



National Institute of Standards and Technology Office of International and Academic Affairs Activities Report for FY 1999/2000



Special Publication 978

NIST

National Institute of Standards and Technology
Technology Administration, U.S. Department of Commerce

QC
100
.U57
#978
2002
C.2

The National Institute of Standards and Technology was established in 1988 by Congress to "assist industry in the development of technology . . . needed to improve product quality, to modernize manufacturing processes, to ensure product reliability . . . and to facilitate rapid commercialization ...of products based on new scientific discoveries."

NIST, originally founded as the National Bureau of Standards in 1901, works to strengthen U.S. industry's competitiveness; advance science and engineering; and improve public health, safety, and the environment. One of the agency's basic functions is to develop, maintain, and retain custody of the national standards of measurement, and provide the means and methods for comparing standards used in science, engineering, manufacturing, commerce, industry, and education with the standards adopted or recognized by the Federal Government.

As an agency of the U.S. Commerce Department's Technology Administration, NIST conducts basic and applied research in the physical sciences and engineering, and develops measurement techniques, test methods, standards, and related services. The Institute does generic and precompetitive work on new and advanced technologies. NIST's research facilities are located at Gaithersburg, MD 20899, and at Boulder, CO 80303. Major technical operating units and their principal activities are listed below. For more information contact the Publications and Program Inquiries Desk, 301-975-3058.

Office of the Director

- National Quality Program
- International and Academic Affairs

Technology Services

- Standards Services
- Technology Partnerships
- Measurement Services
- Information Services

Advanced Technology Program

- Economic Assessment
- Information Technology and Applications
- Chemistry and Life Sciences
- Materials and Manufacturing Technology
- Electronics and Photonics Technology

Manufacturing Extension Partnership Program

- Regional Programs
- National Programs
- Program Development

Electronics and Electrical Engineering Laboratory

- Microelectronics
- Law Enforcement Standards
- Electricity
- Semiconductor Electronics
- Radio-Frequency Technology¹
- Electromagnetic Technology¹
- Optoelectronics¹

Materials Science and Engineering Laboratory

- Theoretical and Computational Materials Science
- Materials Reliability¹
- Ceramics
- Polymers
- Metallurgy
- NIST Center for Neutron Research

Chemical Science and Technology Laboratory

- Biotechnology
- Physical and Chemical Properties²
- Analytical Chemistry
- Process Measurements
- Surface and Microanalysis Science

Physics Laboratory

- Electron and Optical Physics
- Atomic Physics
- Optical Technology
- Ionizing Radiation
- Time and Frequency¹
- Quantum Physics¹

Manufacturing Engineering Laboratory

- Precision Engineering
- Automated Production Technology
- Intelligent Systems
- Fabrication Technology
- Manufacturing Systems Integration

Building and Fire Research Laboratory

- Applied Economics
- Structures
- Building Materials
- Building Environment
- Fire Safety Engineering
- Fire Science

Information Technology Laboratory

- Mathematical and Computational Sciences²
- Advanced Network Technologies
- Computer Security
- Information Access and User Interfaces
- High Performance Systems and Services
- Distributed Computing and Information Services
- Software Diagnostics and Conformance Testing
- Statistical Engineering

¹ At Boulder, CO 80303.

² Some elements at Boulder, CO.

NIST Special Publication 978

Office of International and Academic Affairs Activities Report for Fiscal Years 1999/2000

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

June 2002



U.S. Department of Commerce
Donald L. Evans, Secretary

Technology Administration
Phillip J. Bond, Under Secretary for Technology

National Institute of Standards and Technology
Arden L. Bement, Jr., Director

Certain commercial entities, equipment, or materials may be identified in this document in order to describe an experimental procedure or concept adequately. Such identification is not intended to imply recommendation or endorsement by the National Institute of Standards and Technology, nor is it intended to imply that the entities, materials, or equipment are necessarily the best available for the purpose.

National Institute of Standards and Technology Special Publication 978
Natl. Inst. Stand. Technol. Spec. Publ. 978, 107 pages (June 2002)
CODEN: NSPUE2

U.S. GOVERNMENT PRINTING OFFICE
WASHINGTON: 2002

For sale by the Superintendent of Documents, U.S. Government Printing Office
Internet: bookstore.gpo.gov — Phone: (202) 512-1800 — Fax: (202) 512-2250
Mail: Stop SSOP, Washington, DC 20402-0001

Office of International and Academic Affairs Staff

Dr. B. Stephen Carpenter Director, Office of International and Academic Affairs	
Dr. Claire M. Saundry Chief, Office of International Affairs	Dr. Susan F. Heller-Zeisler International Affairs Officer
Dr. Jack J. Hsia Chief, Office of Academic Affairs	Ms. Magdalena Navarro International Affairs Officer
Ms. Diane Fazio Secretary	Mrs. Cathy A. Smith International Specialist
Ms. Janice H. Campbell Secretary	Mrs. Bonnie J. Debord International Specialist
Ms. Veronica Joy Brooks Information Specialist	Mrs. Aija E. Roess International Specialist

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 that 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 on 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 National Quality Program. The coordination of all 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 1999 and 2000.

An important milestone for international recognition in measurement sciences was realized in October 1999, when NIST was one of 38 signatories of the Comité International des Poids et Mesures (CIPM) Mutual Recognition Arrangement (MRa). 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 Interamerican System of Metrology (SIM). In addition, OIAA coordinates the foreign guest researcher program and the more than 800 foreign visitors to NIST per year.

In the fiscal years 1999 and 2000, OIAA hosted many distinguished high level visits including the President of the Institute for Technological Research, Brazil, the Director General of the Joint Research Center for European Commission, the Director-General of the National Technology Agency of Finland, the Chief Executive, ministry of Research, Science and Technology of New Zealand, the Director of the National Directorate of Metrology and Calibration for Albania, the President of the State Committee of the Russian Federation for Standardization Metrology and Certification, the President of

National Institute of Metrology, Standardization and Industrial Quality, the Division Director of the Ministry of International Trade and Industry in Japan, the Director of the Israeli National Physical Laboratory, the President of CIPM, the director of NMi, of the Netherlands, the former New Zealand Prime Minister, and the President of the Egyptian National Institute for 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 institutions 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.

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.

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 last name "Carpenter" clearly distinguishable.

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

Table of Contents

Office of International Affairs	5
Office of Academic Affairs	24
Baldrige National Quality Program	27
Program Office	29
Advanced Technology Program	30
Manufacturing Extension Partnership Program.....	32
Electronics and Electrical Engineering Laboratory	33
Manufacturing Engineering Laboratory	39
Chemical Science and Technology Laboratory	47
Physics Laboratory	56
Materials Science and Engineering Laboratory.....	63
Building and Fire Research Laboratory.....	69
Information Technology Laboratory	75
Technology Services.....	82
Appendix I	92
Appendix II: Organizational Chart	97
Appendix III: List of Abbreviations	98

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 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 1999 and 2000, and also the international activities and outreach of OIA and the Office of the Director.

International Agreements Signed in Fiscal Years 1999 & 2000

Brazil

In May 2000, a Memorandum of Understanding (MOU) between NIST and the Instituto de Pesquisas Tecnológicas (IPT), in São Paulo, Brazil was signed. This MOU between NIST and IPT, concerning technical cooperation in chemistry, physics and engineering measurement sciences was signed on April 28, 2000 by the Director of NIST, and on May 5, 2000 by the Director President of IPT. The MOU is effective for five years.

Canada

The Standards Council of Canada (SCC) and NIST extended their Mutual Recognition Arrangement (MRa) in March of 1999 for a period of one year. The MRa provided for mutual recognition of the testing laboratory accreditation systems administered by the two organizations, and now has been superseded by the Asia Pacific Laboratory Accreditation Cooperation (APLAC) MRa, which was signed by SCC in 1999.

A Joint Research Agreement between the Radiation Protection Bureau of the Environmental Health Directorate, Health Canada, and the Radioactivity Group of the Isotopes and Radiation Division of NIST was signed in April 2000. The agreement concerns scientific cooperation for Standard Reference Material (SRM) development and calibration of radionuclide phantoms, and is valid until June of 2015.

Czech Republic

The MOU between NIST and the Czech Office for Standards, Metrology and Testing (COSMET) was extended on September 3, 1999. The MOU supports cooperation in the areas of metrology and testing, and is in effect for an additional five years.

Ecuador

An MOU between NIST and the Ecuador National Institute of Standardization (INEN) was extended by the Director of NIST and the General Director of INEN on June 10, 1999. The agreement is for cooperation in chemistry, physics, and engineering measurements, and is valid for five years.

European Union

An Implementing Arrangement (IA) with the European Commission for Cooperation in the fields of Metrology and Measurement Standards was signed October 5, 1999 in Brussels, Belgium, by the Director of NIST. The co-operations resulting from this agreement will address all measurement quantities relevant for trade between the United States and the European Union (EU), as well as quantities important for public health safety and the environment.

Germany

On May 12, 2000, an MOU between NIST and the Physikalisch-Technische Bundesanstalt (PTB) and the Bundesanstalt für Materialforschung und –Prüfung (BAM) was signed in Berlin, Germany by the Director of NIST. This MOU supports scientific and technical cooperation in chemistry, physics and engineering measurement sciences, materials technology, standards-related activities and the interchange of technical information and experiences, and is in effect for five years.

A project Annex for the NIST/BAM/PTB MOU was signed on June 26, 2000 by the Director, Materials Science and Engineering Laboratory and the President of BAM. The MOU, between the Materials Science and Engineering Laboratory and BAM, concerns a joint program on the development of reference materials. The Annex is valid until June 2005.

Japan

An IA between NIST and the Agency of Industrial Science and Technology of Japan (AIST), was signed on November 2, 1999, to promote cooperation in metrology and measurement standards. The IA enables NIST's Measurement and Standards Laboratories and AIST laboratories to cooperate on efforts to realize the pact's aims to demonstrate the equivalence of measurement capabilities in both organizations. This cooperation will include activities in chemistry, physics, materials sciences, and metrology, and was to remain in effect for five years. In light of the recent reorganization of AIST into a non-government agency, the agreement will be renegotiated.

The Agreement for Cooperation with the Nippon Telephone and Telegraph Corporation (NTT), in basic science and telecommunications, was extended for an additional five years on October 29, 1999. This agreement will continue to establish a framework for

cooperation in mutually selected areas of the science and technology of semiconductors, telecommunications, computers, and computer networking, and time and frequency measurement.

Kenya

An MOU between NIST and the Kenya Bureau of Standards (KEBS) was signed on December 3, 1998 by the Secretary of the Department of Commerce for NIST and the Minister for Industrial Development for the Kenya Bureau of Standards. Effective for five years, the MOU concerns technical cooperation in chemistry, physics and engineering measurement sciences.

Korea

The MOU between NIST and the Korea Research Institute of Standards and Science (KRISS) for technical cooperation in chemistry, physics, and engineering measurement sciences was extended in April 2000 for an additional five years.

On May 9, 2000, an MOU between NIST and the Korean Agency for Technology and Standards (KATS), for cooperation relating to standardization, conformity assessment, and legal metrology, was signed by the Secretary of Commerce on behalf of NIST and for KATS by the Minister for Commerce, Industry and Energy. The MOU is valid until May 2005.

A Cooperation Agreement between NIST's Manufacturing Engineering Laboratory and the Automation Networks Laboratory of the Hanyang University on Intelligent sensor Technology for Field Networks was signed by the Director of the Automation Networks Laboratory, Hanyang University on August 21, 2000, and by the Acting Director of the Manufacturing Engineering Laboratory on August 30, 2000. This agreement, which is in effect for two years, provides a mechanism for the two organizations to collaborate on research on smart sensors and interfaces and integration of sensors and interfaces with field networks.

An Annex to the MOU between NIST and the Electronics and Telecommunication Research Institute (ETRI) was signed in March 1999 and remains in effect until February 2001. This annex to the 1994 MOU concerns Technical Cooperation in Broadband Integrated Services Digital Network Technology.

Mexico

A Project Annex to the IA for scientific and technical cooperation between NIST, the Secretariat of Commerce and Industrial Development, and the National Center for Metrology (CENAM) was signed in July 1999. The Annex, between NIST and CENAM, supports mutual recognition of measurement capabilities.

The Netherlands

In August 1999, a Memorandum of Cooperation (MoC) was signed with The Netherlands Measurement Institute (NMI) for the intercomparison of primary standard gas mixtures. The term for this agreement continues through June 30, 2005.

A Declaration of Equivalence for primary standard gas mixtures was signed by the Chemical Science and Technology Laboratory of NIST and NMI in September 1999, and remains in effect until 1 July 2001. The intercomparison program supporting this declaration will be maintained under the terms of the mutual MoC.

Russia

An Implementing Agreement between the State Committee of the Russian Federation for Standardization, Metrology and Certification (GOSSTANDART) and NIST for cooperation in Aerospace Metrology was signed on March 22, 1999. The Agreement concerns implementation of advanced standards, calibration and validation of radiometric instrumentation.

The IA between NIST and the Russian Research Center for Standardization, Information and Certification of Materials was extended by exchange of letters in September 1999 for an additional four-year period. The Agreement concerns cooperative work on the NIST X-ray Photoelectron Spectroscopy (XPS) Database.

Saudi Arabia

The MOU between NIST and the Saudi Arabian Standards Organization (SASO) was extended for three years by exchange of notes in July 2000. This MOU concerns technical cooperation on standards-related activities.

Singapore

An Agreement of Cooperation between NIST's Materials Science and Engineering Laboratory (MSEL) and the Data Storage Institute, a National University of Singapore-affiliated national research institute, was signed in Singapore on February 28, 2000. The cooperation is in the area of Nanotribology of magnetic hard disks and remains in effect for three years.

Taiwan

A document outlining new guidelines for a Cooperative Program in Physical Sciences between NIST and the American Institute in Taiwan (AIT) was signed in February 1999 to provide a mechanism through which NIST as AIT's designated representative and the National Science Council (NSC) and the Industrial Technical Research Institute in Taipei can engage in continued cooperation in the physical sciences.

Under the NIST-AIT Guidelines, an Implementing Arrangement for cooperation in the field of nanotechnology was signed in February 1999, which involves Nano-Scale Metrology Group of the Precision Engineering Division, NIST and the Precision Instrument Development Center (PIDC) of the NSC for nano-scale metrology.

Multilateral

The Directors of the 38 Member States of the Metre Convention, including NIST, and representatives of two international organizations, signed the Comité International des Poids et Mesures (CIPM) MRa on October 14, 1999. The MRa will provide a framework for technical cooperation in the measurement sciences with the purpose of providing the technical basis for acceptance of calibration certificates issued by NMIs. In addition, it is expected that the MRa will provide technical information necessary to resolve trade disputes that arise over differences in measurements and standards.

Gulf Cooperation Council Countries

An MOU between NIST and the Standardization and Metrology Organization for the Gulf Cooperation Council (GCC) Countries was extended by exchange of letters in March 1999. The extension is valid until 10 March 2002.

NORAMET

The Memorandum of Arrangement with NORAMET (the North American countries sub-region of the Inter-American System of Metrology) on Calibration and Measurement Certificates of the National Metrology Institutes (NMIs) was renewed in September 1999 for an additional five years.

MENAMET

The Middle East and North Africa Metrology Program (MENAMET) was established in order to provide a suitable platform for cooperation in metrology in this region. To date, the MENAMET MOU has been signed by Israel, Kenya, Morocco, the Palestine Authority, South Africa, Turkey, and the United States, on 27 May 1999 in Istanbul. South Africa and the United States are Associate Members, and Ulusal Metroloji Enstitüsü (UME) in Turkey holds the position of "Regional Coordinator and Secretary".

APLMF

An MOU was signed with the Asia-Pacific Legal Metrology Forum (APLMF) by the Director of Technology Services, NIST on April 26, 2000. Other signatories of the agreement include legal metrology authorities in the Asia-Pacific Economic Cooperation (APEC) economies and other Pacific Rim economies. The objective of the MOU is the development of legal metrology and promotion of free and open trade in the region through harmonization and removal of technical barriers to trade in the field of legal metrology. The MOU is valid for two years with an automatic two year renewal.

Bilateral Cooperative Activities

Brazil

The Director of the Office of International and Academic Affairs (OIAA) attended the Regional Metrology Organization for the Americas Council meeting and finalized the technical arrangements for the MOU with IPT in Rio de Janeiro.

Ecuador

The Director of OIAA held discussions with the Minister for International Trade and the Director General of INEN on activities that can be developed under the agreement between NIST and INEN.

Egypt

The Director of OIAA represented NIST, as a member of the Joint Board, at the U.S.-Egypt Science and Technology Board Meeting in Egypt in May 1999. Among the joint workshops and projects approved for funding at this meeting were two with NIST: a workshop on Industry Needs Assessment, and a project on Reference Data for Faults and Failures for Software Quality.

A workshop co-hosted by NIST and the Egyptian National Institute for Standards (NIS), and supported by Joint S&T Board funds, entitled "Egyptian Industry Needs Assessment" took place during May of 2000 in Cairo, Egypt. The focus of the workshop was on Egyptian's industry's measurement standards needs. Representatives from 36 Egyptian private sector companies in the areas of communications, electronics, steel, aluminum, rubber and plastics, furniture, third party testing laboratories, and textiles attended the conference, as well as personnel from several NIST divisions. The workshop helped to identify standards-related services that need to be developed in Egypt to support their local industry, modeled after the U.S. system.

At the U.S. – Egypt S&T Board meeting, held on May 25, 2000, which followed the fourth cycle of proposal reviews, a total of 31 projects and three workshops were funded. The new joint project between NIS in Egypt and the Process Measurements Division, Chemical Science and Technology Laboratory (CSTL) will develop high pressure primary standards.

OIAA is participating in the U.S. Egypt S&T Small Working Group. The Working Group has been charged with several activities, including framing the scope of work for the Joint U.S.-Egypt S&T Board Five Year Assessment, and reviewing and improving the framework for the Bilateral Workshop proposals and for a new program to support the Project Development Visits.

The Director of OIAA participated in a mission with the World Bank in August 2000, to discuss plans to restructure and improve Egypt's metrology infrastructure. This mission was made at the request of Egypt's Minister of Industry and Trade. A brief plan was submitted by NIST and the World Bank intends to elaborate on this plan, and to also assist in submitting proposal for World Bank funds. In conjunction with this mission, a workshop was held on Industrial Competitiveness and Global Competition: The Role of Measurements, Standards, Testing and Quality Systems.

El Salvador

The Director of OIAA took part in an assessment of the standards and measurement needs of El Salvador, sponsored by the World Bank. Meetings were held with government and private industry officials, including the Minister of Industry, and site

visits were made to several national laboratories and universities. The need for establishing a metrology infrastructure was emphasized, as well as the importance of educating both professional and citizens on metrology (*e.g.*, standardization of the "pound"). Plans were made to hold four workshops before the end of FY 2001 on various metrology issues.

Germany

The Director of NIST and the Director of OIAA traveled to Germany to meet with the President of PTB for in depth discussions on the Mutual Recognition Agreement (MRA) for the CIPM and to discuss PTB's role with respect to the NIST-EU Agreement on measurement standards. They also met with the President of BAM.

India

An interagency group, including representatives from NIST, developed guidelines for a successor to the U.S. – India Cooperative Science and Technology Program, which expired in January 1998. That program supported the U.S.-India Fund (USIF), with a wide range of cooperative research, involving over twenty agencies of the U.S. Government. The new Indo-U.S. Science and Technology Forum was realized in March 2000, with the signing of the Indo-U.S. Science and Technology Forum Agreement. This agreement formalizes the bilateral commitment to ongoing scientific discussions and collaboration. Additionally, it supports the exchange and advancement of multidisciplinary science and technology exchanges between public and private sector communities. The first Forum meeting is scheduled for the end of 2000.

On September 15, 2000, a U.S. – India High Level Roundtable on Science and Technology was held in conjunction with Prime Minister Vajpayee's visit. Representatives from both countries convened to seek greater cooperation to advance the frontiers of science and technology. Neal Lane, Assistant to the President for Science and Technology and Dr. V.S. Ramamurthy, Secretary, Department of Science and Technology, co-chaired the session. The Deputy Director of NIST participated as part of the U.S. Delegation. The Roundtable provided an opportunity for a broad-based, high-level exchange of official views on critical science and technology issues. In particular, the two governments agreed to focus on genomic research, especially on how gene expression influences susceptibility to infectious disease, on biotechnology for a safe and nutritious food supply, on nanotechnology, and building on existing cooperations in weather and climate prediction in collecting and distributing data such as in the Array of Real-time Geostrophic Oceanography (ARGO) program.

NIST currently supports 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. This NIST contractor also collaborates with the U.S. Foreign Commercial Service, the American Business community, with the Bureau of Indian Standards, Indian Customs Department, and other organizations involved in clearing American imports in to India.

The Deputy Director of NIST visited the U.S. Embassy in New Delhi to discuss on-going interactions regarding software standards with software professionals and review current science and technology activities. She also visited the National Physics Laboratory for an overview of their metrology programs.

Israel

NIST serves as one of the three U.S. Government representatives and the only U.S. technical representative on the U.S. - Israel Binational Industrial Research and Development (BIRD) Foundation Board of Governors, which must approve all grants made by the Foundation. OIAA provides administration of the technical review and selection process for proposals submitted to the U.S. - Israel BIRD Foundation Board. The BIRD mission is to stimulate, promote and support industrial R&D of mutual benefit to the United States and Israel. BIRD supports U.S.-Israel company partnerships dedicated to developing and commercializing non-defense-related innovation products or processes. The conditional grants are paid directly to the participating companies. BIRD funds up to 50% of the companies' expenses in developing a product to the stage of commercial readiness. BIRD funding is provided in the form of a conditional grant, which does not entitle BIRD to equity or intellectual property rights. If the project is a commercial success, BIRD receives repayments – a pretax expense 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 U.S. - Israel BIRD Board meets two times each year. During the fiscal years 1999 and 2000, the total numbers of BIRD projects funded were 24 and 23, respectively.

The Director of NIST spoke at the Metrology Conference on Trends and Applications in Calibration and Testing Laboratories in Jerusalem, Israel in May 2000. The Director of CSTL and the Director of OIAA also attended the conference.

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. Meetings were held with the Treasury, Justice and Ministry of Industry and Trade and the importance of having a centralized government laboratory for accreditation, standards, metrology and testing was stressed.

Italy

The 6th Biennial Review meeting on U.S. - Italy science and technology cooperation was held in Rome, Italy in April 2000. NIST, along with the other U.S. - Government technical agencies participated in the U.S. delegation, which was led by the U.S. Department of State. In the area of standards and metrology, NIST and our Italian counterparts satisfactorily reviewed the nine cooperative projects that were active in 1998-1999. In addition, we agreed to continue the mutual exchange of information and to continue to explore potential new activities. Potential new areas of cooperation include chemical and environmental metrology, advanced materials, information technology and exchange of researchers.

Jamaica

The Director of OIAA met with the Minister of Foreign Affairs and senior staff, the Minister of Industry, Commerce and Technology and senior staff, and the senior staff members of the Jamaica Bureau of Standards in October 2000. The role of metrology in Jamaican trade was discussed from domestic, regional and global views. The Ministers said that they would fully support the activities of the Jamaican Bureau of Standards in the Caribbean and in the Interamerican System of Metrology (SIM) and in the support of its domestic metrological activities.

Joint Funds

Until 1997, the U.S. Government had contributed each year to jointly funded Science and Technology Programs with Eastern Europe, and more recently with Egypt and Spain. The Joint Fund programs with Croatia, the Czech Republic, Hungary, Macedonia, Poland, the Slovak Republic, and Slovenia are now focused on more direct interactions between institutions.

Jordan

The Director of NIST and Director of OIAA held meetings at the Jordanian Institution for Standards and Metrology in Amman in May 2000.

Kenya

Visits were made by the Director of NIST and the Director of OIAA to the Kenya Bureau of Standards to discuss the needs of measurements and standards for economic improvement and to discuss possible areas of cooperation, prior to the signing of the MOU between NIST and KEBS.

Lesotho

The Director of OIAA attended an awareness seminar in Maseru on the role of Standardization, Quality Assurance and Metrology (SQAM) in Economic and Social Development and Trade and participated in discussions on the need to develop a national metrology system. The seminar was attended by representatives from NIST, PTB, the South African National Metrology Laboratory (CSIR), the United Nations Industrial Development Organization (UNIDO) and the United Nations Conference on Trade and Development (UNCTD). The Director made a presentation on "Eliminating Technical Barriers to Trade Through the Establishment of SQAM", and met with the Ministry of Trade and Industry to emphasize the need to develop a formal metrology system.

Mexico

In January of 1999, the Deputy Director of NIST met with Undersecretary for Industries of Mexico to discuss the role of international metrology, and also met with the Director General of the National Council for Science and Technology of Mexico.

The Director of NIST held discussions with the Undersecretary for Industries on the bilateral activities between NIST, CENAM, and the Secretaría de Comercio y Fomento Industrial (SECOFI), which is the Mexican Ministry of Commerce and Industrial Development.

Mozambique

The Director of OIAA took part in discussions in Maputo to promote the development of a formal metrology system in Mozambique. An awareness seminar, "The Role of SQAM in Economic and Social Development and Trade" was held and was attended by representatives from several NMIs. A presentation on "Eliminating Technical Barriers to Trade Through the Establishment of SQAM" was also given.

Palestine Authority

The Director of OIAA attended a one-day meeting with the Ministry of Industry and Trade, Palestinian Authority, and the United States Agency for International Development (USAID). One of the discussion topics was a proposed agreement between NIST and the Palestinian Standards Institute. The proposed co-operation would include workshops, seminars, training, and Standards in Trade activity, depending on needs assessment of their industries. Because of the current political situation, this activity is on hold.

Saudi Arabia

NIST has maintained an experienced engineer working with SASO and with the Foreign Commercial Counselor in the U.S. Embassy. The NIST Standards Expert assists SASO with writing and revising documentary standards that have a strong influence on bilateral trade. The expert also reviews all SASO standards documents; those that do not agree with either international or American standards are sent to NIST where, with the help of staff from U.S. industrial associations, they are revised and sent back for further processing. The expert also assists with conformance assurance and certification that facilitate access by U.S. businesses to the Saudi market. The American business community in Saudi Arabia credits this arrangement with a substantial increase in U.S. exports to the Kingdom.

Spain

The U.S. – Spain Joint Commission for Scientific and Technological Cooperation met in Madrid, April 10-11, 2000. The Commission awarded 62 grants for projects submitted in the third call for proposals, including one from NIST submitted by the Optical Technology Division in the Physics Laboratory, for "Development of Spectroscopic Techniques in the THz Region".

South Africa

In May 2000, the Director of OIAA attended the Year 2000 Calibration & Testing Workshop/Conference, held in Pretoria. A visit was also made to the CSIR Manufacturing Advisory Centers (MAC), which have a similar design to the Manufacturing Extension Program (MEP).

Tunisia

The Director of OIAA met with the Minister of Industries to discuss the World Bank loan for developing the measurements and standards infrastructure.

Turkey

NIST provides UME - Tubitak, Turkey's NMI, with technical support in the area of standards and measurement infrastructure development. This support includes technical expert travel to Turkey, providing SRMs and calibrations, and is supported through a loan to Turkey from the World Bank

Multilateral Cooperative Activities

Over the last 40 years, six Regional Metrology Organizations (RMOs) have been created: the European Metrology program (EUROMET), the Central and Eastern Europe Metrology Program (COOMET), SIM, the Asia-Pacific Metrology Program (APMP), the Southern African Development Cooperation in Metrology (SADCMET), and the new MENAMET. The RMOs were created to promote regional cooperation in metrology, which has important implications for trade within regions, as well as globally. With the signing of the CIPM MRa, the role of the RMOs takes on a new and increasingly critical role in global trade issues especially in the area of technical barriers to trade. Through the RMOs, the United States is able to leverage its activities and dollars with countries throughout the world. For example, when NIST conducts a comparison with South Africa, we are connected through the Southern African Development Cooperation in Metrology (SADCMET) to other countries in Sub-Saharan Africa.

For the United States, NIST participates in SIM, which is the metrology organization of the Americas. It was formed in 1979, and is comprised of 34 countries in five subregions, the North American countries sub-region of SIM (NORAMET), the Andean countries sub-region of SIM (ANDIMET), the Central American countries sub-region of SIM (CAMET), the Caribbean countries sub-region of SIM (CARIMET), and the South American countries sub-region of SIM (SURAMET). The Director of OIAA chairs the Technical committee, one of the steering committees of SIM, and serves as the technical advisor to SIM. NIST staff also chair several of the working groups of the Technical Committee.

NIST interacts with the different regional metrology organizations both on a bilateral basis with the countries in each RMO and on a regional basis through the Joint Committee for Regional Metrology Organizations (JCRB) and the Bureau International des Poids et Mesures (BIPM). More detail on some of the interactions with specific RMOs is included below.

EU/CIPM

In October 1999, the Director of NIST signed the NIST/European Union Implementing Agreement for Standards and Measurement Science in Brussels, Belgium. Afterwards, the NIST Director and the Director of OIAA attended the 21st General Conference of Weights and Measures in Paris, France, where the CIPM MRa was signed by the directors of the national metrology institutes of 38 Member States of the Metre Convention on October 14, 1999.

The NMIs and the BIPM are developing a framework for establishing mutual recognition of measurements and national measurement standards. Such recognition will be based on measurement and calibration capabilities that are supported by measurement comparison data. The implementation of an International Comparisons Database (ICDB) was one of the key action items in the recently agreed upon CIPM MRa, which is designed to help resolve trade disputes that arise over differences in measurements and standards. The ICDB was launched simultaneously on web sites at NIST and the BIPM on November 30, 1999. The MRa establishes a formal system of "key" measurement comparisons among the NMIs in the signer nations. These key comparisons (KCs) establish how closely a particular measurement, *e.g.*, voltage, force or length, performed at one NMI agrees with results of counterpart institutes in other countries. Levels of agreement establish the basis for linking measurements across international borders. Initially, the new database will contain information on the design protocols and the participants of completed and ongoing key comparisons among the NMIs of nations that signed the MRa. About 130 of these round-robin measurement exercises have been initiated. Once the Consultative Committees of the CIPM evaluate the reliability of the actual measurement results, those results will be cleared for entry into the database. Once entered, results between pairs of participants or between any participant and a reference value can be directly compared. The database will also contain lists of calibration and measurement service capabilities asserted by each participating NMI. The ultimate goal is to provide a recognized and readily available means to compare measurement data anywhere along the chain of national systems of traceability and international comparability.

The Deputy Director of NIST participated in a high-level panel and discussions on measurement aspects in implementing the Joint Research Centre's (JRC's) mission in Brussels, Belgium. The JRC is the scientific body of the European Commission.

A representative from the NIST Program Office participated in a panel session at the forum on Electronic Commerce for Transition Economies in the Digital Age, in Geneva, Switzerland. The Forum is sponsored by the United Nations, Economic Commission for Europe. The panel session is entitled "Best Practices in Electronic Business". Remarks were focused on the U.S. approach to technical standards development related to E-Business and small manufacturers.

MENAMET

A Middle East Regional Workshop was held in November 1998 in Sharm El Sheikh, Egypt to develop a Middle East and North Africa Regional Metrology System (MENAMET). Representatives of the NMIs in the United States, Egypt, Israel, Jordan, Morocco, Saudi Arabia, South Africa, Tunisia, Kenya, Turkey and Ghana attended this workshop. Participants discussed standardizing the measurement and calibration services among the countries of the Middle East and Northern Africa to facilitate mutual recognition of measurement services in the region and ultimately to support trade.

As a result of this meeting, an MOU to provide a framework for developing a recognition mechanism for those countries was developed. This MOU was signed on 27 May 1999

in Istanbul by the NMIs from the U.S., Turkey, the Palestinian Authority, Israel, Morocco, Kenya and South Africa. Representatives of the NMIs in Algeria, Cameroon, Ghana, and France have also made commitments to sign. South Africa and the United States are Associate Members, and UME in Turkey, holds the position of "Regional Coordinator and Secretary". The MENAMET MOU is an agreement between the participants from the national metrology institutes or other organizations of the participant countries/economies in the MENA region who have been delegated the authority for metrology in their respective countries or economies. The members of MENAMET have pledged to support the agreement through cooperation in calibrations, measurements and testing in support of quality and accreditation within the region. The ultimate objective of the collaboration is to increase efficiency in these activities and other metrological areas and use measurements and standards as a mechanism to reduce technical barriers to trade within the region, and to facilitate global trade.

SIM

On December 4, 1998, SIMnet was launched to help address measurement issues which could affect free trade in the Americas. SIMnet will support real-time comparisons of measurements performed at laboratories throughout the 34 nations that make up SIM. SIM's efforts are critical to increasing cooperation in science and technology, eliminating technical barriers to trade and establishing the proposed Free Trade Area of the Americas (envisioned to extend from Alaska to Tierra del Fuego) by 2005. Organized by NIST and conducted under the auspices of SIM, SIMnet will be pilot tested in a 12-nation intercomparison of high-precision digital multimeters. SIM is essential to accomplishing two major objectives set at the 1994 Summit of the Americas: increasing cooperation in science and technology, and promoting prosperity and free trade by eliminating technical barriers to trade.

The Director of OIAA attended the 1999 SIM General Assembly meeting and participated in a workshop with Ecuadorian Government officials, in Quito, Ecuador.

The SIM General Assembly 2000 was held in Jamaica 25-26 September 2000. Also held in conjunction with the Assembly meeting was a seminar on "Measurement: The Key to Global Trade", where NIST was one of the sponsors. A Workshop entitled "Hands-On Pesticides", and conducted by representatives from the Analytical Chemistry Division was held following the General Assembly.

U.S./Israel/Jordan Trilateral Industrial Development Initiative (TRIDE)

As part of the Peace Process in the Middle East, the Governments of the United States, Israel and Jordan have contributed equal funds to form the pilot TRIDE Initiative. The purpose of the TRIDE Initiative is to help private sector firms form strategic partnerships to develop a commercial product of mutual benefit to all three countries. NIST represents the United States on the Board of Governors of TRIDE, and serves as the U.S. technical contact for review of TRIDE proposals

WORLDnet

The first discussions on WORLDnet were held at NIST on April 27, 2000, for the initial design and deployment the global Internet-based metrology services delivery system based on the recent work of SIMnet. The meeting was jointly sponsored by OIAA and by the Manufacturing Engineering Laboratory's (MEL's) Automated Production Technology Division.

International Committee Participation

In FY 1999-2000, NIST professional staff held memberships in 142 international committees in 28 international standards organizations. Activities of committees on which NIST staff hold lead positions are indicated in the specific operating unit chapters. For a complete listing of memberships and activities, refer to the NIST publication, Directory of Department of Commerce (DoC) Staff Memberships on Outside Standards Committees.

Workshops and Conferences

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

Summary of Countries/Regions within the 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
Lesotho	Namibia	Zambia
Malawi	South Africa	Zimbabwe

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. A foreign guest researcher is any qualified person who is a non-U.S. citizen, is not an employee of NIST, is sponsored by an organization or is self-employed or is 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 collaborates with NIST on research of mutual interest. Foreign guest researchers may be employees of foreign government agencies, state and local governments, industry, nonprofit organizations (including universities), post-graduate researchers, graduate students, or 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 can sometimes provide a modest allowance for U.S. living expenses, guest researcher support generally comes from sponsoring companies or organizations. OIA 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 consultant for non-U.S. citizens; and financial assistance for foreign guest researchers. NIST hosted 612 Guest Researchers in FY 1999 from 67 different countries, and in FY 2000 NIST hosted 600 Guest Researchers from 72 countries. The following is a list of guest researchers at NIST in FY 1999:

Albania	1	Egypt	17	Korea	35	Slovak Republic	2
Algeria	2	Estonia	1	Laos	1	Slovenia	3
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	TOTAL	612

The following is a list of guest researchers at NIST in FY 2000:

Algeria	4	Finland	4	Luxembourg	1	Serbia	6
Argentina	1	France	87	Malaysia	2	Slovak Republic	3
Armenia	1	Georgia	1	Mexico	10	Slovenia	1
Australia	14	Germany	43	Morocco	4	South Africa	5
Austria	3	Ghana	3	Netherlands	9	Spain	17
Bangladesh	2	Greece	2	New Zealand	3	Sweden	1
Belgium	3	Hungary	9	Niger	1	Switzerland	2
Bosnia	2	India	40	Nigeria	2	Taiwan	11
Brazil	5	Iran	3	Norway	1	Tanzania	1
Cameroon	2	Ireland	3	Pakistan	1	Thailand	1
Canada	14	Israel	12	Panama	1	Togo	1
China	53	Italy	12	Peru	2	Trinidad	1
Croatia	4	Japan	22	Philippines	2	Tunisia	2
Czech Republic	4	Jordan	2	Poland	13	Turkey	4
Denmark	5	Korea	44	Portugal	1	Ukraine	2
Egypt	16	Kuwait	1	Romania	3	United Kingdom	17
Estonia	1	Liechtenstein	1	Russia	36	Uruguay	1
Ethiopia	3	Lithuania	3	Senegal	1	Uzbekistan	1
							TOTAL 600

Foreign Visitor Program

OIAA serves as the focal point for foreign visitors and arranges for NIST services to users in friendly countries. 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 1999, NIST hosted a total of 782 foreign visitors from 87 different countries in fiscal year 1999. The majority of these visits were coordinated by OIAA.

Antigua	3	Ecuador	10	Japan	106	Slovenia	1
Argentina	12	Egypt	10	Kazakhstan	14	South Africa	4
Armenia	3	El Salvador	5	Kenya	1	Spain	7
Australia	9	Eritrea	1	Korea	17	St. Kitts & Nevis	1
Austria	4	Ethiopia	1	Kuwait	1	St. Lucia	1
Azerbaijan	4	Finland	10	Kyrgyzstan	6	Suriname	3
Bahamas	1	France	19	Malaysia	1	Sweden	12
Bahrain	3	Georgia	7	Mexico	17	Switzerland	3
Barbados	4	Germany	32	Moldova	4	Taiwan	66
Belgium	5	Greece	1	Morocco	1	Tajikistan	4
Brazil	35	Grenada	1	The Netherlands	9	Thailand	10
Bulgaria	1	Guatemala	4	New Zealand	1	Trinidad & Tobago	6
Canada	20	Guyana	2	Nicaragua	3	Turkmenistan	6
Chile	4	Haiti	4	Norway	5	Ukraine	25
China	130	Honduras	1	Oman	3	United Arab Emirates	2
Colombia	8	Hungary	8	Panama	9	United Kingdom	41
Costa Rica	17	India	18	Peru	1	Uruguay	5
Croatia	2	Indonesia	4	Poland	5	USA (non-citizens)	11
Czech Republic	3	Iran	1	Qatar	1	Uzbekistan	17
Denmark	4	Israel	6	Russia	56	Venezuela	3
Dominican Republic	5	Italy	7	Saudi Arabia	11	Vietnam	3
Dominica	1	Jamaica	10	Singapore	1	Yugoslavia	1

In FY 2000, NIST hosted a total of 1052 foreign visitors from 72 different countries.

Albania	1	Dominica	1	Korea	50	Saudi Arabia	12
Argentina	2	Ecuador	1	Kyrgyzstan	4	Singapore	10
Australia	21	El Salvador	1	Kuwait	3	Slovakia	1
Austria	2	Finland	25	Lebanon	2	South Africa	2
Bahrain	3	France	20	Mexico	9	Spain	8
Barbados	1	Georgia	1	Moldova	1	Sweden	5
Belgium	17	Germany	49	Nepal	1	Switzerland	2
Bolivia	1	Guatemala	2	Netherlands	9	Taiwan	19
Brazil	16	Hungary	11	New Zealand	3	Thailand	1
Cameroon	1	India	15	Nicaragua	1	Turkey	2
Canada	9	Indonesia	1	Oman	3	Turkmenistan	1
Chile	2	Ireland	2	Panama	1	Ukraine	16
China	337	Israel	6	Paraguay	1	United Arab Emirates	3
Colombia	2	Italy	20	Peru	1	United Kingdom	66
Costa Rica	2	Jamaica	1	Poland	19	Uruguay	1
Cote d'Ivoire	1	Japan	139	Portugal	1	Uzbekistan	4
Cyprus	1	Jordan	1	Qatar	1	Venezuela	6
Demark	5	Kazakhstan	6	Russia	31	Vietnam	16

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 all academic affairs of NIST. In particular, OAA administers the NIST/ (National Research Council (NRC) Postdoctoral Research Associates Program, assists staff of the technical Operating Units (OU's) in identifying and promoting research collaboration efforts with universities on scientific and technical research projects of mutual interest, interacts with committees within NIST, interacts with outside organizations and other government agencies, serves as an academic related resource at NIST, and coordinates some K-12 related activities.

NIST Postdoctoral Research Associates Program

NIST's Postdoctoral Program supports a nationwide competitive postdoctoral program administered in cooperation with the National Academy of Sciences (NAS)/(NRC). 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 mutual communication with university researchers, shares NIST 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.

Activities include administering the NIST/NRC Postdoctoral Research Associates Program, updating yearly the book on Opportunities for Research, arranging NRC staff meetings with NIST advisers and associates, participating in the NRC Laboratories representatives meetings, organizing focus group and participating in the Workshop on Enhancing the Postdoctoral Experience of the NRC Committee on Science, Engineering and Public Policy.

In 1999, NIST selected 39 postdoctoral research associates for FY 2000. The distributions are: Electrical and Electrical Engineering Laboratory (EEEL) - 4, Manufacturing Engineering Laboratory (MEL) - 3, Chemical Science and Technology Laboratory (CSTL) - 7, Physics Laboratory (PL) - 12, Materials Science and Engineering Laboratory (MSEL) - 9, Building and Fire Research Laboratory (BFRL) -2, and Information Technology Laboratory (ITL) - 2. All associates are supported by NIST central fund except one from CSTL, two from PL, and two from MSEL supported by Laboratory fund.

In 2000 NIST selected 58 associates for FY 2001. The distributions are: EEEL (4), MEL (3), CSTL (17), PL (11), MSEL (19), BFRL (3), ITL (1). All associates are supported by NIST central fund except one each from MEL, CSTL, & PL, and four from MSEL supported by Laboratory fund.

Liaison and Collaboration with Universities

This Office maintains liaison with College of Computer Science, Mathematics and Physics and department of Electrical Engineering of University of Maryland, Department of Physics of Ohio University, Graduate School of Wayne State University, College of Engineering and Design of Florida International University, Department of Electrical and Computer Engineering of New York University at Buffalo, Physics Department of Morgan State University, Engineering Research Institute of Tennessee State University, and Munsell Color Science Laboratory of Rochester Institute of Technology.

Minority Serving Institutions (MSI) – OAA, together with the Office of Technology Partnerships, coordinated visits to MSI by NIST Laboratory staff members: Delaware State University on applied optics; California State University at Fresno on chemistry, physics, and material science; and Howard University on semiconductor electronics and computer science. Starting in FY 2000, this Office has coordinated reports on NIST outreach activities with MSI (excluding grants and fellowships). The total NIST expense was \$104,000 in FY 2000.

Interactions with Committees and Programs within NIST

OAA interacts, assists, collaborates on educational matters with Student Programs, Educational Clearinghouse, Civil Rights Office, African American Association, Hispanic Association, Asian Pacific Association, Committee for Women, 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.

This Office interacts on professional matters with American Society for Testing and Materials, Illumination Engineering Society of North America, Council for Optical Measurements, International Standards Organization, International Electrical Commission, and serves as a Board members of International Commission on Illumination with 41 member countries. This Office serves on the advisory committee of the International Technology Education Association.

Academic Resource

This Office serves as a resource for NIST Postdoctoral Programs and other academic affairs. In 1999, OAA also provided to the Technical Administration of DoC with data on NIST female postdoctoral associates, to staff members of the Army Research Laboratory about the operation of NIST Postdoctoral Program, and to faculty members, postdoctoral associates, graduates, undergraduates, and K-12 teachers a website on research opportunities at NIST.

K-12 Related Activities

This office maintains liaison with the National Science Teachers Association. In 1999, OAA coordinated the Community alliance for Math, Science, and Technology Literacy (CASTL) program. The purpose of the CASTL program was to establish pilot programs partnering local school boards and businesses for enhanced professional development of K-12 math, science, and technology teachers. Proposals were received. Due to lack of funding, awards were not made.

On December 18, 1998, the "Teacher Science and Technology Education Enhancement Program" Workshop was held at NIST. Below is the summary of that workshop.

A. GENERAL

1. Develop self-confidence, motivation, interest in science and technology.
2. Develop critical thinking skills.
3. Be a continuous program.

B. SPECIFICS:

1. Work with grade 6-8 teachers first, then with grade 9-12 teachers.
2. Provide teachers with summer Internship experience at NIST laboratories working with current and retired, enthusiastic scientists and engineers, followed by supplementary class material development with outside assistance.
3. Use applications such as environmental issues and consumer products to introduce to teachers: scientific measurements, testis and standards development, industrial competitiveness and quality, manufacturing, technology transfer.
4. Foster teacher-to-teacher interaction.
5. Target college students with education major -- help them develop good attitudes early.
6. Make both electronic and hard copy forms available for developed materials.
7. Consider offering Continuing Education units (CEUs) for internship and website learning.
8. Focus on nationwide local programs and develop local links.
9. Work through National Science Teachers Association (NSTA) and National Council of Teachers of Mathematics (NCTM).
10. Partner with industry/business and non-profit organizations.
11. Develop criteria to assess effectiveness/progress/success of this Program. Tap Scientists/engineers/teachers retirees.

C. EXAMPLES OF PROGRAM/ACTIVITY

1. Industry Research Institute
2. Boston (scientists/engineers retirees)
3. HP, Dow, Merck
4. NY State (CEU for website learning over weekends)
5. American Plastics Council (survey of what materials are available for teachers)
6. Howard Hughes/National Institutes of Health (NIH) summer internship

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, 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 6 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 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 1999/2000 included the following:

- The Deputy Director of BNQP attended the quality award ceremonies of Sweden and Mexico in February and June 2000, respectively.
- In October 2000, BNQP participated in a meeting of six global excellence model/award organizations, each of which was the owner of its region's leading edge performance excellence business models. Regions represented were Australia,

Europe, Japan, Singapore, South Africa and the Southern Africa Development Community, and the U.S. (BNQP).

- November 28 – December 1, 2000, the BNQP's Director and Deputy Director conferred with the Japanese Quality Award and the Japanese Union of Scientists and Engineers concerning the Baldrige Criteria, quality award program issues, and quality principles.
- BNQP hosted visitors from Malaysia, Uruguay, New Zealand, Japan, China, and Korea.

Program Office
Dr. Michael Casassa, *Acting Director*

NIST recently developed a system for assuring quality in the results of NIST measurements delivered to its customers. The goal of this effort was to satisfy the International Committee of Weights and Measures (CIPM) Mutual Recognition Arrangement (MRa) requirement for mutual confidence among National Measurement Institutes in the results of measurements delivered to customers in calibration and measurement certificates. Achieving this goal ensures the facile inclusion of NIST calibration and measurement capabilities (CMCs) in Appendix C of the MRa. The Program Office is coordinating this effort with the Laboratories.

NIST operates in accordance with the NIST System in establishing traceability of its own measurement results as well. Documentation maintained includes a description of how traceability is achieved for each measurement result. This is a key aspect of the NIST Policy on Traceability.

The NIST System was designed to be as simple, flexible and non-bureaucratic as possible. Elements include technical descriptions of the measurement facility, system, or methods, the procedures for conduct of the measurement(s), the analysis of uncertainty of the measurement results, and the procedures for statistical control of the measurement process. The NIST System also requires that the person(s) conducting the measurement must be proficient in performing the required calibration or measurement tasks and the inclusion of procedures for dealing with discrepant results.

Advanced Technology Program

Dr. Marc Stanley, *Acting Director*

Begun in 1990, the Advanced Technology Program (ATP) is 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 mid-FY 2001, the ATP has funded 526 projects, of which 38 of 173 joint ventures were foreign-owned, U.S.-based companies, and 20 of 353 single-company awards were to foreign-owned, U.S.-based companies. The ATP has entered into multi-year partnerships with industry for high-risk, enabling research and development at a level of nearly \$3,336M between 1990 and 2001—of which ATP's share is slightly less 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 526 projects selected by the ATP since its inception, 161 of the proposals included universities as subcontractors and an additional 45 as joint-venture members. Small- and medium-size enterprises (SME's) account for 59% of all projects and 33% of joint venture projects awarded.

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.

Mexico

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.

South Africa

MEP staff provides support to the CSIR in its efforts to initiate a program similar to MEP in South Africa. More details regarding this support can be found in the International Activities section as part of the NIST strategy for support and collaboration with 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 lightwave 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.

Bilateral Activities

Australia

The Fundamental Electrical Measurement (FEM) Group of the Electricity Division collaborates with the Impedance Laboratory of the Commonwealth Scientific and Industrial Research Organization (CSIRO) on the development of AC bridges and transformer design. Discussions between the two groups have also been held on recent work in the area of low voltage transfer standards and high frequency modeling. In addition, a representative of the FEM group participated in an assessment of the Resistance Project of the National Measurement Laboratory (NML), a unit of CSIRO.

Belgium

A representative from the Radio-Frequency Technology Division received training from Agilent in Brussels on Agilent's Nonlinear Network Measurement System (NNMS). NIST's Nonlinear Device Characterization project is procuring the NNMS through the Belgian Network Measurement and Description Group. The trip allowed the traveler to receive advance training on the NNMS, to conduct necessary experiments with collaborators in the Agilent Network Measurements and Description Group, and to start international measurement comparisons between similar systems.

France

The Electricity Division put a collaboration in place with researchers at the Université Paul Sabatier, in Toulouse. The collaboration will be on Boltzmann-code analysis using the NIST-assessed cross sections and transport coefficients for the plasma processing gas CHF_3 .

Germany

Representatives from the Optoelectronics Division visited PTB in Braunschweig, Germany to explore the potential for collaborations and comparisons. Future collaborations were discussed and include completion of in-progress comparisons in medium and high power laser measurements and optical fiber power measurements; a comparison of 248 nm excimer laser measurements, and a further dialog on fiber measurements.

Italy

The Radio-Frequency Technology Division continued a collaboration with the University of Rome. The research topics include studies of time-domain integral equations, composite material, and lossy transmission line of printed circuit boards.

Japan

Two representatives from the Optoelectronics Division had the opportunity to conduct research in laboratories in Japan. A ten-month collaboration at the NTT Optoelectronics Laboratories in Ibaraki focused on metrology methods using optical low coherence reflectometry, arrayed waveguide grating devices, dispersion compensation modules, and transversal filters, resulting in two joint publications. The other collaboration involved research at the National Research Laboratory for Metrology (NRLM) in Tsukuba, Ibaraki for two months. This collaboration, which involved development of new methods for performing short-pulse laser research, was part of an invitation program organized by the Japan Industrial Technology Association, and set up by AIST.

The U.S.-Japan Joint Optoelectronic Project (JOP) expedites the design and development of advanced computing technologies that integrate optical, optoelectronic and electronic components. As a working model for international research collaborations in competitive, high technology areas, JOP-supplied devices help augment and accelerate ongoing research programs funded by the Defense Advanced Research Projects Agency (DARPA), NSF and other federal organizations. A few JOP-supplied devices were instrumental in developing and demonstrating concepts with near-term commercial potential, and the JOP encourages advanced research by providing access to leading-edge devices not commercially available. The JOP brokers successfully streamlined the connections between users and suppliers and helped overcome cultural differences between the U.S. and Japanese research and business communities and reduced legal barriers, paperwork and fulfillment time for device requests. EEEL played a key role in establishing the JOP and continues to monitor and facilitate its work.

Discussions were held at NTT in Tokyo by representatives of the Electricity Division on a possible collaboration to develop single-electron tunneling transistors based on the

silicon on insulator technology. This collaboration would allow access to samples which may have no charge offset, and which are not available anywhere else in the world. Discussions were also held with Nippon Electric Corporation (NEC) researchers to validate the idea for these experiments.

A member of the Electricity Division worked with the Gaseous Electronic Institute in Nagoya, and the Keio University in Tokyo. The collaboration included a Monte Carlo code analysis using NIST-assessed cross sections and transport coefficients. The results of these calculations will be published in a joint paper after the calculations are finalized. A possible U.S.-Japan collaboration on electron collision and related data involving the Japan Society for the Promotion of Science (JSPS) and the National Science Foundation (NSF), NIST, NRC, the Department of Energy (DoE) and the National Aeronautics and Space Administration (NASA) was discussed, and would also include industry participation.

The Netherlands

A staff member from the Electricity Division collaborated with colleagues at NMi in Delft concerning the Josephson voltage standard (JVS) intercomparison experiment for the on-going EUROMET project. Discussions over methods to improve uncertainties by a JVS direct comparison were held.

United Kingdom

An intercomparison involving the Electricity Division regarding high-speed electrical pulse parameters with NPL has been completed. Only NIST and NPL provide formal measurement services in this area, but other national metrology institutes are currently developing this capability.

Representatives from the Optoelectronics Division visited the NPL in Teddington to discuss measurement capabilities in optoelectronics, and to explore 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. In addition, three areas will be explored: calibration of the optical fiber power meter used in the EUROMET intercomparison, the possibility of a direct comparison of cryogenic radiometers, and collaboration on excimer laser standards.

A representative from the Semiconductor Electronics Division participated in an on-site assessment for National Voluntary Laboratory Accreditation Program (NVLAP) of the National Computing Center for a scope of accreditation in Government Open Systems Interconnection Profile (GOSIP) testing.

Multilateral Activities

Key Comparisons and Other Intercomparisons

A comparison of 10 V voltage reference standards was carried out between BIPM and EEEL from October 1998 to January 1999. The NIST participation included the Electricity Division in Gaithersburg and the Electromagnetic Division in Boulder. The primary purpose of this comparison was to provide a solid link between comparisons of

JVS via Zener reference standards in North America and in Europe. Two additional goals of this BIPM-NIST comparison were to test the techniques used in the JVS comparisons, in particular, the veracity of the corrections applied to the traveling Zener standards due to variations in atmospheric pressure and, to test the stability of the traveling standards when shipped overseas as freight.

In April 1999, researchers in the Electricity Division and BIPM carried out a first comparison of their primary resistance standards using a traveling quantized Hall resistance (QHR) system. During this comparison, QHR measurements on the two systems agreed to within their combined measurement uncertainties of about 2 parts per billion.

The final measurements were performed on traveling digital multimeters that have been circulated among the SIM regions of ANDIMET, CARIMET, and SURAMET. The recently-inaugurated metrology network, SIMnet, was used to share test setup information (including high-resolution photos, full-motion video, and data) with participants in the SIM International Comparison of Electrical Units.

The largest formal international comparison of 50/60 Hz power was completed in early 2000, for which NIST served as the pilot laboratory. In all, 15 national metrology institutes from six metrology regions participated in the comparison, which began in June 1996. While state-of-the-art uncertainty for power is about five parts-per-million (ppm), the current results indicate that most of the measured values fall within 25 ppm of each other. While this level of agreement is more than an order of magnitude better than the uncertainty required for revenue metering, there is increasing demand for lower revenue-supporting measurements. This indicates the continued need for interactions between NMIs in these key measurements.

The Electrical Systems Group has been the lead laboratory for conducting the Comité Consultatif d'Electricité et Magnétisme (CCEM) round robin in alternating current power. A staff member from the Electrical Systems Group hand-carried the CCEM traveling wattmeter to the National Research Council Canada (NRCC) in Ottawa, Ontario to finish the CCEM comparison of power at 60 Hz. Also discussed was NRCC's active burden for current transformer calibrations and the development of shunt to have temperature coefficients as low as 0.01 ppm per degree C by Measurements International in Canada.

Other Multilateral Activities

A three-way collaboration between the Electricity Division, the Université Paul Sabatier in Toulouse, France, and the University of Mexico, was proposed regarding the plasma processing gas Cl_2 , an important etching gas in plasma reactors. The existing knowledge on this gas has recently been reviewed and assessed at NIST, and serious gaps in the present database have been identified, especially on electron transport, ionization, and attachment coefficients. Bridging these knowledge gaps will enable a meaningful Boltzmann-code analysis for this gas.

International Committee Participation and Interactions

The Electricity Division participates in the Video Quality Experts Group (VQEG). The VQEG is part of the Moving Pictures Expert Group (MPEG), which in turn is a working group of ISO/IEC in charge of the development of standards for coded representation of digital audio and video. An outcome of one meeting was to prepare a preliminary report of its extensive inter-laboratory examination of objective methods for the measurement of video quality. The study, involving scientists and engineers from Europe, Japan, South America, and North America, was conducted over the past two years to validate the degree in which state-of-the-art computational vision models could emulate the subjective judgment of digital video subjected to MPEG-2 compression. As a result of contributions to the VQEG effort, NIST has gained international recognition as a key player in the rapidly-developing field of digital video and multimedia telecommunications and information systems.

Staff members of EEEL, including the Director of EEEL, have extensive involvement and serve in key positions in CCEM, especially in the working group on Key Comparisons. The May 2000 CCEM meeting included discussions on the format of BIPM database entries and also on accreditation requirements. One of the main topics for discussion was the layout of the Appendix C of the MRa (BIPM) Database for Capabilities of NMIs. A meeting was also held on CCEM's activities in magnetics, and a Working Group on Measurement of the Quantized Hall Resistance with Alternating Current. The lack of international comparisons related to magnetic measurements was discussed, as well as the on-going electrical metrology key comparisons.

Staff members from the Electricity Division serve in leadership positions of Working Groups in the IEC Technical Committee 93 on Design Automation. This committee provides a formal means for both creating and harmonizing documentary standards needed by the electronics design community. EEEL also represents NIST on the international consortium RosettaNet, which develops documentary specifications to support the automated exchange of technical data among electronics industry supply chain partners.

EEEL staff members represent NIST on a variety of IEEE societies, including the Antennas and Propagation Society, the International Electron 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.

International Workshops and Conferences

The Radio-Frequency Technology Program reports that the Institute of Electronics and Electrical Engineers (IEEE) 802.16 Working Group on Broadband Wireless Access, has been rapidly moving toward consensus on an air interface specification for fixed broadband wireless access systems, which are expected to play a major role in providing broadband access to the Internet and other services. In May 2000, 158 people attended a week-long session on this topic in Gaithersburg. A European standardization body also

attended, with which the global IEEE organization has developed a plan to seek a uniform standard.

The 2000 International Conference on Characterization and Metrology for Ultra-Large Scale Integration (ULSI) Technology was hosted by NIST from June 26-29, 2000. The conference is the third in a series; the current conference attracted more than 220 attendees from the U.S., the Netherlands, Belgium, France, Spain, Germany, Switzerland, Israel, Korea, China, Japan, and Taiwan. In addition to EEEL's Semiconductor Electronics Division and the National Semiconductor Metrology program of NIST, sponsors included the International Semiconductor Manufacturing Technology (SEMATECH); National Science Foundation; American Vacuum Society, Manufacturing Science and Technology Technical Group; Semiconductor Equipment and Materials International; American Physical Society, Forum for Industrial and Applied Physics; The Electrochemical Society; and the Semiconductor Research Corp. Additional sponsors for the poster sessions were Applied Material; Boxer Cross; Charles Evans and Associates; Digital Instruments, Veeco Metrology Group; Dupont Photomasks Inc.; KLA Tencor; MEMC Electronic Materials Inc.; Rudolph Technologies Inc., SensArray, and Solid State Measurements. Topics for the conference included challenges, front-end processing, contamination and defect analysis, lithography, interconnect and back-end processing, thin films, and critical analytical techniques.

Manufacturing Engineering Laboratory

Dr. Dale E. 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

Australia

Expect, MEL's interaction automation software, is in use at the South Pole through NSF's South Pole Infrared Explorer (SPIREX) and Australia's Automated Astrophysical Site-Testing Observatory (AASTO). Experiments at the South Pole are difficult and expensive but significant due to its unique conditions. Since living conditions are harsh, the goal is to build an observatory that needs no human intervention to run for a year at ambient temperatures down to -80° C. The Expect software facilitates this goal by allowing control of astronomical equipment via embedded controllers over the Internet.

Canada

The Manufacturing Engineering Systems Integration Division has a cooperative project with the University of Toronto entitled "Ontologies for Extensions of the Process Specification Language". The goal of the project is the creation of a process specification language to facilitate the complete and correct exchange of process information among manufacturing applications.

A representative from the Process Measurements Division had discussions at Vortek Corp in Toronto on the possible use of NIST's thin-film/wire thermocouple wafer in Vortek's new arc lamp thermal processing tool for spike anneals of dopant implants in silicon wafers. The use of the NIST thermocouple wafer would improve the absolute calibration on their temperature measurements; commercial wire thermocouple wafers being too slow and had too much thermal disturbance near the connections. Vortek wants to initiate a joint project in the public domain to investigate dynamic temperature

measurements in their tool. It is planned to ship a thin-film thermocouple calibration wafer to Vortek for preliminary trials and design refinement and to plan a research project to investigate the potential capabilities of the NIST calibration wafer under dynamic temperature measurement conditions.

Egypt

A NIST-NIS cooperative project, supported by the U.S. Egypt Joint Fund, is establishing technical details for a 3-dimensional measurement system. This project will develop two surface calibration systems to calibrate surface topography for engineering surfaces with varying surface roughnesses. The work will also establish measurement traceability on surface metrology to NIST.

France

Representatives from the Manufacturing Systems Integration Division visited the Ecole Supérieure d'Informatique et Applications de Lorraine (ESIAL) campus in Nancy to discuss collaborative work related to the NIST Design Repository Project, and to explore possible guest researcher agreements in this area. The long-term objectives of the Design Repository project are to develop a framework to enable the creation of design repositories, that is, 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. Representatives from the Information Technology Laboratory were also in attendance to explore the potential for joint collaboration.

Germany

A representative from the Precision Engineering Division met with researchers at PTB in Braunschweig to talk about surface metrology topics, covered under the MOU between NIST, PTB and BAM.

A representative from the Automated Production Technology Division met with microforce researchers at PTB in Braunschweig, Germany, where a future collaboration on instrumented indentors, scanning probe microscopes, and microelectro-mechanical systems was discussed.

Japan

A representative from the Manufacturing Systems Integration Division was awarded a three month fellowship from the Mechanical Engineering Laboratory within the Japanese Science and Technology Agency (STA). During the fellowship, the staff member visited several universities, private sector companies and factories, to observe and discuss advanced manufacturing processes.

The Precision Engineering Division conducts collaborative research related to scanned probe microscopy applications with the Electrotechnical Laboratory (ETL) at AIST. In support of this research, Japan's STA recently awarded a research fellowship to a Division staff member. The funding provided by this award allows NIST to continue development of nanofabrication techniques based on scanned probe oxidation with

integrated electrical characterization. The scanned probe oxidation technique, pioneered by NIST, is currently being employed by research groups in the United States, Europe, and Asia, for advanced prototyping nanoelectronic devices, optoelectronic gratings, and nanoelectromechanical structures.

The Precision Engineering Division does collaborative research with ETL in Ibaraki in the area of scanned probe microscope (SPM)-based nanofabrication. The work uses scanned probe oxidation, a technique pioneered by NIST several years ago, and scanning Maxwell-stress microscopy (SMM), a technique developed at ETL. The focus of this work is to construct a solid technical foundation for SPM-based nanofabrication and characterization. SPM oxidation is the leading candidate for R&D of prototyping nanometer-scale electronic devices and electromechanical structures. The NIST-ETL collaboration demonstrated simultaneous electrical characterization of SPM oxide nanostructures during fabrication, from which a space-charge-limited growth model was hypothesized. As a result of technical progress made during these visits to ETL, additional collaborations involving university research groups in Spain and Taiwan and at Matsushita (Panasonic) in Japan were initiated. A major achievement from this collaboration is the improved performance and sensitivity of the SMM technique brought about by the implementation of carbon nanotube (CNT) probe tips.

Mexico

The Precision Engineering Division conducted a technical evaluation of a large coordinate measuring machine being constructed by the Instituto de Astrofisica, Optica, y Electrónica (INAOE) Tonantzinla, Puebla.

Spain

A two week research visit to NIST by a researcher from the Universitat Autònoma de Barcelona, in Barcelona, Spain was supported by funding from the Fulbright Commission for U.S. – Spain cooperative research. The visit was part of a joint project on the optimization of scanned probe oxidation, a method of resistless nanofabrication and lithography pioneered by MEL. The aluminum films are being used by the Barcelona group, in conjunction with other EU researchers, in the fabrication of critically dimensioned features for nanoelectromechanical systems applications.

Representatives of MEL, including the MEL Director, visited the Tekniker Foundation, near San Sebastian, Spain. Tekniker is a non-profit, private foundation providing calibrations and manufacturing engineering research and development services predominantly to Spain's machine tool manufacturing sector, which is focused in the Basque country.

Sweden

The Automated Production Technology Division has discussed a possible collaboration with NEOS Robotics AB in Stockholm on parallel kinematic machine tool characterization.

Taiwan

The Precision Engineering Division collaborates with the Precision Instrument Development Center (PIDC) and the Industrial Technology Research Institute, Center for Measurement Standards (CMS), both in Taiwan. Both of these organizations continue to actively support MEL's molecular measuring machine (M3) project by providing guest researchers to assist in instrument development. The Precision Engineering Division also conducts collaborative research with researchers at the National Tsing-Hua University in the area of scanned probe oxidation.

United Kingdom

A representative from the Automated Production Technology Division visited NPL in Teddington to discuss possible collaborations in geometric measurements of optics. These discussions were prompted by a request from industry to make a measurement NIST currently does not offer.

Multilateral Activities

Intelligent Manufacturing Systems

MEL participates in the Intelligent Manufacturing Systems (IMS), 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 and Norway, Switzerland, Japan and the U.S. participate in this program. IMS provides a support structure for conducting R&D projects within specific arrangements for the protection of intellectual property rights. NIST participates by providing U.S. Secretariat services, by paying the annual U.S. contributions and by membership in the Steering Committee. The IMS program was initiated by Japan to foster international cooperation on manufacturing research and development.

One of the eighteen projects under IMS is the Next Generation Manufacturing Systems (NGMS) project. This project's International Open Forum was held in May 2000 at NIST, where it was reported that an 87% reduction in manufacturing costs was achieved by two companies participating in Phase I of the project's research.

Modeling and Simulation Environments for Design, Planning, and Operation of Globally Distributed Enterprises (MISSION) is another IMS project. MISSION focuses on specifying neutral interfaces for the integration of manufacturing simulation systems. The project is aimed at developing and testing modeling and simulation environments for design, planning and operation of globally distributed enterprises. It involves 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 will support simulations over a range of vantage points, from individual factories to entire supply chains. A distributed supply chain prototype is being built to demonstrate the generic platform. NIST, which hosted the first quarterly meeting of regional leaders for the MISSION Project in November 1998, is

taking a lead role in this project. A staff member in the Manufacturing Systems Engineering Group is serving as the U.S. regional coordinator.

In the first cooperative agreement under MISSION, the partners have agreed that any intellectual property created during the course of work will be placed into the public domain. Signing for the U.S. along with NIST – the regional coordinator of the U.S. team – were seven major U.S. simulation software vendors, two companies, five universities and the Department of Defense's Defense Modeling and Simulation Office. Twenty projects are currently underway, involving over 250 companies and more than 200 research institutes from Australia, Canada, the European Union, Japan, and the U.S.

In October 1999, NIST hosted the annual international conference for the MISSION Project in Gaithersburg. MISSION is focusing on the development of neutral interfaces for distributed manufacturing simulation. About 45 participants, representing the European Union, Japan, and the U.S. regions attended the meeting.

Key Comparisons (KCs) and Other Intercomparisons

The Automated Production Technology Division participated in a joint calibration of two IEC Type LS1P Laboratory Standards Microphones, along with NPL in Teddington, U.K.

The Manufacturing Engineering Division took part in the Key Comparison CCL-K2, and transported the artifacts to the next participants, the Instituto Nacional de Metrologia, Normalização e Qualidade Industrial (INMETRO) in Rio de Janeiro, Brazil. Because the bars are sensitive to the handling and treatment they receive, it is mandated in the key comparison protocols that the bars be hand-carried from one laboratory to the next.

The Automated Production Technology Division participated in an accelerometer intercomparison, which included NIST and four other standard laboratories in North and South America, under the SIM project AV-1. Discussions were held about developing precision calibration systems for accelerometer calibration over a broad frequency spectrum.

Other Multilateral Activities

The Automated Production Technology Division was involved in the implementation of all facets of an International Telecommunications Union (ITU) H.323 standards-based multimedia conferencing prototype system. MEL's Office of Manufacturing Programs provided a great deal of support in the procurement, implementation and deployment of this prototype. The ITU is the international organization that organizes, develops, regulates, and standardizes global telecommunications. The ITU H.323-based prototype developed at NIST stems from an Organization of American States (OAS) initiative to provide electrical measurement services to North America. The system provides multiple clients with the ability to share Internet-based audio, video, data, and applications collaboratively in both low and high bandwidth situations.

Awards

Michael Pratt in the Manufacturing Systems Integration Division was presented with the 1999 John Gregory Memorial Prize for outstanding contributions to geometric modeling. Pratt received this prize while attending a Seminar on Geometric Modeling in Schloss, Germany.

International Committee Participation

Representatives from MEL actively participate in many of the CIPM Consultative Committees including:

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 on water flow: 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;

the Consultative Committee on Acoustics, Ultrasound, and Vibration (CCAUV), where personnel from the Automated Production Technology Division participate;

and 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. These key comparisons are interlaboratory round-robin measurements that test key dimensional-metrology measurement techniques. Discussion centered on the nature of evidence needed to insure mutual confidence in measurement service – the number and nature of required key comparison and additional evidence that might be used in support of claimed measurement capabilities.

Other Committees

A representative from the Automated Production Technology Division served as the head of the U.S. delegation at the meeting of the International Organization for Legal Metrology (OIML) Technical Committee 13 (Measuring instruments for acoustics and vibration) and at the meetings of the International Electrotechnical Commission (IEC) Technical Committee No. 29 (TC 29) Electroacoustics, and as the U.S. Expert Member of TC 29/Working Group 5 (WG 5) on calibration methods and specifications for standards microphones.

The Precision Engineering Division participated in the General Assembly of The International Organization for Production Engineering Research (CIRP) in Montreux, Switzerland and in technical work and discussions of CIRP Standing Technical Committees on surfaces and on precision engineering and metrology. An extended report was given on U.S. dimensional metrology standards activities and recent work at NIST in

the area of coordinate measuring machine metrology, performance validation, and measurement uncertainty evaluation.

A representative from the Automated Production Technology Division participated in the International Wassenaar Arrangement technical experts group meeting in Vienna, Austria. The proposed arrangement is an international agreement between 33 countries to control exports of sensitive item such as weapons and technologies that are used to make weapons, including machine tools, electronics, etc. to rogue states defined by this group of countries. No final agreement was reached at this meeting, but as part of the official US delegation, the staff member provided technical support for the U.S. position on machine tool export control criteria, as well as evaluating and discussing the proposals from the other countries participating in this meeting.

A representative from the Manufacturing Engineering Laboratory attended the World Trade Organization Agreement on Technical Barriers to Trade Meeting (TBT) in Geneva, Switzerland.

International Workshops and Conferences

MEL staff members participated in the XVI International Measurement Confederation (IMEKO) World Congress held September 25 - 28, 2000 in Vienna, Austria. The Congress was hosted by the Austrian Society for Measurement and Automation and held at the former Austrian imperial palace, the Hofburg. The chairman of the IMEKO Technical Committee on Mass and Force (TC3) extended invitations to the staff members to participate in this international metrology forum. This event provided an opportunity to interact with international colleagues conducting research in mass and force metrology. Discussions held at the Conference revealed that 1) the European Cooperation for Accreditation has endorsed guidelines on the calibration of static torque measuring devices, 2) many major national metrology institutes in force metrology are establishing mechanisms for realizing and disseminating the unit of torque, and 3) U.S. manufacturers will no longer be able to rely on independent force and length calibrations for traceability and uncertainty of torque measurements when dealing with foreign markets. Future efforts regarding development of a torque calibration capability at NIST will depend on further guidance and requirements inputs from U.S. industry.

The XV IMEKO World Congress was held in Osaka, Japan. At this meeting, NIST's Rockwell indenter was accepted as a CIPM key comparison, both on the microform geometry measurements and hardness performance tests. A NIST calibrated standard indenter was selected as a pilot indenter for these international comparisons.

MEL's Intelligent Systems Division hosted the fourth in a series of annual conferences on intelligent systems at NIST Gaithersburg on September 14-17, 1998. This year, three conferences came together to form "A Joint Conference on the Science and Technology of Intelligent Systems." Included were the IEEE International Symposium on Intelligent Control (ISIC) held jointly with the International Symposium on Computational Intelligence in Robotics and Automation (CIRA) and the NIST-Intelligent Systems and

Semiotics (ISAS) conference. Papers were presented by a broad cross-section of international researchers representing fields as diverse as biomedical research, cognitive reasoning, autonomous vehicles, evolutionary programming, and manufacturing systems integration.

Chemical Science and Technology Laboratory

Dr. Hratch G. 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.

Bilateral Activities

Austria

The Surface and Microanalysis Science Division has a collaboration with the Technical University of Vienna and the University of Vienna. The joint research involves sample preparation and quantification capabilities for Accelerator Mass Spectrometry applied to carbonaceous aerosol collected at the Global Atmospheric Watch high altitude station in Austria. An additional collaboration with the Austrian Technical University is on the development of a new database called Quantitative Electron Spectroscopy for Electron Spectroscopy Techniques (QUEST), in which Auger Electron Spectroscopy (AES) and XPS spectra can be simulated for complex specimen morphologies.

Canada

The Analytical Chemistry Division has a collaborative research project with McMaster University and the National Water Research Institute in Burlington, Ontario on the potential use of Liquid Chromatography/Mass Spectrometry for the quantitative determination of high molecular weight polycyclic aromatic hydrocarbons (PAHs).

For three weeks in June and July of 1998, representatives from the Surface and Microanalysis Science Division participated in the International Crown Fire Modeling experiment (ICFME) near Great Slave Lake, Northwest Territories. Organized by the Canadian Forestry Service, the ICFME is an ongoing experiment in the controlled burning of the boreal forest for the purpose of measuring the behavior of high-intensity crown fires and emissions from these fires. A total of 59 researchers and operational staff from Canada, Russia, Australia, France, and the U.S. participated in this comprehensive study. NIST's efforts focused on the sampling of combustion aerosols both at ground

level and in the smoke plum via helicopter. These samples will provide a unique opportunity for researchers to characterize these emissions chemically and isotopically, especially the carbonaceous component. Since boreal wildfires are a natural combustion source, it is particularly important to distinguish the chemical/isotopic character for these emissions from those of anthropogenic sources such as fossil-fuel combustion and agricultural biomass burning. Through this research, NIST will help the world community address critical metrological challenges in characterizing black carbon from combustion processes and in developing methodologies to distinguish natural boreal wildfire emissions from those emissions from the burning of tropical grasslands. Efforts will lead to improved identification of global biomass-burning sources as climate change proceeds into the 21st century.

Chile

The Analytical Chemistry Division provided technical assistance and instruction in the development of a chemical standards program at the invitation of Corporación de Investigación Tecnológica (INTEC) in Santiago. This supports the commitment of CSTL/NIST (as part of NORAMET) to provide leadership in the development of the chemical metrology program within SIM.

EU

The Physical and Chemical Properties Division participated in a panel investigating the state of the science, technology, and technology transfer of molecular modeling in Europe, which included visits to London and Manchester in the U.K., Paris and Lyon in France, and Geleen in The Netherlands. The panel was organized by the World Technology Division of International Technology Research Institute (WTEC/ITRI) of Loyola College, with NIST being one of the sponsors. Among the findings of the panel was that Molecular Modeling (MM) no longer appears to be considered a "boutique" research area and has few problems that don't afflict other research specialties. The integration of MM into research teams is most effective, with software issues appearing to be more urgent than hardware, although hardware may be the bottleneck for more academic, long-term research.

The Physical and Chemical Properties Division met with scientists and EU science managers in Brussels, Belgium to discuss joint U.S. and European projects in ozone research. The head of the Biodiversity and Global Change Unit, within the European Commission's Preserving the Ecosystem Directorate, signed a statement of coordinated research between the Sage III Ozone Loss and Validation Experiment (SOLVE) and the Third European Stratospheric Experiment on Ozone (THESEO) -2000 campaigns, as an example of implementation under the 1998 "European Union/United States Science and Technology Cooperation Agreement". The agreement is important to foster NIST's role as an active participant in the international atmospheric research community with a particular emphasis on the changing chemical composition of the atmosphere and the feedback mechanisms connecting ozone depletion and climate change.

France

The Biotechnology Division collaborates with scientists at Institute Gustave-Roussy and at the Centre National de la Recherche Scientifique, Commissariat à l'Énergie Atomique (CNRS-CEA), the Center for Low Radioactivities in France, on oxidative DNA base damage and repair.

A representative from the Analytical Chemistry Division traveled to the Laboratoire National D'Essais in Paris to install, test, and provide training on the operation and maintenance of the NIST Standard Reference Photometer, SRP 24.

Germany

A representative from the Analytical Chemistry Division visited PTB to discuss possible collaborations in the development and use of clinical reference methods. There was special interest in the area of organic analytical methods on clinical analytes and collaborative work in certification analyses for NIST Standard Reference Materials.

Hungary

A representative from the Physical and Chemical Properties Division discussed collaborative research being conducted at the Institute of Chemistry, Chemical Research Center, Hungarian Academy of Sciences in Budapest. The topic of the research is the development and kinetic application of highly-sensitive transient absorption techniques.

Italy

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.

Japan

The Analytical Chemistry Division has a collaboration with the University of Tokyo for research on contaminants in marine animals.

The Fluid Flow Group of the Process Measurement 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 the flowmeter as a transfer standard, and will test it on a periodic basis to 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.

Mexico

A representative of the Analytical Chemistry Division assisted scientists at CENAM in implementing the classical wet chemical techniques of gravimetry and titrimetry for the determination of major constituents in reference materials.

Poland

The Surface and Microanalysis Science Division collaborates with the Institute of Physical Chemistry in Warsaw regarding a new version of the NIST Elastic Electron Scattering Cross Section Database. The collaboration will also include planning the design of a new NIST database, which would contain relevant data from Standard Reference Database (SRD) 64 and SRD 71. This new database could be used, together with information on the experimental configuration supplied by the user, to determine values for measurement of overlayer thicknesses by AES and XPS. The database would also supply other useful information such as mean escape depths and emission depth distribution functions.

Portugal

The Physical and Chemical Properties Division has a collaboration with the University of Lisbon in the area of thermophysical properties.

Slovenia

A representative from the Surface and Microanalysis Science Division met with the group for Electron Microscopy and Microanalysis, Ceramics Department, at the "Jozef Stefan" Institute in Ljubljana to discuss on electron microprobe analysis on sputter-deposited lead zirconate titanate (PZT) films and reference materials.

Switzerland

Staff members from the Analytical Chemistry Division collaborate with the Swiss Federal Institute of Technology in Zurich, performing joint research in environmental analytical chemistry.

The Analytical Chemistry Division collaborated with the Swiss Federal Laboratories for Materials Testing and Research (EMPA) in Dübendorf, for a Comité Consultatif pour la Quantité de Matière (CCQM) Key Comparison on Zinc mass.

United Kingdom

A representative from the Surface and Microanalysis Science Division visited several laboratories in England and Wales and gave presentations on Desktop Scientific Image Processing with MacLispix, which has been developed at NIST. Two collaborations were discussed and developed; one with Defense and Evaluation Research Agency (DERA), a department of the British Ministry of Defense on automatic classification of particles by shape, and the other with the Materials Department at Oxford University to use MacLispix to measure radiation-damage defects in micrographs.

The Analytical Chemistry Division is conducting an intercomparison with NPL on Fourier Transform Infrared Spectroscopy (FTIR) measurements of several hazardous air pollutants.

Multilateral Activities

SIM

CSTL holds the Chair for the Chemical Metrology Working Group. Since only three of the 34 SIM countries have formal programs in chemical metrology, CSTL conducted five training courses in FY99 in the areas of organic, spectrochemical, nuclear, gas metrology and classical analytical methods. The number of participants ranged from 6 to 15 in these one week, hands-on courses given for current or designated future leaders of chemical metrology programs of NMIs within SIM.

Key Comparisons (KC) and Other Intercomparisons

A major KC activity has involved the realization of the International Temperature Scale of 1990 (ITS-90), in which the Thermal and Reactive Processes Group of the Process Measurements Division has participated. In one case, KC 3 [83.8058 K (argon triple point) to 933.473 K (aluminum freezing point)], NIST fulfilled responsibilities as the pilot laboratory (organization and data reduction), which involved 14 NMIs.

The CCQM is establishing a global infrastructure for traceability of chemical measurements to the SI. The Analytical Chemistry Division is active in KCs organized through the CCQM. These include the determination of dichlorodiphenyldichloroethane (DDE) in spiked and unspiked fish oil, cholesterol in serum, various gas standards, (*e.g.* carbon monoxide), and pH.

A representative from the Process Measurements Division transported a standard platinum resistance thermometer (SPRT) and a high temperature SPRT, an Al freezing-point cell and a Ag freezing -point cell to IMGC in Italy, as required for their participation in the Consultative Committee on Thermometry (CCT) KC #3 and #4.

A key comparison for humidity standards has been organized with NIST as the pilot laboratory. The collaboration with the CCT and with other NMI participants continues NIST involvement in leading and contributing to these critical assessments of national standards

Six comparison exercises have been developed to test the proficiency of SIM NMIs. The NORAMET sub-region of SIM consists of NIST, NRCC, and CENAM-Mexico, all of which produce Certified Reference Materials (CRMs). These institutes have agreed to compare their capabilities while assisting in each other's reference materials certification campaigns. Comparisons for metals in drinking water, elements in sediments and mussel tissue, organic compounds in sediments and fish tissue, methylmercury in fish tissue, and vitamins and minerals in milk powder took place in FY99 using this approach.

The Process Measurements Division has conducted international pressure comparison measurements with a number of SIM countries, including the Oficina Nacional de Normas Uniddes de Medida (ONNUM) in Costa Rica; and the Instituto Nacional de Defensa de la Competencia y de la Proteccion (INDECOPI) in Peru. The Process Measurements Division also conducted an international comparison of vacuum standards and the realization of the Pascal together with NPL and PTB.

The Analytical Chemistry Division participated along with NPL and NMI in an intercomparison of low concentration nitric oxide, hydrogen sulfide, and hydrogen chloride gas standards.

Other Multilateral Activities

The Surface and Microanalysis Division has a joint project with the Southern Danish University, A. N. Technology Ltd. in Oxford, U.K, and ANTECH Corporation, located in Denver Colorado. The collaborative project is to improve measurements of electron inelastic mean free paths. ANTECH develops, designs, manufactures, markets and services a range of instruments and systems for the measurement of special nuclear materials for both safeguards and nuclear material accountancy, including nuclear waste measurements for the NIST XPS Database

The Analytical Microscopy Group in the Surface and Microanalysis Science Division participated in the acceptance testing, training, and initial operation of a secondary ion mass spectrometer (SIMS), which was delivered to the International Atomic Energy Agency Laboratory (IAEA) in Seibersdorf, Austria. Sample preparation training and technical support was also provided to IAEA staff for the effective implementation of the SIMS. These activities were supported through the IAEA Safeguards program.

A representative from the Analytical Microscopy Group also participated in the IAEA Consultants' Meeting on "Particle Analysis of Safeguards Samples" in December 1999. The meeting was held to better understand the technical requirements of the IAEA in the area of environmental sampling and better contribute to the important international activity of nuclear safeguards.

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.

A representative of the Surface and Microanalysis Science Division coordinated the Isotopic Black Carbon in the Environment: New Metrology for ^{14}C and its International Impact for the 1649a Comparison Exercise. The staff member also participated in a workshop of the International Steering Committee for the Development of Black Carbon Reference Materials in Jena, Germany 7-9 March 2000, to meet for work and planning of

international documents on fundamental chemical metrology, for the International Union of Pure and Applied Chemistry (IUPAC).

Awards

Oliver Borchert, from the Analytical Chemistry Division and a former guest researcher from Germany, received the second prize for his poster presentation concerning representation and handling of result data in a device capability dataset (DCD). This prize was awarded at the LabAutomation '99 Conference in San Diego.

At its centenary meeting in London, England, the Institute of Refrigeration awarded its J&E Hall Gold Medal to Ray Radebaugh, of the Physical and Chemical Properties Division, for his development of super-cold pulse tube refrigerators. Dr. Radebaugh's pioneering work on the development and theory of pulse tube refrigerators has stimulated an intense worldwide study of this new refrigeration method for many cryogenic cooling applications," the citation states. The award is sponsored by J&E Hall Ltd., the world's oldest refrigeration company.

International Committee Participation

The Surface and Microanalysis Division participated in the International Organization for Standardization/Technical Committee (ISO/TC) 201 on Surface Chemical Analysis held in Matsue, Japan, on October 15-17, 1998. They were among the more than 60 delegates, with representation from Australia, China, Hungary, Japan, Korea, Sweden, Switzerland, United Kingdom, United States, and two liaison organizations. The main objectives for the CSTL staff members were to provide U.S. input in standards needs and potential solutions as well as to help establish a U.S. position in this important metrology.

The Thermometry Group participated in working group meetings of the CCT. These include those concerning the international traceability of temperature measurements on ITS-90, and for humidity measurements.

A representative from the Surface and Microanalysis Division attended the annual meeting of national representatives to the Surface Chemical Analysis Technical Working Area (SCATWA) of the Versailles Project on Advanced Materials and Standards (VAMAS). The meeting was held in Avilla, Spain.

The Analytical Chemistry Division participates in various CCQM working groups, which advises the CIPM on matters related to the accuracy of quantitative chemical measurements and traceability to the SI. Staff members are active in the Inorganic Working Group, Gas Standards Working Group, pH Working Group, Organic working Group,

A representative from the Physical and Chemical Properties Division served as the technical liaison to the U.S. Delegation to the Organization for the Prohibition of Chemical Weapons (OPCW) for negotiations on analytical methods, which was held in September 2000.

The Analytical Chemistry Division participates in meetings of the IUPAC Commission V.5 (Electroanalytical), and represents NIST in the areas of pH metrology and electrolytic conductivity.

International Workshops and Conferences

The Nuclear Analytical Methods Group organized and conducted the highly successful "Tenth International Conference on Modern Trends in Activation Analysis" in April 1999. This quadrennial meeting brings together the worldwide community to assess nuclear analytical techniques and their applications, with emphasis on innovative recent developments. This session was attended by 204 scientists from 37 countries.

The North Atlantic Treaty Organization (NATO)'s "Advance Research Workshop on Polymer Structure and Transport in Confined Spaces", co-sponsored by NIST's Biotechnology Division, NATO and Avanti Polar Lipids, was held June 20-25, 1999, at Puchner Castel, in Bikal, Hungary. The meeting sought to advance the scientific and technological state-of-the-art of the physical mechanical and transport properties of polymers in biological systems.

The Director, CSTL, and other representatives of CSTL participated in a Workshop on "Establishment of Chemical and Medical Metrology Laboratories" at UME, from June 16-22, 2000 in Istanbul, Turkey. The Workshop was held jointly by NIST and UME, which is the national metrology institute for Turkey. The workshop was organized to promote discussions on interactions between NIST and UME toward the development of a program on Chemical Metrology. The need for development of "core competencies" (*i.e.* expertise in analytical methodologies, which included aspects of instrumentations, method development assessment of sources of error, statistics, *etc.*), was stressed over the more "mechanical" aspects of chemical measurements. It was suggested that development of a reference material by UME might provide an exposure to the types of problems and the skills required for a successful program in chemical metrology, and a possible guest scientist visit to observe and participate in the development of an appropriate SRM was discussed.

A workshop, "Measurement Traceability for Clinical Laboratory Testing and In Vitro Diagnostic Test Systems", was held November 2-3, 2000 in Gaithersburg. The Workshop, co-sponsored by NIST, was geared for members of the medical diagnostics industry, professional organizations, government and national and international standards-developing organizations. A new European Union directive on in vitro diagnostics will require that calibration of all new medical diagnostic devices be traceable to "standards of a higher order" by 2003. Existing diagnostic products, without the European Union stamp of approval, can remain on the market only until 2005. Although NIST produces many reference materials for medical tests, the United States currently does not have a formalized system for tracing the accuracy of all tests performed with in vitro diagnostic devices and systems. U.S. manufacturers, who produce over 60 percent of the devices sold in Europe, potentially could have their products challenged on the basis of this directive. Additional sponsors of the Workshop were the American Association for Clinical Chemistry, the Centers for Disease Control and Prevention, the

Health Industry Manufacturers Association and the National Committee for Clinical Laboratory Standards. Extensive discussions were held on how to establish the needed measurement traceability and reference systems for health care manufacturers.

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 Atomic Physics Division has a collaborative project with the Australian National University and James Cook University on the trapping and cooling of rare gas atoms.

Botswana

A representative from the Time and Frequency Division visited the Botswana Bureau of Standards (BOBS) in Gaborone to discuss time and frequency dissemination techniques that may be applicable to that organization. Among the discussion topics were the feasibility of including a time dissemination system into the television station being built in Gaborone, and the possible installation of a telephone time transfer system, such as the Automated Computer Telephone System (ACTS), which is used at NIST.

Denmark

The Atomic Physics Division collaborates with the University of Copenhagen to study cooled and trapped magnesium atoms.

Egypt

The Time and Frequency Division has a collaborative project with NIS that is funded from the U.S. Egypt Joint Board on S&T. The project is developing advanced time and frequency dissemination through innovative use of the Nilesat satellite, involving the installation of time code generators and cesium beam oscillators at a Nilesat uplink site.

Finland

The Optical Technology Division conducted a bilateral comparison of Spectral Irradiance and Spectral irradiance responsivity in Helsinki.

France

The Atomic Physics Division has several collaborative research projects with French institutions. These collaborations include work with researchers at ESIAL where collaborative research is performed on the theoretical treatment of ultra-cold collisions relevant to their experimental measurements for cesium and rubidium; CNRS on understanding the Carbon dimer lu spectra; the University Paul Sabatier, on photoassociation in ultra-cold atomic beams; the Institute Laue Langevin (ILL) to perform precision gamma-ray measurements on the NIST precision gamma-ray spectrometer; and with the Laboratory for Molecular Photophysics on collisions of ultra-cold cesium atoms. The division, in collaboration with the University of Bourgogne, and other guest researchers, has also developed accurate, efficient computational models for understanding and analyzing images made by Near-Field Optical Microscopy (NSOM), to improve optical spatial resolution over the diffraction limit.

The Ionizing Radiation Division also has a collaborative project with ILL. The project is designed to study ultracold neutron transmissions through various window materials. These measurements are necessary to support the design of a new ultracold neutron source here at NIST.

Germany

A collaboration between researchers in the Neutron Interactions and Dosimetry Group of the Ionizing Radiation division, Harvard University, the Hahn-Meitner Institute, and Los Alamos National Laboratory demonstrated the magnetic trapping of neutrons for the first time in late 1999. This work demonstrates the loading, trapping, and detection techniques necessary for performing a neutron-lifetime measurement. Further refinements of this method should lead to an improved precision in the measurement of the neutron lifetime, an important parameter for understanding the weak nuclear force and the creation of matter during the Big Bang. This collaboration is continuing with the characterization of materials being developed for use in a monochromatic beam facility at the Hahn-Meitner Institute in Berlin. Eventually, these samples will be used at NIST in the development of a new ultracold neutron facility.

The Optical Technology division collaborated with PTB for an intercomparison of the reflectance scale and the CIPM key comparison of reflectance. This included the comparison of detector-based irradiance scales using a common high temperature black body radiator at PTB. For another intercomparison, the Optical Technology Division conducted an ultraviolet radiation experiment at BAM.

Hungary

The Ionizing Radiation Division collaborates with the Hungarian Academy of Sciences in Budapest, along with the Pacific Northwest National Laboratory in Richland, Washington

to develop an inexpensive, mass-produced radiation dosimeter, targeted for enhancing the safety of irradiated foods. The "Sunna" dosimeter measures the full range of absorbed doses applied in industrial radiation processing, and may serve as a low-cost measurement tools for other applications, including the sterilization of medical equipment, the curing of inks and paints, quarantine control of fruit and vegetables, and the treatment of stored transfusions blood supplies.

Italy

The Time and Frequency Division assisted in the assembly of the Italian Cesium Fountain Clock, which is located in Sorrento.

Japan

The Atomic Physics Division collaborates with the University of Electro-Communications in Tokyo on laser cooling, trapping and manipulating techniques for rare gas metastable atoms.

An atomic frequency primary standard was delivered, installed, configured and tested in the Communications Research Laboratory in Tokyo, with the assistance of a representative from the Time and Frequency Division.

Kenya

A representative from the Time and Frequency Division traveled to KEBS in Nairobi to discuss appropriate time and frequency dissemination techniques. The time and frequency elements of the MOU technical cooperation between KEBS and NIST was discussed, including a time scale, a system for making time scale comparisons with other labs and reporting those results to BIPM and a time distribution system for computers and voice. There were also inputs on other areas, including building and construction, chemical metrology, chemistry and microbiology, and website development.

Mexico

A collaboration between the Time and Frequency Division and CENAM has resulted in the development of a new approach to the measurement of PM and AM noise in pulsed amplifiers. The new system will allow manufacturers to evaluate the performance of pulsed amplifiers directly, rather than on interfering amplifier performance from the overall performance of the system.

Portugal

The Atomic Physics Division is continuing 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 the U.S.

Russia

Along with Russian researchers, the Ionizing Radiation Division collaborates in the Russian American Solar Neutrino Experiment (SAGE). A paper published in the December 1999 issue of Physical Review Letters presents the limits imposed by the SAGE data on vacuum oscillation parameters.

The Ionizing Radiation Division collaborates with the Kurchatov Institute on studies in weak interaction physics.

The Time and Frequency Division, along with the Novosibirsk State University, developed a new concept of two-dimensional sideband Raman cooling and Zeeman state preparation in an optical lattice. The development of this concept was driven by the need to reduce transverse velocities of laser-cooled atoms in primary cesium-fountain frequency standards, and will provide for significant reduction in the uncertainty of NIST-F1, NIST's new primary frequency standard.

Switzerland

The Quantum Physics Division carried out joint research at the Plasma Physics Research Center (CRPP) in Lausanne. The collaborative experiments were designed to improve the understanding of silica on particle growth in silane discharges, and are capable of explaining the crucial initial growth of anions in these discharges. Part of the NIST role was to develop a model that incorporates this into the full particle-growth problem. The interpretation of the experiments was aimed at obtaining fundamental rate-growth, particularly in discharges used to produce amorphous silicon devices, such as solar cells and thin-film transistors for display. This is a multi-billion-dollar industry, and the efforts to understand the fundamental growth processes and the causes of device quality and growth-rate limitations have significant influence on the competitiveness of U.S. manufacturers.

United Kingdom

Charles Clark, from the Electron and Optical Physics Division, served as the Dr. Lee Visiting Research Fellow at Christ Church College, Oxford University.

The Ionizing Radiation Division collaborates with the University of Lancaster in neutron lifetime experiments. The joint project has involved the production of isotopically pure ^4He , which will be utilized in NIST's work using ultracold neutrons.

Multilateral Activities

In March 2000, it was announced that NIST, the Canadian National Research Council, and the Mexican Centro Nacional de Metrología have declared that their respective versions of Coordinated Universal Time (UTC), the world time standard, are equivalent to within five microseconds for time measurements, and within one part in a trillion for frequency deviations. The official time scales of North America are coordinated through regular comparisons, and the equivalency comes after several years of international comparisons and negotiations. The common time scale defined in the declaration is known as UTC North America. It supports trade and technology across the region, especially through such things as time tags for financial transactions and scientific observations. This declaration supports trade and technology across the region, especially through such things as time tags for financial transactions and scientific observations.

The Radioactivity Group of the Ionizing Radiation Division and ITL's Statistical Engineering Division collaborated with the International Committee on Radionuclide Metrology to develop a unique ashed bone SRM (SRM 4356) for low-level radionuclides in bone.

Researchers in the Time and Frequency Division have developed improved microwave frequency synthesizers to support new laser-cooled atomic clocks for both laboratory and advanced space applications. Critical to the dissemination of the signals from these new laser-cooled clocks are the high performance microwave frequency synthesizers developed by Boulder personnel with the help of guest researchers from Serbia (University of Belgrade) and the National Physics Laboratory in India.

The Optical Technology Division will serve as the host laboratory for the Consultative Committee on Photometry and Radiometry (CCPR) international intercomparison of spectral responsivity scales in the near infrared (NIR), which is one of the CCPR's key comparisons. A total of sixteen laboratories are included in this intercomparison. A total of three rounds are planned, with one-third of the laboratories participating in each round.

The Ionizing Radiation Division recently calibrated a secondary-standards ionization chamber for the IAEA, Dosimetry and Medical Radiation Physics Section. This section serves as the central measurement and administrative laboratory of the IAEA/World Health Organization (WHO) network of Secondary Standard Dosimetry Laboratories (SSDLs) and provides traceable calibrations, free of charge to all SSDLs in the 76-member network. The chamber will be used to improve the quality of mammograms taken worldwide. Member laboratories have been established in countries from Algeria to Yugoslavia and include many in South and Central America, Europe, Africa and the Near, Middle and Far East. The calibrations were performed at the NIST Mammography Calibration Facility, and were conducted for 17 NIST mammography X-ray beam qualities, since the IAEA laboratory has modeled their available mammography beam qualities after the NIST facility. The calibrations will allow the IAEA to transfer the NIST standards for exposure (air-kerma) to the IAEA/WHO SSDL network.

Awards

Eric Cornell, from the Quantum Physics Division, and Carl E. Wieman of the University of Colorado won the Lorentz Medal from the Royal Netherlands Academy of Arts and Science. The medal, which honors Hendrik A. Lorentz (1853-1928), a lifelong member of the Academy and the co-winner of the Nobel Physics Prize in 1902, was awarded for Cornell and Wieman's 1995 creation of the first Bose-Einstein condensate, a new form of matter predicted by Albert Einstein and Satyendra Bose more than 70 years ago. The two researchers were presented the award at a special session of the Academy's Science Division. This prize is awarded every four years. They were honored for their breakthrough production of the first gaseous Bose-Einstein condensate (BEC), accomplished through laser-cooled rubidium vapor and magnetic trapping techniques to lower the sample temperature to about 170 nanokelvin, the coldest temperature (at that time) ever achieved, leading to the BEC state in which all atoms occupy the same quantum state.

Mark Edwards, from the Electron and Optical Physics Division and an Intergovernmental Personnel Exchange Agreement (IPA) appointee, was awarded one of the first prizes established by The European Research Conference on BEC. This prize will be awarded every two years for the most valuable contribution to this emerging field of research, which was launched by the demonstration of BEC.

International Committee Participation

A representative of the Time and Frequency Division attended the Radiocommunication Assembly in Istanbul, Turkey, as part of the U.S. Delegation and vice chairman of International Telecommunications Union, Radiocommunications Sector (ITU-R) Study Group 7. The U.S. delegation of 29 included participants from the State Department, The National Telecommunications and Information Administration (NTIA), the Federal Communications Commission (FCC), Department of Defense (DoD), NASA, NIST, government contractors, and several private sector companies with radiocommunication interests. Discussions were held over a revised resolution to "encourage organizations dealing with radiocommunications to take into account the global activities of the Radiocommunication Study Groups". The recommendations referenced approved standards which are maintained by other recognized external organizations, *e.g.* standards development organizations, and other activities to encourage increased involvement by organizations in the Radiocommunications. An MOU may be developed as required for the exchange of technical information on a reciprocal basis pending appropriate copyright agreements.

International Workshops and Conferences

The Optical Technology Division hosted the first International Symposium on "Measurements of Optical Radiation Hazards", held at NIST-Gaithersburg in September 1998. The Commission Internationale de l'Eclairage (CIE), the International Commission on Non-Ionizing Radiation Protection, the U.S. Army Center for Health Promotion and Preventive Medicine—Laser/Optical Radiation Program, and the Food and Drug Administration's Center for Devices and Radiological Health were the other co-sponsors of the meeting. The meeting was organized to cover the biological basis for health risk assessment, regulatory recommendations and guidelines, and measurement techniques necessary for hazard evaluations. Attending the conference were 139 researchers from the United States, Europe, Japan, Australia, and South Africa.

The Ionizing Radiation Division co-sponsored a workshop in April 1999 with the Council on Ionizing Radiation Measurements and Standards (Public and Environmental Radiation Protection subcommittee), DoE/Office of Environment, Safety and Health, DoE /Office of Environmental Management/National Analytical Management Program, International Atomic Energy Agency/Monaco and Seibersdorf, Hewlett Packard, and VG Elemental. Fifty participants from instrument manufacturers, national laboratories, NIST, the Environmental Protection Agency (EPA), DoE, France, Korea, and the United Kingdom attended the workshop to develop strategic plans to address the growing need for SRMs,

CRMs, and intercomparison and performance evaluation materials for low-level and environmental radionuclide atom counting.

The Ionizing Radiation Division was a co-sponsor of the Conference on "Radionuclide Metrology and Its Application", held in Prague, Czech Republic in June 1999. Topics included in the conference were metrology techniques, source preparation, measurement standards and reference materials, alpha-particle spectrometry, beta-particle spectrometry, gamma-ray spectrometry, nuclear decay data, life sciences, and low-level radioactivity measurements.

Researchers in the Neutron Interactions and Dosimetry Group held an informal workshop at the NIST Center for Neutron Research on the application of polarized ^3He spin filters to neutron scattering. The workshop was attended by 17 outside scientists, including representatives from the Spallation Neutron Source, Los Alamos National Laboratory, Argonne National Laboratory, the Canadian National Research Council, the Niels Bohr Institute (Denmark), the ILL (France), Johns Hopkins, the University of Nottingham, Science Research Labs, and Indiana University. A novel idea for a polarized ^3He detector/analyzer emerged out of the meeting and the technical feasibility of the idea will be evaluated.

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

The Director of the NIST Center for Neutron Research, traveled to the Institute for Nuclear Energy Research in Taipei, Taiwan and the Australian Nuclear Science and Technology Organization (ANSTO) in Sydney Australia, to review the design and solicitation of a new research reactor in Taipei, Taiwan.

Canada

Representatives from the Center for Neutron Research participated as instructors for the NRCC's 6th "Summer School on Neutron Scattering" in June 2000 at Chalk River, Ontario.

The Polymers Division established a new collaboration with McGill Polymer group to produce co-polymers of low molecular mass. NIST will do Matrix-Assisted Laser Desorption Ionization (MALDI) and data analysis. This collaboration will allow NIST to study more effectively the effect of ion association on the MALDI process.

Croatia

The Materials Reliability Division collaborates with the Mechanical Engineering Faculty in Slavonski Brod on the characterization of a welding procedure based on monitoring of welding variables. The research was conducted as part of a project under the U.S.-Croatia joint fund.

France

The Center for Neutron Research has an on-going collaboration with scientists at ILL to carry out measurements of the high energy spin wave dispersions on the IN-8 spectrometer, one of the best thermal triple axis instrument in the world. These experiments were an integral part of the upgrade of the equipment at NIST to a triple axis instrument.

Germany

The Materials Reliability Division collaborates with the Institute for Materials in Energy in Cologne on thermal conductivity of coatings for turbine blades.

The Center for Neutron Research collaborates on studies of neutron spin echo spectrometry with the Forschungszentrum Jülich.

A representative from the Polymers Division visited BAM in Berlin to discuss future cooperative research. The proposed collaborative work is on developing joint certification and issuing of CRMs, including testing of surface area and porosity ceramic standards produced by BAM.

A representative from the Materials Reliability Division visited the Max-Planck-Institut fuer Metallforschung, (MPI) Stuttgart to perform transmission electron microscopy (TEM) experiments and learn more about analysis procedures for measuring strain in copper interconnects. The research concerned details on the analysis procedure for evaluation of convergent-beam electron diffraction (CBED) patterns, and performing CBED measurements of lattice constants in single crystal copper at elevated temperature analyzed data using different method from current NIST methods. Also, dynamical shift calculations can now be worked into the NIST program. The feasibility of acquiring electromigration data at elevated temperatures within the TEM was also demonstrated during this collaboration.

On June 26, 2000, the Director of MSEL and the president of BAM signed a Project Annex to the NIST/BAM/PTB MOU, establishing a framework for collaboration between MSEL and BAM for joint development of reference materials. The objective of this collaboration is to jointly develop reference materials for distribution worldwide, thereby contributing to the global harmonization of material measurements. The first two joint SRM/CRMs currently planned under this program are a ceramic powder with a high surface area and a ceramic porosity standard. These reference materials will complement the ceramic standards that are presently available from NIST and BAM.

Israel

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

Japan

A representative of the Polymers Division visited the National Research Laboratory of Metrology, the National Institute of Materials and Chemical Research, and the Tokyo Medical and Dental University to discuss future collaborations. Among the proposed research topics was an evaluation technique to measure the microstructure of composite materials.

A representative from the Ceramics Division visited National Industrial Research Institute of Nagoya (NIRIN), to discuss the possibility of collaboration between NIST and NIRIN in the areas of machining and wear research. Also discussed was the status of the joint program on powder characterization with Japan Fine Ceramic Center (JFCC), and a proposal to VAMAS to establish a new Technical Working Area on Powder characterization.

The Director, MSEL, visited the National Research Institute for Metals (NRIM) in Tsukuba, Japan. The Director was part of a government-mandated committee that formally evaluates the NRIM's performance every five years.

A representative of the Materials Reliability Division discussed a joint test program for Charpy verification specimens at the National Research Laboratory of Metrology (NRLM) in Tsukuba-shi. Also discussed was the need to harmonize these verification programs.

The Materials Reliability Division has a collaboration with Osaka University on electromagnetic acoustic resonance. This technique is used to measure elastic-stiffness tensor of metal-matrix composites.

Korea

The Materials Science and Engineering Laboratory has a collaboration on Damage Accumulation and Fatigue in Ceramics with Prof. Do Kyung Kim, from the Korea Advanced Institute of Science and Technology (KAIST), in Taejon, Korea through a Korea Science and Engineering Foundation (KOSEF) grant.

The Ceramics Division collaborates with the Sun Moon University on tribological behavior and contact damage in ceramic materials.

Russia

The Ceramics Division does collaborative research with the Russian Academy of Sciences in Moscow in the area of ceramic coatings.

Singapore

A representative from the Surface Properties Group in the Ceramics Division gave a series of invited lectures at the Advanced Lubrication/Tribology seminar and visited the Data Storage Institute in Singapore.

Spain

The Ceramics Division collaborates with scientists at the Universidad de Extremadura in Badajoz under a U.S. -Spain Joint Fund project involving brittle coating structures.

United Kingdom

Thermotech Ltd., in Guilford, Surrey, is developing code that utilizes subroutines originally developed at MPI, Stuttgart, and is generalized and expanded at NIST. Thermotech will provide the software that results from this collaboration with the Metallurgy Division to NIST at no charge.

The Metallurgy Division discussed a possible collaboration with the Engineering and Material Science Departments at Cambridge University, over putting mechanisms maps on the internet. This collaboration would use the data handling experience of NIST and the mechanism map expertise of Dartmouth (and Cambridge, if needed). It is also proposed that the mechanism maps would be part of a NIST Metals Webbook.

Multilateral Activities

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. It 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 next three years. A new Technical Working Area (TWA) with the title Thermal Properties of Thin Films was established under VAMAS. The objective of the 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 technical working area 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

Results from the first-ever international comparison of Charpy impact verification programs offered by the U.S., Japan, France and the European Commission showed good agreement. Charpy impact testing is often specified as an acceptance test for structural

materials, and companies performing these tests are required to verify the performance of their machines using certified specimens, obtainable only from the Institute for Reference Materials and Measurements, (IRMM), Laboratoire National D'Essais (France), the National Research Laboratory of Metrology (Japan) and NIST.

Representatives from the Ceramic Division have participated in the International Energy Agency (IEA) Executive Committee on High Temperature materials. The IEA was formed via an international treaty of oil-consuming countries in response to the energy crisis of the 1970's. A major objective of the IEA is to promote secure energy supplies on reasonable and equitable terms. The governing board, which is composed of energy officials from each member country, regularly reviews the world energy situation. To facilitate this activity, each member country provides energy experts who serve temporary staff assignments at IEA headquarters. Implementing agreements are the legal instruments used to define the general scope of the collaborative projects. There are currently 40 active implementing agreements covering research topics such as advanced fuel cells, coal combustion science, district heating and cooling, enhanced oil recovery, fluidized bed conversion, fusion materials, solar heating and cooling, pulp and paper, hydropower, heat pumping technologies, hybrid and electric vehicles, high temperature superconductivity, wind turbines, and high temperature materials.

The Ceramics Division led the international Round Robin Testing on Ceramic Powders, an activity conducted under the IEA. Thirty-four laboratories participated, with the goal to draft uniform standards test methods in each participating country and through the ISO.

The Center for Neutron Research took part in the NATO Advanced Research Workshop, which was supported by the Institut für Festkörper- und Werkstofforschung in Dresden through the NATO Grant.

The Center for Neutron Research collaborates on the collection of inorganic crystallographic data with the Cambridge Crystallographic Center in the UK and the Fachinformationzentrum in Karlsruhe.

The Director, Materials Science and Engineering Laboratory co-chaired the materials session at the "New Vistas in Transatlantic S&T Cooperation" conference. The objective of the conference was to discuss and amend the stipulated contents of the U.S./European Union Science and Technology Agreement and the 5th Framework Program of the European Community for Research, Technological Development and Demonstration Activities by current scientific and industrial contributions. The Director also visited the Federal Institute for Materials Research and Testing to discuss NIST's MOU that provides for joint collaborative activities.

International Workshops and Conferences

In September 2000, the first NIST-Kyoto Institute of Polymer Science Symposium on Polymer Science was held in Kyoto, Japan. This meeting was an outgrowth of earlier joint discussions on research in polymer blends and block copolymer research. The purpose of the conference was to strengthen the on-going collaborative efforts between the two laboratories dedicated to advanced polymer science research.

MSEL's Metallurgy Division, along with Pacific Northwest National Laboratory, sponsored the Dislocations 2000 conference on June 18-22, 2000 at NIST. This conference is used to track progress in understanding dislocations, which are the crystal defects which account for the permanent, or plastic, deformation behavior of metals. The results of the conference will be used to direct and focus the Metallurgy Division's own metal forming projects to aid U.S. industry more effectively in the production of formed metal products. More than half of the 150 attendees were from outside the U.S., with France, Germany, and Japan heavily represented.

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.

Bilateral Activities

Canada

Discussions were held with representatives of the NRCC regarding possible ways that BFRL and NRCC might cooperate on Partnership for Advancing Technology in Housing (PATH)-related research.

Denmark

The Building Materials Division collaborated with the Technical University of Denmark, to study the development of concrete properties and transport mechanisms in cementitious materials. A representative from the division also conducted a week-long short course at the University on "Hydration and Microstructure of High Performance Concrete".

Dominican Republic

The Structures Division supported the DoC/USAID Hurricane Reconstruction Program throughout the Fall and Winter of 1999/2000, which responded to the damage caused by Hurricane Georges in the Dominican Republic. As part of the reconstruction program, NIST, in cooperation with the Department of Housing and Urban Development (HUD), aided local and regional development of appropriate building construction codes, standards and guides for design loads, and construction practices to result in buildings that will be better able to resist hurricanes and other natural hazards in the Dominican Republic. These efforts included meetings, consultations and workshops, which started in the fall of 1999 and extended through the summer of 2000. Among the many issues addressed were administrative/logistical arrangements for the United States Government

(USG) long-and short-term personnel, interagency coordination and elaboration of work plans, building codes, and meetings with the USAID Housing/Disaster program manger, local officials and non-government offices (NGOs) for the purpose of developing further the work plans for the Hurricane Disaster Reconstruction Project, and coordinating efforts with HUD. Representatives from the Structures Division attended the disaster mitigation coordination meeting at the request of USAID and conducted a follow-up site evaluation. NIST, through DoC's IAA with USAID, is committed to assisting USAID and international donor entities such as the Inter-American Development Bank (IDB) and the World Bank (WB) to improve building codes and standards and their enforcement in the Dominican Republic.

France

The Mechanical Systems and Controls Group, Building Environment Division has a collaboration with CSTB in Marne-la-Vallée in the area of fault detection and diagnostics (FDD) of air-handling units (AHU). CSTB has established expertise in rule-based diagnostics and the development of user-interfaces.

The Organic Building Materials Group of the Building Materials Division collaborated with CSTB to perform microtomography experiments at the ID19 beamline at the European Synchrotron Research Facility (ESRF) facility at Grenoble. The objective of the experiments was to view the 3-D microstructure of hydrating cement paste *in-situ*, and to obtain high quality 1 μm resolution 3-D images of hydrating cement paste microstructures. The data generated during this study should be invaluable both to the modeling efforts at NIST and to an increased general understanding of the behavior of these complex materials.

Poland

The Organic Building Materials Group of the Building Materials Division collaborates with the Warsaw University of Technology in Warsaw. The research project "Ultrasonic evaluation method applicable to polymer concrete" is sponsored from the U.S.-Polish Maria Sklodowska-Curie Joint Fund.

Saudi Arabia

In September 1996, an MOU was signed between NIST and the National Conference of States on Building Codes and Standards (NCSBCS) as a joint effort to cooperate with other countries wishing to adopt building codes and standards similar to those used in the United States. The Saudi Arabia Building Code Project has been conducted under the NIST/NCSBCS MOU. Since the official start of the Saudi project in May 1997, work has progressed on the development of the national Saudi Arabia Building and Fire Codes (SBC) based on the International Conference of Building Officials (ICBO) family of codes. To achieve this objective in an effective manner, the Saudi Arabian Standards Organization established a SBC Coordination Committee, comprised of appropriate experts from involved organizations from within the Kingdom, to review the ICBO codes and make suggestions regarding the relevance of each section to Saudi Arabia. A significant portion of this work was completed by November 1998, and was delivered to ICBO for review by their appropriate technical experts (80% to 100% of the initial

reviews of the building and fire codes are completed). During the period of February 20-24, 1999, a technical workshop was conducted in Riyadh. The first edition of the Saudi Arabia Building and Fire Codes was published in the Fall of 1999.

Slovenia

A representative from the Fire Safety Engineering Division visited the Pozarni Inzeniring Radjovica, which is licensed to practice fire engineering in Slovenia and the only one licensed to work on the country's nuclear power plant. The company makes extensive use of BFRL's fire models and data, FIREDOC. Discussion topics included the fire models of BFRL, the current best practices of fire safety engineering, and the developing International Code Council (ICC) and the National Fire Protection Association (NFPA) building codes. Several questions were resolved about the best use of the models and data following the NFPA and the Society of Fire Protection Engineers (SFPE) Guidelines.

Spain

The Building Materials Division continued a collaboration with the Institute of Construction Science "Eduardo Torroja" (IETCC) in Madrid. The collaborative research is on chloride ingress and service life of concrete, and is funded by a joint U.S.-Spain grant.

Turkey

The Structures Division participated in a team that traveled to Turkey to conduct reconnaissance of damage to engineered structures as a result of the August 1999 Kocaeli earthquake. The team also included engineers and geologists from the U.S. Geological Survey and the Earthquake Engineering Research Institute.

United Kingdom

A representative of the Fire Science Division visited the Fire Research Station in Garston and the University of Greenwich to identify the latest developments in fire science worldwide as a basis for developing collaborations and future directions for the NIST Fire Research Program.

Multilateral Activities

Caribbean-Central America

Another project under the NIST/NCSBCS MOU on Building Codes and Standards supports the Caribbean/Central American Forum on Building Codes and Economic Development. BFRL, with support from USAID has contracted with the NCSBCS to facilitate this project. A two-day Forum, developed by the NCSBCS and hosted by Puerto Rico's Administration de Reglamentos y Permisos (ARPE), brought together representatives from the region's regulatory, development, insurance, banking, tourism, and construction sectors. The objective is to bring together representatives from economic development and construction communities to explore common building code, public health and safety needs, resources and cooperative approaches toward enhancing economic development in the building environment in the Caribbean Basin and Central American Region.

NIST will be involved in a multilateral collaboration on producing a compendium of computer-based models used in quantitative assessments of performance of building elements or systems. Among those included in the collaboration are CSIRO in Australia, Technion in Israel. This plan was approved by the Director of the Building and Fire Research Laboratory at a committee meeting of the International Council for Research, held in Milan, Italy in November 1999. Such a compendium is an important step in developing a common set of approaches for acceptance of products and materials for building in the global market. NIST's involvement in these projects will help in gaining global acceptance of technical approaches developed in the USA.

Awards

Ronald Rehm, Kevin McGrattan, and Howard Baum of the Fire Safety Engineering Division and a former NRC Post-Doctoral Fellow were awarded the Philip Thomas Medal of Excellence for the Best Paper at the Fifth Symposium of the International Association of Fire Safety Science (IAFSS). The paper was entitled "Transport by Gravity Currents in Building Fires"

Tinh Nguyen from the Building Materials Division, and Tze-jer Chuang from the Ceramics Division, won the Roon Foundation Award of the Federation of Societies for Coatings Technology (FSCT). This award was given at the 1998 FSCT Annual International Coatings Exposition and Technical Conferences on October 16, 1998, in New Orleans, Louisiana. The award was given for their work in developing a physics-based micromechanic theory for predicting the debonding rate of coatings from rigid/inert substrate subjected to environmental corrosive attacks. Roon Foundation Awards are the most prestigious awards given by the FSCT.

David Didion from the Building Environment Division received the Gustav Lorentzen Prize in Sydney, Australia. This prize was recently established by the International Institute of Refrigeration and is the highest professional recognition in the refrigeration field, and this was the first award of the Gustav Lorentzen Prize.

International Committee Participation

BFRL participates in various standards committees on standards, 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 researches in this field outside the U.S. and will ensure inclusion of U.S. technology of international standards.

The Building Materials and Building Environment Divisions have participated in several International Standard Organization (ISO) Technical Committees (TCs), including one on Durability of Single Family Housing, and one on Building Control System Design.

BFRL participates at Director level in the International Council for Research and Innovation in Building and Construction (CIB) Board. This is an international organization 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 able to be coordinated by CIB.

The Fire Safety Engineering Division plays an active part in the National Fire Protection Association (NFPA), which is a private standards development organization that promulgates over 200 codes and standards used extensively in the U.S. NFPA 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 US companies.

The Structures Evaluation and Analysis Group in the Structures Division participates in many of the Technical Committees (TCs) of the International Association for Building Materials and Structures (RILEM). These activities include HSC and Test Methods for Mechanical Properties of Concrete at High Temperatures.

International Workshops and Conferences

In April 2000, 25 representatives from major international fire laboratories laid the groundwork for an international cooperative program designed to improve fire researchers' ability to experimentally characterize fire behavior. The workshop on "Measurement Needs for Fire Safety" was attended by representatives from Canada, China, Denmark, Finland, Germany, Japan, Norway, Sweden, the U.K. and six organizations in the U.S. The workshop was organized by BFRL under the auspices of the Forum for International Cooperation in Fire Research (FORUM), an organization consisting of leaders from the world's leading fire laboratories and dedicated to fostering international cooperation in fire research.

BFRL participated in the International Workshop on Interactive Intelligent Remote Operations (IIRO) at the Institute for Information Technology, hosted by the National Research Council of Canada and the Canadian Space Agency that was held October 13, 1999. The IIRO was created to address the inherent challenges of controlling and monitoring remote equipment systems over large distances. "No single nation or organization has sufficient resources to do the needed research to make construction automation a reality. International collaboration is essential. Partnering with peer organizations is a viable strategy for helping advance US-based technologies in global standards, and US industry to sustain a competitive edge in global markets for construction automation technologies. The NRCC forum presented a unique opportunity to assess hands-on research developments that bear directly on our construction automation efforts at NIST.

In May 2000, BFRL's Structures Division hosted a delegation of 14 researchers from Japan for the 32nd Joint Meeting of the U.S.-Japan Cooperative Program in Natural Resources (UJNR) Panel on Wind and Seismic Effects. The panel was established in 1969 to develop and exchange technologies aimed at reducing damage from high winds, earthquakes, storm surge, and tsunamis. NIST provides the U.S.-side Chairman and Secretary General and The Public Works Research Institute of Japan (PWRI) provides

the Japan-side Chairman and Secretary General. The joint meeting consisted of four days of presentations of technical papers, discussion, and Task Committee meetings. From May 20-24, 2000, the U.S. led a technical site tour to Puerto Rico to visit the construction of a light rail rapid transit system (Tren Urbano) in San Juan.

Information Technology Laboratory

Dr. Susan F. 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.

Bilateral Activities

Canada

The Cryptographic Module Validation Program (CMVP), a joint effort between NIST and the Communications Security Establishment (CSE) of the Canadian Government, encompasses validation testing for cryptographic modules and algorithms, including:

- Federal Information Processing Standard (FIPS) 140-1, Security Requirements for Cryptographic Modules.
- FIPS 46-3 and FIPS 81: Data Encryption Standard (DES) and DES Modes of Operation.
- FIPS 186-2 and FIPS 180-1: Digital Signature Standard (DSS) and Secure Hash Standard (SHS), which specify the DSA, RSA, ECDSA, and SHA-1 algorithms; and
- FIPS 185: Escrowed Encryption Standard (EES).

FIPS 140-1 specifies the overall requirements for all cryptographic modules protecting sensitive, unclassified information, and provides a framework for all other NIST cryptographic standards. FIPS 140-1 was developed in cooperation with CSE, cryptographic product developers and integrators, and interest user communities. Products validated by this program are accepted for use in both Canada and the United States for the protection of sensitive, unclassified information. Vendors of cryptographic products are able to build to a common standard and utilize one common validation process. The program requires accredited, independent, third-party testing laboratories to test products for FIPS 140-1 validation. NVLAP announced that four laboratories have been accredited thus far to perform FIPS 140-1 testing. Test results from these accredited laboratories are examined by NIST and CSE, who issue appropriate, joint validation certificates. U.S. and Canadian industry participation as Accredited Testing Laboratories is being encouraged by both NIST and CSE. Both NIST and CSE are encouraging vendors of cryptographic modules to make use of accredited laboratories for FIPS 140-1

testing. In FY 2000, there were 62 new cryptographic modules validated bringing the total number of validated modules to 150. In addition, the draft FIPS 140-2, which will supersede FIPS 140-1 was announced on November 17, 1999, and the public comment period closed February 15, 2000. NIST is now considering those comments for incorporation in the draft FIPS.

China

A representative from the Mathematical and Computational Sciences Division attended the Second Annual Chinese-American Frontiers of Science Symposium in Beijing, China at the joint invitation of the U.S. National Academy of Sciences and the Chinese Academy of Sciences. The symposium was designed to bring together outstanding young scientists to discuss advances and opportunities in their fields, to learn about research at the cutting edge of other disciplines, and to build new ties between future leaders of scientific enterprise of both nations.

Egypt

ITL is developing a repository for reference data on software faults and failures. A guest researcher from the Egyptian National Institute of Standards worked with ITL to develop an Arabic language version of the database and tools to improve Egyptian software

Finland

The Advanced Network Technologies Division collaborates with the Information Processing Laboratory at the University of Oulu, in the area of multimedia and document image processing and services.

France

Representatives from the High Performance Systems and Services Division visited ESIAL University in Nice to make a presentation on genetic programming and NIST's proposed industrial project, the "Population Initialization Project." Students in this program work in small teams on projects that are proposed by commercial companies or other outside organizations, such as NIST. The students participating in the program are third-year graduate students. Representatives from the Manufacturing Engineering Laboratory also proposed projects.

Japan

The Mathematical and Computational Sciences Division is collaborating with Japan's Electrotechnical Laboratory (ETL) on the design of high performance mathematical software for numerical linear algebra. As part of this work, ETL maintains a mirror Web site for the Matrix Market in Asia, including a visual database of large sparse matrices from industrial applications, while NIST incorporated interactive matrix generation software from ETL into the Matrix Market.

The High Performance Systems and Services Division (now the Convergent Information Systems Division) led a benchmarking trip to the Advanced Telecommunications Research Laboratory (ATR), located in the Kansai region outside Kyoto. ATR is a research IT lab that was formed with funding derived from the breakup of the Nippon

Telegraph and Telephone Corporation (NTT) and Canon Media Technology Lab, a hardware company.

The Distributed Systems Technologies group of the Convergent Information Systems Division worked on Interoperable Message Passing Interface issues at the Hitachi Central Research Laboratory (HCRL) in Kokubunji.

A representative from the Statistical Modeling and Analysis Group, Statistical Engineering Division, was awarded a fellowship from the AIST to conduct research at 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 nanoparticle resolution, using Monte Carlo simulation codes, model validation, transient study and stability studies.

Russia

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

United Kingdom

The Computer Security Division participated in a workshop to write security specifications for agent systems with the Foundation of Intelligent Physical Agents, at the request of IBM Watson Labs.

Multilateral Activities

Common Criteria Project

Since 1993, NIST has been engaged in a cooperative project with the National Security Agency 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." The Common Criteria project provides the structure and components to describe standardized security requirements for all types of computer-related projects. The BIPM 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 2000, this MRa was extended to the International Common Criteria Recognition Arrangement, when 13 nations (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.

As part of the National Information Assurance Partnership (NIAP), ITL is developing a Common Criteria Evaluation and Validation Scheme for IT Security. The scheme will

provide an organizational structure a framework for private-sector testing laboratories to conduct security evaluations of IT products using the Common Criteria, which was accepted as ISO international Standard 15408 in June 1999. IT security criteria common to Europe and North America will help broaden the market for these products. NIST and the National Security Agency have announced the approval of the first four Accredited IT security testing laboratories under the Common Criteria Evaluation and Validation Scheme (CCEVS). These Common Criteria Testing Laboratories (CCTLs) are the first in a series of commercial organizations that are undergoing NVLAP accreditation for participation in NIAP CCEVS. The evaluation results produced by these CCTLs and validated by the NIAP CCEVS Validation Body will be recognized by 12 other countries currently participating with the US in the Common Criteria MRA. In order for the Validation Body to issue an internationally recognized certificate, the evaluation must have been conducted by a third party independent laboratory in accordance with the requirements of the NIAP.

The Computer Security Division actively participates in the Common Criteria project in various activities, such as the NIST- European Computer Manufacturers' Association (ECMA) project to produce the Common Criteria Protection Profile, meetings of the Common Evaluation Methodology and Interpretations Management Boards, and plans to include additional countries within the European Union, Australia and Japan in the Common Criteria MRA.

Advanced Encryption Standard

NIST has been working with industry and the cryptographic community to develop an Advanced Encryption Standard (AES). The goal is to develop a FIPS that specifies an encryption algorithm(s) capable of protecting sensitive government information well into the next century. The algorithm(s) is expected to be used by the U.S. Government and, on a voluntary basis, by the private sector. The formal call for candidate algorithms, made in September 1997, required implementation of a symmetric key cryptography as a block cipher with minimum block sizes of 128-bits and key sizes of 128-, 192-, and 256-bits. In addition, the AES specified a publicly disclosed encryption algorithm available royalty-free worldwide. Out of 15 candidate algorithms announced in August 1998, five algorithms were chosen as AES finalists. This followed a period of testing and discussion of the results of analyses conducted by the global cryptographic community. Further, more in-depth analyses of the five algorithms (MARS, RC6, Rijndael, Serpent, and Twofish) were conducted, with the AES3 Candidate Conference held April 13-14, 2000, in New York, NY, for open forum discussion of the analysis results. In Fall 2000, NIST announced Rijndael as the proposed AES algorithm. The two researchers who developed and submitted Rijndael for the AES are both cryptographers from Belgium: Dr. Joan Daemen of Proton World International and Dr. Vincent Rijmen, a postdoctoral researcher in the Electrical Engineering Department of Katholieke Universiteit Leuven. Following the comment period (of at least three months), the standard will be revised by NIST, as appropriate, in response to those comments. A review, approval, and promulgation process will follow. If all steps of the AES development process proceed as planned, it is anticipated that the standard will be completed by the summer of 2001. At the time that NIST publishes the AES standard, it is intended that validation testing (*i.e.*,

conformance testing) for AES implementations will be available through NIST's Cryptographic Module Validation Program.

Miscellaneous Multilateral Activities

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 worldwide financial industry. The goals of the group are to develop industry-agreed security requirements for smart cards and to develop the criteria for widely acceptable security testing programs for them. SCSUG was formed under the sponsorship of the joint NIST-NSA 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.

The Computer Security Division provided support to the United Nations-sponsored International Y2K Cooperation Center (IY2KCC). The center received and validated reports on the status of a dozen infrastructure sectors from national coordinators in 150 countries. The IY2KCC monitored the rollover as it occurred in each time zone from New Zealand through Hawaii. NIST staff provided technical expertise in the assessment of problems reported by national coordinators and additional information sources during the rollover.

The Text Retrieval Conference (TREC), co-sponsored by NIST and DARPA, was started in 1992 as part of the TIPSTER Text program. Its purpose is to support research within the information retrieval community by providing the infrastructure necessary for large-scale evaluation of text retrieval methodologies. The Amaryllis Project in France and the National Institute of Informatics (NACSIS) in Japan have used TREC as a model for creating large text retrieval test collections. In addition to the language emphases, the different evaluations have other differences that are the results of different task definitions.

The Mathematical and Computational Sciences Division together with scientists in the Materials Science and Engineering Laboratory are collaborating with researchers in England, France and Belgium on the mathematical modeling of solidification and other applications of phase transformations in materials science. The work includes studies of diffuse interface models of solidification with the Industrial Applied Mathematics Group at Southampton University, United Kingdom, studies of interface demarcation by Peltier pulsing with the Universite d'Aix-Marseille III in Marseille, France, and studies of thermal diffusion during directional solidification with the Universite Libre de Bruxelles in Brussels, Belgium.

Awards

Donna Harman, from the Information Access and User Interfaces Division, received the Tony Strix Award from the Institute of Information Scientists. This award is presented for "outstanding practical achievement in information retrieval," with the citation for her leadership and inspiration in the Text Retrieval Conference (TREC), "the most important development in experimental information retrieval since the Cranfield tests of the late fifties and early sixties."

Chris Dabrowski, from the Software Diagnostics and Conformance Testing Division, received the Committee Management Award from the National Committee for Information Technology Standards for his outstanding international leadership, as ISO/TC 211/WG 1 Convener, in the rapid progression of the ISO 19100 series of standards for Geographic Information Systems (GIS).

Gene Troy, from the Computer Security Division, received the Technical Excellence Award from the National Committee for Information Technology Standards for his long-standing participation on Technical Committee T4, Security Techniques, where he has served as the principal motivating force behind the successful development of the three part ISO/IEC 15408, Common Criteria for Information Technology Security Evaluation, as well as the Project Editor for ISO/IEC 15408-1, Introduction and General Model.

International Committee Participation

The Security Technology Group of the Computer Security Division participates in the American National Standards Institute (ANSI). This includes X9F1, the Cryptographic Tools working group of the Information and Data Security subcommittee of the Accredited Standards Committee X9, which is involved in the development of ANSI standards for cryptographic tools used in the financial services industry, and participation in the Information Technology Standards-Technical Group.

The Advanced Network Technologies Division participates in MPEG. Recent discussions have been held to facilitate the development of multimedia applications through NIST contributions and the websites maintained on behalf of the participants. MPEG has requested that the ftp/http site for MPEG documents be hosted by NIST.

The Visual Image Processing Group, Information Access Division, participates in working group ISO/IEC/JTC1/SC29/WG01 on international JPEG standards. Recent topics have included a new data format using Trellis encoding, easing the exchange of JPEG 2000 content among other systems such as the PDF format.

The Computer Security Division participates in the RSA EURO 2000 Security Conference as a member of the FIPS 140-1 (Security Requirements for Cryptographic Modules) panel and to separately brief the status of the Advanced Encryption Standard selection process.

The Advanced Network Technologies Division participates in the Optical Interworking Forum Technical Committee to further the development of the Optical User-to-Network

Interface (UNI) implementation agreement. Optical network technology is one of the focus areas of the High Speed Network Technologies Group of the Advanced Network Technologies Division in ITL. Attendance at the Optical Internetworking Forum (OIF) allows NIST to accomplish the project goal by speeding up the standardization process.

International Workshops and Conferences

The TREC workshop series is sponsored by NIST and DARPA to support the text retrieval industry by providing the infrastructure necessary for large-scale evaluation of text retrieval methodologies. TREC-7 was held at NIST in November 1998, with 150 participants. Fifty-six groups from 13 different countries and 19 companies attended, and ITL published the proceedings of TREC-7 as NIST Special Publication 500-242. ITL and DARPA also sponsored the TREC-8 workshop series on November 16-19, 1999 at NIST. Sixty-six groups participated in TREC-8, including representatives from 16 countries.

ITL sponsored NIST's Second AES Candidate Conference, held March 22-23, 1999, in Rome, Italy. At this conference, members of the world's cryptographic community gathered to discuss and critique the 15 candidate algorithms. NIST received approximately 60 public comments and about 30 papers.

On May 23-25, 2000, NIST hosted the First International Common Criteria Conference (ICCC). NIST, the National Security Agency, and the National Information Assurance Partnership co-sponsored the event. Six hundred participants from 23 nations attended the meeting. Conference highlights included the signing of the International Common Criteria Mutual Recognition Arrangement by the U.S., Canada, Australia, New Zealand, the United Kingdom, France, Germany, the Netherlands, Finland, Norway, Italy, Spain, and Greece. The 13 nations 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. Executives from information technology companies will learn about the international computer security arrangement that makes it easier for American companies to sell their products in other countries.

ITL organized and hosted the 2000 NIST Speaker Recognition Evaluation Workshop June 26-27, 2000 in Linthicum, Md. The purpose of the workshop was to review performance of systems in the evaluation, to discuss trends in text-independent speaker recognition, and to plan the next evaluation. Workshop attendees included 36 representatives from DoD, NIST, and other government agencies; the 12 participating sites; and two other contributing sites. The participating and contributing sites were from industry, academia, and governments in Australia, France, India, Israel, South Africa, Spain, and the United States. For the past five years, ITL has organized evaluations of text-independent speaker recognition performance on conversational telephone speech. The talks included one-speaker detection, two-speaker detection, speaker tracking, and speaker segmentation. The 2000 evaluation included for the first time some data in Castilian Spanish and other non-English languages.

Technology Services

Dr. Richard Kayser, *Director*

Technology Services provides a variety of products and services to U.S. industry and trade and the public, in collaboration with NIST laboratories, federal agencies, national measurement institutes, state and local governments, and the private sector. These products and services 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. These services 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.

The Office of Standard Services (OSS) in Technology Services (TS) formulates and implements standards-related policies and procedures to enhance domestic commerce and international trade. OSS 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 OSS are dedicated to the following specific areas in standards and conformity assessment: Laboratory Accreditation, Technical Standards Activities, Global Standards and Information.

The Laboratory Accreditation Program 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.

Operation 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). Mutual recognition arrangements will reduce the need for redundant testing and accreditation thereby lessening the cost of traded goods. The Technical Standards Activities Program (TSAP) provides technical support for public and private sector standards-related activities. TSAP 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. TSAP 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 Global Standards and Information Program (GSIP) in OSS 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 currently has five experts abroad in Saudi Arabia, Mexico, Brazil, Belgium, and India working in the capacity of NIST Standards Attaché/Representative. The representative in Saudi Arabia is also responsible for covering Gulf Cooperation Council (GCC) countries, which include Bahrain, Kuwait, Oman, Qatar, Saudi Arabia, and the United Arab Emirates. The attaché in Brussels, Belgium covers standards-related activities of the European Union. The attaches in Mexico and Brazil also share regional responsibilities for Latin America. 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. GSIP 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). GSIP conducts standards-related training programs for technical experts from various regions that are important for U.S. trade. GSIP staff review standards-related and conformity assessment issues when other nations seek accession to the WTO regarding areas that may be of importance to U.S. industry and exporters for trade with those nations. GSIP also manages the National Voluntary Conformity Assessment Evaluation Program (NVCASE), designed to evaluate and recognize competent accreditors of laboratories, certifiers, or registrars of quality assessors.

The GSIP also maintains the National Center for Standards and Certification Information (NCSCI). The center 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. GSIP 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 Office of Measurement Services in TS supports industry and commerce with four major programs: Standard Reference Data, Standard Reference Materials, Calibration, and Weights and Measures programs. 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. Measurement 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.

Bilateral Activities

Canada

Representatives of the Laboratory Accreditation Program conducted the final evaluation of the Standards Council of Canada for Mutual Recognition Arrangement (MRa) purposes including the APLAC in May of 1999.

China

In September 1999, OSS sponsored a workshop for representatives of the Chinese building and construction sector in support of the U.S.-China Housing Initiative. The workshop objective was to promote understanding of, and confidence in, the U.S. approach to relevant standardization and conformity assessment issues. The 26 workshop participants, who came from government and private-sector organizations, resolved to continue collaborative discussions through the continuation of the U.S.-China Housing Initiative to advance discussions on building and residential codes and collaborative research projects between Chinese research institutes and NIST, and continued information exchange on new developments.

The OSS, the U.S. International Trade Association, and China's Ministry of Foreign Trade and Economic Cooperation (MOFTEC) co-sponsored the second Sino-U.S. Workshop on Standards and Conformity Assessment. This workshop was held in Beijing, China, March 10-12, 1999, to assist U.S. businesses interested in exporting to markets in China, and also to enhance mutual understanding in the harmonization of standards and the application of conformity assessment programs. There were more than 350 participants, primarily from Chinese agencies within MOFTEC and the Ministry of Construction. The workshop was very well attended and considered successful by both sides.

Japan

The OSS Director, along with the Director of NIST, attended the IEC meetings in Kyoto, Japan, and met with senior Japanese officials in standardization and accreditation. In

Tokyo, discussions were held by the Director of OSS with U.S. embassy personnel about linking the OSS website to the U.S. and Foreign Commercial Service sites abroad, so that their users can get immediate access to OSS information and publications.

NIST and the Ministry of International Trade and Industry (MITI) conducted their Sixth Joint Information Forum on Standards and Conformity Assessment Issues in April 2000. The forum's purpose is to build a strong and lasting relationship for activities of mutual interest. The director of the Office of Standards Services hosted the meeting, with the Deputy Director-General of MITI's Standards Department leading the Japanese delegation. Forum participants exchanged information on mutual recognition of measurement standards, the status of the Asia Pacific Economic Cooperation Telecommunications Mutual Recognition Arrangement (MRA), and the U.S.-EU MRA. Similar arrangements that Japan has with its major trading partners also were reviewed. Other discussions included recent developments in the International Organization for Standardization (ISO) Committee on Conformity Assessment, the National Cooperation for Laboratory Accreditation, and the International Laboratory Accreditation Cooperation. In addition, cooperation in the ISO and International Electrotechnical Commission was discussed, and the standards development processes in the United States and Japan were described. In a visit to the office of the United States Trade Representative, the Japanese delegation was given an overview on U.S. policy and activities related to the TBT agreement, the Organization for Economic Cooperation and Development, the Asia-Europe Meetings, and the Transatlantic Business Dialogue.

Sweden

The TSAP assisted the Sveriges Provning och Forskning (Swedish National Laboratory for Mass), under the Swedish National Testing and Research Institute, to organize and conduct a workshop in Borås, Sweden. The workshop, attended by specialists from national reference laboratories, disseminated information on the 1st Committee Draft of R111 "Weights" and examined the effectiveness, value, and proper functioning of the Test Procedures and Format of the Test Report. This activity was supported by OIML.

Venezuela

The OSS co-sponsored a course titled, "The Accreditation Process According to ISO/IEC Guide 25", held in Caracas in September 1999. The course was a follow-up activity to an OSS Standards in Trade Workshop for the Andean Community. Thirty-eight individuals representing primarily company laboratories participated in the course.

Multilateral Activities

CITEL

NIST is the U.S. designating authority for U.S. conformity assessment bodies (CABs) under the InterAmerican Telecommunications Commission (CITEL) MRA on Telecommunications Equipment. The GSIP 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.

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.

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 has also been an invited speaker in the IAAC seminars that are held jointly with the IAAC annual meeting.

NVCASE

In FY 2000, the OSS, through the National Voluntary Conformity Assessment Systems Evaluation (NVCASE), designated 28 U.S. CABs for electromagnetic compatibility and 12 for Radio and Telephone Terminal Equipment (R&TTW) for the operational phase of the U.S.- EU MRA in the telecommunications and Electromagnetic Compatibility (EMC) sectors and nominated seven U.S. CABs under the transitional phases for Medical Devices. Under the APEC MRA, NIST has designated 20 U.S. CABs for Canada and 103 U.S. CABs for Chinese Taipei. The CABs will provide test data responding to Canadian or Taiwanese requirements under the terms of Phase I of the Asia Pacific Economic Cooperation (APEC) MRA on telecommunications equipment. The test data produced by these bodies will be accepted by the relevant authorities and used in the product approval process for telecommunications products tested under national standards, including Canadian Standard, CS-03.

PASC

NIST participates actively, as a member of ANSI, in the Pacific Area Standards Congress (PASC). NIST has also worked closely with ANSI to create a web-based means of disseminating information to PASC members. U.S. linkage with regional standards organizations is seen as critical in building strategic alliances to ensure that global standards meet global needs.

International Comparisons Database (ICDB)

TS has continued the development of the 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.

Training and Outreach Activities to Foreign Colleagues

The GSIP conducts two different training programs intended to familiarize participants from developing nations with U.S. standards and conformity assessment practices. The first, the Standards in Trade (SIT) program, is sponsored by the Department of Commerce and carried out by NIST. In both programs, NIST invites speakers from relevant Federal Agencies, Standards Developing Organizations, and industry and trade associations to address topics of particular relevance to the attendees. Workshop typically focus on a particular sector of interest.

Other Multilateral Activities

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.

In July 2000, TS Office of Standards Services (OSS) nominated 22 testing laboratories to the Canadian government to serve as CABs. All of the nominees have been accepted and confirmed by Industry Canada (IC). These CABs will provide test data responding to Canadian requirements under the terms of Phase I of the APEC MRa on Telecommunications Equipment. The test data produced by these bodies will be accepted by IC and used in the product approval process for telecommunications products tested under Canadian Standard, CS-03. OSS is preparing to nominate CABs to several other APEC nations. OSS is also preparing dossiers for a group of CABs to be nominated to the European Commission as final designations under the electromagnetic compatibility (EMC) and Telecommunications Sectors of the U.S.- EU MRa.

Awards

NACLA presented an Outstanding Achievement Award to TS Director Richard Kayser for serving as the primary architect of the NACLA/NIST MOU. Belinda Collins, Director of the OSS, received the NACLA Lifetime Achievement Award in recognition of her outstanding contributions to and leadership in the creation and development of NACLA both prior and subsequent to its private sector incorporation in 1998.

Ernest Garner of the TS Calibration Program received the 2000 Wildhack Award from NCSL International (the highest award given by this organization) at its meeting on July 18 in Toronto. The award cited his work on ANSI/NCSL Z540-1 for calibration labs and the supporting handbook as well as for his early work in setting up NORAMET. The award also recognized Garner's career-long dedication and service to metrology, metrologists and customers.

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 like the International Standards Organization (ISO), International Electrotechnical Commission (IEC), and the International Organization of Legal Metrology (OIML).

As the world's largest program in producing reliable, evaluated data in the physical and engineering sciences, NIST, and in particular the OMS 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 Standards Reference Data Program, was elected as the President of CODATA for the 1998-2002 term.

The Director of OSS was elected as International Laboratory Accreditation Cooperation (ILAC) Chair in October 1998. At a recent ILAC Executive committee meetings, 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 GSIP staff participates 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. GSIP staff also participated in meetings of Working Party 29 of the UNECE. Working Party discussions were held on international standardization issues. This discussion provided a critical background for NIST contributions to the development of a National Standards Strategy for the U.S. TBT Agreement provision.

International Workshops and Conferences

Standards in Trade (SIT)

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

The OSS organized a 3-day course on the "Accreditation Process According to ISO/IEC Standard 17025" in several countries in the Latin American region. The course is a follow-up activity to the OSS Standards in Trade Workshops held for all the countries of the hemisphere from 1996-2000. Countries that have benefited to date are Argentina, Venezuela, El Salvador, Peru and Trinidad and Tobago. Attendance has ranged from 120 participants to some 40 individuals. With the smaller groups, practical exercises were included to increase the usefulness of the course.

The OSS hosted two SIT Workshops in the fall of 1998. Participants included representatives of Central America, the Caribbean, Belize, Guyana, and Suriname. Twenty-five participants attended the workshop for Central America and the Dominican Republic, held September 21-October 2, 1998. Twenty-one participants from the public and private sector of Antigua and Barbuda, the Bahamas, Barbados, Dominica, Grenada, Guyana, Haiti, Jamaica, St. Kitts and Nevis, St. Lucia, Suriname, and Trinidad and Tobago attended the workshop for the Caribbean, held November 9-20, 1998. Topics included U.S. standards development, product certification, conformity assessment, metrology, laboratory accreditation, the U.S. regulatory process, and the National Center for Standards and Certification Information (NCSCI).

A seminar was presented on standards information in Managua, Nicaragua, as part of the SIT Workshop program. This seminar, held in October 1999, was a follow-up to one held at NIST in March 1998. The seminar, sponsored by the Nicaraguan Ministry of Development, Industry and Commerce, addressed such as organization and operation of a standards information center, and a WTO inquiry point, training of staff, assistance to exporters, inquiries, and information technology tools. Participants from Guatemala, El Salvador, Honduras, Nicaragua, Costa Rica, and Panama shared their experience in obtaining and providing standards information within their countries and their region.

From June 19-28, 2000, the OSS hosted a delegation of quality auditors from the GCC countries (Bahrain, Kuwait, Oman, Qatar, Saudi Arabia, and the United Arab Emirates) for a workshop on topics related to quality in manufacturing. This was the third SIT workshop at NIST for officials from the GCC countries and is part of an ongoing program of standards assistance.

NIST sponsored a SIT workshop in the field of Building and Construction for the Association of Southeast Asian Nations (ASEAN) in Hanoi, Vietnam from July 19-21, 2000. The workshop was conducted by officials of NIST and the private sector, and included presentations by staff from the Building Materials Division and the Global Standards Program. Participants included those from Brunei Darussalam, Indonesia, Malaysia, Philippines, Singapore, Thailand and the ASEAN Secretariat, and more than

two hundred people from Vietnamese agencies with interests in building and construction. This workshop closely followed the signing of a Bilateral Trade Agreement between the United States and Vietnam and represented the first joint activity following the Agreement. The Workshop, which was co-sponsored by the Vietnam Directorate for Standards and Quality (STAMEQ), was an opportunity for representatives from ASEAN to learn of the procedures and processes by which the U.S. regulates its construction industry through the development of building codes and standards to the benefit of public health, safety, and welfare.

SABIT Workshops

From May 22-June 2 2000, the OSS hosted 17 delegates from Uzbekistan, Kyrgyzstan, Russia, Ukraine, Kazakhstan, and Moldova. The visitors participated in the Special American Business Intern Training (SABIT) training on "U.S. Standards and Conformity Assessment Practices in the Information Technology Sector."

Other Workshops

As part of a Middle East and North Africa Metrology Workshop, held 8-11 November 1998 in Sharm El Shiek, Egypt, TS convened a meeting to assess the quality of iron and steel analysis in Egypt, focusing on capabilities and measurement needs. The Egyptian economy is greatly dependent on the strength of metallurgical industries, and is considered to be rich in metals and ores, consequently the importance of these industries is enhanced. Under the comprehensive economic and reform policy that the Egyptian government is now pursuing the metallurgical industries are at the top of the list of local and international Egyptian investments. The focus of the workshop was to assist the Egyptian iron and steel industries and their products to compete globally. Therefore, the need to assess the measurement and standards needs of the iron and steel industry and the use of international standards and NIST Standard Reference Materials to achieve credibility and quality was vital. The workshop had the following observations and recommendations: Egyptian industries need training and education in laboratory accreditation; NIST SRMs are needed in chemical and physical analysis of ores, and products of iron and steel; American standards specifications embedded in the ASTM standards are well represented among the companies as well as those of other foreign entities; and the use of specifications depends upon customer requirements.

In March 1999, the OSS and five private sector organizations co-sponsored a one-week workshop on "Electrical Safety Systems for the Americas." This successful partnership among NIST, the National Electrical Manufacturers Association, the National Fire Protection Association, Underwriters Laboratories, Intertek Testing Services, and the International Code Council established an international forum on building codes, product certification, installation, and enforcement practices in several countries in the Americas. Twenty participants from standards organizations, government agencies, and industry associations in Argentina, Brazil, Chile, Colombia, Mexico, and Venezuela exchanged ideas with twenty-five representatives from counterpart U.S. organizations regarding existing systems in the hemisphere.

The OSS held a workshop on April 12-14, 1999, for U.S. and Canadian entities desiring to be designated as Conformity Assessment Bodies (CABs) for medical devices under the U.S.-EU and Canada-EU MRAs. This workshop was held in conjunction with the Food and Drug Administration and the European Commission. On April 26-27, 1999, the European Commission in conjunction with the Federal Communications Commission and OSS held a workshop for U.S and Canadian entities desiring to be CABs for telecommunications and electromagnetic compatibility (EMC) under the U.S.-EU and Canada-EU MRAs. After each of the training workshops, OSS conducted a public workshop on proposed requirements for recognition under NIST's National Voluntary Conformity System Evaluation program in each sector, soliciting public comments.

European and North American leaders assessed twenty-first century prospects for integrating regional markets and improving regulatory cooperation in transatlantic trade on October 12-14, 1999, at the "Transatlantic Regulatory Harmonization and Global Standards: 21st Century Challenges and Opportunities for Regulatory Policy Cooperation, Cross-Border Competition, and Global Market Governance in North America and Europe" conference. The event was hosted by George Washington University, and was sponsored by NIST, the German Marshall Fund, and other major public and private organizations. The Secretary for the Department of Commerce and the European Union ambassador to the United States, were among the invited speakers.

The Office of OSS co-sponsored a one week workshop, November 29-December 3, 1999, on "Standardization in the Americas: Perspectives for the New Millennium". The co-sponsors were the American National Standards Institute, The American Society for Mechanical Engineers, the American Society for Testing and Materials, Intertek Testing Services, Met Laboratories, National Electrical Manufacturers Association, National Fire Protection Association, and Underwriter Laboratories. Leaders from 24 national standards bodies in the Americas participated in panel discussions of standards-related issues of strategic importance.

NIST co-sponsored the "Eighth Symposium on Biological and Environmental Reference Materials" held September 17-22, 2000, at the Natcher Conference Center in Bethesda, Md. The symposium theme was "Reference Materials for the 21st Century" and NIST chaired the scientific program committee whose membership represented 15 different countries. The conference attendance was approximately 170, including 35 NIST participants. The technical program opened with presentations on current trends and requirements for reference materials and global activities surrounding reference materials needs, development, and use. Sessions throughout the week included inorganic and organic speciation, methodologies for determining trace elements in complex matrices, food characterization, advanced inorganic methodology, recent requirements for reference materials, dietary supplements, food characterization, and foundations for environmental measurements. The symposium week ended with a session on the certified reference materials/user interface that promoted discussions on issues such as traceability, accreditation of reference materials producers, and estimating uncertainties resulting from the instability of matrix reference materials.

Appendix I

MEMORANDA OF UNDERSTANDING

<u>COUNTRY</u>	<u>DATE SIGNED</u>	<u>TERMINATION DATE</u>	<u>COMMENTS</u>
Brazil	July 24, 1996	July 23, 2001	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.
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, 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

Indonesia	November 16, 1994	indefinite	MOU between the Department of Commerce and the Ministry of State for Research and Technology. The Implementing Agencies are NIST and the National Standardization Council (DSN) for cooperation in standards, metrology, and conformity.
Japan	October 29, 1999	October 28, 2004	MOU with the Nippon Telephone and Telegraph Corporation (NTT) for cooperation in basic science and telecommunications.
Kazakstan	November 26, 1996	November 25, 2001	MOU with the Committee for Standardization, Metrology and Certification (Kazakstandart) on standards, conformity and metrology.
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	September 15, 1994	September 14, 1999	MOU with the Electronics and Telecommunication Research Institute (ETRI) for science and technology cooperation in BISDN.
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 (GOSSTANDART) for cooperation in standards, conformity and metrology.
Russia	July 16, 1996	July 15, 2001	MOU with the Russian Academy of Sciences for cooperation on chemistry, physics and engineering sciences.
Saudi Arabia	July 29, 2000	July 28, 2005	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 (CRM).
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 9, 2002	MOU with the Standardization and Metrology Organization for the Gulf Cooperation Council Countries for technical cooperation in standards activities.
Regional	April 4, 1995	April 3, 2002	MOU for Asia Pacific Laboratory Accreditation Cooperation (APLAC).

OTHER AGREEMENTS

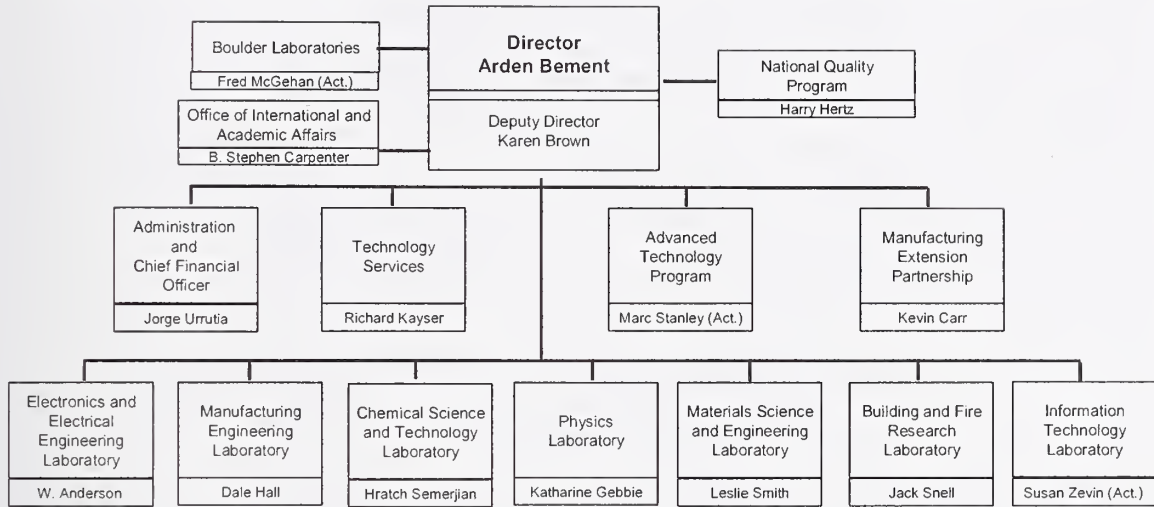
<u>COUNTRY</u>	<u>DATE SIGNED</u>	<u>TERMINATION DATE</u>	<u>COMMENTS</u>
Canada	August 9, 1995	indefinite	Implementing Agreement with the Communication Security Establishment (CSE) for cryptographic module validation.
Chile	May 2, 1994	indefinite	Letter of Cooperation with the Comision Chilena De Energia Nuclear (CCHEN). (CSTL)
Czech Republic	April 26, 1993	indefinite	Implementing Agreement with the Prague Institute of Chemical Technology (PICT).
Germany	March 27, 1995	indefinite	Statement of Intent on recognition of traceability of measurement standards with the Physikalisch-Technische Bundesanstalt (PTB).
Germany	June 26, 2000		Project Annex to the MOU with the Bundesanstalt fur Materialforschung und prufung (BAM) for cooperative studies on advanced materials with MSEL
Germany	June 24, 1997	December 31, 2002	Cooperative Project among Fachinformationszentrum Karlsruhe (FIZ) and Gmelin-Institute fur Anorganische Chemie der Max-Planck-Gesellschaft zur Forderung der Wissenschaften to develop a crysrallographic 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.
India	August 14, 1995	August 13, 2000	Statement of Intent with the Indian National Physics Laboratory (NPL).
India			Mutual Recognition Agreement with NABL and NVLAP.

Japan	March 21, 1996	indefinite	Project agreement with the Communications Research Laboratory to pursue contractual arrangement to construct and evaluate an optically pumped primary frequency standard. (PL)
Japan	November 4, 1988	indefinite	Record of Discussion with the Electrotechnical Laboratory (ETL), Agency of Industrial Science and Technology (AIST), MITI to develop measurement devices and superconductive materials. (EEEL)
Japan	March 21, 1997	indefinite	Record of Discussion with the NRLM on comparisons of hardness standards.
Japan	April 1, 2000	March 31, 2001	Consignment Agreement with the Real World Computing Partnership of MITI for joint optoelectronics project: NIST selects, supervises and controls the US Broker (facilitator between the user with a novel design and the suppliers who perform fabrication). (EEEL)
Japan	November 2, 1999	November 1, 2004	Implementing Arrangement with the Agency of Industrial Science and Technology for cooperation in the fields of metrology and measurement standards.
Korea	September 26, 1995	September 25, 2000	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)
Mexico	December 4, 1996	December 3, 2001	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	December 3, 2001	Project Annex with CENAM for Mutual Recognition of Measurement Capabilities.
The Netherlands	February 29, 1996	indefinite	Letter of Intent for cooperation with the Netherlands Meetinstituut Van Swinden Laboratory for cooperation on standards, and equivalencies.
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. (CSTL and TS)

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. (PL)
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. (ITL)
United Kingdom	June 28, 1995	indefinite	Letter of Agreement with the National Physical Laboratory in the fields of length, time, temperature, electrical resistance and capacitance.
Multilateral	May 1, 1992	March 31, 2002	International accord with France, UK, Italy, Canada, Japan, Germany and the EC- VAMAS- for cooperation on materials science.
Multilateral	December 10, 1997	indefinite	Mutual Recognition Agreement with the Asian Pacific Laboratory Accreditation Cooperation.
<u>Multilateral CIPM MRA</u>	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	September 10, 1999	September 9, 2004	Memorandum of Arrangement with NORAMET on Calibration and Measurement Certificates of NMI's.

Appendix II: Organizational Chart

National Institute of Standards and Technology



Appendix III: List of Abbreviations

A

Automated Astrophysical Site Testing Observatory (AASTO)
Accreditation Body Evaluation Program (ABEP)
Automated Computer Telephone System (ACTS)
Auger Electron Spectroscopy (AES)
Advanced Encryption Standard (AES)
Advanced Global Atmospheric Gases Experiment (AGAGE)
Air-handling units (AHU)
Agency of Industrial Science and Technology of Japan (AIST)
American Institute in Taiwan (AIT)
Andean Countries Sub-region of SIM (ANDIMET)
American National Standards Institute (ANSI)
Australian Nuclear Science and Technology Organization (ANSTO)
Asia-Pacific Economic Cooperation (APEC)
Asia-Pacific Laboratory Accreditation Cooperation (APLAC)
Asia-Pacific Legal Metrology Forum (APLMF)
Asia-Pacific Metrology Program (APMP)
Array of Real-time Geostrophic Oceanography (ARGO)
Administration de Reglamentos y Permisos (ARPE)
Association of Southeast Asia Nations (ASEAN)
Advanced Technology Program (ATP)
Advanced Telecommunications Research Laboratory (ATR)

B

Bundesanstalt für Materialforschung und –Prüfung (BAM)
Bose-Einstein condensate (BEC)
Building and Fire Research Laboratory (BFRL)
Bureau International des Poids et Mesures, or International Bureau of Weights and Measures (BIPM)
U.S.-Israel Binational Industrial Research and Development (BIRD)
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)
Convergent-Beam Electron Diffraction (CBED)
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 on Photometry and Radiometry (CCPR)
 Comité Consultatif pour la Quantité de Matière (CCQM)
 Consultative Committee on Thermometry (CCT)
 Commissariat à l'Énergie Atomique (CEA)
 National Center for Metrology (CENAM)
 Continuing Education Units (CEU)
 International Council for Research and Innovation in Building and Construction (CIB)
 Comité International des Poids et Mesures (CIPM)
 Computational Intelligence in Robotics and Automation (CIRA)
 International Organization for Production Engineering Research (CIRP)
 InterAmerican Telecommunications Commission (CITEL)
 Calibration and Measurement Capabilities (CMC)
 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)
 Czech Office for Standards, Metrology and Testing (COSMET)
 Certified Reference Materials (CRMs)
 Plasma Physics Research Center (CRPP)
 Communications Security Establishment (CSE)
 South African National Metrology Laboratory (CSIR)
 Commonwealth Scientific and Industrial Research Organization (CSIRO)
 Centre Scientifique et Technique du Bâtiment (CSTB)
 Chemical Science and Technology Laboratory (CSTL)
 Committee on Trade and Investment (CTI)

D

Defense Advanced Research Projects Agency (DARPA)
 Device Capability Dataset (DCD)
 Dichlorodiphenyldichloroethane (DDE) Data Encryption Standard (DES)
 International Committee on Developing Country Matters (DEVCO)
 Department of Commerce (DoC)
 Department of Defense (DoD)
 Department of Energy (DoE)
 Digital Signature Standard (Technical University of Denmark (DTU))

E

European Computer Manufacturers' Association (ECMA)
 Electronics and Electrical Engineering Laboratory (EEEL)
 Escrowed Encryption Standard (EES)
 Electromagnetic Compatibility (EMC)
 Swiss Federal Laboratories for Materials Testing and Research (EMPA)

Environmental Management Systems (EMS)
Environmental Protection Agency (EPA)
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)

F

Federal Communications Commission (FCC)
fault detection and diagnostics (FDD)
Fundamental Electrical Measurement (FEM)
Federal Information Processing Standard (FIPS)
Forum for International Cooperation in Fire Research (FORUM)
Federation of Societies for International Coatings (FSCT)
Fourier Transform Infrared Spectroscopy (FTIR)
Fiscal Year (FY)

G

Gulf Cooperation Council (GCC)
Geographic Information Systems (GIS)
Government Open Systems Interconnection Profile (GOSIP)
State Committee of the Russian Federation for Standardization Metrology and Certification (GOSSTANDART)
Global Standards and Information Program (GSIP)

H

Hitachi Central Research Laboratory (HCRL)
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)
Intercomparison (IC)
International Conference of Building Officials (ICBO)
International Common Criteria Conference (ICCC)
International Comparisons Database (ICDB)
International Crown Fire Modeling experiment (ICFME)
Inter-American Development Bank (IDB)
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)
 Interactive Intelligent Remote Operations (IIRO)
 International Laboratory Accreditation Cooperation (ILAC)
 Institute Laue Langevin (ILL)
 International Measurement Confederation (IMEKO)
 Institute of Metrology "G. Colonetti" (IMGC)
 Interoperable MPI specification (IMPI)
 Intelligent Manufacturing Systems (IMS)
 Instituto de Astrofísica, Óptica y Electrónica (INAOE)
 Instituto Nacional de Defensa de la Competencia y de la Protección (INDECOPI)
 Ecuador National Institute of Standardization (INEN)
 National Institute of Metrology, Standardization and Industrial Quality (INMETRO)
 Israeli National Physical Laboratory (INPL)
 Immigration and Naturalization Service (INS)
 Corporación de Investigación Tecnológica (INTEC)
 Intergovernmental Personnel Exchange Agreement (IPA)
 Instituto de Pesquisas Tecnológicas (IPT)
 Institute for Reference Materials and Measurements (IRMM)
 Intelligent Systems and Semiotics (ISAS)
 International Symposium on Intelligent Control (ISIC)
 International Organization for Standardization/Technical Committee (ISO/TC)
 Information Centers of the International Organization for Standardization (ISONET)
 Information Technology Laboratory (ITL)
 International Temperature Scale of 1990 (ITS-90)
 International Telecommunications Union (ITU)
 International Union of Pure and Applied Chemistry (IUPAC)
 International Y2K Cooperation Center (IY2KCC)

J

Joint Committee for Guides on Metrology (JCGM)
 Joint Committee for Regional Metrology Organizations (JCRM)
 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)
 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 Science and Engineering Foundation (KOSEF)
 Korea Research Institute of Standards and Science (KRISS)

L

M

Molecular Measuring Machine (M3)
Mutual Acceptance Arrangement (MAA)
Manufacturing Advisory Centers (MAC)
Matrix-Assisted Laser Desorption Ionization (MALDI)
Malcolm Baldrige National Quality Award (MBNQA)
Manufacturing Engineering Laboratory (MEL)
Middle East and North Africa Metrology Program (MENAMET)
Manufacturing Extension Program (MEP)
Modeling and Simulation Environments for Design, Planning and operation of Globally-Distributed Enterprises (MISSION)
Ministry of International Trade and Industry (MITI)
Molecular Modeling (MM)
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 Science and Engineering Laboratory (MSEL)
Minority Serving Institutions (MSI)

N

North American Calibration Cooperation (NACC)
National Center for Standards and Certification Information (NCSCI)
National Institute of Informatics (NACSIS)
North American Free Trade Agreement (NAFTA)
National Academy of Sciences (NAS)
National Aeronautics and Atmospheric Administration (NASA)
North Atlantic Treaty Organization (NATO)
National Conference on Building Codes and Standards (NCSBCS)
National Council of Teachers of Mathematics (NCTM)
Nippon Electric Corporation (NEC)
National Fire Protection Association (NFPA)
Next Generation Manufacturing Systems (NGMS)
non-government offices (NGOs)
National Information Assurance Partnership (NIAP)
National Institutes of Health (NIH)
Near infrared (NIR)
National Industrial Research Institute of Nagoya (NIRIN)
National Institute for Standards (NIS)
National Institute of Standards and Technology (NIST)

Netherlands Measurement Institute (NMI)
National Metrology Institute (NMI)
National Measurement Laboratory (NML)
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 Science Council (NSC)
National Science Foundation (NSF)
Near-field Optical Microscopy (NSOM).
National Science Teachers Association (NSTA)
National Telecommunications and Information Administration (NTIA)
Nippon Telephone and Telegraph Corporation (NTT)
National Voluntary Conformity Assessment Evaluation Program (NVCASE)
National Voluntary Laboratory Accreditation Program (NVLAP)

O

Organization of American States (OAS)
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)
Oficina Nacional de Normas Unidas de Medida (ONNUM)
Organization for the Prohibition of Chemical Weapons (OPCW)
Office of Standards Services (OSS)
Operating Unit (OU)

P

Polycyclic Aromatic Hydrocarbon (PAH)
Pacific Area Standards Congress (PASC)
Partnership for Advancing Technology in Housing (PATH)
Precision Instrument Development Center (PIDC)
Physics Laboratory (PL)
Physikalisch-Technische Bundesanstalt (PTB)
Public Works Research Institute (PWRI)
Lead Zirconate Titanate (PZT)

Q

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

R

Research and Development (R&D)
International Association for Building Materials and Structures (RILEM)
Regional Metrology Organizations (RMOs)

S

Special American Business Intern Training (SABIT)
Standards Council of Canada (SCC)
Southern African Development Cooperation in Metrology (SADCMET)
Russian American Solar Neutrino Experiment (SAGE)
Saudi Arabian Standards Organization (SASO)
Saudi Arabia Building and Fire Codes (SBC)
Surface Chemical Analysis Technical Working Area (SCATWA)
Standards Conformity Program (SCP)
Smart Card Security Users Group (SCSUG)
Secretaría de Comercio y Fomento Industrial (SECOFI)
Semiconductor Manufacturing Technology (SEMATECH)
Interamerican System of Metrology (SIM)
Secondary Ion Mass Spectrometer (SIMS)
Standards in Trade (SIT)
Sage III Ozone Loss and Validation Experiment (SOLVE)
South Pole Infrared Explorer (SPIREX)
Small- and Medium-Sized Enterprises (SME)
Scanning Maxwell-Stress microscopy (SMM)
Scanning Probe Microscopy (SPM)
Standard platinum resistance thermometer (SPRT)
Standardization, Quality Assurance and Metrology (SQAM)
Standard Reference Database (SRD)
Standard Reference Material (SRM)
Secondary Standard Dosimetry Laboratories (SSDLs)
Science and Technology Agency (STA)
Vietnam Directorate for Standards and Quality (STAMEQ)
South American Countries Sub-region of SIM (SURIMET)

T

Technical Barriers to Trade (TBT)
Technical Committee on Mass and Force (TC3)
Taipei Economic and Cultural Representatives Office (TECRO)
Transmission Electron Microscopy (TEM)
Third European Stratospheric Experiment on Ozone (THESEO-2000)
Text Retrieval Conference (TREC)
U.S./Israel/Jordan Trilateral Industrial Development Initiative (TRIDE)
Technical Standards Activities Program (TSAP)
Technical Working Area (TWA)

U

Upper Atmosphere Research Program (UARP)

U.S.-Japan Cooperative Program in Natural Resources (UJNR)
Ultra-Large Scale Integration (ULSI)
Ulusal Metroloji Enstitüsü (UME)
United Nations Economic Commission for Europe (UNECE)
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)

V

Video Quality Experts Group (VQEG)
Versailles Project on Advanced Materials and Standards (VAMAS)

W

World Bank (WB)
World Health Organization (WHO)
World Technology Division of the International Technology Research Institute
(WTEC/ITRI)
World Trade Organization (WTO)

X

X-ray Photoelectron Spectroscopy (XPS)

Y

Z

NIST Technical Publications

Periodical

Journal of Research of the National Institute of Standards and Technology—Reports NIST research and development in those disciplines of the physical and engineering sciences in which the Institute is active. These include physics, chemistry, engineering, mathematics, and computer sciences. Papers cover a broad range of subjects, with major emphasis on measurement methodology and the basic technology underlying standardization. Also included from time to time are survey articles on topics closely related to the Institute's technical and scientific programs. Issued six times a year.

Nonperiodicals

Monographs—Major contributions to the technical literature on various subjects related to the Institute's scientific and technical activities.

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

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

National Standard Reference Data Series—Provides quantitative data on the physical and chemical properties of materials, compiled from the world's literature and critically evaluated. Developed under a worldwide program coordinated by NIST under the authority of the National Standard Data Act (Public Law 90-396). NOTE: The Journal of Physical and Chemical Reference Data (JPCRD) is published bimonthly for NIST by the American Institute of Physics (AIP). Subscription orders and renewals are available from AIP, P.O. Box 503284, St. Louis, MO 63150-3284.

Building Science Series—Disseminates technical information developed at the Institute on building materials, components, systems, and whole structures. The series presents research results, test methods, and performance criteria related to the structural and environmental functions and the durability and safety characteristics of building elements and systems.

Technical Notes—Studies or reports which are complete in themselves but restrictive in their treatment of a subject. Analogous to monographs but not so comprehensive in scope or definitive in treatment of the subject area. Often serve as a vehicle for final reports of work performed at NIST under the sponsorship of other government agencies.

Voluntary Product Standards—Developed under procedures published by the Department of Commerce in Part 10, Title 15, of the Code of Federal Regulations. The standards establish nationally recognized requirements for products, and provide all concerned interests with a basis for common understanding of the characteristics of the products. NIST administers this program in support of the efforts of private-sector standardizing organizations.

Order the following NIST publications—FIPS and NISTIRs—from the National Technical Information Service, Springfield, VA 22161.

Federal Information Processing Standards Publications (FIPS PUB)—Publications in this series collectively constitute the Federal Information Processing Standards Register. The Register serves as the official source of information in the Federal Government regarding standards issued by NIST pursuant to the Federal Property and Administrative Services Act of 1949 as amended, Public Law 89-306 (79 Stat. 1127), and as implemented by Executive Order 11717 (38 FR 12315, dated May 11, 1973) and Part 6 of Title 15 CFR (Code of Federal Regulations).

NIST Interagency or Internal Reports (NISTIR)—The series includes interim or final reports on work performed by NIST for outside sponsors (both government and nongovernment). In general, initial distribution is handled by the sponsor; public distribution is handled by sales through the National Technical Information Service, Springfield, VA 22161, in hard copy, electronic media, or microfiche form. NISTIR's may also report results of NIST projects of transitory or limited interest, including those that will be published subsequently in more comprehensive form.

U.S. Department of Commerce
National Institute of Standards and Technology
Gaithersburg, MD 20899-0001

Official Business
Penalty for Private Use \$300