most measuring equipment is calibrated in-situ and documented in a corporate IT system. Calibration requirements are accessible to employees in the calibration work order. The readings of the UUT and standard are documented directly in the IT system, which calculates and evaluates whether the calibration has passed or failed to assist the employee in making the final decision. This calibration process is paperless and eco-friendly, with the capability to trend calibration data as described in [3].

Calibrations outsourced to suppliers are also managed within the same IT system, although the digital maturity level is lower. Calibration requirements are available in the IT system for the employee requesting the calibration; however, data covering the calibration requirements such as calibration points and requirements for accuracy, is manually transferred to a letter that is sent to the supplier together with the equipment. After calibration, some departments transfer the calibration result data into the IT system, where a second person verifies the correct transfer. Other departments do not transfer this data. The IT system only evaluates calibration data when it has been transferred, and trending on the data is possible only if data transfer occurs. Currently, approximately 25% of all calibration certificates received by Novo Nordisk are digitally signed PDF certificates, indicating progress toward a fully paperless process.

On average, it takes 20 minutes to transfer data from a certificate to the IT system and for a second person to verify the data transfer accuracy. It typically takes 25 minutes to transfer calibration requirements from the IT system to a letter. Additionally, 5% of all revised calibration certificates are due to errors in Novo Nordisk's calibration requests.

The successful transfer of data is just one aspect; true success is achieved when calibration data is used to trend the performance of measuring equipment, building leading indicators and gaining valuable insights for proactive action, as described in [3].

5. Conclusion

An international standard for Digital Calibration Certificates DCC and Digital Calibration Requested DCR is essential for a successful global implementation. Such a standard ensures that all aspects of the DCC and DCR adhere to a common framework, facilitating smoother operations across different countries and suppliers. Data integrity is crucial to ensure trustworthy and reliable data, which forms the backbone of any effective implementation.

A step-by-step implementation simplifies change management breaking down the process into manageable phases. This method allows for careful planning, monitoring, and adjustment at each stage, reducing the risk of errors and ensuring that the transition is seamless. Furthermore, being a first mover is challenging and comes with a risk of rework. This makes it important to choose the right collaboration partner, one who shares your vision and can provide the expertise and support needed for successful implementation.

In summary, the combination of adhering to international standards, ensuring data integrity, adopting a phased implementation approach, and partnering with the right collaborators are key factors in achieving a successful global implementation.

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[2] International Organization for Standardization, *ISO 17025:2017 General requirements for the competence of testing and calibration laboratories*, 2017, https://www.iso.org/standard/66912.html

[3] Schroll-Fleischer J., Paustian F. A., "Calibration Data Mining – Perspectives from Novo Nordisk," 2024, Novo Nordisk, XXIV IMEKO World Congress, Hamburg, Germany - Pending Publication.

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IN DAYS OF OLD

Surrounded by History

Dan Wiswell
Amblyonix Industrial Instrument Company

Many years ago, I worked in a building in Boston that had a plaque on an outside wall that commemorated the invention of the telephone by Alexander Graham Bell.

Passing by it nearly every day, I used to think about how things must have been when those old experiments were going on. People may not realize that while Bell was working in his lab, there was an ambient chatter of telegraphic communication already going on and had been for decades.

By the beginning of the twentieth century, companies that catered to the needs of the growing electrical and communications industries employed thousands of people in the greater Boston area. Cambridge, Massachusetts became the birthplace of a multitude of companies that had their beginnings in or around the periphery of the radio and communications industries.

It must have been an absolute bonanza to be involved in metrology back then. With so many innovations occurring daily, the need for test and measuring instruments of all kinds must have been nearly inexhaustible. Back then, a local company that was involved in this trade was the Rawson Electrical Instrument Company, located at 110 Potter Street Cambridge, Massachusetts. Homer E. Rawson founded the company in 1918. Prior to the founding of his company, Mr. Rawson had been vice-president of the General Radio Company also located in Cambridge.

In his newly formed company, Mr. Rawson's chief engineer was Arthur J. Lush. Mr. Lush had been previously employed by Paul Instruments of London, England. On January 19, 1920, Arthur Lush applied for a patent for an improved binding post with a captive cap. While still an English citizen and resident of Cambridge MA, he was granted patent number 1490336 by the United Stated Patent Office on April 15, 1924. Upon receipt, he assigned this patent to the Rawson Electrical Instrument Company.

In those days, beyond the commercialization of electricity, there was a tremendous amount of interest in the field of amateur radio. One publication of the time was *QST* magazine. It promoted itself as "A Magazine Devoted Exclusively to the Wireless Amateur." The August 1919 edition contains an article written by H.E. Rawson titled "Measurement of Wavelength, Capacity and Inductance with Oscillating Vacuum Tube." Towards the back of this issue of the magazine is an advertisement posted by the Rawson Electrical Instrument Company advertising itself as the "Sole U.S. agent for Robt. W. Paul, London, and Paul Instruments." Makers of "Portable Galvanometers of Extreme Sensitivity and Measuring Instruments for all purposes on direct current and alternating current of any frequency."

Robert Paul invented the unipivot meter movement in England during 1903. His meter movements can be seen in many of the earliest products in the Rawson Electrical Instrument product line. A classic example of a unipivot-based instrument is the Model 501 Galvanometer pictured on the following page.

This instrument is equipped with a Paul Instruments unipivot meter movement. The top and bottom details of the meter movement are depicted to the right of the instrument. The bottom of the movement has a pivot and jewel assembly similar to those found in conventional d'Arsonval meter movements.

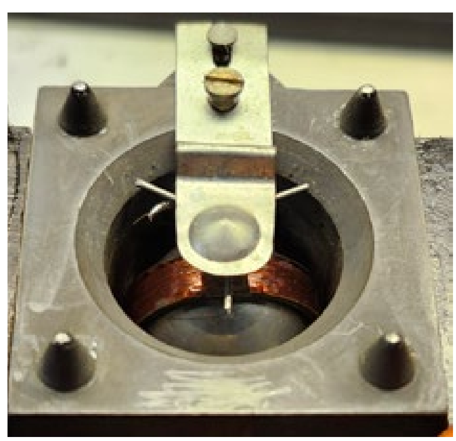
However, at the top of the meter movement, instead of a corresponding pivot and jewel assembly, this design utilizes a tensioned helical coil to fix the at-rest meter indication at a desired point on the scale. As advertised, these instruments provided extreme sensitivity of measurements and were best used in a controlled laboratory environment.

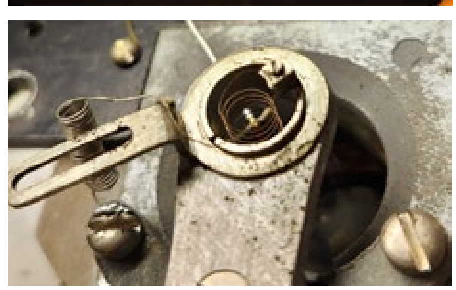
To provide such accuracy, it was very important for the meter movement to be precisely balanced. Measurements were required to be made while the instrument was positioned on a flat surface and observed by looking down on the scale from above the instrument. The mirrored scale removed parallax errors when readings were viewed properly in this fashion.

There were a few notable deficiencies in this design. This type of movement was not as rugged as the improved d'Arsonval movement designed by Dr. Edward Weston in 1888. These instruments tended to drift off a set zero indication with a change in ambient temperature. A small but important feature of these products can be seen on the inside of the top cover. A small rubber button was positioned so that when the case cover was closed, it depressed a clamp on the front of the movement that locked the movement in place during transportation. This significantly added to the durability of the instrument. This clamp button was positioned in the "up" position when measurements were made and returned to the locked position during storage or transportation.

The Rawson Electrical Instrument Company made a variety of other types of measuring instruments including "thermal" and conventional multimeters. One problem that early instrument design engineers had to contend with was equilibrating an AC voltage with a corresponding DC voltage value. In those days, thermal transfer or reference standards were used for this purpose. Basically, a thermocouple was used to sense the value of an AC or DC voltage signal. The resultant meter deflection was plotted on a hand drawn scale. As a thermocouple is an inherently non-linear device, the resultant readings would also appear on a non-linear scale.

These scales (or dials) were made by a process called "hand pointing." As each instrument reached its final assembly, it was fitted with a blank scale before a metrologist would put it through its calibration process. As readings were obtained, a small pencil mark was "pointed" on the scale identifying exactly where the pointer came to rest during each measurement. The marked-up blank was then sent to an art department where the scale was created from these cardinal points. The finished scale was then serialized and re-united with its host instrument before final calibration.





This technique for enhancing the accuracy of an analog meter was still being practiced in the first calibration laboratory I worked in during the late 1970s. I'm sure it is still going on somewhere.

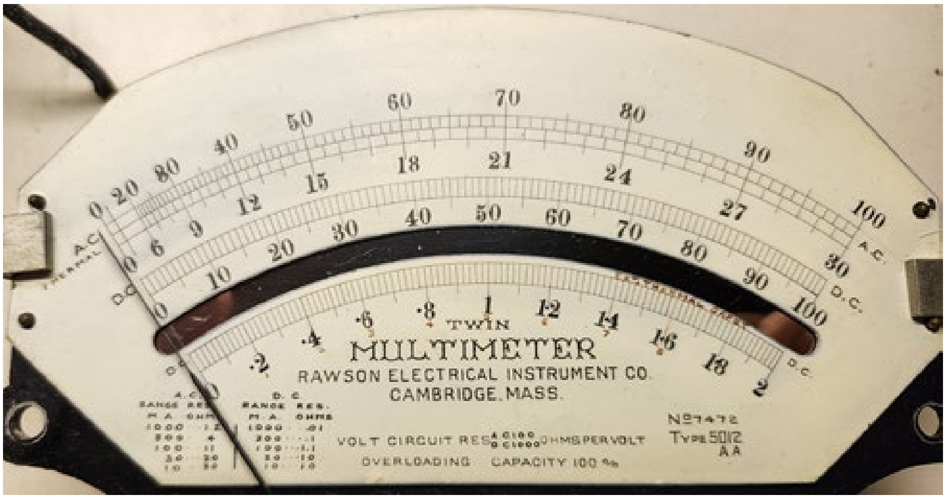
Let's look at a few examples of Rawson thermal multimeters. Depicted below is a Rawson Electrical Instrument Company Model 502 Thermal Multimeter, serial number 9239.

One general feature that stands out is that all ranges and functions are measured using various non-linear scales. This points to the fact that every measurement utilizes an internal thermo-electric sensor. Pictured below is an internal view of the product with the sensor in the foreground. Notice the heavily varnished, woven-fabric insulators that were in use before the days of circuit boards.

Another indicator of the age of this specimen is the font used on its scale. This font type was also used in the early days by the Boston Red Sox, a stylized version of which still adorns their team logo. The serial number is an important reference point as I have not found any date stamps or other notes created during the manufacturing process on any Rawson Electrical Instruments Company products, ever. So, without any other available information, we can make an informed guess as to its age using the following logic: If there are approximately two hundred and sixty workdays in a year and the company was able to produce roughly ten units per workday, this unit's serial number could have been achieved within four years of production. As the supply chain from Paul Instruments appears to have been fully developed prior to 1920, this could possibly mean that this specific unit may be about one hundred years old, give or take a hand grenade. As of the date of this publication, that's the best I can do.

Another version of a Rawson multimeter was the Rawson Electrical Instrument Company Model 5012 Twin Multimeter. This instrument was designed to measure AC and DC voltage and current across a fairly broad selection of ranges. A close look at its scale reveals that only the AC ranges have non-linear arcs.

This means that only the AC functions pass through the internal thermal detector to produce a



measured reading. An indication of the age of this instrument, beyond its archaic construction, is its ohms-per-volt rating. At one thousand ohms-per-volt on DC voltage ranges and one hundred ohms-per-volt on AC voltage ranges, these multimeters would load down a measured circuit significantly more than modern multimeters. As a point of reference, a few decades after the construction of this unit, the Simpson Electric Model 260-3 VOM offered an ohms-per-volt rating of twenty-thousand ohms-per-volt.

As the advertisement in *QST* magazine said, the Rawson Electrical Instrument Company offered a broad assortment of measuring instruments. One such instrument was the Model 503 Megohmmeter pictured below.

This megohmmeter was designed to measure high-resistance values with an applied test signal of one-hundred-and-fifty DC volts. Able to measure resistances of up to ten gigohms, its most prominent feature is the turret that protrudes above the rest of the front panel. I'm not sure why I have never taken the time to examine this instrument further. Now that I have, I must admit to some level of embarrassment at what I discovered when I did.

This causes me to think back on some of the stories that I was told by older metrologists that I worked with as a young man. Many of the older gentlemen that I worked with at the Mancib Company in the 1970s had been in World War II. One of them was a sailor that had volunteered for service in the submarine corp. He told many stories of being onboard when his submarine had been depth charged while on duty in the south Pacific. When that happened, he said that afterwards the sailors would find things that had shaken loose on the ship, like welding rods or flashlights that had been left in place during the ship's construction. A close miss from a depth charge often caused damage to the pivot-and-jewel assemblies of d'Arsonval-movement-based meters on board. He told me that this problem was solved late in the war by retrofitting the old-style meters with newer, taut-band-based meters that could sustain and survive a much greater shock than a pivot-and-jewel-based meter movement could.

As I began researching other articles that I have had published in this magazine, I found numerous places online, including statements on the websites of some panel meter manufacturers, that taut-band meter technology gained wide acceptance only after advances in materials research made them strong enough to be a viable alternative solution to pivot-and-jewel based meters in the 1950s. Prior to this, spring-loaded jewel assemblies had been one solution for creating what were called "ruggedized" meters. Imagine my astonishment when I removed

the outer shroud of this megohmmeter's front-panel turret. The picture above clearly shows the leaf spring assembly of what the English manufacturer used to attach what they called a ligament wire to the coil assembly of the movement. Over here, we called it a taut band.

This meter movement is a hybrid of pivot-and-jewel and taut-band technology. It's the only one I've ever seen. To me, it is proof that nothing beats direct research on any subject. It makes perfect sense to me that the creator of a single-pivot meter movement would also employ other techniques to solve a difficult engineering problem.

During my research of the Rawson Electrical Instrument Company, one thing that stands out is that the company must have had a very reliable supply chain of parts. Instruments separated by decades of time were built with the exact same switches, knobs, movements and Bakelite front panels. This is evident in the product shown as our next example (shown right), a Rawson-Lush Instrument Co. Inc. Model 963 AC/DC Thermal Voltmeter.

It features switches, knobs, meter movement and case-style that were ubiquitous throughout the entire life cycle of the Rawson-Lush legacy. For me, it underlies a somewhat melancholy aspect of this story. Although Homer Rawson founded his company in 1918, he passed away in 1923, and never saw the transfer of Arthur Lush's patent to the company for his improved binding post in 1924. Arthur Lush went on to become the president of the company and passed away forty years after the passing of Homer Rawson in 1963. His son Morely J. Lush, born March 2, 1919, renamed the company the Rawson-Lush Instrument Company, Inc. and in 1963 moved the company to Acton, Massachusetts. Morely J. Lush brought his company into the modern era. He was the president and chief engineer of the company for over forty years and was a resident of Acton Massachusetts. He died on July 11, 2012, a prominent and well-respected member of his community. I wish that I had met this man during his lifetime. We would surely have had a lot to talk about.

Dan Wiswell (dcwiswell@aol.com), is a self-described Philosopher of Metrology and President/CEO of Amblyonix Industrial Instrument Company in North Billerica, Massachusetts.

Mahr Expands Precimar® SM 60 Length Measurement Family

Delivers Enhanced Flexibility and Accuracy for Precision Parts Measurement in a Production Environment

PROVIDENCE, RI – December 18, 2024 – Mahr Inc., (https://www.mahr.com/) a leading provider of dimensional metrology solutions, announced the expansion of its Precimar® SM 60 length measurement product line with the introduction of the Precimar SM 60-V small-length measuring bench. This new version of the SM-60 has the ability to use Mahr's standard contact inserts with 3.3mm mounting. These inserts enable the SM-60 to be individually adapted to a wide range of measuring tasks. For example, it can measure recesses, external gears, the pitch diameter of external threads, and perform many other measuring tasks. It is also ideally suited for precise measurements at the point of manufacture or in a measurement center.

The Precimar SM 60 family features a measuring range of 60 mm, with a 25 mm sensitive contact and a fixed reference jaw with a 35 mm adjustment to obtain the total 60 mm measurement capacity. Equipped with a 5 N measuring force, the Precimar SM 60-V includes a robust construction for use in the production environment, designed to meet the demand for high-performance gaging at the point of manufacture. It also offers a simple setup for fast adaptation to new workpieces.

The Precimar SM 60-V is highly-flexible. It is configurable with various Mahr readouts to provide a system tailored to the performance level required for the specific measurement application, including:

- MarCator 1086R or 1087R digital indicators
- Millimess® 2000 high-performance digital comparator
- Millimar® P2004 LVDT with +/-2mm range and C1200 bench amplifier
- Incremental probes: P 1530 V using Millimar® C 1202 and the N 1702 VPP-module, providing long-range and high-resolution capabilities

Interchangeable measuring inserts provide hardened steel or carbide surfaces in a wide variety of shapes, along with numerous thread measuring options. An adjustable support table is positioned up or down to ensure proper part location and then locked into place. Retraction of the sensitive contact is accomplished with a simple lever that is easy to use by right- or left-handed operators.

"The expansion of the Precimar SM 60 family with the new SM 60-V model demonstrates Mahr's commitment to delivering innovative solutions that meet the evolving needs of manufacturers," said Nick Russo, Product Manager at Mahr. "The flexibility, accuracy, and durability of the Precimar SM 60-V make it an ideal choice for manufacturers seeking to perform precise measurements in a production environment, enhancing their measurement capabilities and driving productivity."

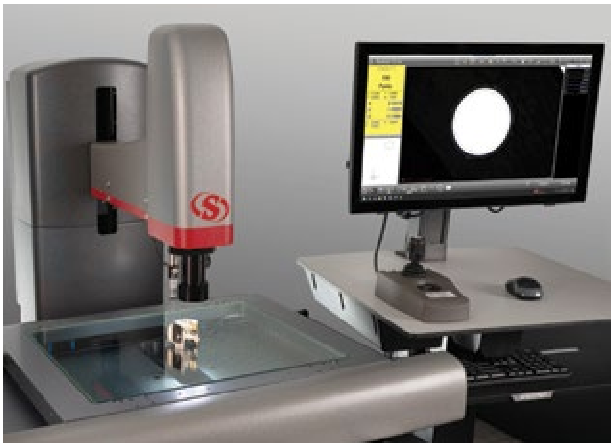
AW-Lake Introduces Cost-Effective Turbine Flow Meter for Measuring Light Viscosity Fluids

Oak Creek, Wisconsin, December 3, 2024 – AW-Lake, flow instrumentation manufacturer, has announced the launch of the TN Turbine Flow Meter. This meter offers a cost-effective solution for measuring light viscosity fluids, including glycol, water and solvents. It can be used for liquid flow measurement both on or off the oilfield. Additionally, the TN Turbine Flow Meter serves as easy drop-in replacements for other brands of flow meters.

With flow ranges from as low as 0.3 gallons per minute (GPM) to as high as 5,500 GPM, the TN Turbine Flow Meter is accurate to within ±1% of reading and offers repeatability of ±0.1% across the full range. Available in a wide range of sizes, the turbine flow meter provides multiple process connections and can work with various existing electronics. Its all-stainless-steel construction and precise machining tolerances ensure excellent durability and long life, making it suitable for even the most demanding flow measurement applications.

The TN Turbine Flow Meter can be employed in various industries, including oil pipelines, water applications, and test systems in aerospace and automotive plants. It is also utilized in HVAC and building automation, beverage processing, and power generation. The turbine flow meter performs best under steady flow conditions as turbulence, fluctuating flow, or cavitation can impact performance and accuracy.

For more information, contact Marcia Reiff, Director of Marketing Communications, at 414-574-4300, e-mail mreiff@aw-lake.com, or visit AW-Lake's Web site at https://aw-lake.com/product/tn-turbine-flow-meter .



Starrett Introduces AVR400 System

Faster, Accurate Measurement and Inspection on a Larger Platform Benchtop System

ATHOL, MA U.S.A. (October 23, 2024) – The L.S. Starrett Co., a leading global manufacturer of metrology systems, precision measuring tools and gages and more, has expanded its AVR Vision Metrology Line with the introduction of the AVR400 CNC Vision System, the largest benchtop platform to date from Starrett with stage travel that is twice the speed of previous Starrett AVR models. The stage travel is 15.8″x 11.8″x 7.9″ (400mm x 300mm x200mm) in the X-Y-Z axes with a speed of up to 120mm/ sec.

"We are very pleased to offer customers a new, faster vision system capable of measuring a broader range of larger part sizes, as well as providing the ability to put more parts on the stage at one time," said Mr. Mark Arenal, General Manager, The L.S. Starrett Company – Metrology Division. "Users will reduce inspection and measurement time, while maintaining accuracy."

The Starrett AVR400 offers full CNC capabilities including X-Y-Z positioning and comprehensive zoom and telecentric lens options. Users can also choose to use motorized manual positioning via a pendant with a joystick and track ball. Equipped with the M3 software package from MetLogix™, a traditional mouse as well as a touchscreen monitor make user interaction easy and intuitive.

Auto part recognition enables creating a part measurement program that comprises the desired features of a part for inspection, which can automatically be saved in the system or to a network. Programmable light output options can be built into the program as defined steps, including being called up as the part recognition program initiates. Once the program is created, placing that part within the camera's field-of-view allows for the saved program to initiate and run the inspection. A Renishaw Touch Probe may also be utilized for quick acquisition of discreet points along a part's profile as well as Z-axis measurements.

For high stability, the AVR400 features a granite base. An extensive line of accessories is available including a modular system workstation on rolling caster wheels, providing convenient repositioning on the shop floor and in QC labs. The AVR400 Vision Metrology System is Made in the U.S.A.

For more information and specifications, visit https://www.starrettmetrology.com/product-page/avr-400-vertical-benchtop-vision-system.

Durable New High-Frequency Connectors Fit 0.034 and 0.047 Semi-Rigid Coax Cables

Fairview Microwave's Newest Offering Excels in Applications up to 40 GHz

IRVINE, Calif. –Fairview Microwave (https://www.fairviewmicrowave.com/), an Infinite Electronics brand and a leading provider of RF, microwave and millimeter-wave products, has announced the launch of its new line of 2.92 mm, SMA, SMPM and 3.5 mm connectors, designed for 0.034 and 0.047 semi-rigid coaxial cables.

The connectors are compatible with PE-047SR, PE-SR047AL, PE-SR047FL and PE-034SR-BULK cables, providing robust solutions for high-frequency applications. They support frequencies from DC to 18 GHz or 40 GHz, making them ideal for demanding environments where stable and reliable signal transmission is critical.

The new connectors are engineered with a clamp/solder attachment, ensuring a secure and durable hold. This is essential for maintaining optimal performance in RF systems. Whether used in telecommunications, aerospace or defense, they offer versatile solutions for industries that require precision in high-frequency operations. The 50-ohm impedance provides minimal signal loss, and the wide frequency range is suitable for both existing and new installations.

"These connectors offer unmatched reliability and versatility in RF applications," said Senior Product Line Manager Amar Ganwani. "Their ability to handle up to 40 GHz and the broad compatibility with various semi-rigid cables make them vital for industries that demand top-tier performance."

Fairview Microwave's new 2.92 mm, SMA, SMPM and 3.5 mm connectors are in stock and available for same-day shipping. For inquiries, please call +1 (972) 649-6678.

The Problems with Hardware Emulation Modes

Michael L. Schwartz
Cal Lab Solutions, Inc.

Let me start with "I hate it!" It is okay for simple tasks, but calibration and metrology is not a simple task. Often, what we do in automation is very complex—getting into the low-level settings of our lab standards so we can configure it to make the most accurate measurements. Then, we want to take several measurements so we can evaluate how close the measurement is to the true value.

This is where emulation modes break down; for example, on a Keysight E44440A Spectrum analyzer, I have to look at the status bytes when I want to check the calibration status. That command for the Keysight PSA/E444xA Spectrum analyzers is "STAT:QUES:CAL?" The returned results contain information on whether the spectrum analyzer needs alignment and what alignments need to be performed.

For another manufacturer to emulate low-level operations like status questionable, indicating that the spectrum analyzer's measurement quality may not be accurate. Emulating low-level commands like this would be challenging because the statutes are closely tied to the hardware design of the E4440A spectrum analyzer. Yet, the query is critical if you want to know the status of the hardware before you make a measurement.

In Metrology.NET®, we check the hardware status before each measurement. If the instrument status is questionable, we can run the self-calibration, equipment zero, or whatever operation is needed to enable the hardware to make the best measurements.

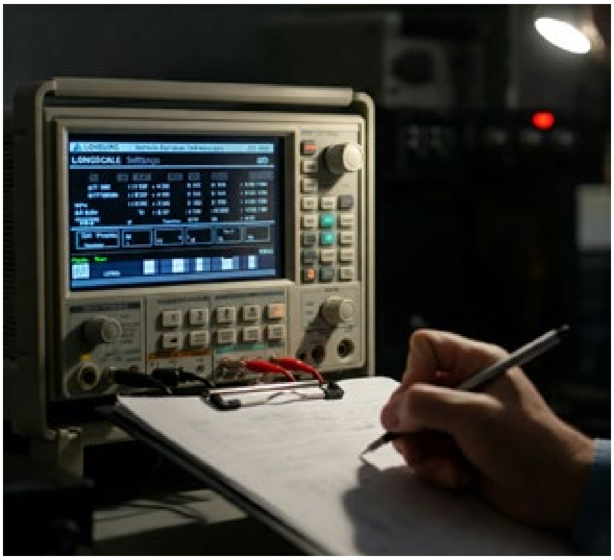


Image generated using Google's Gemini.

Several things can affect the quality of a measurement, especially temperature drift. Most high-accuracy measurement circuits are affected by temperature. Every good calibration lab logs the temperature and humidity. Plus, all of your lab standards will specify the operating temperature ranges with associated uncertainties.

Some instruments will take it a step further by embedding temperature sensors inside the hardware. For example, the Hewlett-Packard 3458A has an internal temperature sensor. It is used to measure the temperature inside the instrument. The instrument's accuracies are specified based on the internal temperature at the time of calibration and the temperature at the time of the last ACAL.

To further my stance on hating emulation modes, several digital multimeters emulate the command set of the HP 3458A, but none of them implement the temperature queries. The reason is their digital multimeter was designed differently, and their uncertainties are not based on the Calibration and ACAL temperatures–some of them don't even have temperature sensors inside the instrument.

Those are just some of the problems with emulation mode not working because the equipment manufacturer didn't add support for all the commands implemented by the equipment they are trying to emulate. I'm sure there are thousands of additional examples. However, the biggest one for metrology is related to measurement uncertainties.

Most hardware calculates uncertainties using a percent of reading pulse percent of range formula. It may be specified in parts per million (ppm) or floor value instead of ppm of range, but either way, it is a slope + offset calculation. So, even if you can substitute one device for another because the emulation mode works, you still have the problem of uncertainty calculations, such as: What is the range the device was on when it made the measurement? How high above the range can the instrument make a measurement 1%, 5%, 10%?

In metrology, we need to know the exact state of our reference standards to make an accurate measurement and calculate the measurement uncertainties. This is why I hate the idea of using emulation modes in metrology software hardware.