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**Office of International and Academic Affairs
Activities Report for Fiscal Years 2001/2002**

S.F. Heller-Zeisler, Editor
*Office of International and Academic Affairs
Office of the Director*

August 2004



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Executive Summary

The National Institute of Standards and Technology (NIST) has the unique responsibility of ensuring that U.S. industry has access to whatever measurement and standards systems it needs to compete in a global market. Because advancing technology is a significant stimulus for developing new measurement capabilities and new standards, NIST maintains a world-class research and development program to support emerging measurement needs. In addition, NIST's measurement capabilities support U.S. regulatory agencies in their efforts to ensure the health and safety of U.S. citizens. Therefore, NIST has found it advantageous to participate in a wide range of international activities. NIST targets its international activities in those areas in which U.S. industry needs access to a broader metrology base than that which is available domestically. When NIST researchers have a history of cooperation with their counterparts from other countries, it is generally easier to adopt consistent measurement systems. Thus, participation in international science and technology (S&T) arrangements significantly enhances NIST's ability to achieve its mission. NIST accomplishes its mission through a portfolio of programs, including the measurement and standards programs, the Advanced Technology Program, the Manufacturing Extension Partnership, and the Baldrige National Quality Program. The coordination of international and academic activities in these programs is the responsibility of the Office of International and Academic Affairs (OIAA). This report presents an overview of international and academic activities both through OIAA and throughout NIST for the fiscal years 2001 and 2002.

NIST is continuing international cooperation in measurement sciences as one of the 38 signatories of the Comité International des Poids et Mesures (CIPM) Mutual Recognition Arrangement (MRA), signed in October 1999. This Arrangement provides a framework for cooperation in the measurement sciences by providing the technical basis for acceptance of calibration certificates issued by the national measurement institutes. It is expected that the MRA will provide the technical information necessary to resolve trade disputes that arise over differences in measurements and standards. OIAA continues to remain actively involved in this process.

Among the activities coordinated by OIAA are several extensive on-going international programs, including the U.S. - Israel Binational Industrial Research and Development (BIRD) Foundation, the U.S. - Egypt Joint S&T Fund program, and the Sistema Interamericano de Metrologia (SIM). In addition, OIAA coordinates the foreign guest researcher program and the more than 1800 foreign visitors to NIST per year.

In the fiscal years 2001 and 2002, OIAA hosted many distinguished high-level visitors including the Minister of Trade and Industry from Norway; the Minister of Science and Education from the Republic of Lithuania; the Minister of Science and Technology from Brazil; the President of the Korea Information Security Agency (KISA); the Minister of Labor and Employment from Sri Lanka and members of the Sri Lankan Parliament; the Director of the Agency of Industrial Science and Technology (AIST) of the Ministry of International Trade and Industry (MITI) from Japan; the Director of the National Institute for Metrology from Thailand; the Director and Deputy Director from the National Physical Laboratory, United Kingdom; the Director General of the Saudi Arabian Standards Organization (SASO); and the President of the Jamaican Bureau of Standards.

OIAA continues its outreach not only to the NIST community, but also to our partners elsewhere in the United States and abroad through a comprehensive homepage on the World Wide Web. The OIAA homepage provides information on the international and academic activities at NIST, links to other national metrology institutes and national standards bodies, a directory of all NIST international agreements, links to organizations which fund international S&T cooperation, and information for NIST travelers, as well as other useful information.

NIST priorities in international activities are to ensure that the measurement capability needed to support commerce in U.S. goods and services exists around the world; to ensure that U.S. manufacturers can have access to whatever accreditation or conformity assessment system is required by any country in the world for importation of goods or services; to conduct scientific technological, and metrological activities to further U.S. foreign policy; to ensure that international standards reflect U.S. measurement capabilities to the extent possible; and to provide education and training in measurements, standards, and measurement and standards systems.

This record of international activities underscores the efforts of NIST to promote S&T, and measurement sciences specifically. The importance of international cooperation in S&T has increased, not decreased, with recent world

events. Science, as a universal language, continues to be the foundation of bilateral and multilateral cooperation among nations, even when conflicts exist.

OIAA hopes that you find this Report useful and welcomes your comments and suggestions on future reports.

A handwritten signature in black ink, appearing to read "B. Stephen Carpenter". The signature is fluid and cursive, with the first name "B." and the last name "Carpenter" clearly visible.

Dr. B. Stephen Carpenter
Director, Office of International and Academic Affairs

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Office of International Affairs

Dr. Claire M. Saundry, *Chief*

The mission of the Office of International Affairs (OIA) is to provide advice on international science and technology affairs, including the management of international programs and the interpretation of foreign policy guidelines set by the Departments of State and Commerce; serve as liaison between the National Institute of Standards and Technology (NIST) and the international science and technology offices of other Government agencies, foreign governments, and international bodies; provide NIST representation on various delegations to international meetings and on committees; manage NIST international bilateral and multilateral cooperative programs; represent the Director in the negotiations of international agreements; serve as the focal point for foreign visitors and guest researchers; provide assistance to NIST travelers visiting foreign laboratories and institutions; and arrange for NIST services to users in friendly countries (15 U.S.C. 273). This section summarizes the international agreements that have been signed in fiscal years 2001 and 2002, and also the international activities and outreach of OIA and the Office of the Director.

International Agreements Signed in Fiscal Years 2001 & 2002

Argentina

A Memorandum of Understanding (MOU) between the National Institute for Industrial Technology (INTI) of the Secretariat of Industry and NIST was signed effective September 19, 2002. The MOU is for the cooperation in chemistry, physics, and engineering measurement science, and remains in effect for five years.

Brazil

On April 10, 2002, NIST and Brazil's National Institute of Metrology, Standardization and Industrial Quality (INMETRO) signed a Memorandum of Understanding concerning Technical Cooperation in Chemistry, Physics, and Engineering Measurement Sciences. The MOU was signed by the Deputy Director of NIST and the President of INMETRO. NIST and INMETRO have worked together on electricity measurements, on establishing measurement methods, optical frequency standards, resistance measurements, acoustical metrology, and the development of a Reference Materials Program in Brazil. The MOU is valid until 2007.

Egypt

NIST and Egypt's National Institute of Standards (NIS) have renewed a science and technology agreement that aims to strengthen technical capabilities in both countries and to foster closer economic ties. The MOU, for cooperation in the measurement sciences, chemistry, physics, and engineering, and standards-related activities, was originally signed in 1996. Under the agreement, NIST and NIS staff collaborate on projects ranging from software engineering to flame-retardant materials made with the tools of nanotechnology. One team developed the means to broadcast high-accuracy time and frequency signals from Egypt's Nilesat satellite. Training, workshops, and exchanges

of personnel also are carried out under the agreement. In addition, NIST is assisting Egypt in efforts to broaden its chemical measurement capabilities and services. The extension of the agreement was signed on April 22, 2002, by NIST Director Arden Bement and by NIS President M.S. Shaalan, and remains in effect until 2007.

Finland

The National Institute of Standards and Technology (NIST) and the National Technology Agency of Finland (TEKES) signed a Memorandum of Understanding (MOU) concerning cooperation in science and technology to promote science and technology collaboration between the two countries. The agreement was signed on May 30, 2002, by NIST Director Arden Bement and by TEKES Director General Veli-Pekka Saarnivaara in Gaithersburg, Maryland, and is valid until 2007.

Japan

On July 31, 2001, NIST and the National Institute of Advanced Industrial Science and Technology (AIST) of Japan signed a Cooperation Agreement in Gaithersburg during the visit of a Japanese delegation headed by Prof. Naohiro Soga. Under the agreement, various collaborations of mutual interest will be pursued, including intercomparisons of standards, research exchanges, and exchanges of technical information reference data and materials. In total, there are sixteen research collaborations planned, of which eight are continuing from the previous NIST – AIST agreement. The agreement remains valid until July of 2006.

Korea

On November 2, 2000 NIST renewed the Implementing Arrangement with the Korea Institute of Energy Research (KIER), which had its

beginnings in September 1995 to exchange science and technology information and to conduct joint research on energy-related technologies. Under this Arrangement, the NIST Building and Fire Research Laboratory has carried out joint research with KIER on automated real-time performance optimization, fault detection, and diagnosis of thermal systems to improve energy efficiency, increase safety and reliability, and reduce operating costs.

A Research Agreement between the Building Environment Division of NIST and the Energy Conservation Research Department of KIER was signed on November 2, 2000 to promote the exchange of scientific and technological knowledge and to encourage joint research in the field of energy technology. The agreement will continue in effect for five years.

Mexico

The Implementing Agreement between NIST and The National Council for Science and Technology (CONACYT) and the Secretariat of Economy (SECONOMIA), the Office of the Federal Attorney General for Consumer Protection (PROFECO), and the National Center for Metrology (CENAM) of the United Mexican States concerning Technical Cooperation in Chemistry, Physics, and Engineering Sciences, Standards Related Activities and Interchange of Technical Information and Experiences was amended and extended on January 21, 2002. The agreement will continue in effect for five additional years.

South Africa

In August 2001, NIST and CSIR, a corporate body in South Africa established in terms of the Scientific Research Council Act in 1988, renewed the Agreement for technical cooperation in chemistry, physics, and engineering measurement sciences for an additional five years.

Taiwan

An Implementing Agreement between the American Institute in Taiwan and the Taipei Economic and Cultural Representative Office for technical cooperation on neutron scattering research was signed February 16, 2001. This agreement remains in effect for five years.

Multilateral Agreements

Gulf Cooperation Council Countries (GCC)

The MOU between NIST and the Standardization and Metrology Organization for the Gulf Cooperation Council Countries (SMO-GCC) concerning technical cooperation on standards was renewed in March of 2002 for an additional three years. The agreement provides a continuing framework for technical cooperation between NIST and the GCC with respect to standard-related activities. The agreement provides for cooperation encompassing all aspects of standardization, but has concentrated thus far on documentary standards and conformity assessment.

Trilateral Agreement with Spain and Japan

A trilateral Research Cooperation Agreement involving the National Microelectronics Center of Spain (Barcelona, Spain), the Nanotechnology Research Institute of the National Institute of Advanced Industrial Science and Technology (Tsukuba, Japan), and the Precision Engineering Division of NIST was signed and completed on September 3, 2001, to be valid for three years. The purpose of the agreement is to establish scientific cooperation in the area of advanced lithography of functional nanostructures.

International Activities of the Office of International Affairs and the Office of the Director during FY 2001/2002

Bilateral Cooperative Activities

Algeria

The Director of the Office of International and Academic Affairs (OIAA) and a representative from the Process Measurements Division of the Chemical Science and Technology Laboratory (CSTL) visited Algiers in September of 2002, as part of the U.S. Department of Commerce (DoC)/Commercial Law Development Program's (CLDP's) Oil and Gas Metrology Assistance to the Algerian government. This program is part of the U.S. – North Africa Economic Partnership program for Algeria. The visit included discussions on developing a cooperation to establish a flow metrology laboratory in Algeria, and tours of several measurement laboratories and oil refinery plants.

Argentina

The Director of OIAA visited INTI in May of 2001 to discuss future cooperative activities. These discussions led to the renewed interest in cooperation between the two institutes, and to the eventual signing of the MOU between NIST and INTI in September of 2002.

Brazil

Several international congresses and workshops were held in Brazil, sponsored by National Institute of Metrology, Standardization and Industrial Quality (INMETRO), and having support from NIST in the form of technical experts. One such activity was Metrologia 2000, held in Rio de Janeiro in October of 2000, which covered electrical, chemical, optical, and telecommunications measurements and legal metrology. This international conference was organized by the Brazilian Society of Metrology in close cooperation with INMETRO and other national and international organizations such as the International Measurement Confederation (IMEKO), the Sistema Interamericano de Metrologia (SIM), also known as the Inter-American Metrology System, and NCSL International. INMETRO also sponsored the International Meeting on Quality and Metrology, which took place April 8-13, 2002, and was attended by the Deputy Director of NIST and the Director of OIAA as well as by several NIST technical staff, who gave presentations on specific aspects of metrology. During this meeting, the Deputy Director of NIST and the

President of INMETRO signed an extension to the MOU, concerning technical cooperation in chemistry, physics, and engineering measurement sciences.

On June 18-19, 2002, the Brazilian Ministry of Science and Technology (MCT) hosted a bilateral meeting in Brasilia on Science and Technology (S&T) cooperation between Brazil and the U.S. The Director of OIAA participated as part of the U.S. delegation, which was led by the Secretary of State's Science and Technology Advisor. The delegation also included representatives from eight other U.S. government technical agencies. Brazil's Minister for Science and Technology headed the Brazilian side, which included over forty representatives from eleven agencies and four Ministries. One of the discussion topics included a request for NIST for advice on how to increase participation of small- and medium-sized enterprise (SMEs) and private industry involvement in S&T in Brazil.

The Director of OIAA participated in an Instituto de Pesquisas Tecnológicas (IPT)-sponsored seminar, "Net of Technological Knowledge for Micro and Small Companies – National and International Experience", in São Paulo, on June 24-28, 2002, which followed the bilateral S&T meeting. The Director of OIAA presented some of NIST's experiences on cooperation with SMEs and the Advanced Technology Program at the seminar.

In September 2002, the Director of OIAA and a representative from the Advanced Technology Program (ATP) participated in the Economic Impact Seminar, which was held in São Paulo. This seminar was held in conjunction with the Metrosul and Metrochem-III meetings in Curitiba, Parana, Brazil, in which the Chief of the Analytical Chemistry Division, Chemical Sciences and Technology laboratory (CSTL) also took part.

Canada

The Deputy Director of NIST participated in the Conference on Precision Electromagnetic Measurement (CPEM) 2002 Conference held June 16-21, 2002 in Ottawa, Canada.

Ecuador

In February 2002, the Director of OIAA led a NIST delegation for an evaluation of the Ecuador National Institute of Standardization (INEN) in Quito. This visit was requested by the Ministry of International Trade to help improve the current national schemes of scientific, industrial and legal metrology, and was undertaken as part of the MOU between INEN and NIST. The Chief of the Process Measurements Division, CSTL, and the Chief of the Electricity Division, Electricity and Electrical Engineering Laboratory (EEEL) also participated.

Egypt

NIST is an active participant in the U.S. – Egypt Science and Technology Joint Board. This activity is part of the bilateral science and technology agreement signed by the Governments of the United States and Egypt in 1995 under the auspices of the Gore-Mubarek Economic Commission to promote cooperation between the research establishments in the two countries. Under the agreement, the two countries have contributed equally each year to a joint fund, which supports activities agreed upon by the Joint Board. The Board is responsible for the technical review and approval of joint proposals, made on a competitive basis. The priority areas for cooperation are Biotechnology, Standards and Metrology, Environmental Technology, Manufacturing Technology, and Information Technology. The Board is co-chaired on the U.S. side by the State Department and includes representatives of several U.S. technical agencies, including OIAA, on behalf of NIST. At the recent annual meetings of the Joint Board, one in May 2001 held in Cairo, and the other held in Washington, D.C. in May 2002, three projects were approved that partnered NIST with NIS. Two of the projects are with the Analytical Chemistry Division of CSTL, and the third is with the Fire Research Division of BFRL.

Finland

The Director of NIST and the Director of OIAA visited TEKES, the Nokia Research Laboratory, and the Technical Research Center of Finland (VTT) in August 2002. This visit followed the May 2002 signing of an MOU between NIST and TEKES, and provided an opportunity to learn more about specific efforts of Finland in information technology and to explore future areas of collaboration under the new MOU.

A delegation of Finnish Telecommunications and Information Technology researchers from industry and university research laboratories visited various sites in the U.S., including NIST in October 2002.

Germany

The Director of NIST, the Director of OIAA, and the Director of MSEL, attended the Installation Ceremony of the new President of the Bundesanstalt für Materialforschung und Prüfung (BAM) in August 2002. They also visited the Physikalisch Technische Bundesanstalt (PTB) to discuss on-going activities under the NIST-PTB-BAM MOU.

From August 25-28, 2002, the Deputy Director of NIST traveled to Berlin to attend the second meeting of a commission for the evaluation of PTB in Berlin and Braunschweig, Germany.

India

OIAA continues to participate in the Indo-U.S. Discussion Group, where representatives of the technical agencies meet to discuss issues involving Indo-U.S. science and technology collaborations, and to keep informed on the activities of the Indo-U.S. Science and Technology Forum, which was formalized in March 2000. The Forum is an outgrowth of the previous U.S.-India Fund (USIF), which is developing beyond a body that funds bilateral research proposals between partners in the two countries, to one that strives to identify promising future areas of joint Indo-U.S. research, and finding ways to encourage and help enable the joint research. The Forum is currently focusing on selected workshops, aimed at forming cooperative partnerships in areas of S&T that are of mutual interest.

Italy

The Director of OIAA served as the co-chair of the NIST/Italy Science and Technology Working Group meeting and participated in the 6th Italy-U.S. Bilateral Seminar, “Cooperation in Metrology, Equivalence of the National Standards and Dissemination of SI units”. The meeting was held in Turin in November of 2000. The purpose of this seminar was to foster cooperation between the U.S. and Italian national metrology institutes (NMIs) for the advancement of metrology sciences, and in assuring equivalence of the national standards and dissemination of SI units. During the seminar, on-going cooperative activities between NIST

and the Italian NMIs were reviewed and possible new areas for cooperation were discussed. Also attending the Seminar were representatives from the Process Measurement and the Analytical Chemistry Divisions of CSTL, the Manufacturing Metrology Division of the Manufacturing Engineering Laboratory (MEL), and the Optical Technology Division of the Physics Laboratory (PL). The participating Italian institutes included the Istituto Elettrotecnico Nazionale G. Ferraris (IEN), the Istituto di Metrologia "G. Colonnetti" (IMGC-CNR), and the Turin Istituto Nazionale di Metrologia delle Radiazioni Ionizzanti, (ENEA - INMRI). Initiatives linked with the international Comité International des Poids et Mesures (CIPM) Mutual Recognition Arrangement (MRA) were emphasized, with special attention to the Key Comparisons and to the implementation of quality systems within the NMIs.

Israel

NIST is an active participant in the U.S.-Israel Binational Industrial Research and Development (BIRD) Foundation. Established in May 1977 by an executive agreement signed in 1976 between the U.S. and Israeli governments, BIRD supports U.S.-Israel company partnerships dedicated to developing and commercializing non-defense-related innovation products or processes. BIRD's mission is to stimulate, promote, and support industrial research and development (R&D) of mutual benefit to the United States and Israel. The foundation funds up to 50% of the companies' expenses in developing a product to the stage of commercial readiness, where funding is provided in the form of a conditional grant, and does not entitle BIRD to equity or intellectual property rights. All BIRD-funded projects must be jointly proposed and implemented by a partnership between an Israeli company and an American company. If the project is a commercial success, BIRD receives re-payments on pretax expenses to the grantee up to a maximum of 150 percent of the conditional grant. Financial support for BIRD is derived from two sources: interest earned on the \$110 million endowment granted in equal parts by the United States and Israeli governments, and repayment income from companies participating in successful BIRD-funded projects. The conditional grants are paid directly to the participating companies.

NIST has served since 1981 as one of the three U.S. Government representatives and the only U.S. technical representative on the BIRD Foundation Board of Governors, which must approve all grants made by the Foundation. The Director of Advanced Technology Program is the NIST representative to the Board of Governors, while OIAA provides administration of the technical reviews and selection process for proposals submitted to the U.S.-Israel BIRD Foundation Board. Two review periods are conducted each year, and typically occur during the months of April through June and October through December. During these periods, joint proposals are sent for technical reviews to NIST in the United States and to the Ministry of Industry and Trade in Israel. These proposals range across such diverse topics as information technology, medical applications, material science, biotechnology, and applied chemistry. Following the review process, the BIRD Board of Governors meets and awards the projects based on the technical merits of the joint proposals. During the fiscal years 2001 and 2002, a total of 29 BIRD projects were funded each year. Additional information may be found on the BIRD Foundation web site at www.bird.com.

The Director of OIAA participated in an assessment of the Israeli National Physical Laboratory (INPL) in August 2000, by invitation of the Director General and the Israeli Accreditation Corporation. During the trip, meetings were held with the Israeli Ministry of the Treasury, the Ministry of Justice, and the Ministry of Industry and Trade, where the importance of having a centralized government laboratory for accreditation, standards, metrology, and testing was stressed.

Jamaica

The Director of OIAA visited Kingston in October of 2000, to meet with officials of the Jamaican government and discuss metrology issues. The Director met with the Minister of Foreign Affairs, senior staff of the Ministry of Industry, Commerce and Technology, and senior staff of the Jamaica Bureau of Standards. The role of metrology in Jamaican trade was discussed from domestic, regional, and global views. The Ministries pledged their support of the metrological activities of the Jamaican Bureau of Standards in the Caribbean region and in SIM. The possibility of applying for a full

membership in the Metre Convention was also discussed.

Japan

In May 2002, the Deputy Director of NIST attended the first meeting of the Advisory Committee of the National Institute of Advanced Industrial Science and Technology (AIST) Advisory Committee in Tokyo City, Japan. The AIST Advisory Board was set up as an independent administrative institution to conduct an annual comprehensive review by eminent scientists and authorities, both from Japan and overseas, of all aspects of institute management. At this first meeting, fifteen advisors were in attendance, and the President of Kyoto University chaired the meeting.

Mexico

In May of 2001, the Director of OIAA and the Director of Technology Services (TS) participated in a metrology symposium at the Centro Nacional de Metrologia (CENAM) in Santiago de Querétaro, México. The seminar dealt with the future of metrology in scientific and technical fields. The NIST perspective on metrology developments and traceability was presented. The NIST representatives also held discussions about the legal metrology needs of the Dirección General de Normas (DGN), CENAM, and PROFECO, and they also visited the Centro de Investigación en Ciencia Aplicada y Tecnología Avanzada (CICATA-IPN).

In November 2001, the Director of OIAA traveled to Mexico to discuss the continuation of MOU between NIST and the Mexican government agencies CONACYT, SECONOMIA and CENAM. Another visit was made in January 2002, where the NIST Director signed an agreement to extend the MOU. The extended agreement continues the bilateral cooperation and collaborations that NIST has with CENAM, CONACYT, SECONOMIA, and PROFECO.

As follow-up to the visits, and to the extended agreement, in August of 2002 NIST hosted a Dialogue with our Mexican counterparts to discuss legal metrology, product certification, and supplier's declaration of conformity, and consumer product regulations, both present and future.

The Netherlands

The Director of NIST and the Director of OIAA visited the Nederlands Meetinstituut (NMI) in August 2002 to discuss research and calibration topics of mutual interest to both metrology institutes. The excellent collaborative work in gas metrology was noted and it was agreed that this work should definitely be continued.

Nicaragua

The Director of OIAA visited the National Metrology Laboratory of Nicaragua in March of 2001, together with the Director of Physical Metrology of CENAM. Meetings were held with the Minister of Economy to discuss Nicaragua's measurement infrastructure.

Saudi Arabia

In July 2001, NIST hosted the Director General of the Saudi Arabian Standards Organization (SASO). Meetings were held with representatives in Technology Services (TS) to discuss the NIST-SASO MOU and with representatives of the Baldrige National Quality Program.

In July 2002, representatives of SASO met with the Director of OIAA during the Gulf Cooperation Council (GCC) First Middle East Metrology Conference, which was held in Bahrain from May 6-8, 2002. During the meeting, the SASO representatives requested technical assistance in several areas, including planning of an upgrade to their metrology laboratory facilities, physical metrology training, and expansion of building and fire code work. In response, to SASO's request for assistance in the review of the design of new metrology laboratories, the Director of OIAA visited SASO in May of 2002 and conducted a preliminary evaluation of the existing SASO metrology laboratories. Further advisory meetings were held at NIST in July of 2002 with SASO personnel, during a metrology workshop held at NIST for the GCC countries. This included discussions with the architects of the NIST Advanced Measurement Laboratory (AML) and a tour of the facility. In addition to the laboratory upgrade plans, SASO has also requested assistance to establish a National Quality Award system based on the NIST Baldrige National Quality program. The NIST Standards Expert for Saudi Arabia is working with the Baldrige Office to gather information for SASO on developing such a program.

South Africa

The Director of OIAA visited Pretoria in July 2002 for consultations on the changing role of the South African National Metrology Institute (NMI) and the South African National Metrology Laboratory, CSIR. There was a one-day high-level meeting, followed by additional meetings for mid-level managers on metrology awareness. CSIR and NMI are realigning so that CSIR will become “part government, and part industry”. NMI, previously a sector of CSIR, is being promoted to a higher level of responsibility, and will have a staff increase by 50%. Discussions were also held on the renewal of activities under the MOU between the two institutes. The MOU, first signed in 1996, was extended in 2001, and remains valid until 2006.

United Kingdom

The Director of NIST visited the National Physical Laboratory (NPL) in Teddington, in August 2002 to discuss research and calibration topics relevant to both metrology institutes.

Multilateral Cooperation Activities

Asia Pacific Economic Community (APEC)

A NIST representative attended the Asia Pacific Economic Community Trade and Investment Liberalization Fund (APEC-TILF) Workshop on “Quality Systems in National Metrological Institutes”, in Singapore from December 1-9, 2000. The workshop concentrated on the requirement for each National Metrology Institute (NMI) to have a quality system that satisfies the provision of ISO 17025 in managing its calibration services. Sponsored by the CSIRO National Measurement Laboratory, and the National Association of Testing Authorities (NATA) in Australia, the meeting included participants primarily from the 21 economies and 7 signatories of the Asia Pacific Laboratory Accreditation Cooperation (APLAC) Mutual Recognition Arrangement (MRa) in the APEC region. Additional attendees included those from SIM and the Central and Eastern Europe Metrology Program COOMET. NIST’s participation in the workshop continues our support of APEC’s efforts toward achieving its MRa objectives.

Comité International des Poids et Mesures (CIPM)

The Deputy Director of NIST attended a symposium honoring the 125th Anniversary of

the Metre Convention, held in Paris, France in October of 2000. Meetings of the Comité International des Poids et Mesures (CIPM) and of the Directors of the National Metrology Institutes (NMIs) also took place.

European Union

In May 2001, the Director of OIAA participated in a Joint Consultative Group (JCG) meeting in Brussels, Belgium, as part of the delegation led by the U.S. Ambassador to the European Union (EU). The JCG met on the topic of U.S. - EU S&T cooperation on the “Vision for the Future”. The topics under discussion included such research areas as bioethics, food safety, and biotechnology in the life sciences; information technology for the disabled, grid technologies, research training networks, and e-learning under information technology; scientific policy under education; fuel cells, solar power, industrial electric motor systems, carbon sequestration under energy; chemical management; children’s environmental health protection, earthquake engineering under environment; and nano-technology.

Gulf Cooperation Countries (GCC)

The Director of OIAA participated in the First Middle East Metrology Conference, held in Bahrain from May 6-8, 2002. The conference stressed the importance of unified standards of measurement for the GCC. This conference is expected to be held regularly to continue to provide a strong foundation for the GCC countries to improve and unify their efforts in this area. While there, the Director of OIAA had meetings with representatives of the individual member countries of the GCC, who have expressed interest in expanding their cooperation with NIST into measurement standards.

Inter-American Metrology System (SIM)

OIAA, along with representatives from the NIST Laboratories, actively participates in the technical activities of SIM, and the regional metrology systems within SIM. Along with the Organization of American States (OAS), OIAA supports invitational travel of participants in SIM meetings and seminars, and the Director of OIAA participates as Technical Advisor in Technical Committee Meetings, and in seminars and workshops aimed at improving harmonization and quality in the many metrology systems of the Americas. The Director of OIAA has given several presentations in support of these topics, among

them “Trade Issues and International Metrology” at the July 2002 meeting of the Caribbean Countries Sub-Region of SIM (CARIMET), entitled “Measurement in the Small and Developing Economy – A Tool for Progress” in Trinidad and Tobago, and “Trade Issues and International Metrology” at the SIM-sponsored Sub-Regional Awareness Seminar held in San Salvador, El Salvador during May of 2002.

At the Metrologia 2000 International Congress and Measuring Instruments Exhibition in Metrology, held in Rio de Janeiro, Brazil in October 2000, several SIM-related events occurred where NIST representatives attended or held key roles. A representative from the Standards Services Division conducted a workshop on the International Organization for Standardization (ISO) Guidelines for Uncertainty Estimation, and a thermal metrology course was also held.

SIM held its annual 2001 General Assembly meeting in Miami Beach, Florida during the week of December 9-14, 2001. The meeting brought together representatives from the 34 member states of the OAS who are responsible for metrology in their respective countries, and other interested parties. There was also a symposium discussion “Infrastructure Development in the Americas” during that week, which focused on topics related to free trade in the region. There were two additional symposia, one on “Genetically Modified Foods: Measurements and Standards Needs”, and the other on “Packaging and Labeling Issues Associated with Legal Metrology”, given during this time. In conjunction with the SIM week, a four-day gas metrology course was also held. On the final day of the course, the results of the international pilot study on automobile emission gases were discussed.

SIM organized a Forum on “Quality Systems Implementation” on July 30, 2002 at NIST in Gaithersburg. The Forum was the first in a series of meetings and other activities focused on quality systems realization. Various approaches for the implementation of Quality Systems to underpin the delivery of measurement services at the NMI level were presented and discussed. This topic has become a high priority for SIM as a result of the CIPM MRa requirement for the presence of “means of assuring quality” in the signatory NMIs. The Joint Committee of the Regional Metrology Organizations (JCRB) of

the BIPM has determined that this requirement must be met by 31 December 2003. Member NMIs presented various approaches for implementing Quality Systems to provide the basis for the delivery of measurement services within their countries/economies. A special emphasis was placed on particular needs, requirements, and characteristics that may differ from those of secondary and end-user laboratories. Presentations at this first Forum included several from NIST, as well as presentations from NRC (Canada), INMETRO (Brazil), and CENAM (Mexico).

Southern Africa

NIST has been working with the relevant government agencies in improving the measurement and standards infrastructure within the South Africa region. One activity is to assist the Southern African Development Cooperation for Metrology (SADCMET) to conduct an analysis of the measurement and standards infrastructures of some of the countries that participate in this regional metrology organization. The participating countries include: Angola, Botswana, the Democratic Republic of Congo, Lesotho, Malawi, Mauritius, Mozambique, Namibia, the Seychelles, South Africa, Swaziland, Tanzania, Zambia, and Zimbabwe. Following this infrastructure review, relevant government agencies were advised about specific needs and how to develop plans to assist the participating countries to be better able to support regional and global trade.

The Director of OIAA has participated in several SADCMET-sponsored seminars that support improvements in metrology infrastructure:

- 1) In April 2001, a SADCMET meeting was held in Maseru, Lesotho, and the Director of OIAA made a presentation on “Motivation: Encouraging the Development of Metrologists”.
- 2) In June 2002, two seminars were held, one in Maputo, Mozambique, and the other in Maseru, Lesotho, on “The Role of Standardization, Quality Assurance, Accreditation and Metrology (SQAM). The Director of OIAA presented information at both seminars on what measurement capacities NMIs need to demonstrate to meet the requirements of the World Trade Organization (WTO) Technical Barriers to Trade (TBT).

NIST is also involved, through OIAA, in support activities of the Southern Africa Development Cooperation (SADC). The Director of OIAA

representing NIST and SIM, participated in an economic awareness seminar with SADC in Luanda, Angola, in July of 2002.

World Standards Day

NIST and the American National Standards Institute (ANSI) organized the U.S. celebration of World Standards Day 2000, held on October 18, 2000. The Director of NIST delivered the luncheon address. The annual event recognized the important role that voluntary standardization efforts play in industry, the U.S. economy, and the protection of human health, safety, and the environment.

Miscellaneous Activities

The Chief of the Advisory Services, Human Resource Management Division, made a presentation to the International Civil Service Commission focus group held in Vienna, Austria in December of 2000, and participated in the group as a Subject Matter Expert. The briefing was on the NIST Alternative Personnel Management System, and was made to the focus group as part of a review of the current United Nations (UN) Personnel system, and proposed program changes. Implementation concerns and issues of the broad-banding structure of the system were discussed.

During the celebration of NIST's centennial, there were many international visitors attending the festivities and events to mark this momentous occasion. These events included the Centennial Symposium, which began the Centennial week. This was held March 5, 2001, and highlighted many of NIST's accomplishments. This was continued by the Symposium on Standards in the Global Economy on March 7, 2001, which focused on the impact of standards on the future of the global economy and changes in the standards environment. Attendees included corporate leaders, directors of professional societies, standards organizations and other national and international standards laboratories and NMIs, policymakers, and the news media.

On March 8, 2001, a meeting of National Metrology Institute (NMI) Directors was held at the NIST campus in Gaithersburg, which included directors and top officials from international metrology institutes. Many of the attendees also participated in the NIST Centennial festivities. Participants in the meeting included the President, National

Institute of Industrial Technology (INTI), Argentina; the Director of the National Measurement Laboratory (NML-CSIRO), Australia; the President, National Institute of Metrology, Standardization and Industrial Quality (INMETRO); the General Director of the National Center of Metrology, State Agency for Standardization and Metrology (SASM), Bulgaria; the Director General, Institute for National Measurement Standards, National Research Council, Canada; the Executive Director of the Instituto Nacional de Normalizacion, Chile; the Deputy Director General, National Institute of Metrology, China; the Director of the Czech Metrology Institute; the Director of the Danish Institute of Fundamental Metrology; the President, Instituto Ecuatoriano de Normalization (INEN), Ecuador; the President, National Institute for Standards (NIS), Egypt; the Director of the Bureau National de Métrologie (BNM-INM) France; the Vice President, Physikalisch Technische Bundesanstalt (PTB), Germany; the President, (OMH) National Office of Measures, Hungary; the Director of the National Physical Laboratory (NPL), India; the President of the National Physical Laboratory, Israel; the President, Istituto Elettrotecnico Nazionale Galileo Ferrari, Italy; the Director of the Istituto di Metrologi "G. Colonnetti" (IMGC-CNR), Italy; the Director General, National Center for Metrology (CENAM), Mexico; the Vice President, Instituto Portugues da Qualidade, Portuguese Institute for Quality, Portugal; the Director of the State Committee of the Russian Federation for Standardization, Metrology, and Certification (GOSSTANDART), Russia; the Director of the Slovak Institute of Metrology, Slovak Republic; the Director of the Centro Español de Metrologia (CEM), Spain; the Director of the Swiss Federal Office of Metrology and Accreditation (METAS), Switzerland; the Director of the National Institute of Metrology, Thailand; and the Director of the National Physical Laboratory, United Kingdom.

NIST acted as a co-sponsor of the National Conference of Standards Laboratories International (NCSLI) 2001 Conference held in Washington, D.C., from July 29 to August 2, 2001. The Acting Director of NIST spoke at the conference and, at a luncheon meeting, received congratulatory plaques honoring NIST's 100th anniversary. There was a special session at the conference planned in honor of NIST's centennial, and the important contributions that

NIST has made to the national and international commercial measurement systems. NIST also conducted tours of various NIST laboratories for 90 attendees of the conference.

Workshops and Conferences

OIAA facilitates interactions and travel of NIST experts to places all over the world. These interactions strengthen NIST efforts to eliminate technical barriers to trade, harmonize standards and metrology, and promote comparability of measurement capabilities that support a global economy.

Summary of Countries/Regions within the Regional Metrology Organizations (RMOs)

Interamerican System of Metrology (SIM)

(includes NORAMET, ANDIMET, CAMET, CARIMET, SURAMET)

Antigua & Barbuda	Dominican Republic	Peru
Argentina	Ecuador	St. Kitts & Nevis
Bahamas	El Salvador	St. Lucia
Barbados	Grenada	St. Vincent & Grenadines
Belize	Guatemala	Suriname
Bolivia	Guyana	Trinidad & Tobago
Brazil	Haiti	United States
Canada	Honduras	Uruguay
Chile	Jamaica	Venezuela
Colombia	Mexico	
Costa Rica	Nicaragua	
Dominica	Panama	

European Union Metrology Program (EUROMET)

Austria	Germany	Norway
Belgium	Greece	Poland
Czech Republic	Hungary	Portugal
Denmark (including Greenland)	Iceland	Slovak Republic
European Commission	Ireland	Spain
Finland	Italy	Sweden
France	Luxembourg	Switzerland
	The Netherlands	Turkey
		United Kingdom

Asia-Pacific Metrology Program (APMP)

Australia	Korea	Sri Lanka
Bangladesh	Malaysia	Taiwan
China	Nepal	Thailand
Fiji	New Zealand	Vietnam
Hong Kong	Pakistan	Egypt (as Associate)
India	Papua New Guinea	South Africa (as Associate)
Indonesia	Philippines	Syria (as Associate)
Japan	Singapore	

Southern African Development Cooperation in Metrology (SADCMET)

Angola	Mauritius	Swaziland
Botswana	Mozambique	Tanzania
Congo	Namibia	Zambia
Lesotho	Seychelles	Zimbabwe
Malawi	South Africa	

Central and Eastern Europe Metrology program (COOMET)

Bulgaria	Slovak Republic	Germany
Russia	Poland	Cuba
Czech Republic	Romania	

Middle East and North Africa Metrology Program (MENAMET)

Algeria	Israel	South Africa (as Associate)
Cameroon	Kenya	Turkey
Ghana	Morocco	United States (as Associate)
France (as Associate)	Palestinian Authority	

Foreign Guest Researcher Program

The Foreign Guest Researcher Program offers scientists from around the world the opportunity to work collaboratively with scientists in NIST laboratories. Foreign guest researchers are defined as any qualified individuals who are non-U.S. citizens, are not employees of NIST, and are sponsored by an organization or are self-employed, or are working at NIST under the auspices of a NIST funding agreement (contract, grant/fellowship, cooperative agreement, or simplified acquisition) with a U.S. university or a U.S. company, and collaborate with NIST on research of mutual interest. Foreign guest researchers may be employees of foreign government agencies, state and local governments, industry, non-profit organizations (including universities), post-graduate researchers, graduate students, or those who are self-employed.

Foreign guest researchers at NIST fall into three categories: those supported by their home institutions; researchers supported through bilateral programs or international organizations; and direct scientist-to-scientist collaboration or support. Although NIST may sometimes provide a modest allowance for U.S. living expenses, guest researcher support generally comes from sponsoring companies or organizations. OIAA provides assistance with: policy and procedures on foreign guest researcher appointments; visas (serves as the primary point of contact at NIST for the Immigration and Naturalization Service (INS) and the United States Information Agency (USIA)); management of the exchange visitor J-1 program; coordinating hiring of non-U.S. citizens at NIST; tax consultation for non-U.S. citizens. NIST hosted 609 Guest Researchers in FY 2001 from 65 different countries, and in FY 2002 NIST hosted 669 Guest Researchers from 74 countries.

The following is a summary list of guest researchers at NIST in FY 2001:

Argentina	3	Ethiopia	3	Lithuania	4	South Africa	3
Armenia	1	Finland	5	Luxembourg	1	Spain	11
Australia	13	France	67	Malaysia	2	Sweden	1
Austria	2	Germany	57	Mexico	12	Switzerland	1
Bangladesh	3	Ghana	2	Morocco	4	Taiwan	19
Barbados	1	Greece	2	Netherlands	11	Tanzania	2
Bosnia	1	Hungary	7	Norway	1	Togo	1
Brazil	6	India	42	Pakistan	1	Tunisia	1
Cameroon	1	Iran	3	Peru	3	Turkey	6
Canada	15	Ireland	4	Philippines	2	Ukraine	2
China	66	Israel	11	Poland	20	United Kingdom	15
Croatia	2	Italy	18	Portugal	1	Uruguay	1
Cyprus	1	Japan	20	Romania	3	Venezuela	3
Czech Republic	4	Jordan	1	Russia	43	Yugoslavia	2
Denmark	8	Kenya	1	Serbia	4		
Egypt	17	Korea (South)	35	Slovak Republic	2		
Estonia	1	Laos	1	Slovenia	3	TOTAL	609

The summary list of guest researchers at NIST in FY 2002 is given below.

Algeria	3	Egypt	8	Luxembourg	1	Slovenia	2
Argentina	3	El Salvador	1	Malaysia	1	South Africa	5
Australia	11	Estonia	1	Mexico	5	Spain	16
Austria	1	Ethiopia	2	Moldova	1	Sweden	1
Bangladesh	1	Finland	6	Morocco	5	Switzerland	5
Belarus	2	France	88	Netherlands	5	Taiwan	12
Belgium	1	Germany	51	New Zealand	4	Thailand	5
Bulgaria	4	Ghana	1	Nigeria	3	Uganda	1
Brazil	4	Greece	1	Norway	2	Turkey	10
Cameroon	1	Hungary	11	Pakistan	3	Ukraine	5
Canada	13	India	46	Peru	1	United Kingdom	19
China	93	Iran	3	Philippines	4	Uruguay	1
Columbia	1	Ireland	4	Poland	14	Uzbekistan	1
Costa Rica	1	Israel	13	Portugal	1	Venezuela	2
Croatia	2	Italy	13	Romania	8	Vietnam	1
Cuba	1	Japan	30	Russia	47	Yemen	1
Cyprus	1	Korea (South)	76	Serbia	5	Yugoslavia	1
Czech Republic	4	Lebanon	1	Singapore	2		
Denmark	8	Lithuania	1	Slovak Republic	1	TOTAL	669

Foreign Visitor Program

OIAA serves as the focal point for foreign visitors. OIAA identifies areas of mutual interest of the visiting scientists and NIST programs and coordinates presentations by NIST staff that emphasize these mutual interests and foster international cooperation. In FY 2001, NIST hosted a total of 953 foreign visitors from 72 different countries. The majority of these visits were coordinated by OIAA.

Algeria	24	Egypt	20	Lithuania	1	South Africa	8
Argentina	6	El Salvador	1	Mexico	24	Spain	6
Armenia	5	Finland	17	Moldova	5	Sri Lanka	1
Australia	24	France	20	The Netherlands	32	Sweden	3
Austria	5	Georgia	4	New Zealand	8	Switzerland	5
Belgium	9	Germany	36	Nigeria	8	Taiwan	45
Bolivia	1	Greece	1	Norway	1	Tajikistan	1
Brazil	34	Guatemala	1	Pakistan	1	Thailand	1
Bulgaria	1	Honduras	1	Panama	1	Trinidad & Tobago	1
Cameroon	1	Hungary	4	Paraguay	1	Turkey	2
Canada	21	India	18	Peru	3	Turkmenistan	1
Chile	7	Israel	9	Poland	3	Ukraine	10
China	151	Italy	9	Portugal	2	United Kingdom	46
Colombia	3	Jamaica	2	Romania	3	Uruguay	2
Costa Rica	1	Japan	117	Russia	91	Uzbekistan	5
Czech Republic	5	Kazakhstan	3	Saudi Arabia	5	Venezuela	2
Denmark	2	Korea (South)	47	Singapore	5		
Ecuador	2	Kyrgyzstan	2	Slovenia	1	TOTAL	953

In FY 2002, NIST hosted a total of 1921 foreign visitors from 96 different countries. Again, a majority of these visits were coordinated by OIAA.

Albania	1	Finland	35	Lithuania	10	Slovenia	2
Argentina	5	France	89	Malaysia	21	South Africa	2
Armenia	5	Georgia	1	Mexico	19	Spain	17
Australia	38	Germany	111	Moldova	3	Sri Lanka	18
Austria	12	Ghana	2	Netherlands	74	St. Kitts	1
Bahrain	3	Greece	2	New Zealand	5	St. Lucia	1
Bangladesh	1	Grenada	1	Nicaragua	10	St. Vincent	1
Barbados	3	Guatemala	2	Nigeria	23	Sweden	34
Belgium	16	Guyana	1	Norway	2	Switzerland	19
Belize	2	Honduras	1	Oman	3	Taiwan	57
Bolivia	4	Hungary	3	Pakistan	3	Tajikistan	2
Brazil	26	India	56	Palestine	1	Thailand	6
Bulgaria	2	Indonesia	8	Panama	2	Turkey	2
Canada	107	Iran	2	Paraguay	2	Turkmenistan	1
Chile	10	Ireland	3	Peru	2	Ukraine	16
China	211	Israel	22	Philippines	5	United Arab Emirates	3
Colombia	3	Italy	22	Poland	8	United Kingdom	66
Costa Rica	2	Jamaica	8	Portugal	1	Uruguay	2
Croatia	2	Japan	238	Qatar	3	Uzbekistan	3
Czech Republic	4	Kazakhstan	6	Romania	19	Venezuela	2
Demark	14	Korea (South)	154	Russia	40	Vietnam	5
Dominica	1	Kuwait	3	Saudi Arabia	15	Yemen	1
Ecuador	5	Kyrgyzstan	2	Singapore	10	Yugoslavia	1
El Salvador	1	Liechtenstein	1	Slovakia	1	Zimbabwe	1
						TOTAL	1921

Office of Academic Affairs

Dr. Jack J. Hsia, *Chief**

The Office of Academic Affairs (OAA) serves as the focal point for NIST's cooperation with academic institutions, and coordinates academic affairs for NIST. In particular, OAA administers the NIST/National Research Council (NRC) Postdoctoral Research Associates Program; identifies and maintains knowledge of fellowships and assistantship programs that are of benefit to NIST; provides liaison with members of the academic community involved in scientific and technical programs with prominence in disciplines of interest to NIST; serves as a resource in identifying and promoting diversity in the academic community; interacts with universities with significant minority populations and establishes points of contact for resource purpose; coordinates NIST outreach activities with minority-serving institutes; and coordinates some K-12 -related activities.

*retired as of September 2004

NIST Postdoctoral Research Associates Program

NIST participates in a nationwide competitive postdoctoral program administered in cooperation with the National Academy of Sciences (NAS) and National Research Council (NRC), the NIST/NRC Postdoctoral Research Associates Program. The Postdoctoral Program brings research scientists and engineers of unusual promise and ability to perform advanced research related to the NIST mission, introduces the latest university research results and techniques to NIST scientific programs, strengthens communication with university researchers, shares NIST's unique research facilities with the U.S. scientific and engineering communities, and provides a valuable mechanism for the transfer of research results from NIST to the scientific and engineering communities. OAA administers this program, which includes annually updating the book on Opportunities for Research, arranging NRC staff meetings with NIST advisors and associates, participating in the NRC Laboratories representatives meetings, organizing focus groups and participating in the Workshop on Enhancing the Postdoctoral Experience of the NRC Committee on Science, Engineering and Public Policy.

In 2001, there were 78 applicants for the FY 2002 postdoctoral associates, of which 36 were selected for both the Gaithersburg and Boulder laboratories. The distributions were: Electrical and Electrical Engineering Laboratory (EEEL) - 5, Chemical

Science and Technology Laboratory (CSTL) - 6, Physics Laboratory (PL) - 14, Materials Science and Engineering Laboratory (MSEL) - 10, and Building and Fire Research Laboratory (BFRL) - 1. All associates were supported by the NIST central fund except six supported by Laboratory funds.

In 2002, there were 140 applicants and 52 associates were selected for FY 2003. The distributions were: EEEL (8), MEL (3), CSTL (11), PL (10), MSEL (16), BFRL (2), IITL (2). All associates were supported by the NIST central fund except 12 supported by Laboratory funds.

During FY 2002, OAA began sponsoring monthly "no-host" brown bag lunch gatherings for NRC postdoctoral research associates. All postdoctoral associates are invited, from those newly arrived and those who may be nearing the end of their tenure at NIST. The purpose of these lunches is for NRC postdocs at NIST to get to know each other, establish a contact network, and to provide a forum for discussion of issues of common interest.

In addition to the NIST NRC program, there are additional programs providing postdoctoral opportunities at NIST, which are outlined below, in the section on "Academic Resources at NIST and Collaboration with Universities".

Outreach with Minority-Serving Enterprises and Institutions (MSIs)

On September 24, 2002, the Director of NIST signed a Memorandum of Understanding (MOU) with the Director of the Minority Business Development Administration (MBDA) to improve the competitiveness of minority-owned businesses. The agreement calls for both agencies to leverage their expertise; share knowledge; and develop strategies to increase the number of minority businesses

participating in NIST programs, services and contracting opportunities. Activities include familiarizing MBDA partners with standards and technology components of the global economy through NIST OIAA, and providing selected MBDA staff with training on the principles and guidelines of the Baldrige National Quality Program, a public-private partnership to improve performance in U.S.

organizations. The other NIST programs that will be key to the partnership include the Manufacturing Extension Partnership (MEP), a nationwide network of local centers offering technical and business assistance to smaller manufacturers, and the Advanced Technology Program (ATP), which accelerates the development of innovative technologies by co-funding research and development partnerships with the private sector.

The more formal collaboration with MBDA emphasizes NIST's efforts to provide outreach assistance to Minority Business Enterprises (MBEs), and increased interaction with universities that serve minority populations. Highlights of other NIST outreach activities in these areas during FY 2001-2002 include (with additional details found below):

- Participation in the Advanced Technology Program Conference for Minority Entrepreneurs,
- Participation in the annual Minority Enterprise Development Week, and
- Sponsorship of the Science and Engineering Alliance Minority Student Technical Conference.

OAA has coordinated reports on NIST in-kind outreach activities with MSIs (excluding grants and fellowships). These activities have included NIST staff members' visits to MSIs, participation in conferences with MSIs, and MSIs members' visits to NIST. The NIST in-kind contributions were: \$140,000 for FY 2001 and \$392,000 in FY 2002.

NIST participates in the annual Minority Enterprise Development (MED) Week conferences, which are held in Washington, D.C., every September. The National MED Week observance recognizes the outstanding achievements of MBEs and honors those corporations and financial institutions that support minority business development.

K-12 Related Activities at NIST

NIST has offered many opportunities for developing interest in science and technology among Kindergarten through Grade 12 (K-12) students, as well as sponsoring programs aimed at assisting teachers in enhancing their experiences to pass them on to their students. These education outreach activities have ranged from offering laboratory tours, to holding Science Fairs, to fellowships for teachers. Additionally, NIST manages the outreach activities of the high school laboratory experience program.

On December 4-5, 2000, ATP and the Department of Commerce's Technology Administration (TA) sponsored a two-day conference at Clark Atlanta University in Georgia on "Advanced Technology Development and Commercialization Opportunities." Designed particularly for minority entrepreneurs engaged in high-tech research, the program brought together entrepreneurs, researchers, business specialists, and program managers from business, universities, and federal R&D funding agencies to discuss R&D funding opportunities for taking a new product from the laboratory to the marketplace.

On October 11-12, 2001, the National Institute of Standards and Technology (NIST) co-sponsored the 11th Annual Science and Engineering Alliance (SEA) Minority Student Technical Conference. The SEA was founded as a non-profit, tax-exempt consortium to serve four state-supported Historically Black Colleges and Universities and a national laboratory. The purpose of SEA is to help ensure an adequate supply of top-quality minority scientists, while meeting the research and development needs of the public and private sectors.

On March 22, 2002, NIST entered into a partnership with the SEA to support and foster collaborative research among the staff of both organizations and to serve as a vehicle for the exchange of students, faculty, and staff members between the SEA institutions and NIST. SEA member institutions are four state-supported historically black colleges and universities, including Alabama A&M University, Jackson State University, Prairie View A&M University, and Southern University and A&M College, in alliance with Lawrence Livermore National Laboratory in California. SEA was established in response to a reduction in resources for undergraduate and graduate education and a government and industry mandate to improve science and mathematics education at all levels, including enhanced research infrastructures and participation by faculty and students in high-quality, collaborative research in science, engineering, and related fields.

Highlights of education outreach activities for FY 2001-2002 included the following, with more details to be found below:

- Visits of selected finalists from the annual Intel Science Talent Search,
- Hosting of the Annual Montgomery Area Science Fair,
- The May 2001 Open House event at the Gaithersburg and Boulder sites,
- Tours for Elementary and Secondary Science and Math Teachers,

- Hosting the Triangle Coalition for Science and Technology Education Einstein Fellows at the Quest for Excellence XIV conference,
- Hosting high school students attending a summer enrichment program at the University of Maryland Baltimore County, and
- Hosting of a Girl Scout event, “Science: Get Psyched!”

In March 2001, NIST hosted five of the 40 finalists of the 2001 Intel Science Talent Search in tours of laboratory facilities, and discussions of their individual projects. The Intel Science Talent Search is America’s oldest and most prestigious pre-college science competition, and was created to discover and encourage high school students who demonstrate exceptional ability in science and engineering. In March 2002, NIST again hosted four finalists from the 2002 Science Talent Search.

NIST has played host to the annual Montgomery Area Science Fair held in late March or early April every year. The science fair includes participants from both public and private schools in Montgomery County, Maryland. NIST has hosted the event for over 45 years, and in 2001, the fair attracted over 350 participants.

On May 10-11, 2001, the Gaithersburg campus of NIST hosted 8,000 students in grades 4 through 12 for demonstrations and presentations to help them better understand and appreciate science and technology. NIST’s Boulder Laboratories in Colorado hosted about 2,000 students on May 11, and several thousand students and community members for similar presentations on May 12. The events were part of NIST’s efforts to heighten awareness of the agency and its work during the NIST centennial.

On July 13, 2001, NIST hosted the University of Maryland Summer Study in Engineering for High School Women. This visit gave the students an opportunity to talk with female engineers and enhance their interest in the engineering field.

On July 20, 2001, NIST hosted high school students attending a summer enrichment program at the University of Maryland, Baltimore County. The students’ interests are in chemistry and physics.

The Center for Neutron Research in the Materials Science and Engineering Laboratory (MSEL) has given occasional tours of its facilities, specifically tailored for high school science classes. Groups of up to 40 can be accommodated for the two-hour introductory lecture and tour. The tour emphasis is on how neutrons are used to probe the sub-microscopic structures and molecular motions that determine the properties of materials ranging from concrete to cell membranes.

On April 27, 2002, NIST’s Physics Laboratory hosted “Science: Get Psyched!”. This event has been held once a year for 300 Girl Scouts from the local area. The scouts are divided into small groups and visit several rooms where lively, hands-on science demonstrations are presented. The scouts also have the opportunity in a panel discussion to ask women scientists from NIST about why they chose science and what it is like to be a scientist.

NIST has been a participant in the Albert Einstein Distinguished Educator Fellowship Program. The Program offers public and private elementary and secondary mathematics, technology, and science classroom teachers with demonstrated excellence in teaching an opportunity to serve in the national public policy arena by offering one-year fellowships to serve on Capitol Hill and in federal agencies. It is administered by the U.S. Department of Energy and the Triangle Coalition for Science and Technology Education. During FY 2002, NIST sponsored one of twelve Einstein Fellows, a high school physics teacher from Austin, Texas, for a one-year fellowship in the Baldrige National Quality Program. NIST also hosted a tour in January 2002, for the FY2002 Einstein Fellows. They visited the Physics, Chemical Sciences and Technology, and Information Technology Laboratories.

Two representatives from the Magnetic Technology Division of EEEL hosted a Practical Hands-On Application to Science Education (PHASE) teacher during the summer of 2002. The goal of the work was to develop and construct demonstrations in superconductivity and magnetism for outreach programs. During the stay, multiple kits of five different demonstrations were developed and completed.

Academic Resources at NIST and Collaboration with Universities

NIST provides opportunities to encourage interest and understanding of various science and technology areas for undergraduate students by hosting tours of NIST facilities, and information exchange with NIST

scientists. During FY 2001 and 2002, these tours included:

- Students from the Howard University and 10 other minority-serving institutions from around the country in July of 2001. The

students, with interests in life sciences and engineering, were funded through a National Science Foundation grant.

- Students majoring in computer science and information systems, in August 2001. The students toured the Information Technology Laboratory.
- Students from the Washington Internships for Students of Engineering (WISE) in July 2001. These college students were from different parts of the country and had interests in engineering and public policy.
- A tour of the Information Technology Laboratory for students who were majoring in computer/technology at Montgomery College took place in August 2001.

NIST also monitors various programs of outreach for Undergraduate and Graduate students. These include:

- the Summer Undergraduate Research Fellowship (SURF) program,
- the Professional Research Experience Program (PREP),
- JILA,
- Graduate Studies in Atomic, Molecular, and Optical Science through the University of Maryland, and
- Graduate Studies involving the Center for Advanced Research in Biotechnology (CARB).

The SURF program at NIST awards summer fellowships to students in various areas of research, which include all of NIST laboratories. SURF is part of the National Science Foundation (NSF) Research Experiences for Undergraduates (REU) program. Undergraduate students interested in pursuing

graduate degrees in physics, materials science, engineering, computer science, chemistry, applied math, or related areas come to NIST Laboratories for a 12-week summer honors-academy program involving them in hands-on research. The program is especially interested in encouraging female and minority science students to pursue advanced degrees in science and engineering. In the program begun in May of 2002, NIST welcomed 101 participants for the summer program.

PREP is designed to provide valuable laboratory experience and financial assistance to undergraduate and graduate students from the University of Colorado at Boulder and from the Colorado School of Mines at Golden. The program is also available to postdoctoral researchers.

Research opportunities are available for undergraduate and post-graduate students for cooperative work at JILA and at CARB. JILA is a joint enterprise between NIST and the University of Colorado, through the Physics Laboratory's Quantum Physics Division. Participating Colorado University departments include Physics, Chemistry and Biochemistry, and Astrophysical and Planetary Sciences (APS), while CARB is a cooperative enterprise between NIST and the University of Maryland at College Park.

An annual activity at the NIST Gaithersburg campus is the Sigma Xi Scientific Honor Society Postdoctoral Poster Presentations, which take place every February. Current postdoctoral fellows are invited to present their research in a session open to all NIST staff, which promotes interaction and exchange of scientific information.

Interactions with Committees and Programs within NIST

OAA interacts, assists, and collaborates on educational matters with various student programs, educational clearinghouses, the Civil Rights Office, the African American Association, the Hispanic

Association, the Asian Pacific Association, the NIST Committee for Women, and the Sigma Xi Scientific Honor Society.

Interactions with Outside Organizations and Government Agencies

OAA represents NIST on academic-related matters interacting with Maryland Suburban High Technical Council, Association of American State Colleges and Universities, National Association of State Universities and Land Grant Colleges, National Physical Science Consortium, and American Association of Engineering Education.

Illumination Engineering Society of North America, Council for Optical Measurements, International Organization for Standardization, International Electrical Commission, and serves as a Board member of International Commission on Illumination with 41 member countries. This Office serves on the advisory committee of the International Technology Education Association.

OAA also interacts on professional matters with American Society for Testing and Materials,

Baldrige National Quality Program

Dr. Harry Hertz, *Director*

The Baldrige National Quality Program (BNQP) has proven to be a remarkably successful public and private partnership, starting in 1987 with industry's assistance in raising more than \$10 million to help launch the Program. Among BNQP's responsibilities is the administration of the Malcolm Baldrige National Quality Award (MBNQA). The Award originally covered large and small (under 500 employees) manufacturing and service businesses. In 1999, the Award Program was expanded to include for-profit and not-for-profit health care and education organizations. BNQP has worked closely with a wide variety of groups to extend the benefits of systematic management of organizational performance and to stimulate activities nationwide. These organizations run the gamut of trade and professional groups in all three Award sectors – business, education, and health care.

BNQP has helped to stimulate a movement to improve the performance of U.S. organizations covered by the MBNQA (businesses, academic institutions; and health care organizations), as well as Federal, state, and local government agencies and not-for-profit organizations not eligible to apply for the Award. Nationwide, interest in the Baldrige model has grown steadily since its inception. In 1991, fewer than 10 state and local quality awards existed. Now, most states have or are establishing award programs. Most are modeled after the Malcolm Baldrige National Quality Award.

Quality award programs in more than 25 foreign nations spanning six continents use adapted Baldrige Criteria for Performance Excellence as a model for organizational excellence and as the basis for determining their award recipients. The adoption of these Criteria indicates that these nations recognize the value of organizational performance excellence in achieving competitive improvement. Many early award recipients of the foreign quality awards have been subsidiaries of U.S. companies, located outside of the United States. Receipt of such awards promotes acceptance of U.S. companies in foreign markets.

The Baldrige National Quality Program (BNQP) interacts with foreign quality award programs and exchanges materials with these programs. BNQP makes available its Criteria, case studies, training materials, and a wide variety of other documents and information - both in hard copy and/or electronically through the BNQP web site.

Key interactions with performance excellence programs or individuals of foreign origin during 2001/2002 included the following:

- The Baldrige National Quality Program hosted a meeting of leaders of international excellence models and quality awards from five continents in October of 2000. The leaders shared historical perspectives and benchmarked current activities and processes.

- Participants included program CEOs from South Africa, Japan, Australia, Singapore, and the European Foundation for Quality Management.
- In March 2002, the Director of BNQP was the keynote speaker at the awards banquet of the Australian Business Excellence Summit in Melbourne, Australia.
- In July 2002, the Baldrige National Quality Program hosted an exhibit at the National Association of College and University Business Officers National Meeting in Vancouver, British Columbia, Canada.
- The Director of BNQP hosted a group of visitors from the Singapore Ministry of Defense in August of 2002.

Advanced Technology Program

Mr. Marc Stanley, *Director*

Begun in 1990, the Advanced Technology Program (ATP) has been a unique partnership between government and the private sector. The ATP cost-shares multi-year funding of advanced technology research to companies of all sizes. Projects are selected through a competitive, peer-review process according to published selection criteria. The ATP funds high-risk, applied research for enabling technologies, and does not fund projects that are predominantly basic research or product development. The funded technologies are expected to lead to the development of new products, processes, and services across diverse application areas.

The primary goal of the ATP is to invest in technologies that would otherwise not be developed in time, or at the same scale and scope, to compete in the global market, and which benefit the U.S. economy by creating a better way of life—new jobs, increased productivity, and environmental, health, and other social benefits. The ATP awards U.S. companies, and has made awards to U.S.-based, foreign-owned companies when their participation in the projects is in the economic interest of the nation. These economic interests include performance of the proposed Research and Development (R&D) activities in the United States; investments in U.S. research, development, and manufacturing; significant contributions to employment in the United States; and procurement of supplies from competitive U.S. suppliers. In addition, the parent company's country of origin must open similar programs to U.S.-owned companies, afford U.S. companies local investment opportunities comparable to those afforded to any other company, and protect intellectual property rights.

Research proposals are accepted on a year-round basis, and the competitions are open to all technology areas. ATP awards have covered a broad spectrum of technologies in areas including computing information and communications, biotechnology, materials, electronic, manufacturing, chemicals and processing, and energy and the environment. Approximately 9 out of 10 organizations indicate that ATP funding accelerated their R&D cycle.

Through FY 2002, the ATP had funded 642 projects, of which 44 of 195 joint venture awards included U.S. subsidiaries of foreign-owned companies, and 22 of 447 single-company awards were to U.S. subsidiaries of foreign-owned companies. The ATP has entered into multi-year partnerships with industry for high-risk, enabling research and development at a level of nearly \$3,884M between 1990 and 2002—of which ATP's share is slightly more than half.

The ATP places special emphasis on working directly with industry, in contrast to other Federal funding programs that provide primary support for R&D at universities and Federal laboratories. By law only for-profit companies and industry-led joint ventures are allowed to receive ATP awards. But universities, a traditional source of research excellence in the United States, play a significant role in many ATP projects, either as subcontractors to private companies or as members of industry-led joint ventures. Out of the 642 projects selected by the ATP since its inception, 334 included universities as subcontractors and an additional 45 as joint-venture members. Small- and medium-size enterprises (SMEs) account for 87% of all single applicant projects and lead 50% of all joint ventures.

The Advanced Technology Program (ATP) interacts with foreign programs and exchanges materials and information. ATP makes available its criteria, case studies, and a wide variety of other documents and information - both in hard copy and/or electronically through the ATP web site.

Key interactions with programs or individuals of foreign origin during 2001/2002 included the following:

- A meeting with biotechnologists in Stockholm, Sweden in February 2001 to discuss methods to develop biotechnology companies.
- The co-organization and participation of the workshop, International Congress for Science and Technology of the Mexican Association of Directives of Applied Research and Technical Development in April of 2001.
- The participation in International Conference on Commercialization of Microsystems in the United Kingdom in August, 2001.
- The presentation and participation in the Organization for Economic Cooperation and Development (OECD) Working Party on Innovation and Technology Policy (TIP) Workshop on “Public/Private Partnership for

Innovation”, which was held in Paris, France in December of 2001.

- The participation in the Workshop in Stockholm, Sweden on Entrepreneurship for

Policy for the Future: Lessons from the U.S. and Sweden, in December of 2001.

- The participation in the Biotechnology Industry organization annual meeting, BIO 2002 in Toronto, Canada in June of 2002.

Manufacturing Extension Partnership Program

Mr. Kevin M. Carr, *Director*

The Manufacturing Extension Partnership (MEP) program is a growing network of services to assist smaller manufacturers in becoming globally competitive. MEP partners federal support with state and local organizational support. Services are locally driven so that they address the specific needs of area manufacturers. At the same time, MEP is developing common tools and resources to address recurring and consistent challenges faced by all manufacturers nationwide. The MEP program continues to support efforts to establish similar industrial extension programs in various parts of the world. The MEP program staff has given various presentations on manufacturing extension to representatives from Korea, Japan, China, India, the United Kingdom, and other EU representatives.

- MEP staff has provided support to the government of Mexico in its efforts to initiate a program to stimulate growth and competitiveness of indigenous industry.
- MEP staff has provided support to the CSIR, South Africa, in its efforts to initiate a program similar to that of MEP in South Africa.

Electronics and Electrical Engineering Laboratory*

Dr. William E. Anderson, *Director*

The Electronics and Electrical Engineering Laboratory (EEEL) provides the fundamental basis for all electrical measurements in the United States. In close consultation with industry, research and calibration programs are tailored to meet the most critical measurement needs for the manufacture and operation of electrical and electronic systems, including semiconductor, magnetic, radio-frequency, microwave, optical, optoelectronic and superconducting equipment; flat-panel displays; electronic instrumentation; and electrical power apparatus and systems. Other programs are concerned with basic research to develop quantum standards that enable more accurate maintenance of the fundamental electrical units. Laboratory researchers also conduct studies on the new measurements needed for the successful development of promising future technologies such as high-temperature superconductors, quantum mechanical devices, and hybrid computer chips that utilize both electronic and light wave signals. These measurement techniques, as well as Standard Reference Materials, such as those developed for optical fiber diameter, silicon resistivity, and superconducting critical current, play a significant role in helping to improve the efficiency and quality of manufacturing. In addition, the laboratory manages metrology development work across NIST in response to the needs of mainstream silicon semiconductor device manufacturing. It also applies science and technology to solve key problems of the criminal justice communities.

*Division names have changed due to reorganization; names in this report reflect organization during FY 2001/2002

Bilateral Activities

Argentina

The Electricity Division is working with National Institute for Industrial Technology (INTI) of Argentina on the development of thin-film multijunction thermal current converters. This collaboration, planned for 2003, was the first under the new NIST-INTI Memorandum of Understanding (MOU), signed in September 2002.

Australia

A collaboration with the University of Queensland is under development with the Electromagnetic Technology Division in the area of quantum computer technology. One possible area of cooperation may be in studies using optical-based quantum computing.

Belgium

A collaboration is being developed by the Semiconductor Electronics Division with the Interuniversity Microelectronics Consortium (IMEC), through International SEMATECH, to perform research and development in the area of device integration for devices having alternate dielectrics. This research will aid in the continued development of thin film and device metrology.

The Electricity Division has a project with the Vrije Universiteit Brussel (VUB) on mutual testing of data converters. This will involve a comparison of a VUB modeling method and basis functions to NIST-developed testing strategies. A staff member from the division also participated as a member of a jury for the defense of a Ph.D. thesis on "Model-Based Calibration of D/A Converters".

Brazil

A representative from the Electricity Division worked with the Voltage Standard Laboratory at the National Institute of Metrology, Standardization and Industrial Quality (INMETRO) in Rio de Janeiro. Assistance was provided in improving the operation of the INMETRO's 10 V Josephson voltage standard (JVS). The 10 V JVS will greatly improve INMETRO's capability to maintain and disseminate the volt to Brazil's industrial and scientific communities.

Several representatives from the Electricity Division visited Instituto de Pesquisas Tecnológicas (IPT) during the Metrologia-2000 conference, held from December 2-7, 2000 in Rio de Janeiro. IPT is a secondary calibration laboratory run by the state. They visited IPT's electricity calibration laboratory where they do calibrations in voltage, resistance, capacitance, inductance, current, time and frequency, and ac-dc difference. IPT is very interested in improving their calibration systems and would like NIST's assistance in doing this. Eventually, they intend to do collaborative research with INMETRO.

Canada

The Electricity Division works with the National Research Council (NRC) Canada on measurements of a standards color illumination source. This cooperation will assist industry in achieving reproducible measurements of electronics displays by reducing uncertainties

The Chief of the Electricity Division visited the National Research Council of Canada (NRC) in

November 2001, to meet with counterparts to discuss potential joint calibration efforts. Additional areas discussed included Comité Consultatif d'Electricité et Magnétisme (CCEM) key comparisons on power and a new intercomparison for dissipation factor measurements. This visit was followed by the visit of another Electricity Division representative in December of 2001 for additional discussions on upcoming intercomparisons.

A representative from the Electricity Division worked with staff at the Institute for National Measurements Standards (INMS) in Ottawa on resistance and measurement procedures. While there, the staff member delivered 4 resistance standards as part of an international key comparison, a test repeated only once every 10 years, as hand delivery is required to reduce temperature variations and possible mechanical shock.

The Office of Law Enforcement Standards (OLES), together with the National Institute of Justice (NIJ), co-sponsors a technical program with the Royal Canadian Mounted Police which documents studies on the threat of multiple hits from machine gun fire. Eventually, this effort will result in the delivery of a multi-barrel test device, an assessment of realistic test requirements, and a description of a proposed test methodology. The results of this effort are likely to be adopted in the next revision of NIJ's body armor standards that OLES is developing.

China

A representative from the Semiconductor Electronics Division visited several major high-volume electronics manufacturing companies in the Hong Kong/Shenzhen area in March of 2001. This area of China is a major microelectronics manufacturing center for Central Asia. Among the sites visited were the Electronics Packaging Laboratory of the Hong Kong University of Science and Technology and the Electrical Engineering Department at the Hong Kong University of Science and Technology (HKUST), to tour their electronics packaging facilities and learn about their education programs. The information obtained from this trip will help establish the direction of NIST electronic packaging programs as well as to advise other government agencies and related companies on the state of electronic packaging and associated infrastructure technologies.

A representative from the Radio-Frequency Technology Division held meetings in Beijing with Chinese representatives attending a wireless conference and exposition to promote the acceptance of broadband wireless standards, recognized by the Institute of Electronics and Electrical Engineers (IEEE), into China. Harmonization of such standards

will promote the broadband wireless access industry worldwide.

Finland

A guest researcher from Nokia Research Center in Helsinki and the Radio-Frequency Technology Division are collaborating on documentation to specify and test compliance to the IEEE Standard for Broadband Wireless Access. Nokia and NIST have a long relationship of collaboration in this area, with NIST having a leading role in the development of consensus standards.

The Integrated Circuits Technology Group of the Semiconductor Electronics Division, in collaboration with the National Research Center of Finland (VTT) and the George Washington University (GWU), has demonstrated the feasibility of a novel non-contact, capacitive sensor metrology tool developed for chrome photomasks. The sensor is intended for use as an independent metrology tool for mask makers and mask users. The linewidth metrology sensor, developed using a Low Temperature Co-Fired Ceramic (LTCC) technology, is based on non-contact micro-capacitance measurements of features located on chrome-on-glass reticles (grid plates). Initial results indicate that the non-contact capacitive sensor is capable of extracting chrome-feature linewidths in the range of 0.4 μm to 0.5 μm .

France

The Electromagnetic Technology Division has an ongoing collaboration with researchers at the Bureau National de Metrologie (BNM) in Paris. The collaboration involves a quantum metrology triangle experiment, specifically on metrology applications of single-electron tunneling devices. In this work, an electron pump is used to pass electrons, one at a time, as a standard of electrical current. NIST has an advanced version of this device and is providing advice in this project.

The Electricity Division is also working with BNM on Watt balance experiments, in the development of new ideas that can be incorporated in the next generations of experiments. This will include calculations and estimates of various new geometries to be considered and preliminary test measurements.

The Electromagnetic Technology Division works with Commissariat à l'Energie Atomique (CEA) on the Nanoscale Cyroelectronics Project. The work concerns the new Single Electron Tunneling Capacitance Standard and with Coulomb blockade physics and devices

The Electricity Division collaborates with the Université Paul Sabatier in Toulouse on the plasma processing gas, trifluoromethane (CHF_3). The studies

concern Boltzmann-code analysis using the NIST-assessed cross sections and transport coefficients for the gas.

Germany

A guest researcher from Physikalisch-Technische Bundesanstalt (PTB) worked in the Electromagnetic Technology Division during 2001. The visit, sponsored under the MOU with PTB, was for the development of superconducting quantum interference devices (SQUIDs). These SQUIDs were fabricated and tested at PTB, and were brought back to NIST for measurement comparisons.

The Magnetic Technology Division held preliminary discussions with PTB on magnetic force microscopy of perpendicular media. The preliminary discussions have centered on self-assembled media, in the area of MicroElectroMechanical Systems (MEMS).

EEEL also works with PTB in several areas of standards comparison and development:

- The Optoelectronics Division collaborates on fiber measurements, specifically on the comparison of optical-fiber meters.
- The Radio-Frequency Division has cooperated on network characterization. This work on single-mode transmission lines built on lossy silicon substrates and asymmetric coupled lines, is built with 0.25 μm complementary metal oxide semiconductor (CMOS) technology. This work laid the foundation for NIST to characterize 4-port networks.
- The Electricity Division is one of the collaborators, along with PTB, on a proposal for the Development of a Primary AC Voltage Standard and Primary Electrical Impedance Parameters Standard in the Ukraine.

Italy

A representative from the Electricity Division held discussions with staff at the Constructions Electromiques Industrielles Automatismes (CEIA) research and test facility in Florence to discuss interactions between CEIA, OLES, and the Electricity Division. NIST is assisting NIJ in revising standards for metal weapon detectors, and CEIA has one of the most extensive Research and Development (R&D) facilities for metal detection technology. The discussions provided information on state-of-the-art weapon detector performance test methods, quality measurement, and manufacturing practices of this industry.

India

A representative from the Office of Law Enforcement Standards (OLES) gave a presentation to the Indian Science Congress Session in New Delhi in January 2001 on DNA projects that have a role and importance in setting standards in forensic science for products, procedures, and processes. The organizers for the Indian Science Congress have recognized the benefit of standardization in forensic science, and that the production of NIST Standard Reference Materials (SRMs) is viewed as the framework by which to build procedures and protocols. The Congress, in an effort to promote the ideas of standardization among their peers, invited NIST/OLES, as well as other representatives, to speak on the importance of standards in forensic science.

Japan

The U.S. – Japan Joint Optoelectronics Project (JOP) encompassed a seven-year collaboration between American and Japanese researchers on a joint program to develop advanced computing technologies that integrated optical, optoelectronic and electronic components. The JOP has provided a unique way to foster international cooperation and progress in a competitive high-technology field while protecting intellectual property in both countries. It offered a virtual laboratory in which advanced optoelectronic devices and components still in the research and development stages were made available to systems researchers and designers eager to develop its own technologies. Since its inception in 1994, the JOP has enjoyed significant technical accomplishments, resulting in more than 100 research publications, the stimulation of new research efforts, products, patents, and increased trade between the two countries over a period of about seven years. Besides business and university participants, five federal agencies were active in the conduct of the JOP: the National Science Foundation (NSF), the Defense Advanced Research Projects Agency (DARPA), the Department of Energy (DoE), the State Department and NIST. EEEL served as the lead technical agency in the project. The success of the JOP has led NSF and DARPA to develop a domestic program, with prospects for participation by other federal agencies and for future international participation, based on JOP principles. Initiation of the activity, known as the Photonics Technology Access Program (PTAP) is currently undergoing final approval. A final report on the JOP, which ended in December of 2001, was issued in May of 2002.

The Electricity Division collaborates with Nippon Telephone and Telegraph Corporation (NTT) Basic Research Laboratories in Japan on a fabrication process for Silicon-based Single Electron Tunneling transistors (SETTs).

The Electromagnetic Technology Division works with the Agency of Industrial Science and Technology of Japan (AIST) to develop cryocooler-compatible Josephson junctions for programmable voltage standards. Because present instruments require liquid helium, they are not practical in industrial settings, and NIST has recently completed a trial design using high-temperature superconducting materials. The aim of the collaboration is to develop portable, practical, and programmable Josephson junction voltage standards for industrial use. Preliminary discussions have also been held at the Nippon Electric Corporation (NEC) Fundamental Research Laboratories in Tsukuba on a potential collaboration on a High Temperature Superconductivity (HTS) junction project. The NEC lab is the Japanese foundry for Low Temperature Superconductivity (LTS) digital circuits. They fabricate with 2 μm junctions at 2.5 kA/cm².

Korea

Under the NIST- Korea Research Institute of Standards and Science (KRISS) MOU, renewed in April of 2000, the Electronics Division has been working with KRISS on electrical standards. In addition, one project annex has been signed in the field of laser spectroscopy to improve scientific knowledge in the field of laser spectroscopy and to apply this knowledge to diagnostic techniques.

Mexico

The Electricity Division is producing electron transport measurements in plasma processing gases in collaboration with researchers from the Centro de Ciencias Físicas at the National Autonomous University of Mexico (UNAM).

Netherlands

The Electromagnetic Technology Division has provided guidance to a European Union (EU) effort, in which the Netherlands Measurement Institute (NMI) participates, for the development of voltage standards. This program involves the Josephson Voltage Standards (JVS) intercomparison experiment for an on-going European Metrology Program (EUROMET) project.

Russia

The Magnetic Technology Division collaborates with the Moscow State Engineering Physics Institute in Moscow, through a North Atlantic Treaty Organization (NATO) collaborative linkage grant. This cooperation was initiated to study the fundamental mechanisms of magnetic transitions in magnetized thin films. These materials are important to technological progress in the field of magneto-optic (MO) recoding, which is rapidly becoming one of the dominant methods for read/write data storage.

Singapore

A representative from the Semiconductor Electronics Division visited the Institute of Microelectronics (IME) to discuss their consortium on wire bonding to copper-metallized chips with low dielectric constant insulation. The consortium has invited NIST to cooperate in the program.

Taiwan

A representative of ETEL met with staff from the Center for Measurements Standards (CMS) of the Industrial Technology Research Institute (ITRI) in Taiwan in Hsinshui. CMS is very interested in working with NIST in the development of electrical standards.

United Kingdom

The Electromagnetic Technology Division cooperates with the United Kingdom (UK) Astronomy Technology Centre and the University of Edinburgh on SCUBA-2, a replacement for the Sub-millimeter Common User Bolometer Array (SCUBA). This is a large-format infrared camera that will be mounted on the James Clerk Maxwell telescope on Mauna Kea in Hawaii. NIST is participating in the fabrication of the arrays of superconducting transition-edge sensor (TES) detectors and SQUID multiplexers for the SCUBA-2 project. The project is funded by the PPARC (the UK equivalent of the NSF) to develop TES devices and SQUID multiplexers for SCUBA-2. SCUBA-2 will provide a nearly thousand-fold improvement in performance over currently available sub-millimeter arrays, and for the first time, provide a true sub-millimeter camera.

The Semiconductor Electronics Division works with the University of Edinburgh on the production of Source Code Control System Reference Material (SCSRM) wafers. These wafers are being processed at the University for the International SEMATECH (ISMT) in accordance with the NIST-ISMT contract. ISMT is a unique endeavor of thirteen semiconductor manufacturing companies from seven countries aiming to gain manufacturing advantage through cooperative work on semiconductor manufacturing technology. The organization strives to be the most effective influence on global consortium semiconductor manufacturing technology. The cooperation provides for enhancements in the SCSRSM fabrication process to eliminate scanning electron microscope (SEM) charging edge-roughness, edge-roughness, and Compact Disc (CD) non-uniformity.

A representative of the Optoelectronics Division is collaborating with the University of Kent on optical radiation metrology. As part of this collaboration, NIST-built pyroelectric detectors were used to

evaluate noise characteristics of a CO₂ laser being used to create tapered sections in optical filters. This evaluation will provide information to improve the behavior of thermal coatings deposited on pyroelectric detectors that will lower measurement uncertainty.

The Optoelectronics Division works with Perkin Elmer Instruments in Workingham on the production of NIST Standard Reference Material (SRM) 2538. This SRM is a non-mode-coupled polarization mode dispersion (PMD) artifact, designed to emulate the PMD typically found in telecommunications components. The artifact is being developed toward providing it as a NIST Traceable Reference Material (NTRM), and discussions have been held on issues regarding assembly of the devices, reflection sources, and stray PMD.

The Electromagnetic Division collaborates with the National Physical Laboratory (NPL) to provide a programmable 1 V probe and chip for their Watt-balance experiment. NPL will purchase the probe from NIST and construct their own bias electronics and computer controls. Both NIST and NPL are also conducting independent Watt-balance experiments.

The Electricity Division also works with NPL in several areas of standards comparison and development:

- An intercomparison regarding high-speed electrical pulse parameters has been completed. Only NIST and NPL provide formal measurement services in this area, but other national metrology institutes are currently developing this capability.
- Both are participating in an inter-laboratory comparison of color measurement capabilities, using a NIST-developed standard.
- Collaboration on a series of interlaboratory measurements of a standard illumination source and optical filter targets. The measurements will serve as a basis for assessing the interlaboratory repeatability of electronic display measurements of Gamut Assessment Standards (GAS), part of the Display Measurement Project. The collaboration with NPL serves as a crucial

first step toward reducing the uncertainty associated with display measurement and performance specification.

- An intercomparison with NPL was continued regarding high-speed electrical pulse parameters.

In the Semiconductor Electronics Division, NIST is working with NPL to conduct an interlaboratory comparison on SiO₂ film thickness measurement.

Representatives from the Optoelectronics Division and NPL have discussed measurement capabilities in optoelectronics, and explored the potential for several comparisons to assure consistency among the programs. Target areas for possible collaborations were discussed, including electromagnetic interference measurements and laser radiometry. Three possible areas for intercomparison are calibration of the optical fiber power meter used in the European Metrology Program (EUROMET) intercomparison, the possibility of a direct comparison of cryogenic radiometers, and collaboration on excimer laser standards. A representative from the Optoelectronics Division has also worked with NPL on improved pyroelectric detectors for ultraviolet (UV), visible, and infrared (IR) radiometry.

The Radio Frequency Technology Division has maintained an optimal level of contact and collaboration with its counterparts at NPL for decades. Visits, key professional conferences, exchanges of publications, email and telephone communications, intercomparisons (informal and through BIPM) technical interchanges, standards committees and other fora serve as the basis for regular and effective cooperation between NIST and NPL.

Ukraine

The Electricity Division is collaborating with the Science and Technology Center in Ukraine (STCU) to help establish their AC voltage and impedance calibration capabilities. The collaboration is funded by the Office of Proliferation Threat Reduction of the U. S. Department of State.

Multilateral Activities

Key Comparisons (KCs) and Other Intercomparisons

SIM is promoting a number of intercomparisons within the Americas to improve electrical measurement capabilities, and NIST serves as the primary U.S. laboratory for on-going international

comparisons in the areas of ac and dc voltage current, dc resistance, and power.

Several representatives from the Electricity Division visited INMETRO in Brazil during the Metrologia-2000 conference, held from December 2-7, 2000.

While there, advice was given on INMETRO's resistance calibrations and the establishment of a Quantized Hall Resistance (QHR) standard. It was also advised that instead of a cryogenic current comparator measurement system, a room-temperature direct current comparator would be more compatible for working conditions there.

Bureau International des Poids et Mesures (BIPM)/ Comité International des Poids et Mesures (CIPM)

In April 2002, representatives from NIST's Electricity Division assisted in drafting a proposal to the BIPM for the analysis of noise and correlation in measurements of Zener voltage standards. The plan is to use NIST's JVS system to make a series of measurements using various digital and analog voltmeters and different models of Zener voltage references. The purpose of these measurements is to investigate the frequency-based noise in measurements of the commonly-used voltage standards. It is expected that this cooperation will provide a better understanding of Zener characteristics and guidelines for Zener applications.

A representative from the Electricity Division participated in an intercomparison of continuous absolute gravimeters held in Paris during July of 2001. The comparison exercise included twenty other continuous absolute gravimeters, and the exercise was used to gain more expertise for determining the local gravity at the required increased accuracy needed for future results. The NIST gravimeter used for this intercomparison is also used in the NIST Electronic Kilogram project, and the accumulated data will be useful for this project.

Representatives from the Electricity Division held discussions in June of 2001 regarding future directions for monitoring the artifact kilogram at four national measurement laboratories. Besides NIST, the discussions included representatives from the BIPM; the Bureau National de Metrologia (BNM) in France; the Bundesanstalt für Materialforschung und -Prüfung (BAM) in Germany; the Federal Office of Metrology and Accreditation (METAS) in Switzerland; and the National Physical Laboratory (NPL) in the United Kingdom. These included comparisons of electronic Watt-balance methods for monitoring the kilogram, and a CCEM-sponsored workshop for summarizing the status of various methods of determining the kilogram.

Office of Law Enforcement Standards (OLES)

Body Armor Standard - The National Institute of Justice (NIJ), an agency of the Department of Justice (DOJ), sponsored the NIST research that led to the

stab-resistant body armor standard, developed by the Office of Law Enforcement Standards (OLES). For the first time, state, county, and local law-enforcement and correction agencies have been able to purchase NIJ-approved stab-resistant vests through funding from the Department of Justice Vest Partnership Program. The OLES stab-test fixture is a development of work carried out in the United Kingdom by the Police Scientific Development Branch, with which OLES associates have collaborated.

Concealed Weapons Standards - OLES participates in international technical support working group meetings where passive millimeter wave imaging and other concealed weapons technologies are demonstrated. NIST is evaluating the monitoring of concealed weapons technology for potential development of performance-based standards of these types of equipment.

Chemical and Biological Warfare - A representative from OLES participated in an international symposium, "Protection Against Chemical and Biological Warfare (CBW) Agents", held in Stockholm in June of 2001. The symposium showcased the latest technologies and equipment in CBW protection as well as the presentation of invited papers on protection, threat assessment, detection, decontamination, and chemical treatment.

Blunt Trauma - OLES participates in the North Atlantic Treaty Organization (NATO) Behind-Armor Blunt Trauma (BABT) working group. OLES is one of the collaborative funding partners, along with the Department of Defense (DoD), Defense Research and Development Canada (DREV), and the French government, in studying the blunt trauma behind ballistic helmets.

Voluntary Standards - NIST has participated in international meetings of the Society of Automotive Engineers (SAE) Emergency Warning Lights and Devices Standards Committee (EWL/D) and the SAE Emergency Vehicle Siren Task Force. The NIJ and the OLES at NIST are highly instrumental in the development of voluntary standards applicable to equipment used by criminal justice agencies. This includes sirens used on emergency vehicles.

Electronic Evidence - Meeting strongly-expressed needs of the criminal justice community, OLES has completed a guide on electronic evidence for law-enforcement personnel first responding to a crime scene, a challenging and increasingly important new forensic area. The guide has been published by the National Institute of Justice as Electronic Crime Scene Investigation: A Guide for First Responders. This guide, developed by a diverse group, will aid

law enforcement officers called out to investigate a complaint or criminal activity in progress. It offers simple explanations on how to recognize potential electronic evidence, and how to collect and transport the items or media in a fashion that will maintain the integrity of the evidence and meet challenges in the courtroom.

Awards

Michael Cresswell, leader of the Linewidth and Overlay Standards for Nanometer Metrology Project in the Semiconductor Electronics Division (SED), was elected as a Fellow of the Institute of Electrical and Electronics Engineers (IEEE) by the IEEE Board of Directors in 2001. Cresswell was cited "for the development of linewidth calibration artifacts for advanced lithography metrology instruments."

Robert Scace, from the EEEL office, received the 2001 honor award from the European region of the global standards program of Semiconductor Equipment and Materials International (SEMI), the first time this award was presented. He was cited for his major contribution to the semiconductor industry.

In 2002, Allen Hefner, group leader of the Device Technology Group of the Semiconductor Division, received the IEEE Fellow Award. He was honored at the IEEE Power and Electronics Specialists Conference held in Cairns, Australia.

Other Multilateral Activities

The Electromagnetic Technology Division participated in the Enrico Fermi International School of Physics, Electron and Photo confinement in Semiconductor Nanostructures, which was held from 22 June to 8 July 2002, in Varenna, Italy.

International Committee Participation and Interactions

Bureau International des Poids et Mesure/Comité International des Poids et Mesures (BIPM/CIPM)

Staff members of EEEL, including the Director of EEEL, have extensive involvement and serve in key positions in the Consultative Committee for Electricity and Magnetism (CCEM) of the CIPM, especially in the working groups dealing with Key Comparisons. These working groups include those on AC quantum resistance, and one on Radio-Frequency Quantities (GTRF). In addition to these working groups in CCEM, the Optoelectronics Division participates in the Consultative Committee for Photometry and Radiometry (CCPR).

Deutsches Institut für Normung (DIN)

A representative from the Office of Microelectronics Programs (OMP) participated in the Deutsches Institut für Normung (DIN) Standards meetings in Berlin, November 5-10, 2000 as liaison of NIST and of ASTM (formerly the American Society for Testing and Materials) ASTM F-01 Committee on Electronics. Participation in this meeting enables NIST to disseminate (or obtain) information from industry critical to standards development, NIST semiconductor research, and specifically to the National Semiconductor Metrology Program. Many DIN standards employ NIST output as a foundation. They may or may not be technically similar to the corresponding ASTM standards. It is to the benefit of the U.S. industry that this technical correspondence be kept as close as is feasible, to avoid the use of differing technical standards as non-tariff barriers.

International Electrotechnical Commission (IEC)

Several staff members from the Electricity Division serve in leadership positions of Working Groups in the International Electrotechnical Commission (IEC) Technical Committee. Activities have included the IEC International Special Committee on Radio Interference (CISPR) meeting, whose committees produce technical standards, which directly impacts U.S. industry and international trade.

Institute of Electronics and Electrical Engineers (IEEE)

EEEL staff members represent NIST on a variety of IEEE societies, including the Antennas and Propagation Society, the International Electronic Devices Society, the Electromagnetic Compatibility Society, the Microwave Theory and Techniques Society, the Dielectrics and Electrical Insulation Society as well as others. This involvement provides a valuable source for industry requirements, and a platform for external collaboration.

A representative of the Radio-Frequency Technology Division participates as chair of the IEEE Working Group 802.16 on Broadband Wireless Access Standards. NIST strongly supports this standardization effort and success in this project will boost the broadband wireless access industry worldwide.

The Electricity Division has participated in meetings of the Lightning Protection Technical Committee 81, as a member of the U.S. National Committee Technical Advisory Group and liaison representative from the IEEE Surge-Protective Devices Committee. This group provides an avenue for dissemination of

NIST research results as well as gaining information on state-of-the-art advances made by the international researchers. It also serves to establish contact for possible collaborative research.

International Organization for Standardization (ISO)

Representatives from the Electricity Division participate in the International Organization for Standardization (ISO) Technical Committee (TC) 159 Subcommittee (SC) 4 Working Group (WG) 2, and the working group's display measurement subgroup.

MicroElectroMechanical Systems (MEMS)

A representative from the Semiconductor Electronics Division was elected as the chief delegate for the United States to the Micromachine Summit, held in the Netherlands in May of 2002. This gives NIST an international leadership role in MicroElectroMechanical Systems (MEMS) standardization and provides interactions with international MEMS industry leaders, which includes representatives from the Far East, North America and Europe. The purpose of the summit is to bring together representatives from countries that have programs in Micromachines, MEMS and

Microstructures Technology (MST) to discuss advances in these technologies, trends, future plans, government programs, and standardization. NIST is currently working with ASTM to develop measurement standards for MEMS technologies. Representation at these summits will contribute to the development of these standards for adoption by international organizations that will facilitate world trade.

Interamerican System of Metrology (SIM)

NIST participates as the primary U.S. laboratory for ongoing regional measurement intercomparisons in the areas of ac and dc voltage current, dc resistance, and power. Working group meetings from these areas allow representatives from all the SIM countries to communicate on issues related to these intercomparisons and to determine future directions.

Semiconductor Equipment and Materials International (SEMI)

EEEL participates in a Semiconductor Equipment and Materials International (SEMI) Semi-Insulating Silicon Carbide Regulations Subcommittee, which is overseen by ISO. SEMI represents the European region of the global standards program.

International Workshops and Conferences

EEEL hosted the Ninth International Symposium on Gaseous Dielectrics in May 2001, in Ellicott City, Maryland. Besides the Electricity Division of NIST, the symposium was co-sponsored by the Air Force Research Laboratory, Asea Brown Boveri Ltd (ABB), Hitachi, Ltd., Kansai Electric Power Co., Mitsubishi Electric Corp., Tokyo Electric Power Co., and Toshiba Corp. The IEEE Dielectrics and Electrical Insulation Society was a technical sponsor. With over 100 participants from 16 countries in attendance, 90 papers were presented in 10 oral sessions and one poster session. In addition, there were two discussion panel sessions, one on "Databases for Gaseous Dielectrics and Plasma Processing", and one on "Industrial Outlook." The symposium covered an array of topics from the basic physics of gaseous dielectrics and understanding of fundamental gas discharge mechanisms to the very practical issues of recycling of used SF₆, a gas extensively used as an electrical insulator in high-voltage equipment for the electric power grid, but also one of the most potent greenhouse gases. The main theme of the meeting was SF₆ replacements and in particular SF₆/N₂ mixtures. The meeting provided an invaluable forum for a broad discussion of the many issues relating to this problem, the understanding of the various aspects of the problem, and the formulation of sound solutions, including the development of substitute dielectrics.

The 2nd IEEE Conference on Standardization and Innovation in Information Technology (SIIT2001) held in Boulder, Colorado, from October 3-6, 2001. SIIT2001 was co-sponsored by IEEE's Microwave Theory and Techniques Society and by NIST. The International Center for Standards Research at the University of Colorado organized the event. The conference brought many of the world's standards developers together with key industry leaders. SIIT2001 was co-sponsored by the IEEE's Microwave Theory and Techniques Society and NIST.

The Display Metrology Project of the Electricity Division hosted the semi-annual meeting of the ISO "Visual display requirements" Working Group at NIST from May 15-17, 2002. This working group, consisting of ergonomists and engineers from Asia, Europe, and the U.S., is responsible for the development of standards that set requirements for the design factors of electronic visual displays that affect user comfort and fatigue in an office environment. A series of standards have been published concerning cathode ray tubes (CRTs).

EEEL's Optoelectronics Division hosted the annual meeting of the International Organization for Standardization (ISO) Technical Committee 172,

Subcommittee 9, at the NIST facilities in Boulder, Colorado, from June 26-29, 2001. The meeting was co-sponsored by NIST and the U.S. Laser and Electro-Optics Manufacturers' Association and was attended by approximately 35 people from four countries. The document standards being developed by the working groups within this subcommittee cover various aspects of laser radiation properties, such as power, energy, beam profile, and polarization, as well as properties of optical materials used with lasers. In conjunction with the ISO meeting, a joint working group composed of both ISO and International Electrotechnical Commission (IEC) experts held a meeting to discuss diode laser standards. A satisfactory agreement was reached between the ISO and IEC members, allowing these standards to proceed.

NIST-Boulder hosted the International Symposium on Advanced Radio Technology (ISART) from March 4-6, 2002. The symposium was co-sponsored by IEEE Communication Society, IEEE Broadcast Technology Society, IEEE Vehicular Technology Society, the Institute for Telecommunications Sciences, and the Defense Advanced Research Projects Agency (DARPA). The purpose was to develop an understanding of the current state of the art and future trends in the development and deployment of Advanced Radio Technology. Topics included an overview of the future of advanced radio technology spectrum management and radio frequency standards; advances in wireless technology, antennas and radio propagation, software defined radio, and ultra-wideband technology.

Manufacturing Engineering Laboratory

Dale L. Hall, *Director*

The Manufacturing Engineering Laboratory (MEL) provides technical support for industry groups that develop standards for measurements, measurement techniques, hardware, software, and data interfaces. MEL realizes the fundamental units of length and mass and disseminates measurements in those areas as well as in force, vibration, acoustics, and ultrasonics. MEL researchers are working to develop a sound basis for measurements and standards that support advanced applications of information in manufacturing. It operates the National Advanced Manufacturing Testbed, a unique national resource for studying the advanced infrastructure technologies required to support future manufacturing operations at both the systems and equipment levels. Laboratory researchers also work at the forefront of the emerging field of nanofabrication, developing measurement tools for atomic-scale production technologies of the future. Laboratory staff members work closely with their industry counterparts, from the planning of research projects to the dissemination of results. MEL engineers and scientists are developing many of the underpinning components of automated intelligent-processing systems that soon will be the core of all world-class manufacturing operations. These components include intelligent machines; advanced sensors for real-time in-process measurements; software for precision control of machine tools; and information technology for integrating all elements of a product's life cycle.

Bilateral Activities

Canada

Staff from the Intelligent Systems Division of MEL has held discussions with the British Columbia Institute of Technology (BCIT) Internet Engineering Laboratory on possible collaborations in the intelligent open-architecture control of manufacturing systems and critical infrastructure protection programs. The discussions included topics in real-time control over Ethernet, specifically on Ethernet/Industrial Protocol (IP), and hardware and software vulnerabilities in our nations' critical industries.

The Precision Engineering Division collaborates with Forensic Technology Inc. (FTI) in Montreal for the evaluation of reference bullets and casings. FTI tested NIST prototype standard casings and NIST standard bullets Reference Material (RM) 8240 using the FTI Integrated Ballistics Identification Systems (IBIS). Following initial tests, FTI has found the IBIS calibrations to be satisfactory, as well as the NIST proposed algorithm for bullet signature comparisons using IBIS. FTI now plans to use RM 8240 for IBIS calibrations and ballistics measurement quality control, and to establish ballistics measurement traceability nationwide.

The Manufacturing Systems Integration Division and the University of Windsor in Ontario, Canada have been working together to develop software for generating reference algorithms. These algorithms evaluate the performance and uncertainty of software that fits circles to grids of data, rather than to points nominally on the curve. The algorithms then generate a battery of reference pairs (grids along with reference fits).

Finland

A delegation of fourteen visitors from the National Technology Agency of Finland (TEKES) and the Technology Program for Mechanical Engineering (MASINA) visited NIST in June 2002, and were hosted by the Deputy Chief of the Manufacturing Metrology Division. NIST presentations to the group included those on Smart Machine tools, Predictive Process Engineering, Open Architecture Machine Control and Nano-Manufacturing. Presentations of the TEKES and MASINA Programs were in turn made to the NIST staff attending.

France

The Engineering Metrology Group of the Precision Engineering Division continues collaborative work with the Institute for Advanced Study of Materials and Mechanical Construction (ISMCM) in Toulouse. In support of the collaboration, the Acting Deputy Director of MEL visited ISMCM in January of 2001 and discussed areas of mutual interest in dimensional metrology and possible future collaborations.

The Manufacturing Systems Integration Division collaborates with the École Supérieure d'Informatique et Applications de Lorraine (ESIAL) campus in Nancy on work related to the NIST Design Repository Project. The long-term objectives of the Design Repository project are to develop a framework to enable the creation of design repositories, *i.e.*, databases of design artifact and process information. Students of the ESIAL program work in small teams on projects that are proposed by commercial companies or other outside organizations, and are third-year graduate students. Recent developments in this area have included a query interface for search and retrieval of product

knowledge from design repositories. The second area of collaboration with ESIAL was related to the OpenADE and Design Tolerancing Representation projects in the Design Process group of the Manufacturing Systems Integration Division, and concerns the development of an information model that merged and reconciled aspects of two independently-developed models for assembly and tolerance information into a single representation.

Germany

The Chief of the Precision Engineering Division visited the Physikalisch-Technische Bundesanstalt (PTB), Braunschweig, in November of 2001, to confer with the management and technical staff of PTB on areas for potential collaboration in the area of dimensional measurements and standards. One potential collaboration that was discussed is to develop a consensus-view of the American Society of Mechanical Engineers (ASME)-International Organization for Standardization (ISO) documentary standards recommended practice of traceability in dimensional measurements.

In 2001, the Manufacturing Metrology Division (MMD) hosted the Vice-President of PTB on a visit to the MMD's mass and force measurement facilities. The primary purpose for the visit to NIST was to negotiate a bilateral mutual recognition agreement between Germany and the United States for National Type Evaluation of load cells. The Chairman of the National Conference on Weights and Measures (NCWM), the Chief of the Standards Services Division (SSD), the Chief of the Weights and Measures Division (WMD), and other NIST staff participated in discussions held during the visit. During the discussions, NIST and PTB reached a verbal agreement on recognition of the technical work performed in the respective force laboratories, based on intercomparison results. The formal agreement is in development with NCWM, through the SSD and WMD. This agreement is still being actively pursued, but as yet has not been formalized.

A staff member from the Intelligent Systems Division held discussions in February 2002 with the German company S-Tec on a possible collaboration in Next Generation Laser Radar Tracking (LADAR). A collaboration involving a cost-shared Complementary Metal-Oxide Semiconductor (CMOS) detector survey and feasibility study was discussed.

NIST, through the Precision Engineering Division, and PTB, have recently established a collaboration on input to the development of future U.S. national and ISO-international documentary standards on recommended practices of realization standards on recommended practices of realization and supporting assertion of traceability in industrial dimensional measurements, including local realization of the unit

of length for traceability directly to the International System of Units (SI). The main action will be through an American Society of Mechanical Engineers (ASME) committee on this subject which is being established.

The Manufacturing Metrology Division has carried out research with the Heidenhain Corporation on performance testing of a two-axis high-precision motion stage. The new instrument will be used in the MEL Meso-Scale Machine Tool Metrology project. Heidenhain is a world leader in design, development, and manufacturing of linear and rotary measurement products and devices, and has agreed to donate a high-precision, two-axis (XY) motion stage to NIST, in support of the collaborative work. A second stage will be built and kept by Heidenhain to facilitate further collaboration. Different control systems will be used on each so that the two organizations can test the systems and compare results. Furthermore, NIST will use the donated platform to build a three-axis meso-scale machine tool for machining small parts up to 50 mm³ in size.

Italy

A representative from the Manufacturing Metrology Division attended the 6th Italy-U.S. Bilateral Seminar in Torino, Italy, which was held in November of 2000. The staff member presented an overview of the NIST force laboratory facilities and measurement services and discussed possible intercomparison efforts between the U.S. and Italy.

The Precision Engineering Division has held discussions with the Italian National Coordinate Measuring Machine (CMM) Association regarding a potential collaboration in the field of nanometer-scale metrology.

Japan

A representative from the Precision Engineering Division participated in a National Voluntary Laboratory Accreditation Program (NVLAP) Assessment of Asanuma Giken, in Tokyo. The company is a large Japanese manufacturer of automobile, telecommunication, and air conditioning system parts that are sold in the U.S. The company uses coordinate measuring machine technologies to inspect and measure dimension-critical components; these complex measurement systems must be controlled with appropriate techniques to ensure the measurements do not compromise the integrity of the artifacts and parts that are sent to the U.S. Compliance with the NVLAP regulations for measurement traceability and uncertainty calculations was assessed, as well as evaluating the process control techniques used for keeping their high-accuracy CMM under proper measurement control. This was the first time a laboratory has attempted

NVLAP certification for measuring a three-dimensional gage with three-dimensional measurands and parameters.

Discussions have been held between the Manufacturing Systems Integration Division and Nihon University regarding a possible collaboration on design processes involving the assembly model and industrial case study.

MEL hosted a group of executives from the Mitutoyo Corporation in August 2000, including the President and members of the Executive Board. MEL has a Cooperation Research and Development Agreement (CRADA) with Mitutoyo America; Mitutoyo is the world's largest manufacturer of precision measuring instruments.

A representative from the Manufacturing Systems Integration Division collaborates with the National Metrology Institute of Japan (NMIJ) on CMM Simulation. In the project, a mathematical model of the CMM is used and is expected to estimate the uncertainty by this simulation technique.

Another NMIJ collaboration involving the Precision Engineering Division is for the measurement of surface parameters. The target is to develop measurement techniques of surface parameters, such as roughness, step height, and pitch, in the micro-region (sub-nm to mm). The collaborators expect to establish uncertainty estimations in Atomic Force Microscopy measurements and comparisons of pitch measurement.

Korea

The Manufacturing Systems Integration Division works with the Automation Networks Laboratory of the Hanyang University in Korea on intelligent network technology for field networks. This work is supported by a cooperation agreement signed by MEL of NIST and the Hanyang University, and provides a mechanism for research on smart sensors and interfaces, integration of sensors and interfaces with field's networks. A recent phase of the cooperation involves a guest worker from the University with the project "Design-Analysis Integration and Enhanced Product Representations".

Under the MOU between the Korea Research Institute of Standards and Science (KRISS) and NIST, the Precision Engineering Division participates in cooperative research in the areas of nanotechnology research, and information exchange on surface metrology and atomic force spectroscopy.

Netherlands

In February 2001, the Chief of the Manufacturing Metrology Division visited the Philips Centre for Industrial Technology (CFT) in Eindhoven, to act as a consultant in advanced work in precision engineering. The invitation was extended by the Philips CFT to participate in a benchmarking exercise to assess their state-of-the-art operations in the fields of advanced precision engineering and precision manufacturing. Part of this benchmarking is a presentation of their work to a team of outside experts.

Norway

The Manufacturing Systems Integration Division has proposed a collaboration with EPM Technology AS in Oslo, Norway, to develop and deploy a Smart Repository for Industrial Data Management (SMART-IDM). NIST is advising the SMART-IDM project on required functionality by documenting user requirements and validating project results in pilot studies, and will support initiatives to improve the related standards as well as the development guidelines of the International Organization for Standardization (ISO) Technical Committee (TC) 184, Subcommittee (SC) 4.

Serbia

A representative from the Manufacturing Systems Integration Division gave invited presentations at the University of Belgrade and the Serbian Chamber of Commerce and discussed a possible collaboration between NIST and the University. The University of Belgrade and, in particular, the Faculty of Organizational Sciences, has significant potential to perform relevant work in the area of e-Business standards and technologies. The new focus on the e-Business technology research within both the graduate programs and specialized studies promises to mobilize important resources. The proposed collaborative work between the Faculty of Organizational Sciences and NIST will allow the two sides to share research findings.

Switzerland

A staff member from the Intelligent Systems Division held discussions with the Center for Optoelectronics and Microfabrication (CSEM) in Zurich on Next Generation Laser Distance and Ranging (LADAR). CSEM is interested in collaborative work in the area of Next Generation LADAR (NGL), possibly in using LADAR for automation in construction and manufacturing, and for Automated Guided Vehicles (AGV) and Unmanned Guided Vehicles (UGV) applications.

Taiwan

The Chief of the Manufacturing Metrology Division visited the Precision Instrument Development Center (PIDC) in Hsinchu and the Center for Measurement Standards (CMS) of the Industrial Technology Research Institute (ITRI) during April of 2001. Presentations on nanotechnology and scanning probe microscopy were given to PIDC, CMS, and the National Taiwan University (NTU) as part of the American Institute in Taiwan (AIT) - NIST collaborative agreement. The collaborating institutes in Taiwan have provided scientific and technical contributions to the Molecular Measuring Machine project, the Atomic Force Microscope project, and other projects within the Manufacturing Engineering Laboratory.

Also as part of the AIT-NIST agreement, the Precision Engineering Division (PED) works with the Department of Physics of National Tsing-hua University and CMS in the area of scanned probe oxidation. A guest researcher from NTU worked on the Molecular Measuring Machine Project as part of this cooperation. In addition a representative of the PED division visited CMS for consultation and collaboration on nanotechnology. In 2002, a guest researcher from CMS spent 6 months with the Nanoscale Metrology Group of PED. The primary focus of the visit involved working on scanned probe

microscope (SPM) lithography. During his visit, he produced a one-dimensional grating and a two-dimensional grid pattern which are being used for a wide variety of applications of interest for nanoscale metrology. These applications include pitch calibration by optical and scanning electron microscopes, and providing valuable uncertainty limits for future SPM lithographic patterning of nanoelectronic device structures and templates. Two-dimensional grids will be used with combinatorial chemical methods for collaborative studies with a group from the Polymers Division.

United Kingdom

The Automated Production Technology Division and the National Physical Laboratory (NPL) have discussed possible collaborations in geometric measurements of optics, possibly extending capabilities at NIST.

Informal cooperation has taken place between NIST and NPL in the areas of acoustics and vibration. Examples of this cooperation include investigating the free-field acoustic center correction to be used for International Electrotechnical Commission (IEC) type 13.2 mm nominal diameter (Type LS2aP) laboratory standard microphones, and trilateral comparisons of calibrations of accelerometer sensitivity with an industrial laboratory.

Multilateral Activities

Trilateral Cooperation with Spain and Japan

A trilateral Research Cooperation Agreement involving the National Microelectronics Center of Spain (CNM) in Barcelona, Spain, the Nanotechnology Research Institute (NRI) of the National Institute of Advanced Industrial Science and Technology (Tsukuba, Japan), and the Precision Engineering Division of NIST was signed on September 3, 2001. The signing of the agreement was the result of discussion between these long-term collaborators, with the purpose to establish scientific cooperation in the area of advanced lithography of functional nanostructures, using the scanned probe oxidation technique. The collaboration will focus on standardizing scanned probe microscope (SPM) oxidation lithography practices and procedures, with initial efforts toward the development of a dedicated lithography instrument capable of routine patterning of features in the range of 10 nm to 100 nm. A second important area that the collaboration will emphasize is to develop a systematic understanding of the scanned probe oxidation process across the entire range of materials – metals, semiconductors, and insulators – amenable to SPM nanolithography.

Intelligent Manufacturing Systems (IMS)

MEL participates in the Intelligent Manufacturing Systems (IMS) program, which is an industry-led, international research and development program established to develop the next generation of manufacturing and processing technologies. Companies and research institutions from Australia, Canada, the European Union, Japan, Norway, Switzerland, and the U.S. participate in this program. IMS provides a support structure for conducting Research and Development (R&D) projects within specific arrangements for the protection of intellectual property rights. IMS currently has eighteen projects, with three projects having been completed and another going through the final review stages. NIST participates in several of the IMS projects and has membership in the Steering Committee. In addition, the U.S. Regional Secretariat for IMS is located in MEL and a MEL representative acts as the manager of the Secretariat.

The Modeling and Simulation Environments for Design, Planning, and Operation of Globally Distributed Enterprises (MISSION) was one of the IMS projects in which NIST has participated. MISSION focused on specifying neutral interfaces for the integration of manufacturing simulation

systems. The project aimed at developing and testing modeling and simulation environments for design, planning, and operation of globally distributed enterprises. It involved partners from the U.S., Japan, and the European Union in the building of the software equivalent of a docking station, a generic modeling platform with interfaces that link and integrate distributed models and user-selected simulation tools, such as those for evaluating production scenarios. The platform supported simulations over a range of vantage points, from individual factories to entire supply chains. A distributed supply chain prototype was built to demonstrate the generic platform. NIST took a lead role in this project, with a staff member in the Manufacturing Systems Engineering Group serving as the U.S. regional coordinator. Although the formal project was officially closed in February 2002, the partners' activities around "Modeling and Simulation for Supply Chains and Distributed Enterprises" are still ongoing.

NIST has also participated in the international collaboration on the IMS "Next Generation Manufacturing Systems (NGMS)" project. NGMS is led by the Consortium for Advanced Manufacturing – International (CAM-I).

Key Comparisons (KCs) and Other Intercomparisons

MEL participates in various intercomparisons, both through the Bureau International des Poids et Mesures (BIPM) and regional organizations. Participation in key comparisons has included:

- A Key Comparison (KC) of line scales, coordinated by PTB with fourteen national laboratories around the world participated in this comparison. Two 280-mm scales, one Zeodur and one quartz, were measured on the NIST Line Scale Interferometer (LSI). These scales were manufactured by Heidenhain, Co. for PTB, and were shipped to the participating laboratories in a precision shipping container, which was equipped with temperature, humidity, and shock sensors.
- A Key Comparison in Vibration, in which the Manufacturing Metrology Division took part.

- The Precision Engineering Division participated in a Interamerican System of Metrology (SIM) regional comparison on Roughness and Step Heights.

An international intercomparison on Rockwell indenter measurements. In December of 2000, measurement reports of the geometrical parameters of two Rockwell C diamond indenters were issued to the Materialprüfungsamt Nordrhein—Westfalen (MPA NRW), Germany. These measurement reports are the first NIST official reports for Rockwell indenter measurements. The two indenters are being used as common indenters for an international Rockwell hardness comparison to establish a worldwide-unified Rockwell hardness scale with metrological traceability. NIST, because of the high accuracy of its indenter characterization system, was selected to characterize the form of the indenters prior to the start of the international comparison. NIST Rockwell indenter measurements are performed with a microform calibrations system developed in 1995 using a stylus instrument. These measurements comprise a special test item of NIST calibration services. NIST's microform measurement system currently has the lowest measurement uncertainty for this type of form measurement in the world. MPA RW and NIST have used the system to measure the indenter parameters of radius, cone angle, deviation from the spherical profile, cone flank straightness, and holder axis alignment error.

European Union (EU)

A representative from the Manufacturing Systems Integration Division held discussions with the European Commission (EC) in Brussels in July 2002 to plan collaboration on enterprise systems integration research and development topics. The collaboration would involve NIST with the Information Science Technologies (IST), and the topic is considered a priority for the 6th European Union (EU) Framework. Preliminary discussions centered on a collaborative road mapping activity with IST and NIST. If successful, new projects may be initiated within the 6th EU Framework, which would include activities within the NIST-IST project and the Interoperability Testbed.

International Committee Participation

Bureau International des Poids et Mesures (BIPM)/Comité International des Poids et Mesures (CIPM)

Representatives from MEL actively participate in many of the Comité International des Poids et Mesures (CIPM) Consultative Committees including:

- *Fluid Flow Metrology* - the Consultative Committee on Mass and Related Quantities (Comité Consultatif pour les Masses et les grandeurs apparentées, or CCM) Working Group for Fluid Flow (WGFF), which has six sub-groups: hydrocarbon liquid flow, low-pressure gas flow, high-pressure natural gas flow, air speed and volume. NIST will take primary responsibility in the low-pressure gas flow sub-group and secondary responsibilities in high-pressure natural gas flow and on hydrocarbon liquid flow. Each sub-group will design, build, and test transfer standards intended for the initial Key Comparisons in each of the six measurement areas;
- *Acoustics, Ultrasound and Vibration Metrology* - the Consultative Committee on Acoustics, Ultrasound, and Vibration (CCAUV), where personnel from the Automated Production Technology Division and the Manufacturing Metrology Division participate;
- *Dimensional Metrology* – Representatives from the Precision Engineering Division participate in the Working Group on Dimensional Metrology, Consultative Committee for Length (Comité Consultatif des Longueurs, or CCL). This committee is responsible for resolving technical issues related to the Key comparisons that provide the technical basis for mutual recognition of measurement capabilities by national measurement institutes throughout the world on dimensional metrology issues.

Joint Committee on Guides to Metrology (JCGM)

A representative of the Precision Engineering Division participates in the Joint Committee on Guides to Metrology (JCGM) Working Group 1 (WG1) on expression of uncertainty in measurement. WG1 is responsible for

maintenance of the document, "Guide to the Expression of Uncertainty in Measurement (GUM), and for producing supplemental and supporting documents. Recent activities of WG1 have included the preparation of supplemental documents to the GUM: 1) to provide guidance on the use of computer-based Monte Carlo methods of propagating probability distributions of measurement uncertainties; 2) a supplement to the GUM generalizing the propagation of uncertainty to multivariate models where there is more than one measurand; 3) a study of the use of measurement uncertainty in conformance testing and risk analysis; 4) a document providing general guidance on measurement modeling, including the effects of drift of standards and /or measurands, and 5) a supplement to the GUM providing guidance on the use of computer-based Monte Carlo methods of propagating probability distributions for the evaluation of measurement uncertainty. The study of the use of measurement uncertainty in conformance testing and risk analysis is led by representatives of the Precision Engineering Division at NIST.

International Organization for Standardization (ISO)

MEL participation in International Organization for Standardization (ISO) Committees aids in supporting U.S. views on developing international standards. During the ISO meetings NIST represents the Department of Commerce in its efforts to increase exports by eliminating import barriers, which has an impact on U.S. industry. U.S. participation in the development of these international standards is very important from the point of view of the U.S. industry, as lack of conformance to these standards will create significant obstacles to selling U.S. equipment abroad. European countries and Japan are heavily involved in these standard committees, and by participating in these meetings, NIST/MEL is able to put forward standards which are consistent with our national standards in machining center and turning center testing. MEL participates in various ISO committees, including:

- ISO Technical Committee (TC) 39 Subcommittee (SC) 2 meeting, on the development of ISO 10303 Part 14, "Product data exchange – the Express-X Information Mapping Language";
- ISO TC 108 on Mechanical Vibration and Shock;
- ISO 10303, the Standard for the Exchange of Product Model Data, (STEP), a comprehensive ISO standard

that describes how to represent and exchange digital product information;

- ISO TC 184/SC1/Working Group (WG)1 Standards meeting on ISO 14649 STEP-NC;
- ISO TC 184/SC4 on Industrial Data/Progress for Dimensional Inspection Information Exchange Project. STEP working committees of Technical Committee 184, Subcommittee 4 for Industrial Data and Global Manufacturing Languages of STEP;
- ISO/TC184/SC5/WG4 in the standardization of manufacturing software interoperability framework. The principal activity is to participate in this quarterly meeting to continue developing ISO Working Draft 16100 Part 1 – Framework for Interoperability;
- ISO TC 213 on “Dimensional and Geometrical Product Specifications and Verification” Work Group, and “Statistical Tolerancing of Mechanical Parts”; and
- ISO TC184/SC1/WG7 Standards Meeting on ISO 14649 STEP-NC; “Data Model for Computer Numerical Controllers”.

International Wassenaar Arrangement

A representative from the Manufacturing Metrology Division participates in the International Wassenaar Arrangement meetings on international export control of products and technologies as part of the U.S. delegation. The Wassenaar Arrangement is an international agreement between 33 countries to control exports of sensitive items, such as weapons and technologies that could be used to make weapons, to rogue states, as defined by this group of countries. These sensitive exports include such items as machine tools and electronics. The representative provides technical support for the U.S. position on machine tool export control criteria as well as evaluations and advice on the proposals from the other countries participating in this meeting. Recent meetings have concentrated on

improvements for control criteria for the export of machine tools. The current control criteria are based on positioning accuracy and the number of axes. However, there is a general disagreement among the members about the validity of such criteria to adequately represent the capability of machine tools, which are used for militarily critical applications.

Object Management Group (OMG)

The Manufacturing Systems Integration Division represented NIST at the Object Management Group (OMG) meeting, for the standardization of interfaces for software systems supporting manufacturing. The principal activities included participation in the Manufacturing Domain Task Force, the Joint Product Data Management Enablers development team, and the Common Enterprise Models Domain Task Force. The Enterprise Engineering program is directed to supporting industry by developing and promulgating information exchange standards and mechanisms to support planning and execution of manufacturing operations. NIST views the Object Management Group as a primary provider of consensus standards in this area, by virtue of the required participation of the software vendors in its standards development process, and is providing technical expertise and some logistical support to the development process. NIST is also providing technical expertise and some logistical support to the development of certain OMG standards, notably Project Data Management (PDM) Enablers.

Other Committees

Representatives from MEL also participate in other international committees including:

- SIM Metrology Working Groups (MWG) 9 on Acoustics and Vibration and MWG 7, on Mass and Related Quantities,
- International Institution for Production Engineering Research (CIRP),
- International Electrotechnical Commission (IEC), and
- International Task Force on Vehicle-Highway Automation (ITFVHA).

Chemical Science and Technology Laboratory

Dr. Hratch Semerjian, *Director**

The Chemical Science and Technology Laboratory (CSTL) performs cutting-edge research in measurement science; develops and maintains measurement methods, standards, and reference data; and develops models for chemical, biochemical, and physical properties and processes. CSTL provides these capabilities to enhance U.S. industry's productivity and competitiveness; ensure equity in trade; and improve public health, safety, and environmental quality. The technologies and services provided by CSTL help the U.S. chemical manufacturing, energy, healthcare, biotechnology, food processing, and materials-processing industries to meet the broad range of international measurement requirements and compete in global markets. One of CSTL's goals is to anticipate the measurement needs of new technologies so that a measurement infrastructure is available by the time a new technology is implemented. Needs are expanding for accurate, quantitative measurements at ever-decreasing detection limits, in harsher environments, and for a wider range of chemical species. In addition, the development of novel and improved processing techniques and new approaches to pollution prevention and control are critical to the economic success of U.S. industry. Through a strong commitment to basic research, and by leading the advancement of measurement science in critical areas, CSTL is poised to meet emerging national needs.

*currently Acting Director of NIST (February 2004)

Bilateral Activities

Australia

Discussions were held between the Analytical Chemistry Division and the National Analytical Reference Laboratory (NARL) in Pymble in July of 2001 regarding methodology for production of metal standards solutions and high-accuracy assay techniques.

Austria

The Surface and Microanalysis Science Division has a collaboration with the Austrian Technical University on the development of a new database, "Quantitative Electron Spectroscopy for Electron Spectroscopy Techniques (QUEST)". In this database, Auger Electron Spectroscopy (AES) and X-ray Photoelectron Spectroscopy (XPS) can be simulated for complex specimen morphologies.

A representative from the Analytical Chemistry Division traveled to the Federal Environment Agency in Austria to install, test, and provide training on the operation and maintenance of the NIST Standard Photometer.

Belarus

The Physical and Chemical Properties Division collaborates with the Thermodynamics Research Center (TRC) at Belarus State University in Minsk, on the project "Comprehensive Program on Critical Data". Establishing the TRC data entry facility and the TRC Data Quality Assurance Program will dramatically increase the TRC capabilities, in order to implement a dynamic data evaluation concept.

The Physical and Chemical Properties Division has another cooperative project with Belaruss State

University on characterizing the physical properties of ionic liquids and developing a physical properties database. Ionic liquids, a class of organic salts that are liquid at room temperature, have been proposed as new "green solvents" for various industrial applications. This work will provide industry with essential data on physical properties and reaction kinetics to help accelerate the development of industrial processes that exploit the unique properties of ionic liquids.

Canada

A representative of the Physical and Chemical Properties Division served on an Atmospheric Chemistry Subgroup of the peer review panel for the review of the Canadian government's research and development programs. The panel of international experts examined the research and development programs of the Meteorological Service of Canada (MSC).

The Process Measurements Division is working with Vortek in Vancouver to evaluate NIST thin-film/wire thermocouple calibration wafers to be used in an industrial production rapid thermal processing (RTP) tool at Vortek. Tests have been performed to optimize temperature measurement calibration models and evaluate a comparison between these thermocouple wafers and the RTP tool's radiation thermometers.

A representative of the Analytical Chemistry Division participated in the technical assessment of a laboratory of the National Research Council Canada (NRCC). The assessment was for the accreditation of the Glow Discharge Mass Spectrometry Facility at

the Institute for National Measurement Standards, NRCC to the standards of ISO 17025.

Chile

The Analytical Chemistry Division participated in a workshop on “Developing a Chemical Metrology Network in Chile” held in Santiago in February 2002. The workshop was conducted at the Instituto Nacional de Normalización (INN) with NIST and the Physikalisch-Technische Bundesanstalt (PTB). The discussions at the end of the workshop were summarized into recommendations and priority activities to establish the network.

The Physical and Chemical Properties Division is working with the Department of Physics in Santiago in the area of density functional theory. To develop and validate a computationally efficient algorithm leading to density functional theory methodologies that will not require the optimization of molecular orbitals and will enable scientists to perform quantum mechanical calculations on large-scale systems. If successful, this novel method will significantly decrease the computational effort of quantum chemical calculations, allowing researchers in industry to conduct theoretical studies of molecular systems of unprecedented size. One of the obvious applications of the proposed algorithm will be in the area of ab initio molecular dynamics simulations, which are currently hindered by the computational cost of the quantum mechanical calculations.

Egypt

The Analytical Chemistry Division cooperates with the National Institute of Standards (NIS) under the U.S. - Egypt Science and Technology Joint Board Program. Following the fifth cycle of proposal reviews in May 2001, the project “Development of Cotton Fiber and Fabric Certified Reference Materials”, and under the sixth cycle of proposal reviews, a project on “Creating an Egyptian Certified Reference Materials Program for NIST Traceable Elemental Solutions” was approved in May of 2002.

France

The Physical and Chemical Properties Division cooperates with the Atmospheric Chemistry Group at the University of Lille on studies characterizing accurate computation of rate constants of polyatomic reactions in chemical kinetics.

Germany

Under the Memorandum of Understanding (MOU) between NIST and the Physikalisch-Technische Bundesanstalt (PTB), the Experimental Chemical Kinetics and Thermodynamics Group of the Physical and Chemical Properties Division is collaborating with PTB on calibration protocols for calorimetric reference materials for differential scanning

calorimetry. The aim is to determine more accurately the enthalpies of fusion of metals that PTB has recommended as calibration standards.

Another collaborative program being established between PTB and NIST is with the Analytical Chemistry Division in the area of reference methods and reference materials for health status markers, with a special interest in the area of organic analytical methods for clinical analytes. In addition, the Analytical Chemistry Division is working with the German government (through PTB) on three pilot projects designed to expand the chemical measurement traceability infrastructure within the Americas. The three pilot projects are: 1) Outreach and Awareness Seminars; 2) Interamerican System of Metrology (SIM) Chemical Measurement Proficiency Assessment Program; and 3) Calibration and Measurement Capability (CMC) Database for High-Priority Measurement Services Important for Trade, Health and Environmental Decision-Making. Increased participation of countries within the Andean Countries Sub-region of SIM (ANDIMET), the Central American Countries Sub-region of SIM (CAMET), and the Caribbean Countries Sub-region of SIM (CARIMET) is both desired and expected. Additionally, efforts will be made that involve additional countries within the SURAMET region as well. The project plan was developed on behalf of the SIM council.

Staff members in the Analytical Chemistry Division have held discussions with counterparts at Bundesanstalt für Materialforschung und Prüfung (BAM) and PTB to explore ideas for collaborative research using the beam line at the Berliner Elektronenspeicherring-Gesellschaft für Synchrotronstrahlung (BESSY)-2 synchrotron, which is operated by BAM, and sponsored by PTB. Research ideas are focusing on fundamental parameters measurements and micro X-ray fluorescence spectrometry.

A representative from the Physical and Chemical Properties Division met with colleagues at the University of Düsseldorf to discuss theoretical models involving odorant carbonyl sulfide, hydrogen sulfide, and toluene.

The Physical and Chemical Properties Division has a collaborative project with the University of Hannover and the University of the Federal Armed Forces in Germany on simulations of viscous properties of the Lennard-Jones Fluid. Equilibrium molecular dynamics (EMD) simulations were carried out to determine the coefficients of self-diffusion, shear viscosity, and bulk viscosity of the fluid using the Einstein plot method.

The Analytical Chemistry Division works with the University of Applied Sciences in Germany on SpectroML: An Extensible Mark-up Language for Molecular Spectroscopy Data. This is a "Web-aware" mechanism for instrument-to-instrument, instrument-to-application, and application-to-application data interchange. As the work evolves, Spectro-ML will expand to include more of molecular spectrometry, and perhaps even to atomic spectrometry and chromatography.

The Physical and Properties Division is working with Rubotherm, Inc. of Bochum, Germany on a new apparatus for high-accuracy fluid density measurements over wide ranges of temperature, pressure, and density. The new instrument employs a buoyancy technique using two sinkers immersed in the fluid of interest. Sinkers and magnetic suspension coupling comprise the heart of the densimeter. The electromagnet at the top hangs from the balance and levitates the permanent magnet below it. The use of two sinkers leads to a cancellation of effects, such as surface adsorption, which can affect the accuracy of single-sinker techniques, making this instrument especially useful for the measurement of complex mixtures and vapors near saturation. The density measuring system was developed in collaboration with Rubotherm, and the components were integrated with the bulk of the system, which was fabricated in the NIST Instrument Shops.

A representative from the Analytical Chemistry Division installed, tested, and provided training on the operation and maintenance of a NIST Standards Photometer at the Umweltbundesamt in Frankfurt.

Hungary

Under the U.S. Hungarian Science and Technology Joint Fund, a workshop was held in September of 2002 in Budapest, Hungary to develop a Web-based database of recommended thermodynamic values. Meetings were held between representatives of the Physical and Chemical Properties Division and the International Union of Pure and Applied Chemistry (IUPAC) Task Group on Thermodynamics of Radicals. This project will include a much larger body of evaluated data than is currently contained in the NIST/Joint Army-Navy-Air Force (JANAF) file of chemical thermodynamic properties.

Israel

In cooperation with Daren Laboratories in Israel, the Physical and Chemical Properties Division is characterizing the behavior of contaminants in clay and organo-clay soils. The studies involve the investigation of the structure, adsorptive separations, and characterization of surfactant/clay complexes. This work impacts many applications, since clays are

used in such areas as pollution prevention and remediation, enhanced oil recovery, the treatment of petroleum liquids, the manufacture of cosmetics and pharmaceuticals, and the synthesis of polymer nanocomposite materials.

Italy

Several representatives from CSTL attended the U.S.- Italy Bilateral Seminar on Metrology and equivalency of National Standards, which was held November 2000 in Turin. Discussion topics included nuclear analytical techniques with the Analytical Chemistry Division, and temperature scale and pressure measurements with the Process Measurements Division. With the Institute of Metrology "G. Colonetti" (IMGC), the status of the deuterium fixed point cells being purchased by NIST, as well as the pending bilateral NIST/IMGC exchanged of hydrogen fixed points were discussed. The Pressure and Vacuum Group of the Process Measurements Division has worked with IMGC to develop a specially-characterized piston gage transfer standard for a key comparison in the area of pressure. The Thermometry Group in the Process Measurements Division has cooperative research activities with the Institute of Metrology "G. Colonetti" (IMGC) and the National Electrotechnical Institute "G. Ferraris" (IEN). This research includes the non-uniqueness of high-temperature platinum resistance thermometers, the development of a reference function for Pt/Pd thermocouples, and the fabrication of sealed fixed-point cells for low temperatures.

The Thermometry Group in the Process Measurements Division has cooperative research activities with the IMGC and the IEN. This research includes the non-uniqueness of high-temperature platinum resistance thermometers, the development of a reference function for Pt/Pd thermocouples, and the fabrication of sealed fixed-point cells for low temperatures.

Japan

The Analytical Chemistry Division works with the National Institute of Environmental Studies (NIES) in Tsukuba City on organic environmental reference materials, and the determination of carbon-14 in reference materials.

A collaboration between the Surface and Microanalysis Science Division and NIES has also been discussed on isotopic measurements of reference materials, including CO₂ isotopic ratios.

The National Metrology Institute of Japan (NMIJ) has several cooperative projects with the Analytical Chemistry Division, including a bilateral comparison in progress for mineral solutes of Sr, Zn, and other

trace elements, and on new volatile organic standards. These cooperative projects are carried out under the Implementing Agreement (IA) between NIST and the National Institute for Advanced Industrial Research (AIST) of Japan for Cooperation in the Fields of Metrology and Measurement Standards, signed on November 2, 1999 in order to establish mutual measurement comparability and equivalence.

Also under the cooperative agreement between NIST and AIST, the Physical and Chemical Properties Division works with NMIJ on the development of a database for thermophysical properties of alternative refrigerants and on a mass spectra database.

The Process Measurements Division is working with NMIJ on a method to automate the data-gathering process in calibration of pressure standards. Rather than adjusting small trim masses until the balances generate equal pressure, two balances are brought into approximate pressure equilibrium and a pressure transducer measures the remaining pressure differences. This method improves piston gauge calibrations by reducing or removing operator judgment and manual data entry, and introduces more consistency.

The Fluid Flow Group of the Process Measurements Division has a collaboration with Hirai Inc. in Tokyo to develop a new nozzle-based flowmeter that operates as a mass flow controller (Sonic Nozzle Controller). The Fluid Flow Group will evaluate calibration stability. A staff member involved in this project is also obtaining his Ph.D. at Kogakui University in the general area of gas flow standards and measurements.

Korea

The Pressure and Vacuum Group of the Process Measurements Division collaborates with the Vacuum Group at the Korea Research Institute on Standards and Science (KRISS) on vacuum measurements and testing methods of vacuum equipment. A bilateral comparison involving vacuum gauges, as well as the evaluation of helium leak artifacts was discussed and planned.

Mexico

The Physical and Chemical Properties Division is working with the Institute of Chemistry at the Autonomous National University of Mexico (UNAM) in Mexico City on studies in computational chemical kinetics. This topic is receiving greater interest in Mexico due to the importance of these methods in understanding the mechanisms governing complicated chemical processes contributing to air pollution.

Netherlands

The Analytical Chemistry Division is continuing its long-standing collaboration with the Netherlands Measurement Institute (NMI) in gas mixture analysis. This work has included an MOU for the intercomparison of primary gas mixtures, and a Declaration of Equivalence. This Declaration has been recognized by the U.S. Environmental Protection Agency (EPA) and by European environmental regulatory bodies as documenting the equivalence between seven NIST and NMI primary gas mixture suites.

The Nuclear Methods Group of the Analytical Chemistry Division is working with the Technical University Delft on characterizing uncertainties in neutron activation analysis and in establishing instrumental neutron activation analysis as a primary analytical method. One project in this effort was the accurate measurement of the half life of ⁷⁶As.

The Physical and Chemical Properties Division is part of the National Aeronautics and Space Administration's (NASA's) Ozone Monitoring Instrument (OMI), a joint U.S./Netherlands project. The OMI is a contribution of the Netherlands' Agency for Aerospace Program (NIVR), in collaboration with the Finnish Meteorological Institute (FMI) to NASA's Earth Observing Systems (EOS) Aura mission. OMI will continue the Total Ozone Mapping Spectrometer (TOMS) record for total ozone and other atmospheric parameters related to ozone chemistry and climate. This mission is part of the U.S. Global Change Research Program. A representative from the Physical and Chemical Properties Division is the NASA Headquarters Program Scientist for the project.

A representative from the Physical and Chemical Properties Division traveled to Breda to give instruction on the proper operation and use of the NIST software, Automated Mass Spectral Deconvolution and Identification System (AMDIS).

Pakistan

The Physical and Chemical Properties Division and a guest researcher from the University of Peshawar have collaborated on methods of thermal decomposition of chlorinated hydrocarbons. Chlorinated hydrocarbons are widely utilized throughout the chemical industry, both as end products and as precursors for a wide variety of useful products, including plastics, solvents, pesticides, refrigerants, and other products. The information provides computational chemists with crucial benchmark data on highly polar compounds, which are key species in a much wider variety of industrial chemistries.

Poland

The Surface and Microanalysis Science Division collaborates with the Institute of Physical Chemistry in Warsaw on a new version of the NIST Elastic Electron Scattering Cross Section Database. The collaboration also includes planning the design of the new database, which would contain relevant data from the Standards Reference Database (SRD) 64 and SRD 71. This new database will be used, together with information on the experimental configuration supplied by the user, to determine values for the measurement of overlayer thicknesses by Auger Electron Spectroscopy (AES) and X-ray Photoelectron Spectroscopy (XPS).

The Physical and Chemical Properties Division is working with a guest researcher from the Institute of Nuclear Chemistry and Technology in Warsaw to obtain kinetic and mechanistic information on the elementary reactions involved in the photochemical reduction of carbon dioxide and to develop strategies for the reduction of carbon dioxide into fuel or feedstock materials. This fundamental investigation will provide information on whether a process based on homogeneous photocatalysis should go forward.

Portugal

A representative from the Analytical Chemistry Division worked with the Direccão Geral do Ambiente (DGA) in Lisbon on the installation, testing, and training on the operation and maintenance of the NIST Standard Photometer. The use of the photometer will improve the basis for international comparisons for ozone measurements critical in pollution monitoring.

Russia

The Physical and Chemical Properties Division is collaborating with the Institute of Energy Problems of Chemical Physics, Russian Academy of Sciences (RAS), to develop simplified methods of calculating global warming potentials of halogenated compounds. In addition to method development, new infrared absorption cross sections have been characterized, as well as integrated band intensities for 21 haloalkanes of industrial importance.

The Process Separations Group of the Physical and Chemical Properties Division works with the Dagestan Scientific Center of the Russian Academy of Sciences on a number of different research topics. One area of cooperation involves characterizing the chemistry and properties of the trace components of fuel gas. Knowledge of the physical properties and chemistry of individual components of natural gas and LPG (liquefied petroleum gas) is needed for custody transfer, the calculation of calorific value, quality control, safety and environmental compliance, as well as efficient and safe design of plant

equipment operated with fuel gases. It has become very clear that components present at minor levels (or even at trace quantities) can have a significant impact on the overall properties of the fuel gas mixture. Recent work has included (1) completion of work on carbonyl sulfide (COS) hydrolysis in propane, (2) the relationship of COS hydrolysis on the Copper Strip Corrosion Test (CSCT), and (3) a comprehensive evaluation of the applicability of the CSCT.

Another area of cooperation with Dagestan is in modeling and database development for supercritical fluids and alternative solvents. Safe replacements for toxic solvents come from fully or partially fluorinated alkanes, ether or ketones, with negligible ozone depletion potential, as well as from functionalized glycol ethers and siloxanes. The most important thermophysical parameter required to assess the feasibility of a solvation process is the solute-solvent phase equilibrium. This cooperative research has demonstrated that solvation strength of glycol ethers is constant even in dilute aqueous solutions, which allows production of solvent formulations at much lower cost and no sacrifice on effectiveness.

The Physical and Chemical Properties Division also has a joint project with the Dagestan Center for calorimetric measurement of properties of water/methanol mixtures, and one to produce an updated correlation for the vapor pressure of heavy water (D₂O). These projects are part of the International Association for the Properties of Water and Steam (IAPWS), which develops international standards for water properties.

The Physical and Chemical Properties Division has long-standing collaborations with institutes within the Russian Academy of Sciences (RAS) who provide high-quality mass spectra which are reviewed for inclusion as reference spectra in the NIST/ National Institutes of Health (NIH)/Environmental Protection Agency (EPA) Mass Spectral Library. These collaborations involve scientists from the Topchiev Institute of Petrochemical Synthesis, the Institute of Element-Organic Compounds, and the Institute of Organic Chemistry, all located in Moscow. Spectra are also contributed from researchers at Moscow State University.

In a collaboration with the Thermodynamics Research Center (TRC) of the Physical and Chemical Properties Division, researchers at the Russian Center on Standardization, Information, and Certification of Materials in Moscow supplied thermophysical and thermochemical property data previously published in Russian during the 1950s in the format generated by the Guided Data Capture Software developed at TRC.

South Africa

A guest researcher from CSIR - National Metrology Laboratory worked with the Process Measurement Division on a new design of water flow rate measurement to reduce measurement uncertainty. The "Error Free Liquid Flow Diverters" for Calibration Facilities makes use of a double-action flow diversion process whereby the components of the diverter valve error are self-canceling. Initial testing indicates substantial reduction in diverter error component contribution.

Spain

A representative from the Analytical Chemistry Division worked with the Instituto de Salud Carlos III in Madrid to upgrade, re-certify, and provide training on the operation and maintenance of the NIST Standard Photometer.

A guest researcher from the University of Barcelona worked with the Surface and Microanalysis Science Division on a new version of the NIST Electron Elastic-Scattering Cross-Section Database. Cross sections for the elastic scattering of electrons by atoms are needed for modeling the transport of electrons in materials by Monte Carlo simulations and other means. Such transport calculations are needed to improve the accuracy of surface analyses, bulk analyses, and thin-film analyses of inhomogeneous samples by the techniques of Auger-electron spectroscopy (AES), X-ray photoelectron spectroscopy (XPS), electron-probe microanalysis (EPMA), and analytical electron microscopy (AEM). The cross sections are also needed for similar transport calculations in other applications including radiation dosimetry, radiation therapy, radiation processing, radiation protection, and electron-beam lithography.

Sweden

The Biotechnology Division has studied the electrophoretic migration of DNA molecules, in cooperation with a guest researcher from Chalmers University of Technology in Sweden. The purpose of the work is to investigate the various conditions affecting plasmid DNA separation in a particular polysaccharide resin that forms hydrogels if a divalent ion is added. The gel can be reversed to solution by adding EDTA, which makes it a promising candidate for preparative electrophoretic separation of biomolecules.

Switzerland

A representative from the Analytical Chemistry Division traveled to the Swiss Federal Office of Metrology and Accreditation in Bern to upgrade, re-certify, and provide training on the operation and maintenance of the NIST Standard Photometer.

The Analytical Chemistry Division is continuing collaborative research with the Swiss Federal Laboratories for Materials Testing and Research (EMPA) in emission spectrometry. The research concerns research in High Performance Inductively-Coupled Plasma Optical Emission Spectrometry (HP-ICP-OES) and the production of spectrometric solution reference materials. EMPA, together with BAM, currently have the only other (than NIST) active program that disseminates traceable spectrometric solutions to end-users.

Ukraine

Researchers at the Thermodynamics Center in Kiev, cooperate with TRC of the Physical and Chemical Properties Division on critical evaluation of transport properties of organic compounds. This work has been included in recent publications of the TRC Thermodynamic Tables.

United Kingdom

The Analytical Chemistry Division is conducting an intercomparison with the National Physical Laboratory (NPL) on Fourier Transform Infrared Spectroscopy (FTIR) measurements of several hazardous air pollutants. There have also been discussions on a proposed Memorandum of Cooperation and Declaration of Equivalence regarding the disseminated transmittance scales maintained by NPL and the Analytical Chemistry Division.

A representative of the Surface and Microanalysis Science Division participated in a meeting in October 2001 held in London as part of the U.S. delegation for a U.S. – United Kingdom project on "Sampling and Analysis of Graphite from Nuclear Reactors". The project is coordinated in the U.S. through DoE.

A representative of the Analytical Chemistry Division participated in a National Voluntary Laboratory Accreditation Program (NVLAP) accreditation of two companies in London and Cambridge. The subject of assessment was for the certification of NIST Traceable Reference Material (NTRM) neutral density filters.

The Biotechnology Division worked with the University of Cambridge to develop a data model and application program interface for Nuclear Magnetic Resonance (NMR) structural data.

The Physical and Chemical Properties Division conducted collaborative research in Fourier Transform-ultraviolet/visible (FT-uv/vis) spectroscopy with Imperial College in London. Additionally, studies of surface structure and properties of chromium oxide were performed jointly, in order to better characterize this substance

that is used in a range of technological applications. In the model that was developed, it was possible to obtain a phase diagram, indicating a complex surface chemistry with an extreme sensitivity to environmental conditions, which can account for much of the variability and controversy in previous studies.

The Physical and Chemical Properties Division collaborates with the University of Nottingham on the thermodynamics of aqueous vapor mixtures. This is important in a variety of areas, from properties of combustion gases for the power industry to the improvement of humidity standards. An appropriate description for many of these systems is at the level of the second virial coefficient (the first correction to the ideal gas). The difficulties in the measurement of the second virial coefficient have been eased by applying intermolecular potentials determined from ab initio quantum mechanics to the calculation of thermodynamic properties at low and moderate densities for aqueous gas mixtures of importance in research and industry. The thermophysical properties

of gas mixtures containing water are important for many industrial applications, including advanced combustion turbines which are becoming the dominant force in electric power generation, analysis of auto exhaust gases, industrial processing of semiconductors, polymers, and other materials, processing of natural gas, and measurement standards of humidity, mass and length. Mixtures of interest include water in air, N₂ and O₂, CH₄, CO₂ and rare gas species such as He and Ar.

Venezuela

The Physical and Chemical Properties Division collaborates with the Computational Catalysis Group of the Venezuelan Institute for Scientific Research on studies in computational chemistry. Many of the studies are in the area of state-of-the-art quantum chemistry methods that can be applied in the prediction of molecular properties such as electronic conductance, current voltage curves of single molecules or molecular ensembles and so on.

Multilateral Activities

European Union (EU)

NIST chemists quantified trace amounts of lead in wine in a new clean room facility in the Advanced Chemical Science Laboratory. This was part of an international pilot study of how accurately 14 national metrology institutes around the world measured the hazardous metal in wine. The participants' results agreed closely with the level of lead in wine samples provided by Institute for Reference Materials and Measurements (IRMM) in Geel, Belgium, which is part of the Directorate General - Joint Research Centre of the European Commission.

The European Union (EU) In-Vitro Diagnostic (IVD)-Thyroid Project is composed of three separate research projects, each related to clinical thyroid function determinations. The part of the project in which NIST has been very active is the validation of reference methods for the measurement of the thyroid hormones T3 and T4. NIST/CSTL has participated in two round robin comparisons of T3/T4 reference methods with two labs in the EU and one lab in the UK. This has been very beneficial because it has allowed method improvement through evaluating accuracy and examining sources of potential measurement bias. NIST has also assisted in the purity assessment of pure T3 and T4 reference materials.

Key Comparisons (KCs) and Other Intercomparisons

Two pressure key comparisons, piloted by CSTL, under the auspices of the Consultative Committee for Mass and Related Quantities (CCM) Comité International des Poids et Mesures (CIPM), were recently completed. One covered the range from 1 Pa to 1000 Pa (absolute), and involved seven national metrology institutes using two different principal techniques. The other was from 1 Pa to 1000 Pa (differential), and involved 4 National Metrology Institutes (NMIs). The completed comparisons were the first successful international comparisons in this pressure range (1 to 1000 Pa, absolute and differential modes), and demonstrated general equivalence among the participants, revealed no systematic bias between alternative realizations of the Pascal, and were the only CCM pressure comparisons completed on-time. The third comparison (3×10^{-6} to 9×10^{-4} Pa) has been completed, and is in the analysis and reporting phase.

Other comparisons through the Consultative Committee on the Quantity of Material (CCQM) included those in Gas Metrology, Classical and Electroanalytical Metrology, and Inorganic Analytical Measurements:

- Gas Metrology: The Analytical Chemistry Division participated in two pilot studies, one on the preparation of gravimetric Gas Standards, and the on Greenhouse Gases, as well as the Natural Gas Key Comparison

and the Volatile Organic Compounds (VOC) Key Comparison.

- **Classical and Electroanalytical Metrology:** The Analytical Chemistry Division participated in four pilot studies connected with classical techniques, pH metrology, and anion solutions.
- **Inorganic Analytical Metrology:** The Analytical Chemistry Division participated in five pilot and key comparisons of the of inorganic working group of the CCQM, Arsenic in Shellfish, Cadmium in Rice, Zinc in Rice, Synthetic Food Digest, and Minor Elements in Steel.

The Physical and Chemical Properties Division participated in an international round-robin study of the thermal properties of polymer melts, organized by the National Physical Laboratory (NPL) in the UK. The polydimethylsiloxane (PDMS) samples were studied at seven laboratories around the world, with the results summarized in NPL Report CBTLM S35, published in December 2000. The NIST measurements of the thermal conductivity of liquid PDMS cover the temperature range of reference data used to calibrate thermal conductivity apparatus at temperatures up to 700 K. The NIST data were measured with an absolute transient hot-wire instrument and are the only data available on the PDMS sample at temperatures above 420 K. The agreement between 5 participating laboratories and the ASTM recommended value at 298 K is within $\pm 2\%$ for the thermal conductivity of the samples of PDMS.

International Atomic Energy Agency (IAEA)

The Analytical Chemistry Division participates in several programs of the International Atomic Energy Agency (IAEA):

A representative from the Organic Analytical Methods group was part of a consultants' meeting on "Isotopic and Other Techniques for Organic Micronutrients Analysis and Quality Assurance" in Vienna in December 2000. IAEA funds studies that use stable and radioactive isotopes to assess dietary requirements and bioavailability of various micronutrients (*e.g.*, vitamins, carotenoids, trace metals). In intervention studies in developing countries, the diets of participants are supplemented with these micronutrients, and it is necessary for laboratories in those countries to monitor the effectiveness of the intervention through reliable, accurate analysis of samples – generally using non-isotopic techniques. NIST has demonstrated that active participation in quality assurance (QA) programs (*e.g.*, the Micronutrients Measurement Quality Assurance Program run by the Analytical Chemistry Division) can improve the proficiency of

analytical laboratories over time. Thus, the consultants recommended that laboratories participating in IAEA-funded research also participate in a QA program such as NIST's and that these laboratories value-assign in-house control materials.

- A representative from the Nuclear Methods Group participated in an IAEA meeting in Vienna in April 2001. The consultant group met to develop the framework for a Coordinated Research Project (CRP) "Use of Nuclear and Related Analytical Techniques in Studying Health Impacts of Toxic Elements Consumed Through Foodstuffs Contaminated by Industrial Activities." The committee consisted of five experts from different member countries of the United Nations. The CRP defined by the committee will supplement existing IAEA, World Health Organization (WHO), and Food and Agriculture Organization research activities.
- A representative of the Nuclear Methods Group served as a consultant for the IAEA CRP for the development of a database for prompt gamma-ray neutron activation analysis.
- A representative of the Surface and Microanalysis Division participated in a meeting on Particle Analysis of Safeguard Samples in Vienna in December of 2001. This meeting emphasized the technical requirements of environmental sampling in the area of nuclear safeguards.

Interamerican System of Metrology (SIM)

CSTL holds the Chair for the Chemical Metrology Working Group for the Interamerican System of Metrology, the Sistema Interamericano de Metrologia (SIM). To support the SIM countries developing formal programs in chemical metrology, CSTL conducts training courses in the areas of organic, spectrochemical, nuclear, gas metrology and classical analytical methods. The number of participants range from 6 to 15 in the one week, hands-on courses given for current or designated future leaders of chemical metrology programs of NMIs within SIM. Recent workshops have included a Gas Metrology Course and a Workshop on Pesticide Analysis.

The Chief of the Analytical Chemistry Division met with representatives from 5 SIM Sub-regions in Montevideo, Uruguay, in February 2002, to discuss the proposal for PTB support for SIM activities in Chemical Metrology. (See related item in the section in Bilateral Cooperation, Germany)

Versailles Project on Advanced Materials and Standards (VAMAS)

The Surface and Microanalysis Science Division participates in the Surface Chemical Analysis Working Area (SCATWA) 2, of the Versailles Project on Advanced Materials and Standards (VAMAS). VAMAS is an international cooperative program involving Canada, France Germany Italy, Japan, the U.K., the U.S. and the E.U. VAMAS supports trade in high technology products through international collaborative projects aimed at providing the technical basis for drafting standards. The SCATWA is one of twenty VAMAS Technical Working Areas and has twelve active projects directed at the generation of reference data, the characterization of data-processing algorithms, and the organization of interlaboratory comparisons.

Other Multilateral Activities

A representative from the Physical and Chemical Properties Division manages the Upper Atmosphere Research Program (UARP) for NASA. The principal tropospheric measurement activity supported under UARP is the Advanced Global Atmospheric Gases Experiment (AGAGE) Network, which is an international measurement activity which focuses on tropospheric abundances of several naturally-occurring and anthropogenic trace gases important in stratospheric ozone depletion and global warming. UARP is part of an interagency agreement between NIST and NASA, where NIST's role has a particular emphasis on atmospheric change and environmental fate analyses. The scientific exchange through such discussions is an essential part of the research planning for NIST activities in chemical kinetics, photochemistry, thermodynamics, spectroscopy, and standards research. The program provides a verifiable database upon which environmental policy can be formulated.

CSTL, in partnership with the North America natural gas industry, has developed a interlaboratory comparison testing program to ensure the quality of measurements in the three major natural gas flow calibration facilities in North America: the Iowa facilities of the Colorado Engineering Experiment

Station, Inc.; the Winnipeg facilities of TransCanada Calibrations Ltd.; and the Gas Technology Institute Metering Research Facility operated by Southwest Research Institute in San Antonio, Texas. CSTL will work with the Gas Technology Institute, Measurement Canada, Daniel Industries, which is supplying the metering equipment for use in the test, and the three calibration facilities, to demonstrate the degree of equivalency between the calibrations provided to the North America natural gas industry. A primary objective of this work is a rigorous evaluation of the uncertainty associated with the test results. CSTL's Process Measurement Division has teamed with IITL's Statistical Engineering Division to develop the instrumentation and sensor package, testing protocol, and data analysis to be used in the project.

The Physical and Chemical Properties Division collaborates with the Atmospheric Chemistry Group at the University of Lille on a project involving theoretical and experimental studies of heterogeneous kinetics. An additional link is with Karlsruhe University, where the group will develop methods that will allow the understanding of the reliability of state-of-art theoretical tools currently used in computational kinetics. These methods are relevant to the efforts of the Division's Experimental Kinetics and Thermodynamics Group in the areas of atmospheric chemistry and combustion.

Awards

Stephen Wise, CSTL, was the recipient of the Achievement Award of the International Society for Polycyclic Aromatic Compounds for his outstanding contributions to studies of the chemistry and biological effects of polycyclic aromatic compounds (PACs). He was cited for significant contributions in fundamental investigations of mechanisms that control chromatographic retention procedures and development and evaluation of chromatography methods for identifying and quantifying PACs in complex matrices; development of certified reference materials; and development of protocols for collecting, preparing, and preserving biological materials.

International Committee Participation

Bureau International des Poids et Mesures/Comité International des Poids des Mesures (BIPM/CIPM)

Representatives from CSTL actively participate in many of the Comité International des Poids et Mesures (CIPM) Consultative Committees including:

- *Thermometry*: The Thermometry Group of the Process Measurements Division participates in meetings of the Consultative Committee for Thermometry (CCT) of the

Bureau International des Poids et Mesures (BIPM). These include working groups concerning the international traceability of temperature measurements on ITS-90, on thermophysical properties, and on humidity measurements.

- *Pressure and Vacuum*: The Pressure and Vacuum Group of the Process Measurements Division participates in several Working Groups of the Consultative

Committee for Mass and Related Quantities (CCM), including those for Pressure, Fluid Flow and the Ad-Hoc Working Group on Viscosity.

- *Amount of Substance:* The Analytical Chemistry Division participates in the Consultative Committee on the Quantity of Material (CCQM) and in several CCQM working groups, which advise the CIPM on matters related to the accuracy of quantitative chemical measurements and traceability to the SI. CSTL's Analytical Chemistry Division is currently leading various activities within five of the seven working groups: gas analysis, organic analysis, inorganic analysis, electrochemistry, biometrology, surface analysis, and Key Comparisons. During FY 2001, CSTL participated in 25 CCQM comparison studies, serving as the Pilot Laboratory in 13. Key Comparison studies have been completed and international equivalence statements approved or drafted for: Natural Gas, Automobile Emission Gases, Acid Rain Precursors Gases, Ethanol in Air, Volatile Organic Compounds, Cholesterol in human Serum, pp'-DDE in Fish Oil, Elemental Standards Solution, Lead in Drinking Water, and pH. Other completed Key Comparisons include Glucose and Creatinine in Human Serum, Lead and Cadmium in Sediment and pp' DDT in fish Oil. CSTL is also participating in 14 Pilot Studies including Arsenic in Shellfish, Trace Metals in Food, PCBs and Tributyl tin in Sediment, and LSD in Urine.

Cooperation on International Traceability in Analytical Chemistry (CITAC)

A representative of the Analytical Chemistry Division participates in the Cooperation on International Traceability in Analytical Chemistry (CITAC) meetings and working groups. This work is concentrated particularly in the CITAC Uncertainty and Traceability Working Group, which is refining a draft of the Guide to Traceability in Analytical Chemistry in support of the International Organization for Standardization (ISO) 17025 requirements for the analytical chemistry community. The representative is working to ensure that the guide is consistent with NIST policy.

The Analytical Chemistry Division also participates actively in the newly-formed Joint Committee on Traceability in Laboratory Medicine (JCTLM). The JCTLM is comprised of the international and intergovernmental organizations of CIPM/BIPM, the International Federation of Clinical Chemistry and

Laboratory Medicine (IFCC), the International Laboratory Accreditation Cooperation (ILAC) and WHO as the four principal promoters who will act as the Executive Committee. The world's national metrology institutes are represented through CIPM/BIPM. There are two working groups under the JCTLM: Reference Materials and Reference Procedures, and Reference Laboratory Networks.

International Union for Pure and Applied Chemistry (IUPAC)

The International Union for Pure and Applied Chemistry (IUPAC) Biophysical Chemistry Commission sponsored a project for "Measurement and Analysis of Biological Substances Using Differential Scanning Calorimetry (DSC)". The team, headed by NIST and PTB, consisted of a total working party of ten scientists, and was formed to address the need for recommended procedures on the measurement and analysis of results obtained on biological substances with DSC. DSC has been widely used to determine the thermodynamics of phase transitions and conformational changes in biological systems including proteins, nucleic acid sequence, and lipid assemblies. The IUPAC report consists of recommendations of DSC measurement procedures, calibration procedures, procedures for testing the performance of the DSC instrument analysis of the measurements, and the reporting of results.

Representatives from the Physical and Chemical Properties Division participate in several committees of the IUPAC. These included the Conference on Chemical Thermodynamics, the Committee of Printed and Electronic Media, including a subcommittee on XML and Chemistry, Committee on Electroanalysis, and a Task Group on the Study of Standards Potentials of Radicals in Aqueous Solution.

Organization for the Prohibition of Chemical Weapons (OPCW)

Representatives from the Physical and Chemical Properties Division serve as the technical liaison to the U.S. delegation to the Organization for the Prohibition of Chemical Weapons (OPCW). This includes consultations on sample handling procedures and negotiations on analytical methods. They also participate in meetings of the Validation Group for the Updating of the Central Analytical Database, in support of the U.S. delegation to the OPCW, which includes the use of the NIST Mass Spectrometry database.

Other Committees

Representatives from CSTL also participate in many other international committees including: the

technical committees of ISO on traceability and the AOAC International (formerly the Association of

Official Analytical Chemists).

International Workshops and Conferences

In early November 2000, representatives of government, the In Vitro Diagnostic (IVD) industry, and the medical professions from 15 nations representing four continents gathered at NIST to participate in the "Workshop on Measurement Traceability for Clinical Laboratory Testing and In Vitro Diagnostic Test Systems." Their goal: to develop recommendations regarding the needs for measurement traceability for health status markers to (1) address IVD industry needs for compliance with international standards (e.g., the EU IVD Directive) and (2) improve comparability of clinical measurement data to facilitate better decision-making by medical professionals. The workshop was attended by 135 scientific experts and stakeholders from around the globe (25% were from outside the United States). Traceability to internationally recognized and accepted standards is an important component in assuring the accuracy and comparability of clinical laboratory measurements. In addition, the global marketplace is presenting new demands for measurement traceability. Recently, an important opportunity has emerged that applies new pressure to the quest for traceability and the demand for reference systems. Prompted by the European Union's In Vitro Diagnostics Directive (IVDD), the European Committee for Standardization's Technical Committee 140 (CEN/TC 140), in vitro diagnostic systems, began drafting a standard on metrological traceability. Full implementation of the IVD Directive is expected by December 2003 and will require that calibration of all IVD assays be traceable to available reference materials or methods of higher metrological order. At the conclusion of the workshop, there was general agreement on some critical issues. The need for global reference systems composed of reference methods, reference materials, and a mechanism for demonstrating competence and equivalence was of paramount importance. Internationally recognized and accepted reference laboratories should implement these reference systems, using a networked approach. In order to meet the immediate requirements of the IVD Directive, a catalog of the available reference methods and reference materials must be communicated to the IVD manufacturers. There was concurrence that, when properly implemented, traceability is a value-added exercise that will improve patient care, testing accuracy, reliability and availability, market access, and, in the long run, reduce costs. However, it was emphasized that efforts undertaken must be designed to minimize redundancy and barriers, encourage new technologies, and facilitate global collaborations.

A workshop on "The Accuracy Barrier in Quantitative EPMA and the Role of Standards" was held at NIST on April 8-11, 2002. Leading experts in electron probe x-ray microanalysis (EPMA) from industry, academia, and government from the United States, Canada, and Europe were among workshop participants, which sought to reach an understanding of the present state of quantitative EPMA, especially to identify those factors that limit its accuracy and to develop elements of a roadmap for future progress.

CSTL sponsored the Second International Conference on "Oxidative Stress and Aging – Technologies for Assessment and Intervention Strategies", which had been organized by the Biotechnology Division. The Conference took place in Maui, Hawaii, on April 2-5, 2001. This meeting focused on the latest research on molecular gerontology with emphasis on oxidative stress-related mechanisms of aging and longevity determinants. The conference was sponsored by 17 organizations, including NIST, and was attended by more than 200 people.

A forum on "Quality Systems Implementations Within SIM" was held at NIST on July 29 – August 2, 2002. This Forum, organized under SIM, focused on Quality Systems Implementation within the Americas. A series of meetings and symposia were held where member NMIs presented various approaches for implementing quality systems for measurement services within their countries/economies. Special emphasis was placed on particular needs, requirements, and characteristics that may differ from those of secondary and end-user laboratories. Various approaches for the implementation of quality systems to underpin the delivery of measurement services at the NMI level were presented and discussed. Participation included speakers from NIST, the National Center for Metrology (CENAM) in Mexico, the National Research Council (NRC) Canada, and the National Institute of Metrology, Standardization and Industrial Quality (INMETRO) in Brazil.

A Conference on "Biophysics from First Principles: From the Electronic to the Mesoscale" was held September 7-12, 2002, in San Feliu, Spain, where NIST was one of the co-sponsors. The purpose of this conference was to bring together theoretical and experimental researchers from physics, chemistry, biological sciences, and industry to foster interdisciplinary approaches to the study of living systems. The principal focus was on the application of theoretical physics from first principles to classical

simulations, as well as statistical approaches to understanding biological processes. Session topics included: Understanding Biological Mechanisms; Transition Metal Chemistry; Predicting the Biological Activity of Chemicals; Structure and Function of Biological Macromolecules; and Molecular Interactions and Solvation: Short- and Long-Range Forces. Challenges facing industry and the environment were presented by invited plenary speakers from Dupont), BASF, and the U.S. Environmental Protection Agency (EPA). The maximum capacity of 135 researchers from academic and government institutions around the world attended, as well as industrial participants from companies such as Dupont, BASF, Unilever, Toshiba, and IBM. There was a waiting list of over 150 people hoping to attend. The conference was deemed so successful and the interdisciplinary need

so timely that the European Science Foundation has decided to initiate a new conference series entitled “Computational Biophysics: Integrating Theoretical Physics and Biology” to be held every two years.

CSTL sponsored a SIM workshop, “Needs Assessment for Methods and Standards for Genetically Modified Organisms (GMOs)” in December of 2001. Discussions were held on regulatory differences, existing measurement methods, new methods and standards needs, gap analysis, and plans of action. The workshop was attend by 63 public and private officials from 28 countries, including representatives from Australia, New Zealand, South Africa, Belgium, Germany, and the U.K, as well as from the SIM regions of the Americas.

Physics Laboratory

Dr. Katharine B. Gebbie, *Director*

The NIST Physics Laboratory supports U.S. industry by providing measurement services and research for electronic, optical, and radiation technology. It pursues directed research in the physical sciences; develops new physical standards, measurement methods, and data; conducts an aggressive dissemination program; and collaborates with industry to commercialize inventions and discoveries. The laboratory's programs range from tests of fundamental postulates of physics to the more immediate needs of industry and commerce. Much of the laboratory's research is devoted to overcoming the barriers to the next technological revolution, in which individual atoms and molecules will serve as the fundamental building blocks of electronic and optical devices. To develop the necessary measurement capabilities for these new products, laboratory scientists use highly specialized equipment to study and manipulate individual atoms and molecules. The laboratory's work in support of industry covers a broad scope of activities. For example, the laboratory is working to improve optical measurement techniques used in remote sensing, advanced color graphics systems, and optically pumped atomic clocks. Research also is focused toward advancements in the measurement and dosimetry of ionizing radiation used in medicine and industry and supports the development of emerging technologies such as X-ray lithography, digital X-ray imaging, and electron beam processing.

Bilateral Activities

Australia

The Laser Cooling Group of the Atomic Physics Division performed collaborative experiments with the University of Queensland in quantum optics. The experimental results demonstrated the phenomenon of dynamic tunneling predicted by quantum mechanics theory. Ultra-cold atoms oscillating in optical potential wells were observed to tunnel from one allowed motion to another that was not well connected via a classical thermodynamic pathway.

Austria

The Atomic Physics Division works with the Institute of Theoretical Physics at the University of Innsbruck on research in quantum information. The research concerns collisional shifts in the Cesium Fountain Clock, and will benefit NIST's Quantum Information Program.

Brazil

A representative from the Ionizing Radiation Division visited the Institute for Energy and Nuclear Research (IPEN), Brazil's National Nuclear Energy Agency, at the request of the International Atomic Energy Agency (IAEA), to advise and help IPEN researchers in radionuclide standardization in the nuclear metrology laboratory. Also during the visit, an evaluation was conducted on laboratory capabilities and measurement programs.

Canada

The Electron and Optical Physics Division and the University of Toronto cooperate on finite temperature studies in a Bose gas. This has led to a joint publication in *Phys. Rev. Letters*, "Dynamical

instability of a condensate induced by a rotating thermal gas". An additional area of joint research with the University of Toronto is on spin waves in a dilute Bose gas, along with the Quantum Physics Division and JILA at the U. Colorado.

The Optical Technology Division has partnered with Vortek Industries in Vancouver to conduct comparative temperature measurement experiments using Vortek's Rapid Thermal Processing (RTP) tool.

China

A representative of the Quantum Physics Division visited East China Normal University in Shanghai in January 2001 to discuss a possible collaboration and potential guest scientist visits. The possible topics of collaboration include optical atomic clock, laser spectroscopy, and single-atom tracking. JILA has a long-standing collaboration with the university.

Denmark

A staff member in the Atomic Physics Division collaborates with the Niels Bohr Institute regarding studies on cooling and trapping of cold alkaline earth atoms. The emphasis is on studying ultra-cold atomic collisions with these systems, employing a magnesium magneto-optical trap. This work has supported current research on cold atoms and ultra-precise atomic clocks within the European Union (EU) and at NIST.

Egypt

Galia Mehena, associate professor of Physics at Cairo University in Egypt, completed a one-year assignment from June 2000 to June 2001 at NIST's

Synchrotron Ultraviolet Research Facility (SURF). The assignment was part of the program to develop the Synchrotron-Light for Experimental Science and Applications in the Middle East (SESAME), which will be the first international research center in the Middle East. SESAME is a United Nations project, and will be located in Jordan. The German government has agreed to donate a working synchrotron to the SESAME project. The U.S. Department of Energy (DoE) has committed funds to train Middle Eastern scientists at U.S. synchrotron radiation facilities. NIST and DoE supported the cost of Meheba's training.

The Time and Frequency Division completed a collaborative project with the National Institute of Standards (NIS), which was sponsored by the U.S. Egypt Joint Science and Technology (S&T) Board. During the project, advanced time and frequency dissemination methods were developed through the use of the Nilesat satellite. This dissemination is being done through the installation of time code generators and cesium beam oscillators at a Nilesat uplink site.

France

The Quantum Physics Division works with the Laboratoire de Gravimétrie et Géodynamique, Institut de Physique du Globe and the Laboratoire de Recherches en Géodésie, both in Paris, in the area of gravimetry. Discussions have been held on possibly acquiring a working cam-driven gravimeter (NIST-developed) for use and testing in the field, and also in providing user-experience on the NIST small absolute gravimeter.

A guest researcher from the University of Lyon worked with the Optical Technology Division to develop methods to calibrate instruments used in Earth remote sensing and assessing the effects of measurement uncertainties on the data.

The Optical Technology Division has a long-term collaboration with the Université de Paris Sud on the analysis of ultrahigh resolution infrared spectra of atmospheric molecules. Of special interest are molecules involved in the ozone destruction cycle as well as other pollutant molecules. Recent work has been on the assignment and modeling of several infrared bands of chlorine nitrate which fall in the atmospheric window, which NIST is studying as part of the NASA project for the Upper Atmosphere Research Program (UARP).

The Optical Technology Division has started a new project to investigate and develop measurement methods and standards for photometry and colorimetry of light-emitting diodes (LEDs). The NIST work is linked to the standardization efforts by

several of the Commission Internationale de l'Éclairage (CIE) technical committees.

The Atomic Physics Division participates in experiments at the Institute Laue Langevin (ILL) to perform precision gamma-ray measurements on the NIST precision gamma-ray spectrometer.

The Atomic Physics Division works with the University of Orsay Laboratories on experiments and theoretical models dealing with the Bose-Einstein condensation of metastable helium. Due to the characteristic of the condensate atoms not being in the ground state, the unique feature of the experiment is the capability of detection of the atoms almost one by one, as soon as they hit a surface. These experiments are of interest both in the area of condensed matter physics and to provide an understanding of the collisions between metastable atoms in the condensate.

Germany

Several divisions within the Physics Laboratory have cooperative activities with Physikalisch- Technische Bundesanstalt (PTB), including:

- The Optical Technology Division of the Physics Laboratory, which collaborated with PTB for an intercomparison of the reflectance scale and a CIPM reflectance key comparison. This included the comparison of detector-based irradiance scales, using a common high-temperature black body radiator at PTB.
- The Ionizing Radiation Division has cooperated with PTB in neutron dosimetry in various activities for three international comparison exercises of fluence measurements that are being carried out by the Neutron Measurements Section of the Consultative Committee on Ionizing Radiation (CCRI).
- Also in the Ionizing Radiation Division is a calibration service for protection-level beta-particle sources and instrumentation that has been in place for several years. The measurement system is automated, and capable of measuring extremely low absorbed-dose rates. The second-generation beta-particle secondary standard system, which includes the isotope ⁸⁵Kr, is now utilized routinely for calibrations and research into standard extrapolation-chamber data-handling techniques. The sources were calibrated both at PTB and at NIST, allowing a direct intercomparison of calibrations. The systems are also being used for the dosimetry characterization of a photo-stimulatable luminescence-phosphor imaging system. The standardized

techniques developed at PTB and NIST are now included in an International Organization for Standardization (ISO) draft standard and are being implemented in the NIST calibration service.

- PTB scientists also cooperate with NIST in providing training courses for technicians and engineers from industry here at NIST in the general area of optical radiation measurements.

The Optical Technology Division and the Max-Planck Institute for Quantum Optics in Garching work together in the area of coherent vibrational control. Experiments have included monitoring population distributions excited by broadband five-micrometer femtosecond pulses in W(CO)₆ dissolved in *n*-heptane. Observations were made of a distribution of vibrational state excitation using standard infrared pulses available from the instrument at the Max-Planck Institute. Future studies will include those to develop methods for precisely exciting high overtones of condensed-phase vibrations to efficiently cleave specific molecular bonds. These methods could enable future use of tailored laser pulses to produce new or previously unknown molecular species.

The Time and Frequency Division collaborates with the Max-Planck Institute on studies toward the development of a new generation of atomic clocks. The collaborative studies have demonstrated optical frequency standards with a microwave output, with the potential for performance well beyond atomic clocks currently in use. The potential uncertainty of the optical clock is one part in 10¹⁸, a factor of 1000 times better than today's best standards

The Atomic Physics Division has discussed the development of a cooperative project with the University of Hamburg in the area of quantum nanosystems. Preliminary discussions have centered on quantum nanocrystals.

A research team involving the Ionizing Radiation Division, with Harvard University, Los Alamos National Laboratory, and Hahn-Meitner Institute in Berlin demonstrated the magnetic trapping of neutrons for the first time. This work is essential to the improved precision in the measurement of the neutron lifetimes, an important parameter for understanding the weak nuclear force and the creation of matter during the Big Bang.

The Atomic Physics Division and the Ruhr University in Bochum collaborate on studies involving spectral line shape parameters. This contributes to the on-going compilation of data on line shape parameters of atoms and atomic ions in the

gas phase, as well as radiative lifetimes of atomic and ionic levels.

Hungary

The Optical Technology Division completed a collaborative project with the Hungarian National Office of Measures, under the U.S. - Hungarian Mobility Grant Program. The project, "Comparison in the Field of Transmittance Measurement and Uncertainty Analysis", compared measurements between the two groups in the wavelength range of 210 nm to 280 nm on metal filters in the density range of 0.01 to 0.02. For this range, the results demonstrated an agreement within 0.0012 to 0.0002 transmittance units, which is better than the combined, extended uncertainty for $k=1$. Intercomparison measurements in the wavelength range of 300 nm to 1100 nm on absorbing glass filters in the density range of 0.3 to 4 also show similar agreement.

India

The Optical Technology Division had a joint project with the National Physical Laboratory (NPL) in New Delhi on optical property studies. The project, supported by the U.S. - India Fund (USIF), dealt with the determination of total spectral reflectance and total spectral transmittance in the infrared region of various materials in the form of films and bulk samples. The collaboration involved the development of a new instrument for spectral diffuse reflectance and transmittance measurement.

Italy

The Optical Technology Division has collaborated with the Istituto di Metrologia "G. Colonnato" (IMGC) in Turin on spectral emissivity intercomparisons.

The Atomic Physics Division, together with the Observatory of Palermo (Italy), and with other U.S. partners, have developed a method to measure the remote temperature of hot plasmas. A team of scientists from NIST, the Harvard-Smithsonian Center for Astrophysics, the Naval Research Laboratory, the Observatory of Palermo (Italy), the National Aeronautics and Space Administration (NASA) Goddard Space Flight Center, the Massachusetts Institute of Technology (MIT), and the Lawrence Berkeley National Laboratory have worked together on an experiment that took place at the NIST Electron Beam Ion Trap (EBIT) facility to assist NASA scientists in measuring the temperature of hot plasmas. Precisely-controlled x-ray spectra from highly ionized iron and krypton atoms were produced by using an intense, monoenergetic electron beam threaded through a cryogenic ion trap. The highly ionized atoms were held at a temperature of approximately 5 million Kelvin, while x-rays were

measured with a prototype microcalorimeter detector similar to those being developed for future space missions.

The Time and Frequency Division collaborates with the Politecnico di Torino, along with the Jet Propulsion Laboratory (JPL), the University of Colorado, and the Harvard-Smithsonian Center for Astrophysics on a NASA-funded project, Primary Atomic Reference Clock in Space (PARCS). This is a NIST-led program, whose objectives are to test certain aspects of relativity theory, to improve upon the realization of the second, to study the performance of the Global Positioning System (GPS) clocks, and to study the dynamics of atoms in microgravity. PARCS will be used to test gravitational theory, study laser-cooled atoms in micro-gravity, and explore ways to improve the accuracy of timekeeping on Earth. Atoms in microgravity can be slowed to speeds significantly below those used in atomic clocks on Earth, providing a predicted 10-fold improvement in clock accuracy. The current U.S. standard, the NIST-F1 clock, is accurate to within one second in 30 million years. The PARCS space clock will be compared continuously to the hydrogen maser, a fundamentally different clock to provide a test of an Einstein theory that predicts that two different kinds of clocks in the same environment will keep the same time. To measure gravitational frequency shift, comparisons will be made between the space clock and a clock on Earth. Signals conveyed to the ground from such space clocks someday might serve as an international time standards. The mission is scheduled to fly on the International Space Station in 2006.

Jamaica

The Time and Frequency Division has held preliminary discussions with the Bureau of Standards of Jamaica on defining equipment and laboratory requirements for a National Time and Frequency capability in Jamaica.

Japan

The Optical Technology Division collaborates with Kanazawa University on the analysis of dimethylphosphonate. The collaboration is part of a joint National Science Foundation (NSF) – Japan Society for the Promotion of Science (JSPS) project to explore the possibility of studying information transfer between functional groups in conjugated organic systems using the experimental technique of Fourier transform microwave spectroscopy.

The Time and Frequency Division works with the Communications Research Laboratory (CRL) in Tokyo on frequency standards. The joint project was to develop an improved version of NIST-7, the U.S. primary frequency standard. The objectives were to

construct an optically-pumped standard with an uncertainty comparable to that of NIST-7, to compare this new standard with NIST-7, and to improve a number of subsystems allowing for more rapid, automated evaluation of systematic frequency offsets. Major improvements made during the project included a more robust diode-laser system for optical state preparation and detection, new servo-control and monitor software using a more flexible object-oriented approach, identification of a number of smaller source of systematic offset, and improved modeling of several of the larger systematic frequency shifts. Improvements made to the new standard during this development project have now been incorporated into NIST-7.

The Physics Laboratory has several collaborations with the National Metrology Institute of Japan (NMIJ)

- The Quantum Physics Division works with NMIJ to develop a portable iodine-stabilized laser (Nd:YAG-SHG). Frequency comparisons are continuing to establish the laser as a practical length standard.
- The Atomic Physics Division collaborates with NMIJ on studies on thin films by x-ray reflection. The target is to establish its standards for industry and for an international Key Comparison.
- The Atomic Physics Division also works with NMIJ on fine angle measurements by x-ray. Methods are being developed in x-ray and neutron diffraction techniques to measure small angles, and to apply the technique to measure x-ray wavelengths precisely, referring to the lattice constant as the standard.
- The Optical Technology Division works with NMIJ on absolute detector-based temperature determination of high-temperature eutectic points. The cooperation involves absolute radiometric temperature determination of the freezing/melting points of Ir-C and Re-C eutectics and to develop applications of these fixed-point blackbodies for realization and maintenance of spectral irradiance and radiance scales as well as of photometric units.

The Netherlands

The Quantum Physics Division and the Institute for Plasma Physics in Nieuwegin cooperate on studies involving cooling and trapping of cold molecules. The interaction of molecules with an electric dipole moment are observed with time-varying electric fields, and using these fields to focus, to slow down, to trap, and to store molecules. JILA/NIST uses these potentials in ultrahigh resolution spectroscopy,

cold-molecule collisions, and precision measurements.

The Electron Physics Group of the Electron and Optical Physics Division has collaborated with the Research Institute for Materials at the University of Nijmegen to make an artifact that bridges measurements between the micrometer and the nanometer. This artifact relies on a technology called laser-focused atomic deposition. In a modified process of the original, two arrays of lines with slightly different spacing are superimposed, creating a Moiré pattern with periodicity of 44.46 μm . When viewed through polarizers, this pattern is clearly visible with an optical microscope. The result of this process is that nanometer-scale and micrometer-scale patterns are created on a single substrate in coherent registration with each other. Ongoing investigations indicate that the dimensions of the patterns may be accurately traced to an atomic frequency, so that the patterns can be used as absolute length standards on the nano- and micro-scales.

Portugal

The Atomic Physics Division has continued joint work with the Center of Atomic Physics at the University of Lisbon on the application of relativistic atomic structure theory to atomic collisions. The work will benefit heavy ion fusion research in both the U.S. and in Portugal.

Poland

The Atomic Physics Division has a joint research project with the Nicholas Copernicus University in Torun. The joint research has focused on modeling on the electrical and optical properties of quantum nanostructures. A variety of software tools have been developed for modeling in several systems of quantum nanostructures, including quantum dots, nanocrystals, and quantum wires.

A representative of the Electron and Optical Physics Division presented an invited talk on "Solutions and Vortices in Bose-Einstein Condensates" at the 5th International Conference on Quantum Optics in Koscielisko, under the provision of research grant PAN/NIST 98-340, awarded to NIST by the U.S.-Poland Maria Skodowska-Curie Joint Fund.

Russia

The Physics Laboratory together with the Applied Physics Institute of the Russian Academy of Sciences (RAS) is developing a sub-millimeter wave spectroscopy system. The new instrument, which significantly improves upon plasma diagnostics, measures the absorption of terahertz frequency radiation to clearly identify a broad range of plasma components, such as radicals, ions, and molecules.

The Ionizing Radiation Division has participated in the Russian American Solar Neutrino Experiment (SAGE), on the solar neutrino flux. The data from the solar neutrino flux measurements have been analyzed for their implication that neutrinos burned in the sun. This is utilizing a low-background spectrometer with potential applications in neutron dosimeter, low background counting, and fundamental physics. The data analysis will be used to better understand the discrepancy between measurements of the solar neutrino flux and the predictions derived from the Standards Solar Model.

The Time and Frequency Division and the Novosibirsk State University collaborated to develop a new concept for two-dimensional sideband Raman cooling and Zeeman state preparation in an optical lattice. The development of this concept was driven by the need to improve the uncertainty of the primary cesium-fountain frequency standards through the reduction of transverse velocities of laser-cooled atoms. The approach suggested in their recent paper appears to be both simpler and more effective than previously proposed methods and has two significant advantages: the method only requires laser beams transverse to the atomic fountain axis, and the cooling process simultaneously pumps atoms into the desired ground-state energy level.

A representative from the Optical Technology Division visited the All-Russian Research Institute for Optical and Physical Measurements (VNIIOFI) to study their photometric measurement facility and discuss an international project on the realization of the lumen, in which NIST is collaborating.

The Ionizing Radiation Division has employed electron paramagnetic resonance (EPR) for retrospective biological dosimetry studies. EPR has been applied to tooth enamel to gain knowledge on dose-effect relationships for radiation-induced stochastic and deterministic effects. The acquisition of data on the dosimetric effects from populations with chronic radiation exposure are of special interest, such as Chernobyl and the Techa River. Results have been obtained for members of the Techa riverside population from 1945 to 1949, who were exposed to radioactive waste from the Mayak nuclear weapon plant near the Techa River in the Urals.

Spain

The Electron and Optical Physics Division had a joint collaboration with the Research Center for Energy, Environment, and Technology (CIEMAT) under the U.S.-Spain Joint Committee for Scientific and Technology Cooperation. The collaboration involved experiments on a ultraviolet/x-ray linear camera that used phosphor screens for plasma diagnostics.

As part of an ongoing scientific collaboration between CIEMAT and the Ionizing Radiation Division, several joint reference standards have been produced. The Radioactivity Group delivered to CIEMAT several pieces of jointly-developed radioactivity calibration equipment, including a state-of-the-art 4π alpha/beta pressurized gas-flow proportional counter system with dual sodium-iodide detector, an alpha/beta liquid scintillation counter system with a large sodium iodide well detector, and a complete anti-coincidence logic system for use with these detector systems. The equipment is used to perform direct calibrations of many radionuclide measurements using the particle photon coincidence and anti-coincidence technique. Having identical systems at CIEMAT and at NIST makes it easier to share and develop new measurement techniques and facilitate the comparison of measurement results.

The Atomic Physics Division is continuing joint work on the application of relativistic atomic structure theory to atomic collisions with the University of Lisbon, Center of Atomic Physics.

Taiwan

A representative from the Quantum Physics Division attended the Bose Einstein Condensation (BEC) School/Symposium at the National Tsing Hua University in Hsinchu in December 2000. The aim of the symposium was to foster discussions between groups in the U.S. and Taiwan.

United Kingdom

NIST and the National Physical Laboratory (NPL) of the United Kingdom (U.K.) have undertaken a comparison of scales for regular transmittance and reflectance in the mid-infrared part of the spectrum. This is the first time an international intercomparison of infrared spectrophotometry scales at a NMI level has been performed. The comparisons have been carried out as "Supplementary Comparisons" of the Consultative Committee for Photometry and Radiometry (CCPR) of the Bureau International des Poids et Mesures (BIPM). The transmittance comparison was performed using a Schott NG11 glass as the comparison artifact. Measurements were carried out at seven wavelengths between 2.5 μm and 5 μm where the gradient of the transmittance profile was flat. The reflectance comparison was performed using three different artifacts – a non-overcoated front-aluminized glass mirror, a NiCr coating on a glass substrate, and an uncoated plate of Schott BK7 optical glass – to cover a range of reflectance values. Measurements were carried out for near-normal incidence between 2.5 μm and 18 μm .

The Quantum Physics Division collaborates with the Institute for Gravitational Physics at the University of Glasgow. The work involves studies in geophysics

using the Advanced Laser Interferometric Gravitational-Wave Observatory (LIGO) gravitational wave antenna. The recent focus of the collaboration is in the area of suspensions and flexures and schemes for enhancing low frequency isolation by increasing the mechanical period and energy of suspended systems.

The Atomic Physics Division collaborates with Oxford University on atom interactions in optical lattices and cold atom interactions (Bose-Einstein collisions). The collaboration benefits the NIST program on quantum information.

The Ionizing Radiation Division, together with the University of Nottingham and the Rutherford Appleton Lab, collaborates on the Polarized Spin Filter program, and the neutron polarization initiative at Rutherford Appleton laboratory. The NIST polarized ^3He program seeks to improve the availability of polarized ^3He for applications in fundamental physics, materials science, and medicine.

The Optical Physics Division collaborates with Oxford University using far-infrared laser-magnetic-resonance (FIR-LMR) spectroscopy to make observations of bending vibration spectra of a number of important carbon-carbon molecules. The improved sensitivity of FIR-LMR spectroscopy allows the detection of transitions about 100 times less intense than a pure rotational or electronic transition and the method is especially useful when the number density of such highly reactive species is low.

A representative from the Electron and Optical Physics Division worked with Oxford University on a review of the evolution of the theoretical understanding of Bose-Einstein Condensation (BEC) research, which traced experiments performed since the beginning ones in 1995. BEC is a phase transition in which virtually all atoms of a gas are forced to occupy the same quantum state. BEC provides a practical mechanism for the production of macroscopic numbers of atoms in identical, well-defined quantum states.

In collaboration with the University of Cambridge, the Thin Film Magnetism Group of the Electron and Optical Physics Division has used the NIST Scanning Electron Microscopy with Polarization Analysis (SEMPA) facility to directly image the magnetic domain structure of mesoscopic ring magnets. The micrometer-sized rings and discs, patterned out of Co thin films, are the basis for new types of nonvolatile, magnetic random access memories. The SEMPA measurements provided the first images of various magnetic structures in these patterned films. Some of

the magnetic structures agreed with predictions based on earlier non-spatially-resolved magnetization measurements of these films, but additional, unexpected domain wall structures were also observed. Knowledge about the nanoscale magnetic

structure of the various magnetic states and how the states switch from one to another is a critical part of determining whether these patterned magnetic structures will make useful magnetic memories.

Multilateral Activities

Bose-Einstein Condensate Summer School

Representatives from the Electron and Optical Physics Division, and the Quantum Physics Division attended the 2002 Bose-Einstein Condensation (BEC) Summer Programme at the European Centre for Theoretical Studies in Nuclear Physics and Related Areas, in Trento, Italy. The program, sponsored by the European Science Foundation, brought together more than 100 participants from 15 different countries for discussion and collaborative work on problems of BEC and dynamics of degenerate quantum gases.

European Union (EU)

The Laser Cooling and Trapping Group of the Atomic Physics Division participates as a member of the Cold Quantum Gases (CQG) European Union Network, working on the project "Preparations and Applications of Quantum-Degenerate Cold Atomic/Molecular Gases." The project has as its primary objectives to advance the field of atom optics, degenerate quantum gases, and Bose-Einstein condensation (BEC). There are nine institutions represented in the Network: the National Institute for the Physics of Matter (INFN) in Pisa, Italy; the Center for Theoretical Physics of the Polish Academy of Science (CFT-PAN) in Warsaw, Poland; the École Normale Supérieure (ENS), in Orsay, France; Vrije Universiteit (VU) in Amsterdam, the Netherlands; University of Hannover (UHANN) in Hannover, Germany; the University of Innsbruck (UINNSBRUCK) in Innsbruck, Austria; Oxford University in Oxford, the United Kingdom, and NIST in Gaithersburg, Maryland, USA. The Network was established in 2000 and will exist for 4 years. NIST's participation as a member of the network has been by exchanging ideas and expertise and providing training opportunities for students and post-docs.

International Atomic Energy Agency (IAEA)

A representative of the Ionizing Radiation Division visited IPEN and the Institute for Energy and Nuclear Research, Brazil National Nuclear Energy Agency in São Paulo, in September, 2002 at the request of the International Atomic Energy Agency (IAEA), to advise and help local scientists in radionuclide standardization in the nuclear metrology lab, and to evaluate their lab capabilities and measurement programs.

A representative of the Ionizing Radiation Division attended an IAEA meeting on the Coordinated Research Program (CRP) on "Development of Radioactive Sources". While at the meeting at the Polish Radioisotope Center (POLATOM) in Warsaw, collaborations were continued on the development of NIST's Triple to Double Coincidence Ratio (TDCR) detection systems and studies of liquid scintillation counter deadtime effects.

A representative from the Ionizing Radiation Division collaborated on an IAEA publication "EPR – Tooth Biodosimetry", which is a guide that will impact electron paramagnetic resonance (EPR) dosimetry measurement methods used to collect data for human radiation risk.

Key Comparisons (KCs) and Other Intercomparisons

The Ionizing Radiation Division is participating in three international comparison exercises of the Consultative Committee on Ionizing Radiation (CCRI). NIST is leading a comparison of thermal neutron fluence measurements; the PTB is leading a comparison of fast neutron fluence measurements; and NPL in Teddington, U.K. is leading a neutron source emission rate comparison. For the thermal neutron comparison, a transfer instrument system was prepared, based on an active ¹⁰B ionization chamber. Measurements of neutron inelastic scattering in steel have been made in collaboration with Ohio University and Pennsylvania State. These measurements are needed for a better understanding of nuclear reactor pressure vessel damage estimation. Initial measurements with a spherical shell of 4 cm thickness were recently reported at the Nuclear Data 2001 meeting in Tsukuba, Japan.

The Optical Technology Division has been involved in a number of key comparisons (KCs), including spectral responsivity (from 200 nm to 1600 nm), spectral irradiance, aperture area, luminous intensity and luminous flux, spectral regular transmittance, and diffuse spectral reflectance. These intercomparisons form the underpinning of the Mutual Recognition Arrangement (MRA) verification process as described in Appendix C.

The Ionizing Radiation Division participated in an international intercomparison for absorbed-dose-to-water calibrations of Co-60 radiotherapy instruments.

Nuclear Cross Section Standards

The Ionizing Radiation Division is participating in studies of nuclear cross sections, together with the U.S. Cross Section Evaluation Working Group (CSEWG) and two international committees, the International Atomic Energy Agency (IAEA) and the Nuclear Energy Agency Nuclear Science Committee (NEANSC). Neutron cross section standards are important since almost all nuclear cross sections are measured relative to them. Any improvement in a cross section standard leads to improvement in all measurements that have been or will be made, relative to that standard. The NIST neutron cross section standards project has played a significant role in the improvement of the neutron cross section standards through both evaluation and experimental work. NIST is leading an effort that will result in a new international evaluation of the neutron cross section standards. This has involved motivating and coordinating new standards measurements, detailed examination of the standards database, and pursuing the extension of the standards over a larger energy range.

Other Multilateral Activities

The Atomic Physics Division, along with the University of Stockholm and the École Normale Supérieure et Université Pierre et Marie Curie in Paris, have collaborated to publish the new x-ray wavelength reference table. For the past 35 years, it has been a standard reference in the field. However, scientists engaged in precision x-ray wavelength measurements have recognized that important experimental and theoretical developments have created the need for a modern revision. This collaboration resulted in a new, comprehensive x-ray wavelength reference table that has been accepted for publication in *Reviews of Modern Physics* in early 2003. The last table was published in *Reviews of Modern Physics* by J.A. Bearden from Johns Hopkins University in 1967. The compilation contains K- and L- x-ray transition and absorption edge energies for all of the elements from neon to fermium and includes carefully selected and evaluated experimental data and trusted estimates obtained from state-of-the art theoretical procedures.

The Ionizing Radiation Division, along with the Statistical Engineering Division, led a collaborative effort with the International Committee on Radionuclide Metrology (ICRM) to develop and characterize a reference material for low-level radionuclides. An international group of experienced laboratories collaborated to develop a unique seaweed reference material for low-level radionuclides, such as Sr-90, Ra-226, Th-230, Th-232, U-234, and Pu-238. Seaweed is one of the most important oceanic biological sinks for a number of long-lived radionuclides, and their accurate

determination in seaweed specimens is essential for improving geokinetics modeling and assessing the spread of radionuclide waste repository contamination. However, lack of a seaweed standard for method validation and quality control in analytical measurements limits the reliability of the current analytical results and the data comparability among national and international laboratories. An interlaboratory comparison among experienced radioecology metrology laboratories will determine the mass activities of important radionuclides using a variety of radiochemical procedures and detection methods.

The Atomic Physics Division collaborates with the University of Paris, Harvard University, and the University of Stockholm on characterizing properties of nanoscale systems. Quantum mechanical and electromagnetic methods are being developed and applied for calculating the electronic and optical properties of quantum nanostructures and for modeling the optics of nanoscale objects. Such systems have a wide variety of technological applications, including semiconductor lasers and advanced semiconductor devices. Applications of nano-optics modeling include scanning near field optical microscopy for use in nanometer-scale optical metrology, single-molecule spectroscopy, and optical nanostructures for novel uses in atom trapping, quantum information and intradvice optical communications. Also, an experimental activity to generate and characterize novel types of nanoscale fractures on surfaces is underway at the NIST Electron Beam Ion Trap (EBIT) facility. Techniques such as Scanning Transmission Microscopy (STM), Atomic Force Microscopy (AFM), and photoluminescence are used to characterize the response of surfaces to highly charged ion beams. In order to understand the formation and decay of the "hollow atoms" that underly the production of the nanoscale features, x-ray spectroscopy is used to observe the surfaces during ion bombardment.

Awards

Nobel Prize in Physics: Dr. Eric Cornell was named on October 9, 2001 as one of the three winners of the 2001 Nobel Prize in Physics, along with Carl E. Wieman of the University of Colorado at Boulder and Wolfgang Ketterle of the Massachusetts Institute of Technology. The trio was recognized for their work creating a new form of matter that occurs at just a few hundred billionths of a degree above absolute zero. The research is predicted to bring revolutionary applications in fields including precision measurement, quantum information, and nanotechnology. Predicted in 1924 by Albert Einstein, who built on the work of Stayendra Nath Bose, the Bose-Einstein Condensate (BEC) occurs when individual atoms meld into a "superatom"

behaving as a single entity at just a few hundred billionths of a degree above absolute zero. Cornell and Wieman first observed the condensate in June 1995. Ketterle achieved the new state of matter two months later and made some of the first studies of its properties. The BEC allows scientists to study the quantum physics as if they are looking through a giant magnifying glass. Its creation established a new branch of atomic physics that has provided a treasure-trove of scientific discoveries. Future applications of the BEC may include its use in nanotechnology and precision measurement.

Dr. Barry N. Taylor, Manager of the Fundamental Constants Data Center in PL, received the Committee on Data for Science and Technology (CODATA)

Prize 2000 at the 17th Biennial International CODATA conference held in October 2000 in Baveno, Italy. The CODATA Prize is a newly established award to recognized outstanding achievement in the world of scientific and technical data. Taylor, the first recipient of the prize, was chosen for his many contributions during the last 35 years to improving our knowledge of the values of the fundamental physical constants. CODATA was established in 1966 as an interdisciplinary committee of the International Council for Science (ICSU), which was formerly the International Council of Scientific Unions. CODATA seeks to improve the quality, reliability, processing, management and accessibility of data important to science, and technology.

International Committee Participation

Comité International des Poids et Mesures (CIPM)

Staff members of PL have extensive involvement and serve in key positions in several Consultative Committees of the CIPM including:

- the Consultative Committee on Photometry and Radiometry (CCPR), including Working Group 5 on Radiation Thermometry;
- the Consultative Committee on Length (CCL);
- the Consultative Committee on Electricity and Magnetism (CCEM), including the working group on Key Comparisons;
- the Consultative Committee on Temperature (CCT), including Working Group 5;
- the Consultative Committee on Time and Frequency (CTF), including the Subcommittee on International Atomic Time, and the working group on Two-Way Satellite Time and Frequency Standards; and
- the Consultative Committee on Ionizing Radiation (CCRI).

International Committee for Weights and Measures IUPAC)

The Atomic Physics Division participates in meetings of the Working Group on the Avogadro Constant of the International Committee for Weights and Measures (IUPAC).

Institute of Electronics and Electrical Engineers (IEEE)

The Ionizing Radiation Division participates in the Institute of Electronics and Electrical Engineers (IEEE) Nuclear and Plasma Science Society's ADCOM meeting as an elected technical advisor as per NIST/Department of Energy (DoE) interagency agreement.

International Electrotechnical Commission (IEC)

The Ionizing Radiation Division participates as a U.S. delegate and work group convener in the development of international standards of the International Electrotechnical Commission (IEC).

International Organization for Standardization (ISO)

The Ionizing Radiation Division participates in working group meetings of ISO Technical Committee TC85/SC2/WG2.

International Commission on Radiation Units and Measurements

The Ionizing Radiation Division participates in meetings of the International Commission on Radiation Units and Measurements (ICRU). Activities include revision/approval of reports to improve and harmonize international standards and protocols in radiation dosimetry that affect NIST calibration programs.

International Workshops and Conferences

The Eighth International Conference on New developments and Applications in Optical Radiometry (NEWRAD) was held in Gaithersburg in May 2002. Co-sponsored by the Optical Technology Division and the BIPM, the conference serves as a forum for discussions of advances in radiometry and

photometry, with applications in remote sensing, and metrology. Represented at the meeting were 22 countries, with presentations on advances in absolute radiometry, photometry, remote sensing, photolithography and UV processing.

Materials Science and Engineering Laboratory

Dr. Leslie E. Smith, *Director*

The Materials Science and Engineering Laboratory provides technical leadership and participates in developing the measurement and standards infrastructure related to materials critical to U.S. industry, academia, government, and the public. Materials science and engineering programs at NIST cover a full range of materials issues from design to processing to performance. A unifying aim is to acquire the knowledge and tools needed for intelligent manufacturing methods with real-time automated process controls. Separate research initiatives address ceramics, metals, polymers, composites, and superconductors. This research supports efforts of U.S. industry to develop reliable, low-cost manufacturing methods for producing tailor-made materials and products with superior properties. Through laboratory-organized consortia and one-to-one collaborations, NIST's materials scientists and engineers work closely with industrial researchers. Examples include work on improved processing of rapidly solidified metal powders, polymer composites, ceramic machining, aerospace alloys, and non-destructive evaluation sensors for aluminum and steel manufacturing. The laboratory also is strengthening its relationships with manufacturers of high-technology products, the major users of advanced materials.

Bilateral Activities

Australia

A representative from the NIST Center for Neutron Research visited Sydney to consult on the small-angle neutron scattering (SANS) instrument at Australia's Replacement Research Reactor.

A representative from MSEL collaborates with several Australian universities on biomedical materials development. These include the University of Western Australia, Curtin University, and the University of Adelaide.

Researchers from NIST, the University of Melbourne, Australia, and the University of Missouri at Columbia have demonstrated a new form of neutron radiography that produces greatly enhanced images of fine structural details in test samples with relatively low levels of radiation. Conventional radiography, using either x-rays or neutrons, works by detecting the absorption of the radiation as it passes through different materials. But if two materials have very similar absorption characteristics or the feature under inspection is very small, radiographs often show very little detail. In recent years, researchers have explored a more subtle effect called phase-sensitive imaging. As radiation passes through a specimen, the phase of the wave can shift at the boundary between materials of two different densities, just as light diffracts when passing through a glass of water. Because the phase-shift effect is often much stronger than the absorption effect, images based on the phase difference of the emerging waves can show much greater detail, particularly of boundaries or edges, with relatively smaller doses of radiation. Phase-contrast x-ray images have been studied for several years, producing dramatic images of tissue specimens that clearly show fine details. The experiments at NIST are the first to demonstrate

the same phenomenon and achieve equally dramatic image enhancement using neutron beams, which have broad industrial applications in materials research.

The Materials Reliability Division continues to work with researchers at the Commonwealth Scientific and Industrial Research Organization (CSIRO, West Lindfield, Australia) on mechanical property measurements using non-destructive techniques. A CSIRO representative spent 3 weeks at NIST in 2002 measuring the mechanical properties of nanocomposite hardness coatings made at CSIRO using the SAWS (Surface Acoustic Wave Spectroscopy) technique.

Canada

Representatives from the Center for Neutron Research participated as instructors for the National Research Council Canada's (NRCC's) Summer School on Neutron Scattering in June 2001 and June 2002 at Chalk River, Ontario.

China

A representative from MSEL held discussions with the University of Hong Kong to discuss mutual research on biomedical materials.

Croatia

The Materials Reliability Division cooperates with the Mechanical Engineering Faculty in Slanoski Brod, Croatia on a joint project in weld repair, started under the U.S. – Croatia Joint Fund. The formal joint project has been completed, but informal cooperation has continued in several areas including the investigation of spatter formation and porosity.

Denmark

The Metallurgy Division collaborates with the Denmark National Research Laboratory (RISØ) in Copenhagen on electron microscopy experiments.

France

The Center for Neutron Research has an on-going collaboration with scientists at Institute Laue Langevin (ILL) in Grenoble, on spin echo studies. The measurements involve high-energy spin wave dispersions on the IN-8 spectrometer, one of the best thermal triple-axis instruments in the world. Recent experiments have also used the IN-15 Spin Echo Spectrometer to investigate the vortex dynamics in niobium. This experiment required a position-sensitive detector on the instrument, which was not yet available on the NIST Center for Neutron Research (NCNR) spin-echo spectrometer. The experiment was carried out in collaboration with Brown University and Hahn Meitner Institute.

Germany

MSEL and the Bundesanstalt für Materialforschung und – Prüfung (BAM) collaborated on the production of a joint reference material for porosity, the first to be completed under the Project Annex to the NIST/BAM/ Physikalisch-Technische Bundesanstalt (PTB) Memorandum of Understanding (MOU). During the ceremony to install the new Director of BAM in August of 2002, the Director of NIST presented a ceremonial bottle of the porosity standard to the new Director of BAM. The Director of MSEL also attended the event. Besides the porosity Standard Reference Material (SRM), NIST and BAM are cooperating on standards for particle size distribution, and reference film systems for mechanical test methods.

The Materials Reliability Division (MRD) cooperates with the Max-Planck Institute für Metallforschung (MPI) in Stuttgart on transmission electron microscopy (TEM) experiments. A representative from MRD had an extended stay at MPI from October 2000 to June 2001 to refine strain measurement methods using convergent-beam electron diffraction (CBED) patterns, conducting electromigration tests, and working on thin-film deformation mechanisms. An additional area of study was on measuring strain in copper interconnects. The feasibility of acquiring electromigration data at elevated temperatures within the TEM was demonstrated.

MSEL has additional collaborations with MPI including studies on interfaces and in vitreous bonded ceramics, and on the chemical properties of silicon nitride.

The NIST Center for Neutron Research (NCNR) has collaborated with Forschungszentrum Jülich on experiments in neutron spin echo spectrometry

The Ceramics Division has a continuing collaboration with the Fachinformationszentrum in Jülich on the Inorganic Crystal Structure Database (ICSD). This database is a comprehensive collection of crystal structure data of inorganic compounds containing more than 57,000 entries and covering the literature from 1915 to the present. The materials research community uses crystallographic data models on a daily basis to visualize, explain, and predict the behavior of chemicals and materials. Access to reliable information on the structures is an invaluable aid to researchers. Recent work has concentrated on the re-design of the database, and includes enhanced features for the characterization of materials based on lattice and chemistry search modules, three-dimensional visualization, and powder pattern simulation of inorganic structures.

A representative from the NCNR consulted with Bruker Scientific Company in Karlsruhe on the development of x-ray scattering equipment.

The Materials Reliability Division (MRD) has a collaboration with the Fraunhofer Institute for Nondestructive Testing (IZFP) in Saabrücken on nanoscale mechanical property measurements. The measurements are being made with a non-destructive method to measure elastic properties of materials with sub-micrometer spatial resolution, called atomic force acoustic microscopy (AFAM). A representative from MRD visited IZFP in both 2001 and 2002 for interlaboratory comparison testing, information exchange, and identification of methods to improve the technique. In addition, a guest scientist from IZFP is working with MRD to further this collaboration.

The Materials Reliability Division collaborates with the Institute of Physical Chemistry at the University of Heidelberg on laser-generated pulses. The collaboration involves the comparison of theoretical and experimental results for the measurement of non-linear pulses generated by lasers, and the detection of extremely high amplitude surface acoustic wave pulses. Recent studies have been on a comprehensive study of non-linear surface waves in crystalline silicon.

Israel

The Materials Reliability Division is working with with researchers at Ben-Gurion University in Beer Sheva on the development of a mathematical model of gas metal arc welding. This collaboration was under the auspices of the grant given by the Binational Science Foundation (BSF).

The Metallurgy Division has collaborated with Technion - Israeli Institute of Technology in Haifa, on microstructure and mechanical properties of multi-layer materials.

Italy

A representative from NCNR discussed a possible collaboration with the University of Rome on studies of aluminum-doped magnesium boride. The aim would be to study phonon density of states as a function of aluminum doping using inelastic neutron scattering.

Japan

The Polymers Division and the National Metrology Institute of Japan (NMIJ) are continuing their joint work on polymer analysis. The work includes developing a method to measure the distribution of a polymer's relative molecular mass.

The Polymers Division has a joint study on new non-linear optical polymers, together with the Polymer Science and Engineering Department at the Kyoto Institute of Technology. During this work, new polymers have been designed and studied, which have improved non-linear optical properties by studying composite and co-polymers.

The Polymers Division has discussed a new collaboration with Kyushu University in the area of glass-forming liquids and in the area of gelation in nanoparticle dispersions. Another potential area of cooperative research would be on silica-based counterparts to bucky-tube nanofibers that form gels in polymer matrices. These materials, which are derived from the volcanic ash near Kyushu, have potential applications in a number of polymer blend projects.

NCNR is part of a collaboration on neutron scattering experiments that also includes Pennsylvania State University, Brookhaven National Laboratory, the Japanese Institute for Solid State Physics (ISSP), the University of Tokyo, and Tohoku University. The experiments in February of 2001, at the Japanese Atomic Energy Research Institute in Tokai, involved mapping the sequence of structural phase transitions in a single crystal of a ferroelectric compound at room temperature as a function of an applied electric field.

Korea

A representative from the Ceramics Division visited the Korea Institute of Science and Technology, Korea University, and Hanyang University to discuss collaborations on materials standards.

Norway

A representative from the Metallurgy Division was a participant in a dissertation committee at the Norwegian Institute of Technology, Trondheim, with support from the Norwegian University of Science and Technology Department of Electrochemistry.

Russia

A representative from NCNR collaborates with the Institute of Mathematics and Mechanics, Russian Academy of Sciences (RAS), in Ekaterinburg on the investigation of hydrogen diffusion in intermetallics and to perform other nuclear magnetic resonance (NMR) experiments.

The Metallurgy Division has submitted a proposal with the U.S. Civilian Research and Development Foundation for the Newly Independent States (CRDF), together with the Physico-Technical Institute, Russian Academy of Sciences in St. Petersburg. The proposed project is on the "Development of Ohmic Contacts for Nitride Semiconductor Devices".

Singapore

The Ceramics Division and the Data Storage Institute of Singapore carry out joint research in nanotribology. Nanotribology deals with the subject of adhesion, stiction, friction, and lubrication at the nanometer scale. As components shrink in size, adhesion and stiction become an increasingly important issue. Durability of moving parts in sensors, actuators, and accelerometers govern the component life. Means to control these issues are under active research both in industry and government labs. Accurate and precise measurement methods of nanometer-scale phenomena and microscale devices to measure nanometer components were identified by workshop participants as one of the key needs to further advancement in these technologies. The collaboration is carried out under the MOU signed in March of 2000 between NIST and the Data Storage Institute.

Spain

MSEL has on-going joint projects with the University of Seville and with the University of Extramadura on dental ceramic materials.

South Africa

MSEL has been working with the University of Capetown on a project, "Industrial Applications of Quasicrystal Films". The purpose is to investigate the properties of quasicrystal phase coatings for industrial applications, including studies of their friction and wear properties, with the project being funded by the Defense Advanced Research Projects Agency (DARPA). This work is also in collaboration

with Mintek, a quasi-government research organization of Johannesburg, which is supplying some of the materials for the study.

Switzerland

A representative of the Ceramics Division served as an external referee on a thesis defense from the University of Geneva. The research topic dealt with high phase equilibria on superconducting tapes.

The Ceramics Division and the Paul Scherrer Institute (PSI) in Villigen have a collaborative project to study the microstructure of alloy-based thermal barrier coatings (TBCs) using small-angle neutron scattering (SANS). The experiments are part of a continuing collaboration on the microstructure characterization of metal-based TBCs and their comparison with ceramic TBC microstructures. The main application lies in insulating turbine components from increasingly high operating temperatures, allowing the development of more efficient turbines for electric power generation and jet aircraft.

Taiwan

Representatives from NCNR are acting as advisors for the Institute for Nuclear Energy Research (INER) in Taipei, where a new research reactor (TPR-II) is

being planned. Besides advising on reactor design, NCNR staff continues to give advice on the plans for new instruments, such as SANS.

Thailand

A representative from MSEL does collaborative research with the National Metals and Materials Technology Center in Bangkok. The research concerns brittle coatings of ceramics.

Turkey

A representative of the Metallurgy Division visited the Izmir Institute of Technology in July 2001, to collaborate on a paper regarding aspects of metallurgy.

United Kingdom

The Materials Reliability Division collaborates with NPL in developing Pyroceram 9606 as an international standard for thermal conductivity at high temperatures. Measurements of the material at NIST will be compared with those at NPL in order to develop better measurement methods and to establish a partnership on steady-state measurement of thermal conductivity and for future Standards Reference Material (SRM) collaborations.

Multilateral Activities

Asia-Pacific Economic Cooperation

MSEL has been working with the Asia-Pacific Economic Cooperation (APEC) on the development of a Network for Materials Evaluation Technology among the member economies in APEC. The concept was proposed by a representative from the Korea Research Institute of Standards and Science (KRISS), with whom NIST has an MOU. The formation of the network has been endorsed by the APEC Industrial Science and Technology Working Group. The objective of the project is to build a cooperative framework for materials evaluation and testing, and to facilitate technology transfer among APEC member economies.

Versailles Project on Advanced Materials and Standards (VAMAS)

The Versailles Project on Advanced Materials and Standards (VAMAS) was conceived in 1982 following an economic summit in Versailles, France. Canada, France, Germany, Italy, Japan, the United Kingdom, the United States, and the European Community are partners in the effort. VAMAS supports trade in high-technology products through international collaborative research that leads to codes of practice and specifications for advanced materials. The research embraces all aspects of science and technology related to advanced materials

required as a precursor to the drafting of standards-materials technology, test methods, design methods and materials databases. In May 1999, NIST assumed the role of Secretariat of VAMAS for the following three years. During this time, a new Technical Working Area (TWA), "Thermal Properties of Thin Films", was established. The objective of this TWA is to evaluate measurement methods for determining thermal properties of thin ceramic films and coatings. A round robin was organized as the first TWA activity. The goal was to evaluate different methods of measuring thin-film thermal conductivity, with eighteen laboratories from the United States, Japan, Germany, China, and Korea participating.

Another new TWA on characterization methods for ceramic powders and porous materials has been formed within VAMAS to develop technical data on the size distribution and surface area of particles and porosity of unfired (green) bodies for use by standards-writing organizations. Standardized characterization methods can lead to improved performance and higher reliability of material such as advanced ceramics by eliminating chemical impurities and irregularly shaped or sized particles during raw materials processing and the intermediate stages of ceramic manufacturing.

Other Multilateral Activities

Together with the State University of New York (SUNY) Stony Brook and the Ruhr-Universität, Germany, MSEL researchers have characterized a new type of zeolitic materials: the lithosilicate RUB-29 built in part from LiO_4 building blocks. Neutron diffraction performed at NIST was essential for a complete structural determination for this material. Zeolites are minerals with molecule-sized pores. Different materials have different-sized pores. In the past few decades, chemists have learned to produce new zeolite analogs with a variety of properties. These zeolite materials are used widely for tasks ranging from the production of gasoline to medical oxygen to improved laundry detergents. The novel LiO_4 building units found in RUB-29 are more flexible than others previously employed and allow formerly impossible configurations of pores to be achieved.

In collaboration with diesel engine companies in the U.S., as well as participants from Germany and Japan under the auspices of the International Energy Agency (IEA), the Ceramics Division is evaluating methods for characterizing the contact fatigue behavior of ceramics under rolling and sliding conditions that simulate the cam roller followers, valves, and valve seats. An integral part of the this project is evaluating the effect of machine damage on contact reliability as well as possible interactions between machining damage and contact damage that may lead to premature failure. Reliability and cost-effectiveness are critical issues for implementing

International Committee Participation

MSEL participates in the Comité International des Poids et Mesures (CIPM) Consultative Committee on Mass and Related Quantity (CCM). Representatives from MSEL also participate in many other international committees including the International Organization for Standardization (ISO), acting as the chair of ISO TC 164-4P on impact standards, and the International Energy Agency (IEA).

International Workshops and Conferences

A workshop was held at NIST on June 26-27, 2001 to determine the next steps in the development of MatML, a Materials Markup Language, which will enable efficient transfer of materials data via the World Wide Web. The workshop was organized by representatives from the ceramics Division. Forty individuals from 7 countries participated, representing testing machine and instrument

ceramics in diesel engines. Ceramic components in engines serve under demanding conditions, characterized by high contact loads, elevated temperatures, and corrosive environments. To ensure a reliable service life, standard test methods are needed to evaluate the performance of candidate ceramics.

The Materials Reliability Division is working with the other NMIs that produce Charpy impact standards, those in Belgium and Japan, to compare the energy scales around the world, and to evaluate machine variables.

Awards

Winnie Wong-Ng, from the Ceramics Division, was elected in December 2000 as a Fellow of the International Centre for Diffraction Data. She was honored based upon her long-term, significant contributions to the x-ray powder diffractions data files. Wong-Ng has an international reputation in the field of x-ray diffraction and Phase equilibria. She is currently involved in the determination of complex phase diagrams pertinent to high T_c superconducting materials.

Sheldon Wiederhorn was awarded an Alexander von Humboldt Senior Research Award in 2001. The award enabled him to carry out collaborative research at the Technische-Hochschule in Darmstadt in the winter of 2001. The research was in the area of high-temperature structural ceramics and composites.

Representatives from NCNR participate in the International Symposium on Advanced Utilization of Research Reactors (ISAURR). The ISAURR promotes regional cooperation among the Asian research reactors and increased utilization of the neutron sources in the region.

manufacturers, materials and software companies, auto manufacturers, materials-related professional societies, government agencies, and the academic community. Extensive discussions showed enthusiastic support for the project and strong interest in drawing new parties into the development and trial of MatML.

Building and Fire Research Laboratory

Dr. Jack E. Snell, *Director**

The Building and Fire Research Laboratory (BFRL) enhances the competitiveness of U.S. industry and public safety through performance prediction and measurement technologies and technical advances that improve the life-cycle quality and cost effectiveness of constructed facilities. BFRL's efforts are closely coordinated with industry, professional and trade organizations, academe, and other agencies of government. Major BFRL goals are to improve the productivity of U.S. industries of construction, which now face stiff competition from overseas firms, and to reduce the human and economic losses resulting from fires, earthquakes, winds, and other hazards. Laboratory research includes fire science and fire safety engineering; building materials; computer-integrated construction practices; structural, mechanical, and environmental engineering; and building economics. Products of the laboratory's research include measurements and test methods, performance criteria, and technical data that are incorporated into building and fire standards and codes. Staff members are involved in more than 100 activities to develop voluntary standards. The laboratory conducts investigations at the scene of major fires and structural failures due to earthquakes, hurricanes, or other causes. The knowledge gained from these investigations guides research and is applied to recommendations for design and construction practices to reduce hazards.

*Retired, October 2003

Bilateral Activities

Argentina

At the invitation of the Federation of Societies for Coatings Technology (FSCT), a staff member from the Materials and Construction Research Division gave a 4-hour short course on service life prediction methodologies in Buenos Aires in July 2001. The purpose was to increase collaboration between the FSCT and South American countries.

Australia

A representative from the Materials and Construction Research Division held preliminary discussions with the Commonwealth Scientific and Industrial Research Organization (CSIRO) in Melbourne regarding several areas of mutual research. These areas included nanoscale chemical measurement, kinetics modeling, fire-retardant materials, and fire testing.

Brazil

A meeting was held at NIST in February 2002 with a delegation of Brazilian construction officials for an exchange related to construction standards, regulations, and certification. The program was part of an orientation visit organized by the U.S. Commercial Service in Brazil and funded by the U.S. Trade and Development Agency, and hosted by the Global Standards and Information Group (GSIG) in the Standard Services Division of Technology Services (TS). Participants from NIST included the Acting Chief of the Building Materials Division, the Chief of the Building Environmental Division, and representatives from the Global Standards and Information Program of Technology Services. Outside representatives from the American National Standards Institute (ANSI), the International Code

Council, the International Building Code Officials, and the National Evaluation Service also participated in the meetings. The group was accompanied by the NIST Regional Standards Officer stationed in Brazil, and a representative of the U.S. Commercial Service in São Paulo.

Canada

A representative from the Materials and Construction Research Division collaborates with the Civil Engineering Department of Laval University on the development of a continuum model of transport through concrete. The work included research on the theory of transport of water and aqueous solutions in concrete, and on the development of a molecular dynamics approach to modeling the reactions of cement with water. The collaborative efforts on both the temperature correction to the activity coefficient and the viscosity correction to the transport equation are of great benefit to NIST. These research efforts will contribute to a computer degradation model that incorporates virtually all the relevant thermodynamic and chemical properties of the pore solution. The model will also be relevant to virtually all field ambient conditions.

Chile

Representatives of BFRL and TS have provided assistance to the U.S. Embassy in Chile in the development and construction of a unique fire laboratory. The laboratory, at Catholic University in Santiago, was planned and constructed in response to the dramatic increase of fire losses related to increased construction that was observed during the 1990s. U.S. private-sector experts have also assisted in this effort. The laboratory, completed in May

2002, integrates many U.S. products, such as control, burners, and thermocouples, and complies with and applies U.S. and international standards, including those of the National Fire Protection Association (NFPA) and ASTM (formerly the American Society for Testing and Materials). The Chilean laboratory has the ability to test standards, educate, and train fire professionals, and also to conduct fire research.

China

Representatives from the Building Environment Division met with high-level industrial leaders in the Wuhan New Developing Zone to discuss possibilities of a joint venture. The delegation also visited the Construction Ministry in Beijing to hold discussions on topics of mutual interest.

Dominican Republic

The Materials and Construction Research Division supports the Department of Commerce (DoC)/United States Agency for International Development (USAID) Hurricane Reconstruction Program, formed in the aftermath of Hurricane Georges. NIST, in cooperation with the Department of Housing and Urban Development (HUD), has aided local and regional development of appropriate building construction codes, standards and guides for design loads, and construction practices to result in building that will be better able to resist hurricanes and other natural hazards in the Dominican Republic. These efforts included meetings, consultations and workshops, and have involved advising to the Dominican Agency of Civil Defense, (Obras Publicas and Defensa Civil) on sustainable construction techniques and practices suitable for the Dominican Republic. NIST was requested by USAID to develop and deliver training on sustainable construction techniques and practices suitable for the Dominican Republic. Technical assistance has been provided for guidance on design details and construction practices to provide houses that will be better able to resist severe windstorms and other natural hazards. A major component of this effort is the collection of information from those involved with housing construction.

Egypt

The Fire Research Division has a joint project with the National Institute of Standards in Giza under the U.S. – Egypt Science and Technology Joint Board. Approved in the fifth cycle of research proposals, the project on “Environmentally-Friendly Nanocomposite Flame Retardants” concerns development of a new flame retardant, a nanocomposite based on transition metals ionically bonded to the surface of clay, which due to the non-charring properties of the polymer, will reduce flammability.

France

The Fire Research Division held discussions regarding a possible collaboration in flame retardant nanocomposites and high throughput programs with Rhodia Corporation in Paris.

A representative of the Materials and Construction Research Division led the effort to compare various designs of concrete rheometers at the Laboratoire Central des Ponts et Chaussées, who hosted the first of a set of three week-long tests. A cubic meter industrial mixer was used to prepare the concrete. Twelve batches were prepared and tested on the rheometers, with slump measurements performed as a reference.

Germany

A representative of the Materials and Construction Research Division has installed Virtual Cement and Concrete Testing Laboratory (VCCTL) software at several participating companies of the Consortia in Germany. These have included sites at the laboratory of Dyckerhoff Zement GmbH and the German Cement Association.

Japan

A representative from the Fire Research Division participated in experiments held at the Japan Microgravity Center (JAMIC) in Asahikawa, Japan. The facility was selected due to its extended test time and gravity control. The experiments are part of a project funded by the National Aeronautics and Space Administration (NASA), as part of a collaborative program between NASA and the New Energy and Industrial Technology Development Organization (NEDO). The experiments were conducted using a new instrument set-up with infrared measurements of sample surface temperature distribution and temperature and concentration of carbon dioxide during periods of ignition, transition, and flame-spread. The experiment was successful in demonstrating the feasibility of using a laser as the ignition source. The demonstration of this capability is critical toward preparation for a planned experiment on the International Space Station.

Possible collaborative studies have been discussed between the Fire Metrology Group of the Fire Research Division and the National Metrology Institute of Japan (NMIJ) in Tsukuba. The collaboration would utilize the facilities of NMIJ, including the electro-centrifugal mass classifier which could enable the first quantitative study of the properties of agglomerates as a function of mass. The area of study would be on the mass classification of aerosols for particle diameters between 100 nm and 800 nm, simultaneous light scattering, and fluorescence measurement of particles/bubbles in liquids.

NIST participates in the U.S. – Japan Joint Panel on Wind and Seismic Effects, a project of the U.S. - Japan Cooperative Program in Natural Resources (UJNR). The program was founded in response to the need for improved engineering and scientific practices through exchange of technical data, information, and research personnel between the U.S. and Japan. The Joint Panel on Wind and Seismic Effects is one of 18 panels that comprise the UJNR. The Panel provides a government-to-government mechanism of the exchange of technical data, information, and research personnel for the purpose of improving design and engineering practices to mitigate the damaging effects of earthquake, wind, storm surge, and tsunami on buildings, lifelines and other structures. The joint panel meets annually, alternating between the United States and Japan. The Public Works Research Institute (PWRI) provides the Japanese-side Chairman and Secretary General; NIST provides the U.S.-side Chairman and Secretary-General. Japan is the only country in the world with comparable research activities in the areas of wind and earthquake engineering (including wind surge and tsunami) to the U.S. The Panel provides a formal mechanism for cooperation with Japan that will lead to improved codes and standards for the design and construction of building and lifelines to improve the public safety and reduce economic losses due to extreme natural events. The Panel also continues to provide benefits to U.S. agencies through information exchanged during the meetings and task committee workshops and through the exchange of researchers between participating agencies. Implementation of the strategic plan will serve to strengthen this relationship and focus the Panel's efforts on those problems of greatest importance to both sides. The Panel has focused on the effects of natural events such as earthquake, high winds, tsunami, and storm surge on building and other structures, and on the development of technologies to mitigate these effects.

Korea

The Building and Fire Research Laboratory has carried out joint research with Korea Institute of Energy Research (KIER) on automated real-time performance optimization, fault detection, and diagnosis of thermal systems to improve energy efficiency, increase safety and reliability, and reduce operating cost. The joint research is carried out under the Implementing Arrangement between NIST and KIER, signed in November of 2000.

Mexico

Representatives of the Materials and Construction Research Division met with industrial members of the VCCTL in Monterrey during March of 2001. Discussions concerned results of current research and planning of future activities. VCCTL software had been recently installed at the Mexican cement

institute, CEMEX, in Monterrey, which is a member of the consortium, contributing \$40k per year to the NIST/industry consortium.

Spain

The Building Materials Division works with the Institute of Construction Science “Eduardo Torroja” (IETCC) in Madrid to investigate various methods available for evaluating the diffusion coefficients of concrete. Specific topics of the research included chloride ingress and service life of concrete. The project was funded by a U.S – Spain Joint S&T Fund grant.

Switzerland

Master Builders (MBT) in Zurich is an industrial participant of VCCTL, in which NIST also participates. The Materials and Construction Division, participating as the NIST representative to the Consortium, was in charge of installing the VCCTL software at MBT.

Tunis

The Building Environment Division, along with the Polytechnic School of Tunisia, conducts and reports numerical simulations to investigate the performance of nonlinear hysteretic buildings equipped with passive and semi-active control devices under earthquake ground motions. The simulations were conducted using a software modeling program, developed under this cooperative effort.

United Kingdom

The Fire Research Division has several collaborations with universities within the United Kingdom. One, with Imperial College of London, is on high-temperature nanocomposites. The Division also has a scientific collaboration with Queen Mary University, in the Materials Science Department, an outgrowth of dissemination of the NIST Reactive Molecular Dynamics methods and software. A graduate student at Queen Mary University used the NIST Reactive Molecular Dynamics software to model the thermal decomposition of polyisobutylene, and the work may be the beginning of future collaborative efforts with the group at the Materials Science Department.

The Materials and Construction Division participates in the Service Life Prediction Consortium, a NIST/industry consortium. One of the areas the consortium members want to investigate is to validate the reliability theory for relating accelerated test results with outdoor performance, requesting NIST to take the lead on this. The member from New Castle held discussions with a member of the Materials and Construction Division on the proposed research to use a model epoxy-amine systems for this purpose, with the aim that the coating would provide essential

physical and chemical degradation information within short indoor, as well as outdoor, exposures. Information regarding the chemistry, network

structure, and physical properties of this epoxy coating and its behaviors during weathering was discussed

Multilateral Activities

The Virtual Cement and Concrete Testing Laboratory (VCCTL) is an industry-NIST consortium that has a goal to improve the modeling software so that much of the routine testing of cement and concrete can be eliminated. This would enable the multi-variable, materials science-based, optimization of concrete.

A five-year collaborative effort by NIST and other National Metrology Institutes (NMIs) has resulted in the publication of NIST Technical Note 1444, International Comparison of Guarded Hot Plate Apparatus Using National and Regional Reference Materials. Measurement results from five NMIs on four national and regional reference materials were compared. The technical note presents thermal conductivity data from the Japan Testing Center for Construction Materials (JTCCM), Laboratoire National d'Essais (LNE), the National Physical Laboratory (NPL), the National Research Council Canada (NRCC), and NIST, for thermal insulation Standard Reference Materials SRMs 1451 and 1453, IRMM 440, and a candidate reference material from

Japan. The report provides several recommendations for improving ASTM and ISO standard test methods for guarded hot plate apparatus. The major finding of the comparison is that there are laboratory-to-laboratory differences for three of the four materials and that these difference change from material to material.

Through the American Institute of Steel Construction (AISC) and its Electronic Data Interchange Initiative, a number of U.S. and European companies are developing interoperable software applications that support steel project delivery from design through analysis, detailing, and fabrication. The technical basis for interoperability is the CIMsteel Integration Standards Release 2 (CIS2), a pan-European specification that BFRL helped the AISC assess, select, and endorse. BFRL is working with industry partners in the AISC team to ensure proper interpretation and implementation of the specifications and other areas.

International Committee Participation

BFRL participates in various international standards committees, especially those in the building area. Since no single organization has sufficient resources to address all the research issues, international collaboration is essential. Active participation in international standard activities will allow NIST access to researchers in this field outside the U.S. and will ensure inclusion of U.S. technology in international standards.

Forum for International Fire Research (FORUM)

The Director of BFRL participates in FORUM, the Forum for International Fire Research. FORUM is an informal organization of heads of the world's leading fire research laboratories or programs. Meetings are held which provide a unique opportunity for exploring common interests and to develop collaborations. As a group, the FORUM members agreed to a position statement which supports the use of the most practical scientifically-based technology, to provide support for effective performance-based codes and standards, and directing research to advance fire science and engineering.

International Energy Agency (IEA)

The Building Environment Division participates in meetings regarding the International Energy Agency (IEA) Annex 40, "Commissioning of Building HVAC Systems for Improved Energy Performance". Annex 40 has a program of work for advancing commissioning that includes both near term and far term deliverables. Among those are software tools that use the Building for Environmental and Economic Sustainability (BEE) to deliver commissioning in a more efficient and comprehensive manner than is currently the case. The Energy Resource Station is an Iowa Energy Center facility used for testing and demonstrating energy efficient building technologies. The facility offers the opportunity for controlled testing of commissioning tools of U.S. team members and could also serve as a demonstration site of commissioning tools of both domestic and international Annex 40 partners. This international effort complements the research on cybernetic building systems that is currently being performed by the Building Environment Division.

International Organization for Standardization (ISO)

Representatives from BFRL participate in meetings of ISO involving fire research standards and building

and construction standards. These activities include projects on:

- Delivery of a reference data library to support facility life cycles;
- Standards regarding “Buildings and Constructed Assets: Service Life Planning”; and
- Working sessions to incorporate verification, drafting international standards for fire safety.

Technical Committee 92 (TC92) is the key technical committee in ISO concerned with fire safety, and SC1 is the subcommittee dealing with fire initiation and growth. International standards on fire safety and materials fire performance are being developed and debated in ISO TC92. It is essential that BFRL has representation on the key subcommittees to ensure that the emerging standards are science-based and do not unfairly penalize U.S. manufacturers.

The Building Materials and Building Environment Divisions have participated in several International Organization for Standardization (ISO) technical committees, including one on Durability of Single Family Housing, and one on Building Control System Design.

The International Organization for Standardization (ISO) Technical Committee 205, Building Environment Design, has recently approved BACnet as a Draft International Standard (DIS 16484-5). A five-month ballot and comment period is now underway to approve BACnet as an ISO standard. This ballot is being conducted in parallel with European Committee for Standardization (CEN) Technical Committee 247, Controls for Mechanical Building Services. BFRL researchers worked with industry for many years to develop BACnet, a communication protocol standard for building automation and control systems. BACnet has been translated into Korean, Japanese, and Chinese and is gradually becoming adopted around the world. It solves the problem of integrating control devices made by different manufacturers in order to optimize operations, improve safety, and reduce maintenance costs.

International Council for Research and Innovation in Building and Construction (CIB)

BFRL participates at the director-level in the International Council for Research and Innovation in Building and Construction (CIB) Board. This is an international forum dealing with building research and information, which is made up of building research institutes in government, industry, and academia, addressing issues on current or future concern in all aspects on construction buildings, materials, etc. The CIB Board includes the directors of most of the world's building research establishments. Activities that lend themselves to multi-national collaboration are coordinated by CIB.

BFRL also participates in committee meetings of the CIB. A key role of CIB committees is to perform pre-normative work in support of ISO standards; *i.e.* to address topics of current interest in building research and that often results in pre-standardization documents for ISO standards. The codes and standards used in international trade and for local building projects have a strong influence on the access projects and services from the U.S. to global markets.

National Fire Protection Association (NFPA)

The Fire Safety Engineering Division plays an active part in the National Fire Protection Association (NFPA). NFPA is a private standards development organization that promulgates over 200 codes and standards used extensively in the U.S. These codes are now increasingly being utilized internationally, with other countries adopting NFPA documents. This has a positive effect on trade in goods and services from U.S. companies.

International Association for Building Materials and Structures (RILEM)

Representatives from the Structures Evaluation and Analysis Group in the Structures Division participate in many of the technical committees of the International Association for Building Materials and Structures (RILEM). These include Housing Standards Committee and the Committee on Test Methods for Mechanical Properties of Concrete at High Temperatures.

International Workshops and Conferences

NIST hosted the Third International Conference on Tunnel Fires and Escape from Tunnels in Gaithersburg on October 9-11, 2001.

NIST also hosted the 12th International Conference on Automatic Fire Detection (AUBE) from March 26-28, 2001. Other co-sponsors of the event included the European Society for Automatic Alarm Systems

and the Duisburg University. The purpose of the conference was to disseminate knowledge and coordinate international efforts in fire sensing, signal processing, integrated building controls, fire simulation, and standards, and also to celebrate the contributions made by NBS/NIST in the past 100 years.

Information Technology Laboratory*

Dr. Susan Zevin, *Acting Director***

The Information Technology Laboratory (ITL) strengthens the U.S. economy and improves the quality of life by developing and applying technology, measurements, and standards for information technology (IT). This is a dynamic technology that has sparked the development of many new products and new services. All who work, go to school, maintain a household, or play can do their jobs better and can benefit from this technology. ITL works with industry, research, and government organizations to make this technology more usable, more secure, more scalable, and more interoperable than it is today. The laboratory develops and demonstrates tests, test methods, reference data, proof-of-concept implementations, and other infrastructure technologies needed by IT developers and users to objectively measure, compare, and improve their systems. ITL is uniquely positioned in the exploding world of information technology, providing an objective, independent, cutting-edge forum for measurements and standards development. Our tools, techniques, and metrics enable U.S. industry to maintain a leadership position in the global marketplace.

*Division names have changed due to reorganization; names in this report reflect organization during FY 2001/2002

** Retired, July 2004

Bilateral Activities

Canada

The Cryptographic Module Validation Program (CMVP) is a joint effort between NIST and the Communications Security Establishment (CSE) of the Canadian Government. ITL's Computer Security Division and CSE serve as the validation authorities for the program. The Federal Information Processing Standard (FIPS) specifies the overall requirements for all cryptographic modules protecting sensitive, unclassified information, and provides a framework for all other NIST cryptographic standards. The standard FIPS 140-2, issued in May 2001, replaced the previous standard, FIPS 140-1, and was developed in cooperation with CSE, cryptographic product developers, and interested user communities. Products validated by this program are accepted for use in both Canada and the U.S. for the protection of sensitive, unclassified information. FIPS 140-2 is the Security Requirements for Cryptographic Modules. CMVP requires accredited, independent, third party testing laboratories to test products for FIPS validation. Test results from selected accredited laboratories are examined by NIST and CSE, who issue joint validation certificates. The U.S. and Canadian industry participation as accredited testing laboratories is being encouraged.

Egypt

A collaborative project was completed between ITL and the Egyptian National Institute of Standards (NIS) to develop a repository for reference data on software faults and failures. Besides working on the NIST project, a guest researcher from NIS worked to develop an Arabic language version of the database and tools to improve Egyptian software.

Finland

A guest worker from the Information Technology Laboratory of the National Research Center of Finland (VTT) worked in the Convergent Information Systems Division on research to authenticate architectures and formats using biometric and digital data content.

A delegation of Finnish industrial and university researchers from the telecommunications and information technology sector visited ITL in October 2002 as part of the planned visitor and information exchanges under the NIST-TEKES MOU.

France

A representative from the Computer Security Division participated on the dissertation jury for a Ph.D. student at the Université Claude Bernard Lyon in December of 2001.

A representative from the Advanced Technologies Division attended student presentations at the University of Henri Ponciare (UHP) in Nancy, which included joint projects with NIST researchers, and also held discussions to explore new collaborations.

ITL is continuing collaborations with the École Supérieure d'Informatique et Applications de Lorraine (ESIAL) in applying Smart Space Technology to creating accessible workspace.

India

On August 22, 2002, ITL hosted a high-level delegation from the Indian Ministry of Defense. The meeting resulted from a Department of State bilateral meeting held in New Delhi in March of 2002, at which India was invited to send a delegation to the

U.S. to receive briefings and tours relating to computer network defense. The visit focused on cyber threat/security and information assurance in general, and Common Criteria (CC), National Information Assurance Partnership (NIAP), and system evaluation in particular. The delegation indicated their interest in acceding to the CC Recognition Arrangement and in system evaluation. India has a national accreditation authority similar to NVLAP and uses accredited laboratories to perform various types of testing.

Japan

A representative from the Statistical Engineering Division was awarded a fellowship from the Agency of Industrial Science and Technology of Japan (AIST) to conduct research at National Research Laboratory for Metrology (NRLM) in Tsukuba. The research was to continue collaboration on the performance studies of a prototype aerosol particle spectrometer. The instrument will enable the industrial and scientific community to make more accurate measurements of the size distribution of aerosol particles. The research included the demonstration of nano-particle resolution, using Monte Carlo simulation codes, model validation, and transient study and stability studies.

The Mathematical and Computational Sciences Division participated in the International Discovery Science Project, funded through a Grant-in-Aid by the Japanese Ministry of Education, Science, Sports, and Culture. This was a three-year program, running from April 1998 to March 2001, to develop new methods for knowledge discovery, to install network environments for knowledge discovery, and establish Discovery Science as a new area of computer science. NIST has interest in this as the area of automation of discovery is emerging, and combinatorial experiments are becoming more common.

Russia

The Computer Security Division provides technical support to the Department of Energy (DoE) and the

Pacific Northwest National Laboratory for a joint U.S. – Russia project on non-proliferation of nuclear weapons. The Division provides support on information technology security testing and evaluation in the project.

The Mathematical and Computational Sciences Division collaborates with the Russian Academy of Sciences (RAS) on developing numerical software for mathematical special functions under a grant from the Civilian Research and Development Foundation (CRDF).

Switzerland

The Chief, Convergent Information Systems Division, held discussions with the Swiss National Library in Bern, and made a presentation on electronic books at the World Intellectual Property Organization (WIPO) and European Organization for Nuclear Research (CERN) in Geneva.

United Kingdom

The Mathematical and Computational Sciences Division collaborates with the Industrial Applied Mathematics group at the University of Southampton on research in mathematical modeling and materials science applications. The collaboration is supported by a joint National Aeronautics and Space Administration (NASA) grant, “A Phase-Field/Fluid Motion Model of Solidification: Investigation of Flow Effects During Directional Solidification and Dendritic Growth”, which deals with state-of-the-art techniques in mathematical modeling of phase transformation problems in materials science involving diffuse interface models of solidification.

The Computer Security Division participated in an assessment of Logica, a testing laboratory in the U.K., which applied to become a Cryptographic Module Testing laboratory. The on-site assessment took two days, and involved a detailed review of the laboratory’s quality system and quality documentation.

Multilateral Activities

Advanced Encryption Standard (AES)

In October of 2001, NIST named the Rijndael data encryption formula as its choice for the proposed new Advanced Encryption Standard (AES). The selection capped a three-year international competition organized to develop a strong formula to protect sensitive information in federal computer systems, and to identify a new data encryption technique for a proposed AES Federal Information Processing Standard. Many businesses are expected to use the AES as well. The Rijndael developers are Belgian

cryptographers Joan Daemen of Proton World International and Vincent Rijmen of Katholieke Univeriteit in Leuven. The Rijndael formula was selected because it had the best combination of security performance, efficiency, ease of implementation, and flexibility. ITL’s Computer Security Division worked closely with private sector cryptographers from around the world to conduct the competition. The AES was approved as FIPS 197 in November 2001.

Common Criteria (CC)

Since 1993, NIST has been engaged in a cooperative project with the National Security Agency (NSA) and the governments of Canada, France, Germany, the Netherlands, and the United Kingdom to develop the Common Criteria for Information Technology Security, or “Common Criteria” (CC). The Common Criteria project provides the structure and components to describe standardized security requirements for all types of computer-related projects. The International Bureau of Weights and Measures (BIPM) Mutual Recognition Arrangement (MRA) signed in October 1998, allows sales of evaluated, security-enhanced IT products to Canada, France Germany, and the U.K. without duplicate, costly evaluations in each of these importing nations. In May of 2000, this MRA was extended to the International Common Criteria Recognition Arrangement, when thirteen nations (the U.S., Canada, Australia, New Zealand, the United Kingdom, France, Germany, the Netherlands, Finland, Norway, Italy, Spain, and Greece) agreed to accept the computer security testing results conducted in each others’ accredited testing laboratories, thus greatly reducing the time and cost of security evaluations and increasing the availability of evaluated products for consumers.

Public Key Infrastructure (PKI)

A representative from the Computer Security Division participated in a Public Key Infrastructure (PKI) policy coordination meeting, attend by representatives from the U.S., the U.K., Canada, and Australia. All four English-speaking countries have somewhat similar e-government and e-signature initiatives. All have programs to put certificates in the hands of citizens and use them to deliver services, and to build internal government PKIs.

Smart Card

The Systems and Network Security Group of the Computer Security Division works with the Smart

Card Security Users Group (SCSUG), an international consortium consisting of all the major credit card organizations engaged in implementing smart card technology for the financial industry worldwide. The goals of the group are to develop security requirements industry-wide for smart cards and the criteria for widely acceptable security testing programs for them. SCSUG was formed under the sponsorship of the joint NIST-National Security Agency (NSA) partnership, the National Information Assurance Partnership (NIAP). The group has worked on developing a Common Criteria-Based Protection Profile (security requirement set) for smart cards used in financial payment systems and on companion security testing approaches for smart cards, including planning for development of laboratory accreditation criteria and test methods.

Text Retrieval Conferences (TREC)

ITL has participated in several international conferences patterned after the Text Retrieval Conferences (TREC) series developed and co-sponsored by ITL’s Information Access Division and the Defense Advanced Research Projects Agency (DARPA), and using ITL software for evaluation. A European-funded consortium expanded the cross-language evaluation work that started in 1997 at NIST to more European languages, as well as involving additional European groups. ITL serves on the steering committee of this activity, called the Cross-Language Evaluation Forum (CLEF), and provides evaluation for the English-language portion of the task. Additionally, the National Institute for Information in Japan sponsors a text retrieval conference called NTCIR that uses the task definitions and testing protocols established at NIST for cross-language retrieval in Japanese and Chinese. Korean is to be added. ITL worked closely with the Japanese in terms of providing advice and software for the evaluation of participating industrial and academic systems.

International Committee Participation

ITL participates in various standards committees, especially those in the information and computer security areas. Since no single organization has sufficient resources to address all the research issues, international collaboration is essential. Active participation in international standard activities will allow NIST access to research in this field outside the U.S. and will ensure inclusion of U.S. technology in international standards. Some highlights of the major successes of ITL’s activities in international standards committee are given below.

- **InterNational Committee for Information Technology Standards (INCITS) Biometric Standards in Support of E-commerce, the Prevention of Identity Theft, and Countering Terrorism.** Biometrics are automated methods of identifying a person or verifying the identity of a person based on a physiological or behavioral characteristic. Physiological characteristics include hand or finger images, facial characteristics, speaker verification, and iris recognition. Behavioral characteristics are traits that are learned or

acquired, such as dynamic signature verification and keystroke dynamics.

At the request of the industry and government members of the International Committee for Information Technology Standards (INCITS) Executive Board, ITL prepared a proposal for a new national standards group for generic biometric standardization. Based upon the NIST proposal, the INCITS Executive Board established Technical Committee (M1) for Biometrics in November 2001. A staff member from the Convergent Information Systems Division was appointed chairman of M1 in April 2002.

ISO/IEC JTC 1 (JTC 1 TAG), in February 2002, NIST prepared a U.S. contribution, JTC 1 N 6702, titled – U.S. National Body Contribution for the Establishment of a New JTC 1 Subcommittee for Biometrics and U.S. Offer to Serve as Secretariat for the New SC. In March 2002, NIST prepared a contribution titled, Proposed New JTC 1 Subcommittee on Biometrics - Scope and Initial Program of Work, which was included in the JTC 1 letter ballot (JTC 1 N 6738) issued April 2002. In June 2002, the new JTC 1 Subcommittee was approved by JTC 1 and designated as JTC 1 SC 37 on Biometrics. In August 2002, A staff member from the Convergent Information Systems Division was appointed to be the acting chairman of JTC SC 37. At the first plenary meeting of JTC SC 37 in December 2002, SC 37 endorsed the staff member for a three-year term of office as SC 37 Chairman.

- **INCITS and U.S. Smart Card Interoperability Specifications.** The federal government is expanding smart card use among federal employees because of the security features and inherent versatility of smart cards. For example, a single smart card could be used as an identification card, to provide access to secure buildings, to securely logon to computer systems, and to make small purchases. However, the federal government has been reluctant to use smart cards on a large scale primarily due to the lack of interoperability among smart card products. Scientists in ITL's Computer Security Division have been working with the General Services Administration, other federal agencies, and industry partners for the past several years to establish a Government Smart Card (GSC) program to facilitate widespread deployment of interoperable smart card systems. Specifically, ITL set out to build a framework for smart card interoperability,

enabling broad adoption of this critical technology by the public and private sectors. The mechanism and technical foundation for this framework is the Government Smart Card Interoperability Specification (GSC-IS). The GSC-IS version 2.0 was published on June 27, 2002 as NISTIR 6887.

The GSC-IS lays the groundwork for smart cards to work in an open environment. It defines an architectural model for interoperable smart card service provider modules, compatible with both file system cards and virtual machine cards, that allows smart card application developers to obtain various services (*e.g.*, encryption, authentication, digital signatures, *etc.*) from GSC-compliant smart cards through a common, interoperable smart card services interface. The GSC-ISv2.0 is available as NISTIR 6887 at <http://smartcard.nist.gov>.

ITL staff presented the specification to the INCITS Executive Board, INCITS Technical Committee B10, and ISO/IEC JTC 1 SC 17 and have received widespread support for internationally fast processing the revised specification, which will be available in early 2003.

- **Moving Picture Experts Group (MPEG) Next Generation Multimedia Standard MPEG-7.** ITL's Information Access Division actively participated in the development of the MPEG-7 Multimedia Content Description Interface standard, which was released at the Moving Picture Experts Group (MPEG) meeting in Thailand in December 2001. The MPEG-7 standard provides standardized, core technologies allowing metadata description of audio-visual data content in multimedia environments. An ITL staff member provided MPEG-7 schema and sub-schemas validation for the ISO/IEC Multimedia Description Scheme (ISO/IEC 15938-5); MPEG-7 sub-schemas included Description Definition Language (DDL), Visual, Audio, and W3C 1998 XML Namespace. The staff member is the co-chair of the MPEG-7 Applications and Promotion to Industry (MAPI) group, an active steering committee member within MPEG-7 Industry Forum (M7IF), and serves as the webmaster for the MPEG-7 website (<http://mpeg-industry.com>).

- Institute of Electrical and Electronics Engineers (IEEE) Wireless Personal Area Network (802.15) Standard.** ITL contributed significantly to a new standard for wireless personal area networks (WPANS) approved by the Institute of Electrical and Electronics Engineers (IEEE) on March 21, 2002 (<http://standards.ieee.org/announcements/802151app.html>). The approval of IEEE 802.15.1 was the long-awaited formal acceptance of the Bluetooth Special Interest Group (SIG) Core Specification by a recognized standards body. Although the Bluetooth Core Specification defines all the layers from physical layer to the application layer, only the lower layers, which are considered within the scope of the IEEE 802 Medium Access Control and Physical layers, are included. This wireless technology operates in the 2.4 GHz frequency band and provides voice communications at 64 bit/s and data transfers up to 732 kbit/s at distances up to ten meters. The technology is meant to be inexpensive, thus positioning itself for system integration as one of the pervasive computing technologies.

ITL has been involved in this effort since the Bluetooth SIG first released the specifications and the IEEE 802.15 Working Group was formed. The work consisted of reviewing, verifying, and validating the protocols being defined. As a means to speed and ideally show the completeness and correctness of the protocols, ITL Advanced Network Technologies Division undertook the task of creating a formal description of the text prose using the ITU-T standardized formal description language called Specification and Description Language (SDL) that was included as an informative annex in the standard. SDL uses a finite state machine and describes the behavior in the form similar to a flow chart. This process generated thousands of comments and suggested changes that were incorporated in the Bluetooth specifications v1.1. In addition, ITL held editorship of several sub-clauses in the draft standard and participated in the creation of the Protocol Implementation Conformance Statement (PICS) proforma.

IEEE 802.15.1 is the first in a series of new WPAN technologies being developed in IEEE 802.15. Standards for higher (20 Mbit/s) and lower (250 kbit/s) rate WPANs are under development. The website is

<http://www.itl.nist.gov/pervasivecomputing.html>.

- XML Technology Conformance Tests.** ITL developed and released conformance tests for several XML technology areas, including XML 1.0, Second Edition, XML Schema, eXtensible Stylesheet Language (XSL), and the Document Object Model (DOM). The XML Conformance Test Suite, v1.0, Second Edition, contains over 2000 test files and an associated test report. The test report contains background information on conformance testing for XML as well as test descriptions for each of the test files included in this release. The test suite provides a set of metrics for determining conformance to the W3C XML 1.0 (Second Edition) Recommendation.

Over 6000 XML Schema tests, which have been included as part of a larger W3C Schema testing effort, are available for the built-in simple datatypes defined in the W3C Recommendation XML Schema Part 2: Datatypes. All the built-in primitive datatypes are represented, as are all the built-in derived datatypes whose derivation is by restriction and which may appear alone in an instance document with no internal or external references to entities other than a defining schema document and the XML Schema namespace for instances.

Conformance tests were developed for both XSL Formatting Objects (XSL-FO) and XSL Transformations (XSLT/Xpath). The XSL-FO tests were developed as part of a larger testing effort within the W3C XSL-FO subgroup. Currently there are over 600 tests, which cover many of the basic formatting objects and associated properties. The XSLT/Xpath tests were developed by ITL for inclusion in the OASIS XSLT/XPath test suite. Currently, there are over 200 tests that exercise various XSLT/Xpath features.

ITL also partnered with W3C to develop a set of DOM Level 2 tests. As part of this effort, a generic test language was developed for DOM, and XSLT transformations are used to generate specific language bindings for Java and ECMAScript. ITL recently submitted over 400 DOM tests to this effort. All of these test suites are freely available at: <http://www.nist.gov/xml/>.

- **Advanced Television System Committee (ATSC) Interactive Digital Television Standard.** The Advanced Television System Committee (ATSC), an international industry consortium of more than 200 members consisting of broadcasters, content creators, software vendors, and equipment manufacturers, announced at their October 2001 meeting that the DTV Application Software Environment (DASE) standard was approved. DASE is the North America middleware standard for broadcast interactive television. NIST and the DASE specialist group are developing these standards in advance of widespread use of digital television technology. The NIST open reference implementation of the DASE standard provides application developers and consumer electronic manufacturers an application development environment and a basis for an interoperable Digital TV receiver implementation.

The NIST implementation was a deciding factor in the final approval of the DASE standards documentation. Because of the complexity and size of this forward-looking standard, industry participants requested that ATSC demonstrate that DASE was implementable. The ATSC membership voted, by a clear majority, that this requirement was satisfied by the NIST Procedural (Java) Application Environment implementation and the Samsung Declarative Application Environment implementation.

The interactive digital television community has been very responsive to the NIST prototype implementation. Over 800 copies of the software have been downloaded since its release, announced in June at the 2001 DASE Symposium held at NIST. The NIST implementation is an enormous undertaking,

In addition to these highlights, additional international committees in which ITL representatives participate relating to IT issues include those listed below:

American National Standards Institute. The Security Technology Group of the Computer Security Division participates in the American National Standards Institute (ANSI). This includes the Cryptographic Tools working group of the Information and Data Security Subcommittee of the Accredited Standards Committee, X9-F1, which is involved in the development of ANSI standards for

consisting of over 100,000 lines of Java code. The NIST environment provides not only the DASE implementation, but also an ATSC DTV receiver simulation and DASE reference applications. This is a major accomplishment for the digital TV industry, as all analog transmission is mandated by the FCC to be digital in 2007.

- **INCITS and Common Industry Format for Usability Test Reports.** In November 2001, the Executive Board of the InterNational Committee for Information Technology Standards (INCITS) approved the Common Industry Format (CIF) for Usability Test Reports (NCITS 354). This document standardizes the types of information captured in the software development testing process. Developed through a series of workshops sponsored by NIST ITL, the CIF specification was created by the Industry Usability Reporting (IUSR) Project involving 70 representatives from industry, government, and academia. Usability is a key factor in predicting successful deployment of software. ITL researchers created the CIF by collecting the usability testing formats used by the participating organizations, comparing the formats, and finding a set of elements that met with approval of all the members. The purpose of the CIF standard is to make it easier to incorporate usability into the procurement decision-making process for software. The CIF enables human factors engineers and usability professionals in software development companies to report the methods and results of usability tests in a standard format to customers. The INCITS press release is available at <http://www.ncits.org/press/2001/CIFfasttrakpr.htm>; information on the development of the CIF is available at <http://zing.ncsl.nist.gov/cifer/>.

cryptographic tools used in the financial services industry, and participation in the Information Technology Standards-Technical Group.

Association for Information and Image Management International (AIIM). ITL participates in AIIM, the world's leading global association for information management professional and providers of digital document technologies. Through ITL's participation in AIIM, the development of digital document standards worldwide is facilitated.

Common Criteria Recognition Arrangement Management Committee. A group of fourteen industrialized nations formed a cooperative agreement to recognize the results of security testing of IT products and systems conducted by accredited, independent, third party testing laboratories, the Common Criteria Recognition Arrangement (CCMRA). A representative of the Computer Security Division serves as the Chairman of the CCMRA Executive Subcommittee. ITL's leadership in this area has benefited both government and industry by increasing the availability of commercially tested IT products necessary to build more secure systems and networks for critical infrastructure applications.

Electronic Book Exchange. Providing intellectual property protection for the e-Book industry is the focus of the Electronic Book Exchange (EbX). ITL participates as a team member with technical support for the projects, and chairs the authoring group for the Open e-Book Initiative, an industry group focused on developing standards for electronic content on electronic book reading systems.

International Organization for Standardization (ISO) a worldwide federation of national standards bodies from some 140 countries, one from each country. ISO is a voluntary organization comprised of a number of national standardization bodies working together to develop internationally-acceptable standards. It is subdivided into a number of technical committees. ITL participates in the committee dealing with general standardization in the field of IT, the Joint Technical Committee 1 (JTC1), and its subcommittee 27 (SC27), which addresses IT security techniques. These subcommittees meet twice per year to work on accepted projects and are comprised of volunteer technical experts from the various national bodies.

Organization for the Advancement of Structure Information Standards (OASIS) is an international consortium dedicated to accelerating the adoption of product-independent format based on public standards. These standards include XML, HTML,

and CGM as well as others that are related to structure information processing. ITL's participation includes the development of conformance tests for these standards

Object Management Group (OMG) is a nonprofit international consortium of 500 organizations whose mission is to research, develop, and promote the use of object-oriented technology for distributed systems development. ITL staff have participated in a number of OMG meetings, including one of systems and knowledge modeling.

Optical Storage Technology Association (OSTA) is an international trade association dedicated to promoting the use of writable optical technology for storing computer data and images.

Society of Motion Picture and Television Engineers (SMPTE) is an international technical society devoted to advance the theory and application of motion-imaging technology. ITL participates on the committees for Data Essence Technology, the Study Group on Conditional Access for Digital Cinema, and the Video Quality Experts Group.

Motion Picture Expert Group (MPEG) has developed the MPEG-7 standard. This standard defines highly structured, textual and binary forms for describing multimedia content, from low-level features (colors, shapes, sound frequencies) to high-level, semantic information. ITL continues to participate in MPEG's development of its specification for interoperable Intellectual Property Management and Protection (IPMP) to Committee Draft. IPMP is MPEG's term for Digital Rights Management. This specification will allow managed and protected content to be used across compliant devices.

World Wide Web Consortium (W3C) is an international industry consortium created to lead the World Wide Web to its full potential by developing common protocols that promote its evolution and ensure into interoperability.

A complete list of international committees in which ITL has representation and participation is given here:

ATSC, Advanced Television Systems Committee (ATSC) T3/S17 - Digital TV Applications Software Environment (DASE) Application Programming Interface (API)
BioAPI Consortium, Biometric Application Programming Interface (API) Consortium
BLAS Technical Forum, Sparse Subcommittee
CCMC, Common Criteria Management Committee
FPSH, Forum on Privacy and Security in Healthcare
FSTC, Financial Services Technology Consortium FAST Working Group
HDSA, High Density Storage Association
IEEE, Software Engineering Body of Knowledge (SWEBOK)
IEEE, P2001, Web Best Practices Working Group

IEEE 802.15, Working Group for Wireless Personal Area Networks
 IEEE 802.16, Working Group on Broadband Wireless Access Standards
 IETF-INTNET, Internet Area (DNS Extensions, IP Next Generation, Service Location, Zero Configuration)
 IETF-SUB-IP, SUB-IP Area (CCAMP, IPO, MPLS, TEWS)
 IETF-RTG, Routing Area (MPLS, Intra/Inter Domain Routing, Mobile IP, MANETS)
 IETF-SEC, Security Area (IP Security Protocol, IP Security Policy, S/MIMIE, PKI Using X.509)
 IETF-TP, Transport Area (Differentiated Services, Performance Metrics, IP Telephony, Session Initiation Protocol)
 IFIP, Working Group 2.5 Numerical Software
 IMPI, Interoperable Message Passing Interface
 IMPI Testing, Conformance Testing of the Interoperable Message Passing Interface
 INCITS TC L3, Coding of Audio, Picture, Multimedia and Hypermedia Information (JTC1/SC29)
 INCITS TG L3.1, MPEG Development Activity (JTC1/SC29/WG11)
 INCITS TG L3.2, Still Image Coding (JTC1/SC29/WG1)
 INCITS TC L8, Data Representation (JTC1/SC32/WG2)
 INCITS TC M1, Biometrics
 INCITS TC T3, Open Distributed Processing (ODP) (JTC1/SC6/WG7)
 INCITS TC T4, Information Technology Security Techniques (JTC1/SC27)
 INCITS TC V2, Information Technology Access Interfaces
 INCITS TC V3, ECommerce
 ISO REMCO, Committee on Reference Materials WG1 for ISO Guide 35
 Java, Real-Time Java Expert Group
 Java Grande Forum, Numerics Working Group
 NAOMI, North American Open Math Initiative
 NIST/Biometric Consortium, Biometric Interoperability, Performance and Assurance Working Group
 NIST/Biometric Consortium – Biometric Interoperability, Performance and Assurance Working Group, Common Biometric Exchange File Format
 OASIS, Organization for the Advancement of Structured Information Systems Consortium
 OIF, Optical Internetworking Forum Architecture, Internetworking and Management
 OMG, Business Object Management
 OPEN GROUP (formerly X/Open) Security Group
 PTools, Parallel Tools Consortium
 RosettaNet, RosettaNet eBusiness Standards Consortium
 SCSUG, Smart Card Security Users Group
 SMPTE, Society of Motion Picture and Television Engineers – Committee on Data Essence Technology
 SMPTE, Society of Motion Picture and Television Engineers – Study Group on Conditional Access for Digital Cinema
 SMPTE, Society of Motion Picture and Television Engineers – Video Quality Experts Group
 VESA, Video Electronics Standards Association Display Committee
 VESA, Video Electronics Standards Association Display Metrology Committee
 VESA, Video Electronics Standards Association Flat Panel Display Interface Committee
 VESA, Video Electronics Standards Association Micro-display Committee
 W3C-QA, World Wide Web Consortium Quality Assurance (QA) Activity
 W3C-DOM, World Wide Web Consortium Document Object Model (DOM) WG
 W3C-Schema, World Wide Web Consortium Schema WG
 W3C-XSL, World Wide Web Consortium Extensible Stylesheet Language (XSL) WG
 W3C-CSS, World Wide Web Consortium Cascading Stylesheets (CSS) WG
 W3C-XML, World Wide Consortium XML WG
 W3C-SYMM, World Wide Consortium SYMM WG
 Web3D, Web3D Consortium
 X.9F.5, Digital Signature & Certificate Policy
 X9F, Data and Financial Information Security
 X9F.1, Cryptographic Tool Standards and Guidelines
 X9F.3, Cryptographic Protocols

Management Groups

ANSI , Information Infrastructure Standards Panel (IISP)
ANSI, IISP Steering Committee
ANSI, Information Systems Standards Board (ISSB)
BioAPI Consortium, Steering Committee
BioAPI Consortium, External Liaisons Working Group
IEEE-SA, Board of Governors, IEEE-Standards Association
INCITS , InterNational Committee for Information Technology Standards
INCITS/PPC, Policy and Procedures Committee
ISO TC 69, Statistical Methods
Japanese Electronic Book Consortium Steering Committee
JTC1 TAG, U.S. TAG to ISO/IEC JTC1 (ISO/IEC JTC 1 on Information Technology)
Micromagnetic Modeling Activity Group – Steering Committee
NAIPC, North American Interoperability Policy Council
NIAP, National Information Assurance Partnership
NIST/NSA, Biometric Consortium
OMG, Object Management Group
T1, Telecommunications
VESA, Video Electronics Standards Association
W3C, World Wide Web Consortium Advisory Committee
XIWT, Cross Industry Working Team

International Workshops and Conferences

ITL's Information Access Division hosted the ninth workshop in the Text Retrieval Conference (TREC) series at NIST in Gaithersburg on Nov 13-16, 2000. Seventy groups representing 17 countries participated in the workshop to discuss the results of a yearlong cycle of testing that was conducted by the division's Retrieval Group. In addition to the breakthrough in question-answer technology, a second emphasis in this year's TREC was an examination of the infrastructure required to evaluate Web search engines. The Web differs from other data collections used in TREC in a variety of ways: size; variety of subject matter, media types, languages, and presentation styles; lack of specific editorial control; explicit links among documents; frequent changes to documents; and generated content.

On Feb 7-8, 2001, the Biometric Interoperability Performance and Assurance Working Group held its second meeting at NIST. Sponsored by ITL's Convergent Information Systems Division and the Biometric Consortium, the group is developing a simple testing methodology to determine the performance of biometric systems, as well as addressing issues on biometric assurance. In addition the group is focusing on the use of biometrics data in smart card applications by developing a smart card format compliant to the Common Biometric Exchange

File format (CBEFF), another ITL initiative. The ITL initiative promotes exchange of information and collaborative efforts between users and private industry in all things biometric and supports the advancement of technically efficient and compatible biometric technology solutions on a national and international basis. The group consists of 65 participants representing over 50 national and international organizations from the U.S., Australia, Italy, South Korea, UK, Canada, Sweden, and France. Member organizations include biometric vendors, system developers, information assurance organizations, commercial end users, universities, government agencies, national laboratories, and industry organizations.

On March 26-27, 2002, the Cryptographic Module Validation Program (CMVP) held its second technical conference in Washington, D.C. Co-sponsored by the Communications Security Establishment (CSE) of the Canadian government, the event included presentations and discussions on the new Federal Information Processing Standards (FIPS) 140-2, Security Requirements for Cryptographic Modules, differences between FIPS 140-1 and FIPS 140-2, algorithm testing suites, Common Criteria and the CMCP, and a number of panel discussion. More than 125 attendees from the international community attended the conference

Technology Services

Dr. Richard Kayser, *Director**

Technology Services (TS) provides a variety of products and services to U.S. industry and trade and the public, in collaboration with NIST laboratories, federal agencies, national metrology institutes, state and local governments, and the private sector. TS activities include support for NIST calibrations, Standard Reference Materials, Standards Reference Data, and Weights and Measures; coordination of documentary standards activities; training of foreign standards officials; laboratory accreditation; facilitating partnerships between NIST researchers and U.S. industry; and access to the NIST Research Library. Specifically, activities within TS include: 1) cooperating with other departments and agencies of the federal government, state and local governments in establishing uniform legal metrology practices, standards, codes, and specifications; 2) developing, producing, and distributing Standard Reference Materials; 3) providing Standard Reference Data; 4) providing calibration and laboratory accreditation services; 5) coordinating metric usage to the extent practical in federal government procurement, grants, and business-related activities; 6) managing the Small Business Innovation Research Program (SBIR); and 7) providing information services in support of NIST and collaborating with NIST's Laboratories in carrying out technology services responsibilities.

*Currently Acting Deputy Director of NIST

The Standards Services Division (SSD) formulates and implements standards-related policies and procedures to enhance domestic commerce and international trade. SSD tracks NIST and other agency representation to domestic and international organizations and Federal agencies concerned with standardization, product testing, certification, laboratory accreditation, and other forms of conformity assessment. Programs in SSD are dedicated to the following specific areas in standards and conformity assessment: Laboratory Accreditation, Standards Coordination and Conformity, Global Standards and Information, and the National Center for Standards and Certification and Information (NCSCI). SSD also serves as the DoC technical contact point to investigate non-tariff trade barriers for non-agricultural products under the World Trade Organization (WTO) Agreement on Technical Barriers to Trade (TBT).

The Laboratory Accreditation Group in SSD manages the National Voluntary Laboratory Accreditation Program (NVLAP). This program responds to legislative mandates, regulatory needs, and private sector requests for third-party accreditation of testing and calibration laboratories. The program is in full conformance with the standards of the International Organization for Standardization (ISO) and the International Electrotechnical Commission (IEC), including ISO Guide 25, General Requirements for the Competence of Calibration and Testing Laboratories, and ISO Guide 58, Calibration and Testing Laboratory Systems – General Requirements for Operation and Recognition. NVLAP currently has about 100 calibration accreditations representing 10 fields of calibration and about 720 testing accreditations

representing 6 major testing program groups listed in the 2000 NVLAP directory.

Operating in 47 states, Puerto Rico, and eight foreign countries, the listed laboratories together offer 850 services that were judged by NVLAP to satisfy internationally-accepted competency requirements. NVLAP entered into a mutual recognition arrangement with seven Asia Pacific countries in the Asia-Pacific Laboratory Accreditation Cooperation (APLAC) and has obtained similar recognition by European nations, which are members of the European Cooperation on Accreditation (EA). NVLAP is also a signatory to the International Laboratory Accreditation Cooperation (ILAC) mutual recognition arrangement which brings together regional organizations including APLAC, EA, and similar organizations in the Americas and Africa. Mutual recognition arrangements will reduce the need for redundant testing and accreditation thereby lessening the cost of traded goods.

The Global Standards and Information Group (GSIG) in SSD provides technical information to Federal agencies and industry to assist in resolving non-tariff trade-related issues on standards and conformity assessment. These barriers may be caused by disparities in standards and conformity assessment practices between the U.S. and its trading partners. NIST/GSIG provides technical support to three Foreign Commercial Officers that serve as Standards Experts for the Department of Commerce - in Mexico, Brazil, and Belgium. The Standard Expert in Brussels, Belgium covers standards-related activities of the European Union. The Standards Experts in Mexico and Brazil share regional responsibilities for Latin America and the Caribbean.

NIST/GSIG also has a contractor that serves as a Standards Expert in Saudi Arabia and is responsible for covering Gulf Cooperation Council (GCC) countries, which include Bahrain, Kuwait, Oman, Qatar, Saudi Arabia, and the United Arab Emirates. Standards experts have a variety of responsibilities, which include working with host country standards organizations, acting as the communication point of contact to channel requests for information and technical assistance to NIST for input by the U.S. Government and industry, and offering technical support to U.S. embassy commercial and economic staffs. GSIG also participates in the activities of interagency groups to establish U.S. Government positions for the North American Free Trade Agreement (NAFTA), the International Committee on Developing Country matters (DEVCO), and the United Nations Economic Commission for Europe (UNECE). GSIG conducts standards-related training programs for technical experts from various regions that are important for U.S. trade.

GSIG also manages the implementation of several government-to-government agreements, including the U.S.-European Union Mutual Recognition Arrangement (MRA), the APEC Mutual Recognition Arrangement (MRA) for Conformity Assessment of Telecommunications Equipment and the CITELE Mutual Recognition Agreement (MRA) on Telecommunications Equipment. NIST's National Voluntary Conformity Assessment Evaluation (NVCASE) program, managed by GSIG, supports implementation of these agreements through evaluation and recognition of competent accreditors of laboratories, certifiers, and management system registrars. Under the NVCASE Program, NIST recognized the American National Standards Institute (ANSI) as an accreditor of Telecommunications Certification Bodies.

The National Center for Standards and Certification Information (NCSCI) serves as a central depository for standards-related information in the U.S., providing access to standards, technical regulations, and related documents published by the U.S. and foreign governments, and domestic, foreign, and international private sector standards organizations. NCSCI responds to domestic and foreign requests for

information on U.S., foreign, regional, and international standards, technical regulations, and conformity assessment procedures. Other activities include: access to the Network of Information Centers of the International Organization for Standardization (ISONET); serving as the U.S. inquiry point under the Agreement on TBT of WTO. NCSCI operates the U.S. NAFTA inquiry point, which provides information about standards and technical regulations of the NAFTA countries. The center also operates two telephone "hotlines" that offer weekly updates on draft European standards and proposed foreign regulations.

The Measurement Services Division supports industry and commerce with programs on Standard Reference Data, Standard Reference Materials, Calibration and Testing. Through these programs the measurement standards and services generated in the technical laboratories of NIST are provided to meet the needs of state and local governments, federal agencies, industry, and the scientific community for traceability, at necessary levels of accuracy, to national standards. These services provide expert guidance and services regarding legal metrology to state and local governments, business, and industry to ensure measurement uniformity, traceability, and equity in domestic and international commerce.

The Weights and Measures Division (WMD) promotes uniformity in U.S. weights and measures laws, regulations, and standards to achieve equity between buyers and sellers in the marketplace. In doing so, consumer confidence is enhanced, and U.S. businesses are able to compete fairly in the domestic and global marketplaces. WMD is organized into four program areas: the Legal Metrology Devices Group, the International Legal Metrology Group, the Laboratory Metrology Group, and the Laws and Metric Group. The International Legal Metrology Group (ILMG) of the TS Weights and Measures Division provides technical support for public and private sector standards-related activities. ILMG manages U.S. participation in the International Organization of Legal Metrology (OIML), a treaty organization that promotes global trade for harmonizing performance requirements for measuring instruments used in legal metrology.

Bilateral Activities

Argentina

A representative from the Global Standards and Information Group of the Standards Services Division (SSD) participated in the American National Standards Institute (ANSI) delegation visit to Argentina. The purpose of the visit was to promote communication and to develop closer ties between

the U.S. standards community and the standards organizations of Argentina, the Instituto Argentino de Normalizacion (IRAM) and the Argentine Accreditation Body (OAA). The aim of developing closer cooperation with these organizations and their counterparts in the U.S. is to help lead to harmonization of policy and technical positions in international standards organizations, and improve

understanding of each other's standards and conformity assessment systems.

Brazil

The Global Standards and Information Group of SSD held meetings in April 2002 with representatives with Associacao Brasileira de Normas Tecnicas (ABNT), the national standards body of Brazil. Closer cooperation with the U.S. was requested, and included possible training for ABNT staff and standards professionals, help to upgrade information technology for both conducting standards business and for developing standards.

Canada

A representative from GSIG of SSD met with the Standards Council of Canada in September of 2001 to discuss the "Export Alert" system. ExportAlert!, a free web-based service, electronically notifies U.S. industry subscribers of changes regarding foreign technical regulations proposed by members of the World Trade Organization (WTO). The National Center for Standards and Certification Information (NCSCI) of GSIG is the WTO U.S. inquiry point for non-agricultural products and is responsible for distributing notification to U.S. industry of proposed foreign technical regulations for review and comment as appropriate. The WTO requires its members to give notice of proposed regulations that might significantly affect trade. Using Export Alert! improves U.S. companies' awareness of proposals that might affect their business.

China

The Chief of the Measurement Services Division participated in an exchange visit to Beijing on scientific data activities, including discussions on the Committee on Data for Science and Technology of the International Council for Science (CODATA) program. The visit was sponsored by the U.S. National Academy of Sciences.

A representative from SSD was part of an ANSI delegation to China. The delegation met with officials from the China State Bureau of Technical Supervision (CSBTS) to learn about the current Chinese standards and conformity assessment system. The CSBTS was in the process of merging with the State Administration of Inspection and Quarantine (SAIQ) to become a new Ministry-level organization, the current State Administration for Quality Supervision, Inspection and Quarantines (AQSIQ). The new Ministry will review existing International Organization for Standardization (ISO)/International Electrotechnical Commission (IEC) standards to see which standards are appropriate for Chinese adoption, and will aid in China's accession to the WTO.

NIST has promoted the implementation of a voluntary consensus standard on wireless networks, the Institute of Electronics and Electrical Engineers (IEEE) Standard 802.16 in China. It was developed by IEEE Working Group on Broadband Wireless Access with participation of many countries, including China.

Ecuador

A representative from the Global Standards and Information Group of the Standards Services Division worked with German Physikalisch-Technische Bundesanstalt (PTB) staff in September 2002 on an exchange of information on standards and technical regulations with Ecuador.

Egypt

Representatives from SSD were part of a U.S. delegation for a three-day seminar, held January 2002 in Cairo. The seminar, sponsored by the Department of Commerce's Commercial Law Development Program (CLDP), and the Egyptian Ministry of Industry for Standardization and Quality Control (EOS), and was funded by the U.S. Agency for International Development (USAID). The seminar was to introduce and discuss U.S. concepts, approaches, and methods in standards and conformity assessment.

Germany

The Measurement Services Division works with Fachinformationszentrum (FIZ) Karlsruhe on the Inorganic Crystal Structure Database (ICSD). This database is a comprehensive compilation of crystal structure data of inorganic compounds. ICSD contains records of all inorganic crystal structures, with atomic coordinates, published since 1915. The data base contains 64,734 structures as of December 2002. It is updated twice a year, each update comprising about 2000 new records. All data are recorded by experts and are checked several times. The multiple search options, calculation software, and graphical representations are enhanced and updated continuously. The product portfolio covers two PC versions (Windows, DOS) an internet version and various intranet versions (UNIX, Linux). Production, quality control, and software development are coordinated by Fachinformationszentrum Karlsruhe. A new PC-Windows version has been developed in co-operation with NIST. The WWW interface was programmed by Institut Laue Langevin (ILL). FIZ Karlsruhe also collaborates with the Measurements Services Division in contributing to CODATA.

The Global Standards and Information Group, SSD, collaborated with PTB on the planning and implementation of a seminar on laboratory accreditation for participants from developing

accreditation bodies in Latin America and the Commonwealth of Newly Independent States (NIS). The three-day seminar was held in Berlin in the fall of 2002, and focused on shared experience and a chance for interactive dialogue about common challenges facing developing accreditation bodies. This seminar was a follow-up on accreditation issues for developing economies. The seminar included informational sessions on marketing accreditation services and the use of the NIST intercomparisons database to find measurement capabilities for various national metrology institutes (NMIs). Questions were incorporated into the program to help identify the most serious obstacles to establishing effective accreditation systems, possible novel solutions, and steps to implementing new ideas. Through this joint seminar, NIST and PTB demonstrated the shared interests of the two institutes, and avoided duplication of effort, and to maximize the impact of the respective technical assistance programs.

India

As part of the Asia Pacific Laboratory Accreditation Cooperation (APLAC) Mutual Recognition Arrangement (MRA), the National Voluntary Laboratory Accreditation Program (NVLAP) of SSD has an on-going relationship with the National Accreditation Board for Calibration and Testing Laboratories (NABL), which is located in New Delhi, in the area of laboratory accreditation.

NIST has supported a Standards Representative's Office at the Indian National Physical Laboratory (NPL) in New Delhi. NPL is India's major laboratory for physical and chemical standards. NIST is using a local contractor, who collects information on standards, conformance testing, and trade practices. The NIST contractor also collaborates with the U.S. Foreign Commercial Service, the American business community, the Bureau of Indian Standards, Indian Customs Department, and other organizations involved in clearing American imports to India.

Japan

The Chief of the Measurement Services Division (MSD) served on a review panel in February of 2001 for the Research Institute on Artifacts, Center for Engineering, at the University of Tokyo, Awaji Island.

SSD hosts an Annual Information Exchange between NIST and the Japanese Ministry of Economy, Trade and Industry (METI). These meetings represent a continuing dialogue that is aimed at building lasting cooperative relationships between the two agencies. Discussions regarding specific areas for cooperative standards development activities are targeted; current cooperative activities include color management, boilers and pressure vessels, iron and steel, electrical

safety, and electromagnetic compatibility. The two agencies have agreed to work together in technical assistance activities within the Asia-Pacific Economic Cooperation, the Association of Southeast Asia Nations (ASEAN), and the Global Relevance Initiative within the IEC.

Korea

Representatives of the United States and the Korean Agency for Technology and Standards (KATS) began having annual Dialogue Meetings on Standards and Conformity Assessment Issues in July of 2001, within the framework of the NIST-KATS MOU, which was signed in 2000. The Deputy Director of SSD hosted the meetings; with the Director of the International Standards Division of KATS, leading the Korean delegation. Participants discussed a joint project on standard test methods for fire tests of wood-frame assemblies, carried out under the memorandum. NIST and KATS also agreed that they share concerns on a draft measuring instrument directive currently before the European Council of Ministers and Parliament for comment. Additional areas of discussion included Korean toy certification requirements, training programs at NIST for Korean officials, and a possible U.S.-Korea Free Trade Agreement.

The Global Standards and Information Group is hosting a guest researcher from the Korean Agency for Technology and Standards (KATS) for one year. The guest researcher created training programs for KATS officials, drafted a publication on Korea's standards and conformity assessment system, planned and implemented a standards-related workshop for KATS personnel, and monitored activities under the NIST-KATS Memorandum of Understanding.

On July 18, 2002, the second annual Dialogue Meeting on Standards and Conformity Assessment Issues was held at NIST with KATS. The Director of SSD hosted the meeting, and the Director of the International Standards Division of KATS, led the Korean delegation. Several issues relating to the ISO and IEC, including elections to various boards and cooperation in pictogram and zinc standardization activities, were discussed, along with a review of the work being carried out by guest researcher from KATS in SSD. Joint projects on standards test methods for fire tests of wood-frame assemblies and for sharing comments on possible technical barriers to trade in other countries were other topics on the agenda.

From July 8-19, 2002, TS and the Korean Agency for Technology and Standards (KATS) co-sponsored a two-week Standards in Trade workshop. The 12 Korean participants represented KATS, two universities, and a private-sector testing laboratory.

The objectives of the workshop were to: familiarize participants with U.S. technology and practices in standardization, conformity assessment, and metrology; describe and understand the roles of the U.S. government and the private sector in developing and implementing standards; and develop professional contacts as a basis for facilitating trade. The workshop agenda briefings and panel discussion were supplemented with visits to ASTM International, MetLabs, and several NIST laboratories. A forum on the final day identified possible areas for collaboration in standards and conformity to facilitate trade between the U.S. and Korea. The participants suggested that future workshops be scheduled and that they be sector-specific. They also recommended that the U.S. and Korea cooperate to develop joint positions in the International Organization for Standardization (ISO) and the IEC.

Mexico

From August 20-21, 2002 a dialogue was held at NIST under the NIST – Mexico Implementing Agreement on Technical Cooperation. This dialogue took place with several of Mexico’s governmental agencies, including the Direccion General de Normas (DGN), the National Standards Body of Mexico of the Secretaria de Economia, the Centro Nacional de Metrology (CENAM), the National Center for Metrology in Mexico, and the Procuraduria General del Consumidor (PROFECO), the Office of the Federal Attorney General for Consumer Protection. The agenda focused on shared interests in legal metrology as well as regulations for the protection of consumer health, safety and the environment; the relationship between regulations and voluntary standards; conformity to standards and regulations and laboratory accreditation.

Peru

The Global Standards and Information Group of SSD co-sponsored a course in October 2000, “The Accreditation Process According to ISO/IEC 17025” at the National Institute for the Defense of Competition and Protection of Intellectual Property (INDECOPI) in Lima. INDECOPI is the Peruvian organization responsible for accreditation. This course was a follow-up activity to the Standards in Trade Workshop for the Andean Community, which was held in June of 1997, and was designed primarily to offer an interpretation of the requirements posed by ISO/IEC 17025, “General Requirements for the

Competence of Testing and Calibration Laboratories”. The course was intended to offer a detailed description of the accreditation process and information about how a laboratory should prepare for accreditation.

Russia

Under the MOU between NIST and the State Committee of the Russian Federation for Standardization and Metrology (GOSSTANDART), GOSSTANDART, data is evaluated and contributed to the NIST Standard Reference Databases.

SSD provides the U.S. co-chair for the U.S. - Russia Standards Working Group under the Joint U.S. – Russia Business Development Committee. This Working Group is the primary vehicle for the two sides to exchange information on standards development and conformity assessment practices and activities in the two countries to facilitate harmonization and increase trade. Meetings of the Working Group have exposed Russian government participants to a wide range of U.S. standards developers (SDOs), providing them with an opportunity to pursue follow-on activities with their technical counterparts. With NIST assistance, two SDOs – the American Society of Mechanical Engineers (ASME), and the Society of Automotive Engineers (SAE) – have translated key standards into the Russian language. These standards will be made available in Russia and other NIS countries. Recent meetings of the Standards Working Group have been September 2001 in Washington, D.C. and June 2002 in Moscow. This standing relationship provides an important opportunity for NIST to share with GOSSTANDART the U.S. perspective on product safety regulations, the use of standards in technical regulations and other similar issues.

Trinidad and Tobago

A representative from GSIG of SSD facilitated the NIST-sponsored course, "The Accreditation Process According to ISO/IEC 17025”, in March of 2001, which took place at the Trinidad and Tobago Bureau of Standards (TTBS). The course was a follow-up to the Standards in Trade Workshop for the Caribbean, held in November 1998, and was designed primarily to offer interpretations of the requirements imposed by the recently-published international standards ISO-IEC 17025, “General Requirements for the Competence of Testing and Calibration Laboratories”.

Multilateral Activities

Asia and Pacific Region:

SSD works with the Office of the U.S. Trade Representative and with other U.S. Government Agencies to establish positions on standards,

technical regulations, and conformity assessment related issues in discussions and negotiations pertaining to Asian member economies. This work involves participation in the Asia-Pacific Economic

Cooperation (APEC) Sub-Committee on Standards and Conformance (SCSC), the Asia Pacific Laboratory Accreditation Cooperation (APLAC), the Asia-Pacific Legal Metrology Forum (APLMF), the Association of Southeast Nations (ASEAN), the ANSI Regional Standing Committee on Asia-Pacific, the Pacific Area Standards Congress (PASC), and the APEC Telecommunications MRA.

WMD participates in the Asia-Pacific Legal Metrology Forum (APLMF) to promote U.S. legal metrology practices and to facilitate harmonization of legal metrology standards throughout the Asia-Pacific region. As Chair of the APLMF Working Group on Mutual Recognition Agreements, WMD works to keep the APLMF informed and prepared to participate in the Mutual Acceptance Arrangement for Type Evaluation (MAA) under development in the International Organization of Legal Metrology (OIML).

Western Hemisphere:

The Global Standards and Information Group participates in many standards-related activities in the Western Hemisphere. The main goal is to coordinate many of the activities related to standardization that are taking place due to global and regional economic changes. These activities include participation in: InterAmerican Telecommunications Commission (CITEL); Free Trade Area of the Americas (FTAA) on Standards and Technical Barriers to Trade; North American Free Trade Agreement (NAFTA) Standards Related Measures (SRM) Committee; Chile Free Trade Agreement (FTA); Pan American Standards Commission (COPANT); Interamerican Accreditation Cooperation (IAAC); American National Standards Institute Regional Standing Committee for the Americas (ANSI-RSC-A) ; and the InterAmerican System of Metrology (SIM).

- **InterAmerican Telecommunications Commission (CITEL):** NIST is the U.S. designating authority for U.S. conformity assessment bodies (CABs) under the InterAmerican Telecommunications Commission (CITEL) Mutual Recognition Arrangement (MRA) on Telecommunications Equipment. The GSIG participated in a MRA workshop and meetings of the CITEL, which included approximately 150 representatives from government and industry in 18 countries. The countries that are ready to implement the MRA are the U.S., Canada, and Brazil. NIST continues to play a major role in the InterAmerican Telecommunications MRA by

providing education for other economies at workshops on the MRA process and implementations, promoting the CITEL agreement, and elimination of technical barriers to trade.

- **Pan American Commission of Technical Standards (COPANT):** NIST is an active participant in the work of the Pan-American Standards Commission (COPANT) and has attended numerous meetings held throughout the hemisphere. NIST participates as part of the delegation led by the American National Standards Institute (ANSI). NIST has partially funded and worked closely with ANSI to upgrade the COPANT home page, which establishes a web-based hemispheric network for standards information. This was part of a three-year restructuring campaign to enable this regional organization to respond more quickly and more appropriately to the needs of the national standards bodies that constitute its membership. NIST is continuing to work closely with ANSI and participate actively in COPANT committees where contributions can be made to regional standardization efforts, such as the committee for elector-technical issues. This cooperation further supports the National Technology Transfer and Advancement Act (NTTA), which directs NIST to coordinate with the private sector on standards and conformity assessment issues. Working in COPANT enhances the ability of all countries in the hemisphere to support technical standards, certification, and other standards-related activities in the Free Trade Area of the Americas intended to reduce standards as technical barriers to trade.
- **Inter-American Accreditation Cooperation (IAAC):** NIST is also an active participant in the work of the Inter-American Accreditation Cooperation (IAAC) and has chaired Working Group 1 for the last four years. NIST representatives have also been an invited speaker in the IAAC seminars that are held jointly with the IAAC annual meeting.
- **North American Calibration Cooperation (NACC):** NVLAP chairs the North American Calibration Cooperation (NACC), in which the United States, Canada, and Mexico are working toward mutual

recognition of their respective calibration laboratory accreditation programs.

European Union (EU)

SSD has published two additional guides in its series addressing European Union (EU) directives. These guides address the EU's directives on radio and telecommunications terminal equipment and product liability. The introductory references are designed to acquaint businesses and government officials with the directives' essential requirements and their relationship to other EU product safety laws. The guides lists the types of products covered by the directives, as well as those that are excluded.

International Comparisons Database (ICDB)

TS has continued the development of the International Comparisons Database (ICDB), compiling information on international comparisons NIST has been involved with in the last 10 years. The ICDB provides access to results of comparisons of National Metrology Institute (NMI) measurements and standards. The ICDB serves the U.S. and the Inter-American System of Metrology (SIM) with information based on Appendices B and D of the Comité International des Poids et Mesures (CIPM) Mutual Recognition Arrangement (MRa). The official source of the data is The BIPM key comparison database. The National Institute of Standards and Technology (NIST) signed the CIPM MRa at a meeting of directors of NMIs on October 14, 1999 in Paris during the 21st quadrennial meeting of the General

Conference on Weights and Measures. The database will eventually contain the measurement and calibration capabilities of the NMIs referred to as Appendix C in the CIPM MRa. This version of the database contains the key and supplementary comparisons identified by the CIPM and carried out by the Consultative Committees, the BIPM, and the Regional Metrology Organizations. For comparisons that have been completed and results submitted, users can query the database for these results and for the degree of equivalence between any two sets of results or between a set of results and the comparison reference value. The official source of the data is the BIPM key comparison database.

Awards

Krista Johnsen, of the Technical Standards Activities Program (TSAP), was awarded an Alexander von Humboldt Foundation German Chancellor Scholarship during 2001. Her focus was on policy issues related to international standards in the telecommunications industry, dealing with the implementation of third-generation wireless telecommunications in Germany, the United States and Europe, and working with the standardization body for telecommunications in Frankfurt and at the German Institute for Standardization (Deutsches Institut fuer Normung, or DIN) in Berlin. The goal is to explore how Germany, its European Union partners, and the United States establish and maintain commercial or voluntary product standards.

International Committee Participation

TS staff supports the incorporation of U.S. standards and practices into international standards through active cooperation in international standards developing organizations such as the International Organization for Standardization (ISO), International Electrotechnical Commission (IEC), the International Laboratory Accreditation Cooperation, and the International Organization of Legal Metrology (OIML). Representatives from TS also participate in other committees and cooperation groups, some already mentioned under multilateral cooperation include:

- Pan American Commission of Technical Standards (COPANT);
- Free Trade Association Area (FTAA) Market Access Negotiation Group;

- International Laboratory Accreditation Cooperation (ILAC);
- Inter-American Accreditation Cooperation (IAAC);
- North American Calibration Cooperation (NACC);
- National Cooperation on Laboratory Accreditation (NACLA);
- Organization of American States (OAS);
- InterAmerican System of Metrology (SIM);
- U.S.-EU Mutual Recognition Arrangement (MRa) Task Force;
- United Nations/Economic Commission for Europe (UN/ECE) Working Party on Technical Harmonization and Standardization Policies; and

- World Trade Organization Technical Barriers to Trade (WTO TBT).

As the world's largest program in producing reliable, evaluated data in the physical and engineering sciences, NIST, and in particular the MSD staff, has traditionally played key roles in the activities of Committee on Data for Science and Technology of the International Council for Science (CODATA). In turn, this exposes NIST to the latest worldwide ideas in data management and establishes relationships critical for building bilateral data partnerships. The Chief of SSD was elected as the President of CODATA for the 1998-2002 term.

The Chief of SSD was elected as International Laboratory Accreditation Cooperation (ILAC) Chair in October 1998. At a recent ILAC Executive committee meeting, the NIST position on the ILAC MRa and policy documents have been presented, and discussions held on some of the opposing points to this position, in order to look for ways to resolve the differences. Other issues related to the acceptance of the ILAC MRa to facilitate global trade by reducing the need for multiple recalibrations and retesting of products, to the benefit of U.S. industry.

The GSIG of SSD staff participate in committee meetings under the TBT Agreement of the WTO – *i.e.*, the information exchange center for coordinating

all notifications with the WTO Secretariat in Geneva on national proposed technical regulations and related conformance requirements. GSIG of SSD staff also participated in meetings of Working Party 6 of the UN/ECE. Working party discussions were held on international standardization issues. These discussions provided a critical background for NIST contributions to the development of a National Standards Strategy for the U.S. TBT Agreement provision.

WMD staff represent the U.S. in the International Organization of Legal Metrology (OIML) on behalf of the U.S. Department of State. The U.S. serves as the Secretariat of 25% of the 68 Technical Committees and Subcommittees in OIML, spanning 122 work projects to develop technical standards used in the regulation of measuring instruments such as scales, meters, thermometers, and pollution monitors.

A WMD staff member serves on the Joint Committee for Guides in Metrology (JCGM) and its two Working Groups, WG1 on the "Guide to the Expression of Uncertainty in Measurement" and WG2 on the "International Vocabulary of Basic and General Terms in Metrology". The staff member also co-chairs the Technical Advisory Group 4, on metrology, of the ISO.

Workshops and Conferences

Standards in Trade (SIT) Workshops

The GSIG conducts different training programs intended to familiarize participants from developing nations with U.S. standards and conformity assessment practices. The Standards in Trade (SIT) program is sponsored by the Department of Commerce and carried out by NIST. In this program, NIST invites speakers from relevant Federal agencies, standards-developing organizations (SDOs), and industry and trade associations to address topics of particular relevance to the attendees. The workshops typically focus on a particular sector of interest.

A representative from GSIG participated in a Department of Commerce (DoC) training activity for standards officials from the Egyptian Organization for Standardization (EOS). The training, held from January 17-28, 2002, was a follow-up activity to previous trainings carried out by the Commercial Law Development Program (CLDP) of the DoC, with assistance by NIST.

GSIG of SSD co-sponsored a one-week workshop entitled "Electrical Safety Systems in the Asia-Pacific," March 18-22, 2002 in conjunction with U.S. standards developers and trade associations. A selected group of 23 expert representatives from public and private sector organizations in Indonesia, Malaysia, Philippines, Singapore, Thailand, and Vietnam discussed electrical safety systems for commercial buildings, industrial plants and homes with the objective of exploring possible joint projects for increased electrical safety in the region. The U.S. sponsors included NIST, the American National Standards Institute, the International Code Council Inc., Intertek Testing Services, the National Electrical Manufacturers Association, the National Fire Protection Association, and Underwriters Laboratories. Workshop topics addressed the development and implementation of the safety of electrical systems in the U.S. and other participating countries. Areas covered include the electrical installation code, electrical product standards, product testing and certification, and inspection and enforcement. For each topic, participants described

their countries' respective practices, including the evolution for their systems

NIST and the International Trade Administration (ITA) of the DoC co-sponsored a training session on building and construction, held from April 2-3, 2002 in Bandar Seri Begawan. The session was co-sponsored with the Construction Planning and research unit of the Ministry of Development of Brunei Darussalam. Seven U.S. representatives and six individuals from ASEAN member countries participated in training more than 35 representatives from public and private sector organizations in Brunei Darussalam, Indonesia, Malaysia, Philippines, Singapore, Thailand, the U.S. and Vietnam. U.S. participant organizations were the International Association of Plumbing and Mechanical Officials, the International Code Council, Inc., and the National Fire Protection Association. The two-day program was carried out with the ASEAN Consultative Committee on Standards and Quality. Presentations covered building codes and standards, model code organizations, standards development processes, building regulatory systems, the code review and permitting process, the use of performance-based standards in building material, and testing and certification. The basic differences between the U.S. and ASEAN standards systems and building regulatory processes were discussed, and the group indicated their desire to have similar exchanges of information in the future.

GSIG of SSD sponsored a two-week workshop in July 2002, entitled "From the Laboratory to the Marketplace", for 20 representatives from the Gulf Cooperation Council (GCC) countries of Bahrain, Kuwait, Oman, Qatar, Saudi Arabia, and the United Arab Emirates. The program addressed a number of scientific and legal metrology issues, with several presentations provided by NIST and private sector representatives. The goal was to share information about U.S. weights and measures standards, test procedures, inspections, and enforcements practices. Several sites, including the Advanced Measurement Laboratory, the Maryland State Weights and Measures Laboratory, and a Safeway grocery store were visited to supplement classroom activities. Participants also observed the activities of the National Conference of Weights and Measures (NCWM) in Cincinnati, Ohio, and saw firsthand how U.S. regulators and private-sector bodies work together to develop and apply uniform weights and measures standards to commercial transactions. At the conclusion of the workshop, participants had a better understanding of the role of weights and measures in ensuring equity and confidence in the

marketplace and the numerous positive outcomes that include uniformity, minimized trade barriers to interstate commerce, consumer protections, and increased opportunities for international trade that come about as a results of the work of the NCWM.

GSIG of SSD and the Commercial Law Development Program (CLDP) of the Department of Commerce co-sponsored a two-day seminar in Gaithersburg for officials from the Egyptian Organization for Standardization and Quality Control (EOS) in July 2002. The seminar was part of a two-week visit by 14 EOS officials to the U.S. to learn about U.S. standards and conformity assessment systems. The two-day seminar addressed a number of topics, including overviews of the U.S. government's role in standards, the U.S. conformity assessment systems, the World Trade Organization Agreement on Technical Barriers to Trade, laboratory accreditation, NIST activities in Egypt and other countries, and the standards role of the U.S. private sector. Seminar participants recommended that NIST and EOS collaborate further in standards-related activities through additional exchanges of personnel and sector-specific seminars.

GSIG of SSD hosted a SIT workshop for Korea in July 2002; additional information can be found above in the section on Bilateral Activities section, Korea.

Conformity Assessment

The GSIG conducts workshops on standards and conformity assessment for public and private sector officials, largely from the Americas, but also for Asia and the Middle East.

GSIG of SSD and private-sector representatives co-sponsored a workshop, entitled "Conformity Assessment in the Americas," during the week of April 23, 2001. A selected group of 24 experts from Argentina, Brazil, Canada, Chile, Colombia, Mexico, Peru, Uruguay, and the United States discussed conformity assessment practices and enforcement issues. The objective was to explore possible joint projects to facilitate trade in the Americas. The non-NIST sponsors were the American National Standards Institute (ANSI) and Intertek Testing Services. The workshop addressed: (1) quality systems certification; (2) third-party product certification; (3) self-declaration of conformance; (4) the use of the private sector in regulatory conformity assessment; and (5) product safety and performance. The workshop participants recommended several action items, such as collating lists (by NIST) of official contacts throughout the region in order to provide alerts when the U.S. government (or other

countries) ban importation of items that might otherwise be trans-shipped and working collectively to increase effective hemispheric participation in international fora.

NIST hosted a workshop, entitled "Conformity Assessment in the Americas" during the first week of October 2001. A selected group of 17 experts from Central America, the Caribbean, South America, and the United States discussed conformity assessment practices and enforcement issues. The objective was to explore possible joint projects to facilitate trade in the Americas. The workshop addressed quality systems certification, third-party product certification, self-declaration of conformance, and the use of private sector in regulatory conformity assessment. The workshop participants recommended several action items.

Another workshop was held in Bogota, "Conformity Assessment Systems in the U.S. and Colombia", in November of 2001.

Special American Business Intern Training (SABIT) Workshops

In conjunction with the ITA, GSIG of SSD periodically hosts delegates from Uzbekistan, Kyrgyzstan, Russia, Ukraine, Kazakhstan, and Moldova to participate in Special American Business Intern Training (SABIT). These workshops are part of a continuing partnership between NIST and the SABIT program, which has conducted more than twenty technical workshops during the last five years. During FY 2001-2002, SSD has participated in six SABIT workshops, two in telecommunications, one on medical equipment, one in chemicals, one on information technology, and one on the oil and gas industry. Each seminar includes presentations on the

U.S. approach to standards and conformity assessment; discussions of appropriate standards, equipment, and certification procedures; and regulatory practices in the United States. If possible, representatives from the private sector also participate. Tours of facilities in the appropriate industrial area are arranged.

Other Workshops

NIST was a co-host and active participant in the International Laboratory Accreditation Cooperation (ILAC) 2000 General Assembly, held from October 30 to November 3, 2000 in Arlington, VA. ILAC is the world's principal international forum for the development of laboratory accreditation practices and procedures, and the promotion of laboratory accreditation as a trade facilitation tool, the assistance of developing accreditation systems, and the recognition of competent test facilities around the globe. Several representatives of Technology Services gave presentations in workshops on laboratory accreditation and international trade, participated in ILAC committee activities, and represented NIST in the General Assembly. A major achievement was the signing of an ILAC MRa by NVLAP and 36 other laboratory accreditation bodies from a total of 28 economies around the world. Also, at the conclusion of the General Assembly meeting, the Director of the Office of Standards Services, ended her chairmanship of ILAC and turned over the gavel to the new Chair, the CEO of the South African National Accreditation System (SANAS).

GSIG personnel participated in MRa implementation meetings in Europe, Asia and Latin America. These meetings are instrumental in preparing guidance documents and MRa databases, and in understanding foreign regulatory requirements.

Appendix I: NIST International Agreements

MEMORANDA OF UNDERSTANDING

COUNTRY	DATE SIGNED	TERMINATION DATE	COMMENTS
Argentina	September 30, 2002	September 29, 2007	MOU with the National Institute for Industrial Technology (INTI) of the Secretariat of Industry for cooperation in chemistry, physics, and engineering measurement science.
Brazil	April 10, 2002	April 9, 2007	MOU with the National Institute of Metrology, Standardization and Industrial Quality (INMETRO) for cooperation in chemistry, physics and engineering measurement sciences.
Brazil	May 5, 2000	May 4, 2005	MOU with the Instituto de Pesquisas Tecnológicas (IPT) concerning technical cooperation in chemistry, physics, and engineering measurement sciences
Canada	March 23, 1992	Indefinite	MOU with the Communication Security Establishment (CSE) in information security.
Canada	May 23, 1992	Indefinite	MOU with the Treasury Board Secretariat (TBS) in standards and metrology.
Canada	April 28, 1992	Indefinite	MOU with the Canada Treasury Board Secretariat, Administrative Policy Branch in standardization supporting government administration.
Czech Republic	September 3, 1999	September 2, 2004	MOU with the Czech Office for Standards, Metrology, and Testing (COSMT).
Ecuador	June 10, 1999	June 9, 2004	MOU with the Ecuadorian Institute Standardization (INEN) for cooperation in chemistry, physics, engineering measurements.
Egypt	December 16, 1996	April 21, 2007 (extended)	MOU with the National Institute for Standards (NIS) for cooperation in measurement sciences in chemistry, physics and engineering related to standards and conformity assessment.
Finland	May 30, 2002	May 29, 2007	MOU with the National Technology Agency of the Republic of Finland (TEKES) for cooperation in manufacturing engineering, information technology, materials science, building technology, and engineering measurement sciences, standards-related activities and interchange of technical information and experiences.
Germany	May 12, 2000	May 11, 2005	MOU between NIST and the Physikalisch-Technische Bundesanstalt (PTB) and the Bundesanstalt für Materialforschung und –Prüfung (BAM) was signed by Ray Kammer, Director of NIST in Berlin, Germany in support of scientific and technical cooperation in chemistry, physics and engineering measurement sciences, materials technology, standards-related activities and the interchange of technical information and experiences

Japan	October 29, 1999	October 28, 2004	MOU with the Nippon Telephone and Telegraph Corporation (NTT) for cooperation in basic science and telecommunications.
Kenya	December 3, 1998	December 3, 2003	MOU with the Kenya Bureau of Standards (KEBS) for technical cooperation in chemistry, physics, and engineering measurement sciences
Korea	April 1, 2000	March 31, 2005	MOU with the Korean Research Institute of Standards and Science (KRISS) for cooperation in chemistry, physics, and engineering measurement sciences.
Korea	May 9, 2000	May 8, 2005	MOU with the Korean Agency for Technology and Standards (KATS) for cooperation relating to standardization, conformity assessment and legal metrology
Russia	March 23, 1998	March 22, 2003	MOU with the State Committee of the Russian Federation for Standardization, Metrology and Certification (GOSSTANDARDT) for cooperation in standards, conformity and metrology.
Russia	July 16, 1996	Under negotiation	MOU with the Russian Academy of Sciences (RAS) for cooperation on chemistry, physics and engineering sciences.
Saudi Arabia	July 29, 2000	July 28, 2008 (extended)	MOU with Saudi Arabian Standards Organization (SASO) for technical cooperation in standards and related activities.
South Africa	July 23, 1996	July 22, 2006	MOU (extended) with the CSIR, a Body Corporate established in terms of the Scientific Research Council Act 1988 for cooperation in chemistry, physics and engineering measurement sciences.
NIST/AIT	January 2, 1997	Indefinite	Cooperative Program in Physical Sciences between the American Institute in Taiwan (AIT) and the Taipei Economic and Cultural Representative Office (TECRO) in the U.S.
Multilateral	May 15, 1990	Indefinite	MOU with six countries to establish COMAR-computer access to Certified Reference Materials (CRMs).
Multilateral	January 25, 1995	Indefinite	MOU with the twenty-seven countries in five regions (NORAMET, CAMET, CARIMET, ANDIMET and SURAMET) of the Interamerican Metrology System.
Multilateral	March 10, 1996	March 11, 2005 (extended)	MOU with the Standardization and Metrology Organization for the Gulf Cooperation Council (GCC) Countries for technical cooperation in standards activities.
Regional	April 4, 1995	April 3, 2002	MOU for Asia Pacific Laboratory Accreditation Cooperation (APLAC).
Regional	April 26, 2000	April 25, 2002 (automatic two year renewal)	MOU with Asia-Pacific Legal Metrology Forum (APLMF).

OTHER AGREEMENTS

COUNTRY	DATE SIGNED	TERMINATION DATE	COMMENTS
Canada	August 9, 1995	Indefinite	Implementing Agreement with the Communication Security Establishment (CSE) for cryptographic module validation.
European Union	October 5, 1999	October 4, 2004	Implementing Arrangement for cooperation in the fields of metrology and measurement standards.
Germany	June 24, 1997	December 31, 2002	Cooperative Project among Fachinformationszentrum Karlsruhe (FIZ) and Gmelin-Institute für Anorganische Chemie der Max-Planck-Gesellschaft zur Förderung der Wissenschaften to develop a crystallographic structural database for inorganic substances.
Hungary	November 22, 1984	indefinite	Implementing Agreement under Article II and III of the Agreement on Cooperation in Culture, Education, Science and Technology for exchange of scientists, and information with the Research Institute for Technical Physics.
Japan	March 21, 1996	indefinite	Project agreement with the Communications Research Laboratory (CRL) to pursue contractual arrangement to construct and evaluate an optically pumped primary frequency standard. (PL)
Japan	January 30, 2003	January 29, 2008	Cooperation Agreement with the National Institute for Materials Science (NIMS) of Japan concerning technical cooperation in the fields of materials science and engineering measurement science.
Japan	July 17, 2001	July 16, 2006	Cooperation Agreement with the National Institute of Advanced Industrial Science and Technology (AIST) for cooperation in the field of measurement standards.
Korea	November 2, 2000	November 1, 2005	Research Agreement with the Energy Conservation Research Department of the Korean Institute of Energy Research (KIER) in the area of energy technology.
Korea	September 26, 1995	November 1, 2005 (extended)	Implementing Agreement under the Science and Technology umbrella agreement with the Korea Institute of Energy Research (KIER) to exchange science and technology knowledge and conduct joint research in energy technology. (BFRL)
Korea	April 26, 2001	May 8, 2005	Project Annex to the MOU with the Korean Agency for Technology and Standards (KATS) on determination of comparability of Korean and U.S. standards for testing wood frame assemblies.
Korea	July 8, 2003	July 7, 2006 (extended)	Project Annex to the MOU with the Korean Agency for Technology and Standards (KATS) on determination of comparability of Korean and U.S. test methods and tools for B2B software integration.
Korea	July 13, 2004	July 12, 2005	Project Annex to the MOU with the Korean Agency for Technology and Standards (KATS) on development of nano-bio reference materials and measurements using fluorescence semiconductor nanocrystals.

Korea	July 16, 2004	(none)	Statement of Intent with the Korean Agency for Technology and Standards (KATS)
Mexico	December 4, 1996	January 20, 2007 (extended)	Implementing Arrangement with the National Council for Science and Technology (CONACYT), the Secretary of Commerce and Industrial Development (SECOFI) and the National Center for Metrology (CENAM) for cooperation in chemistry, physics, engineering measurement sciences, and standards related activities.
Mexico	July 13, 1999	January 20, 2007 (extended)	Project Annex with CENAM for Mutual Recognition of Measurement Capabilities.
The Netherlands	August 10, 1999	October 17, 2004	Memorandum of Cooperation with The Netherlands Measurement Institute (NMI) to demonstrate intercomparison of primary gas mixtures.
The Netherlands	September 16, 1999	July 1, 2004	Declaration of Equivalence with the Netherlands Measurements Institute-NMI for primary standard gas mixture.
Republic of South Africa	May 19, 1998	July 22, 2001	Annex with CSIR of the Republic of South Africa concerning Technical Cooperation in Chemistry, Physics, and Engineering Sciences.
Russia	November 9, 1994	November 8, 2003	Letter of Agreement with the Institute of Experimental Meteorology SPA Typhoon to develop ocean based reference materials.
American Institute in Taiwan/Taiwan	November 2, 1994	indefinite	Implementing Agreement with the Telecommunications Laboratories (TL) through American Institute in Taiwan (AIT) and the Taipei Economic and Cultural Representative Office (TECRO) or (CCNAA) for telecommunications.
Multilateral	September 3, 2001	January 2004	Research Cooperation Agreement between the National Microelectronics Center of Spain, Nanotechnology Research Institute, National Institute of Advanced Industrial Science and Technology of Japan, and NIST
Multilateral	December 10, 1997	indefinite	Mutual Recognition Agreement with the Asian Pacific Laboratory Accreditation Cooperation (APLAC).
Multilateral CIPM MRa	October 14, 1999	indefinite	Mutual Recognition Arrangement between National Metrology Institutes for recognition of National Measurement Standards and of Calibrations, and Measurement Certificates.
Multilateral	October 5, 1999	October 4, 2004	Implementing Arrangement with the European Commission for Cooperation in the fields of Metrology and Measurement Standards.
Multilateral	November 2, 2000	-	Mutual Recognition Arrangement with the International Laboratory Accreditation Cooperation (ILAC) to enhance trade
Regional	October 31, 1997	-	Memorandum of Cooperation between the Inter-American Metrology System (SIM) and the Organization of Legal Metrology (OIML) to cover the fields of international and regional metrology and metrology-related activities

Regional

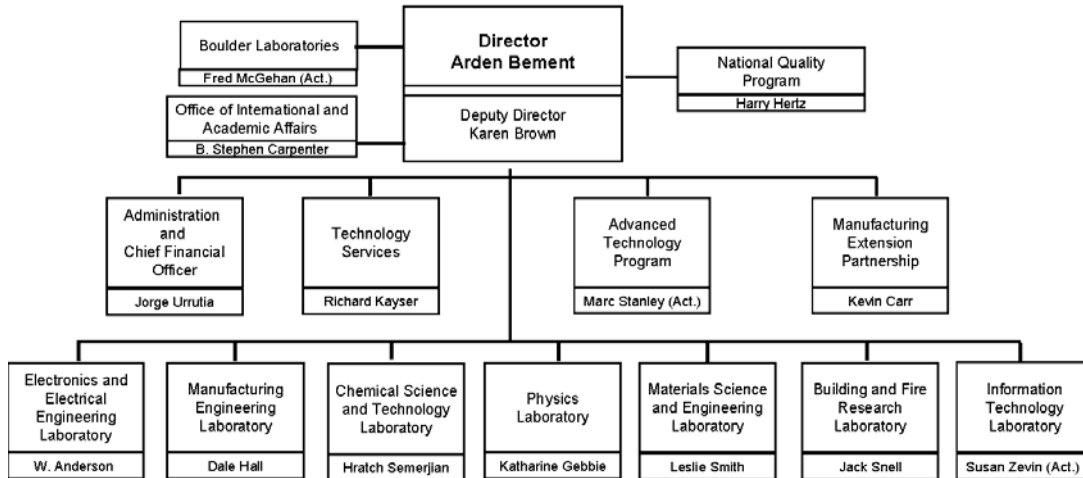
September 10, 1999

September 9, 2004

Memorandum of Arrangement with NORAMET on
Calibration and Measurement Certificates of NMI's.

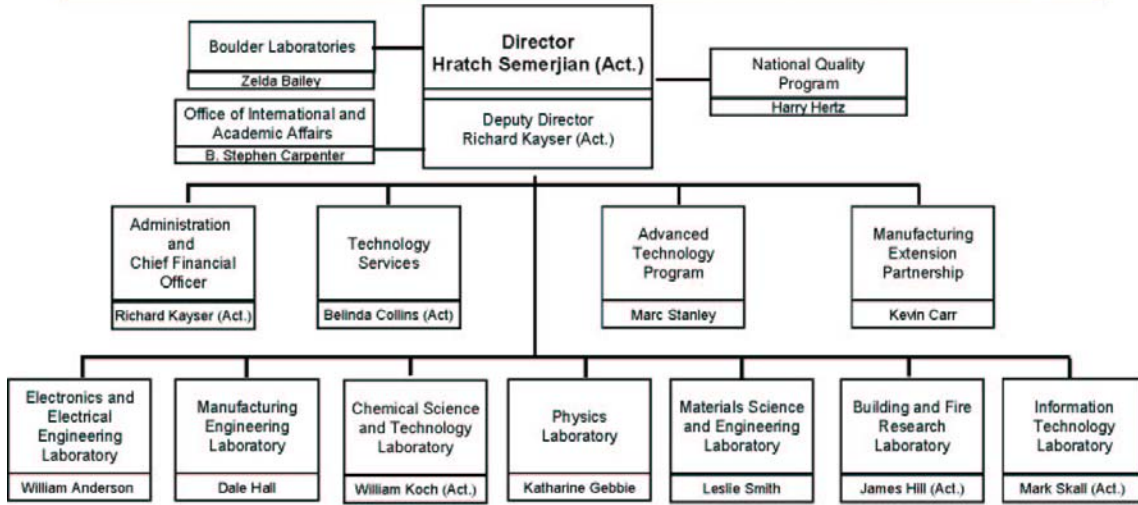
Appendix II: Organizational Chart (FY 2002)

National Institute of Standards and Technology



Appendix III: Organizational Chart (FY 2004)

National Institute of Standards and Technology



Appendix IV: List of Abbreviations

A

Automated Astrophysical Site Testing Observatory (AASTO)
Accreditation Body Evaluation Program (ABEP)
Associacao Brasileira de Normas Tecnicas (ABNT)
Automated Computer Telephone System (ACTS)
analytical electron microscopy (AEM)
Auger Electron Spectroscopy (AES)
Advanced Encryption Standard (AES)
Atomic force acoustic microscopy (AFAM)
Atomic Force Microscopy (AFM)
Advanced Global Atmospheric Gases Experiment (AGAGE)
Automated Guided vehicles (AGV)
Air-handling units (AHU)
Association for Information and Image Management International (AIIM)
American Institute of Steel Construction (AISC)
Agency of Industrial Science and Technology of Japan (AIST)
American Institute in Taiwan (AIT)
Automated Mass Spectral Deconvolution and Identification System (AMDIS)
Andean Countries Sub-region of SIM (ANDIMET)
American National Standards Institute (ANSI)
American National Standards Institute Regional Standing Committee for the Americas (ANSI-RSC-A)
Australian Nuclear Science and Technology Organization (ANSTO)
Asia-Pacific Economic Cooperation (APEC)
Application Programming Interface (API)
Asia-Pacific Laboratory Accreditation Cooperation (APLAC)
Asia-Pacific Legal Metrology Forum (APLMF)
Asia-Pacific Metrology Program (APMP)
State Administration for Quality Supervision, Inspection and Quarantines (AQSIQ)
Array of Real-time Geostrophic Oceanography (ARGO)
Administracion de Reglamentos y Permisos (ARPE)
Association of Southeast Asia Nations (ASEAN)
American Society of Mechanical Engineers (ASME)
ASTM (formerly the American Society for Testing and Materials)
Advanced Television Systems Committee (ATSC)
Advanced Technology Program (ATP)
Advanced Telecommunications Research Laboratory (ATR)
Automatic Fire Detection (AUBE)

B

Behind-Armor Blunt Trauma (BABT)
Bundesanstalt für Materialforschung und –Prüfung (BAM)
British Columbia Institute of Technology (BCIT)
Bose-Einstein condensate (BEC)
Building for Environmental and Economic Sustainability (BEES)
Berliner Elektronenspeicherring-Gesellschaft für Synchrotron-strahlung (BESSY)
Building and Fire Research Laboratory (BFRL)
Biometric Application Programming Interface (BioAPI)
Bureau International des Poids et Mesures, or International Bureau of Weights and Measures (BIPM)
U.S.-Israel Binational Industrial Research and Development (BIRD)
Bureau National de Metrologie (BNM)
Bureau of Measurements Central Laboratory of Industrial Electronics (BNM/LCIE)
Baldrige National Quality Program (BNQP)

Botswana Bureau of Standards (BOBS)
Binational Science Foundation (BSF)

C

Conformity Assessment Bodies (CABs)
Caribbean Countries Sub-region of SIM (CARIMET)
Community alliance for Math, Science, and Technology Literacy (CASTL)
Common Biometric Exchange File format (CBEFF)
Convergent-Beam Electron Diffraction (CBED)
Chemical and Biological Warfare (CBW)
Consultative Committee on Acoustics, Ultrasound, and Vibration (CCAUV)
Comité Consultatif d'Electricité et Magnétisme (CCEM)
Common Criteria Evaluation and Validation Scheme (CCEVS)
Consultative Committee on Length (CCL)
Consultative Committee for Mass and Related Quantities (CCM)
Common Criteria Management Committee (CCMC)
Common Criteria Recognition Arrangement (CCMRa).
Consultative Committee on Photometry and Radiometry (CCPR)
Comité Consultatif pour la Quantité de Matière (CCQM)
Consultative Committee on Ionizing Radiation (CCRI)
Consultative Committee on Thermometry (CCT)
Consultative Committee on Time and Frequency (CCTF)
Compact Disc (CD)
Commissariat à l'Énergie Atomique (CEA)
Constructions Electriques Industrielles Automatisées (CEIA)
Mexican Cement Corporation (CEMEX)
European Committee for Standardization (CEN)
Centro Nacional de Metrology (CENAM)
European Organization for Nuclear Research (CERN)
Continuing Education Units (CEU)
Philips Centre for Industrial Technology (CFT)
Center for Theoretical Physics of the Polish Academy of Science (CFT-PAN)
International Council for Research and Innovation in Building and Construction (CIB)
Commission Internationale de l'Éclairage (CIE)
Research Center for Energy, Environment, and Technology (CIEMAT)
Common Industry Format (CIF)
Comité International des Poids et Mesures (CIPM)
Computational Intelligence in Robotics and Automation (CIRA)
International Organization for Production Engineering Research (CIRP)
Cooperation on International Traceability in Analytical Chemistry (CITAC)
InterAmerican Telecommunications Commission (CITEL)
Commercial Law Development Program (CLDP)
Cross-Language Evaluation Forum (CLEF)
Calibration and Measurement Capabilities (CMC)
Coordinate Measuring Machine (CMM)
Complementary metal oxide semiconductor (CMOS)
Center for Measurement Standards (CMS)
Cryptographic Module Validation Program (CMVP)
Centre National de la Recherche Scientifique (CNRS)
Carbon Nanotube (CNT)
Committee on Data for Science and Technology of the International Council for Science (CODATA)
Central and Eastern Europe Metrology Program (COOMET)
Committee of the Pan-American Standards Commission (COPANT)
carbonyl sulfide (COS)
Czech Office for Standards, Metrology and Testing (COSMET)
Cold Quantum Gases (CQG)

Cooperation Research and Development Agreement (CRADA)
Civilian Research and Development Foundation (CRDF)
Communications Research Laboratory (CRL)
Certified Reference Material (CRM)
Coordinated Research Project (CRP)
Plasma Physics Research Center (CRPP)
China State Bureau of Technical Supervision (CSBTS)
Copper Strip Corrosion Test (CSCT)
Communications Security Establishment (CSE)
Center for Optoelectronics and Microfabrication (CSEM)
Cross Section Evaluation Working Group (CSEWG)
South African National Metrology Laboratory (CSIR)
Commonwealth Scientific and Industrial Research Organization (CSIRO)
Centre Scientifique et Technique du Batiment (CSTB)
Chemical Science and Technology Laboratory (CSTL)
Committee on Trade and Investment (CTI)

D

Defense Advanced Research Projects Agency (DARPA)
Digital TV Applications Software Environment (DASE)
Device Capability Dataset (DCD)
Dichlorodiphenyldichloroethane (DDE)
Data Encryption Standard (DES)
International Committee on Developing Country Matters (DEVCO)
Direccão Geral do Ambiente (DGA)
Dirección General de Normas (DGN)
Deutsches Institut für Normung (DIN)
Department of Commerce (DoC)
Department of Defense (DoD)
Department of Energy (DoE)
Document Object Model (DOM)
Defense Research and Development Canada (DREV)
Differential Scanning Calorimetry (DSC)
Digital Signature Standard (DSS)
Technical University of Denmark (DTU)

E

European Cooperation on Accreditation (EA)
Electron Beam Ion Trap (EBIT)
Electronic Book Exchange (EbX)
European Computer Manufacturers' Association (ECMA)
Electronics and Electrical Engineering Laboratory (EEEL)
Escrowed Encryption Standard (EES)
Electromagnetic Compatibility (EMC)
Equilibrium molecular dynamics (EMD)
Swiss Federal Laboratories for Materials Testing and Research (EMPA)
Environmental Management Systems (EMS)
Ecole Normale Supérieure (ENS)
Egyptian Ministry of Industry for Standardization and Quality Control (EOS)
Earth Observing Systems (EOS)
Environmental Protection Agency (EPA)
electron-probe microanalysis (EPMA)
electron paramagnetic resonance (EPR)
Ecole Supérieure d'Informatique et Applications de Lorraine (ESIAL)
European Synchrotron Research Facility (ESRF)

Electrotechnical Laboratory (ETL)
Electronics and Telecommunication Research Institute (ETRI)
European Metrology Program (EUROMET)
European Union (EU)
Emergency Warning Lights and Devices (EWL/D)

F

Federal Communications Commission (FCC)
fault detection and diagnostics (FDD)
Fundamental Electrical Measurement (FEM)
Federal Information Processing Standard (FIPS)
far infrared laser-magnetic-resonance (FIR-LMR)
Fachinformationszentrum (FIZ)
Finnish Meteorological Institute (FMI)
Forum for International Cooperation in Fire Research (FORUM)
Forum on Privacy and Security in Healthcare (FPSH)
Federation of Societies for Coatings Technology (FSCT)
Federation of Societies for International Coatings (FSCT)
Financial Services Technology Consortium FAST Working Group (FSTC)
Free Trade Agreement (FTA)
Free Trade Area of the Americas (FTAA)
Forensic Technology Inc. (FTI)
Fourier Transform Infrared Spectroscopy (FTIR)
Fiscal Year (FY)

G

Gamut Assessment Standards (GAS)
Gulf Cooperation Council (GCC)
Geographic Information Systems (GIS)
Genetically Modified Organism (GMO)
Government Open Systems Interconnection Profile (GOSIP)
State Committee of the Russian Federation for Standardization Metrology and Certification (GOSSTANDART)
Global Positioning System (GPS)
Government Smart Card (GSC)
Global Standards and Information Group (GSIG)
Radio-Frequency quantities (GTRF)

H

Hitachi Central Research Laboratory (HCRL)
High Density Storage Association (HDSA)
Hong Kong University of Science and Technology (HKUST)
High Performance Inductively-Coupled Plasma Optical Emission Spectrometry (HP-ICP-OES)
High Temperature Superconductivity (HTS)
Department of Housing and Urban Development (HUD)

I

Implementing Arrangement (IA)
Inter-American Accreditation Cooperation (IAAC)
International Atomic Energy Agency Laboratory (IAEA)
International Association of Fire Safety Science (IAFSS)
International Association for the Properties of Water and Steam (IAPWS)
Integrated Ballistics Identification Systems (IBIS)
Intercomparison (IC)
International Conference of Building Officials (ICBO)
International Common Criteria Conference (ICCC)

Inorganic Crystal Structure Database (ICSD)
Inter-American Development Bank (IDB)
International Comparisons Database (ICDB)
International Crown Fire Modeling experiment (ICFME)
International Commission on Radiation Units and Measurements (ICRU)
International Council for Science (ICSU)
International Energy Agency (IEA)
International Electrotechnical Commission (IEC)
Institute of Electronics and Electrical Engineers (IEEE)
National Electrotechnical Institute "G. Ferraris" (IEN)
Institute of Construction Science "Eduardo Torroja" (IETCC)
International Federation of Clinical Chemistry and Laboratory Medicine (IFCC)
Interactive Intelligent Remote Operations (IIRO)
International Laboratory Accreditation Cooperation (ILAC)
Institute Laue Langevin (ILL)
Institute of Microelectronics (IME)
International Legal Metrology Group (ILMG)
Interuniversity Microelectronics Consortium (IMEC)
International Measurement Confederation (IMEKO)
Institute of Metrology "G. Colonetti" (IMGC)
Institute for National Measurements Standards (INMS)
Interoperable MPI specification (IMPI)
Intelligent Manufacturing Systems (IMS)
Instituto de Astrofísica, Óptica y Electrónica (INAOE)
InterNational Committee for Information Technology Standards (INCITS)
Instituto Nacional de Defensa de la Competencia y de la Protección (INDECOPI)
Institute for Nuclear Energy Research (INER)
National Institute for the Physics of Matter (INFM)
Ecuador National Institute of Standardization (INEN)
National Institute of Metrology, Standardization and Industrial Quality (INMETRO)
Instituto Nacional de Normalización (INN)
Israeli National Physical Laboratory (INPL)
Immigration and Naturalization Service (INS)
Corporación de Investigación Tecnológica (INTEC)
National Institute for Industrial Technology (INTI)
Intergovernmental Personnel Exchange Agreement (IPA)
Institute for Energy and Nuclear Research (IPEN)
Intellectual Property Management and Protection (IPMP)
Instituto de Pesquisas Tecnológicas (IPT)
Infrared (IR)
Instituto Argentino de Normalización (IRAM)
Institute for Reference Materials and Measurements (IRMM)
International Symposium on Advanced Utilization of Research Reactors (ISAURR)
International Symposium on Advanced Radio Technology (ISART)
Intelligent Systems and Semiotics (ISAS)
International Symposium on Intelligent Control (ISIC)
Institute for Advanced Study of Materials and Mechanical Construction (ISMCM)
International Organization for Standardization (ISO)
Information Centers of the International Organization for Standardization (ISONET)
Information Systems Standards Board (ISSB)
Information Technology (IT)
International Trade Administration (ITA)
Information Technology Laboratory (ITL)
International Temperature Scale of 1990 (ITS-90)
Industrial Technology Research Institute (ITRI)
International Telecommunications Union (ITU)

International Union of Pure and Applied Chemistry (IUPAC)
In-Vitro Diagnostic (IVD)
In Vitro Diagnostics Directive (IVDD)
International Y2K Cooperation Center (IY2KCC)
Fraunhofer Institute for Nondestructive Testing (IZFP)

J

Japan Microgravity Center (JAMIC)
Joint Army-Navy-Air Force (JANAF)
Joint Committee for Guides on Metrology (JCGM)
Joint Committee for Regional Metrology Organizations (JCRM)
Joint Committee on Traceability in Laboratory Medicine (JCTLM)
Japan Fine Ceramic Center (JFCC)
Joint Optoelectronic Project (JOP)
Joint Photographic Experts Group (JPEG)
Joint Research Centre (JRC)
Japan Society for the Promotion of Science (JSPS)
Japan Testing Center for Construction Materials (JTCCM)
Josephson voltage standard (JVS)

K

Korea Advanced Institute of Science and Technology (KAIST)
Korean Agency for Technology and Standards (KATS)
Key comparisons (KCs)
Kenya Bureau of Standards (KEBS)
Korea Institute of Energy Research (KIER)
Korea Science and Engineering Foundation (KOSEF)
Korea Research Institute of Standards and Science (KRISS)

L

Next Generation Laser Radar Tracking (LADAR)
light-emitting diode (LED)
Advanced Laser Interferometric Gravitational-wave Observatory (LIGO)
Liquefied petroleum gas (LPG)
Low Temperature Co-Fired Ceramic (LTCC)
Low Temperature Superconductivity (LTS)

M

Molecular Measuring Machine (M3)
Mutual Acceptance Arrangement (MAA)
Manufacturing Advisory Centers (MAC)
Matrix-Assisted Laser Desorption Ionization (MALDI)
MPEG-7 Applications and Promotion to Industry (MAPI)
Malcolm Baldrige National Quality Award (MBNQA)
Master Builders (MBT)
Manufacturing Engineering Laboratory (MEL)
MicroElectroMechanical Systems (MEMS)
Middle East and North Africa Metrology Program (MENAMET)
Manufacturing Extension Program (MEP)
Swiss Federal Office of Metrology and Accreditation (METAS)
Ministry of Economy, Trade and Industry (METI)
Modeling and Simulation Environments for Design, Planning and operation of Globally-Distributed Enterprises (MISSION)
Massachusetts Institute of Technology (MIT)
Ministry of International Trade and Industry (MITI)

Molecular Modeling (MM)
Manufacturing Metrology Division (MMD)
Memorandum of Cooperation (MoC)
Ministry of Foreign Trade and Economic Cooperation (MOFTEC)
Memorandum of Understanding (MOU)
Moving Pictures Expert Group (MPEG)
Max-Planck-Institut fuer Metallforschung (MPI)
Message Passing Interface (MPI)
Mutual Recognition Agreement (MRA)
Mutual Recognition Arrangement (MRa)
Materials Reliability Division (MRD)
Measurement Services Division (MSD)
Materials Science and Engineering Laboratory (MSEL)
Minority Serving Institutions (MSI)

N

National Accreditation Board for Calibration and Testing Laboratories (NABL)
North American Calibration Cooperation (NACC)
National Cooperation on Laboratory Accreditation (NACLA)
North American Open Math Initiative (NAOMI)
National Center for Standards and Certification Information (NCSCI)
National Institute of Informatics (NACSIS)
North American Free Trade Agreement (NAFTA)
North American Interoperability Policy Council (NAIPC)
National Analytical Reference Laboratory (NARL)
National Academy of Sciences (NAS)
National Aeronautics and Atmospheric Administration (NASA)
North Atlantic Treaty Organization (NATO)
NIST Center for Neutron Research (NCNR)
National Conference on Building Codes and Standards (NCSBCS)
National Council of Teachers of Mathematics (NCTM)
National Conference on Weights and Measures (NCWM)
Nuclear Energy Agency Nuclear Science Committee (NEANSC)
Nippon Electric Corporation (NEC)
New Energy and Industrial Technology Development Organization (NEDO)
New Developments and Applications in Optical Radiometry (NEWRAD)
National Fire Protection Association (NFPA)
Next Generation Manufacturing Systems (NGMS)
non-government offices (NGOs)
National Information Assurance Partnership (NIAP)
National Institute of Environmental Studies (NIES)
National Institutes of Health (NIH)
National Institute of Justice (NIJ)
Near infrared (NIR)
National Industrial Research Institute of Nagoya (NIRIN)
National Institute for Standards (NIS)
Commonwealth of Newly Independent States (NIS)
National Institute of Standards and Technology (NIST)
Netherlands' Agency for Aerospace Program (NIVR)
Netherlands Measurement Institute (NMI)
National Metrology Institute (NMI)
National Metrology Institute of Japan (NMIJ)
National Measurement Laboratory (NML)
Nuclear Magnetic Resonance (NMR)
Nonlinear Network Measurement System (NNMS)
North American Countries Sub-region of SIM (NORAMET)

National Physics Laboratory, India (NPL)
National Physical Laboratory, United Kingdom (NPL)
National Research Council (NRC)
National Research Council Canada (NRCC)
National Research Institute for Metals (NRIM)
National Research Laboratory for Metrology (NRLM)
National Security Agency (NSA)
National Science Council (NSC)
National Science Foundation (NSF)
Near-field Optical Microscopy (NSOM).
National Science Teachers Association (NSTA)
National Telecommunications and Information Administration (NTIA)
NIST Traceable Reference Material (NTRM)
Nippon Telephone and Telegraph Corporation (NTT)
National Technology Transfer and Advancement Act (NTTA)
National Taiwan University (NTU)
National Voluntary Conformity Assessment Evaluation Program (NVCASE)
National Voluntary Laboratory Accreditation Program (NVLAP)

O

Organization of American States (OAS)
Organization for the Advancement of Structure Information Standards (OASIS)
Argentine Accreditation Body (OAA)
Office of Academic Affairs (OAA)
Office of International Affairs (OIA)
Office of International and Academic Affairs (OIAA)
Optical Internetworking Forum (OIF)
International Organization of Legal Metrology (OIML)
Office of Law Enforcement Services (OLES)
Ozone Monitoring Instrument (OMI)
Object Management Group (OMG)
Office of Microelectronics Programs (OMP)
Oficina Nacional de Normas Unidas de Medida (ONNUM)
Organization for the Prohibition of Chemical Weapons (OPCW)
Office of Standards Services (OSS)
Optical Storage Technology Association (OSTA)
Operating Unit (OU)
Office of Weights and Measures (OWM)

P

polycyclic aromatic compound (PAC)
Polycyclic Aromatic Hydrocarbon (PAH)
Primary Atomic Reference Clock in Space (PARCS)
Pacific Area Standards Congress (PASC)
Partnership for Advancing Technology in Housing (PATH)
polydimethylsiloxane (PDMS)
Precision Engineering Division (PED)
Protocol Implementation Conformance Statement (PICS)
Precision Instrument Development Center (PIDC)
Public Key Infrastructure (PKI)
Physics Laboratory (PL)
Polish Radioisotope Center (POLATOM)
Particle Physics and Astronomy Research Council (PPARC)
Procuraduria General del Consumidor (PROFECO)
Paul Scherrer Institute (PSI)
Photonics Technology Access Program (PTAP)

Physikalisch-Technische Bundesanstalt (PTB)
Public Works Research Institute (PWRI)
Lead Zirconate Titanate (PZT)

Q

Quality Assurance (QA)
Quantitative Electron Spectroscopy for Electron Spectroscopy Techniques (QUEST)
Quantized Hall Resistance (QHR)

R

Research and Development (R&D)
Russian Academy of Sciences (RAS)
International Association for Building Materials and Structures (RILEM)
Denmark National Research Laboratory (RISØ)
Regional Metrology Organizations (RMOs)
Rapid Thermal Processing (RTP)

S

Special American Business Intern Training (SABIT)
Society of Automotive Engineers (SAE)
Standards Council of Canada (SCC)
Source Code Control System Reference Material (SCCSR)M)
Sub-Committee on Standards and Conformance (SCSC)
Southern African Development Cooperation in Metrology (SADCMET)
Russian American Solar Neutrino Experiment (SAGE)
State Administration of Inspection and Quarantine (SAIQ)
South African National Accreditation System (SANAS)
Small-angle neutron scattering (SANS)
Saudi Arabian Standards Organization (SASO)
SAWS (Surface Acoustic Wave Spectroscopy)
Saudi Arabia Building and Fire Codes (SBC)
Sub-committee (SC)
Surface Chemical Analysis Technical Working Area (SCATWA)
Standards Conformity Program (SCP)
Smart Card Security Users Group (SCSUG)
Sub-millimeter Common User Bolometer Array (SCUBA).
Specification and Description Language (SDL)
Standards Developing Organizations (SDOs)
Secretaría de Comercio y Fomento Industrial (SECOFI)
Semiconductor Electronics Division (SED)
Scanning electron microscope (SEM)
Semiconductor Manufacturing Technology (SEMATECH)
Semiconductor Equipment and Materials International (SEMI)
Scanning Electron Microscopy with Polarization Analysis (SEMPA)
Synchrotron-light for Experimental Science and Applications in the Middle East (SESAME)
Silicon-based Single Electron Tunneling transistors (SETTs)
Standardization and Innovation in Information Technology (SIIT2001)
Interamerican System of Metrology (SIM)
Secondary Ion Mass Spectrometer (SIMS)
Standards in Trade (SIT)
Smart Repository for Industrial Data Management (SMART-IDM)
Small- and Medium-Sized Enterprises (SME)
Scanning Maxwell-Stress microscopy (SMM)
Society of Motion Picture and Television Engineers (SMPTE)
Sage III Ozone Loss and Validation Experiment (SOLVE)
South Pole Infrared Explorer (SPIREX)

Scanning Probe Microscopy (SPM)
Standard platinum resistance thermometer (SPRT)
Standardization, Quality Assurance and Metrology (SQAM)
Superconducting quantum interference devices (SQUIDS)
Standard Reference Database (SRD)
Standard Reference Material (SRM)
Standard Services Division (SSD)
Secondary Standard Dosimetry Laboratory (SSDL)
Science and Technology Agency (STA)
Vietnam Directorate for Standards and Quality (STAMEQ)
Scanning Transmission Microscopy (STM)
State University of New York (SUNY)
South American Countries Sub-region of SIM (SURIMET)

T

Technical Barriers to Trade (TBT)
Technical Committee (TC)
Technical Committee on Mass and Force (TC3)
Triple to Double Coincidence Ratio (TDCR)
Taipei Economic and Cultural Representatives Office (TECRO)
Transmission Electron Microscopy (TEM)
Transition-edge sensor (TES)
Third European Stratospheric Experiment on Ozone (THESEO-2000)
Thermodynamics Research Center (TRC)
Text Retrieval Conference (TREC)
U.S./Israel/Jordan Trilateral Industrial Development Initiative (TRIDE)
Technical Standards Activities Program (TSAP)
Trinidad and Tobago Bureau of Standards (TTBS)
Technical Working Area (TWA)

U

Upper Atmosphere Research Program (UARP)
Unmanned Guided Vehicles (UGV)
University of Hannover (UHANN)
University of Henri Ponciare (UHP)
University of Innsbruck (UINNSBRUCK)
U.S.-Japan Cooperative Program in Natural Resources (UJNR)
United Kingdom (UK)
Ultra-Large Scale Integration (ULSI)
Ulusal Metroloji Enstitüsü (UME)
National Autonomous University of Mexico (UNAM)
United Nations/Economic Commission for Europe (UN/ECE)
United Nations Industrial Development Organization (UNIDO)
United Nations Conference on Trade and Development (UNCTD)
United States Agency for International Development (USAID)
United States Information Agency (USIA)
United States-India Fund (USIF)
United States Government (USG)
Coordinated Universal Time (UTC)
ultraviolet (UV)

V

Versailles Project on Advanced Materials and Standards (VAMAS)
Virtual Cement and Concrete and Testing Laboratory (VCCTL)
Video Electronics Standards Association Display Committee (VESA)

All-Russian Research Institute for Optical and Physical Measurements (VINIIOFI)
Volatile Organic Compounds (VOC)
Video Quality Experts Group (VQEG)
National Research Center of Finland (VTT)
Vrije Universiteit Brussel (VUB)
Vrije Universiteit (VU)

W

World Bank (WB)
World Wide Web Consortium (W3C)
World Health Organization (WHO)
World Intellectual Property Organization (WIPO)
Weights and Measures Division (WMD)
World Technology Division of the International Technology Research Institute (WTEC/ITRI)
World Trade Organization (WTO)

X

X-ray Photoelectron Spectroscopy (XPS)
eXtensible Stylesheet Language (XSL)

Y

Z