MEASUREMENT SCIENCE CONFERENCE
LONG BEACH, CALIFORNIA | MARCH 10-14, 2014

NIST SEMINARS
Monday-Tuesday, March 10-11, 2014

ASQ TRAINING
Monday-Tuesday, March 10-11, 2014

TUTORIAL WORKSHOPS
Monday-Wednesday March 10-12, 2014

MSC TECHNICAL PROGRAM
Thursday-Friday, March 13-14, 2014

REGISTER ONLINE
www.msc-conf.com
Our promise at Measurement Science Conference (MSC) is to teach and inspire leaders to transcend the ordinary, perform better, and contribute greater value to their teams, their organizations and their communities. The 2014 technical program has been designed to deliver on that promise with its collaborative format, engagement of upper echelon speakers, leveraging of social media business tools and focus on emerging trends and technologies. This approach has been strategically targeted because seldom has the need to advance education and professionalism in measurement science been greater. MSC 2014 has been engineered to reverse the stifling effects that the recent past’s austerity and sequestration measures have had on innovation and competitiveness. It seeks to remediate the damage caused by years of decline in government and private sector educational investment by recognizing that now is the time for re-engagement, for rebuilding professional networks, for rediscovering the advantages that new test equipment and measurement techniques provide, and for harnessing the capacity to convert challenges into opportunities to thrive!

For over 40 years, MSC has provided thousands of Engineers, Managers and Technicians with an unparalleled immersion based learning experience which equips, enables and empowers them to achieve true competitive advantage and to propel their organizations in transformational ways. And, because of this, MSC is recognized as the premier provider of education and training to professionals in the testing, calibration and precision measurement science fields.

What qualifies MSC for such praise? The magic of MSC is that it, like innovation itself, is both science and art. We bring to bear decades of time-tested experience and combine it with the latest, freshest thinking from a dedicated team of world renowned presenters and speakers. These subject matter experts volunteer their time and their efforts in assembling a comprehensive, week long, program that is designed to provide attendees with new insights that translate into value added change. At our Long Beach Convention Center venue, we will, once again, construct an environment that is dedicated to learning and growth amidst a vibrant set of peers from across the globe.

MSC 2014 will inspire you and your team to see broader, innovate more and perform better. We invite you to learn and energize with us this coming March, and we promise you an educational experience unlike any other.
Explore a premier waterfront setting steps away from Long Beach Convention and Entertainment Center and Aquarium of the Pacific when you stay at Hyatt Regency Long Beach. With a perfect combination of style, sophistication and comfort, you can count on a relaxing and productive stay at our luxury downtown hotel, the only 4 Diamond Award-winning hotel in Long Beach. Make yourself at home in one of our newly renovated rooms with ocean views and world-class amenities. Experience California-style dining at Tides and get a fresh cup of coffee at Perks. When it comes time to venture out, you are in the heart of it all with over 100 restaurants within walking distance, shopping and entertainment at The Pike across the street and the fascinating Aquarium of the Pacific less than a mile away. Step back in time on Queen Mary or take in a concert at the Long Beach Arena.

**Hotel Rates:**
$219  Single & Double Occupancy

Cut Off Date:  February 10, 2014

Room availability is limited, so we suggest you make your reservations as soon as possible. Call to make your reservation:

(562) 491-1234

For Hotel Registration, please go to:
https://resweb.passkey.com/go/LB14MeasurementScience

For Government rate, please go to:
https://resweb.passkey.com/go/LB14GovRooms
The MSC Board invites conference attendees to bring their families to our conference and enjoy some of the special sights in and around Long Beach, California.

**Tuesday March 11**

**CATALINA TOUR**

Take a relaxing trip to Catalina. Enjoy the scenic one-hour ocean ride to this coastal gem in Southern California. This is a special adventure with unique and stunning views of Catalina and the Southern California coast. Enjoy leisurely sightseeing on the water, see stunning marine life, and don’t forget to bring your camera. In addition see some of the unique sights at Avalon and see the sights from your own golf cart, Leave the hotel at 5:30 AM and return at 5:30 PM. The MSC special tour price is $60 for this unforgettable trip.

**Wednesday March 12**

**THE PIKE AND THE AQUARIUM OF THE PACIFIC**

Enjoy a walking tour of some of the sights of Long Beach. Then have lunch on your own at one of the great restaurants at the world famous PIKE.

After lunch be an ocean explorer at the Aquarium. Learn about the history of ocean exploration, current missions, new discoveries, and challenges and opportunities for the future. View animals, exhibits, educational displays, films, and an art exhibit. Enjoy the Wonders of the Deep exhibit featuring the unusual and unique animals that live in the deep sea, and the Behind The Scenes Tour. Leave the hotel at 11:00 AM and return in time to enjoy the exhibitors’ reception.

The MSC special Aquarium tour price is $20

**Thursday March 13**

**EXPLORE THE FAMOUS QUEEN MARY**

Transport yourself back in time aboard the legendary Queen Mary. Once the grandest ocean liner in the world, it is now a hotel, historical landmark, and entertainment venue. The Queen Mary gives visitors a unique glimpse into a bygone era when steamships were the most regal way to travel. Imagine you’re a passenger and explore the finest ocean liner ever built.

Enjoy a self-guided tour; the Ghosts and Legends and The Glory Days or Her Finest Hour. Tour leaves the hotel at 11:00 AM and returns around 5:00 PM, in time for the President’s Reception.

MSC passport price is $20 for adults and $10 for those under 12.

All Tour reservations must be received by February 28, 2014.

For reservations or questions, please email: sherillfrnkln@aol.com
Dr. Olthoff received his Ph.D. in physics from the University of Maryland in 1985 in the area of atomic and molecular physics. He then held a two-year appointment at The Johns Hopkins School of Medicine before joining the Applied Electrical Measurements Group of NIST in 1987. In 2001 he became the Chief of the Quantum Electrical Metrology (QEM) Division, which is the organization that maintains the fundamental electrical standards for the United States. In 2007, Dr. Olthoff became Deputy Director of the Electronics and Electrical Engineering Laboratory of NIST. EEEL was responsible for fundamental low and high frequency U.S. electrical standards and research, and provides essential metrology support to the U.S. semiconductor and photoelectronic industries. As Deputy Director for Measurement Services, Dr. Olthoff is responsible for the oversight of all calibration services at NIST. Dr. Olthoff has published over 120 publications and has co-authored/edited four books.

Grace provides services in organizational and process improvement, leadership, and quality. She has worked extensively in public and private business, services, healthcare and community health. She designs and implements effective systems for business success. She has authored 10 texts and many articles on quality, leadership and organizational performance. She is a frequent conference speaker and trainer. Grace holds an MBA from Georgia State University. She is an ASQ CMQ/OE, CQIA, Six Sigma Green Belt, and CQA. Grace is a Lean Six Sigma Master Black Belt and an ASQ Fellow.

Peter is an internationally recognized Keynote Speaker on Innovation. He has a passion for Innovation and has delivered more than 100 keynotes in a range of countries including France, China, Mexico, Brazil, Estonia, Malaysia, Japan, South America, Finland, United Kingdom, USA and Canada.

As Chief Executive of one of the leading Design Brands in Europe he has been an Innovator in one of the most demanding markets. He has consulted with such innovative companies as IBM, BlackBerry, and OPG.

Peter is Chair of the Canadian National Committee on Innovation for ISO and also Chairs the Innovation Group of the ASQ (American Society for Quality).

Peter is the Innovation Columnist for Quality Progress and Author of the books Innovation Generation, Executive Guide to Innovation and Do It Right the Second Time.
Session 1A: BioPharma Track
Paperless Calibration and Maintenance Management Software Implementations for the Healthcare Industry— The good, the bad, and lessons learned from a Firsthand Perspective
Marcus McNeely
Blue Mountain Quality Resources

From start to finish, hundreds of thousands and even millions are often spent in CMMS implementations, in addition to precious time and resources at stake in productivity gains / losses. While a well-planned and executed turnkey CMMS implementation leads to productivity, efficiency and compliance gains, the polar opposite can prove to be the case under a poorly planned / funded implementation. This paper details simplistic approaches to implementing paperless asset management in the Healthcare Metrology industry to maximize both productivity and compliance, and overviews key steps in making the right decisions to avoid problem areas in the process.

Session 1B: Aerospace Track
Metrology Analysis: Lost Art or Required Process
Steve Marschke and Nat Russo
Raytheon Space and Airborne Systems

10:15AM, Thursday, March 13, 2014

Session 1C: Laboratory Track
Using SAP Business Management Software for managing test and measuring equipment
Gerhard Mihm
Technical Center for Information and Technology Training

SAP is well-known in the business management software market. This presentation will not sell SAP – but give an idea how the equipment management of test- & measurement equipment can be handled and might help make decisions.

Session 1D: Emerging Trends and Technologies Track
Somewhere over the rainbow: Metrology in the year 2045
Chet Franklin
The Franklin Training Group

How rapidly is technology changing? What will be the “Metrology Paradigm” in 2045 or somewhere over the rainbow? This session will focus on the effect of technology advancements on measurement systems and the resulting economic challenges.

Session 1E: Quality Management Track
Understanding and Implementing ISO/IEC 17025:2005
Bob Mehta
Adjunct Faculty at California State University Dominguez Hills

Medical device industry, pharmaceutical, dietary supplement, and aerospace industries all have reliance on testing and calibration. The prudent path is to select and to qualify calibration laboratories that are ISO/IEC 17025 accredited.

Session 2A: BioPharma Track
Best Lessons Learned from FDA Warning Letters
Walter Nowocin
Medtronic

This session will review examples of FDA warning letters from the past twelve months. Best practices will be discussed to help eliminate these findings from the FDA website search tools.
**Session 2B: Aerospace Track**

**Intelligent RF Measurement Systems**  
Nghiem Van Nguyen PhD  
Raytheon Space and Airborne Systems

An Intelligent Automated RF Measurement System has been developed under Microsoft Word - Excel Macro. It is intended to present a unique innovation and to assist Metrology Engineering to understand RF automated calibration test equipment.

**Session 2C: Laboratory Track**

**An Enterprise View of Metrology Software Systems**  
Michael Swartz  
CalLab Solutions

Software running on a single computer of platform is obsolete. Today’s metrology software needs to be scalable, flexible, and dynamic. This paper outlines software architecturally designed around metrology systems, along with interchangeable standards, measurement uncertainties, and system integration.

**Session 2D: Emerging Trends and Technologies Track**

**Product Manufacturing, Quality, Reliability Initiatives to Maintain a Competitive Advantage in the Semi-Conductor Industry**  
Greg Capps  
International Rectifier

Integrated circuit (IC) semiconductor manufacturers and their customers must work together to assure quality, cost, and schedule while simultaneously alleviating the problems of electrical over-stress (OS) and re-test okay (RTOK).

**Session 2E: Quality Management Track**

**Calibration Quality Improvement**  
Mark Kuster  
B&W Technical Solutions

Test and calibration laboratories at every level depend on cost-effective, innovative, quality measurements for competitive advantage, budget limitations, or requirements compliance. This paper details four cost reducing quality improvements.

**Session 3A: BioPharma Track**

**USP National Formulary: Implementation of New general Chapter 41 and General Information Chapter 1251**  
Ian Ciesniewski  
Mettler Toledo

New general Chapter 41/1251 have not been published. During the session, we will discuss all relevant issues, show how to calculate the required metrics, and discuss implementation and impact.

**Session 3B: Aerospace Track**

**Qualifying a High temperature Cavity Furnace as a Radiation Thermometry Calibration Source**  
Tom Kolat  
Fluke Corporation

The paper presentation discusses operating blocks of a typical High Temperature cavity Furnace (HTCV) usage in high temperature radiation thermometry, including key performance parameters and corresponding performance tests.
Session 3C: Laboratory Track
Lean Thinking in the Laboratory
Jerry VerDuft
Adjunct Faculty at California State University Dominguez Hills

The pitfalls (waste) of a traditional laboratory setting; application of lean elements to the laboratory and an evaluation scheme for reviewing your laboratory’s leanness.

Session 3D: Emerging Trends and Technologies Track
Lock Out / Tag Out
Jo Ann Hrudio
CSUDH OSHA Training Center

This session covers the recognition of positional energy controls hazards. Focus is on equipment Lockout/Tagout (LOTO) while machinery is not in operation.

Session 3E: Quality Management Track
The Use of Best Practice Tools for Cost and Cycle Time Reduction and Quality and Process Improvement
Vern Goodwalt
Adjunct Faculty at University of California Riverside

This session will identify the best practice approaches and tools for cost, cycle time reduction, quality, and process improvement. Best practice application of tools supporting lean, effective quality and process management will be examined.

Session 4A: BioPharma Track
Metrology and Calibration in the Human Life Sciences Industry in the Year 2020
Cesar (Jun) Bautista Jr.
Genzyme

This extended session will focus on future trends within the Life Sciences Industry that will revolutionize metrology as a science including industry trends to outsource metrology and calibrations.

Session 4B: Aerospace Track
Risk Management for Aerospace
Dr. Catherine Martin
Raytheon Company

This presentation describes the process for auditing the calibration system to control the accuracy of Inspection, Measurement, and Test Equipment, including Special Test Equipment (STE) used to ensure the compliance of product and service with requirements. Methods and techniques to conduct periodic audits of the calibration facilities to verify compliance to standards will be discussed. A risk-based audit support tool provides an objective method for risk-based audit scheduling of the calibration system. Additionally, the ISO 9000:2008/AS9100C Quality Management Systems—Requirements for Aviation, Space and Defense standard govern the aerospace industry. A key change in AS9100C Standard is the new requirement to implement a risk management approach: responsibility, criteria, mitigation and acceptance.

Session 4C: Laboratory Track
Hoshi Kanri: Strategic Planning and Execution for Laboratory Quality Management Systems
Jd Marheiko
VP Quality and Lean, Accuride Corporation

An interactive session where participants learn how to effectively transform business strategies into tactical Quality Management System actions. Participants will create a working sample relevant to their unique business environment.
Leaders need to focus on change processes and mechanisms. Proactive measures are needed to prepare people and processes for both sustainability of current activities and preparation for large-scale organizational changes.

Session 4E: Quality Management Track
Need for Skilled Metrology and Quality Professionals
Director of Human Resources
Raytheon Space and Airborne Systems

Presentation is designed for developing of an awareness of the need and importance of metrology and quality in manufacturing at the high school and early college level.

Conducting humidity measurements in the field introduces a variety of obstacles. Temperature equilibrium and chemical interference of the measurement can be mitigated by using technologically advanced sensors and specialized software, instruments can revert back to original conditions.

Session 5B: Aerospace Track
Game-Changing Space Instrumentation: Control health management and remedy systems
Sarkis Barkhoudarian
Independent Consultant

Apply novel space non-intrusive and remote instrumentation, control, condition management and remedial technologies to industrial and power plants: Significantly improve safety, life and efficiency, reducing maintenance, breakdowns, carbon output, and de-rating.

Session 5C: Laboratory Track
Thermal Mass Flow Conversion Factors
Jim Chiun Wang, PhD
Care Fusion Inc

Thermal mass flow meters and controllers are used for the measurement and control of the delivery of process gases during the fabrication of MEMS and semi-conductor devices. The paper examines the gas conversion factor related issues.

Session 5D: Emerging Trends and Technologies Track
Metrology in Additive Manufacturing
John Slotwinski
National Institute of Standards and Technology

Session 5E: Quality Management Track
Application of Lean and Six Sigma Tools for Information Process Management
Ron Starzinski
Borrego Community Health Foundation

This session explores a Quality approach to the measurement of information processes. The utilization of Lean and Six Sigma tools provides a platform to measure critical information services as data base management and configuration management.
**Session 6A: BioPharma Track**  
*Study of Cell Membranes and Critical membrane Proteins*  
*Shiv Acharya and Tyler Smith*  
*UCLA Graduate Program*  

Cell membranes and critical membrane proteins used in medical applications responsible for critical physiological functions require advanced measuring technologies limited by current technologies. This presentation will examine alternative measuring techniques to address this need.

**Session 6B: Aerospace Track**  
*Microwaving in the Future*  
*Ron Ginley*  
*National Institute of Standards and Technology*  

The current life cycle of a new cell phone is less than six months. What does the mean for the future of microwave measurements? This paper examines the trends and future potential of microwave measurement.

**Session 6C: Laboratory Track**  
*Auto-verification: A potential tool to improve analytical laboratory processes*  

**Session 6D: Emerging Trends and Technologies Track**  
*Training German Armed Forces Calibration Technicians*  
*Gerhard Mihm*  
*Technical Center for Information Technology and Training*  

German armed forces set up their own syllabus for training calibration technicians. The training provides not only the essential information for understanding the importance for doing calibration, but also sets up a baseline for calibration technicians.

**Session 6E: Quality Management Track**  
*Preparing for Metrology Audits*  
*Nat Russo*  
*Raytheon Space and Airborne Systems*  

Preparing for audits with various requirements may seem overwhelming, but it is not frightening with an organized plan and proper preparations. We will examine how a motivated attitude and well documented processes will allow an audit to improve your performance and prepare you to excel towards future growth.

**Session 7A: BioPharma Track**  
*Mitigating Risk in the FDA Approval Process*  

**Session 7B: Aerospace Track**  
*TBD*  

**Session 7C: Laboratory Track**  
*Calibrating a UUT on a remote computer using MetCal*  
*Michael Swartz*  
*CalLab Solutions*  

Future test equipment will be modular and coupled with a computer’s operating system. This paper will show how a Fluke MET/CAL® procedure can be written integrating Metrology.NET® to remotely calibrate a UUT connected to a remote computer.

**Session 7D: Emerging Trends and Technologies Track**  
*GHS HAZCOM Workshop*  
*Frank Pedraza*  
*CSUDH OSHA Training Center*  

The workshop will provide information to enable employers to implement all of the elements of the standard and provide a sample written HAZCOM program.
**Session 7E: Quality Management Track**

**ASQ Certification and its Competitive Advantage on Innovation in Quality and Metrology**

*Dilip Shah*
*EMC3 Solutions*

ASQ certified professionals have worldwide recognition for subject matter expertise. What impact does it have on an employer that hires an ASQ certified metrology professional? What are financial benefits and technological benefits gained from hiring certified individuals?

**Session 8A: BioPharma Track**

**High Performance Liquid Chromatography – Best Practices**

*Nick Jones*
*Pharmaceutical Calibration and Instrumentation (PCI) Inc*

This presentation provides best practices and trade tools for high performance liquid chromatography (HPLC). We will discuss best practices for instrument operation, maintenance, troubleshooting, and instrument productivity tools.

**Session 8B: Aerospace Track**

**Automated System for 2D and 3D Airspeed Calibration**

*Losif Shinder*
*National Institute of Standards and Technology*

The measurement of gas flows in or around objects requires calibrated 3D airspeed probes. NIST designed an automated rig to calibrate airspeed probes for measuring airspeed vectors in low-turbulence flows. This presentation addresses calibrations in turbulent flows.

**Session 8C: Laboratory Track**

**Real Gas Corrections for High Beta Ration Critical Flow Venturi**

*Aaron Johnson*
*National Institute of Standards and Technology*

Real gas corrections in critical flow venturi gas flow meters have been made using a single parameter, the critical flow factor. This session presents real gas corrections for Beta up to 0.6 in several gases.

**Session 8D: Emerging Trends and Technologies Track**

**Facilitating the Future Technicians of Nanotechnology**

*Megan Crail*
*San Bernardino Community College*

The Applied Technology Training Center (ATTC) facilitates the necessary courses and equipment needed for training technicians in Nanotechnology. The technical skills taught, provide incumbent workers the hands-on experience and on-the-job training needed for the booming Nanotechnology field.

**Session 8E: Quality Management Track**

**Critical Chair: Measuring, Monitoring, and Minimizing waste and variation in a Knowledge Environment**

*Gary Miller*
*Raytheon Technical Services*

The problem of determining a consensus mean and its uncertainty from the results of multiple measurement methods or laboratories is an important NIST problem. Many solutions, both Bayesian and non-Bayesian, have been proposed over the years. In a Bayesian analysis, the consensus mean is specified through probabilistic dependency as either a “parent” or a “child” of the method means. In this paper, we propose a unified approach to some of these Bayes solutions by specifying the consensus mean as a measurable function of the method means and some ancillary variable. This Measurement Equation Approach is the standard approach used by the ISO Guide to the Expression of Uncertainty in Measurement (ISO GUM). When the measurement equation is linear in the ancillary variable, the uncertainty of our Bayes estimator has a decomposition that is ISO GUM compliant. We will also examine desirable criteria for an objective performance comparison of the solutions to this problem and use them to compare the existing solutions.

the critical flow venturis that exhibits this oddity has been performed.
The 2014 MSC will host the following NIST Seminars. Unless otherwise noted, all Seminars are two full days long and will begin at 8:00am on Monday, March 10, 2014 and end at 5:00pm on Tuesday, March 11, 2014. Three-day Seminars will end on Wednesday, March 12, 2014.

For any questions please contact:
Gregory Strouse, gregory.strouse@nist.gov, 301 975 4803
Christina Dawn Cross, christina.cross@nist.gov, 301-975-4822
Emil Hazarian, ehazar@att.net, 213-392-2495

N01: Selection, Calibration, and Use of Contact Thermometers - 3 days
Presenters: Dawn Cross, Michal Chojnacky, Karen Garrity
NIST, Process Measurements Division

In this seminar, we will discuss contact thermometers commonly used in industry for applications that use platinum resistance thermometers, thermistors, thermocouples, and liquid-in-glass thermometers. Lecture topics covered will include:

- Thermometer overview of each type, characteristics, and expected uncertainties;
- Selecting a thermometer for a specific application;
- Creating a calibration uncertainty budget and a temperature measurement uncertainty budget,
- Selecting and using alternative digital thermometers (e.g. replacing mercury thermometers);
- Digital thermometers for cold chain monitoring of vaccines;
- Calibration techniques and measurement validation methods,
- Alternatives to traditional calendar recall dates for recalibration,
- Statistical process control and maintaining traceability to NIST;
- The step-by-step development of a Scope of Accreditation (e.g. uncertainty budgets) for different temperature calibration services,
- An assessor’s point of view during an on-site technical assessment, and
- Proficiency tests for achieving accreditation.

Laboratory session will include:

- Using digital thermometers
- Using an ice melting to check the calibration status of your thermometer
- Determining the uncertainty of a dry-well block calibrator
- Exploring the measurement differences and uncertainties between alternative thermometers

For additional technical information, contact:
Dawn Cross, dawn.cross@nist.gov, 301-975-4822
Michal Chojnacky, michal.chojnacky@nist.gov, 301-975-4821
Karen Garrity, karen.garrity@nist.gov, 301-975-4818

N02: NIST Pressure and Vacuum Measurement - 2 days
Presenters: Jay Hendricks and Douglas Olson,
NIST, Thermodynamic Metrology Group

A making good pressure measurement from ultra-high vacuum to atmospheric pressure and higher requires the correct use of many kinds of gauges and proper use of vacuum technology. Among the most widely used gauges are ionization gauges, spinning rotor gauges, thermal conductivity gauges, capacitance diaphragm gauges, quartz bourdon tube gauges, and resonant silicon gauges. However, the incorrect use of any of these gauges can result in bad measurements that cost time and money. This two-day course will cover the fundamentals of pressure measurements from 10^-8 Pa to 10^-6 Pa (10^-10 torr to 10^-8 torr), focusing on the selection and proper use of appropriate gauging technology for a given application. A survey of calibration techniques will be presented along with recommendations for obtaining best performance. Part of the class time will be devoted to set-up of a simple vacuum calibration system. This will enable live demonstration of some of the gauges discussed in the course, and give students an opportunity to participate in the vacuum system set-up and disassembly.

New for this year is a section devoted to the use of piston gauges as the reference standard. We will also bring back the popular overview of good vacuum system design and construction using off-the-shelf vacuum equipment and fittings. Basic vacuum
system design do's and don'ts will be covered. Pumping systems, sealing systems, valves, and vacuum plumbing solutions will be briefly covered. For pressures substantially higher than atmosphere, proper selection and operation of piston gauges for gas and oil calibrations will be covered. Attendees are invited to share their own pressure measurement and or vacuum system design problems for in-class discussion.

For further information, contact:
Jay Hendricks, jay.hendricks@nist.gov, 301-975-4836
Douglas Olson, douglas.olson@nist.gov, 301-975-2956

N03: Flow Measurement and Uncertainties - 2 days
Presenters: Aaron Johnson, John Wright
Fluid Metrology Group, NIST, Gaithersburg, MD 20899

We will cover background metrology and fluid mechanics subjects that are important for flow measurement including:
- the transition from laminar to turbulent flow
- pipe flow profiles and boundary layer concepts
- the continuity equation and conservation of mass
- fluid and gas properties and their calculation
- Pressure and temperature measurement

The operating principles and equation of flow for the commonly used flow measurement techniques will be derived and explained including:
- Differential pressure devices (laminar flow meters, orifice plates, venturi tubes)
- Critical flow venturis and nozzles
- Ultrasonic flow meters
- Turbine and positive displacement meters
- Electromagnetic flow meters
- Coriolis flow meters
- Thermal meters
- Rotameters

Methods of flow meter calibration used in laboratory, including NIST standards will be covered. Field conditions will be discussed as well as installation effects and how distorted velocity profiles affect flowmeter accuracy.
Flow calculations and uncertainty analyses for certain flow meter types will be taught. Our goal is cover topics with a range of physics and mathematical difficulty so that the course will be of interest to students with a wide range of mathematical backgrounds and flowmeter experience. Distributed throughout the course, there will be optional, advanced sections of interest to only extreme flow geeks.

For further information, contact:
Aaron Johnson, aaron.johnson@nist.gov, 301-975-5954
John Wright, john.wright@nist.gov, 301-975-5937

N04: Train the Trainer: Designing Training for High Performance - 2 days
Presenters: Georgia Harris, Vernon Alt, Jr.
1Office of Weights and Measures, NIST, Gaithersburg, MD 20899
2Northrop Grumman Corporation, Baltimore, MD, 21090

Taking subject matter experts (SME) and simply assigning them to a training function is a common strategy when implementing training. Most SMEs in the measurement sciences are good measurement professionals but don’t necessarily have an educational background. Ongoing professional development of our SMEs in the area of adult educational concepts and methods is critical for 1) designing and implementing effective training; and 2) having an adequate number of trainers or metrologists with training skills to develop the next generation of metrology professionals. This two-day tutorial will cover some essential training design concepts and provide an opportunity to practice what is learned.

Intended Audience: training designers and presenters
Pre-work: identify a specific class or module you would like to create or update (think about a 30 min presentation or a 1 to 2 hour webinar, or a 4 hour tutorial)
Bring: electronic resources from your class/module along with a laptop for you to work on during the session
Learning Objectives:

At the end of this two day session, using notes and provided resources, participants will be able to:

• Describe educational models and concepts (e.g., ADDIE model, Bloom’s Taxonomy, Teaching Styles, Adult Learning Methods, Partnership Model, Job Task Analysis);

• Analyze performance and learning objectives;

• Write clear and effective learning objectives, analyze learning objectives for others;

• Identify and select suitable openers, closers, and other learning activities, create and demonstrate a learning activity, and provide feedback on others’ activities; and

• Identify applicable methods to assess student learning during the training event.

NOTE: This class is a repeat of the 2012 Train the Trainer tutorial.

For further information, contact:
Georgia Harris, georgia.harris@nist.gov, 301-975-4014
Vernon Alt, Jr., vernon.alt@ngc.com, 410-765-3293

N05: The ISO/IEC 17025 Accreditation Process – 2 days
Presenters: Dana Leaman, NVLAP, Kari Harper, NVLAP
NVLAP, NIST, Gaithersburg, MD 20899

This two-day interactive seminar will help laboratories prepare for and understand the accreditation process whether the laboratory is new to accreditation or in the renewal process. It’s ideal as an orientation for new staff, quality managers, or as a refresher to update your knowledge of the Standard and the process. An overview of the requirements of the Standard will be provided with examples drawn from the NVLAP Accreditation process. Particular emphasis will be placed on Internal Audit and Management Review, Proficiency Testing, presenting measurement uncertainties and reporting them ensuring the metrological traceability of your calibrations and the complaint/corrective action process. We will present several important ILAC documents with respect to Proficiency Testing (ILAC P9), Metrological Traceability (ILAC P10) and Reporting Measurement Uncertainty (ILAC P14). We will provide an overview of the on-site assessment process, how they are conducted and by whom. We will also describe how NVLAP and other Accrediting Bodies become signatory to and maintain their status with respect to the International Laboratory Accreditation Cooperation (ILAC) Mutual Recognition Arrangement and what it means to your lab. The schedule allows for extended discussions of those topics of particular interest to the participants.

Intended Audience: Technical and Quality personnel from accredited laboratories as a refresher, those who are seeking accreditation, or those investigating the process.

Materials will be provided. A laptop may be helpful.

Learning Objectives: At the end of the two day seminar, using notes and provided resources, participants will be able to

• Analyze the adequacy of a documented management system and technical procedure to fulfill the requirements of the ISO/IEC 17025.

• Differentiate between an Internal Audit, a Management Review, and an on-site assessment as performed by an Accrediting Body.

• Identify evidence of metrological traceability.

• Identify proper use of the Accrediting Body Mark in terms of NVLAP and international accreditation policies.

For additional technical information, please contact:
Dana Leaman, dana.leaman@nist.gov, 301-975-4679
Kari Harper, kari.harper@nist.gov, 301-975-6612

N06: Hands-on Workshop on Assessing and Reporting Measurement Uncertainty – 3 days
Presenters: William Guthrie, NIST, Statistical Group
Hung-Kung Liu, NIST, Statistical Group

This short course covers many aspects of the propagation of uncertainty using the methods outlined in the JCGM Guide to the Expression of Uncertainty in Measurement. Exercises and hands-on applications will use functions for uncertainty analysis from the free software package, metRology, written for the open-source R statistical computing environment. The functions will be accessed via an Excel graphical user interface that is available as a free add-in. This short course is being given as part of the 2014 Measurement Science Conference.

For additional technical information, please contact:
William Guthrie, William.guthrie@nist.gov, 301-975-2854
Hung-Kung Liu, hung-kung.liu@nist.gov, 301-975-2718
There are a large number of books on dimensional metrology. Nearly all of them are at the beginner level and focus on how to use the instruments for inspection. Core concepts like thermal expansion, elastic deformation, stability, refractive index of air, closure and reversal methods, deterministic metrology, comparator principle and the use of check standards are generally ignored. This tutorial will be an overview of some of these important techniques and concepts not covered in books and classes. Each concept will be presented with examples of how the techniques make measurements more accurate, and in some cases, more efficient.

For additional technical information, please contact:
Ted Doiron, doiron@nist.gov, 301-975-3472

See Web Site for latest Details
www.msc-conf.com
The 2014 MSC will host the following Tutorial Workshops. Tutorial Workshops are either full day or half day, offered same day in the morning and afternoon or only in the morning or afternoon. Tutorial Workshops will begin on Tuesday, March 11, 2014 and end on Wednesday, March 12, 2014.

An ASQ/CCT two days training is offered Monday and Tuesday, March 10-11, 2014, followed by exam on Wednesday, March 12, 2014.

For any questions contact
Emil Hazarian,
Chairman NIST Seminars & Tutorial Workshops
ehazar@att.net

MONDAY, MARCH 10, 2014

Preparation for ASQ Certified Calibration Technician Exam Refresher Workshop-Part 1 (Full day)
Author/Presenter: Dilip Shah
Courtesy of: E = mc3 Solutions

Abstract: ASQ certifications have had a history of recognition for over 35 years and they are recognized and endorsed internationally by major corporations. The ASQ Certified Calibration Technician Exam was first offered in 2003 and shall approach its eleventh anniversary in 2014 with over 1000 candidates passing the exam. For the year 2014, the MSC is offering a refresher workshop (March 10-11) in conjunction with the administration of the CCT Exam (March 12). The refresher workshop shall prepare the CCT candidate for a final practice round of exam questions, exam taking techniques and any other concerns.

Important Note:
The prospective candidate has to apply and pay separately for taking the exam. Apply for the exam here:
http://prdweb.asq.org/certification/control/calibration-technician/apply

PLEASE NOTE THAT EXAM APLICATION DEADLINE IS FEBRUARY 10, 2014.
THERE ARE NO EXCEPTIONS FOR LATE APPLICATIONS!

There are pre-requisites for taking the exam.
MSC does not administer the CCT exam. ASQ administers the exam in facilities provided by MSC at Long Beach Convention Center, Long Beach, California. Check the MSC and ASQ web sites for any further updates on the workshop. Please bring a non-programmable scientific calculator to the workshop.

ASQ shall also administer the CCT exam only on March 21 at Long Beach Convention Center, Long Beach, California. Please leave cellular devices in your car or somewhere safe. Cellular Devices are not permitted during the Exam Administration For those candidates planning to take the exam, here are a few tips offered:

• The exams are open book.
• Bring a good scientific calculator (TI-30, TI-36) that you are familiar with using. There is no time to learn how to calculate standard deviation or other functions during the exam. We will go over the refresher with it if you have the calculator. Ensure the calculator has fresh batteries or bring a spare calculator just in case. If the lighting in the exam room is not enough, the solar powered ones may not function well. Programmable calculators are not allowed.
• The Metrology Handbook by ASQ Quality Press. An absolute must if you cannot bring any other reference books. The Measurement Quality Division of ASQ sponsored the writing of this book to be a sort of concise reference for the CCT exam and to have on the metrologist’s desk for future reference.
• NIST SP811, NIST 330, NIST 1297 - bring printed copies of them. You are not allowed to have a computer during the exam. You can download these from http://physics.nist.gov/Pubs/.
• Bring Post-it notes to mark the pages of the books. It makes it easy to reference the pages during the exam.
• Good No. 2 pencils and even better erasers in case you decide to change your answer.
• Scratch paper.
• Copy of ISO 17025, ANSI/Z 540.1, ISO 9001 and ISO Guide 99:2007 if you have them.
• Create a “cheat sheet” of formulas from the scratch paper so you have easy access to them during the exam without flipping through the books. We will also ask you to make one during the workshop.
• Hard copies of any NCSLI RP or RISPs are good references to have, but not absolutely necessary www.ncsli.org/publications/index.cfm
• A good first year college Physics book and any other reference you feel will help. The CCT Body of Knowledge is listed at: www.asq.org/certification/calibration-technician/bok.html

• You will be provided the CCT Primer by Quality Council of Indiana during the workshop. But, if you want to practice test questions from it earlier (I recommend highly), buy the solutions manual from Quality Council of Indiana earlier (http://www.qualitycouncil.com/cct_p.asp). You will get a good idea of the logic behind the way the questions are asked and answered. You cannot take the solutions manual or sample questions from the CCT Primer during the exam.

For more information please contact
Dilip Shah at (330) 328-4400,
emc3solu@aol.com,
web site: www.emc3solutions.com

TUESDAY, MARCH 11, 2014

Preparation for ASQ Certified Calibration Technician Exam Refresher Workshop-Part 2 (Full Day continued)

Author/Presenter: Dilip Shah
Courtesy of: E = mc3 Solutions

T01 – (Full Day) - Good, Bad, or Indeterminate: Who Makes the Call?

AUTHOR: Jeff Gust, Fluke Corporation

Abstract: ILAC P14 requires calibration certificates to include measurement uncertainty that is applicable for each measurement. In addition, if a statement of compliance with specifications is made on the calibration certificate, the uncertainty of measurement must be taken into account when making the decision. This tutorial provides an overview of measurement uncertainty as it applies to addressing compliance with specifications and the requirements of ILAC P14. The tutorial also provides an introduction to measurement decision risk, providing an overview of the more commonly used techniques to evaluate risk, and reduce it to acceptable limits by guardbanding. The theory, associated probability of false accept and false reject risk, and the strengths and weaknesses of each guardbanding technique will be discussed. The concepts are presented in a format that is easily understandable to attendees with no background in measurement decision risk, but the information also provides detail and depth that benefits Metrologists experienced in measurement uncertainty and measurement decision risk. At the end of the tutorial, the attendee should have the knowledge about the best risk containment/guardbanding strategy to use for their organization in order to meet any metrological quality standard requested by their customers.

T02 - (Full Day) - Flow Metrology - Gas & Liquid and Viscosity Fundamentals. Hands-on

AUTHOR: Richard Fertell, Proteus Industries Inc.

Abstract: This full-day workshop is an overview of gas and liquid flow rate with associated measurement uncertainties and viscosity with hands-on units and experiments with flow technologies and viscometers. The flow demonstration systems will show the actual effects of flow cavitation, turbulence and viscosity on different flow meter technologies. The viscosity experiments will aid attendees in learning the difference between Newtonian and non-Newtonian fluids and rationale for the different methods of measuring viscosity. Learn the difference between and the application of volumetric versus mass flow rate measurement. Understand the influences and interactions of fluid viscosity, density, turbulence in flow, temperature, compressible and non-compressible fluids, and electro-magnetic interference on different flow sensing technologies as well as the operation principle of different gas & liquid flow rate measurement technologies. Explore flow calibration methods and techniques to achieve better sensor field performance for gas, LPG, water, liquid hydrocarbons, and silicone oils.
T03 - (Full Day- Part 1) - Building a Strong Foundation For Your Calibration Program So Your Company Will Have a Competitive Advantage Worldwide

AUTHOR: Dr. Jay L. Bucher, Bucherview Metrology Services, LLC

Abstract: The vast majority of calibration departments within the biotech, pharmaceutical, medical device, healthcare and life science community still state they are traceable to NIST. FDA inspectors still write up metrology departments for not being traceable to NIST, and this misconception is passed on through ignorance and the inability to read and understand what the regulations and standards actually require to be compliant with their documentation. That is all going to change when you attend this four hour course.

This tutorial will explain to the attendee what the regulations and standards actually say in both, regulatory form and plain English; show how to incorporate that information into their calibration records; and most importantly, provide the information needed to educate upper management and the auditor and/or inspector on the proper way to show traceability to the SI.

The learning objectives include:

• The definitions and links between traceability and calibration
• Designing your calibration records to “stand alone” with all the data needed for an audit or inspection
• The differences between calibration records and calibration certificates
• Debunking the myths about traceability to NIST and other calibration misconceptions
• Provide the attendees with the information needed to educate others about why all calibrations must be traceable to the SI

T03 - (Full Day- Part 2) - Two Ways To Have A Totally Paperless Calibration Record System

AUTHOR: Dr. Jay L. Bucher, Bucherview Metrology Services, LLC

Abstract: I’ve written numerous articles and given many presentations on why a metrology or calibration department should go paperless with your calibration records. After the presentations, I always ask why the attendees have not tried, or started a paperless program. The most prevalent answer is...”We don’t want to get written up during an audit.”

That sounds about as logical as not driving a car because you’re afraid of getting a ticket. If everyone follows the law concerning your speed, parking, drinking and driving, and not causing accidents; then you don’t have to worry about getting a ticket. The same can be said about going paperless. The FDA’s quality system regulation (QSR) and ISO standards have their guidelines and regulations. When they are followed, there usually are no problems. After attending this tutorial, the reasons for not going paperless will have been greatly reduced or eliminated.

This tutorial will cover how to use MS Word to design your calibration forms; and Adobe Acrobat Professional 9.0 and Nuance PDF Converter Professional 8 to create your own electronic forms. Attendees will get Lessons Learned about formatting, field placement, editing finished forms and protecting both the form that you use and the data recorded from modification and tampering. One software package usually costs between $250.00 and $450.00. The other is less than $50.00.

The learning objectives include:

• Designing calibration records that fill your requirements
• Turning your Word documents into 21 CFR Part 11 compliant forms
• Learn how to build electronic forms using text fields and check boxes using either version of software
• Lessons learned on designing and implementing a totally paperless calibration record system

T04 - (Full Day) - Mass Metrology

AUTHOR: Ian Ciesniewski, Mettler-Toledo

Abstract: Mass Comparators: Optimal performance in the modern mass laboratory. Modern mass metrology is a sophisticated field. Whether working to fulfill internal or external customer requirements, there are many important aspects that need to be addressed when producing mass calibration results. The course is designed to cover a number of topics that will dovetail together, establishing a solid knowledge-base for mass metrology professionals to draw upon. The course will help to optimize the performance from their installed Comparators, helping to understand the external influences that may be constraining the uncertainties they can achieve.

During the course, consideration will be given to:

• Technical terms and background of mass comparison
• Requirements for mass labs
• Weighing methods
• Weighing influences
• Weighing process
• Air buoyancy and other influences

T05 - (Full Day) - 5S, Lean Thinking and Project Management for Metrology Laboratories
AUTHOR: Nat Russo, Raytheon, Space & Airborne Systems

Abstract: Many businesses are concerned about the growing cost of overhead services and calibration costs are always undergoing scrutiny. With cost of capital equipment, expense items and labor, metrology services are questioned as to their worth to the company. 5S, Lean Thinking and Project Management tools can help the metrology lab reduce cost, improve their efficiency and show the company that not only are their services valuable, but are performed with minimal cost.

In the workshop we will discuss how to recognize the need for change and address how your coworkers may perceive change. We will discuss how to manage and plan activities to engage people and make them part of the solution.

Using the 5S methodology created by Hiroyuki Hirano, we will show how to use various tools to demonstrate how Sort, Set in Order, Sweep, Standardize and Sustain will organize, order, clean, establish processes and maintain improvements.

After setting the foundation of 5S, techniques and tools in Lean Thinking will be use to evaluate processes using flow charts, value stream maps, Kaizen events and Poke Yoke.

Project Management will demonstrate the value of using schedules, work elements, budgets and metrics to monitor progress and report results to management.

Using these tools effectively will improve the operational efficiencies of a laboratory making a metrology laboratory an asset to the company instead of a perceived drain to the company.

T06 - (Full Day) - Laboratory Project Management
AUTHOR: Chester Franklin, Franklin Training Group

Abstract: This tutorial addresses the functional disciplines required to design, develop, test, produce, and support the planned result of any project undertaken by any laboratory, regardless of size. It covers the five Process Groups and the nine Knowledge Areas identified in A Guide to the Project Management Body of Knowledge (PMBOK®), fourth edition. The PMBOK defines a project as, “a temporary endeavor undertaken to create a unique product, service, or result”. It should be noted that neither budget size nor time period are a part of that definition. Neither does it define the product or result. The temporary nature of projects indicates a definite beginning and end and this tutorial will describe the process tools to be applied from the beginning to the end. The project Planning Phase includes an introduction to the risk management tool, Failure Mode and Effects Analysis (FMEA). The tracking and monitoring process includes an introduction to the Earned Value Management System (EVMS). Additionally there is a section on Systems Engineering, a technical management process used to evaluate, manage, and control the technical aspects of a project.

Workshop Objective: Upon completion of this tutorial, attendees will know and understand: project life cycle, the management tools for planning and executing a laboratory project of any size, and the process for tracking progress to ensure that their project remains on schedule and within budget. Additionally, attendees will know and understand five project management process groups and nine process Knowledge Areas.

This tutorial workshop will provide the participants with the necessary management tools for planning and executing laboratory projects of any size, and tracking progress to ensure that projects remain on time and within budget throughout their lifecycle.

Upon completion the participants will understand:
• Project Life Cycle
• Organizational influences on Project Management
• The five Process Groups
• The nine Knowledge Areas
• The importance of developing and managing the laboratory project scope
• Risk Management, using the risk management tool, Failure Mode, Effects & Critically Analysis (FMECA).
• The Earned Value Management System (EVMS)
• Systems Engineering Management
T07 - (Full Day) - Elements of Measurement Techniques, Part II Intermediate Metrology

AUTHOR: Emil Hazarian, Prof. Dipl. Engineer, Metrology Advancements

Abstract: Continuing the three part series, this Intermediate Metrology workshop will address some of the metrology topics of large interest such as metrological characteristics of measuring instruments, including measurement uncertainty, specifications of measuring instruments, reporting the results, compliance decision, proficiency testing, and more, applied for both calibration and testing operations. Working examples will facilitate the understanding of lectured topics.

This workshop is addressed to all metrology operators, technicians, engineers, managers, and can be considered stand alone or in conjunction with Part I Metrology for Beginners and Part III Advanced Metrology.

T10 TBA

WEDNESDAY, MARCH 12, 2014

T11 - (Full Day) - Measurement Uncertainty – Fundamental Applications

AUTHOR: Dilip Shah, E = mc3 Solutions

Abstract: Most calibration technicians have learnt the measurement uncertainty fundamentals from previous workshops presented at MSC. They have worked on generating the uncertainty budgets for their standards and for reporting on their laboratory Scope of Accreditation. Is this all there is to it? This workshop takes the next step of using measurement uncertainty data for the laboratory by showing how it can be used:

- For process improvement.
- Generating measurement uncertainty for the customer’s Unit Under Test.
- Ensuring that metrological traceability is maintained.
- Meeting ILAC P14 requirements.
- Meeting testing laboratory’s measurement uncertainty requirements.

Learning Objective for this workshop are:

- Understanding the Measurement Uncertainty Process.
- Developing and understanding statistical tools for analyzing and improving the measurement uncertainty process.
- Developing tools and methods for reporting customer’s measurement uncertainty per ILAC P14 guidelines.

This workshop is intended for laboratory managers and technicians who are involved in the daily laboratory operations. It is intended for both beginner and intermediate level of comprehension.

T12 - (1/2 Day AM/PM) - Dimensional: Micrometers and Calipers Calibration

AUTHOR: Roberto Benitez Chavez, Technological Institute for Metrology (I.T.M. – Instituto Tecnológico de Metrología)

AUTHOR: Roberto Benitez Jr., Technological Institute for Metrology (I.T.M. – Instituto Tecnológico de Metrología)

Abstract: This material covers the basic calibration instructions for micrometers and calipers used to measure internal, external and depth dimensions. The issue covered includes the calibration and verification methods and how to generate an uncertainty budget for a measurement, taking in account the temperature effects. With all the information of this course, the generation of a Calibration Certificate can be made. In this course the student has the opportunity to know the general care and how to use the instruments.

T13 - (1/2 Day AM/PM) - Flow Detailed Measurement Uncertainty Analysis

AUTHOR: Richard Fertell, Proteus Industries Inc

Abstract: Determining uncertainty of two to four technologies with review of fundamental equations for selected technologies, such as Coriolis Mass Flow, Turbine Meters with Roshko & Strouhal Coefficients, Calibration Weigh Standard.

T14 - (1/2 Day AM/PM) - Radiation Thermometry Fundamentals

AUTHOR: Frank Liebmann, Fluke Calibration

Abstract: This tutorial is an overview of radiation and infrared thermometry. It teaches the attendee information to use and calibrate
these instruments. The tutorial consists of both classroom lectures and hands-on demonstrations. The ratio of lecture to hands-on is roughly two to one. The lectures cover basics of radiation temperature measurement, uncertainty budgets, radiation thermometry standards, and infrared thermometry calibration. The hands-on portion reinforces the topics covered in the lecture giving the user practical experience to include the calibration of an infrared thermometer. The attendee will be provided with a spreadsheet to facilitate the computation of uncertainty for this calibration. The type of radiation thermometer covered in this presentation is an infrared thermometer with a thermopile detector and an 8 – 14 µm bandwidth. However, the principals taught are applicable to other classifications of radiation thermometers to include radiation thermometers with pyroelectric detectors and thermal imagers. The tutorial is geared to those who are new to radiation thermometer metrology, those who need a refresher on the subject, and to those who would like to make better measurements.

**T15 - (1/2 Day AM/PM) - Basics of Humidity**

**AUTHORS:** Michael Boetzkes, Vaisala, Inc.
Yumi Alanoly, Vaisala, Inc.

**Abstract:** This tutorial workshop will present the following topics:

1. Fundamental concepts of water vapor physics
   a. What is water vapor?
   b. Behavior of water vapor
      i. Saturation vapor pressure
      ii. Ideal gas law
      iii. Dalton’s law
      iv. The role of temperature
   c. Common units to express water vapor quantities
      i. Partial pressure of water vapor
      ii. Relative humidity
      iii. Dewpoint
      iv. Rationale for selecting units
   d. Real life concerns
      i. How temperature gradients affect relative humidity
      ii. Pressure dewpoint or atmospheric dewpoint?

2. Measuring water vapor
   a. Different technologies and sensors
      i. Wet wool
      ii. Hair hygrometer
      iii. Sling psychrometer
      iv. Capacitive sensors
      v. Resistive sensors
      vi. Condensation hygrometers
      vii. Cavity ring down hygrometers
   b. Rationale for selecting technologies and sensors

3. Calibration of hygrometers
   a. Methods for creating known humidity environments
      i. Fundamental generators
      ii. Mixing wet and dry
      iii. Saturated salt solutions
   b. Accuracy with uncertainty taken into account
   c. Common pitfalls of humidity calibration

**T16 - (1/2 Day AM/PM) - RF/Microwave Measurement Basics**

**AUTHOR:** Ronald Ginley, NIST - Electromagnetics Division – RF Electronics Group

**Abstract:** This session will give an introduction to measurement concepts for microwave power and scattering-parameters. Specific topics include transmission line theory, practical handling or the do’s and don’ts for transmission lines and microwave connectors, Vector Network Analyzer calibration/measurements and real world sources of uncertainties, microwave power detectors types,
power measurements and uncertainties, and the session will conclude with a discussion of verification techniques centered on VNA measurements, but are applicable to other areas as well.

T17 - (1/2 Day AM/PM) - Essential DC and Low Frequency Metrology for Calibration Personnel

**AUTHOR:** Jesse Morse, Morse Metrology

**Abstract:** It is typical today that people involved with calibrating general measurement and test equipment (M&TE) have not had formal metrological training such as US Air Force PMEL. This tutorial is based on the assessment of needs gleaned from ten years of teaching metrology to people new and experienced in the field without such training. It presents background knowledge and philosophy needed for a person to understand what is really going on when they follow a prepared calibration procedure, and “why” it is so important not to deviate. People attending this course will gain knowledge about how to handle mathematics performed according to the International System of Measurement (SI), understand how measurement traceability works and how easily an untrained person may innocently break the chain, and know the perils of not using correct cables and connections when connecting instruments together. They will learn how to correctly calculate measurement uncertainty at any point on a range using a manufacturer’s specification, and they will develop a practical knowledge relating to how interactions of standards with units under test affect measurements.

**Workshop Outline:**
1. A Brief Overview of Metrology
2. A Review of Common Metrological Terms
3. What is Traceability and How It Works
4. Mathematics According To the International System of Measurement
5. An Overview of Measurement Uncertainty
6. Figuring Out Uncertainty from Manufacturer’s Specifications
7. Cabling, Connections, and Interactions Effect on Traceability
8. Principles of DMM Calibration
The Measurement Science Conference (MSC) has an established fund to grant scholarships of up to $2,000 to students in an Engineering, Science, or Quality Assurance degree program. The scholarship prize also includes admission to the 2014 Measurement Science Conference exhibit hall, the MSC luncheon, and any technical programs offered on Friday, March 14, 2014. Attendance at the conference provides a valuable opportunity for students to learn about and experience being in a professional environment and to begin forming their professional network. The scholarship program places emphasis on experience or accomplishments related to the application or advancement of measurement science and technology.

Please apply online at: http://msc-conf.com/contests/scholarships/

The Woodington Award is intended to honor those individuals who personify the highest level of Professionalism and Dedication to the Metrology Community. Do you know such an individual? Someone who consistently demonstrates dedication, unquestioned competence, and commitment? Has this individual demonstrated noteworthy Professional achievements that have warranted national and/or international recognition?

The Woodington Award, since its inception in 1978, has been an annual award under the aegis of the Measurement Science Conference. It is awarded by the Conference to recognize a member of the Measurement Community who represents the highest level of professionalism and dedication to the Metrology Profession. Candidates for the Woodington Award shall have exhibited noteworthy professional achievement in the Metrology Profession.

Send recommendations by using the Recommendations form at:

http://msc-conf.com/contests/woodington-awards/

The conference will end on Friday afternoon with a drawing for Door Prizes. All attendees are welcome to participate with a very good chance of winning a prize.

The door prize activity is supported by our Exhibitors, Sponsors, Friends and the MSC Committee.
## MSC 2014 EXHIBITORS

<table>
<thead>
<tr>
<th>COMPANY</th>
<th>WEBSITE</th>
</tr>
</thead>
<tbody>
<tr>
<td>A.K.O. Inc.</td>
<td><a href="http://www.accurateinstrument.com">www.accurateinstrument.com</a></td>
</tr>
<tr>
<td>Accurate Instrument Repair</td>
<td><a href="http://www.accurateinstrument.com">www.accurateinstrument.com</a></td>
</tr>
<tr>
<td>Additel</td>
<td><a href="http://www.additel.com">www.additel.com</a></td>
</tr>
<tr>
<td>Agilent Technologies</td>
<td><a href="http://www.agilent.com">www.agilent.com</a></td>
</tr>
<tr>
<td>Ashcroft</td>
<td><a href="http://www.ashcroft.com">www.ashcroft.com</a></td>
</tr>
<tr>
<td>Asset Smart</td>
<td><a href="http://www.asset.com">www.asset.com</a></td>
</tr>
<tr>
<td>Crystal Engineering Now AMATEK</td>
<td><a href="http://www.crystalengineering.net">www.crystalengineering.net</a></td>
</tr>
<tr>
<td>Fluke</td>
<td><a href="http://www.fluke.com">www.fluke.com</a></td>
</tr>
<tr>
<td>GE Measurements &amp; Control</td>
<td><a href="http://www.ge.com">www.ge.com</a></td>
</tr>
<tr>
<td>Guildline Instruments</td>
<td><a href="http://www.guildline.com">www.guildline.com</a></td>
</tr>
<tr>
<td>King Nutronics</td>
<td><a href="http://www.king.com">www.king.com</a></td>
</tr>
<tr>
<td>Lighthouse</td>
<td><a href="http://www.lighthouse.com">www.lighthouse.com</a></td>
</tr>
<tr>
<td>Lockheed Martin</td>
<td><a href="http://www.lockheed.com">www.lockheed.com</a></td>
</tr>
<tr>
<td>Measurements International</td>
<td><a href="http://www.measurements.com">www.measurements.com</a></td>
</tr>
<tr>
<td>Mesa Labs</td>
<td><a href="http://www.mesa.com">www.mesa.com</a></td>
</tr>
<tr>
<td>Mettler Toledo</td>
<td><a href="http://www.mettler.com">www.mettler.com</a></td>
</tr>
<tr>
<td>MSC 2015</td>
<td><a href="http://www.msc.com">www.msc.com</a></td>
</tr>
<tr>
<td>NCSLI</td>
<td><a href="http://www.ncsli.org">www.ncsli.org</a></td>
</tr>
<tr>
<td>NIST</td>
<td><a href="http://www.nist.gov">www.nist.gov</a></td>
</tr>
<tr>
<td>Northrup Grumman</td>
<td><a href="http://www.northrupgrumman.com">www.northrupgrumman.com</a></td>
</tr>
<tr>
<td>NVLAP</td>
<td><a href="http://www.ts.nist.gov">www.ts.nist.gov</a></td>
</tr>
<tr>
<td>Ohm-Labs</td>
<td><a href="http://www.ohmlabs.com">www.ohmlabs.com</a></td>
</tr>
<tr>
<td>OPTO-CAL</td>
<td><a href="http://www.optocal.com">www.optocal.com</a></td>
</tr>
<tr>
<td>Pond Engineering</td>
<td><a href="http://www.pondengineering.com">www.pondengineering.com</a></td>
</tr>
<tr>
<td>Precision Environments</td>
<td><a href="http://www.precisionenvironmentsinc.com">www.precisionenvironmentsinc.com</a></td>
</tr>
<tr>
<td>Primary Stds. N. America</td>
<td><a href="http://www.primarystandards.com">www.primarystandards.com</a></td>
</tr>
<tr>
<td>RH Systems</td>
<td><a href="http://www.rhs.com">www.rhs.com</a></td>
</tr>
<tr>
<td>Thunder Scientific</td>
<td><a href="http://www.thunderscientific.com">www.thunderscientific.com</a></td>
</tr>
<tr>
<td>Tovey Engineering</td>
<td><a href="http://www.toveyengineering.com">www.toveyengineering.com</a></td>
</tr>
<tr>
<td>Trioptics</td>
<td><a href="http://www.trioptics.com">www.trioptics.com</a></td>
</tr>
<tr>
<td>Vaisala</td>
<td><a href="http://www.vaisala.com">www.vaisala.com</a></td>
</tr>
<tr>
<td>Workplace Training</td>
<td><a href="http://www.wptraining.com">www.wptraining.com</a></td>
</tr>
</tbody>
</table>

(Check the Website for a complete updated list)
MSC BOARD OF DIRECTORS

Chairman of the Board
Raul Troncoso
Amgen Inc.
rault@amgen.com

President
Miguel Cerezo
Amgen Inc.
mcerexo@amgen.com

Executive Vice President
Milt Krivokuca
CSUDH
Milt619@cox.net

Board Secretary
John Schulz
JCS Engineering
jcsgunner@aol.com

Board Treasurer
Alan Ho
The Boeing Company
alan.f.ho@boeing.com

Director, Speakers,
Fall Tutorials
Arman Hovakemian
arman.hovakemian@gmail.com

Director, Registration Lead
John Bowman
Wilmington Instruments
jtbfluke@msn.com

Director
Nidal Kerdiya
eDoc Publish, Inc.
nidalk@edocpublish.com

Conference Committee

Logistics
Rey Cheesman
reycheesman@rocketmail.com

Social Media
Chuck Ellis
National Association for Proficiency Testing / NAPT
ellis@proficiency.org

Sponsorships
Bob Everly
CSC
beverly@cscnorco.com

Scholarships
Mary Fishell
ATS
marykfish@gmail.com

Exhibits
Chet Franklin
Franklin Training Group
franklintraininggroup@gmail.com

Guest Programs
Sherill Franklin
Arbonne International
sherillfrnkln@aol.com

Technical Programs BioPhrma
Dennis Frazier
Amgen Inc.
dfrazier@amgen.com

Registration
Julie Ginesi
jhginesi@yahoo.com

Evaluations
Vern Goodwalt
The 3 Point Group
The3pointgroup@aol.com

Technical Programs NIST Seminars
Emil Hazarian
ehazar@att.net

Supporting Organizations
Bernice Holtsclaw
Parker Hannifin Corp.
Aerospace Group
bholtsclaw@parker.com

AV, Ancillary Meetings
Karen Jackson
AV, Ancillary Meetings
kvjackson58@gmail.com

Door Prizes & Exhibitor’s Raffle
Galen Liao
Northrhp Grumman
Aerospace Systems
galen.liao@ngc.com

Technical Programs Energy
Tim Mason
Edison ESI
Tim.mason@sce.com

Arrangements; Site Selection
Frank Mendoza
seaqngk@yahoo.com

Publicity
John Schulz
JCS Engineering
jcsgunner@aol.com

NIST Liaison
Greg Strouse
NIST
gstrouse@nist.gov

Administrative Support
Sue Slagle-Smith
Northrop Grumman
Aerospace Systems
sue.slagle-smith@ngc.com
ssluggo8894@gmail.com

Marketing/Public Relations
Nidal Kerdiya
eDoc Publish, Inc.
nidalk@edocpublish.com

Technical Programs
Milt Krivokuca
CSUDH
Milt619@cox.net

Web Master
Raul Troncoso
Amgen Inc.
rault@amgen.com

WWW.MSC-CONF.COM 866.672.6327