President's Message

Steven Stahley
NCSLI President

A global meeting of our customer.

"The Spectrum of Metrology: From the State-of-the-Art to the Everyday" is this year's conference theme for the 2003 Annual Workshop and Symposium. In the past couple of newsletters I have focused on our NCSLI customers and their needs. When I talk about our customer, I am really focused on our member companies of NCSLI, and how our organization and its leadership can best understand and meet their needs.

The annual conference is a critical milestone in the year's activities. It provides an opportunity for metrology professionals, NCSLI members and non-members alike, to network, learn and develop as metrology professionals. We selected the theme for this year's conference with the intention of reminding us that the metrology community is made up of a wide spectrum of technologies and professionals. NCSLI has a broad membership that spans from some of the world's largest national metrology institutes and regional organizations to 1-to 3-person testing and calibration service organizations. Each of these organizations has its own specific needs, but one common goal, to provide its customers the best measurements possible.

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EDITOR'S MESSAGE–

Here's a volunteer project that is worthwhile

Chris Grachnen just came up with a proposal to create an archive capability on the NCSLI website, which will give members a search routine for old conference papers, newsletter articles and other archival material of interest.

The project is described in brief on page 15, and Chris is looking for computer-savvy volunteers to help with the effort, and perhaps offer ideas on usefulness and functionality. Ever since the Newsletter went to electronic publishing about 10 years ago, I have been saving the files of those issues, so we will have at least one place to start. We also know that the annual conferences went CDROM some years ago. VERY interesting proposal. Nice going Chris.

Publishing winning conference papers

I've been publishing the Best Paper conference technical papers starting last January, at the urging of the Board. We tried to recognize the fact that quite a large number of you readers don't get to travel to the Annual Conference. I was doing pretty well, until I came up against the 4th paper at San Diego, and found it is 20+ pages long, which just can't justify in terms of newsletter pages. I hope that Authors Tsai and DeWitt understand?

Continued on page 32

**Articles and other material appearing in the NCSLI Newsletter express the views of the authors and contributors, and are not necessarily those of the Editor or the NCSLI International.**

Visit our website:
<www.ncsli.org>

On the cover: A Quantized Hall Effect setup.
Photo courtesy of Lockheed-Martin.
As Metrologists, Scientists, and Engineers, we can lose sight of where metrology often takes place. When many of us hear the word metrology, we think of the lab-coat-adorned scientist working in a state-of-the-art laboratory, performing what we sometimes call black art and attempting to measure what has never been measured. While this is metrology, we must remember that the science of measurement takes place at many levels and in many forms. For example, a technician calibrating a scale in a warehouse, a specially designed in-process gage used to control a machining line, or the analysis of wastewater to ensure that we are not impacting the environment—all of these involve the science of measurement. The spectrum of metrology is very broad and encompasses a range of sciences, techniques, tools and levels of accuracy. One does not need to measure microinches or at the parts-per-million level to perform metrology. In many instances, metrology that touches our everyday lives is the metrology that makes the final decision as to whether the product meets our requirements. At the end of the day, metrology covers a continuum of measurements performed from the highest-level laboratories to the gasoline pump, and each level presents unique challenges and rewards.

Papers, Panels & Workshops:
The Workshop & Symposium offers papers, panels, and workshops that explore this year’s Conference theme, and are organized into the following five categories:

- Theoretical
- Applied
- Management
- International
- Quality

Exhibits:
Meet with key executives and leading technical experts from over 150 of the top Measurement Science industry innovators and suppliers from around the world. To keep pace with rapidly changing technology, this Conference is a must.

Networking:
The Workshop & Symposium affords unparalleled opportunities to meet with key individuals in the field of Metrology to collaborate and gain new information and insights that can help solve ongoing challenges with fresh perspectives, new skills and new partnerships. Examples of areas of involvement include automotive, analytical chemical, pharmaceutical, and forensics.

Tutorials:
As in past years, the 2003 Conference will include a series of tutorials presented before and after the conference. See the Tutorial Registration form and Tutorial Abstracts on the following pages for topics of study.

Please join us in Tampa, Florida prepared to learn, to teach, and to develop new professional relationships with your fellow Metrologists.

For more information, go to www.ncsl.org/conference/2003/
NCSL International 2003 Workshop and Symposium
Registration
August 17-21, 2003 Tampa, FL
(Conference language: English; Conference currency: USD)

Registration Options

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<td>$650</td>
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<td>International Evening: Aug 20, 2003</td>
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</table>

- Exhibitor Booth Inquiries: Call: Tom Huttemann at (585) 554-6295
- Fax: (303) 440-3384
- Tel: (303) 440-3339
- www.ncsl.org

Registrant Information (Please Print or Type)

- First Name:
- Last Name:
- Job Title:
- Telephone No.:
- Fax No.:
- E-mail:
- Organization:
- Mail Stop:
- Dept. / Div. / Lab.:
- Address:
- City:
- State / Province:
- Zip+4 / Postal Code:
- Country (if not USA):

- Please do not add my name to your mailing list.

Special Accommodations
- Please check here if you require special ADA, wheelchair, or dietary needs, and attach a written description so we may serve you.

Please note the only alternate meal option offered at this time is a vegetarian meal.

Credit Card Information (Please Print or Type)

- VISA
- MasterCard
- American Express

- Full Name as it appears on Card:
- Signature:
- Date:
- Job Codes

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<td>Pharmaceutical/Healthcare</td>
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<td>Student</td>
<td>Manufacturing</td>
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Education

- Government
- Community College
- Private College
- Technical College
- University

Cancellation Policy

Full Registration Fees will be refunded IF WRITTEN NOTICE IS RECEIVED (by fax or mail) BY JULY 11, 2003. Registrants who fail to attend and do not cancel prior to July 11, 2003 will be liable for a 50% cancellation fee.

You may transfer your paid Registration to another individual from your organization to attend in your place without penalty. WRITTEN AUTHORIZATION FOR THIS SUBSTITUTION IS REQUIRED. Please mail or fax written notice of substitution to the NCSLI Business Office to arrive by July 25, 2003.

For NCSLI Use Only

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# NCSLI International 2003 Workshop and Symposium
## Tutorial Registration
### August 16-17, 22, 2003, Tampa, FL
(Conference language: English; Conference currency: USD)

#### Registration Options
- Register On-Line at [www.ncsli.org](http://www.ncsli.org)
- Fax Credit Card Registrations to:
  - Fax: (303) 440-3384
  - Tel: (303) 440-3339
- Or Mail Check or Credit Card Registrations to:
  - NCSLI
  - 1800 30th St., Ste. 305B
  - Boulder, CO 80301-1026

#### Tutorial Dates & Fees

<table>
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<th>Tutorial</th>
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<th>After 6/27/03</th>
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<td>An Introduction to Measurement Uncertainty</td>
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<td>Accreditation: View by a Lead Assessor</td>
<td>$100/$130</td>
<td>$120/$150</td>
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<tr>
<td>The Fundamentals of Pressure Metrology</td>
<td>$100/$130</td>
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<td>Good, Bad, or Indeterminate: Using Guardbands to Help Make the Call</td>
<td>$100/$130</td>
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<tr>
<td>Temperature Calibration: Systems &amp; Turnkey Solutions</td>
<td>$100/$130</td>
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<tr>
<td>Weighing In on Mass</td>
<td>$100/$130</td>
<td>$120/$150</td>
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<tr>
<td>Laboratory Compliance with ISO/IEC 17025-Keeping It Simple!</td>
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<td>Gas Flow Measurements</td>
<td>$100/$130</td>
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<td>Estimating the Uncertainties in Deadweight Piston Gauge Pressure Measurements</td>
<td>$100/$130</td>
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<tr>
<td>Introduction to Sound Measurements and Microphones</td>
<td>$100/$130</td>
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<tr>
<td>Force Calibration: Methods and Uncertainties</td>
<td>$100/$130</td>
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<td>Humidity Measurements</td>
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<td>$120/$150</td>
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<tr>
<td>Running an Effective Laboratory - Measuring Performance Testing, Uncertainty Statements, Traceability and More!</td>
<td>$100/$130</td>
<td>$120/$150</td>
</tr>
<tr>
<td>Basics of Vibration, Shock, Accelerometers and their Calibration Fri Aug 22 8:00 am - 12:00 pm</td>
<td>$100/$130</td>
<td>$120/$150</td>
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#### Registrant Information

- First Name: ____________________________
- Last Name: ____________________________
- Organization: ____________________________
- Mail Stop: ____________________________
- Job Title: ____________________________
- Dept./Div./Lab: ____________________________
- Telephone No.: ____________________________
- Address: ____________________________
- Fax No.: ____________________________
- City: ____________________________
- State/Province: ____________________________
- Zip+4/Postal Code: ____________________________
- E-mail: ____________________________
- Country (if not USA): ____________________________

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- Please check here if you require special accommodations and attach a written description so we may serve you.

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- Card #: ____________________________
- Exp. Date: ____________________________
- Signature: ____________________________
- Date: ____________________________

#### Job Codes

- Administration
- Consultant
- Education
- Engineer
- Manager
- Owner
- Professor
- Quality
- Senior Management
- Student
- Technician

#### Industry Codes

- Aerospace
- Automotive
- Chemical Industry
- Commercial Lab
- Consulting
- Corporate Lab
- Electronics
- Pharmaceutical/Healthcare
- Manufacturing

#### Government

- DOC
- DOD
- DOT
- NASA
- Other:

#### Education

- Community College
- Private College
- Technical College
- University

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NCSLI International 2003 Workshop and Symposium
Guest Registration
August 17-21, 2003 San Diego, CA
(Conference language: English; Conference currency: USD)

**Registration Options**

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**Guest Program Dates & Fees**

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<td>Evening Reception</td>
<td>Sun Aug 17</td>
<td>7:00 pm - 9:00 pm</td>
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<tr>
<td>Orientation and Continental Breakfast</td>
<td>Mon Aug 18</td>
<td>7:30 am - 8:30 am</td>
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<td>Salvador Dalí Museum/Dish Restaurant/St. Pete Pier</td>
<td>Mon Aug 18</td>
<td>8:45 am - 3:40 pm</td>
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<td>Tarpon Springs Tour</td>
<td>Tue Aug 19</td>
<td>8:45 am - 3:40 pm</td>
<td>$35</td>
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<tr>
<td>Conference Reception &amp; Banquet</td>
<td>Tue Aug 19</td>
<td>6:00 pm - 9:30 pm</td>
<td>$75</td>
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<tr>
<td>International Event - Tampa Bay Dinner Cruise aboard Starlite Majesty</td>
<td>Wed Aug 20</td>
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<td>$50</td>
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<td>Name of your Host:</td>
<td>Zip+4 / Postal Code:</td>
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<td>Your Host’s Phone No.</td>
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Sensitivity Analysis of One-port Characterized Devices in Vector Network Analyzer Calibrations: Theory and Computational Analysis

Speaker/Author: Godfrey Kwan*
Kwan Research
340 Firelight Drive, Santa Rosa, CA 95403, USA.
Email: <godfreykwan@ieee.org>
Tel: (707) 578-7835

Abstract

In this paper we present the results of a study on the use of characterized devices in microwave vector network analyzer (VNA) calibrations and measurements. We give a brief review of the theory of one-port characterized device calibration. One-port characterized devices such as coaxial opens, shorts and loads are attractive because of their ease of handling and their ruggedness as compared to more fragile devices like sliding loads. The scattering parameter error box representation and widely used terminology of error terms in one-port VNA calibrations such as directivity, source match and tracking are adopted in this paper. Based on these parameters, we examine the quality of one class of one-port VNA calibrations achievable through the use of characterized devices and the effects of different kinds of errors in device characterization can have on VNA calibrations. Computational analysis has revealed interesting properties of this class of calibrations that can lead to significant improvements in the accuracy of VNA measurements.

1. Introduction

Error correction techniques in two-port environment have been proposed [1,2] and used in industry for some time. In a model where the non-ideal behavior of a Vector Network Analyzer (VNA) is assumed to be separable from its ideal characteristics, it is widely accepted that a VNA can be described as a cascade of ideal reflectometers and error boxes. The error boxes are subsequently modeled by the theory of scattering parameters. This is a much simplified picture compared to the complexity of the architecture of modern VNAs. However, this simple model has been very successful in explaining the error correction mechanism of a VNA.

The procedure of characterizing the error boxes through the use of known devices is called network analyzer calibration. In a VNA configuration where there is only one port to be calibrated, as shown in Figure 1, the normalized components of this error box are known as directivity(D), source match(M) and tracking(T). These are three of the four 2-port S parameters of an error box, the fourth parameter has been normalized to unity. $\Gamma_m$ is the reflection coefficient of the device under test modified by the error box. The test port reference plane $P$ in Figure 1 is the plane separating the device under test and the test port of the VNA. Although we also assigned a second reference plane $Q$ to the second port of the 2-port error box, this reference plane is only fictitious just as the 2-port error box itself.

In practice, one may determine the quantities D, M and T by connecting devices of known impedance to a particular test port and measuring each of these devices. These devices are calibration standards and will be referred to as characterized devices in this paper. This VNA calibration technique is known as Characterized Devices Calibration.

In cases where the device geometry and structure are simple enough, the device impedance can be calculated from measured physical dimensions and a few electrical parameters such as conductivity and dielectric constant. Device impedances can also be measured by a system that is of a high order of accuracy. In this paper, we will not be concerned with which of the above methods is actually used nor their relative merits. In any case, impedances of characterized devices can never be determined exactly. Slight errors in these "known" impedance values will lead to slight errors in the determination of the D, M and T values. It is the purpose of the present study to look into how these errors in the models of characterized devices can affect the accuracy in the determination of the error box and thus the uncertainties associated with scattering parameters measurements when using a VNA calibrated with such characterized devices.

In Figure 1, quantities D, M and T are sometimes called the raw error terms. And we shall refer to the error box bearing these 3 terms as the raw error box. The purpose of a calibration procedure is to determine these error terms. When a calibration is completed and the raw error terms are calculated, any future measurement done on the system can be corrected by making use of these error terms.

* Previously: Agilent Technologies
Electrical Standards Laboratory, EPSG/MTA
Rohnert Park. CA 94928. USA.
2. One-Port Calibration Theory

After error correction is applied to a VNA measurement, the VNA is now operating in error correction mode. A VNA operated in such a manner can be further modeled by a similar signal flow graph as shown in Figure 2 where the D, M, and T terms of the raw error box are now replaced by their respective residual errors. The original error box now becomes the residual error box. This error-corrected system, hybrid in nature, now consists of all the circuit components that make up the entire VNA, as well as the 2-port S-parameter error model that we have found to correct for any systematic error in the physical measurement. Measurement data provided under such circumstances are processed data and should be treated as such. In other words, these data are the result of a measurement plus an error term previously determined by a calibration procedure that may or may not be independent of the present measurement. The value of the error term may be related to the device that we are measuring. Even though this is not at all desirable, sometimes it is unavoidable.

The residuals of the error box, residual directivity ($\delta$), residual source match ($\mu$), and residual tracking ($\tau$), can be found in terms of errors in the reflection coefficients of the characterized devices [3,4]. When a characterized device is connected to the test port shown in Figure 2, one obtains the following relationship:

$$\delta = \frac{\tau_i}{1 - \mu_i} = \Gamma_i + \Delta \Gamma_i, \quad i = 1, 2, 3. \quad (1)$$

where $\Gamma_i$, $i = 1, 2, 3$, are the actual reflection coefficients of the characterized devices and $\Delta \Gamma_i$, $i = 1, 2, 3$, are the errors in each of the reflection coefficients due to limitations in the models. This relationship can be rearranged in the form of

$$\left| \begin{array}{c}
\delta \\
\tau \\
\mu
\end{array} \right| = \left| \begin{array}{ccc}
1 & 1 & 1 \\
\Gamma_1 & \Gamma_1 + \Delta \Gamma_1 & \Gamma_1 + \Delta \Gamma_1 \\
\Gamma_2 & \Gamma_2 + \Delta \Gamma_2 & \Gamma_2 + \Delta \Gamma_2
\end{array} \right| \left| \begin{array}{c}
\Gamma_i \\
\Delta \Gamma_i \\
\Delta \Gamma_i
\end{array} \right|, \quad i = 1, 2, 3. \quad (2)$$

and the residuals can be found exactly by solving this system of 3 equations in 3 unknowns. In matrix form, it can be conveniently expressed as follows:

$$\left| \begin{array}{c}
\delta \\
\tau \\
\mu
\end{array} \right| = \left| \begin{array}{ccc}
1 & 1 & 1 \\
\Gamma_1 & \Gamma_1 + \Delta \Gamma_1 & \Gamma_1 + \Delta \Gamma_1 \\
\Gamma_2 & \Gamma_2 + \Delta \Gamma_2 & \Gamma_2 + \Delta \Gamma_2
\end{array} \right| \left| \begin{array}{c}
\Gamma_i \\
\Delta \Gamma_i \\
\Delta \Gamma_i
\end{array} \right|, \quad i = 1, 2, 3. \quad (3)$$

In theory, reflection coefficients of the three characterized devices need only be distinct and can be chosen to be any arbitrary value. However, we see from equation (3) that residuals of directivity, source match and tracking are functions of the errors in the reflection coefficients $\Delta \Gamma_i$'s of the three characterized devices as well as being functions of the reflection coefficients $\Gamma_i$'s themselves. It can be seen that for different reflection coefficients of the characterized devices, the residuals of directivity, source match and tracking take on a different functional dependence on the $\Delta \Gamma_i$'s. This is true even if the $\Gamma_i$'s remain constant when $\Gamma_i$'s vary. By carefully choosing one set of values that the reflection coefficients may take even when we have no control of their associated errors, we can still expect to minimize the values of the residuals to a certain extent.

3. Computational Analysis

Given the values of $\Gamma_i$'s and $\Delta \Gamma_i$'s, equation (3) can be used to compute the values of the residual errors. In the following case studies, nominal values of reflection coefficients for three characterized devices are selected. An error vector $\Delta \Gamma$, is added to the nominal reflection coefficient $\Gamma$. The sum of the nominal vector and the error vector, $\Gamma + \Delta \Gamma$, is the data vector provided by model data for a characterized device. By changing the magnitude and phase of the error vector, we can simulate the effects of errors in model data on the residuals. In this study, the magnitude and phase of the error vector are changed in such a way that the tip of the error vector takes on values inside a circular region at a total of 16 points. These points are approximately equally spaced from one another, clustered around the point $\Gamma_i$.

Parameters used in simulation are chosen to be typical for 2.4 mm precision slotless coaxial devices. That is, the error magnitudes we will be using are values we usually encounter in 2.4 mm coaxial devices. However, the errors in the models of shorts and opens are expressed in terms of degrees which makes the charts created in this study applicable for a wide range of frequencies and connector styles.

In practice, we usually characterize a matched load, an open and a short. This configuration of devices translates to $\Gamma_i = 0$, $\Gamma_i = 1$, $\Gamma_i = -1$ in the ideal case. And it is this special case we will be studying in case 1 to case 4 presented in this section.

In all figures, the following abbreviations and symbols are used.

- $\Gamma_{L, S, O}$: Reflection coefficient of load, short and open respectively
- $\text{Mag}(\Gamma_i)$: Magnitude of reflection coefficient of load.
- $\text{Pha}(\Gamma_i)$: Phase of reflection coefficient of load.
- $\text{Pha}(\Delta \Gamma_i)$: Phases of short and open are defined similarly.
- $\text{Max}(\Delta \Gamma_i)$: Maximum value of amplitude of error vector of load. Quantities related to short and open are defined similarly.

Figure 3 illustrates case study 1. The load error in this case is fixed. That is the error vector in the load is fixed and not swept at all while the errors in the open and the short are allowed to take on a number of values. This is done in order to illustrate how the curves in the simulation are generated and superimposed on one another. In this case, the error vector in the short model takes on only 20 values. Each curve in the graph corresponds to one value of the error vector in the short model. Although the error vector in the open model also takes on discrete values, we have plotted a continuous curve going through those points in order to produce a visual effect of a region of values that the residual source match can take. As more error vectors are allowed to sweep, the number of curves
Figure 3. Curves of residual directivity and source match generated by sampling the complex plane of residual directivity and source match which are functions of 6 complex variables. It is a projection of the magnitudes of these residual functions onto the axis of the phase of the open model.

Case I

A fixed value, $\Gamma_4 = 0.032$, is chosen for the load model. For the short and open, $\Gamma_6 = 1$ and $\Gamma_7 = 1$. The magnitudes of open and short models are fixed while their phases are varied between -0.5 and 0.5. We assigned a nominal value of zero to the true value of the phase of open. And the phase of the short is assigned a value of 180 degrees. Twenty values between -0.5 and +0.5 are sampled with equal intervals.

Case II: Full sweep of all three errors in the models.

In this case, the errors are fully swept for all three models of the characterized devices. In addition to that, 4 different percentage factors are used in order to show how the residual source match will change with increasing accuracy of the models. Errors are swept for 25%, 50%, 75% and 100% of their assigned maximum values. In the example shown in Figure 4, the load maximum error is ±0.01 for Figure 4a, ±0.001 for Figure 4b. In both cases, maximum open phase error is ±0.5 degrees, short phase error is ±0.25 degrees. In Figure 4a, the color of the residual source curves are yellow during the first sweep. In the second sweep, maximum errors of load, open and short are ±0.01*0.75, ±0.5*0.75 degrees and ±0.25*0.75.

Editor's Note: Of course we can't show color. For more complete figures, request the MSWord file.
Worst case value, indicated by the dotted lines in figures 4a and 4b, worst case values are found for the magnitude of residual source match lower by almost 10 dB. We will examine this effect more closely in the next case study. Approximate locations of the three characterized devices are shown on a Smith chart legend accompanying the following case studies.

Worst case value, indicated by the dotted lines in figures 4a and 4b, can be found for the residual source match for each of the 4 different values of the percentage factor. When the factor varies from 0 to 1, worst case value in each sweep can be found and they are plotted against the normalized errors in case studies III and IV. The normalized error has the same value as the percentage factor and is used simultaneously for all three error vectors in a simulation where the worst case values are found for the magnitude of residual source match and directivity and for the magnitude and phase of residual tracking. It can be alternatively defined as follows:

Normalized Error = |ΔΓ_i| / max(|ΔΓ_i|), i=1,2,3.

For example, let's consider the case where Γ_L=0.032, Γ_S=-1 and Γ_D=1, and the error in the load model, max(|ΔΓ_L|), has a value of 0.01, the error in the short model, max(|ΔΓ_S|), has a value of 0.0043 or about 0.25 degree in phase, and the error in the open model, max(|ΔΓ_D|), has a value of 0.0087 or 0.5 degree in phase. If the normalized error has a value of 1.0, the worst case value for each residual error are found using the above maximum values in the variation of the error vectors. If the normalized error has a value of 0.5, each of the maximum values of errors in the models are multiplied by 0.5 before the worst case values are searched.

When max(|ΔΓ_L|) has a value of 0.005 instead of 0.01, the second case that was considered in case study III, a second curve is plotted against the normalized error. And when the normalized error has a value of 1.0, it corresponds to the case where max(|ΔΓ_L|)=0.005, max(|ΔΓ_S|)=0.25 degree in phase, max(|ΔΓ_D|)=0.5 degree in phase. Values of max(|ΔΓ_S|) and max(|ΔΓ_D|) have not changed for the curve where max(|ΔΓ_L|)=0.005. As a result, residual errors at normalized error of 1.0 can be used directly to compare the different scenarios presented in one particular case study. On the other hand, the variation of the residual error along the normalized error axis is similar to a change in the frequency of interest. When the normalized error changes from 1.0 to 0.5, all the error vectors are effectively reduced by half and we can liken this to a decrease in the operating frequency such that the errors in the models become relatively smaller. Although this is especially true for errors in model data of the open and the short, errors in model data for a load may not have this trend.
Case III: Sensitivity of Error in Load Model

$\Gamma_L = -1$, $\max(|\Delta \Gamma_L|) = 0.0043$ or 0.25 degree in phase. $\Gamma_0 = 1$, $\max(|\Delta \Gamma_0|) = 0.0087$ or 0.5 degree in phase. $\Gamma_L = 0.032$.

Four different values of $\max(|\Delta \Gamma_L|)$, 0.01, 0.005, 0.0025 or 0.00125.

Figure 5. Sensitivity of error in model data used for the load. Four different values of $\max(|\Delta \Gamma_L|)$, 0.01, 0.005, 0.0025 or 0.00125 are considered.

A 6 dB improvement in characterizing the load reduces the residual directivity from -40 dB to -46 dB. It also leads to a 3 dB improvement in residual source match from -35 dB to -38 dB. Similar improvement in characterizing the load will continue to improve residual directivity and, to a lesser extent, residual source match. Since the error in the load model is a random number fluctuating around zero as frequency varies, one can expect the residual source match and directivity to exhibit a ripple because of this.

Case IV: Sensitivity of Error in Open Model

$\Gamma_L = 0.032$, $\max(|\Delta \Gamma_L|) = 0.01$. $\Gamma_L = -1$, $\max(|\Delta \Gamma_0|) = 0.0043$ or 0.25 degree in phase.

$\Gamma_0 = 1$.

Five different values of $\max(|\Delta \Gamma_0|)$ in terms of degrees in phase, 2.0, 1.0, 0.5, 0.25, 0.125.

Error in open model has negligible effect on residual directivity. Its effects on residual source match and tracking diminish rapidly below errors ±0.5 degrees phase variation. That is, unless the errors in the load model and the short model are reduced at the same time, it is not useful to measure the open to any better accuracy.
4. Conclusion

In this paper, we presented a study on the sensitivity of characterized device calibration technique with respect to the characterization accuracy of its devices. It is found that the residual source match of a characterized device calibration can be significantly affected by the accuracy of the model data for the matched load. This result underlines the importance of creating an accurate set of data for the load. A sliding termination can emulate the performance of a high quality matched load when the uniformity of the sliding section is taken into account in its measurement. In a characterized device calibration where a sliding termination is used instead of a regular matched load, its performance is thus expected to be more superior because of the important role of the load.

While the accuracy of model data for the load can improve the calibration in terms of both residual directivity and residual source match, it is interesting to find that the accuracy of model data for the open does not seem to have similar importance on the residual source match and has almost no effect on residual directivity. However, it may be due to the reason that the error in model data of the short was not reduced at the same time. Further research is warranted in this area.

Acknowledgment

The author is grateful to Mr. Ken Wong and Mr. Bryan Lai for their helpful discussions and comments on various aspects of the work presented here.

References

Improving Temperature Accuracy for Rapid Thermal Processing at NIST

Speaker: Benjamin K. Tsai
Authors: Benjamin K. Tsai and David P. DeWitt
National Institute of Standards and Technology
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At the National Institute of Standards and Technology (NIST), we have been developing methods to improve the temperature measurement accuracy of semiconductor materials undergoing high-temperature thermal processing. Our goal is for accuracies of 2 °C in the range from 700 °C to 1000 °C. We have demonstrated new methods for calibrating lightpipe radiation thermometers (LPRTs) against blackbodies with an uncertainty of 0.2 °C (k = 1). A more challenging issue is how to achieve accurate traceable temperature measurements in process environments. We have studied two approaches: in situ calibration of the LPRT against a thin-film thermocouple test wafer, and making model-based corrections to spectral radiance temperatures using an LPRT calibrated against a blackbody. We have achieved uncertainties of 2.3 °C and 3.5 °C for the two methods, respectively. While the work specifically addresses a semiconductor application, the approaches have general applicability for achieving reliable, traceable temperature measurements using LPRTs in other material processing and manufacturing environments.

1. Introduction

Recently, many advances have been made in semiconductor metrology. This is evident in the plans by the industry to achieve 100 nm line widths by 2005 [1]. An important growing sector of this industry is rapid thermal processing (RTP) for such purposes as chemical vapor deposition, physical vapor deposition, oxidation, annealing, silicidation, and oxide-etch processes. Compared to the traditional batch processing of silicon wafers, single-wafer RTP can offer advantages of higher ramp rates, shorter processing times, tighter ambient control, and shorter cycle times. Accurate temperature measurement and control during RTP processing is crucial in achieving high throughput and consistent high quality. However, along with the advantages of RTP also come some challenges of making accurate temperature measurements. First, stray light from the source bouncing off reflective surfaces can provide extraneous unwanted signal into the radiometer. In addition, temperature variations with time and with wafer location can complicate the temperature measurement process and can increase the uncertainty of the temperature measurement. Finally, changes in optical properties of the wafer and other parts of the chamber can affect the temperature measurement.

At the National Institute of Standards and Technology (NIST), over the past six years we have been investigating methods of increasing the accuracy of temperature measurement using lightpipe radiation thermometers (LPRTs) in the NIST RTP test bed. Our goals were to achieve 2 °C in temperature accuracy and 0.5 °C in temperature repeatability on a silicon wafer. These goals were based on requirements of the International Technology Roadmap for Semiconductors (ITRS). Implicit in the mission of NIST and our RTP temperature project is the task of developing high quality measurement standards and establishing a calibration system whereby others in the United States can derive their temperature traceability. Although NIST cannot and will not dictate to any user community how to define or set traceability standards, the mission of NIST is "to develop and promote measurement, standards, and technology to enhance productivity, facilitate trade, and improve the quality of life." [2] To this end, we are committed to establishing a national protocol for calibration of LPRTs using stable blackbodies in the temperature range of 700 °C to 1000 °C traceable to the International Temperature Scale of 1990 (ITS-90).

In this paper, the LPRTs and the sodium heat pipe blackbody (NaHPBB) used in the calibration process will be introduced. Next, the calibration and characterization methods of the LPRTs will be described. The two approaches, the in situ calibration of the LPRTs and the model-based method, will be explained. Finally, a discussion of the application of LPRTs in an environment outside of the calibration laboratory will be presented.

2. Lightpipe Radiation Thermometers

Lightpipe (LP) sensors are attractive in temperature monitoring applications for at least four reasons. First, the noncontact and nondestructive nature of the LPs does not alter or destroy the original surface. Second, the LPs provide immunity from shock, vibration, and other adverse environments, such as chemical, thermal, and electromagnetic interference. Third, LPs are very convenient especially in confined areas and can be placed very close to a target if desired. Fourth, LPs are safe even in high voltage areas and in ionizing plasma fields.

The LPRT systems used at NIST in Figure 1 consist of a high-quality sapphire crystal LP linked via flexible quartz fibers to a silicon detector operating in the near infrared. Besides the detector, the control box contains the optics and the electronics necessary to digitize the measured signal and to convert it into the appropriate spectral radiance temperature. The sapphire rod is enclosed in a concentric sapphire sheath for protection and mechanical stiffness.

Figure 1. Photograph of LP.

Editor's Note: After the 2002 San Diego Conference, I agreed to try to publish the top winning papers in the Best Paper competition. I was doing all right until this invited Paper winner showed up. It was 20+ pages long so I just cannot dedicate that much space. So here is the first page, and I invite anyone who wishes to read the entire work, to email the NCSLI Business Office and ask for Paper # 3E-1 from the 2002 Conference in MSWord format.
METROLOGY CALENDAR

NCSLI MEETINGS
August 17-21, 2003
NCSL Workshop & Symposium
Tampa Convention Center, Tampa, FL
CONTACT: NCSL Business Office, (303) 440-3339
FAX: (303) 440-3384
e-mail: <info@ncsli.org>
website: <www.ncsli.org/conference>

INDUSTRY/GOVERNMENT MEETINGS
2nd International Conference on Metrology
November 4-6, 2003
Queen of Sheba Hilton Hotel, Eilat, Israel
CONTACT: Conference Secretariat
ISAS International Seminars
P.O. Box 34001
Jerusalem 91340, Israel
972-2-652-0574
Fax: 972-2-652-0558
e-mail: <confer@isas.co.il>

REGION/SECTION MEETINGS
CANADA REGION
Eastern Ontario Section, October 15, 2003
National Research Council, Ottawa, ON
CONTACT: Wayne Sampson, (902) 468-3344 x244
FAX: (902) 468-1203
e-mail: <wsampson@pylonelectronics.com>

Fall Meeting, October 16-17, 2003
National Research Council, Ottawa, ON
CONTACT: Wayne Sampson, (902) 468-3344 x244
FAX: (902) 468-1203
e-mail: <wsampson@pylonelectronics.com>

Please send Metrology Calendar additions and corrections to the NCSL International Business Office,
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MEASUREMENT UNCERTAINTY CLASS
QUAMETEC Corporation

August 4-6, 2003 in Schaumburg, IL (Hosted by QC Inspection Services)

September 22-24, 2003 in Novi, MI

October 1-3, 2003 in Minneapolis, MN (Hosted by QC Inspection Services)

October 20-22, 2003 in Dallas, TX (Hosted by Technology Rentals & Services)

$1,195 per student. Includes a licensed copy of the software and a copy of "Measurement Uncertainty Analysis Fundamentals" handbook. Uses the new "Uncertainty Toolbox for MSExcel." Class size is limited to 15 students.

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HERE'S A VOLUNTEER PROJECT WITH A PAYOFF FOR ALL OF US

Chris Grachenen

Volunteers Needed - How many times have you needed to research a subject you thought might be in a NCSLI conference article but did not know the title, the author or when the article was written? Or you remembered seeing something valuable in the Newsletter a few years ago, but don't have time to page through all the copies in your archive binders?

NCSLI is setting up a committee to make recommendations and assist in developing a web-based, searchable article depository for its membership. We envision this value-added service to provide users with the ability to search articles by subject, author or key words/phrases which can be easily downloaded. Just think of the time saving! Imagine at the click of a mouse being able to quickly access hundreds of NCSLI articles from any on-line portal - it's like having a gaggle of Metrologists ready to answer your questions anytime, anywhere.

If you would like to participate in getting this exciting new service up and running please contact Christopher L. Grachenen at: <chris.grachenen@hp.com>.
ILAC/NACLA REPORT
Anthony Anderson

International Laboratory Accreditation Cooperation (ILAC) Laboratory Committee (LC)

I attended my first ILAC Executive Meeting in Paris at the end of February as the Chair of the LC. High on the agenda was the outcome of the ILAC/IAF joint Mark ballot. I am very pleased to report that the voting membership of ILAC, the accrediting bodies (ABs), voted against having a joint Mark with IAF. The margin of victory was very small, but it would appear the strong input from the laboratory community managed to convince sufficient ABs that having a joint Mark would create market confusion, and voted the laboratory position.

Interestingly, in a similar ballot sent out to the IAF membership, they also voted against a joint Mark. Both organizations did vote for a common Mark for their respective inspection programs and this will be pursued through the ILAC/IAF Joint Closer Cooperation Committee (JCCC). ILAC will now be working towards a Mark for its use to identify those ABs who are signatories to the ILAC Arrangement, and laboratories accredited by these ABs will be able to use the ILAC Mark on certification and test reports.

At the LC meeting the following week in Orlando, there was a feeling of relief that the views of the laboratory community had been taken into account and pleasure with the outcome of the decision. However, due to the slim margin, the LC was concerned that there would still be efforts to merge accreditation with certification (registration) and is still adamantly opposed to any idea of an ILAC/IAF merger.

There is concern within ILAC that the Arrangement is not being sufficiently promoted and signatories will be asked to re-affirm their commitment to promote the MLA. One way ABs could promote the Arrangement is to ask their accredited laboratories to put a statement on calibration certificates and test reports.

ILAC became incorporated as of January 20, 2003. Under the Articles of Association and Bylaws the following changes of membership class are now effective:

Member: Signatory to the ILAC Arrangement previously called Full members.

Associate: Those previously designated Full Members who had not signed the Arrangement.

Affiliate: Those previous designated associate member.

Stakeholder: unchanged.

It should also be noted that the word member must not be used in the description of any category other than member itself. In other words, only signatories to the Arrangement can call themselves members of ILAC. The LC has expressed concern over the confusion the prohibition of the use of the word member will cause, but recognizes the problem of non-signatories claiming to be in the membership/signatory category.

The ILAC (Policy) P-Series documents are now all approved; however within the Arrangement Management Committee (AMC) there is a feeling that there are too many new documents which have to be complied with, and that the ABs have to deal with too much in too short a time. The concern for the laboratory community is: as the pressure is put on the ABs by ILAC to comply with these new documents, the laboratories will have more directives applied to them. This could lead to a bad impression of ILAC.

The LC proposal to the Executive of ILAC, that ILAC conduct a study to determine the state of progress in implementing the requirements of ISO/IEC 17025 was accepted in Paris. At the LC meeting a work item was begun to prepare a plan and then to draft a questionnaire. The results of this study will be very useful when ISO/IEC 17025 comes due for revision at the end of 2004.

With regard to the alignment of ISO 9000:2000 and ISO/IEC 17025:1999, the minor changes to the Standard, [currently out for comment from the ISO/CASCO WG 25], if accepted may become an amendment, which could be created by the end of 2003.

ILAC is working on improving its liaison with ISO/CASCO in order to prepare positions on issues affecting ILAC in a more proactive manner. A system of prioritizing communications from ISO has been implemented, but a process is needed for communicating with the relevant working groups and getting more involved. As all organizations, more active volunteers are needed, so that ILAC can participate more rather than just react.

National Cooperation for Laboratory Accreditation (NACLA)

I attended the NACLA 2nd Annual Forum, AGM and Board of Directors meeting in March in Columbia, MD. The two-day Forum covered a variety of topics on accreditation including; the basic elements of accreditation, what Specifiers expect of accreditation bodies and how laboratories view accreditation. There were updates on the international front from ILAC, APLAC, and IAAC explaining their respective MRAs.
The Forum was followed by an expanded half day AGM to address some of the concerns about the progress of NACLA. A lively interchange of comments and ideas helped explain some of the misunderstandings of the NACLA process, and provided good input to the Board to solve some of the problems surrounding recognition. Part of the delay in processing applicant ABs has been the difficulty of finding volunteer lead assessors. To address this problem, the NACLA Board has approved the payment of lead assessors in the future to attract more potential candidates. From the positive reaction at the AGM, the ABs accepted the increased cost of achieving recognition to be worthwhile.

The MRA task group reported its findings to the Board following a survey of NACLA stakeholder members. The recommendations of the task group will be considered where language needs to be modified to address the concerns of specifiers and ABs. Dialogue involving MRA signatories, specifiers and laboratory constituents, will be initiated to find practical means to reduce overlap and duplication in laboratory assessments.

The next NACLA Board meeting will be just before the NCSLI Conference in Tampa, August 15-16, 2003

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EUROPEAN COOPERATION IN METROLOGY REPORT (EUROMET)
Seton Bennett

EUROMET’s General Assembly was held this year in Budapest, Hungary on the 27th and 28th of May. The major items on the agenda of the General Assembly, which began with a meeting of the EUROMET Committee, were the formal technicalities of elections and finance, the reports from EUROMET’s 11 Technical Committees, and a discussion of EUROMET’s strategy with respect to the CIPM mutual recognition arrangement and the development of metrology in Europe.

The principal elections were for the Chair of EUROMET and for two vacancies on the Executive. The Committee confirmed me as its next Chairman for a period of two years from June 2004 and elected Attilio Sacconi (IMGC Italy - re-election) and Carlos Nieto de Castro (IPQ Portugal) to the Executive. A number of new Technical Committee Chairs were also confirmed at the meeting, and the full list of Chairpersons is now as follows:

TC Acoustics, Ultrasound and Vibration - Maria Szlag (GUM Poland)
TC Electricity and Magnetism - Hans Bachmair (PTB Germany)
TC Flow - Mijndert van der Beek (NMI Netherlands)
TC Interdisciplinary Metrology - Michael Kühne (PTB Germany)
TC Ionising Radiation - Neley Coutsoi (CEA - France)
TC Length - Andrew Lewis (NPL - UK)
TC Mass and related Quantities - Lars Nielsen (DFM Denmark)
TC Metrology in Chemistry - Philippe Charlet (BNM-LNM France)
TC Photometry and Radiometry - Maria Luisa Rastello (IEN - Italy)
TC Thermometry - Martin de Croon (NMI Netherlands)
TC Time and Frequency - Rado Lapuh (SIQ Slovenia)

EUROMET’s membership was extended, with the National Centre of Metrology in Bulgaria and the Latvian National Metrology Centre being elected as full members on the recommendation of the Executive.

There was quite extensive discussion of the CIPM Mutual Recognition Arrangement (MRA), which has involved EUROMET, and its Technical Committees in particular, in a great deal of work over the last few years. The basis of the MRA is the BIPM’s key comparison database which houses details of key and supplementary comparisons, as well as tables of the Calibration and Measurement Capabilities (CMCs) of participating NMIs. In EUROMET’s case, five sets of CMCs have been completed and published during the last twelve months and a further four new sets have been submitted for review by the other Regional Metrology Organisations. Overall, European NMIs have submitted more than twelve thousand individual CMCs, of which some eight thousand have been published on the BIPM database.

All these data, supported by a massive intercomparison programme, will only be useful as the MRA is taken up and used as the basis for traceability requirements in legislation and laboratory accreditation. Discussion in Budapest recognised the importance of publicising the potential of the MRA to overcome trade barriers and facilitate measurement requirements in industry, regulation, and trade. The Executive was charged with considering ways of improving the awareness of users in these sectors.

EUROMET’s overall strategy, recognising the implications of the MRA with its emphasis on the equivalence of national standards, is moving the European NMIs towards increased collaboration in research, improved planning of major investments, and a recognition of the need for a more structured approach to the provision of metrology services. This strategy is being developed through the MERA (Metrology for the European Research Area) project with partial funding from the European Commission.

The project is investigating different scenarios for collaboration between National Measurement Institutes in Europe and will provide EUROMET NMIs and their policy makers with a "roadmap" for the implementation of the EUROMET strategy with regard to a coordinated European metrology infrastructure. As part of this project, an enquiry is being conducted to solicit the cooperation of all actual and potential customers of the European National Measurement Institutes in providing us with some user feedback.

The full MERA enquiry, including background information can be downloaded from <www.sp.se/metrology/MERA/MERA_frames.htm>. Several pages of questions for the enquiry are also available as MS Word documents. If any customers of European National Measurement Institutes would like to respond, by completing some or all of the questions or by commenting on the contents of the questionnaire, they can e-mail me (see Newsletter Roster for my e-mail) or Leslie Pendrill in SP in Sweden <leslie.pendrill@sp.se>, who is responsible for this questionnaire part of the project. Either of us can furnish an MSWord version of the questionnaire.

All comments will be most welcome. Thank you in advance for your cooperation.
BIPM REPORT
Andrew Wollard

The last few months have been relatively quiet on the BIPM front. We have been busy, though, with the usual steady stream of Consultative Committee meetings culminating in the one for Chemistry (CCQM) last week. This is our biggest committee and at its height, there were some 150 people here.

There is no doubt that chemical metrology is our biggest growth area. It touches on relatively traditional activities in surface science and inorganic materials but is developing rapidly in organic chemistry and biotechnology. One of the key objectives is to agree on an acceptable way of satisfying the European Union's In-vitro directive regulations that require diagnostic kits and materials to satisfy "standards of a higher order."

BIPM and the World Health Organisation are working together on this as well as on ways of introducing traceability into the clinical laboratory medicine world. It is interesting and exciting stuff as it touches directly on human health and well being. More developments are expected in the next few months. Later in the year we are meeting with FAO, the intergovernmental "Food and Agriculture Organisation" to discuss potential collaboration in traceability in food.

I have presented the work of the BIPM/Metre Convention to the EUROLAB general assembly and also discussed the possible collaboration between them and NCSLI. The President of EUROLAB has contributed a very interesting paper for our Tampa conference and I hope that we can arrange a meeting to discuss the options.

I continue to make good progress with ILAC on co-operation and shall be reporting in greater detail to the Tampa conference in a paper that discusses some joint actions between ILAC and BIPM.

Tampa's conference stream for international matters ("D-stream") has turned out rather well, and promises to be as interesting as ever. Thanks to Dick Pettit for his patience and understanding whilst I tried to align a number of sessions and speakers.

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Remembering Barry Bell

A long-time Leader of the Electronic Instrumentation and Metrology Group at NIST, Barry A. Bell, 65, died March 13, 2003 as the result of a stroke. Barry was an electronics engineer who, since 1976, had worked for NIST, in Gaithersburg, Maryland.

Barry was a native of Des Moines, Iowa and grew up in Aurora, Colorado. He was a BSEE 1961 graduate of Stanford University and received a MSEE from Yale in 1962. He saw active duty as Director of the Electrical Division at the U.S. Naval Nuclear Power School in Bainbridge, Maryland from 1962 to 1964, and was in the Air Force Reserve after that.

Barry worked at Martin, Hewlett Packard and Leeds and Northrup before joining NBS. At NBS/NIST, he was the leader of the Electronic Instrumentation and Metrology Group which he led for 25 years, and Barry became Deputy Director of the Electricity Division in 2001. He had served as a NIST Post-Doctoral Advisor since 1993.

Mr. Bell received a Department of Commerce Silver Medal in 1981 for "...developing the technical basis of a measurements program to support modern electronics systems and instrumentation." He retired this year. A short while preceding his retirement, he was appointed Division Quality Manager and began to revitalize the formal quality system for calibrations. Barry became an IEEE Fellow in 1997 for his technical leadership in the development of analog electronic standards based on digital technology.

He was also well-connected within the NCSLI community because of his outreach to the Electricity Division's many calibration customers. He attended many NCSLI Annual Workshops and hosted numerous NIST visits and tours by customers. Barry strove to keep abreast of the metrology support needs of both the instrumentation industry sector and the calibration community.

Survivors include his wife, Jane Herbert Bell, twin daughters, a son, and two step-sons.

Barry is greatly missed by his colleagues for his warmth, friendship and sense of humor, as well as his willingness to go the extra distance to help them meet their professional and technical goals. He was a true leader.
The NCSL International Northeast Section spring meeting was held at Hamilton Sundstrand (HS) in Windsor Locks, CT on April 30, 2003. Phil Noll, the Northeast Section Coordinator and Principal Engineer at HS, conducted the meeting.

The first presenter was Mr. Donald Rethke, Principal Engineer for Human Space Flight at Hamilton Sundstrand (ret). Don provided a history of space involvement at HS as well as keen insight into the hardware that is being provided for the International Space Station. Included in the presentation were explanations of the Extravehicular Mobility Unit (space suit), environmental control within the Space Station itself, and a general overview of space business at Hamilton Sundstrand. Don is a genuine legend at HS, and his ability to provide a professional presentation was well received by all.

The next presenter was Mr. Keith Hadley from Transcat Calibration Services. His presentation, "Validation to 21 CFR 820.75" provided insight on the method used to confirm that their software, CalTrak, meets all specified requirements for use and verification for use in the pharmaceutical industry. From design through final testing Keith provided valuable information on schedule requirements, test methods and final report summary that is required to meet this specification.

The final speaker, Mr. Stephan Santoro was from Vaisala Inc. Steve provided valuable information on humidity measurement. Starting from basic concepts Steve offered valuable information on how to understand your humidity requirements and choose the correct type of instrument to meet your needs.

An open forum to discuss future topics resulted in a tentative agenda for the fall meeting. Topics offered for discussion include uncertainty analysis, dimensional measurement and small group discussions that would enable more in depth discussions.

At the end of the day, a guided tour of the HS Space Flight Metrology Laboratory was conducted.
May 1, 2003  
USAF Primary Standards Laboratory  
Heath, Ohio  
Charles E. Mays  
Southern Ohio/Kentucky Section Coordinator.

The spring meeting of the Southern Ohio/Kentucky Section of NCSTLI was held on May 1, 2003, at the newly-renovated conference center at the Central Ohio Aerospace & Technology Center co-located with the USAF Primary Standards Laboratory in Heath, OH. The meeting was attended by 67 participants representing 25 companies from five states.

Charlie Mays welcomed everyone and introduced co-hosts Colonel Gary Bledsoe, USAF Metrology Program Director, and Ben Fullen, the Bionetics Corporation, Air Force Primary Standards Laboratory Program Manager. After opening comments by Colonel Bledsoe and Mr. Fullen, the podium was turned over to Dr. Klaus Jaeger, who included a plug for the tutorials that will presented at the annual NCSTLI Workshop and Symposium in Tampa, Florida in August.

Speaker: Dr. Klaus Jaeger, Chief Scientist, The Bionetics Corporation

Topic: Documentory Standards and National & International Organizations for Metrology/Accreditation

Dr. Jaeger has worked in Metrology for over 20 years developing and improving primary standards using the latest developments and discoveries in atomic and quantum physics. He has been active for many years with the National Conference of Standards Laboratories International (NCSTLI), and served as President in 1999. He was also Vice President of the NCSTLI for over eight years supervising activities in the areas of Measurement Science and Technology as well as Publications.

Klaus's presentation was divided into two major parts, Documentory Standards and National & International Organizations for Metrology/Accreditation. During the Documentory Standards portion, he provided the chronological evolution of standards from the military MIL-C-45662A in early 1962 through ISO/IEC 17025:1999.

Klaus took us on a journey through the many National & International Organizations for Metrology/Accreditation. He touched on BIPM, ILAC APLAC, NACLA, ISO, EA, and ABs providing the group some insight on their operation and oversight. As we progressed through the different organizations that affect our day-to-day operations, he provided a look at what the future may hold for the Metrology community as we know it.

Speaker: Steve Kaplan, Vice President Marketing, Andeen-Hagerling, Inc.

Topic: New Developments in Capacitance Measurement

Steve has degrees in meteorology (yes, he was a weatherman) and marketing and has a wide background in all the physical sciences. He has worked in various capacities for Texas Instruments, Thorn-EMI, Predicasts, and Cosco Household products. With Andeen-Hagerling since 1994, Steve attends a diverse mix of conferences throughout the year, meeting metrologists, physicists, chemical engineers, materials scientists and other researchers.

This was the most intriguing and mind-boggling presentation on the use of capacitance I have heard to date. To open his presentation, he dropped an unfamiliar term on us "Attofarad" 10^-18 [and I thought I was doing good with Pico and Nano!]. Steve explained how scientists are using capacitance to measure very low temperatures in the 1 to 100 milli-Kelvin range by using capacitive pressure sensors in cryostats. He continued with an explanation of the use of capacitance in "Dilatometry," the measurement of dimensional changes in materials when acted on by external forces such as heat or magnetism in the range of 1/10 angstrom.

Editor's Note: Charlie, don't feel too much bypassed. I just found out recently at a lecture by one of the founders of Google, that googol means 10^100.

Capacitance is even beginning to be used to electrically measure differences in biological cells, as between those that might be cancerous and those that are not. Who knows, someday, capacitance measurements may form the basis of a pressure standard.

What was really neat was seeing that the same instruments we metrologists use to very accurately measure capacitance standards, calibrate decade equipment, and the like, are used by other scientists to investigate new materials, develop highly accurate sensors, and better understand the way crystals, glasses, metals, and biological substances behave.

Speaker: Dr. Klaus Jaeger, Chief Scientist, The Bionetics Corporation

Topic: A Practical Approach to Uncertainty in Measurement

Before presenting detailed information on uncertainties, Dr. Jaeger stated the specific requirements as listed in ISO/IEC 17025 for calibration, calibration certificates, intermediate checks, and uncertainties. Taking the liberty of gleaming much of the following from Dr. Jaeger's slides, he continued with data extracted from A2LA and the GUM.

A2LA Traceability - T4 Where uncertainty calculations are applicable, A2LA requires that testing and calibration laboratories calculate measurement uncertainty in accordance with ISO "Guide to the Expression of Uncertainty Measurement (GUM)." These uncertainties must be supported by uncertainty budgets, and they will be represented as expanded uncertainties typically using a coverage factor of k=2 to approximate the 95% confidence level. The GUM requires the use of Type A and Type B uncertainty components; i.e., statistical data used as type A, all others as type B.

It means that accredited facilities:
1. must provide accredited calibrations with the uncertainty of the calibration.
2. can provide non-accredited calibrations without uncertainties.
3. do not have to show accrediting agency logo on the accredited certificates.
4. must list accredited calibrations with expanded uncertainties, normally at k=2, but other higher k factors are permissible also. The k factor must be listed.
Dr. Jaeger presented several examples for our uncertainty study by using some of the most common instruments encountered in our laboratories such as the HP 3458A DMM, Fluke calibrators like 5500 and 5700, etc.

Speaker: Dilip Shah, E=mc3 Solutions

Topic: Certified Calibration Technician Program

Dilip Shah has more than 25 years of industry experience in metrology, electronics, and instrumentation, measurement and computer applications of statistics in the Quality Assurance areas. He is currently a Principal of E = mc3 Solutions, a consulting practice that provides training and other solutions in ISO9000/QS9000, ISO17025, measurement and computer applications. Dilip is an American Society for Quality (ASQ), Certified Quality Engineer. Dilip also belongs to the Statistics and Measurement Quality Divisions (Chair-Elect 2002-2003 year) of American Society for Quality.

A very in-depth presentation on the ASQ's newest certification exam, the Certified Calibration Technician (CCT) exam was given by the incoming Chair of the ASQ's Measurement Quality Division (MQD), Dilip A. Shah, which is the sponsor of the exam. The exam development process was explained, and the Body of Knowledge (BOK) test was presented at the NCSLI regional meeting at Heath, Ohio.

The meeting was concluded with Board of Governors meeting news from Bernard Morris, Hart Scientific, followed by door prize drawings. Thirty-two of the attendees assembled in several small groups for a tour of the Air Force Primary Standards Laboratory.

I think we have to present Charlie with some sort of Attaway award for turning out this many raptly attentive people in Central Ohio.
The first speaker of the day was Ralph Bertermann of Lighthouse Training Group and past president of NCSL International. Ralph gave an excellent presentation entitled, "Ethics - a Forgotten Ingredient." Ralph reminded us of numerous examples of unethical behavior from the beginning of documented history to current days. He highlighted the importance of ethics in a sound metrology program as well as in life in general. Ralph advocated the development of corporate codes of conduct and ethics programs applied to the field of metrology. He ended his talk by handing out ethics bingo cards to all in attendance. The cards had different unethical actions in each square, for example, "it's only one digit out." The subtitle of the ethics bingo card read; "if you win - you lose."

The second speaker was Jeff Gust of Verizon Electronic Repair Services. Jeff provided us with an overview of an NCSLI interlaboratory comparison (ILC) of a one-ohm resistance standard that he organized and conducted. He discussed the ILC organization, planning, results, data analysis, and other observations. Jeff indicated that ILCs are important tools in assessing and improving lab capabilities. He finished the presentation by emphasizing that, "we need more ILCs."

The third speaker of the day was David Gale of the National Association for Proficiency Testing (NAPT). NAPT is a non-profit organization founded in 1996 to facilitate improvement of measurement quality. Dave gave a presentation entitled, "The Value of Testing." Dave's topics of discussion included the benefits of proficiency testing (PT), the PT process, evaluation of results, and the additional value provided through PTs. Dave also covered PT costs through NAPT that range from $400 (member cost) for one PT to $1000 for three PTs. He also provided contact information for NAPT as well as other PT providers. Three PT providers are:

NAPT: <www.proficiency.org>
HN Proficiency: <www.hn-proficiency.com>
International Proficiency: <www.internationalproficiency.com>

The day ended with a raffle of door prizes followed by a tour of the Baxter Healthcare Metrology Laboratories. I would like to thank all in attendance for their interest and participation. Special thanks go to Ralph Bertermann, Jeff Gust, and David Gale for all their efforts and fine presentations.

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The spring 2003 NCES meeting was held on May 8, 2003 at the Sauer-Danfoss plant in Lawrence, Kansas. Hank Phillips of Sauer-Danfoss was the host for an informative and interesting meeting. Seventeen people from eight different companies were in attendance.

After welcoming by Roger Burton, Dwayne Fehr and Hank Phillips of Sauer-Danfoss gave an overview of the company and explained the products manufactured at the plant. The plant produces hydraulic pumps and motors that are used in a wide variety of applications including construction, agricultural, and recreational equipment.

Speaker: Bob Dearth, Honeywell FM&T

Topic: Development of Measurement Capability for Microsystems Components

Bob gave an overview of Honeywell FM&T's progress on developing measurement capabilities for Microsystems components, particularly for components produced using the LIGA process. LIGA is a technology developed in Germany. LIGA stands for Lithographie Galvaniformung Abformation. Using LIGA technology, extremely small metal parts are produced on silicon wafers and subsequently released.
Measurement capabilities have been established to support in-process verification as well as final part inspection. Capabilities include water flammability, parallelism, film thickness, LIGA component thickness, and 3 dimensional part measurement using a multi-sensor optical CMM. Bob discussed some of the considerations involved in establishing these capabilities as process maps, Measurement System Evaluations, and NIST traceability.

Speaker: Kevin Belisle, Vaisala, Inc.

Topic: Relative Humidity and Dew Point Temperature Instrumentation and Calibration

Kevin provided an overview of humidity measurement and calibration concepts and explained the technologies and methods available for making humidity measurements. Kevin went into detail regarding making humidity measurements at less than 1% RH, and the importance of dew point temperature measurements at low humidity levels.

Speaker: Leon Barnes, Honeywell FM&T

Topic: Automation of Mass Calibrations

Leon gave an update on a Six-Sigma Blackbelt project to automate mass calibrations at Honeywell FM&T. New balances were recently obtained for mass calibrations, which replaced old analog balances that could not be interfaced with a computer. Leon presented Excel spreadsheets that he developed for automating mass calibrations. The new process will be used to validate measurement uncertainty and adequacy, and to provide continuous confirmation of process capability.

Speaker: Dennis Thede, Sauer-Danfoss

Topic: Calibration of Test Stands

Dennis provided an overview of the calibration process used for Test Stands at Sauer-Danfoss. Dennis reviewed the standards used and the general calibration process. Many of their calibrations are concerned with pressure and torque values.

Following the technical presentations, the group toured the Sauer-Danfoss facility. Of particular interest was the system in place to simplify the assembly processes to eliminate defects. The system utilized lighted bins to prompt the operator for the correct component for the next step in the assembly process. The day's activities came to a close with the completion of evaluation forms and drawings for door prizes.

I would like to thank all those who were in attendance, and Bob Dearth, Kevin Belisle, Leon Barnes, and Dennis Thede for giving the technical presentations. Hank Philipp and Sauer-Danfoss deserve a special thank you for hosting the meeting and providing refreshments.

The Kansas City group came through a little pixelated in the digital file. Being metrologists, I'm sure you all understand that some uncertainty in color picture detail is associated with the JPEG picture digitizing process.

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**Attendees:**

- John Gleason, AMC Technologies, Inc.
- Charles Fries, Honeywell
- Philip Juedes, Cal Lab Co.
- Kris Delage, Honeywell AES
- Charles Gaffney, Honeywell AES
- Leon Barnes, Honeywell
- Roger Dauvoux, Honeywell FM&T
- Bob Dearth, Honeywell FM&T
- Lauren Heine, Honeywell FM&T
- Steve Russell, National Research Institute
- Dave Woods, National Research Institute
- Kurt Wilson, Midwest Research Institute
- Davey Piño, Siemens-Danfoss
- Hank Philipp, Siemens-Danfoss
- Gerber Theede, Siemens-Danfoss
- Kevin Belisle, Vaisala, Inc.
- Walter Gilham, Technical

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May 21st, 2003
Bone Care International
Middleton, WI
Jay Bucher
Madison Section Coordinator

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Twenty people were in attendance at the May 21st, 2003, Madison Section meeting held at Bone Care International in Middleton, Wisconsin. Bone Care furnished excellent facilities and snacks, while lunch was "pay as you go" for this meeting.

Erin Quinn, the meeting hostess, welcomed everyone, and opened the meeting by having all the attendees give their name, company, and what they do. There was a large variety of companies and experience on hand.

**Editor's Note:** I know I live too much in the past, but reading about Erin's introduction process reminded me of a marketing association I used to belong to here in Palo Alto. It was an informal group, which met monthly to hear top marketing figures like Les Hogan of Fairchild (usually after significant food and drink, so our introductions were considerably reverent).

It was Watergate scandal time of the 70's, and during one introduction, one of the attendees introduced himself as Maurice Stans, and stated that his job was "confidential finance." (Loud laughter) Those with long memories will recall that Stans was Nixon’s election campaign chairman, jailed for campaign finance violations. When I would introduce myself as being from HP, the MC would observe that you could always tell the HP guys because their ties had horizontal creases from being asleep at their desks. Sorry, Jay, I couldn't resist.
Jay Bucher gave a short briefing on how the American Society for Quality (ASQ) develops their certification programs, using the Certified Calibration Technician (CCT) program as an example. Then each section of the Body of Knowledge (BOK) for the CCT was discussed among the participants. Jay also gave a brief overview of the Metrology Handbook that is being developed through ASQ Press for publication next year.

After the group picture was taken, lunch was enjoyed at either Bone Care's cafeteria, or at one of the numerous area restaurants. Door prizes were handed out, with all attendees receiving something from Promega Corporation, Bucherview Metrology Services, or 3M. We would like to express our gratitude to Terry Condor, our Regional Coordinator for his attendance and participation, along with the great door prize he furnished on behalf of 3M. Erin Quinn provided a very informative and entertaining presentation on the differences between metrology and meteorology, and how she educates the staff at Bone Care International on the capabilities and functions of a metrology department.

I would like to thank all of the attendees for their participation and interest in the topic presented. We had a varied group of people, and it is hoped that future meetings can be attended with the same vigor and enthusiasm. I would also like to thank Erin Quinn for her informative presentation, and being our contact point for this section meeting.

It is fascinating to see the range of technologies of our member companies. It is also interesting to realize that metrology principles are strongly behind the pharmaceuticals and medical advances that some of us may need someday. Reminding me of an HP friend who trained customers for years on HP's heart monitor systems, and one day woke up after his heart attack, looking up at the HP nameplate, and saying, "I hope I trained them right!"

Jesse Morse of Fluke, our host, welcomed us to the NCRLI Region 1430 Spring Meeting, held at Fluke's Everett, Washington facility. The presentations centered on electrical measurements and humidity sensor metrology. Thirty students and instructors participated from North Seattle Community College, Edmonds Community College and Sno-Isle Vorech.

North Seattle Community College has plans to establish a two-year degree program for electronic metrology technicians in the Pacific North West and benefited hugely by the students' participation in the meeting presentations.

Dave Agy, NCRLI Executive Vice President, welcomed the students and instructors in an adjacent conference room. Dave Deaver of Fluke Corporation presented, "Measurement Uncertainty in Electronics" to the students/instructors group.

Derek Porter, NCRLI Western Division Vice President, reviewed the April Board of Directors' highlights from the Boulder, Colo. meeting.

Jason Tang, Boeing - Gave a report and status of the 1M-Ohm ILC currently in progress.

Because of the large number of ILC participants, Jason won't present the final results until the 2004 NCRLI Symposium in Salt Lake City.

Patrick Andre, Andre Consulting, Inc. - Presented a discussion of ESD issues, proper handling, packaging, ESD mats, testing mats, ESD in the lab. That small spark that zaps us when we touch a doorknob or open the car door can have disastrous effects whenever we touch or handle sensitive electronics without considering ESD protection.

Neil Faulkner, Fluke Corporation presented "How the loading of an AC/DC transfer standard can affect your measurements of AC voltage and current". Neil elaborated on potential significant loading errors to be expected with Fluke AC/DC Transfer Standards and explained the sources of this error.

Dick Gronholm, Vaisala - Presented Water Vapor Measurements using various technologies, depending on accuracy and stability. Dick's presentation on this subject at our 1430 regional meeting revealed a pent-up demand for more knowledge and this was reflected in the number of questions asked at the end of the presentation.

Mike Boyd, NCS - Gave an overview of the Certified Calibration Technician Program. Mike reviewed the numerous sources of information available and reference materials when preparing to take the exam. NCS has committed to an ambitious 24-month CCT exam schedule for its entire technical staff.

Kevin Bull, Veriteq - Presented - Almost everything you wanted to
know about measuring relative humidity in the calibration laboratory and in the field. Kevin covered the process whereby calibration labs obtain meaningful ambient humidity and temperature data using a number of different systems. He covered the benefits and trade-offs between the competing systems.

Tom Cosgrove of NCS gave an automated testing demo of an Agilent 34401A using a Fluke 5520 Calibrator and Metalcal.

It was a large gathering with a full agenda. Many companies and organizations from the Pacific Northwest were represented by a huge pool of metrology and calibration talent. Our appreciation to Fluke and to all who attended and participated in our spring meeting.

A very special thanks to Lynn Matthews of the Fluke staff whose tireless work was instrumental to the success of the meeting.

Keith keeps coming up with great ideas for enlarging the impact of his meetings. This time he invited a number of college students with interest in measurements and technology.

Addenda:
Phil D靓o
Kay Sparkeda
Patrick G. Andre
Les Warren
Sandy Rzivin
Stanley Stenson
Dean Stowling
Jeff W. Davis
Vidac Diverse
Phil Johnson
Brian Kronick
David Lutzer
Robert Ochowski
Dennis Porter
Brian Zoblen
Jason Zhang
Lan Weller
Chris Yeehs
David Whiteside
Jim Riser
Joe Glauster
Bill L. Moseley
Tantra Anderson
Youg G. Jacobs
Kenya Wiley
Dave Agy
David Denver
Neal Fleshner
Joe Mores
Dave Hille
John Williams
Athena Mourelle
Charles Heggie
John Bat
Dana Austin
Brian Becker
James Walker
Wayne Banks
Larry Newberry

Facts for the Regions

Dear Mr. Cable,

On behalf of the Sno-Isle students who attended the conference, we would like to thank you for your kindness. While we were attentively listening to the speakers, our knowledge was expanding to new heights. Some very interesting facts that have been impressed into our heads are the calibration of machines. The DMM doesn't measure the exact voltage but can be calibrated to become close. Thank you for the prizes; we will thoroughly enjoy them. We hope to use the lessons we learned in the future. Again, we would like to thank you for inviting us to the conference.

Pavel Mochan
Mohamed Alamedi
Joe Richards
Dear Keith,

As a Sno-Isle student attending the conference, I'm glad to say that it was very informative and interesting. Listening to presentations like the ESD handling techniques were interesting to listen to and may help me and others on a later career path.

It was interesting to also look around the Fluke building, and to become familiar somewhat with the building, and it was nice to be able to talk with people representing other companies around the northwest.

Thank you for inviting us, and giving me the ability to gain experience this provided.

Chris Lacy

Dear Keith,

As a student of Sno-Isle skills center I would like to thank you for paying our way to the metrology conference at Fluke. I enjoyed it and it was a good educational experience to see and meet people from the industry.

We enjoyed looking around at the Fluke facility including the museum. Also, the raffle was fun and the lectures were very interesting.

Again I would like to thank you for giving me this opportunity to help me gain experience in industry.

Justin McMahen

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ERTL (North)
New Delhi, India
S. K. Kimothi
Delhi Section Coordinator

INDIA REGION REPORT

Visit Of Egyptian Govt. Delegates

The Electronics Regional Test Laboratory (North), New Delhi in the Delhi Region 5440, was pleased to host the visit of Egyptian Govt. officials and members of the Study Tour, on 10th & 13th December 2002. This Study Tour to India was sponsored by the United States Agency for International Development (USAID) with the purpose of assisting the Government of Egypt to strengthen their National Accreditation System for Testing & Calibration. This initiative was under the “Strengthening Egypt's Accreditation System (SEAS) Project,” being implemented by the Louis Berger Group Inc., USA, on behalf of USAID. The study tour in India was aimed at sharing the experience & knowledge of Indian Accreditation Bodies and laboratories in implementing a voluntary Laboratory Accreditation System using the same ISO Standards.

As a part of the Study Tour, two teams visited the Laboratory. Team “A”, also called the “Senior Team”, consisted of officials at the helm of affairs who were looking for the inputs which would enable them to launch the accreditation system beginning in 2003, and take steps for MRA within ILAC System. The Junior Team (Team “B”) consisted primarily of the laboratory researchers who wanted to look forward to understand the basics of ISO 17025 Standard criteria and different ways of demonstrating the competence. They also wanted to gain experience on laboratory quality management, standardized test methods, operating procedures, work instructions and documentation.

Mr. S. K. Kimothi, Director of Electronics Regional Test Laboratory (North) and NCSLI Coordinator, Delhi Section welcomed the guests and gave brief presentation on the mission, quality policy, infrastructural facilities, technical competence, activities and achievements of the laboratory. This was followed by detailed discussions and interaction with senior officials of the laboratory on various aspects of laboratory accreditation and elements of ISO 17025 particularly related with internal quality audit, corrective action, management review, proficiency testing and documentation. Thereafter the team members visited the testing and calibration sections of the laboratory to have first-hand impression of the various facilities and interact with the working level officials of the laboratory.

The visitors complemented the laboratory staff for sharing valuable information and having useful & interactive discussions.

A small sign on my co-workers cubicle says: "Innovate where you can add value to your customer-standardize where you cannot." I think these inter-country procedure exchanges do much to share good practices and results, and standardize the ways we perform our tasks.
I'm impressed to see the number of women metrologists in this delegation. I suspect it will be some time until the U.S. will have similar results of women in science.

Delegates from the third world countries visited the Electronics Regional Test Laboratory (North), New Delhi (Delhi Region 5440) on February 10, 2003. The visit was organized by the Central Scientific Instruments Organization (CSIO). Those delegations were sponsored by the Ministry of External Affairs, Govt. of India, under its ITEC/SCAAP Program to attend a Management Development Program on Operation, Maintenance and Repair of Analytical Equipment. As an integral part of this study tour, these visiting delegates are taken to various Research Laboratories, manufacturing concerns and instrumentation facilities in hospitals.

Mr. Gurumukh Singh, Additional Director of Electronics Regional Test Laboratory (North), welcomed the guests and gave brief presentation on the mission, quality policy, infrastructural facilities, technical competence, activities and achievements of the laboratory. This was followed by detailed discussions and interaction with senior officials of the laboratory on various aspects of laboratory accreditation and elements of ISO 17025, particularly related with internal quality audit, corrective action, management review, proficiency testing and documentation. Thereafter the delegates visited the testing and calibration sections of the laboratory to have a firsthand impression of the various facilities and interact with the working level officials of the laboratory.

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COMPENDIUM OF CALIBRATION FACILITIES RELEASED

For mutual acceptability of measurement results, it is essential that they are compatible, i.e. in agreement irrespective of time and place of measurement. The National Measurement System in a country ensures a consistent and internationally recognized basis of measurement and helps in obtaining compatible measurements. Accredited calibration laboratories as part of national measurement system support organizations and individuals to obtain traceable measurements.

The need for calibration services is increasing in developing countries because of regulatory requirements as well as enhanced awareness about quality of products. To meet these requirements, the Government of India has established a network of 14 calibration laboratories under the banner of STQC calibration service. A compendium of STQC calibration facilities consolidating the information on calibration facilities and measurement capability of the above laboratories has been prepared for the benefit of the customers. The compendium was released in a function by Dr. S.L.
Dr. S. Sarnot, NCSLI India Coordinator (l), proudly displays his new Compendium of India calibration facilities.

A new Calibration Compendium consolidates information on India calibration facilities and measurement capabilities.
On May 6th, 2003, the Central CA/Nevada region 1410 had its spring regional meeting at the Anritsu Corporation in Morgan Hill. Regional Coordinator Guy Fleming kicked off the meeting, along with Anritsu's director of Quality, Marcel Dubois. Frank Tieman, senior Vice President and General Manager of Anritsu Corporation, our host for the day, welcomed the attendees.

Guest speakers for the day were:

Dr. Godfrey Kwan of Kwan Research who gave us a presentation on "Modeling of Test Ports in Microwave and Millimeter Vector Network Analyzers Calibrations."

Mathew Patrick of Anritsu gave us a presentation of "Evaluation of EA guidelines for Vector Network Analyzers."

Dick Gronholm, Regional manager of Vaisala who gave us a presentation on "Water Vapor Theory & Measurements."

Vincent Wong of Anritsu who gave us a presentation on "Microwave Power Sensor Cal and Uncertainty Analysis."

Each talk was well received with various questions of the 36 attendees. Door prizes were handed out, courtesy of Fluke and NCSLI. Each of the presenters were given "thank you mementos" for their much appreciated work and time.

After the luncheon, a roundtable discussion was held to see what the attendees would like to discuss and hear at the next meeting. Items such as ILCs, transportation, vacuum, miniature threads, mass flow, web based training, accreditation, cal intervals and equipment repairs were high on the list.

Special thanks go to all those that took time away from their busy schedules to make this session very successful.

Guy Fleming organizes Silicon Valley to drive south a dozen miles to Anritsu in Morgan Hill in the Coyote Valley for their meeting.
President's Message (continued from cover)

As Metrologists, Scientists, and Engineers, we can lose sight of where metrology often takes place. When many of us hear the word metrology, we think of the lab-coat-adorned scientist working in a state-of-the-art laboratory, performing what we sometimes call "black art" and attempting to measure what has never been measured. While this is metrology, we must remember that "the science of measurement" takes place at many levels and takes many forms. For example, a technician calibrating a scale in a warehouse, a specially designed in-process gage used to control a machine-tool production line, or the analysis of wastewater to ensure that we are not impacting the environment; all of these involve the science of measurement.

The spectrum of metrology is very broad and encompasses a range of sciences, techniques, tools and levels of accuracy. One does not always need to measure microrins or at the parts-per-million level to perform metrology. In many instances, metrology that touches our everyday lives is the metrology that makes the final decision as to whether the product meets our needs. At the end of the day, metrology covers a continuum of measurements performed from the highest-level laboratories to the gasoline pump, and each level presents unique challenges and rewards.

As you look at the current NCSLI membership and compare it to the broad metrology community, I believe there are a great number of small to medium metrology organizations that are not members and don't have access to the important information that our NCSLI organization has to offer. Economics many times plays an important factor in the small to medium organizations not becoming members. But in many instances, I believe these organizations simply view NCSLI as not providing information that will necessarily help them in their day-to-day challenges. This is why we selected the theme for this year's conference, to show that the NCSLI can provide a forum for organizations of all sizes and types.

At this year's conference, you will see world-class metrology R&D organizations providing information on the latest in measurement technology, while a group of small businesses provide a tutorial on how to run an effective laboratory. While this year's conference will continue to provide the latest information on state-of-the-art measurement technology and techniques, the attendee will note an increased emphasis on the more fundamental and practical applications of metrology.

Laboratories that directly support product quality in industries such as Automotive or Aerospace, will find information that will provide them with practical tools they can use to improve their technical capabilities and the way they do business. Few, if any, events can provide its attendees with the opportunity to learn and develop from other organizations and cover such a broad range of expertise and technology.

In addition to the metrology professional, the location for this year's conference provides an opportunity for many family activities. I strongly encourage small to medium organizations to attend this year's conference to learn and develop with other metrology professionals from around the world.

Realizing the Long Range Plan (LRP)

In addition to the conference, the NCSLI organization continues to realize the long-range plan established last fall. Following are some highlights discussed at the recent board of directors meeting, listed under the various LRP sections. This further illustrates the commitment of the organization's leadership to further develop the NCSLI organization as a world-class organization.

Operational Objectives for 2003

Communications:

Standards Activities. It was reported by the NCSLI Director to ILAC/NACLA, that a new draft of ISO 17025 harmonizing with ISO 9000:2000 has been written and is estimated to be complete by the end of 2003. It is not clear at this point how or when laboratory accreditation bodies will plan to implement the revised standard.

The ANSI Writing Group, NCSLI Committee 174, has established a Working Group 1 to look into the replacement of Z-540.1-1994 (R2002). The committee is actively seeking volunteers from the testing laboratory community to assist in the development of a revised standard. Any testing laboratories interested should contact the chairman of Committee 174, Jesse Morse, for more details.

At this year's conference, in addition to the traditional committees meeting and presenting their work, there will be several activities involving NCSLI committees involved in surveys. These survey activities are important to help NCSLI understand the needs of the metrology and testing community and进而 present this information to the membership. The committees that will either have meetings or that will be presenting survey findings will include: Measurement Requirements Committee chaired by Jeff Walden & Chef Franklin, the Benchmarking Committee led by John Wade Keith, and the Education and Training Committee led by Tenerelle Wilson. In addition to these committees, the Small Business Initiative Forum, led by Malcolm Smith, will be seeking information on how NCSLI can better service the needs of small businesses involved in testing and calibration.

Education and Training:

Education is seen more and more as a cornerstone of the future of the testing and calibration industry. To this end the board of directors has approved changing the vision statement for NCSLI to:

"Promote competitiveness and success of NCSL International members by improving the quality of products and services through excellence in calibration, testing, and metrology education and training."

In keeping with this increased emphasis on education and training, I would encourage the regions and sections to carry this theme into their local meetings. This could take the form of inviting local schools to attend your regional and sectional meetings. This may help to emphasize the need for the "science of measurement" to be a part of educational curricula. Each section is also encouraged to
identify a point of contact for education that can be the liaison between the local educational institutes and the NCSLI V.P. of Education, Dave Nebel.

This year's conference will set an example by inviting local schools to send students to the conference for an afternoon. Our hope is that this will help students and educators begin to see the opportunities that exist in the testing and calibration industry.

NCSLI is also investigating becoming an accredited CEU provider. This would further NCSLI's ability to offer CEUs to those who attend our technical sessions and tutorials. NCSLI will also begin to award individual scholarships for next year; application forms will soon be available on the NCSLI web site.

Partnerships:

NCSLI has established a reciprocal agreement with the AIAG, the Automotive Industry Action Group, to share information and potentially work jointly on testing and metrology-related projects. Several other industrial and professional organizations have also expressed an interest in establishing a strategic relationship with NCSLI, one that will benefit the members of each organization.

Fiscal Management:

In keeping with good fiscal management, NCSLI is continuing to seek a new location for the NCSLI business office. A location that would provide a better facility for the staff would allow the staff to better serve the membership of NCSLI. In addition, the new NCSLI office could serve as training venue for testing and metrology-related training.

Breakthrough Objectives for 2003:

Value to the Membership:

There are some new committees being considered, the Metrology Knowledge Data Base, led by Dave Nebel and Chris Grachanen. This committee is being considered at the request of some member organizations involved in the development of the ASQ Certified Calibration Technician or ASQ CCT program. Also, in keeping with the emphasis on small business, the Small Business Initiative Forum, led by Malcolm Smith, is being considered. This forum would look at the needs of small businesses involved in the testing and calibration industry.

As mentioned in earlier newsletters, NCSLI has established three new membership options, Educational Organization, Student, and Individual Professional members. I encourage anyone interested in these memberships to visit the NCSLI web site for further information, or contact the Membership Committee chairman, Larry Yates.

In the area of NCSLI publications, soon to be published is "The Matrix," a document entitled "Comparison Between ANSI/NCSL Z540.1-1994 (R2002) and ANSI/ISO/IEC 17025:2000." This will be an invaluable tool for anyone involved in developing a process that must satisfy both of these standards.

NCSLI has also seen an increasing interest in Chemical Metrology, which is highlighted in BIPM and SIM reports. Conference attendees will also note an increased number of technical sessions related to chemical metrology in this year's technical program.

Organizational Management

Some additional conference highlights include:

- On-line registration is available at <www.ncsli.org>.
- Hotel registrations need to be in early, hotels are filling fast.

There is still limited room available in the tutorials, but again you need to act fast to guarantee a seat.

I strongly encourage participation in the various committee meetings. You will find that most of the meetings are held after the technical sessions each day. These meetings are open to all interested parties so please plan to attend.

To continue the development of the NCSLI leadership, there will be a Leadership Workshop for coordinators and committee chairs being held the Sunday afternoon of the Conference. Again I encourage coordinators and committee chairs to attend this professional development opportunity.

I hope that both member and non-member organizations can see that NCSLI is a dynamic organization, adjusting to the needs and size of its members and always striving to improve and better serve its membership and the measurement community.

If you are not a member, I encourage you to look at the real value of becoming an NCSLI member. If you are a member, participate! Whether locally, or at the annual conference, this is your best way to really get maximum value from your membership. I look forward to seeing you all at the conference this year.

Steven Stahlley
NCSLI President
Editor's Message (continued from page 2)

So what I did was to run just the first page of their work, on page 13, and note that if you have deeper interest in thermometry, you can request your own copy in MSWord format from the Business Office, the author or myself, who has the entire file.

Good promotion in Seattle

You will notice that I like to run the full reports from our Regional Commanders, even though sometimes the reports are redundant for the speakers or topics. The reason is that creativity in one region can often be interesting to other coordinators making up their meeting plans.

This issue, Keith Cable in Region 1430 reports on his action to invite a considerable number of college technical students to their region meeting. I think he ended up with 19 students who joined their meeting and plant tours. In addition, it offered the chance to mix and talk with career metrologists to see what a terrifically challenging life we live. No, it’s not all statistics.

Great idea, Keith.

John Minck
Editor

LAURIE BAKER PASSES

Near press time, we received word from Ruben Salazar at Boeing that Laurie Baker passed away Sunday, June 1, 2003. The cause of death was apparently lung cancer. Laurie had been retired from Boeing for several years, but was still active with the Southern California Measurement Science Conference Organization. Baker's tireless work with NCSLI's committees is legendary, and will be expanded in our next issue.

NIST's Charles Erhlich remembers Laurie: "Laurie was one of the first people I met and continuously interacted with outside of NIST after I started there over 18 years ago. From the beginning he showed an unwavering dedication to furthering the cause of metrology, not only through his technical work in his own laboratory, but through his involvement with the Measurement Science Conference and NCSLI.

His participation and leadership on several standards committees was crucial. These included the Pressure RISP committee, an earlier American Vacuum Society committee on calibrated leaks, and his leadership for many years of the NCSLI National Measurement Requirements committee that provided important planning information for NIST and the U.S. Congress. There were doubtless others of which I was not aware.

Laurie was warm, humorous, yet serious, and exhibited an extraordinary even-tempered and rational approach to things, even if he was upset! And he was also a very hard worker, putting in numerous hours, above and beyond, in developing the RISP and other documents. I always looked forward to getting together with Laurie when we were reviewing the RISP yet one more time, since I knew it would be productive yet enjoyable."
Jesse Morse shows us some NCSLI service beyond the normal call of duty, getting around on a cane, to present his Board report.

Bill Wightman (l) leads the agenda discussion for conference activities during the Board meeting.

Steve and Melanie Stahley have a dinner conversation with NCSLI-retired Bill and Inga Sorrells. Bill retired from Agilent a couple of years ago in the Colorado area. It is not surprising to most of us old timers to state that NCSLI relationships last a lifetime.

With our high tech economy in the dumps, it is remarkable to see this kind of member company commitment to our trade association and its key activities.

Carol Hacker shows off her Tampa-2003 Conference shirt. One of the best perks of Board duty is a regular batch of promo T-shirts. You can get your own by signing up for volunteer duty. There are plenty of open spots.

It's always questionable editing to show pictures of our industry volunteers or business office staff with drinks in their hands. But the photographer assured me it was iced tea.
The U.S. Measurement Requirements Committee will be actively involved with the August 2003 Symposium and Workshop in Florida. First, there will be a short-form, one-page Measurement Requirements Survey in the registration packets for each attendee. Symposium and Workshop attendees who complete this survey and turn it in will be eligible for a special door prize award at the end of the conference. Secondly, on Monday the 18th at 4:15 PM there is a special session, hosted by the USMRC, and led by Georgia Harris of NIST on "Magnetism Measurements in Mass."

On Tuesday, there will be two technical sessions: Session 3A, "Transformation in Measurement Requirements," hosted by the US and Canadian MRCS. Then we'll participate in Session 4A, "Towards a National Measurement Strategy", hosted by NIST.

All of this will lead participants on the trail towards meeting the future in measurement requirements. On Wednesday, there is the biannual meeting of the USMRC. Be sure to look for us in the exhibit hall, where we will have a booth this year. There you can get a "Hands-On" demonstration of the new USMRC process, on line at the NCSLI website.

The "Guide for Interlaboratory Comparisons," RP-15, is being slowly updated and will include information on the new ILC certificate, National ILC database, SRM topics, data from ILAC 13 and ISO Guide 43, information on the NIST Dataplot program and an updated Bibliography. The RP-15 will now be titled a "Recommended Practice for Interlaboratory Comparisons" vs a "Guide for Interlaboratory Comparisons." We hope to have most of the material included in the RP re-write by our meeting time at the NCSLI Conference. Material for the update was provided by Georgia Harris, Larry Tarr, Tom Quinet, Clark Hamilton, Jeff Gust and Dick Pettit.

The NCSLI MCP Committee Meeting is scheduled for Tuesday, August 19, from 4:30 to 6 PM in Room 6 at the Marriott Waterside.

An Interlaboratory Comparison Tutorial is scheduled for Friday, August 22, from 8 AM to 12 Noon in the Salon III at the Marriott Waterside. Hosts are Carroll Brickenkamp, Henrik Nielsen and Jeff Gust.

There is also a UV ILC meeting from 4:15 to 6 PM in Room 10 and a Voltage ILC meeting from 4:15 to 6 PM in Room 11 at the Marriott Waterside.

Gary Hysert, NRC Canada, and Michael Koehne, PTB Germany, will host 2 Comparison Sessions at NCSLI. Check the NCSLI web page for more details.

There is also a paper on the NCSLI Josephson Junction ILC on Wednesday, August 20, from 10:45am - 12:15pm - Session given by Stuart Kupferman.

Jason Tang, Boeing, reports that there are 19 active participants in the 10 MegOhm ILC. Due to the delay of this ILC program, its estimated completion date will be in September of 2003. Jason also will have a meeting at NCSLI to discuss this ILC. Results of this ILC will be given at the 2004 NCSLI meeting in Salt Lake City.

All details on the above meetings are also found on the NCSLI web page at <www.ncsli.org>. View this NCSLI web page frequently for any updates as they occur.

If you know of corrections to the above table let me know.
The Mass ILC final report was disseminated by Jim Ross (Quality Control Services) email:

<Lab@qc-services.com>, NIST software was used to generate the final report. Two I-kg artifacts were used in the ILC. Quality Control Resources did the analysis. Jim reports that Quality Control Services is the pivot lab for the WRAP 100 g to 1 mg round robin. Contact him if you are interested.

Bart Schrijver, Agilent Technologies, is coordinating a new RF Power ILC. There are approximately 16 participants. Dilip A. Shah, E = mo3 Solutions, has volunteered as the data processor. A charter has been written and a schedule has been established. The ILC will begin this Summer. See more details in the above table.

John Cable, Honeywell FM&T, <jable@kep.com>, coordinates the IEEE Microwave Theory and Techniques - Automatic RF Techniques Group (ARFTG) round robins in support of automatic network analyzers. The following connector types are supported in the round robin effort. Thanks to John Cable for providing this information. Note the new 7-16 connector.

ARFTG MCP ILC Points of Contact

2.4 mm connector, Bart Schrijver, Agilent Technologies. Phone (707) 577-2405, FAX (707) 577-5484, e-mail <bart_schrijver@agilent.com>

2.92 mm/K connector, Gilbert Perez, Anritsu. Phone (408) 778-2000 ext. 4950, FAX (408) 778-4010, e-mail <gperez@nang.us.anritsu.com>

3.5 mm connector, Phil Yates, JPL. Phone (818) 393-3705, FAX (818) 354-8153, e-mail <pyates@jpl.nasa.gov>

GPC-7 connector, Yeu-Soon (Brian) Lee, Anritsu. Phone (408) 778-2000 ext. 4976, FAX (408) 778-4010, e-mail <brian-ys.lee@anritsu.com>

7-16 connector, Greg Burns, Northrop Grumman. Phone (410) 765-7331, FAX (410) 765-7370, e-mail <burns.greg@postalsese.de.northgrum.com>

Type 'N' connector, John Cable, Honeywell FM&T. Phone (816) 997-4361, FAX (816) 997-3803, e-mail <jable@kep.com>[ARFTG MCP Com.Ch.]

John Cable also reports that ARFTG is looking into the possibility of getting together 1.85 mm & 1 mm MCP kits.

ARFTG is working to re-write and update the instructions for the kits with an effort to do a better job of explaining the measurement convention (connector or port). ARFTG are also going to try and automate the submission of the data files through a web-based script system. They currently e-mail data files to NIST and (with the proper formatting) can expect to see the results returned in one to two days. Our biggest problem has been getting everyone to format the data properly.

Tom Larson, NIST, <thomas.larson@nist.gov> announced the need for a new UV ILC. Tom coordinated a UV ILC in the early 1990s.

New Proposal for Electrolytic Conductivity ILC

Joe Petersen, Metrology Engineer at Abbott Laboratories, informed me that he would like to start an Electrolytic Conductivity (Resistivity) ILC. The range is 0.056 uS/cm to 147 uS/cm. The artifact is a conductivity meter(s) with flow through and dip cells. Joe would like to have approximately 6 to 10 participants. Joe's phone number is (847) 938-9109 and FAX is (847) 938-4634 <joe.petersen@abbott.com>. Joe provided me more information on conductivity in the email I received, as noted below:

Orion offers a nice summary of Conductivity Theory at:

Co mm ittee Ne ws

<table>
<thead>
<tr>
<th>SRM</th>
<th>Type</th>
<th>Nominal Conductivity (us/cm)</th>
<th>Uncertainty (us/cm)</th>
<th>Uncertainty (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3198</td>
<td>KCl in n-propanol deionized water</td>
<td>5</td>
<td>0.19</td>
<td>3.80%</td>
</tr>
<tr>
<td>3199</td>
<td>KCl in n-propanol deionized water</td>
<td>15</td>
<td>0.26</td>
<td>1.73%</td>
</tr>
<tr>
<td>3190</td>
<td>HCl in deionized water</td>
<td>25</td>
<td>0.26</td>
<td>1.12%</td>
</tr>
<tr>
<td>3191</td>
<td>KCl in deionized water</td>
<td>100</td>
<td>0.43</td>
<td>0.43</td>
</tr>
<tr>
<td>3192</td>
<td>KCl in deionized water</td>
<td>500</td>
<td>3.2</td>
<td>0.64%</td>
</tr>
<tr>
<td>3193</td>
<td>KCl in deionized water</td>
<td>1000</td>
<td>0.59</td>
<td>0.06%</td>
</tr>
<tr>
<td>3194</td>
<td>KCl in deionized water</td>
<td>10000</td>
<td>5.9</td>
<td>0.08%</td>
</tr>
<tr>
<td>3198</td>
<td>NaCl in deionized water</td>
<td>20000</td>
<td>20</td>
<td>0.10%</td>
</tr>
</tbody>
</table>

For the ILC, I would probably choose test values of 0.056 us/cm, 1 us/cm, and 147 us/cm. NIST offers the following SRMs (as of 7/3/02):

However there are three industries that depend upon conductivity measurements below 5 us/cm.

1) The microelectronics industry needs pure water for wafer production. The water must normally have a resistivity>18 Mohm*cm (conductivity <0.056 us/cm).

2) The electric power industry relies on conductivity measurements to monitor the quality of boiler water. The same needs may apply to a nuclear reactor in a submarine. I believe that in most cases the water conductivity is less than 15 us/cm.

3) The pharmaceutical industry uses conductivity measurements to verify the purity of water for injection and water used as a component in other health care products. For many applications the upper limit is 1.5 us/cm.

Note from the table above that the NIST SRMs all have conductivity above the critical point of these industries. In lieu of NIST SRMs, many organizations prepare their own standards in accord with ASTM D1125. The lowest value defined in this standard is 147 us/cm. With a 147 us/cm standard, extrapolation of greater than 2 orders of magnitude is used! For the microelectronics and pharmaceutical industries, an uncertainty of around 2% of reading is desirable. It is not clear to me that any one can rigorously claim this uncertainty when extrapolation is used.

Unfortunately not a single person has contacted Joe with interest in the ILC yet. Joe's phone is (847) 938-9109 and FAX is (847) 937-4634 <joe.petersen@abbott.com>.

David Krukar, Sandia National Laboratory, is interested in coordinating a Chilled Mirror Hydrometer ILC for Humidity. Dave can be contacted at (505) 844-5944 or email <dckruka@sandia.gov>.

Interested Participants

Fred S. King <fking@keilabs.com>, QA Manager at Kimball Electronic Laboratory Inc., is interested in participating in future ILCs in measuring Gage Blocks, and DC resistance.

TestEquity Inc. is interested in participating in AC/DC Current and Voltage and Resistance ILCs. Contact Tim Holder, Quality Assurance Coordinator TestEquity Inc. Phone Tim at 805-498-9933 x134, FAX 805-498-3733 or email <timh@testequity.com>.

For more information about the NCSLI MCP Committee contact Jim Wheeler at (619) 545-9698, FAX (619) 545-9861 or Al Teresa at (619) 545-2857.

On a personal note, and for people who communicate with our office, Jim MacKinnon, our NPSL Electrical Competency Manager, retired on May 29th after 30 years at NPSL. He is being replaced here by Wedad Schlotte. Wedad brings to NPSL many years of experience in Navy ATE systems as a manager for CASS.

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DOCUMENTARY STANDARDS APPLICATIONS
Larry E. Nielsen, V.P.

LABORATORY EVALUATION RESOURCES
James Crone

Jim Crone is retiring from Keithley Instruments effective June 1, 2003 and has submitted his resignation as 171 committee chair. NCSLI is indebted to Jim for his committee service and for his years of experience in metrology. Thank you Jim, and we wish you the best in your retirement years. Keep in touch.
LABORATORY FACILITIES
Dr. David Braudaway
Doug Cooper
Dave will be presenting a paper of environmental needs in measurements in Tampa. He is on a panel and will be serving as a session host. Also, he will hold a committee meeting at that time.

METROLOGY PRACTICES
Dr. Howard Casnip
Work has begun on an update to RP-12 (Determining and Reporting Measurement Uncertainties).

WRITING COMMITTEE
Jesse Morse
The board will be asked to vote on publication of "A Comparison Between .Z540.1. and ..17025:2000."

Report:

As a result of having a quorum at the meeting held January 15th during MSC, this has been a productive quarter. Activities begun this quarter will be continuing through the next several quarters. Of particular note is the way this meeting was held; i.e. due to an accident preventing me from traveling, I chaired this meeting remotely with the vice chair (Doug Sugg) facilitating locally. We also had several members call in on conference to actively participate in all transactions. I expect to continue expanding the meeting participation through technology that will further the openness required by ANSI.

The most important action to come out of the January 15th meeting was the establishment of a subcommittee charged with the task of "revising the American National Standard ANSI/NCSL Z540.1-1994 (R2002) to support current and projected National Measurement System requirements for the management of measurement integrity." The objective of this subcommittee is to "establish within a single document, a unified and harmonized framework for the management of measurements from an end-measurement application through applicable test and calibration laboratories to designated standards." The quotes are those that were agreed to and approved by the consensus committee. The completion of this task must be done by July 2006 in order to meet the requirements of ANSI for revising standards.

Del Caldwell was appointed as the chair of the subcommittee, and was approved by the consensus body. A request for volunteers to populate the subcommittee was sent to the 174 committee members on February 13th, and by way of publication of this report notification is given to non-174 committee members that they are welcome to apply for participation as well. All subcommittee members must by confirmed by the main body of the 174 committee. Confirmation of the first sixteen applicants is in process and should be complete in time to have a subcommittee meeting at NCSLI Conference.

The second item of importance that was achieved was the approval of the consensus body to publish a document describing the variations between Z540-1 and 17025. The official title approved by the committee is, "A Comparison Between ANSI/NCSL Z540.1-1994 (R2002) and ANSI/ISO/IEC17025:2000." This document has been submitted to Larry Nielsen (VP) for presenting to the Board of Directors, at the meeting in Boulder in April, for concurrent approval for publication as an NCSLI document. This is a document that is sorely needed in the industry today. I am hopeful it can be available to everybody very soon after technical editing is done with it.

The minutes of the January 15th meeting are posted on the 174 committee website and may be listened to via streaming audio. Also posted is our committee charter, goals, and policies and operating procedures for those interested. Written minutes will be available by May 1st.

ACCREDITATION RESOURCES
James Jenkins
Jim has been consulting with representatives of the various US accreditation bodies and has advised that some consensus has been reached on presentation of laboratory scopes, and that he hopes to incorporate his findings in the update to RP-9 in time for Tampa.

CALIBRATION PROCEDURES
Dale Varner
Dale attended the board meeting in Boulder and provided his report at that time.
BAILEY APPOINTED DIRECTOR OF NIST BOULDER LABS

Zelda Chapman Bailey, a career government employee who has held increasingly responsible positions with the U.S. Geological Survey (USGS) and the National Park Service, has been appointed director of the Boulder Laboratories of the NIST. Bailey will begin her new duties on May 5, 2003.

Bailey formerly was the interim director of the National Cave and Karst Research Institute in the National Park Service. She began her career in 1977 as a hydrogeologist with the U.S. Geological Survey in Indiana and later worked in Tennessee. Bailey then served as assistant district chief for operations for the USGS in the Caribbean District, and moved to Colorado as associate district chief for hydrologic studies. She also completed extended assignments as acting district chief for Colorado and Wyoming.

As director of the Boulder Labs, Bailey is the senior site manager and oversees the facilities and technical infrastructure for NIST Boulder's 400 scientists, engineers, technicians and support staff. She also leads the public outreach associated with NIST Bonder's technical program and is responsible for interactions with the community and the other Commerce agencies on-site.

Contact: Fred McGehan, Boulder, (303) 497-7000

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NIST, HP MOVE TOWARD CRITICAL MOLECULAR ELECTRONICS MEASUREMENTS

Researchers at the NIST and Hewlett Packard (HP) Laboratories will report this week that they are progressing toward reliable methods for measuring the electrical behavior of molecular electronic devices, an infant nanotechnology eyed for future integrated circuits.

Using a "crossbar" test structure consisting of a one-molecule-thick film (a monolayer) sandwiched between a series of perpendicular metal wires, collaborators at separate facilities recorded nearly identical electrical measurements. This step, along with others taken to eliminate potential sources of error, ensures that the measured behavior is directly attributable to the device, not the experimental set-up.

To be announced on April 2, 2003, at the GOMACTECH Conference in Tampa, Fla., the accomplishment: well may be the first capacitance-voltage measurements of a molecular-electronic device. These and other measurements confirmed that the device functioned like a switch, alternating between different currents in response to different input voltages.

The results also pose something of an enigma, says NIST physicist Curt Richter. The two-state system is due to the presence of the molecular layer, he writes with HP collaborator Duncan Stewart. However, the molecular monolayer is not the sole cause. Rather, the researchers say, the switch-like behavior is probably the result of an interaction at the interface between molecule and the wire electron.

Although several research groups have demonstrated single-molecule devices in the laboratory, a suite of reliable measurement methods is needed to move molecular-electronics technology beyond the proof-of-concept stage.

To read the paper "Metrology for Molecular Electronics" by C.A. Richter and D.R. Stewart, go to: <http://www.nist.gov/public_affairs/richter.pdf>.

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NIST CONFERENCE TO SHOWCASE LATEST IN DVD TECH AND STANDARDS

Declining prices and new software have combined to make DVD authoring tools available to home computer users. The change is bringing capabilities to home computer users that, as little as two years ago, were affordable only to professional video producers. In addition, private and public sector organizations are considering the use of DVDs to manage and preserve their digital assets.

DVDs are used increasingly in arenas ranging from instructional training to preservation of massive amounts of digital information. They also are showing up as a replacement for VCRs in many American living rooms and corporate offices.

The NIST and the DVD Association (DVDA) are holding their fourth annual international conference, DVD 2003, on June 9-11, 2003. DVD 2003 will allow industry professionals to see firsthand how DVD technology—the premier format for video, audio and data storage—is influencing a variety of fields, including health care, finance and homeland security.

Topics for the three-day conference include: blue laser technology and HD-DVD, the interactivity of simulations and games with DVD, writable DVD standards and interoperability, the role of DVD in digital preservation, DVD usage in the federal government and niche markets. In addition to the technical program, DVD 2003 will feature short courses on DVD applications and vendor exhibits showing the latest in DVD authoring and replication tools.


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NIST RESEARCHERS 'GO DANCING' WITH SYNCHRONIZED LASERS

Pulsed lasers are like middle schoolers at a dance. You can put them in the same physical space but they still don't pair up very well. Recently, however, NIST researchers working at JILA (a research and teaching institute operated jointly by the University of Colorado at Boulder and NIST's Boulder Laboratories) have coaxced ultrafast
pulsed lasers with different wavelengths not only to match the timing of their pulses but also to lock into the same "phase," or cycle of peaks and troughs. To extend the analogy, the NIST researchers have made unruly, ultrafast lasers do the equivalent of two middle schoolers moving in perfect synchrony like Olympic ice dancers.

The technique provides an important new tool for studying the motions and vibrations of atom groups within molecules. By synchronizing and locking the wave forms of two, sub-picosecond lasers together, the NIST researchers have made a well-controlled, tunable source of infrared radiation that can be used to precisely break specific bonds or produce specific rotational or vibrational changes in large molecules. The technique also may be useful for transmitting ultraprecise frequency signals and for mapping the chemical composition of living cells with pulses so quick they do not damage the living tissue.

The ultimate goal of the research is to make an optical waveform synthesizer that can create an arbitrary optical pulse on demand and use this tailored energy to control molecules and atoms precisely.

Contact Jun Ye, (303) 735-3171, <jy@jila.colorado.edu>.

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NIST TO DISCONTINUE ITS ROLE IN SATELLITE TIME DISSEMINATION

Since 1974, the time and frequency signals of the NIST have been relayed to most of the Western Hemisphere by two GOES (Geostationary Operational Environmental Satellites) weather satellites operated by the National Oceanic and Atmospheric Administration (NOAA). The signals have been able to set clocks with suitable timing receivers to within 100 microseconds (millions of a second) of the Coordinated Universal Time (known as UTC). However, most users of time signals have switched over to those provided by Global Positioning Satellites (GPS), which offer greater accuracy and a worldwide distribution. As a result, GOES timing receivers have been off the market for some time.

With the need for the satellite time service diminishing, NIST and NOAA recently made a joint decision for NIST to discontinue its involvement with the GOES program on Jan. 1, 2005. NIST will continue to control and monitor the time code through Jan. 1, 2005, to allow users who require a high-accuracy signal sufficient time to replace their existing receivers.

NOAA plans to provide a GOES time code indefinitely after Jan. 1, 2005. Existing receivers should be able to continue to receive and decode the time signal; however, the received time is expected to be less accurate when NIST discontinues its involvement.

For more information, contact Michael Lombardi, (303) 497-3212, <lombardi@boulder.nist.gov>.

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NIST RESEARCH IMPROVES PROSPECTS FOR RELIABLE QUANTUM COMPUTERS

Prospects for a powerful new type of computer improved recently when NIST scientists developed a technique that greatly increases their control of "quantum bits," or qubits, which someday may store and process data by harnessing the laws of quantum mechanics.

Using ions (charged atoms) as qubits, the NIST team demonstrated a way of precisely controlling a "logic gate" (or computational operation) between two qubits 97 percent of the time, compared to just 80 percent with previous techniques. With further improvements in reliability of the gate operation, universal computation on a large scale should be possible.

Qubits represent information as 1s and 0s, like digital bits in today's computers. The NIST scientists use lasers to manipulate beryllium ions trapped in a vacuum so that they "spin" up or down to represent 1 or 0. The quirks of quantum mechanics allow ions to exist in blends of the two spin states, and also to become "entangled," so that the properties of two ions are intertwined. Qubits are, therefore, able to represent multiple values simultaneously and to link these values in logical ways, such that a quantum computer could perform tasks like factoring very large numbers that are impossible with today's technology.

The recent NIST experiments, reported in the March 27, 2003, issue of Nature, focused on precisely manipulating qubits to control entanglement and the computation process. The logic gate is activated by conditions that include the frequencies of two laser beams and the ions' spin states. Depending on whether the first qubit is a 0 or 1, the gate may flip the spin of the second qubit.

Logic gates that control entanglement are essential elements of quantum computers, which also would contain other components, such as memory regions, already demonstrated by the NIST team.

For more information, contact Dietrich Leibfried, (303) 497-7880, <dlf@boulder.nist.gov>.

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NIST OFFERS QUICK GUIDE TO DRM ORGANIZATIONS, STANDARDS

The internet has dramatically changed the way digital content, such as digitized music, films and books are produced and sold. Some consumers prefer to buy such things over the Internet because it often is less expensive, more convenient and saves a trip to a store.

Yet Internet offerings have been limited because copyright holders, artists and publishers are reluctant to sell their goods without being able to protect their copyrighted works from illegal copying. Some experts believe digital rights management (DRM) technologies may speed up e-commerce by providing the needed protection. Therefore, computer scientists and engineers are moving ahead with a variety of approaches to electronic intellectual property management.
To facilitate the development, implementation and use of DRM technologies, NIST has published a quick-reference list of organizations and standards relevant to the field. The list is particularly useful for publishers and hardware manufacturers who are trying to work out the standards and technical protocols for e-materials.

One example of what a user will find in the document is the section on the eXtensible Business Reporting Language (XBRL). The text states that XBRL “is an open specification that uses XML-based data tags to describe financial statements. XBRL encoded financial information works across automated supply chains.” The listing then suggests a Web site for more information. The guide is available at <http://www.itl.nist.gov/div895/docs/NIST241assm.9oct.pdf>.

CLEAN DEVICE MAY TELL A LOT ABOUT SUPERNOVAS

Researchers from the NIST, Princeton University and Indiana University believe a proposal device will enable detection of a supernova’s tell tale burst of neutrinos at least 20 times more efficiently than existing light-water detectors. The new detector also would spot the distinctive mu and tau neutrinos that comprise most of a supernova’s energy stream, making it possible to measure total supernova energy output for the first time.

The detector, dubbed CLEAN for Cryogenic Low Energy Astrophysics with Noble gases, would contain a core filled with liquid neon cooled to 27 Kelvin (minus 246.15 degrees Celsius). CLEAN would pick up low-energy neutrinos via neutrino-nucleus elastic scattering, in which incoming neutrinos bounce off the nuclei of neon atoms, generating tiny flashes of light that CLEAN could read.

To distinguish neutrino bursts from background gamma ray “noise” (where the gamma rays act in a similar fashion to neutrino events and outnumber those events by about a thousand to one), NIST statistician Kevin Coakley developed new statistical methods and an algorithm that picks out neutrinos from the blizzard of unwanted signals.

The researchers plan to submit a proposal in the coming year to fund the development of a first-generation prototype CLEAN detector. For more information about CLEAN, contact Coakley, (303) 497-3895, <kevin.coakley@nist.gov>.

NEW CHAIR APPOINTED TO NIST'S MEP ADVISORY BOARD

NIST Director Arden Bement has named Dean Garrison as the new chair of the National Advisory Board for NIST's Manufacturing Extension Partnership (MEP). Garrison is president and CEO of the International Sign Association (ISA), Alexandria, Va. ISA represents manufacturers, users and suppliers of on-premise signs and sign products. Previously, he served as the vice president of small and medium manufacturers with the National Association of Manufacturers. Garrison has been a member of the MEP advisory board since January 2000. The previous board chair, Edward J. Noha, chairman of the board emeritus of CNA Financial Corp., Chicago, Ill., will continue to be an MEP board member.

Members of the advisory board are selected for their expertise in manufacturing and industrial extension, and for their work on behalf of small manufacturers. Meeting three times a year, the board provides advice on MEP programs, plans and policies. Annually, the board summarizes its findings and recommendations in a report to the Secretary of Commerce.

In addition to Garrison and Noha, other board members are: Carl E. Banks, president, Production Technologies (Tracy, Calif.); Rich A. Bendis, president and CEO, Innovation Philadelphia; Maria Estela da Rios, vice president, corporate affairs, Orion International Technologies Inc. (Albuquerque, N.M.); Dan J. Marcum, chairman, Micro Craft Inc. (Tulsa, Okla.); Robert S. Montjoy, director, Economic Development Institute, Auburn University (Auburn, Ala.); Charles E. Shanklin, president, Crestview Aerospace Corp. (Crestview, Fla.); and John A. Yngve, chairman, Bondhus Corp. (Monticello, Minn.).

Contact: Jan Kosko, (301) 975-2767

SECRETARY EVANS APPOINTS THREE TO BALDRIGE AWARD JUDGES’ PANEL

Commerce Secretary Don Evans has appointed three prominent industry, education and health care leaders to serve on the nine-member panel of judges for the Malcolm Baldrige National Quality Award to replace retiring panel members.

The new members are: Roy A. Bauer, executive vice president - U.S. operations, Perstar Inc., Rochester, Minn.; Deborah Lee-Eddie, senior vice president, operations, Catholic Health Initiatives, Denver, Colo.; and Deb Myers, organizational development consultant, Hamilton County Educational Service Center, Cincinnati, Ohio. A fourth judge will be appointed at a later date.

The panel of judges is part of the award’s mostly private-sector board of about 400 examiners who review applications for the Baldrige Award. The judges review examiner comments and scores, select applicants for site visits and recommend Baldrige Award recipients to the Secretary of Commerce.

Harry L. Roady, vice president, director of quality, State Street Corp., North Quincy, Mass., was appointed as chair of the panel. Other judges are: Ruth Ash, dean, School of Education and Professional Studies, Sanford University, Birmingham, Ala.; Dale Crown over, president and CEO, Texas Nameplate Co., Dallas, Texas; Kay Kendall, vice president of corporate quality, Brooks-PRI Automation, Channahon, Mass.; and Kathy Ye, senior vice president, results management, Provident Financial, Pleasanton, Calif.

Contact: Jan Kosko, (301) 975-2767
NIST, CU PUBLISH RECIPE FOR HOME-COOKED BOSE-EINSTEIN CONDENSATE

To encourage scientists to find innovative uses for Bose-Einstein condensates (BEC), researchers at JILA-a joint institute of the NIST and the University of Colorado at Boulder—are publishing a paper that describes how to consistently produce a stable condensate. Using a "cookbook" set of instructions, JILA researchers describe the basic steps for building a BEC apparatus.

The "BEC recipe" begins with directions for setting up the necessary vacuum and optical systems. It then describes the experimental procedure for pre-cooling atoms in a magnetic trap and subsequently, using evaporative cooling to yield a condensate.

The JILA system has many advantages. It is easy to use, many of the necessary components are commercially available, and the transfer works essentially every time without any maintenance.

The research is based on the original work by JILA scientists Eric Cornell and Carl Wieman, winners of the 2001 Nobel Prize in Physics for first achieving the BEC.

For more information and a copy of the paper "Simplified System for Creating a Bose-Einstein Condensate," contact Heather Lewandowski, JILA, Campus Box 440, University of Colorado, Boulder, Colo. 80309-0440; (303) 492-5637; <lewandoh@jila.colordado.edu>.

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NIST WORKSHOP TO FOCUS ON CARD-BASED TECHNOLOGIES

Cards possessing advanced technologies that permit data storage, transfer and processing are being used increasingly within the federal government because of their attractive security features and versatility. For example, a single smart card (a card with an embedded computer chip) could be used for identification, access to secure buildings, logging onto computers, and to make small purchases. Developing standards will ensure that smart cards, optical media, card readers, and other storage and processor card technologies will function smoothly and consistently across the government.

As part of the continuing effort by the NIST to support interoperability among storage and processor card systems, the agency will hold a public workshop on July 8-9, 2003, at its Gaithersburg, Md., headquarters.

Workshop topics will include: current government card-related activities and needs; card-based technology attributes; industry activities in the field; card-related industry consensus standards; multitechnology interoperability issues; and security concerns.

The fee for the workshop is $275. Registration closes on June 30, 2003. There will be no on-site registration because of NIST security regulations.

To register electronically, go to <https://sales.nist.gov/conf/secure/CONF513/conf_register.html>. A detailed workshop agenda will be available from the NIST.


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NIST VIDEO, CD FEATURE LATEST BALDRIGE 'FORMULAS FOR SUCCESS'

The NIST has produced a new set of audiovisual materials showcasing the successful strategies that earned three organizations the 2002 Malcolm Baldrige National Quality Award, including the first recipient in the health care category.

A VHS-format videocassette contains two versions of the Baldrige program, "Quest for Excellence XIV" (short at 12 minutes and long at 40 minutes) that features the 2002 honorees: Motorola Inc., Commercial Government and Industrial Solutions Sector, Schaumburg, Ill. (manufacturing category); Branch-Smith Printing Division, Fort Worth, Texas (small business category); and SSM Health Care, St. Louis, Mo. (health care category).

Also included on the videocassette is "A Journey Worth Beginning," a program encouraging organizations to apply for the Baldrige Award.

A CD-ROM package includes all three video programs, as well as the Baldrige Performance Excellence Criteria for 2003, presentations given by the 2002 award recipients at the Quest for Excellence XIV conference held March 30-April 2, 2003, and other information.

The audiovisual materials will be available May 1, 2003, from the American Society for Quality, P.O. Box 3066, Milwaukee, Wis. 53201-3066. (800) 248-1946. Item T1204 is the CD-ROM for $35. Item TA999 is the videocassette for $20. A combined package with the CD-ROM, video and QEX XIV conference materials (Item T1206) is $59.95.

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REPORT FEATURES THREE DECADES OF NIST 'MILITARY AID'

From cost-effective radar to accurate satellite-positioning systems, the U.S. military has benefited from a long-standing relationship in which the NIST has provided innovative measurement and standards support, as well as coordinated calibration services. A new report documents the more than 30-year-long partnership that also has benefited U.S. industry by contributing to the development of thermal imaging equipment, laser pointers and other civilian products.

Examples of the nearly 500 research projects conducted through the partnership include:

- a standard for measuring phase noise in satellite atomic clocks that helps to assure accuracy in the Global Positioning System (GPS);
- an automated method for determining the radiation pattern of large antennas that has reduced repair times greatly;
• highly sensitive equipment for use as standards in calibrating test equipment used to qualify night-vision goggles, improving the safety and reliability of military night operations (technology incorporated by industry for equipment that observes heat leaks in buildings); and
• a variety of standards and equipment for measuring the power in laser beams, including a device that calibrates laser-targeting receivers for military aircraft (which, in turn, has helped assure the safety of various products such as laser pointers).

A Partnership for Advanced Measurement Standards: The Calibration Coordination Group of the Department of Defense and the National Institute of Standards and Technology is available online at <http://physics.nist.gov/Divisions/Div844/manual/sp980.html>. A single printed copy or CD is available from Sally Bruce, (301) 975-2323, <sally.bruce@nist.gov>.

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NIST REPORTS SIGNIFICANT ADVANCES MADE IN FACIAL RECOGNITION

Computers have become much more adept at "recognizing" human faces during the past two years, says a new report by scientists from the NIST and two other federal agencies. The researchers have completed the most comprehensive evaluation to date of commercially available face recognition systems and concluded that there has been a 50 percent reduction in error rates since comparable tests were conducted in 2000.

Ten companies participated in the tests, which involved matching facial images provided by the U.S. Department of State from its consular office in Mexico. The tests involved matching 121,589 images of 37,437 individuals.

Demographic results show that males are easier to identify than females, and older people are easier to recognize than younger people. The study also found significant differences in matching abilities depending on where the images are made. Face recognition in outdoor environments is only about half as good as images taken in indoor environments, where controlling lighting conditions is easier.

For verification (i.e., determining whether a person is who he or she claims to be), the best facial recognition systems are equivalent to 1988 fingerprint matching technologies, yielding a 90 percent probability of verification with a 1 percent probability of false acceptance.

NIST conducted the tests last summer in conjunction with the Defense Advanced Research Projects Agency (DARPA) and the Office of National Drug Control Policy (ONDCP) Counterdrug Technology Assessment Center (CTAC).

The comprehensive report is available at <http://www.itl.nist.gov/ia/894.03/face/face.html#FRVT2002> and also is posted at <www.frvt.org>.

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NIST DEVICE HELPS ENSURE GUNLOCK PERFORMANCE

In recent years, many states have enacted safety laws in order to help gun owners reduce the chance of accidental shootings or inappropriate use of their firearms. These laws often either require or encourage the use of gunlocks, but there is currently no standard for evaluating the effectiveness of gunlocks. This leads to a potential problem where ineffective gunlocks may be sold to consumers.

To help solve the problem, researchers in the NIST Office of Law Enforcement Standards (OLES) have invented a system that tests cable gunlocks to ensure at least some minimal level of performance. The work has been carried out in conjunction with ASTM International, which has been developing a performance standard for firearm locks so that the gunlock industry and consumers have a consistent tool for evaluating these protective devices.

The NIST system is a prototype test fixture that subjects cable gunlocks to impacts at certain speeds and angles, allowing researchers to assess how well they hold up to abuse. ASTM has adopted the NIST test method as part of its draft performance standard, ASTM Subcommittee F15.53 "Non-Integral Firearm Locking Devices."

The draft standard is in the final stages of the ASTM approval process. For more information, contact Kirk Rice, (301) 975-8071, <kirk.rice@nist.gov>.

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NIST, INTERNATIONAL TEAM DEVELOP MATERIALS DATA EXCHANGE LANGUAGE

Scientists and engineers trying to share materials property data over the Internet will have an easier time now thanks to a new computer language called MatML-Materials Markup Language-developed by an international group of researchers from the NIST, industry, government laboratories, universities, standards organizations and professional societies. MatML provides a standard format for managing and exchanging materials property data on the World Wide Web, eliminating interoperability and interpretation problems.

Based on the Extensible Markup Language (known as XML), MatML is a non-proprietary, generic language that makes it possible to parse and process data without the need for human intervention. The MatML format makes it easily readable and understandable by scientists and engineers. At the same time, MatML provides software developers with a protocol that is both structured and ordered, facilitating the transmission, validation, and interpretation of materials property data between different applications and across different platforms.

Currently, the MatML Steering Committee is coordinating acceptance testing as well as prototype software development.

More information, including the MatML Version 3.0 Schema, which contains the formal specification for the materials markup language, is available at <www.matml.org> or by calling Ed Begley, (301) 975-6118, <begley@nist.gov>.
INTERAGENCY EFFORT OPENS THE 'GATE' ON MANUFACTURING R&D

The NIST is among six federal agencies seeking to enhance the payoffs from federal investments in manufacturing research and development (R&D) through a new effort to exchange information about technical programs in this area, collaborate when it makes sense to leverage resources, and advance issues on an inter-agency level.

The Government Agencies Technology Exchange in Manufacturing (GATE-M) effort will comprehensively address manufacturing R&D across the federal government to benefit the agencies, U.S. manufacturers and the economy as a whole. Strategies will include detailed interagency reviews of programs in specific areas and issuance of joint white papers or position papers. Agencies also may jointly sponsor workshops, promote and sponsor the development of "roadmaps" in specific technical areas, and jointly encourage or support industrial research. The intent is to involve the manufacturing community of industry, government and trade associations in an integrated effort.

Two topics have been identified as initial priority areas: intelligence in manufacturing, a cross-cutting technology area that could transform how manufacturing is carried out in the future; and nano- and micro-scale systems and technologies, an emerging area of science and technology that promises to have a significant and broad impact on U.S. manufacturing as well as the nation's economy. Other technical areas, including homeland and national security, are of interest as well.

Other agencies involved in GATE-M include the Department of Defense, the Department of Energy (represented by two separate entities: the National Nuclear Security Administration and the Office of Energy Efficiency and Renewable Energy), the National Aeronautics and Space Administration, and the National Science Foundation.

A copy of the GATE-M report is available online at <www.met.nist.gov/pdfs/ir6950.pdf>

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NIST GUIDE TO STATE/LOCAL ACCREDITATION PROGRAMS UPDATED

A newly updated NIST directory provides detailed information on 21 state and 11 local government programs that assess the competence of laboratories to conduct tests or inspections required by regulations or agencies' procurement specifications.

Updated for the first time since 1991, the Directory of State and Local Government Laboratory Accreditation/Designation Programs was assembled from responses to a nationwide survey and from previously published sources. The compilation can serve as a guide for manufacturers, distributors and service companies competing for government business in the local and state markets included in the directory.

The directory may be even more valuable as a tool for evaluating laboratory accreditation programs across state and local governments, explains NIST economist Maureen Breitenberg. "Not all U.S. accreditation programs are technically equivalent, especially at state and local levels," she says. "Differing requirements can translate into differing levels of confidence in the competence of accredited laboratories. It's important to understand these differences to avoid impeding the flow of goods and services."

Responding to the need to reduce duplication and inefficiencies, NIST and a number of public and private-sector organizations joined together in 1998 to create the National Cooperation for Laboratory Accreditation (NACLA). The organization's goal is to recognize qualified U.S. laboratory accreditation programs as meeting internationally accepted requirements for technical competence. The updated directory will be useful to NACLA in its outreach efforts.

In preparing this directory, much effort was devoted to gathering information on all relevant state and local programs. However, many agencies did not respond for a variety of reasons. For example, some agencies said that they lacked resources to accredit more laboratories than those already designated to test for compliance with state or local standards.

The Directory of State and Local Government Laboratory Accreditation/Designation Programs (NIST Special Publication 815) and other NIST reports on conformity assessment are available at <http://ts.nist.gov/ts/htdocs/210/gsa/cauinfo.htm>. For more information, contact Maureen Breitenberg, (301) 975-4031, <maureen.breitenberg@nist.gov>.

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VISITING COMMITTEE PRAISES NIST, OFFERS RECOMMENDATIONS

The Visiting Committee on Advanced Technology (VCAT), the primary private-sector board advisory board for the NIST, has released its annual report that evaluates the agency's fiscal year 2002 performance of its mission to work with U.S. industry to promote economic growth. The report, which is submitted to the Secretary of Commerce for transmittal to Congress, reviews and makes recommendations regarding the general policy, organization, budget and programs of NIST.

In its latest report, the VCAT "again finds NIST to be a significant national asset that is recognized as the world's leading measurement and standards organization." Particularly noteworthy accomplishments cited by the committee include:

- Developing a meaningful strategic plan process that cuts across organizational boundaries; Providing an appropriate and rapid response to the 2001 terrorist attacks;
- Fostering an environment that encourages excellence in science as evidenced by the award of the 2001 Nobel Prize in physics;
- Recommendations from the VCAT include improving funding levels; implementing the strategic plan at the operating unit level; developing performance metrics; and increasing collaborations with industry, academia and other federal agencies.

A copy of the report is available from NIST Public Inquiries, fax: (301) 926-1630, <inquiries@nist.gov>.

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NIST TRAPS, PREPARES AND SERVES ATOMS-ONE AT A TIME

Getting a single, constantly moving atom to go exactly where you want it to is a difficult scientific challenge. In the May 5, 2003, Applied Physics Letters, NIST physicists describe a new method that promises to produce individual "atoms on demand," a feat likely to warm the hearts of researchers in fields ranging from nanotechnology to quantum computing to semiconductor processing.

The new method relies on six intersecting laser beams and a magnetic field to trap neutral atoms in a vacuum chamber. A "feedback loop" ensures that only one atom can be loaded into the trap at a time. The system works by sending a stream of atoms past a laser tuned to a frequency readily absorbed by that particular atom. The instant one atom absorbs the laser energy, it enters a lower energy state and drops into the trap.

While the atom is in the trap it fluoresces. A detector senses this and the instant the fluorescence stops (indicating the atom has escaped), it lets another atom in to take its place. If by chance, two atoms should drop into the trap at once, the detector senses too much light and dumps them both out by momentarily shutting off the trap.

So far, the system traps one atom at a time with 99 percent accuracy, and can eject them at a rate of 10 times per second. The NIST scientists hope to substantially speed up that rate with further research and to devise reliable ways to transfer the individual atoms to adjacent instrumentation.

Contact Jabez McClelland, (301) 975-3721. <jabez@nist.gov>

BALDRIGE INDEX BEATEN BY S&P 500 AFTER NINE WINNING YEARS

For the first time since the study began in 1995, the "Baldrige Index" has under-performed the Standard & Poor's 500. The Baldrige Index is a fictitious stock fund made up of publicly-traded U.S. companies that received the Malcolm Baldrige National Quality Award between 1992 and 2001.

Throughout the nine years of the study, the Baldrige Index consistently has outperformed the S&P 500 by as much as 6 to 1. "These studies have shown that businesses that excel in everything they do can achieve success in many areas, including the bottom line," said Harry Hertz, director of the NIST Baldrige National Quality Program. "This past year has been a particularly tough one for technology stocks, which are a very significant component of the Baldrige portfolio. But, I am confident that in the coming years, the Baldrige Award winners will continue to excel in their performance, including in their bottom line," he said.

In this latest study, NIST hypothetically "invested" $1,000 in the two whole company winners; Eastman Chemical Company (1993 winner) and Solectron Corp. (1991 and 1997 winner) and the parent companies of 19 subsidiary winners. Another hypothetical $1,000 was invested in the S&P 500 for the same time period. The investment was tracked from the first business day of the month following the announcement of the Baldrige Award recipients (or the date when they began public trading, if it is later) through Dec. 2, 2002.

The two whole company award winners underperformed the S&P 500 by about -0.71 to 1, with a -3.19 percent return compared to a 48.02 percent return for the S&P 500 over the multiyear period. The group of 19 subsidiary winners underperformed the S&P 500 by approximately -0.53 to 1, with a -23.74 percent return compared to its 45.16 percent return for the S&P 500.

In last year's study, the same two whole company winners, Eastman Chemical and Solectron, outperformed the S&P 500 by about 4.5 to 1, while the parent companies of subsidiary winners outperformed the S&P 500 by about 3 to 1. See: <http://baldrige.nist.gov/Stock_Studies.htm>.

CLOCK ACCURACY BY RADIO? NIST PAPER TELLS ALL

It might surprise you to know that the concept of a radio-controlled clock (RCC) wall clocks, desk clocks, wristwatches and other timepieces that use special radio signals to keep highly accurate time, is nearly as old as radio itself. Or that RCCs may never be off by more than a fraction of a second at any time. These two facts are among the many in a recently published paper by the NIST that explores the history of RCC's, how they work, and the type of radio signals that control them.

Some manufacturers refer to their RCCs as "atomic clocks," but that description isn't true. An RCC is primarily a radio receiver tuned to pick up time code signals derived from measurements made by an actual atomic clock. The RCC then uses these signals to synchronize its clock mechanism, yielding very precise time.

Like all clocks, an atomic clock—such as the NIST-F1 cesium fountain device at NIST's Boulder, Colo., laboratories—works by making the same event happen over and over. The repetition of this event produces a frequency, which is counted to keep time. For example, in a grandfather clock, this repeating event is the swinging of a pendulum. In NIST-F1, it's the transition of a cesium atom as it moves back and forth between two energy states.

This recent proliferation of RCCs represents one of the most significant developments in the history of timekeeping. WWVB consumer-oriented RCCs were relatively rare until 1999, when NIST increased the station's radiated output power to 50 kilowatts, a move that allowed the signal to reach all of the United States.

For a copy of paper no. 21-03, contact Sarabeth Harris, (303) 497-3237, <sarabeth@boulder.nist.gov>.

NIST HELPS U.S. CAPITOL WITH 'OVERHEAD' PROBLEM

Repairing a leaky roof usually doesn't require the expertise and skills of researchers at the NIST, unless the building in need of help is one of the nation's most treasured edifices.

When the 150-year-old dome of the U.S. Capitol in Washington, D.C., began leaking during heavy rainstorms a few years ago, the Office of the Architect of the Capitol consulted with engineers involved in welding research at NIST. The daunting task handed
them: return the cast-iron supporting structure of the dome's outer shell to its original condition without replacing the cracked castings or losing any of the iron work's historical integrity.

That request sparked a search for the right weld that would integrate with 1850s technology. An initial attempt in 1998 failed when the test welds cracked. NIST engineers went back to the drawing board (and the lab) to develop and test other options. The best-working technique turned out to be oxyacetylene brazing (a flame repair process where the filler metal melts at a temperature below that of the casting) combined with a copper-zinc alloy called low-fuming bronze. The bronze forms joints that are very similar in strength to the original castings.

NIST's experts have submitted their recommendation to the Architect's office.

Contact: Fred McGehan (Boulder), (303) 497-7000

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NIST/ISMT LABORATORY PUTS THE 'FORCE' WITH CHIPMAKERS

Star Wars fans know that things go better when the force is with you. While that force helps solve galaxy-sized problems for the Jedi Knights, scientists and engineers at the NIST have teamed up with the semiconductor industry to put the force [atomic force microscopy (AFM), that is] to work at the other end of the size spectrum.

Microchip manufacturers frequently need to measure dimensions of only 100 nanometers (four-millionths of an inch or about one-thousandth the width of a human hair) within the devices they create. This is especially true for "critical dimensions" (known as CD in the industry), the smallest size that can be etched into a computer chip uniformly.

To ensure that chipmakers can accurately and consistently assess CD, NIST has set up a special semiconductor chip processing laboratory with AFM at International SEMATECH (ISMT) in Austin, Texas. The outputs of this lab are reference standards for the industry; standards contained in microchips that have dimensional features measured with accuracy approaching the level of the distances between atoms in a silicon crystal.

NIST's CD reference standards consist of micro-machined silicon crystal materials that act as "rulers" for calibrating instruments that make minuscule measurements during the chip manufacturing process. A one-of-a-kind atomic force microscope, operated by NIST personnel assigned to ISMT, can reveal important information about tiny surface features on a chip with unprecedented clarity.

Contact: Philip Bulman, (301) 975-5661

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'STONE COLD' VIDEO SHOWCASES NIST'S HUNT FOR NEW STATE OF MATTER

It was a scientific milestone that many said would never be realized. Some called it the "Holy Grail of physics." But on June 5, 1995, physicists Eric Cornell of the NIST and Carl Wieman of the University of Colorado at Boulder observed the Bose-Einstein condensate (BEC) for the first time. It had been 71 years since Albert Einstein predicted that a new state of matter would be created if individual atoms melded into a "superatom" at temperatures approaching absolute zero. For their breakthrough, Cornell and Wieman shared the 2001 Nobel Prize in Physics with Wolfgang Ketterle of MIT.

Recently, Cornell gave a public lecture at NIST's Gaithersburg, Md., headquarters on his research entitled "Stone Cold Science." The lecture was videotaped, and the VHS-format program is now available at no charge from NIST.

In the 74-minute video, Cornell chronicles the search for the BEC, describing in detail just what the "weird world of physics at a billionth of a degree from absolute zero" is like. The program will be of great interest to high school, college and graduate-level physics students and teachers, as well as anyone fascinated by the process leading to scientific discovery.

To request a free copy of the educational video, write to NIST Public Inquiries, 100 Bureau Dr., Stop 3460, Gaithersburg, Md. 20899-3460, fax a request to (301) 926-1630, or send an e-mail message to <inquiries@nist.gov>.

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A NEW WIRELESS NETWORK FOR EMERGENCY COMMUNICATIONS

First responders would like to be able to send messages simultaneously to all the emergency workers at the scene of a disaster if necessary, but lack of interoperability among various types of radio equipment prevents them from doing so today. In the future, first responders converging on a disaster scene may be able to quickly and easily exchange emergency messages and data using a wireless ad hoc network recently developed and tested by scientists and engineers at the NIST. NIST's work in this area is part of the federal government's efforts to improve first responder communications in the event of September 11 terrorist attacks.

The network consists of personal digital assistants (PDAs) equipped with wireless local area network (WLAN) cards. Transmission routes among the PDAs are established automatically and without need for networking infrastructure at the emergency site as the first responders arrive on the scene. The network may use any nearby PDA to relay messages to others at the scene and allows transmission of voice, text, video and sensor data. If a worker leaves the disaster scene or a device is destroyed, the network automatically reorganizes itself.

Small video screens can display the names of workers and their roles. In buildings equipped with radios at reference locations, the network would determine the locations of first responders and track their movements. The devices also could receive information from smoke, heat or vibration sensors embedded in smart buildings that could be transmitted by wireless sensor networks or distributed by first responders during emergencies.

Contact: Phil Bulman, (301) 975-5661
AMERICAN SOCIETY FOR QUALITY (ASQ)
Chris Grachanen, Liaison Delegate

CCT Exam Completed!

More than four years work, involving hundreds of calibration practitioners from government agencies, academia, and small and large commercial interests, has culminated in the American Society for Quality (ASQ) Measurement Quality Division (MQD) Certified Calibration Technician (CCT) exam. These calibration practitioners under the auspices of a dedicated ASQ staff and contracted industry professionals engaged in a variety of research, analysis, data acquisition and dissemination of information activities to define the CCT body of knowledge (BOK).

The CCT exam reflects the CCT BOK, deemed appropriate by the above mentioned volunteers, for the mid-level calibration practitioner and formally recognizes the scope and depth of the specialized comprehension required by these professionals. The CCT exam marks the first time that certification criterion for a peer recognition program has been established in the U.S. for calibration practitioners. Congratulations to all those who had a hand in making the CCT exam a reality.

The CCT exam went from working draft to final revision at the CCT Exam Review Workshop conducted on the 4th and 5th of April 2003 at ASQ headquarters in Milwaukee, WI. Nine calibration practitioners from commercial, government, and private calibration interests attended this ASQ sponsored workshop.

As the name implies, the Final Exam Workshop focused on final approval of candidate exam questions for use on the CCT exam. Each candidate exam question had to be evaluated and approved in terms of its applicability, clarity and appropriate cognizant level. In addition, each candidate exam question had to be both accurate and exclusively correct while each of its distracter choices had to be plausible. Each exam question must reference a hardcopy and/or electronic publication available in the public domain. The CCT exam encompasses 125 questions spanning the following 6 major topic areas:

1. General Metrology (30 Questions)
4. Applied Math and Statistics (20 Questions)
5. Quality Systems and Standards (15 Questions)
6. Uncertainty (10 Questions)

References used for CCT exam question development may be found on the ASQ CCT webpage. It is acknowledged that the CCT BOK spans many different publications as is typical of a new ASQ certification. As of this writing (2nd week in May 2003), I am aware of several CCT exam study guides / preparation publications and workshops that currently are, or will shortly be available as well as a Metrology Handbook in the works.

The CCT exam’s first public offering is scheduled for June 7, 2003 (cutoff for exam registration was 3rd week in April 2003). ASQ headquarters has informed me that there are over one hundred CCT exam candidates for the June 7th offering; a healthy showing for the first offering of a new ASQ certification. This response reflects the enthusiasm certification practitioners have for the CCT program.

After the June 7th CCT exam offering, a Cut-Score Study Workshop will be conducted on June 20-21, 2003 at ASQ headquarters in Milwaukee, WI. The Cut-Score Study Workshop will focus on determining the raw score for a passing CCT exam score. The workshop, comprised of 10-12 ASQ calibration practitioners that did not take the CCT exam in June, and would not be eligible to take the CCT exam until June of 2004, will employ various time proven techniques and methodologies in developing the cut-score threshold. Cut-score development activities focus on the borderline case assuming that those exam candidates that belong to the upper grouping (passing the exam) will tend to earn higher scores than those who belong in the lower grouping (not passing the exam).

The cut-score threshold can be viewed as the score one would reasonably expect from a person whose skills are considered borderline between the two groupings. To derive this threshold, Cut-Score Workshop participants must make a judgment for each exam question as to the probability that a borderline test-taker would answer correctly. The result of each participant’s evaluation is then assessed in the context of the group. Analysis and other activities are employed to derive consensus and ultimately the cut-score threshold. These aforementioned activities help ensure that the CCT exam cut-score truly reflects the borderline case.

I wish to express my sincere appreciation to the many volunteers who have contributed to the CCT exam development and to the many individuals developing materials for aiding technicians in studying for the exam. Without their passion, the CCT program would not have gotten beyond the ‘wishful’ stage. The CCT program will be highlighted in session IA at NCSSL’s Tampa Bay national conference. I hope to see you there.

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COUNCIL FOR OPTICAL RADIATION MEASUREMENTS (CORM)
Sally Bruce, Liaison Delegate

The Council for Optical Radiation Measurements (CORM) 2003 conference was held at Stanford University’s SLAC Auditorium during June 18 - June 20, 2003. The conference theme was “Optics in the 21st Century.” The Program included the following topics:

• LED Measurements
• Displays
• Sensors/Detectors
• Microtechnology
• Optical measurements and standards in Biophysics and Medical Science
• Human Interface: Photometry, Colorimetry, Color Science

This year's guest speaker for the Franc Grumm Memorial Dinner was Dr. Sheldon C. Roberts, a founder of Fairchild Semiconductor. His lecture was entitled, "How it all started in the Silicon Valley."

CORM will be participating in the upcoming NCSLI Conference Session 3A on Tuesday August 19. The session topic is National Measurement Requirements. The Council for Optical Radiation Measurements, CORM is a membership-based organization. Its membership consists of representatives from photometric and radiometric instrument manufacturers, optical radiation metrology and calibration laboratories, photographic and xerographic industries, lamp and LED manufacturers, aerospace, and the chemical industry.

CORM was organized 30 years ago to define measurement problems and to follow up with an action plan. CORM sets priorities for optical radiation measurement needs by surveying its membership on a regular basis. CORM reports, based on membership surveys, are published containing the survey results, conclusions, and recommendations. Historically, the CORM reports are presented to the NIST Director along with the management and staff at NIST who are directly involved in optical radiation measurements and research activities.

CORM has expanded its global reach with nearly 15% of its membership being international. As such, CORM maintains liaisons with the National Research Council of Canada (NRC), CENAM (the National Metrology Institute of Mexico), and two divisions at NIST; Optical Technology and Optoelectronics.

2003 NCSLI INTERNATIONAL WORKSHOP & SYMPOSIUM
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NCSL International is a nonprofit association of laboratories or organizations that maintain or have an interest related to measurement standards and calibration facilities.

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- Recommended Intrinsic/Derived Standards Practices
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- Conference Proceedings from 1990 through current

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Title

Department or Division

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( )

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E-mail address

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Appointing Officer's Name

Title

Department or Division

Mailing Address (if different from Member Delegate)

City State Postal Code Country

( )

Telephone Number Extension Fax Number

E-mail address

Signature of Appointing Officer

Date

* The Appointing Officer is the individual from the above company who is appointing the Member Delegate, and is usually the Member Delegate's supervisor.

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- New Educational Institution Member Fee (Jan-Dec 2003) $400

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SIC Codes

- STUDENT MEMBERSHIP FEE: $50 per year

Student membership would consist of a subscription to the newsletter and access to training and employment information on the NCSLI website. Student members would also be able to purchase any NCSLI publications at the reduced member prices.
NCSL INTERNATIONAL STAFF

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(585) 554-6295 FAX(585) 554-4434
e-mail: <thuttemann@aol.com>

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This schedule is for guidance for anyone who needs to submit material for publication in the Newsletter.

FUTURE CONFERENCES

2004 NCSL International Workshop & Symposium
July 11-15, 2004
Salt Lake City, UT

2005 NCSL International Workshop & Symposium
August 7-11, 2005
Washington, DC

Abstracts are required for Workshops, Panels, and Papers. For more information contact:
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(In conjunction with the NCSL International Workshop & Symposium, August 17-21, 2003)

October 26-29, 2003
CENAM
Queretaro, Mexico