

News Briefs

General Developments

Inquiries about News Briefs, where no contact person is identified, should be referred to the Managing Editor, Journal of Research, National Institute of Standards and Technology, Building 416, Room 119, Gaithersburg, MD 20899-0001; telephone: 301/975-3572.

CONSORTIUM TO EVALUATE TAPE-BONDED SEAMS FOR ROOFS

Five companies and two trade associations have joined NIST in a cooperative research consortium to evaluate the performance of pre-formed tape for bonding seams in EPDM membranes, a system commonly used to make low-sloped roofs watertight. EPDM, a synthetic rubber material, is placed in overlapping sheets to form a membrane atop a roof. These sheets must be bonded together to ensure a watertight surface. The most commonly used bonding agents have been liquid-based adhesives formulated with volatile organic compounds (VOC). However, there is a growing movement toward the use of pre-formed, solvent-free tape because of concerns over the environmental effects of VOCs. To meet the need for performance data on tape-bonded systems, the EPDM Seam Consortium will conduct a study centering on “creep-rupture” (where a seam is stressed under a constant load over time until it separates) investigations at NIST. These experiments will be complemented by field inspections of roofs with tape-bonded seams. Data gained from the study will provide the roofing and construction industry with recommendations on the general use of tape-bonded seams, and establish a test method and criteria for evaluating these systems. A supporting sponsor of the consortium’s work is the U.S. Army Construction Engineering Research Laboratories. For more information, contact Walter Rossiter, B348 Building Research Building, NIST, Gaithersburg, MD 20899-0001, (301) 975-6719.

ULTRA-SENSITIVE ASSAY AVAILABLE FOR LICENSING

NIST seeks licensees for a newly patented invention that could provide analytical laboratories with a quick, reusable method for accurately measuring tiny amounts of chemicals in clinical or environmental samples. The liposome flow injection immunoassay can detect as few as one molecule in 10^{12} molecules, which is comparable to detecting a grain of sugar in a swimming pool. The shoe box-size instrument can quantify antibody/antigen reactions using liposomes filled with fluorescent dye and coated with antibodies or antigens that will bind to the sought chemical. Dye released from the liposomes indicates the concentration of the chemical in the sample. NIST researchers have applied the system to the measurement of estrogen by-products for breast cancer risk assessment. For licensing information, contact Terry Lynch, Office of Technology Commercialization, B256 Physics Building, NIST, Gaithersburg, MD 20899-0001, (301) 975-2691, e-mail: jtlynch@micf.nist.gov (via Internet).

“GRAY-SCALE” SOFTWARE IMPROVES FIBER MEASUREMENTS

The optical fiber industry, which in recent years has had a more than \$2 billion U.S. market, is heavily dependent on accurate measurements. In fact, process and quality measurements make up a significant fraction of the cost of manufacturing fibers. Fiber networks require many connections between fibers, and if the geometry of the two connecting fibers is off, the result can be degraded light signals. To assist the industry, NIST has developed a software program which improves the most popular technique for measuring geometry on the factory floor. Termed the gray-scale method, this technique uses a video microscope in conjunction with a frame digitizer to quickly and easily measure geometric parameters such as cladding diameter and circularity. These

gray-scale images can easily be contaminated by dirt or distorted by faulty cuts. The new NIST computer program takes into account such imperfections, automatically rejecting data points not truly on the edge of the fiber. The software and an accompanying technical paper are available from the Superintendent of Documents, Government Printing Office, Washington DC 20404, (202) 512-1800. Order NIST Technical Note 1370, Software for Performing Gray-Scale Measurements of Optical Fiber End Faces, by stock number 003-003-03309-0. A second NIST technical paper describes the video microscope and its ability to measure the cladding diameter within 0.1 μm . Contact the National Technical Information Service, Springfield, VA 22161, (703) 487-4650, and ask for NIST Technical Note 1369, Video Microscopy Applied to Optical Fiber Geometry Measurements. The ordering number is PB 95-173068.

THEORY CENTER WORKSHOP GRANTS AWARDED

The new NIST Center for Theoretical and Computational Materials Science has awarded eight grants to support theory and modeling workshops for academic, industry, and government researchers. The center is funding workshops to form alliances between industrial researchers and theoreticians in academia and government. Grants are being awarded to:

- Case Western Reserve University and the National Science Foundation Center for Advanced Liquid Crystal and Optical Materials to co-sponsor a workshop on Structure Formation in Liquid Crystals, Polymers and their Mixtures;
- Hughes Research for a workshop on Theory and Modeling of Molecular Beam Epitaxial Growth;
- National Center for Supercomputing Applications, University of Illinois for a co-sponsored workshop on the Development of Residual Stresses During Curing of Thermoset Composites;
- University of Chicago and NIST's Materials Science and Engineering Laboratory for a workshop on Large Scale Computation of Realistic Microstructure;
- The University of Utah for a workshop on Optimal Design for Materials and Structures;
- NIST's Building and Fire Research Laboratory for a Tutorial Workshop on Lattice Boltzmann Methods;
- NIST's Materials Science and Engineering Laboratory for a workshop on Collective Dislocation Theory and Modeling;

- NIST's Materials Science and Engineering Laboratory for a workshop on Hygrothermal Effects on Polymer and Composite Performance.

For workshop dates and information, contact James Warren, Metallurgy Division, A153 Materials Building, NIST, Gaithersburg, MD 20899-0001; (301) 975-5708, e-mail: jwarren@enh.nist.gov (via Internet).

NIST HANDBOOKS 44, 130 AND 133 REVISED FOR 1995

The National Conference on Weights and Measures has made available the 1995 revisions of three NIST handbooks. The new publications reflect changes adopted at the 1994 NCWM Annual Meeting. Two of the publications may be obtained from the Superintendent of Documents, Government Printing Office, Washington, DC 20402, (202) 512-1800. The titles, with stock numbers and prices, are:

- Handbook 44, Specifications, Tolerances, and Other Technical Requirements for Weighing and Measuring Devices, 003-003-03298-1, \$16 prepaid; and
- Handbook 130, Uniform Laws and Regulations, 003-003-03308-1, \$13 prepaid.

A third reference, Handbook 133, Checking the Net Contents of Packaged Goods, consists of the 1988 Third Edition and supplements for 1990, 1992, 1993 and 1994. Everything but the 1994 supplement is available as a packaged set from the NCWM, P.O. Box 4025, Gaithersburg, MD 20885, (301) 975-4093. The 1994 supplement may be ordered from GPO for \$4.25 prepaid. Order by stock number 003-003-03299-9.

CARIBBEAN MEASUREMENT ASSURANCE PROGRAM HOLDS ANNUAL MEETING

The third annual Caribbean Regional Measurement Assurance Program (CaMAP) meeting took place in Mayaguez, Puerto Rico, Feb. 6-10, 1995. CaMAP, which was established by the NIST Office of Weights and Measures, is sponsored jointly by Puerto Rico and the University of Puerto Rico.

Topics for the training seminar included mass calibration techniques, buoyancy corrections, volume corrections, volume transfer, gravimetric volume calibration, and a process measurement assurance workshop. There were presentations on the liquid-measuring devices code in NIST Handbook 44, Specifications, Tolerances, and Other Technical Requirements for Weighing and Measuring Devices, and on procedures for conducting an official examination of a retail motor-fuel dispenser. Participants in this year's meeting included representatives from Puerto Rico, Republic of Panama, West Indies, Trinidad, and the Virgin Islands.

1995 NCWM INTERIM MEETING

The National Conference on Weights and Measures (NCWM) Interim Meeting in Costa Mesa, Calif., Jan. 8–12, 1995 was attended by 236 delegates from state and local programs and from industry.

Attendees considered a draft examination procedure for verifying that the prices charged at store checkout counters match advertised or posted prices. The procedure was developed in cooperation with industry in response to public concerns about price accuracy, particularly stores with electronic scanning equipment. The conference will vote on the procedure in July.

The NCWM Executive Committee considered requests from weighing and measuring device manufacturers to expand the United States–Canada Mutual Recognition of Type Evaluation Program. Manufacturers would like the program to cover larger capacity, more complex weighing systems, and liquid measuring devices and systems. A meeting in April in Ottawa was scheduled to consider mutual recognition in the liquid-measuring arena.

The NCWM, which is sponsored by NIST, is a standards-writing organization made up of state and local weights and measures officials and representatives of Federal Government, industry, and consumer organizations. The uniform laws and regulations developed by the NCWM become mandatory when they are adopted by state or local governments.

NIST STAFF ADDRESS GROCERS AND RETAILERS ON PRICING ACCURACY

The National Conference on Weights and Measures (NCWM), which is sponsored by NIST, is developing procedures to verify that consumers are charged the same prices at store checkout counters as those that the store advertises. These procedures will be available for state and local weights and measures officials, grocery stores, and other retail stores to check pricing accuracy.

NIST staff have been assisting the NCWM in making grocers and retailers aware of the test procedures and in soliciting comments on them from industry members. Recent interactions with industry include participation by a spokesman from Weights and Measures Program, NIST Office of Standards Services, in a workshop entitled “98 Percent Accuracy—How to Make It a Reality” at the Markettechnics '95 Conference of the Food Marketing Institute (FMI) on Feb. 20, 1995 in Houston, TX.

In March, the NIST spokesman made presentations on price verification at a meeting of state associations (such as state grocers associations and state retail federations) that are members of FMI, and at a meeting of the

National Users Conference of the Retailer Owned Research Co., which represents some of the largest-wholesale grocer chains in the United States. Another presentation was scheduled for June at the Price Maintenance and Scan Data Quality Seminar sponsored by Retail Systems Consulting.

The NCWM is planning to vote on adoption of the Examination Procedure for Price Verification at its 1995 Annual Meeting in Portland, ME, in July. If adopted, the procedure will be incorporated into NIST Handbook 130, Uniform Laws and Regulations. Several states have indicated they intend to start using the procedures as soon as they are officially adopted.

NIST STAFF PROVIDE TECHNICAL ASSISTANCE TO TV STATION INVESTIGATING SCHOOL MILK AND JUICE SHORTAGES

The NIST Office of Standards Services assisted CBS television station WCCO in Minneapolis, MN, in a study of shortages in milk and juice supplied to local school districts. Two representatives of the Weights and Measures Program taught the station's undercover team how to check liquid commodities gravimetrically and volumetrically and helped the team check milk provided to school districts in Minneapolis and St. Paul.

Minnesota spends \$16 million on school milk each year without ever checking the contents of the nearly 1 billion cartons. The undercover team found that only one of the five dairies supplied the correct quantity of milk to the schools. The average errors from the other four dairies ranged from 0.4 % to over 3 % for 237 mL (1/2 pint) containers. The shortages could cost an estimated \$3,000 a year in one school district alone.

In a similar study, WCCO staff tested 208 juice containers supplied to Minneapolis schools and found an error of 15 mL (1/2 oz), or 12 %, in 118 mL (4 oz) containers. The total juice lost over the school year could cost the city about \$55,000. The station also cited the nutritional loss to children, since a 118 mL container of juice was expected to supply 100 % of the daily value recommended for vitamin C.

The study findings were announced in two WCCO news segments, one on school milk and juice and the other on dairy products found in retail stores.

Minnesota weights and measures officials now have begun to check milk cartons for schools, and milk and juice suppliers have announced plans to correct the problems. WCCO will do another story to check on progress made by suppliers.

A videotape of the two news segments is available from the Weights and Measures Program.

NVLAP QUALITY SYSTEM—ISO/IEC 9001 STANDARD

The National Voluntary Laboratory Accreditation Program (NVLAP) has published its Quality System Manual, NISTIR 5589, describing the policies and control structure of the quality management system used to achieve its mission. The NVLAP Quality System is based on the ISO/IEC 9000 Series. Controlled copies have been distributed in time for preparation for audits by international accreditation organizations, scheduled for the spring and summer of 1995, namely the European Laboratory Accreditation Commission (EAL), Australia, and New Zealand. In addition to the existing agreement with Canada, recognition by these organizations will expand worldwide recognition of NVLAP-accredited laboratories and their tests. This will enhance U.S. trade and commerce. NVLAP has provided leadership in efforts at NIST to establish quality system approaches for conducting operations that fulfill ISO 9000 series guides for quality requirements.

ATLAS OF SURFACE STRUCTURES PROVIDES VALUABLE REFERENCE RESOURCE

The two volume Atlas of Surface Structures has been published as Monograph No. 5 of the Journal of Physical and Chemical Reference Data. This publication is based on the popular NIST Surface Structures Database.

The atlas covers all known surface structures determined between the inception of surface crystallography in the early 1970s through the end of 1991. A total of 597 structures are included. For all of these, atomic positions with respect to the substrate lattice have been determined completely. Many of the included structures have been verified by different experimental techniques. Actual surface structures may be more complex and variable than the idealized and average structures presented here.

Volume IA provides extensive structural information in tabular form. The tables include for each structure: bulk and surface unit cells, a complete list of atomic coordinates for overlayer, epilayer, interfacial and bulk atoms and selected bond lengths and angles, statements on experimental and theoretical methods used, and full literature references. A unified format is used to allow convenient, direct comparisons of related but different structures or of results obtained with different techniques for the same structure.

Volume IB presents high-quality computer-generated views of each surface structure. One view is from directly above the surface and the second is from an angle.

The data in this atlas include commensurate structures (which case covers most solved structures), incommensurate structures (formed for instance with physisorption), and disordered structures of adsorbates and alloys, as well as solid/solid interfaces.

Extensive related and supplementary information is given in seven appendices.

The books can be ordered from the American Chemical Society (1-800-227-5558).

ENERGY-RELATED INVENTIONS PROGRAM RECOMMENDATIONS

During January and February 1995, NIST recommended innovative technologies for commercialization to its DOE partner under the Energy-Related Inventions Program. The technologies include:

- Hydrodyne Process for Tenderizing Meat—a new method for tenderizing meat using explosively generated sound waves instead of refrigerated aging and electrical stimulation. A shock wave from a small explosive charge passing through boneless meat can alter those components of meat that cause toughness without affecting other meat attributes such as appearance, texture, and flavor. U.S. Department of Agriculture tests confirm that the Hydrodyne method increases the tenderness of beef over conventional tenderizing processes.
- Sterol Ice Nucleation Catalysts—a family of hydrated sterol crystals capable of acting as nucleating agents in the formation of ice from water at relatively warm temperatures. The crystals are exceptionally stable when subjected to repeated freeze and thaw cycles. These nucleating agents save energy when used in thermal storage systems where ice is formed at off-peak hours and then used in subsequent peak hours. Prospects for use in the thermal storage market is significant; the frozen food industry is also a potential area for growth.
- Electrolytic Regeneration of Acid Cupric Chloride Printed Circuit Board Etchant—a process for the on-line electrolytic regeneration of acid cupric chloride etchant, which is used widely in etching printed circuits on circuit boards used in computers, televisions, and other electronic equipment. The process works at significantly lower voltage than other processes, uses less than half the energy, and provides for total recycling of the etchant solution.

NIST JOINS WITH COMPANY TO EXPLORE NEW WAYS OF TRANSFERRING NIST ACCURACY TO INDUSTRY

NIST has entered into a Cooperative Research and Development Agreement with a private company to explore a new approach in providing film-thickness artifact standards for the semiconductor industry. A key goal of the work is to evolve a methodology that permits the company to produce standards traceable to NIST without requiring the development of specific supporting NIST Standard Reference Materials (SRMs). The target thickness range is below 10 nm. The industry needs to be able to measure and control the thickness of thin oxide layers such as those separating the gate of a field-effect device from the conducting channel. The necessary supporting measurements are carried out with various optical instruments. Previously, for thicknesses greater than about 10 nm, industry metrologists have used NIST SRMs and commercial artifacts corresponding and traceable to the SRMs as the basis for calibrating these instruments. In response to the call (in the Semiconductor Industry Association's National Technology Roadmap for Semiconductors) for 4.5 nm gate oxides with a process tolerance of $\pm 4\%$ by the year 2001, NIST and the company also plans to investigate the development of silicon dioxide thin-film standards in the 4 nm to 5 nm range. A significant challenge will be producing the required standards having film-thickness uncertainties lower than the process tolerance specification.

SINGLE-ELECTRON TUNNELING ELECTROMETER EXTENDS NULL DETECTOR CAPABILITIES

A team of NIST scientists has demonstrated a useful metrological result using a new type of detector, the single-electron tunneling (SET) electrometer. The team succeeded in measuring the ratio of two capacitors with a relative uncertainty of 1×10^{-6} at frequencies between DC and 1000 Hz, with the SET electrometer used as a null detector. This result constitutes a significant step toward applying SET phenomena for absolute capacitance or current realizations, in an ongoing collaboration with NIST researchers and researchers from the University of Maryland and the Naval Research Laboratory.

The experiment was performed using custom-fabricated cryogenic vacuum-gap capacitors, which have several significant advantages over the silica dielectric capacitors previously used. Earlier results implied a capability to determine capacitance ratio with a relative uncertainty of only about 100×10^{-6} , and a puzzling voltage dependence. The new measurements provide a

relative uncertainty of 3×10^{-6} at 300 Hz, a minimum parallel resistance of $10^{18} \Omega$, and no measurable voltage or frequency dependence. Further, as a result of the extremely high input impedance of the SET electrometer, the device offers for the first time the capability to measure capacitance ratios at sub-hertz frequencies. The cryogenic vacuum-gap capacitors themselves may prove useful as portable secondary standards, by virtue of their stability, low loss, and lack of frequency dependence. A paper describing these results, "Application of Single Electron Tunneling: Precision Capacitance Ratio Measurements," has been accepted for publication in *Applied Physics Letters*.

NIST SBIR GRANT SPAWNS NEW GENERATION OF MAGNETO-OPTIC MATERIALS

Aided by an SBIR (Small Business Innovative Research) grant from NIST, a private company has begun growing a new class of magneto-optic materials specifically tailored for magnetic field and electric current sensing. The optical components group and its predecessor organization at NIST were responsible for managing the contract. Materials known as iron garnets exhibit exceptional characteristics for magneto-optic magnetic field sensing. Bismuth-substituted iron garnets exhibit the most favorable properties for sensing applications, but, until recently, could be grown only in the form of thin epitaxial films. The private company developed a technique to grow these same compositions as bulk crystals, which, for magneto-optic sensing, have several technical advantages over films. The magneto-optic sensitivity of these novel compositions is more than five times greater than that of the previously most sensitive commercially available composition. Applications requiring such ultrahigh sensitivity exist in industry, medicine, and defense. In an earlier phase of the work, the company applied its growth technology based on a multichambered crucible to produce a variety of candidate garnet compositions for investigation.

NIST CONTRIBUTES INVITED REVIEW ON TEST STRUCTURES TO HANDBOOK OF CRITICAL DIMENSION METROLOGY AND PROCESS CONTROL

NIST scientists have contributed the review paper "Microelectronic Test Structures for Feature Placement and Electrical Linewidth Metrology" to the Handbook of Critical Dimension Metrology and Process Control, Volume CR52 in the Society of Photo-Optical Instrumentation Engineers series Critical Reviews of Optical Science and Technology. The review was first presented as an invited paper at the SPIE Microelectronic Processing 93 symposium. The handbook serves

as the proceedings for this conference and is intended to be a reference volume for semiconductor process engineers engaged in metrology and process control.

The NIST contribution constitutes a critical review (49 references) of electrical test methods for determining feature placement and electrical linewidth for sub-half-micrometer design linewidths. The semiconductor industry has identified control of feature placement and control of linewidth as two of the most important challenges to be met in manufacturing advanced microelectronic devices. Microelectronic test structures are electrical devices used to determine selected fabrication tool, process, device, material, and circuit parameters by means of electrical tests. Properly characterized test structures and measurement methods provide a cost-effective means of determining the critical parameters needed to develop, control, and operate the next generation of lithographic patterning tools.

PROJECT TO COMMERCIALIZE PENDING PATENT ON JOINTS FOR STEWART PLATFORMS BEGINS IN NANO-SCALE METROLOGY GROUP

A cooperative project for commercialization of a pending patent, "Adjustable Rigid Strut Joint for Precision Structures," has been initiated with joint sponsorship by the Maryland Department of Economic & Employment Development (DEED) and the University of Baltimore School of Business. The new joint design was invented to improve the ease of fabrication and mechanical stiffness of Stewart Platform structures. This is incorporated into the structure of a new ultra-violet wavelength microscope being developed at NIST.

The project will be managed by a representative from each sponsor with cooperation and consultation of the originating researcher, a NIST scientist. The project's purpose is to move new technology out of Federal labs and into the private sector. The process begins with a three-semester graduate student project on a chosen technology (or invention) from a participating lab in the "Entrepreneurial Opportunity Analysis" course (Mgmt 762). A team of four to six graduate students explores and analyzes market opportunities, creates a business commercialization plan, and seeks to obtain initial private-sector commitment of resources for commercialization of the invention. Following this process, DEED begins work with the private-sector company.

ICP-MS EVALUATION OF CONTINUOUS-FLOW SAMPLE PREPARATION FOR THE DETERMINATION OF LEAD IN ENVIRONMENTAL SAMPLES

A new method for preparing samples for the chemical analysis of lead has been evaluated through a Cooperative Research and Development Agreement between NIST and a private company. Sample preparation is often the most labor-intensive and time-consuming part of lead chemical analysis procedures and typically has not benefited from the tremendous advances in analytical instrumentation—increased automation, sensitivity, and computer control. In addition, sample preparation has the potential to introduce errors from contamination, incomplete digestion, or volatile losses of analytes. The new method uses slurry sampling and flow injection through a microwave, which accomplishes wet digestion. The technique now produces a sample for instrumental measurement in about 10 min and, although not fully automated, has the potential for being included in a fully automated analytical system.

NIST expertise in stable isotope tracer measurements using inductively coupled plasma mass spectrometry (ICP-MS) was applied to evaluate the new method and examine the analytical parameters. Values certified using the traditional analytical procedures were compared directly. One of the major attributes of the system is its ability to handle reactive mixed acid mixtures required for sample dissolution. A broad range of environmental and clinical standard reference materials were analyzed for lead: soil, sludge, dust, paint, air filters, fuels, leaves, blood, and urine. When mixed acids were used, the results were directly comparable—both the accuracy and precision of the analyses showed no significant differences between the techniques for sample preparation. The isotope dilution method is ideally suited toward the new technique, since the accuracy is based on the use of an internal standard and a stable isotope of the same element is the best internal standard available.

WHAT'S NEW WITH SI?

The 11th meeting of the Consultative Committee on Units (CCU) of the International Committee for Weights and Measures (CIPM) was held at the International Bureau of Weights and Measures (BIPM) on Feb. 21–22, 1995. The CCU is one of nine Consultative Committees to the CIPM; its area of responsibility is the

International System of Units (SI). The CCU made several significant decisions at its meeting:

- It recommended that the SI consist of only two classes of units: base units and derived units, with the radian and steradian, the two supplementary units, subsumed into the class of derived units.
- It recommended that the International Electrotechnical Commission propose names and symbols for prefixes denoting powers of two for use in information technology, recognizing that there is an increasing need in information technology to express binary multiples of units such as the bit and byte, whereas the SI prefixes represent strictly powers of 10.
- It proposed a number of changes to the 1991 edition of the SI brochure *Le Système International d'Unités (SI)* including (a) the addition of the neper and bel to the table "Units accepted for use with the International System"; (b) moving the ångström, barn, curie, roentgen, rad, and rem to the table "Examples of units that should preferably be avoided"; (c) keeping the nautical mile, knot, are, hectare, and bar in the table "Units temporarily accepted for use with the International System"; and (d) moving the gal to the table "CGS units with special names, preferably to be avoided."

There were 17 participants representing various international organizations at the meeting, including the BIPM, the International Organization for Standardization, the International Electrotechnical Commission, and several national standards laboratories, including NIST.

COLLABORATION ON ATMOSPHERIC RADON STUDIES INITIATED

NIST recently initiated a collaboration with the Atmospheric Sciences Research Center of the State University of New York at Albany (Western Field Office, Moffett Field, CA) to calibrate and evaluate the performance of airborne instrumentation used to measure radon in the troposphere. Atmospheric radon measurements, both at surface levels and at varying altitudes, are widely used by the meteorology and atmospheric science communities in applications ranging from its use as an indicator of the presence of continental air masses over the oceans to its use as a tracer for identifying air of recent tropospheric origin in the lower stratosphere. It also has become a major tool in the development and verification of global circulation and chemical transport models. These are the complex models used to assess questions such as ozone depletion and the possible effect of supersonic and subsonic aircraft on the chemical state of the atmosphere. Recently, modeling

groups from all over the world have begun to examine some of the significant discrepancies in the various models. Major breakthroughs in evaluating the transport component of the models are now anticipated as a result of significant improvements in the quality of the available radon measurement databases.

In 1991–1992, NIST conducted an in situ calibration and intercomparison exercise for marine atmospheric radon measurements. The participating laboratories have been responsible for perhaps 95 % of the available surface-level measurements gathered around the globe over the last decade. The results of this earlier NIST work now allow the modeling community to put all of these measurement results on a common basis (relatable to U.S. national standards maintained by NIST), and it allows them to apply the data to the models on a more reliable basis. The present collaboration with ASRC will assure and enhance the quality of another significant database required by the modelers—namely, free tropospheric profiles as a function of altitude. The ongoing ASRC tropospheric measurements will represent an order-of-magnitude increase in the size of the database previously available in this region, and the NIST contributions to the collaboration will undoubtedly improve their quality by nearly as much.

AUTOMATION OF PRIMARY FREQUENCY STANDARDS

NIST scientists have developed automation and measurement techniques that will change the way NIST-7 and all future NIST primary frequency standards are operated. At the heart of this development is a digital servo-control

system. While the primary function of this system is to lock a microwave source onto the cesium resonance, its frequency agility under computer control allows for automated control and evaluation of a number of systematic errors. In addition, one of the scientists has generated computer routines that permit automated operation, evaluation, and remote monitoring of subsystems, and the evaluation process. The remote monitoring allows the staff to monitor the standard on weekends and nights (from home), resulting in more nearly continuous operation of the standard.

The servo-control system locks onto the cesium resonance with a very long time constant, so the system can periodically check the frequency of one of the Zeeman lines. Since the frequencies of these lines are related directly to the strength of the magnetic field, this information is used to servo control the field. Between runs, the system automatically takes scans of the Ramsey pattern at predetermined microwave power levels. These provide the basis for determining the atomic velocity

profile, important input to evaluation of several systematic errors. As a result of this automation, full evaluation of the standard can be accomplished in 2 days, a vast improvement over the month-long evaluations of NBS-6.

A NEW TIMING DISTRIBUTION AMPLIFIER

Two NIST scientists and a scientist from the Technical University of Torino, have developed a timing distribution amplifier with exceptionally low environmental sensitivity. The amplifier, operating at 5 MHz and 10 MHz, provides 5 outputs for 1 input and is used for distributing timing signals within a measurement laboratory. The characteristics assure that the performance of the standard driving the amplifier is realized at the many application ports within the laboratory.

The sensitivity to temperature is typically less than 0.3 ps/K at the normal operating temperature. This results in a fractional frequency error of less than $3 \times 10^{-18}/\text{K}$ for a measurement time of 1 day. The isolation from channel to channel and front to back is typically 120 dB. This isolation means that shorting or disconnecting one channel changes the phase of another channel by less than 33 fs.

N₂O LASER

A NIST scientist and a guest researcher from the University of Tokyo have developed a practical 2 m N₂O laser that lases on more than 40 lines in the 9 μm and 11 μm regions of the spectrum. Lasing in the 9 μm region had been observed once in 1969 but with a laser tube that was 6 m long. The observation of the 11 μm hot bands is the first ever for this gas. Frequency measurements of these lines will begin soon. The laser can be saturation stabilized to N₂O in a manner analogous to the way in which the CO₂ laser is stabilized. Hence, N₂O soon should become another infrared frequency standard similar to CO₂. The laser also serves as a pump laser for far infrared lasers; in fact, a new far infrared laser line in methanol pumped by a 9 μm N₂O line already has been discovered.

RAMAN COOLING OF STORED IONS

NIST scientists report experiments in which a bound atom is cooled to the zero-point energy using resolved-sideband Raman cooling. The cooling process involves an interaction between the vibrational states and the internal states of the atom through Raman transitions. These experiments set the stage for future work that is important in several contexts. First, it may be possible to exploit this interaction to create squeezed and other

nonclassical states of particle motion. Second, if the cooling technique is applied to the center-of-mass of two or more ions, it may be possible to prepare correlated internal atomic states that can reduce quantum noise in spectroscopy (or atomic frequency standards), or construct quantum logic gates applicable to the realization of a quantum computer.

In the experiments reported by the scientists, a single beryllium ion bound in an rf (Paul) trap is cooled to the zero-point energy. In one dimension the zero-point energy is achieved 93 % of the time. In three dimensions, the zero-point energy is achieved 58 % of the time. Further improvements in the system, including the application of additional cooling cycles, should improve the three-dimensional Raman cooling.

PHOTONIC FILMS

Single crystal electro-optic films have potential applications in miniaturizing future photonic telecommunication and image-processing systems. Because of its large electro-optic coefficient, barium titanate is an important electro-optic material. Devices fabricated from barium titanate, such as optical switches and modulators, could be made much smaller than current commercial devices made from lithium niobate. However, success in producing single crystal barium titanate films has been limited to date. A milestone to success is the deposition of epitaxial barium titanate on other inexpensive single crystal substrates.

NIST has succeeded in depositing by thermal metal-organic chemical vapor deposition, state-of-the-art barium titanate thin films epitaxially onto single crystal magnesium oxide substrates at 600 °C, a temperature at least 20 °C lower than that reported by other investigators. The advantages of depositing at a lower temperature are better compatibility with standard silicon device processing technology, less interdiffusion with the substrate, and lower concentrations of thermally activated defects. All of these factors are critical to developing thin film electro-optic photonic devices.

IMPROVED MANUFACTURABILITY OF READ HEAD SENSOR FILMS

A major problem in the development of a new generation of ultrahigh sensitivity read heads for computer hard drives is the loss of signal strength that occurs while baking the photoresist during the manufacturing process. Now, researchers at NIST have identified a major cause of this decline and have used this knowledge to produce sensor films that show increased thermal stability and even, in some cases, an increase

in signal strength after baking. The sensor films, which detect magnetic fields by the giant magnetoresistance (GMR) effect, are magnetic multilayers called “spin valves” with the structure 50 nm NiO\2.5 nm Co\2 nm Cu\4 nm Co\2 nm Cu\2.5 nm Co\50 nm NiO. The magnitude of the GMR effect depends sensitively on the thicknesses of the layers in the spin valve structure. When the films are heated to 250 °C, degradation of signal strength occurs, in part, because the Co at the Co/NiO interfaces is oxidized by oxygen atoms diffusing from the NiO layers. The solution to this problem is to make the Co layers adjacent to NiO thicker so they oxidize down to the optimum thickness during the baking process.

Development of this new generation of ultrahigh sensitivity read heads is being supported by an ATP grant to the National Storage Industry Consortium (NSIC), which is working toward a read head that can read 1.5 Gbit/cm² (10 Gbit/in²). This NIST accomplishment constitutes an important step toward achieving that goal.

THERMOPHYSICAL PROPERTIES OF AEROSPACE ALLOYS

As part of the work of the NIST-sponsored Consortium on Casting of Aerospace Alloys, selected thermophysical properties of an important nickel-based superalloy (IN718) and a titanium alloy (Ti-6Al-4V) have been measured with unsurpassed accuracy, at temperatures extending up to several hundred degrees above the melting point. These data are a critical need for use in computer modeling, which is used increasingly to analyze the metal casting process. NIST is coordinating its data measurement activities, which emphasize enthalpy, specific heat, heat of fusion, emissivity, and electrical resistivity, with experiments carried out by other consortium members who measure additional important properties. Previously available data had not been considered highly reliable, especially for the liquid phase, and there were only a few reported measurements for complex engineering alloys. The new property data are now being used by members of the consortium in their modeling work, which has the goals of shortening the development time for new casting designs and analyzing the formation of casting defects. The thermophysical property measurements are being extended to additional alloys, with the long-range goal of understanding how the properties depend on alloy composition and temperature.

WAVELETS PERMIT AUTOMATION OF FIBER COMPOSITE FRAGMENTATION TESTS

Because they are not transparent, measuring the fiber and interface strengths of metal matrix composites is difficult. The number of fiber breaks, needed to characterize their strength distributions, cannot be determined optically. Even if possible, counting the number of fiber breaks is a labor-intensive task. Acoustic emission monitoring is one of the few alternatives available, but the acoustic signals from very fine (8 μm) graphite or glass fibers fractures are exceedingly small, rapidly absorbed by the composite, and corrupted by machine noise. NIST researchers have, therefore, used powerful new wavelet-based techniques to separate the fiber break events from the ambient noise. The noise reduction is dramatic, and acoustic emission results show equivalency with optical methods, as verified by tests of transparent composites. These results permit automation of fiber fragmentation tests, and steps are being made to set up a prototype facility for use at NIST as well as for industrial consideration.

MECHANISTIC STUDY OF SUPER FIRE SUPPRESSANT BEGINS

The search for efficient fire suppressants has been urgent since controls have been imposed on the near-ideal halons due to their harm to stratospheric ozone. Iron pentacarbonyl, Fe(CO)₅, known to extinguish flames at concentrations two orders of magnitude lower than halon 1301, is highly toxic and thus not appropriate for general use. Nonetheless, it is so effective that an understanding of its flame-quenching mechanism may provide avenues for identifying or developing new suppressants.

A NIST scientist and a scientist from a private company have begun such a study. They have performed preliminary experiments in methane-air and propane-air Bunsen flames with argon used as a carrier for the inhibitor. Volume fractions of Fe(CO)₅ as small as 24×10⁻⁶ reduced the methane-air flame velocity by 20 %. For a volume fraction of 100×10⁻⁶, the flame velocity was reduced to half its initial value, and adding further inhibitor had virtually no effect. During inhibition, the flame luminosity increased, likely due to FeO emission. Similar results were observed for the propane-air flames, with slightly less inhibitor efficiency. The research will continue with experiments with diffusion flames and the development of flame models.

NIST STUDIES SUPPRESSANT PERFORMANCE IN HIGH-SPEED, TURBULENT FLAMES

Some flames, especially those resulting from exploding shells, travel at near-sonic velocities. Quenching these fires requires rapid suppressant action with the agent causing little or no accompanying pressure rise. NIST has developed a detonation/deflagration tube in which flame suppressant performance has been related to full-scale test results at Wright Patterson Air Force Base. A NIST scientist and a private company scientist have evaluated the performance of three suppressants (C_2HF_5 , C_3F_8 , and CF_3I) in lean, stoichiometric, and rich ethene-air and propane-air flames.

C_3F_8 provides the most consistent performance over the widest range of fuel/air mixtures and tube geometries. CF_3I has the greatest positive impact at low concentrations but exhibits nonmonotonic increases in flame speed and shock pressure ratio at higher concentrations. All three agents are deemed viable candidates for fire suppression in avionics bays of aircraft.

NIST DEVELOPS NEW TOMOGRAPHIC METHOD FOR TURBULENT FLOW FIELDS

A NIST scientist and two guest researchers have created a new algorithm for the reconstruction of the local transmittance of radiation in a turbulent flame. The method, based on a Fourier inversion, is applicable to both symmetric and asymmetric systems. It is expected to be less sensitive to random errors due to uncertainties in the measurements. The method gives good agreement for reconstructing local probability distribution functions, experimentally determined from line-of-sight measurements, for an axi-symmetric propene-air flame. The algorithm also was accurate in reconstructing synthetic line-of-sight data for a complex, non-axisymmetric Gaussian function.

BUILDING SCIENCE SERIES DOCUMENTS VALIDATION OF MOIST

Using NIST's large calibrated hot box, scientists have completed an extensive laboratory verification of MOIST, a personal computer program that provides building practitioners with the means to develop appropriate guidelines for controlling moisture in building envelopes. MOIST has been distributed to more than 600 individuals and is being used by manufacturers of building materials, moisture consultants, universities, and other research laboratories. Prior to the development of MOIST, moisture control guidelines were, for the most part, unsupported by valid technical analysis. Excessive levels of moisture within a building envelope can lead to major problems including increased energy usage, degradation of building materials, and the growth of unhealthful fungi.

In the experiment, 12 residential wall specimens were exposed collectively to steady and transient winter conditions and steady summer conditions over a 104-day test period. The wall specimens were designed to examine the relative effects of different building components such as the inclusion of a vapor retarder, paint layer, or sheathing layer for reducing moisture transfer. Test conditions were designed to promote the accumulation of moisture in the exterior sheathing under winter conditions and drying under summer conditions. The interior ambient air was maintained at levels typical of indoor residential conditions. Results show that moisture content in the hygroscopic sheathing layers increased during winter conditions, in some cases, by nearly 20 % of the moisture content. The agreement between the moisture content predicted by MOIST and the experimental results was within 1 % of the moisture content for most of the wall specimens.

NIST MEASURES INDOOR PAH EMISSIONS FROM WOODSTOVES

NIST has published a report, NISTIR 5575, Measurements of Indoor Pollutant Emissions from EPA Phase II Woodstoves. The measurements were made for the Consumer Product Safety Commission, which is conducting an assessment of the risk of cancer from benzo[a]pyrene (BaP) and other polycyclic aromatic hydrocarbons (PAH) associated with emissions from woodstoves meeting the EPA Phase II requirements for emissions to the outdoor air. Four stoves meeting the EPA Phase II requirements were tested in a 37 m² test house on the NIST grounds.

This project was a collaborative effort by NIST scientists in which the PAH concentrations in the air samples were determined using liquid chromatography and fluorescence spectrometry. Each test lasted about 10 h, during which a variety of parameters were measured, including indoor PAH concentrations and building air change rates. Based on the data collected, a single-zone mass balance analysis was used to determine PAH emission rates in ng/s and in ng/kg of wood burned. These emission rates were determined for the sum of eight individual PAH compounds and for BaP alone. The emission rates of total PAHs ranged from 0.05 ng/s to 0.24 ng/s, and the total PAH source strengths ranged from 67 ng/kg to 711 ng/kg of wood burned. The emission rates of BaP ranged from 0.003 ng/s to 0.028 ng/s, and the BaP source strengths ranged from 7 ng/kg to 90 ng/kg of wood burned. No statistically significant relationship was evident between these emission rates and source strengths and the type of stove or the number of stove door openings during the test.

PREDICTING THE SERVICE LIFE OF POLYMERIC COATINGS SYSTEMS

The polymeric coatings industry has undergone drastic technological changes over the last 2 decades as a result of legislative actions. The consequence of these changes has been the displacement of almost all commercially important, well-established polymeric coatings by newer systems, the formulation and application of which are based on different chemistries and technologies. Unlike the coatings they have displaced, however, these new coatings do not have well-established performance histories and the only accepted method for generating performance data is through an extensive outdoor exposure program. Since outdoor exposure results typically take 5 years to obtain, there is a desperate need for an accelerated aging methodology capable of generating timely, accurate, and reliable service life estimates of a coating system.

A new paper from NIST, in collaboration with researchers from industry and academia, compares the service life prediction methodology currently used in the coatings industry with the more scientifically rigorous, reliability-theory-based methodology used in the electronics, medical, aeronautical, and nuclear industries. The paper concludes that this reliability-based methodology can and should be applied in predicting the service life of coating systems. Implementation will require substantial changes in the current methodology. These changes will be justified in view of the greater reliability of the results.

For a copy of the paper, BSS 172, Methodologies for Predicting the Service Lives of Coatings Systems, contact Jonathan W. Martin, ext. 6717, e-mail: jmartin@enh.nist.gov (via Internet). This paper recently has been accepted for publication in the Federation of Coatings Societies Monogram Series.

NIST COLLABORATES WITH A COMPANY ON INTEROPERABILITY OF OBJECT DATABASE MANAGEMENT SYSTEMS

NIST established a Cooperative Research and Development Agreement (CRADA) with a private company to conduct test and evaluation of integrating distributed object databases among heterogeneous application environments. The goal of the CRADA is to develop a variety of interoperability experiments for different object database management systems using middleware software implemented according to Object Management Group's Common Object Request Broker Architecture (CORBA).

The company furnished NIST an object-oriented database management system known as MATISSE. The interoperability experiments with CORBA, and object

database systems such as MATISSE will focus on establishing practical experiences for demonstrating heterogeneous application environments. A preliminary demonstration of CORBA and MATISSE with a Mosaic front-end is now available. Those interested in seeing a demonstration can e-mail Elizabeth Fong at efong@nist.gov or call her.

NIST ISSUES GUIDANCE ON ASYNCHRONOUS TRANSFER MODE (ATM) TECHNOLOGY

NISTIR 5561, Asynchronous Transfer Mode Procurement and Usage Guide, assists users in selecting and implementing ATM technology and enables users to properly assimilate ATM products into the workplace. ATM is a new data communications technology that utilizes a high-speed switching protocol to quickly move cells (each containing 53 bytes) between two or more distinct points in a network. The technology uses cell switching for the high-speed transmission of data over a variety of subnetwork technologies; the media used and transmission rates are not a function of ATM. With ATM, users can communicate more information in a fixed period of time.

SOFTWARE REUSE TERMS PUBLISHED

NIST Special Publication 500-222, Glossary of Software Reuse Terms, provides a baseline set of recommended definitions for terms commonly used in the software reuse community. Effective software reuse requires new techniques to supplement traditional software engineering practices. Research has produced new methods, a growing body of technical literature, and a number of software systems developed through reuse. The resulting new terminology is set forth in the glossary, which will be expanded as further research results become available and are evaluated for use in software reuse programs.

OPEN SYSTEM ENVIRONMENT IMPLEMENTORS' WORKSHOP (OIW) HOLDS QUARTERLY MEETING

On March 14-16, 1995 the OIW held its quarterly meeting at NIST. On March 13, the Object Management Group presented a tutorial on the Common Object Request Broker Architecture specification, describing the Object Request Broker architecture and functionality, the role of the Interface Description Language, and its mappings to different programming languages in defining interfaces between software components. Highlights of the OIW included technical work on message handling services (X.400), systems and network

management, multimedia, and manufacturing message services. A new work program was initiated on imaging compression and transmission with the receipt of a suite of profiles from a vendor consortia on imaging standards. NIST Special Publication 500-224, Stable Implementation Agreements for Open Systems Interconnection Protocols—Version 7, Edition 1, presents OIW workshop results as of December 1994. The CD-ROM is available from the IEEE Computer Society, which co-sponsors the OIW.

NEW REPORT ADDRESSES SECURITY CONCERNS ON THE PUBLIC SWITCHED NETWORK (PSN)

NIST Special Publication 800-11, The Impact of the FCC's Open Network Architecture on NS/NP Telecommunications Security, assesses whether the Federal Communications Commission Open Network Architecture (ONA) requirement for nondiscriminatory access introduces additional security concerns into the PSN. Because ONA involves access to communications networks by many external service providers who lie outside the administrative purview of the network owners, security concerns arise. These include the authentication of the service user, control of the user's access to network facilities, and the delimitation of the scope of access to other networks granted to the user. The targeted audience for this report includes general telecommunications managers and technical professionals in the industry.

FEDERAL INFORMATION PROCESSING STANDARD (FIPS) FOR SQL ENVIRONMENTS APPROVED

The Secretary of Commerce approved FIPS 193, SQL Environments, for use by federal agencies. Effective Feb. 1, FIPS 193 is the first step of a continuing effort to define appropriate conformance profiles that can be used by vendors and users to specify exact requirements for how various products fit into an SQL environment. An SQL environment is an integrated data processing environment in which heterogeneous products (all supporting some aspect of FIPS 127, SQL) are able to communicate with one another and provide shared access to data and data operations and methods under appropriate security, integrity, and access control mechanisms.

STATISTICS HANDBOOK AND TOOLKIT UNDERTAKEN BY SEMATECH AND NIST

NIST has entered into a Cooperative Research and Development Agreement (CRADA) with the Statistical Methods Group of SEMATECH to develop an on-line engineering statistics handbook. The handbook, with

supporting statistical software, will offer engineers and scientists a flexible, expandable, guided statistics reference and toolkit that will allow users to select and operate appropriate statistical tools with minimum effort. The software will include a menu-driven extension of the exploratory data analysis package, Dataplot, developed and maintained in the SED in addition to selected commercial systems.

The impetus for the project comes from SEMATECH's desire to emulate the presentational and organizational style of NBS Handbook 91, Experimental Statistics, in an updated version, particularly suited to problems in the semiconductor industry.

CODE COMPLIANCE IS NOW CAUSE FOR "ALARM"

Helping fire safety officers and building managers at health care facilities achieve cost-effective compliance with a widely accepted fire safety code is the goal of ALARM Version 1.0, a personal computer software tool developed by researchers at NIST in cooperation with the U.S. Public Health Service. ALARM generates a set of alternative compliance strategies (and each strategy's estimated cost) to the National Fire Protection Association's Life Safety Code for buildings with health care occupancies (such as hospitals and nursing homes). The LSC allows alternative strategies where one can compare the level of safety provided by combinations of a building's fire safety features with the level that exactly conforms to the prescriptive requirements of the code. If the combinations provide safety at a level as high as the prescriptive requirements, an acceptable performance-based solution is achieved. ALARM uses a mathematical optimization technique called linear programming to quickly evaluate all possible code compliance solutions and design the least-cost means of achieving compliance. Also listed—for both individual building zones and the entire facility—are up to 20 alternative, low-cost compliance plans and the prescriptive solution for benchmarking purposes. Since 1985, the approach used in ALARM has been field tested in nearly 100 hospitals. The result: ALARM's performance-based solutions saved hospitals between 30 % and 35 % of the cost of implementing prescriptive codes. Future updates of ALARM could be tailored to office buildings, schools and prisons. ALARM Version 1.0 runs on an MS-DOS™ PC with a 386 or higher microprocessor, a numeric co-processor, at least one high-density floppy diskette drive and MS-DOS™ Version 5.0 or higher. At least 525 kB of conventional memory must be available. The software is available from the NFPA for \$8.96 prepaid for NFPA members and \$9.95 prepaid for non-members. Call (617) 984-7450 to order. For technical

information, contact Stephen F. Weber, B226 Building Research Building, NIST, Gaithersburg, MD 20899-0001, (301) 975-6137, e-mail: webers@enh.nist.gov (via Internet).

BULLETIN MAKES SATAN SOFTWARE LESS BEDEVILING

On April 5, 1995 software developers made SATAN, the Security Administrator Tool for Analyzing Networks, available over the Internet. Computer network administrators stood in "electronic queues" waiting for their chance to download the software program that can detect vulnerabilities in network configurations that may allow access to intruders. Although SATAN was not developed by the agency, NIST has issued an informational bulletin that answers many questions commonly raised about the software and provides advice for network administrators to improve security of their information systems. To get a copy of this fact sheet, access the NIST computer security resource clearinghouse by one of the following methods: WWW: <http://csrc.nsl.nist.gov>; ftp: [csrc.nsl.nist.gov](ftp://csrc.nsl.nist.gov), login as "anonymous"; e-mail: send message "send INDEX" to docserver@csrc.nsl.nist.gov; dial-in: (301) 948-5717. Paper copies are available from Joy Brooks, A216 Technology Building, NIST, Gaithersburg, MD 20899-0001, (301) 975-3359, fax: (301) 948-0279.

NEW TEM HELPS MAKE THE COMPLEX(ES) SIMPLE

In many applications, the interaction of adjacent layers strongly influences the performance of a material. For example, high diffusion or mixing at the interface between two metals can form intermetallic compounds that make a layered material more brittle or change its properties in other ways. Researchers at NIST recently began collecting data with a new high-resolution transmission electron microscope that may help characterize such complex materials. Cross-sectional slices of the layered materials are first milled into thin films. Parallel beams of electrons are then directed through the film. The electrons knock electrons in the film out of their orbits and lose specific, predictable amounts of energy. A spectrometer separates electrons of different energy levels and a computer analysis produces color maps of chemical compositions. With a resolution of 0.4 nm (about 2-3 atoms), the new system has produced some of the most detailed chemical maps ever produced with TEM. For more information, contact Alexander Shapiro, B106 Materials Building, NIST, Gaithersburg, MD 20899-0001, (301) 975-5970, e-mail: shapiro@enh.nist.gov (via Internet).

LOOKING FOR STRESS? NEW ULTRASOUND MAPPING DOES

NIST recently received a patent for a new nondestructive method for mapping internal stresses within a wide range of high-performance products from microchips to turbine blades. Acoustic techniques long have been used to detect cracks in materials. X-ray and optical methods have been used to detect stresses in small areas of a component. The new technique combines the advantages of both. It is completely nondestructive, can detect both cracks and stresses and, in its latest version, will produce quantitative, three-dimensional maps of stresses for larger components. The technique relies on computer analysis of acoustic waves directed through a part and reflected back to an acoustic microscope. Stressed areas of the material change the amplitude of the reflected polarized waves compared to unstressed areas. The differences in stressed and unstressed areas are displayed with color variances. NIST is working with a maker of acoustic microscopes to adapt the technique for large-scale testing of stresses in packaged microchips. For more information, contact Eva Drescher-Krasicka, A167 Materials Building, NIST, Gaithersburg, MD 20899-0001, (301) 975-6141.

COMPUTER MODELS CONTAMINANT FLOW IN LARGE BUILDINGS

Designers, equipment manufacturers, and others involved in the construction and operation of buildings soon may have computerized help in determining whether or not a facility's airflow can lead to the spread of contaminants. A new NIST-developed computer program called CONTAM recently simulated airflow in four large buildings and predicted how each might spread radon gas. These buildings included a 12-story multifamily residential building, a five-story mechanically ventilated office building with an atrium, a seven-story mechanically ventilated office building with an underground parking garage, and a one-story school building. The CONTAM simulations studied the impact of weather conditions, building characteristics, and ventilation system design and operation on radon entry rates and indoor radon concentrations. One important finding was that vertical shafts, such as elevators and stairways, play a major role in transporting radon from ground-contact floors to the upper floors of a building. For example, when the indoor air temperature is above the outdoor temperature, air flows into these shafts on lower floors and out on upper floors. This flow results in low radon concentrations on the first few floors of a building and elevated concentrations on the upper floors. The project was not undertaken to estimate human exposure

to radon but instead to demonstrate the ability of these models to account for the complexities of airflow and contaminant transport in multizone building systems. For more information, contact Andrew Persily, A313 Building Research Building, NIST, Gaithersburg, MD 20899-0001, (301) 975-6418, e-mail: andyp@enh.nist.gov (via Internet).

FORTY-SEVEN APPLY FOR 1995 BALDRIGE QUALITY AWARD

Forty-seven U.S. companies, including 18 large manufacturers, 10 service companies, and 19 small businesses, have submitted applications for the 1995 Malcolm Baldrige National Quality Award. Some have viewed a decline in applications as a decline in interest on the part of U.S. companies in the award and in quality management. "Quite the contrary," says the director of the Baldrige National Quality Program at NIST. "We continue to see a growing interest in quality and business improvement, nationwide and internationally." For example, participation in state and local award programs has increased steadily. In 1991, fewer than 10 states had award programs. Now, more than 40 state and local quality award programs are operating in about 30 states. Internationally, about 25 quality awards are now in place. Most were established within the past several years, and many are based on the Baldrige Award. Interest in the Baldrige Award program also is picking up with ongoing pilot programs for organizations in the health care and education fields. Companies receiving the 1995 Baldrige Award will be announced in the fall.

RADIOACTIVE WASTE CAN BE STORED WITH "4SIGHT"

A new computer program developed by researchers at NIST offers assistance in answering one of the nuclear era's most pressing questions: How long can low-level radioactive wastes be safely and effectively stored? Currently, the most commonly used disposal method has been to store such wastes in steel containers and then encase the containers within an underground concrete vault. Predicting the service life of these vaults—in other words, how long can they effectively protect their "hot" contents from the environment and vice versa—has been difficult. NIST's new computer program, dubbed 4SIGHT, simplifies the task. By focusing its analysis on a concrete vault's roof—the portion of the enclosure most likely to be affected by the surrounding environment—4SIGHT eliminates the need to evaluate the entire chamber in order to predict its service life. Also, NIST researchers have given 4SIGHT a

"built-in" knowledge of how key factors such as soil acidity, soil sulfate content and corrosion (of steel reinforcements) affect concrete's permeability over time. Future upgrades of the software may look at moisture effects and whether or not long-term exposure to radioactive decay from stored isotopes weakens a concrete vault's effectiveness. For more information, contact James Clifton, B348 Building Research Building, NIST, Gaithersburg, MD 20899-0001, (301) 975-6707.

NEUTRON LIFETIMES PROVIDE CLUES ON UNIVERSE'S ORIGIN

Precise measurements of the lifetime of a neutron are helping researchers determine how subatomic particles coalesced into the elements that formed our universe after the Big Bang. NIST physicists, in collaboration with scientists at the Institute Laue Langevin in France and the Petersburg Nuclear Physics Institute in Russia, are reducing the uncertainty surrounding neutron lifetime measurements. Among the benefits of this research is a clearer view of the "weak force," one of the forces acting on subatomic particles as they cooled after the Big Bang. When neutrons exist outside an atom, as they did at the birth of the universe, they decay with an average lifetime of about 15 min. Just how fast these early neutrons decayed determined, in part, the ratio of elements in the universe.

METROLOGY FOR THE AMERICAS BECOMES A REALITY

All 34 nations of the Organization of American States have agreed to participate in the Interamerican Metrology System (abbreviated SIM for the Spanish translation, System Interamericana de Metrologia), a recently re-established organization seeking to harmonize measurement standards among the countries of the Western Hemisphere. The rebirth of the SIM (the original organization has been dormant since the 1970's) marks the first successful interamerican effort toward realizing two major goals set forth at the "Summit of the Americas" held in December 1994—increasing cooperation in science and technology within the Americas, and promoting prosperity and free trade by eliminating technical trade barriers. SIM members focus on improving their national measurement and standards activities, and then harmonizing these activities with each other and the SIM as a whole. Five regional metrology organizations make up the SIM: NORAMET, North American nations; CAMET, Central American nations; ANDIMET, Northern South American nations; SURAMET, Southern South American nations; and

CARIMET, Caribbean Island nations. NIST and the OAS cooperated with four U.S. Federal agencies and the metrology laboratories of the North American Free Trade Agreement partners to revive the SIM. For more information, contact B. Stephen Carpenter, A505 Administration Building, NIST, Gaithersburg, MD 20899-0001, (301) 975-4119, e-mail: carp@micf.nist.gov (via Internet).

NEW DIODE LASER HAS RESEARCHERS GLAD FOR THE "BLUES"

If diode lasers were crayons, it would be tough to color the sky. For many years, researchers have been working to fill their crayon box with microchip-sized diode lasers that emit light in a variety of colors. Each color represents a separate frequency with potentially different applications. Blue diode lasers have proved difficult to make. However, researchers at NIST have developed a diode laser system that emits 40 mW of blue light in the 425 nm region of the spectrum. The system consists of an infrared laser directed through a potassium niobate crystal that doubles the laser's frequency and creates blue light. The researchers currently are using the system to cool calcium atoms, which may prove to be a better wavelength reference than existing standards. They also are incorporating the system in experiments measuring short-lived atmospheric chemicals believed important in ozone depletion. Future plans call for the diode laser apparatus to be tunable across a range of blue light frequencies. For technical information, contact Richard Fox, Div. 847.80, NIST, Boulder, CO 80303-3328, (303) 497-3478, e-mail: fox@boulder.nist.gov (via Internet).

HIGH POWER LASERS FOCUS OF FALL MEETING

The Boulder Damage Symposium, a principal forum for the exchange of information on the physics and technology of materials for high power lasers, will hold its 27th annual meeting at NIST in Boulder, CO, from Oct. 30-Nov. 1, 1995. Over the years, the symposium has been recognized internationally as the premier meeting for sharing data on all aspects of high-power/high-energy lasers, including environmental degradation, durability, fabrication, material growth or deposition processes, and testing. For registration information, contact Donna Wilson, CREOL/UCF, P.O. Box 162700, Orlando, FL 32816-2700, fax: (407) 823-6966, e-mail: donna@admin.creol.ucf.edu (via Internet).

NIST TAKES WORLD'S LOWEST TEMPERATURE EVEN LOWER

Last August, physicists at NIST's Gaithersburg, MD headquarters announced that they had cooled cesium atoms to 700 nK, or 700 billionths of a degree above absolute zero (-273°C , the temperature at which atomic thermal motion would cease). Now, that world record mark for a kinetic (resulting from the thermal motion of atoms) temperature has been bettered by a team at JILA, the Boulder, CO institute operated jointly by NIST and the University of Colorado. The scientists recently recorded in a gas a much lower kinetic temperature of 200 nK, or 200 billionths of a degree above absolute zero. They confined a large number of atoms of rubidium in a tiny trap using a magnetic field. The hottest (fastest) atoms then were allowed to escape from the trap, leaving the cooler (slower) ones behind. The process is analogous to the way coffee cools in your cup by evaporation. Eventually, the researchers were left with about 50 000 atoms confined to a region only 23 μm on a side, and moving with an average speed of only 4 mm/s. They measured the speed by making the atoms fluoresce under infrared laser light, and video-taping the cloud motion through a microscope. From this, the physicists could infer the temperature. Potential applications of the technique include improved spectroscopy and metrology in general, and may lead to a better understanding of quantum statistical effects, such as superconductivity. For more information, contact Eric Cornell at Div. 848.01, NIST, Boulder, CO 80303-3328, (303) 492-6281, e-mail: cornell@jila.colorado.edu (via Internet).

NIST, NSF LAUNCH NEW CHEMISTRY FELLOWSHIPS

College students and faculty have new opportunities for fellowships in chemistry and chemical engineering at NIST laboratories in Gaithersburg, MD, and Boulder, CO. The National Science Foundation, and NIST, are offering fellowships to graduate students and faculty members under a memorandum of understanding that the two agencies recently signed. Selected graduate students and faculty will conduct research at NIST. NSF is providing funds for student stipends and faculty salaries. In addition to the graduate student and faculty opportunities, a Summer Research Opportunities program, scheduled to begin in the summer of 1996, will offer 10 weeks of laboratory research to up to 15 graduating college seniors. For application information, contact the Chemical Science and Technology Laboratory, A317 Chemistry Building, NIST, Gaithersburg, MD 20899-0001, (301) 975-3143.

Standard Reference Materials

SRM 2090 PROTOTYPE SAMPLES PROVIDED TO INDUSTRY AS A RESEARCH MATERIAL

These new Standard Reference Materials (SRMs) are SEM magnification standards. They function at the low beam voltages used in the semiconductor industry and have calibrated pitch patterns down to 0.2 μm . As an intermediate step to release as fully certified SRMs, prototype samples have been released as research materials to 60 semiconductor manufacturers and suppliers for evaluation and critique. These samples, recently fabricated at a private company, have been sent to representatives of all SEMATECH member companies, other industrial contacts, participants in an interlaboratory SEM study, and university and government laboratories. NIST requested feedback to incorporate into the final design.

NEW SRM PROGRAM CATALOG AVAILABLE

The 1995-96 Standard Reference Materials Program Catalog (NIST Special Publication 260) is now available. It lists some 300 new standard reference materials in 28 major categories. SRMs are well-characterized materials produced to improve measurement science and serve industry. Examples of the technical categories with SRMs listed in the new catalog include: ferrous metals, high-purity materials, inorganics, food/agriculture, ceramics/glasses, thermodynamic properties, radioactivity, surface finish, non-destructive evaluation and fire research. To obtain a free copy of SP 260, contact the NIST SRM Program, 204 Engineering Mechanics Building, NIST, Gaithersburg, MD 20899-0001, (301) 975-6776, fax: (301) 948-3730.

NIST Workshop on Crystallographic Databases

To: Members of the Scientific Community Interested in Using Crystallographic Databases in Research and Analysis

You are invited to attend the "NIST Workshop on Crystallographic Databases" to be held on August 29–30, 1995. These databases are becoming critical to research in the industrial and academic communities. By bringing together top scientists involved in producing crystallographic data with users of the resulting databases, this Workshop will examine how well the scientific community is being served and what data activities the community feels are important in the future. This meeting is sponsored by the National Institute of Standards and Technology and will lay the ground work for future directions with respect to crystallographic databases.

A main goal of the Workshop is to foster interactions between users and providers of crystallographic databases and between the communities that use the different databases. During the Workshop, three sessions of scientific presentations will be held: (1) Formal Data Activities; (2) Scientific Uses of the Databases; and (3) Data Transfer: ensuring state-of-the-art technology. In the first session (chair: D. Watson), a representative from each of the data centers will cover present activities and project future activities of their data center. In the second session (chair: C. Brock), the focus will be on using crystallographic databases in analysis, in the prediction of materials properties and in the design of new chemicals, pharmaceuticals and materials. In the third session (chair: B. McMahon), speakers will address issues related to data transfer such as: (1) data exchange standards (CIF, etc.); (2) the role of journals in the evaluation of published data; (3) data exchange between the journals and crystallographic data centers; (4) computerized modes of data dissemination. Following the presentations, two discussion sessions will focus on Barriers to the Use of Crystallographic Data and on Partnerships for the Future. Workshop proceedings will be published in a special issue of the NIST Journal of Research.

We anticipate that the Workshop will be of special interest to those who use crystallographic data in their research or are involved with this data in some other capacity, such as managers of scientific projects, journal editors, on-line system designers, instrument manufacturers, and librarians, among others. There is no registration fee and attendance will be limited in order to hold the Workshop to an efficient and practical size. If you or a colleague would like to attend the Workshop, please contact us for further information and registration forms.

Dr. Vicky Lynn Karen
Dr. Alan D. Mighell

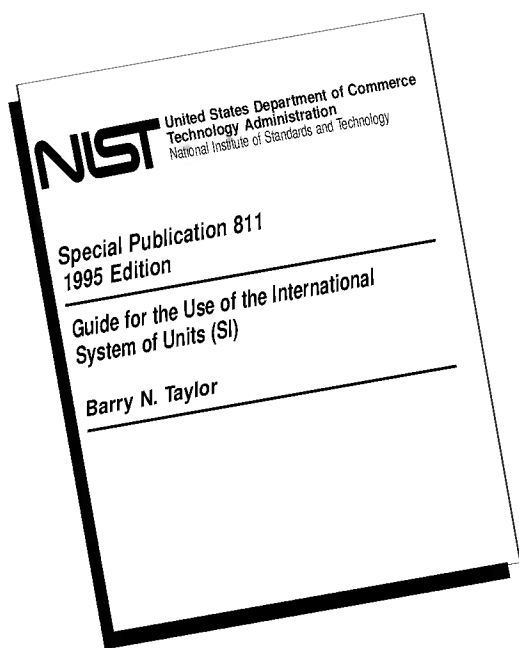
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The International System of Units (SI)

The Modern Metric System



Uncertain about the International System of Units (universally abbreviated SI), the modern metric system used throughout the world? Do you need to know the proper way to express the results of measurements and the values of quantities in units of the SI? Do you need to know the NIST policy on the use of the SI? Then you need the 1995 edition of the National Institute of Standards and Technology Special Publication 811, *Guide for the Use of the International System of Units (SI)*.

The 1995 edition of the National Institute of Standards and Technology Special Publication 811, *Guide for the Use of the International System of Units (SI)*, by Barry N. Taylor, is now available.

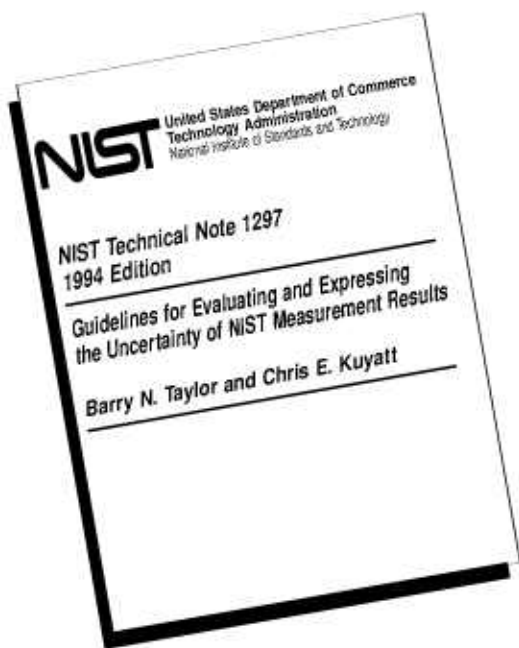
The 1995 edition of SP 811 corrects a number of misprints in the 1991 edition, incorporates a significant amount of additional material intended to answer frequently asked questions concerning the SI and SI usage, and updates the bibliography. The added material includes a check list for reviewing the consistency of written documents with the SI. Some changes in format have also been made in an attempt to improve the ease of use of SP 811.

The topics covered by SP 811 include:

- NIST policy on the use of the SI in NIST publications.
- Classes of SI units, those SI derived units that have special names and symbols, and the SI prefixes that are used to form decimal multiples and submultiples of SI units.
- Those units outside the SI that may be used with the SI and those that may not.
- Rules and style conventions for printing and using quantity symbols, unit symbols, and prefix symbols, and for spelling unit names.
- Rules and style conventions for expressing the results of measurements and the values of quantities.
- Definitions of the SI base units.
- Conversion factors for converting values of quantities expressed in units that are mainly unacceptable for use with the SI to values expressed mainly in units of the SI.
- Rounding numbers and rounding converted numerical values of quantities.

Single copies of the 84-page SP 811 may be obtained from the NIST Calibration Program, Building 820, Room 232, Gaithersburg, MD 20899-0001, telephone: 301-975-2002, fax: 301-948-3825.

Evaluating and Expressing the Uncertainty of Measurement Results



Uncertain about expressing measurement uncertainty? Do you need to know how NIST states the uncertainty of its measurement results and how you can implement their internationally accepted method in your own laboratory? Then you need the newly available 1994 edition of the National Institute of Standards and Technology Technical Note 1297, *Guidelines for Evaluating and Expressing the Uncertainty of NIST Measurement Results*.

The 1994 edition of the National Institute of Standards and Technology Technical Note 1297, *Guidelines for Evaluating and Expressing the Uncertainty of NIST Measurement Results*, by Barry N. Taylor and Chris E. Kuyatt is now available.

The 1994 edition of TN 1297 includes a new appendix—Appendix D—which clarifies and gives additional guidance on a number of topics related to measurement uncertainty, including the use of certain terms such as accuracy and precision. Very minor word changes have also been made in a few portions of the text of the 1993 edition in order to recognize the official publication in October 1993 by the International Organization for Standardization (ISO) of the *Guide to the Expression of Uncertainty in Measurement* on which TN 1297 is based. However, the NIST policy on measurement uncertainty, Statements of Uncertainty Associated with Measurement Results, which is reproduced as Appendix C of TN 1297, is unchanged.

It is expected that the 1994 edition of TN 1297 will be even more useful than its immediate predecessor, the 1993 edition, of which 10 000 copies were distributed worldwide.

Those United States readers who wish to delve into the subject of measurement uncertainty in greater depth may purchase a copy of the 100-page ISO *Guide* from the Sales Department of the American National Standards Institute (ANSI), 105-111 South State Street, Hackensack, NJ 07601. Copies may also be purchased from the ISO Central Secretariat, 1 rue de Varembé, Case postale 56, CH-1211 Genève 20, Switzerland.

Single copies of the 20-page TN 1297 may be obtained from the NIST Calibration Program, Building 820, Room 232, Gaithersburg, MD 20899-0001, telephone: 301-975-2002, fax: 301-948-3825.

NIST Technical Publications

Periodical

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Handbooks—Recommended codes of engineering and industrial practice (including safety codes) developed in cooperation with interested industries, professional organizations, and regulatory bodies.

Special Publications—Include proceedings of conferences sponsored by NIST, NIST annual reports, and other special publications appropriate to this grouping such as wall charts, pocket cards, and bibliographies.

National Standard Reference Data Series—Provides quantitative data on the physical and chemical properties of materials, compiled from the world's literature and critically evaluated. Developed under a worldwide program coordinated by NIST under the authority of the National Standard Data Act (Public Law 90-396). NOTE: The Journal of Physical and Chemical Reference Data (JPCRD) is published bimonthly for NIST by the American Chemical Society (ACS) and the American Institute of Physics (AIP). Subscriptions, reprints, and supplements are available from ACS, 1155 Sixteenth St., NW, Washington, DC 20056.

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NIST Interagency Reports (NISTIR)—A special series of interim or final reports on work performed by NIST for outside sponsors (both government and nongovernment). In general, initial distribution is handled by the sponsor; public distribution is by the National Technical Information Service, Springfield, VA 22161, in paper copy or microfiche form.

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