
NATIONAL
BUREAU
OF
STANDARDS

Cover: The NBS Admini
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Gaithersburg, Md., form
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entrance to the Bureau
grounds in Washington, D.C
Together, they symbolize
continuity of NBS goals a
traditions. The gate was i
stalled in its new location
during the Bureau's 75th
niversary year.

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Acting Director

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"It may be truly said of the Bureau of Standards that its field is the scientific world, and this can be interpreted as widely as the needs of man."

DEPARTMENT OF COMMERCE ANNUAL REPORT, 1915

A Word To Our Readers

The Bicentennial has been a year to celebrate the accomplishments of America and its peoples. In 1976 the National Bureau of Standards was proud to be part of this national celebration. In addition, NBS took time to commemorate another anniversary—its seventy-fifth year of existence.

The two events are more than just a happy coincidence. Because to a very real extent, NBS and modern industrial America grew up together. Born in an age when fairness to the consumer and equity in trade and commerce were vital concerns, NBS has continually tailored its programs to respond to scientific and technological challenges of a growing nation.

We took some time this year to reflect on the role that science and technology has played and is likely to play in America's history. In this, we were fortunate to have eight distinguished scientists and engineers come to Bureau laboratories in Gaithersburg, Maryland, to give their assessments of science and technology in America. We also opened our laboratories in Gaithersburg, Maryland, and Boulder, Colorado, to the American people and more than 50,000 persons, private citizens as well as public officials, came to talk with us, share their visions of America, and see for themselves how our work affects their daily lives and jobs.

In reading these highlights of NBS accomplishments you will gain an impression of how we are contributing to the solution of many problems of national concern. Dedication to basic research leading to the humane application of technology will continue to distinguish the work of the National Bureau of Standards in the years ahead. □

More than 50,000 people visi
NBS laboratories during its
open house. At the right, Fre
Khoury explains NBS resear
in synthetic implants to a gro
of school children.

Ernest Ambler
Acting Director

"It is therefore the unanimous opinion of your committee that no more essential aid could be given to manufacturing, commerce, the makers of scientific apparatus, the scientific work of the Government, of schools, colleges, and universities than the establishment of the institution proposed in this bill."

REPORT ON THE NATIONAL BUREAU OF STANDARDS
FOR THE HOUSE COMMITTEE ON COINAGE,
WEIGHTS AND MEASURES, 1900

Introduction

Madison Square, New York City, circa 1900.

New York City, 1976.

America 1900. The country was caught up ne midst of a great revolu- that ultimately would sform it into an indus- l giant admired by the ld. Yankee ingenuity and ention—symbolized by genius of Thomas A. son and the electric light —galvanized industry business as never before. marvel of the age was tricity, and telegraph s crisscrossed the coun- carrying the message of a prosperity and peace to illion Americans.

ut success also created s. New industries grew lmost overnight, but few standards of quality and rmance for household ucts, industrial goods, or truction materials. A ent builder had to order t 20 percent more rial than he actually ed for the job to allow neven quality and crude ards of materials. The t electric light industry, g neither the British erman standards of the ampere, ohm, or watt actory, adopted its own ards. As a result, an ic lamp requiring 10 res at 45 volts was bed as 2,000 epower in America, the same lamp ured by British or Ger- tandards was rated at 00 to 500 candlepower.

re was also confusion marketplace. House- hold products were often poor in quality, and weights, scales, and dry and liquid measures varied from shop to shop. A quantity of butter might appear to weigh more or less in one store than in another store down the street. And, although Americans were adept at inventing and manufacturing all sorts of scientific and industrial measuring devices, it was still common in 1900 to send these devices abroad to be calibrated.

Against this backdrop, the Congress created the National Bureau of Standards in 1901 to provide the basis for orderly industry and commerce. The legislation establishing the Bureau, brief by modern day standards, succinctly defined its duties.

". . . the functions of the bureau shall consist in the custody of standards; the comparison of the standards used in scientific investigations, engineering, manufacturing, commerce, and educational institutions with the standards adopted or recognized by the Government; the construction, when necessary, of standards, their multiples, and subdivisions; the testing and calibration of standard measuring apparatus; the solution of problems which arise in connection with standards; the determination of physical constants and the properties of materials when such data are of great importance to scientific or manufacturing interests and are not to be obtained of sufficient accuracy elsewhere."

Clearly, the Bureau was to be the source and custodian of the national standards of physical measurement. However, the regulating powers and the enforcement of measurement standards remained the responsibility of the states.

Down through the years, NBS has provided the country with a scientific basis for accurate measurements and sources of information on basic properties of materials determined by such measurements. In addition, its responsibilities to determine physical constants and to solve almost any problem that arises in connection with standards has made its scope of research in the physical sciences exceedingly broad.

The broad intent of its original charter, in the light of changing needs of science and technology, along with additional responsibilities assigned to NBS by many pieces of subsequent legislation, has enabled NBS to bridge the gap between the standards of measurement envisioned by the early legislators and the demanding, sophisticated standards of performance required by society today. As a result, 75 years after its creation, NBS is deeply involved in the performance of scientific research, test method development, and standards writing in such areas of national concern as energy conservation, fire safety, computer applications, environmental protection, materials utilization, and consumer product safety and performance.

The beneficiaries of the Bureau's work, described in 1900 as manufacturing, commerce, science, government, and education, today also include consumers, law enforcement officials, architects and builders, medical practitioners, scientific and trade organizations.

For three-quarters of a century, NBS has served as a catalyst for the application of advanced technology and associated scientific methods to society's problems. At NBS, a diverse staff representing dozens of scientific and engineering disciplines are engaged in more than a thousand projects. The following pages present a brief account of some of the accomplishments and activities carried out at NBS during the 15-month period that includes fiscal year 1976 and the transition quarter ending September 30, 1976. Throughout this report that period will be referred to as FY 76. These activities reflect the spectrum of capabilities and concerns that prompted Commerce Secretary Robert P. Lamont in 1931 to call the National Bureau of Standards "the people's own science laboratory." □

"The Bureau is called upon to settle questions of standards that would scarcely have arisen a few years ago. Another cause contributing to the increased demands along these lines is the necessity for greater accuracy. What would have been considered sufficiently accurate a few years ago will no longer satisfy engineers, manufacturers, merchants, or the public."

NBS ANNUAL REPORT, 1902

Increasing Measurement Capabilities

The newly established National Bureau of Standards largely turned its attention in 1901 to measurement standards for the burgeoning electric power industry. It was quickly recognized that measurement, the Bureau's special province, was vital to the strength and growth of the entire economy. Today, increasingly complex industrial processes, manufacturing, technology, and science demand degrees of precision, based on accurate measurement, far beyond the range practiced by the Nation's scientists at the turn of the century.

Measurement is much more than just a way of making sure things fit together. It is a means of gathering precise, objective information about the physical world, information that also can help determine how well a process or product performs its intended function. NBS research today ranges from making precise measurements of such basic physical quantities as mass, time, and length to exploiting discoveries on the frontiers of science to provide scientists and engineers with measurement tools of ever greater capability. Accomplishments during the year reflect this broad spectrum—from the most accurate determination to date of the length of the second, the fundamental unit of time, to theoretical studies of small geometric patterns, which resulted in an instrument that will aid the manufacture of high-performance microelectronic devices.

Sophisticated communication systems, such as radio, television, and computer networks, navigation systems, electric power grids, and a host of manufacturers and users of electronic components and instruments depend on accurate reference standards of time and frequency. In turn, modern standards of timekeeping and frequency are based on the natural oscillations of cesium atoms serving as atomic clocks. The latest and most accurate generation of NBS atomic clocks was completed during the year. Twice as ac-

As science and technology advance, the determinations of fundamental physical constants can be made with greater precision. In the 1920's, Paul R. Heyl redetermined the Newtonian constant of gravitation. Today, William A. Koldewyn (l.) and James E. Faller are attempting to measure the gravitational constant even more precisely.

curate as its predecessor, NBS 6 became the new NBS primary standard for the second and the hertz. NBS 6 led to a new determination of the length of the second, accurate to within 8.5 parts in 100 million which is comparable to about 1 second in 370,000 years. As a result of the NBS measurement and others performed in West Germany and Canada, the International Time Bureau in Paris will make an adjustment in international atomic time.

An NBS scientist also developed a portable rubidium atomic clock that permits routine comparison of worldwide timekeeping more conveniently than existing cesium atomic clocks. The battery-operated clock, which can be carried to previously inaccessible locations, has a precision better than 1 microsecond.

New ground was broken in another area of basic physical research—tem-

Helmut Hellwig developed a portable rubidium atomic clock which permits more frequent, inexpensive trips to compare independent clock systems used as time standards in many countries.

perature. NBS scientists developed a high-pressu thermometer calibration device which will be use oceanographers who nee highly accurate thermometers to study stabili ocean currents, the relati ship of temperature profi to changing global weath patterns, and the long-te effects of human activitie the oceans. With the dev oceanographers will be a for the first time to test th effectiveness of their platinum resistance thermometers at the exceedi high pressures encounte in ocean depths. The Na tional Oceanographic In mentation Center plans t duplicate this device for e by its network of researc centers.

For medical use, NBS developed a temperature reference fixed-point inv ing the sharply defined n ing properties of gallium metal. The combination this fixed-point device an the precision thermomet offered as NBS Standard Reference Materials give medical and clinical laboratories an unprece-

ted opportunity to im-
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nt of effort required to determine the intensity. Its unique design means the instrument can be used to calibrate practically any kind of laser. NBS scientists also carried out a new photoionization experiment that created a dense homogeneous column of positive ions at relatively low temperatures. This opens up a possible route to short wavelength, vacuum ultraviolet lasers.

Some of the most enduring accomplishments of NBS are made on the forefront of science and technology. During FY 76, NBS contributed new neutron cross-section measurements to the Nation's nuclear energy program. Neutron cross sections for the ^{6}Li (n,α), ^{10}B(n,α), and ^{235}U fission reactions were provided to the National Neutron Data Center and to the subcommittee of the U.S. Data Committee concerned with evaluation of neutron standards. After careful scrutiny, the subcommittee adopted a recommendation giving major weight to the new NBS data on ^{235}U, which represents a downward adjustment as large as 4 percent to the previously accepted data. Since these three cross sections are used as standards for a variety of nuclear fuels, the NBS data are expected to have a large impact on the design of the breeder and other reactors.

In a related area, the developing capability at NBS to measure absolute neutron fission rates was applied to the calibration of new detectors for characterizing radiation fields in test reactors. The method forms the basis of a wide interlaboratory effort to achieve measurement consistency for fission rates of reactor fuels. In addition, experiments on the behavior of atomic nuclei under bombardment by low-energy gamma rays gave scientists a new insight into the process by which energy is released in fission.

Progress in understanding the fusion process, which could supply unlimited energy for future generations, is being made at NBS. In fusion, hot gases are heated to temperatures of 100 million degrees Celsius and held in a magnetic field. These intense conditions create a plasma in which nuclei are driven into each other with such tremendous force that they fuse, releasing energy in the process. Barely measurable impurities in the plasma can cause it to cool to such extent that fusion will not occur. During the year, NBS developed a new transfer standard that will help scientists accurately calibrate the instruments used to detect and measure impurities in the plasma. The standard, a compact, powerful mini-arc ultraviolet source, is now being used by researchers at Princeton University's Tokamak, the largest plasma containment machine in the United States. □

"Much of the success of the Bureau's work has been due to the most hearty cooperation of manufacturers, consumers, and technical experts—especially where the results would enure to the benefit of all . . . the results of the Bureau's work find through these channels the most ready acceptance and application."

NBS ANNUAL REPORT, 1912

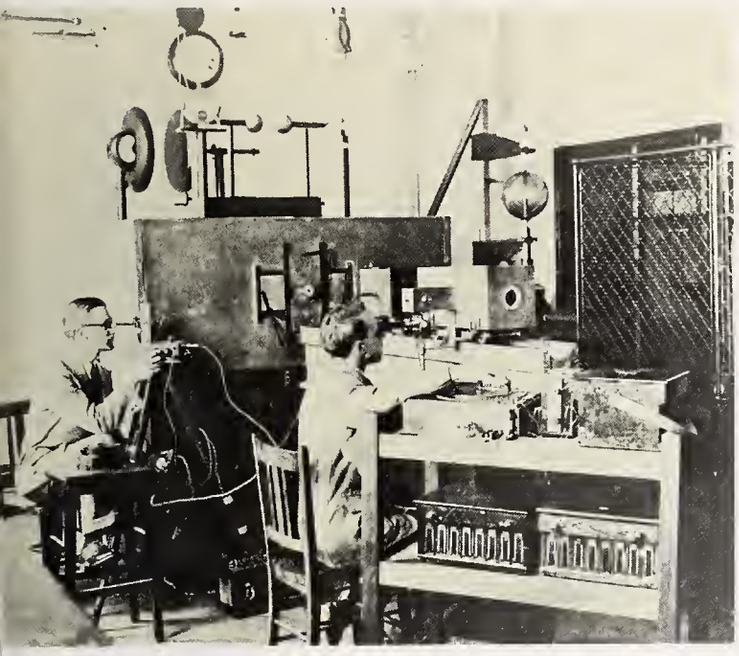
Transferring Research and Technology

Sharing research and measurement expertise is one of the major concerns of NBS. In this area, NBS has always enjoyed a unique relationship with industry, government agencies, universities, and consumers.

As early as 1904, the Federal government turned to NBS to find out what was wrong with its incandescent light bulbs. The bulbs, purchased at the rate of 1 million a year, regularly and rapidly burned out in Federal office buildings. Soon, NBS was testing clinical thermometers, chemical glassware, inks, and, in fact, nearly the whole catalog of supplies purchased for government use. Manufacturers then began coming to NBS to obtain assistance on methods of measurement and quality control. In response the Bureau started to issue standard samples—now known as Standard Reference Materials—and to provide calibration services to help in these tasks.

This relationship continues to grow and expand today as NBS transfers the results of its research and technology into the marketplace. The Bureau serves as a technical resource for the states, which are responsible for regulating weighing and measuring equipment. In 1965 NBS embarked on a program to replace the antiquated weights and measures of the states, many of which dated back to 1836. In the past year, NBS presented new sets of weights, measures, and instruments to Arizona, Alabama, and New Jersey, bringing to 49 the number of states, including the District of Columbia, that have received new standards. Along with the instruments, NBS provides calibration services and guidance on installing equipment and training laboratory personnel.

NBS also serves as a technical resource for a number of Federal government agencies. Among NBS clients are the Department of Housing and Urban Development, the Energy Research and Development Administration, the General Services Administration, the Food and Drug Administration, the Federal Energy Ad-



Left. Lauriston Taylor of NBS (1.) and Walter Brinks of the British National Physical Laboratory performed the first intercomparison of X-ray standards between the two countries in 1931.

Below. William A. Bagley checks instrumentation for calibrating high-voltage dividers used today with diagnostic X-ray units to prevent overexposure to X-rays.

ministration, and the Consumer Product Safety Commission.

NBS signed several new interagency agreements during the past year. One agreement will stimulate cooperation between NBS and ERDA to work on measurements and standards needed in the Nation's energy research and development program. Under another cooperative program with ERDA, the NBS Office of Energy-Related Inventions received nearly 3,300 inventions for evaluation. The inventions, aimed at conserving or increasing energy supplies, were submitted by individuals and small businesses. About 2 percent of the inventions evaluated are ultimately expected to be recommended to ERDA for additional support and development.

One of the Bureau's key efforts is the Experimental Technology Incentives Program which explores policies that will allow the Federal government to stimulate the development, application, and transfer of science and technology in the private sector. In cooperation with other agencies, ETIP conducts experiments in Federal regulatory and procurement practices and policies and supports research and development in the private sector to determine ways of encouraging desirable innovation in the marketplace.

In the regulatory area, ETIP initiated a project with FDA to develop systems for monitoring newly approved medicines for unwanted reactions. The systems would help FDA uncover previously unsuspected adverse effects more quickly than is now possible.

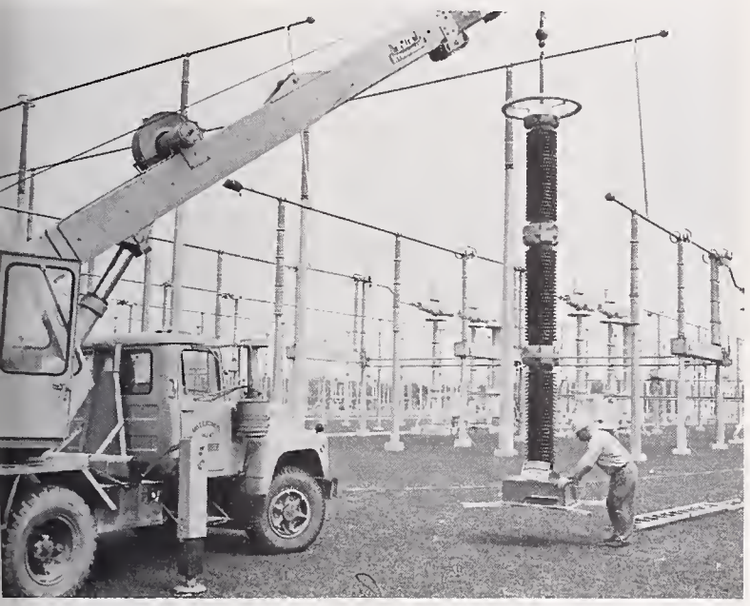
As a result of one ETIP experiment in the procurement area, all GSA contracts for purchases over $100,000 have a new incentive clause that encourages government suppliers to make changes in products that will result in cost savings to the government. The supplier then shares these savings with the government, but the ultimate beneficiary is the taxpayer, because GSA buys $2 billion worth of supplies and equipment every year. In addition, it is expected that such innovations in products will ultimately show up in the general marketplace.

In another program aimed at transferring research and technology, NBS hosted nearly 90 scientists, engineers, and technicians as research associates during the past year. Twenty trade associations, private companies, and the Federal government paid the salaries of research associates to work at NBS on problems of mutual concern.

During the year, a new research associate program with the American Society for Testing and Materials was initiated to provide research on standards for the metals industry. In another ASTM-NBS program, a research associate developed an apparatus for measuring and evaluating the quality and reliability of sealed insulating glass units. The device was adopted as part of a standard test method by ASTM and is now being produced commercially by industry. Two research associates from Superconducting Technology, Inc., are working with NBS scientists to develop the technical bas for conversion of the Josephson Junction Volt Standard from a laborat device to a commercially reproducible form.

The NBS guest worke program provides a simil environment to the resea associate program for for scientists and engineers. During the past year, NB hosted 24 guest workers f 10 countries.

Under another cooper tive program, NBS and t Electric Power Research stitute developed a new p table calibration unit for verifying the accuracy of coupling capacitor voltag transformers used in reve metering in high voltage lines. When used comme cially by utility companie the calibration unit will assure the equitable ex change of energy over ne works of power lines. Th programs emphasize tha Bureau considers cooper tion with the private sect on projects of benefit to society one of its most imp tant missions.



Working with the Electric Power Research Institute, NBS developed a calibration system to assure the equitable exchange of energy over networks of power lines.

rough its calibration esting services, the au helps other institu- and businesses make ate measurements. In onnection, NBS pro- calibration services to than 950 private firms, al, state, and local nment agencies, rsities and hospitals, reign organizations. ding measurements of nce, voltage, and ion, the services were sted by such diverse izations as power s, instrument makers, rs, and the aircraft in- . The services focus on tions that require comparisons to ac- ly maintained national rds. Fees are charged r the costs of this ser- When calibrated by he customer's instru- becomes a transfer rd with NBS-traceable cy.

eral new calibration s were initiated during t year, including ms for impulse tors, high-density tic disks, and pressure cers. NBS also established a calibration service for the high-voltage dividers used with diagnostic X-ray units in support of FDA's efforts to prevent overexposure of the public to X-rays.

One of the most popular services offered by NBS is its high-frequency broadcasts for time and frequency calibrations. NBS began transmitting standard radio frequencies from its station WWV (originally located in Beltsville, Maryland, now in Fort Collins, Colorado) in 1923, and station WWVH (originally located in Maui, Hawaii, but later moved to Kauai) in 1948. Together, the two stations broadcast time and frequency signals to tens of thousands of regular listeners in large areas of the western hemisphere. Recorded time and frequency information is available to the public from WWV by calling 303/499-7111 and from WWVH by calling 808/335-4363. More than 30,000 calls are received by the time-of-day service each week. One regular user of this time and frequency information is the Bell telephone service. In cooperation with other government agencies, WWV and WWVH also broadcast weather digests, alerts on geomagnetic storms and solar activity, and other information.

NBS offers measurement assurance programs as unique supplements to its regular calibration services. Under these programs, NBS sends well characterized instruments or samples to participating laboratories. This service enables laboratories to determine (and correct for) differences between their calibration processes and those of NBS. In addition, this system reduces the risk of damage to instruments during shipment to NBS for calibration. This procedure examines the capability of the whole measurement system, rather than the properties of a single instrument separated from the normal conditions of its use.

During FY 76 NBS began a new measurement assurance program for the power calibration of 1 milliwatt helium-neon lasers, which make up well over half of all laser sales. The service will assist laser manufacturers and users to make more accurate and reliable measurements, which is especially critical in view of new Federal labeling requirements for lasers. NBS also offered a new measurement assurance program for gage blocks widely used as checks on the accuracy of industrial dimensional measurements.

Another integral NBS effort aimed at transferring measurement expertise is the Standard Reference Materials program. SRM's are materials whose chemical or physical properties have been measured and certified by NBS. They are used by manufacturers to calibrate instruments and secondary standards. The program today offers more than 950 SRM's for sale. In FY 76 alone, nearly 40,400 units were sold in the United States and overseas at a value of $2.4 million. About 40 new SRM's, ranging from standard magnetic tapes for computer applications to standards for measuring sulfur in fuel oil, were added during the past year. □

"The quality of materials depends upon their physical and chemical properties, each of which may be measured and standardized exactly as their dimensions are standardized . . . Upon this view that quality may be measured rests the importance of the movement for unified specifications for materials."

NBS ANNUAL REPORT, 1912

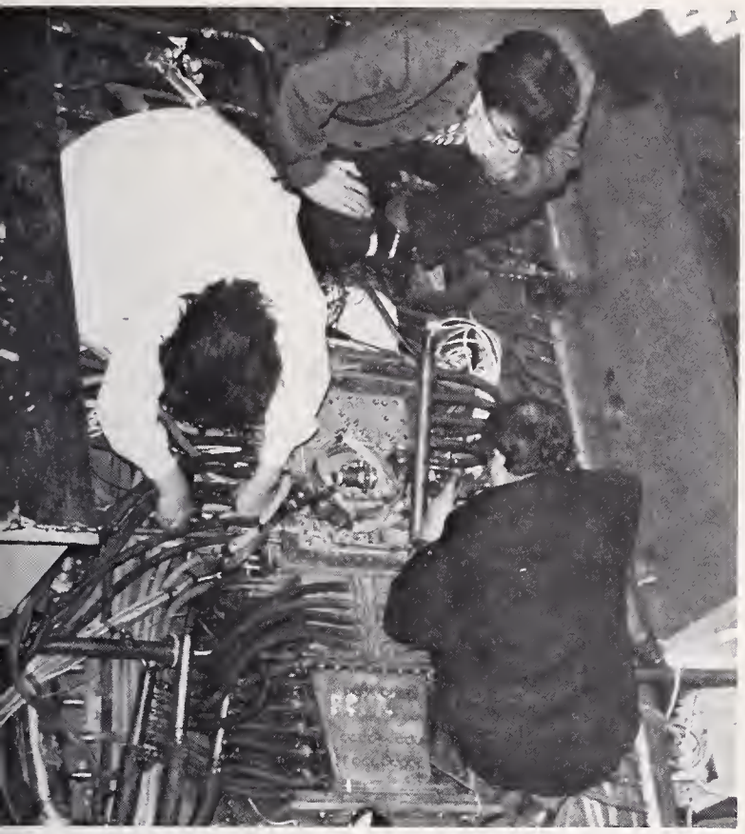
Promoting Better Materials Use

Although people were concerned about materials quality in the early part of the century, they were not worried about exhausting the earth's resources. Materials resources are finite, however, and today some are in critically short supply.

To help conserve the Nation's resources, NBS materials research focuses on accurately determining the properties of materials. By relating these properties to performance, materials may be used more efficiently, while insuring their durability, reliability, and safety. Achievements during the past year highlight the breadth of materials research at the Bureau—from studies of materials used in new energy systems to developing new techniques for detecting flaws in materials before they fail.

Fossil fuels—oil, gas, and, to a lesser extent, coal—are among our most rapidly diminishing resources. NBS scientists work with the Energy Research and Development Administration to find more efficient ways of using coal, the most plentiful U.S. energy resource. Of particular interest is magnetohydrodynamics, or MHD. MHD is a way of generating electricity from coal and other fuels that is potentially more efficient and less polluting than conventional means. One of the main obstacles to MHD development is finding materials that can withstand the extremely corrosive conditions created in MHD systems. NBS studies provide needed endurance and property data on new and existing MHD materials.

During the past fiscal year, NBS coordinated all materials evaluation and characterization activities for the U.S.-U.S.S.R. tests of American-designed and -built electrodes and insulator materials, key components in MHD systems. As a result of these studies some of the problems involved with the materials were identified, paving the way for improvements and, possibly, long life electrodes. NBS scientists also developed several promising new



In 1976, NBS scientists worked with Soviet researchers to evaluate and characterize materials for potential use in magnetohydrodynamic systems. (Photo by William R. Hosler.)

One of the Bureau's early challenges in materials research was to find pot material capable of resisting the corrosive effect of fluid optical glass. Working with industry, NBS researchers produced a procelain pot that was regarded as a major contribution to glass manufacturing techniques.

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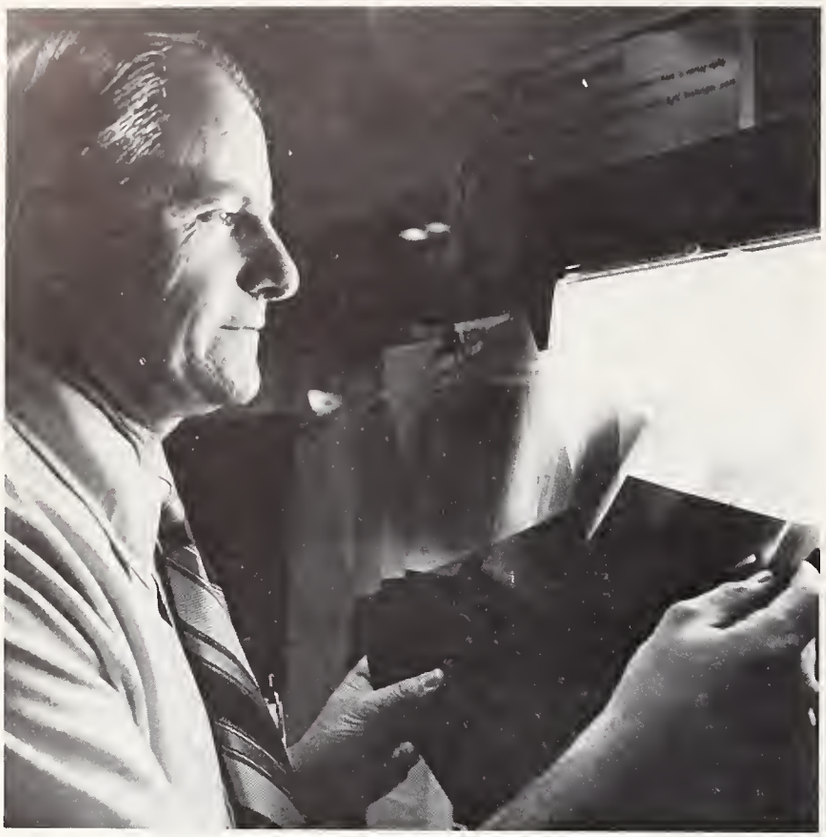
During FY 76 NBS completed successful tests on the metering of LNG, measured thermophysical properties, and began a study involving sampling of the composition of LNG, upon which both the cargo-heating value and the quantity are calculated. These accurate data and handling techniques form the basis for all aspects of LNG technology.

NBS made significant contributions to materials research in another area of national interest—health. A synthetic implant program was formed to assist surgeons, manufacturers, and other specialists in the search for safer, more durable synthetic implant materials. Among results of research in FY 76 was the finding that titanium, a common metallic implant material, is more resistant to corrosion when alloyed with small amounts of nickel and/or molybdenum and given a proper heat treatment. The work also revealed that the strength of



Harold Berger inspects neutron radiographs as part of the NBS program to improve measurement methods used in the nondestructive evaluation of materials.

at least one titanium alloy used in implants can be increased many times by proper heat treatment.

A long standing cooperative health program, dating back to the 1920's, between NBS and the American Dental Association continued to make progress in the development of better dental materials and methods. ADA research dentists working at NBS developed a procedure that makes possible for the first time the simultaneous use of two cavity-retarding techniques. The methods, now used separately by dentists, are direct fluoridation, which makes the tooth surface less susceptible to decay, and sealing, which fills in depressions and crevices where food and bacteria accumulate. The ADA dentists are now testing the procedure on a number of patients. NBS scientists and ADA dentists also developed a new technique that may prolong the life of composite resin fillings widely used to repair front teeth.

In addition, NBS scientists last year provided technical information to the Department of Transportation on test methods to determine properties of plastics used in containers for transporting hazardous materials. With this information, DOT will have a firm technical base which will be useful in developing standards.

Bureau scientists also prepared a report for DOT on the use of fracture mechanics analysis and radiographic and ultrasonic methods to help DOT determine the acceptability of flawed girth welds in the trans-Alaskan oil pipeline.

Radiography and ultrasonic inspection are two of several nondestructive evaluation methods. NDE methods are employed in industry to examine materials for flaws or defects that could seriously impair the useful life of the component. NBS established a nondestructive evaluation program to help industry and other government agencies improve the reliability of materials and structures through standardized NDE measurements. Under this program, NBS and the Electric Power Research Institute are investigating the possibility of using acoustic emission, a new NDE technique, to monitor electrical generating systems and components for early signs of failure. In another program with Argonne National Laboratory, NBS scicntists applied three-dimensional methods to neutron radiography, providing a powerful probe for inspecting complex structural components.

NBS scientists also developed a new instrument that displays the interior of integrated circuits and other semiconductor devices, which are used in electronic systems found in industrial processing, communications, transportation, and health services. Called a laser flying-spot scanner, the instrument will aid reliable design of semiconductor devices and circuits. □

"To waste, to destroy our national resources, to skin and exhaust the land instead of using it so as to increase its usefulness will result in undermining in the days of our children the very prosperity which we ought by right to hand down to them amplified and developed."

THEODORE ROOSEVELT
MESSAGE TO CONGRESS, 1907

iding Environmental Protection

Some 60 years before the environment became a popular cause, President Roosevelt recognized the importance of protecting the environment. An ardent conservationist, his chief concern was limiting commercial development of the country's forests and parklands. Were he alive today, it is likely that Roosevelt would be equally concerned about the hundreds of chemicals, unknown in his day, that have entered the environment.

Pollutants in air and water are of particular importance. Noise, a less tangible form of pollution that seriously affects the well being of millions of Americans, also threatens environmental quality. In all three cases—air, water, and noise pollution—accurate measurements are needed to determine the true levels of pollutants. Without these measurements, scientists cannot correctly relate health effects to levels of pollution, engineers cannot accurately assess the effectiveness of control techniques, and the government cannot rationally make policy decisions on regulating pollution

As one of the newer programs at NBS, environmental pollution research is a natural outgrowth of the Bureau's expertise in measurement science. NBS assists the Environmental Protection Agency by providing a basis for accuracy in pollution measurement. In the past year, NBS scientists developed new measurement methods and standards and determined and disseminated technical data on pollutants to other scientists and state and local governments.

Air pollution is a global problem. A major international issue in recent years is whether chlorofluorocarbons—used as propellants in aerosol sprays and as refrigerants—are breaking down the earth's protective ozone layer. During the year NBS scientists determined new data for several crucial chemical reactions occurring in the upper atmosphere. The information provided the most accurate data available for computer modeling studies that are

Right. NBS scientists assisted the National Geographic Society with two balloon ascensions, in 1934 and 1935, to collect information and data on the stratosphere. (Photo by Master Sergeant G. B. Gilbert and Captain H. K. Baisley.)

Far right. NBS researchers today are studying chemical reactions that occur in the atmosphere. Here Albert E. Ledford is shown with a new, NBS-developed instrument used to measure very small amounts of ozone, a serious air pollutant at ground level.

used to predict the effects of chlorofluorocarbons on the ozone layer.

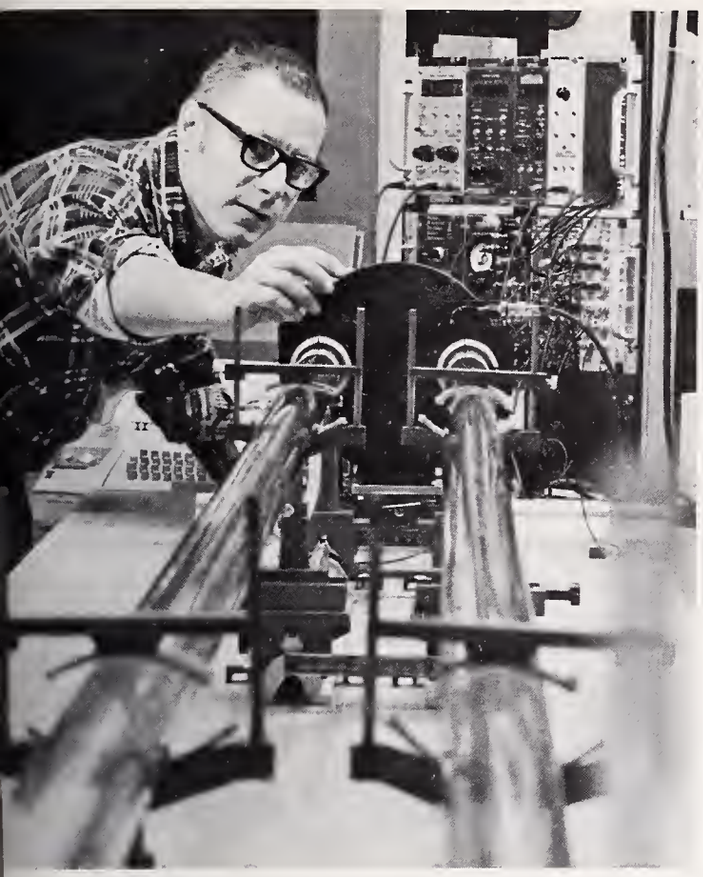
In a study of another industrially important chemical, carbon tetrachloride, NBS scientists showed that it breaks down in the earth's upper atmosphere in a manner similar to the chlorofluorocarbons. During the breakdown process, chlorine atoms are released which then react with ozone. These studies indicated that carbon tetrachloride may also play a role in ozone depletion. Meanwhile, environmentally preferred alternatives to chlorofluorocarbons have been identified in a collaboration between NBS and the National Oceanic and Atmospheric Administration. The NBS-NOAA researchers found that if the chlorofluorocarbon molecules contain hydrogen, their reaction with the atmospheric hydroxyl radical greatly reduces the amount of chlorofluorocarbon material that can reach the upper atmosphere and reduce ozone concentrations. This information is reflected in legislation of the State of Oregon, which restricts the use of non-hydrogen chlorofluorocarbons. Other states are considering similar legislation.

Although ozone in the upper atmosphere protects the earth from harmful ultraviolet radiation, in the lower atmosphere it is a serious air pollutant. An NBS scientist developed a new instrument for measuring precisely very low levels of ozone in the lower atmosphere. The instrument is the only one of its kind in the United States, and scientists from around the country have used the NBS instrument to calibrate their ozone measuring instruments. Calibrations such as these help assure that measurements of ozone made by different groups are accurate and comparable.

Air pollution is not only a health hazard outside—it may also affect industrial workers who often are exposed to potentially toxic materials in the workplace. NBS scientists developed a new sensitive monitor for determining the occupational exposure of a worker to mercury vapors. The monitor will help public health officials protect some 150,000 workers who are employed in industries where exposure to the hazard of mercury is a daily occurrence.

The Bureau also issued a series of Standard Reference Materials for industrial hygiene analysis. These SRM's provide an accurate way of calibrating equipment and methods that are used to determine if workers have been unduly exposed to high levels of industrial pollutants and if the levels of pollutants in the workplace exceeded Federal health standards. Resulting from a joint program with the National Institute of Occupational Safety and Health, the SRM's will be useful in a variety of industries where exposure to toxic substances like beryllium, lead, and cadmium is frequent.

Public health officials are also interested in learning more about very tiny particles found in air pollution. Particles about 1 micrometer or less in size can be



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minating device for
ing water samples from the deepest parts of the ocean. The device maintains the high pressures encountered during and after retrieval. This enables researchers to study in the laboratory organisms that may be present under conditions similar to those found in their natural habitat. Using the sampler, University of Maryland researchers retrieved microorganisms from 3500 meters and are now trying to determine if they are unique to the deep ocean. The sampler is sufficiently rugged for any deep ocean biological sampling and should open up the field to many research laboratories.

Meanwhile, a team of NBS scientists completed a study of naturally occurring levels of hydrocarbons in the marine environment in Alaska. The study was performed in areas expected to be affected by tankers carrying oil from the trans-Alaskan oil pipeline. The study will provide a baseline against which changes in hydrocarbon concentrations may be monitored after the pipeline opens. During the study, NBS scientists designed new methods of taking samples and analyzing them for low concentrations of petroleum components.

Substances used to improve the quality of life may have serious side effects when they or their by-products are dispersed into the environment. Pesticides that are naturally toxic are a case in point. During the year, NBS mathematicians analyzed and extended a model tracing the movement of DDT and other pesticides through soil, rivers and lakes, the atmosphere, oceans, and fish. The model takes into consideration the way in which pesticides are applied and their subsequent movement by convection, solution, precipitation, evaporation, and photodegradation into the environment. From the model, it appears that most of the DDT ends up on the ocean floor.

Just as air and water pollution affect nearly everyone's life, so does noise. Nearly 103 million people in the United States are exposed daily to sound levels that can interfere with normal activities including communication and sleep. Continued high sound levels can also cause a loss of hearing, a problem that affects workers in many industries. A comprehensive program at NBS provides government, industry, and the research community with reliable and useful measurements and standards for noise abatement and control programs. During the year, NBS scientists completed an investigation of the accuracy and precision of various measurement methods for determining the sound power output of machines. They also held a workshop to provide instruction in the operation of sound level meters used in the enforcement of Federal, state, and local noise regulations. □

". . . I am impressed with the fact that we are a people of 110 million on a continent where we have already developed the large proportion of our natural resources, a population growing at a rate. . . in the next fifty years, doubling up to perhaps 200 million people. We must face the solemn economic fact that unless we develop through science the greater utility of our resources, expand by discovery their usefulness, we cannot maintain the standards of living . . . we now enjoy."

SECRETARY OF COMMERCE HERBERT HOOVER
ADDRESS COMMEMORATING 25TH ANNIVERSARY OF NBS, 1926

Conserving Energy Resources

It is truly remarkable that 50 years ago Herbert Hoover accurately predicted the energy shortages of today, for when Hoover referred to natural resources, he was talking mainly about petroleum. But it is probably safe to say that even Hoover did not foresee the magnitude of U.S. dependence on oil. In 1976, petroleum accounted for about 46 percent of the energy used in the United States, and about 40 percent of this oil was imported from foreign countries.

Science, said Hoover, could help the Nation increase its energy options and use its existing energy supplies more efficiently. This is the goal of many current Federal efforts, including those led by the Energy Research and Development Administration. NBS is one of several government agencies contributing to ERDA's multibillion dollar energy research, development, and demonstration program. NBS scientists and engineers develop technical information, test methods, and standards needed to promote the widespread use of solar energy systems and energy conservation practices and technologies. The Bureau also supplies data to ERDA's nuclear energy and fossil fuels program.

The sun, the most available and abundant potential energy source, received a great deal of public attention during the year. Many new solar energy systems are on the market, but builders and consumers are unable to make meaningful comparisons among the various systems because there are no uniform methods for measuring their performance.

To remedy this situation, NBS engineers, with support from ERDA, are developing standard methods to test the performance of solar collectors and thermal storage units, the two principal components in all solar heating and cooling systems. The NBS-proposed test methods are now under review by the American Society of Heating, Refrigerating and Air Conditioning Engineers. In the meantime, NBS has been coordinating a test of solar

lectors at 20 laboratories oss the country to deter- ne the suitability of the posed standards. It is ex- ted that the NBS test hods will form the basis ASHRAE voluntary per- nance standards.

n addition, NBS ineers are developing dards for the Department Housing and Urban elopment on solar nestic hot water and space ing systems. This rmation will be used in unction with HUD's imum Property Stan- is to determine the ac- ability of solar equip- t for mortgage rance.

ne of the main questions it solar energy is its cost pared to conventional ing and cooling systems. ng the year, an NBS omist published elines that will provide rchers and analysts with ble and consistent pro- res for comparing the omic merits of solar gy systems with conven- systems.

til solar energy and new energy tech- nologies are available widely, conserving existing energy resources will be an important option. The Bureau's measurement expertise has made a valuable contribution to the Nation's energy conservation efforts, since the ability to measure precisely where energy is used—and wasted—is the first step in determining how it can be saved and used more efficiently.

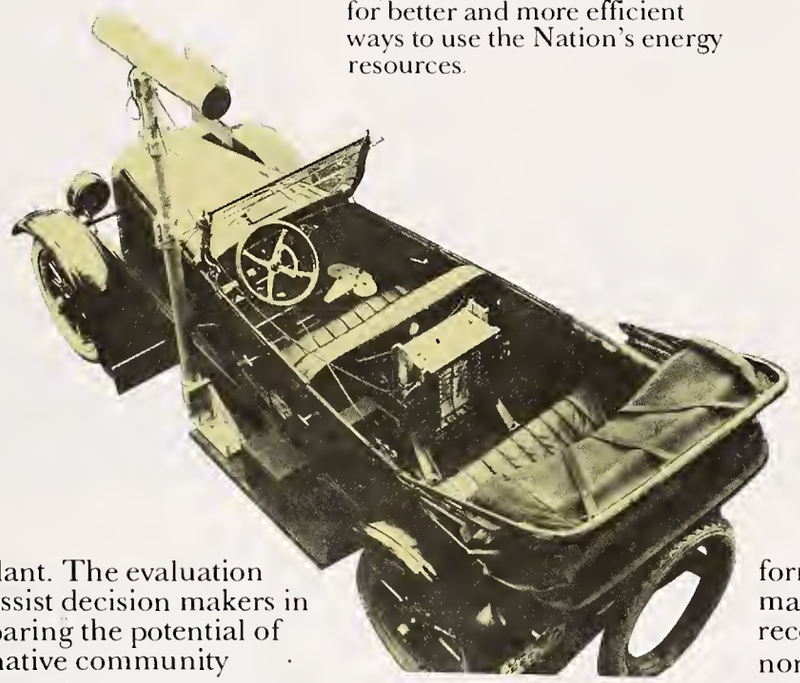
Working with the General Services Administration, the Federal Energy Administration, and ERDA, NBS engineers designed an extensive monitoring and instrumentation system to evaluate the energy consumption of a new GSA office building in New Hampshire. An important feature of this building is that before it was built, NBS computer studies were used to assist the GSA design team in choosing the most effective building designs, materials, and heating, cooling, and ventilating equipment. These studies estimated that the building would use a third less energy than a comparable conventional building. The data collected from the monitoring system will allow NBS to evaluate the actual performance of various energy conservation features in the building against the theoretically expected performance. This information will aid architects and builders in designing energy conserving buildings in the future.

The Bureau continued to make significant contributions to the development of energy conservation standards for new building designs. A widely publicized voluntary consensus standard on energy conservation in new buildings, adopted by ASHRAE in 1976, was derived in part from NBS research. The NBS staff is now aiding in the preparation of guidelines for implementation of this and other standards. It is also helping HUD and other Federal agencies develop energy conservation standards.

Another application of Bureau measurement experience is HUD's Modular Integrated Utility System. MIUS is an innovative system designed to ease the burden on public utilities by

As part of an NBS-FEA project to develop test methods for measuring the energy use of major appliances, NBS researchers measured the amount of energy actually used by cooks in preparing meals.

In a attempt to help conserve the Nation's petroleum resources, a major concern even in the 1920's, NBS scientists studied the automobile below for ways to improve combustion by obtaining better knowledge of fuels, ignition, lubrication, and carburetion. At the left, Donn Ebberts (l.) and John Jenkins adjust solar collectors being tested by NBS for ERDA as part of a continuing search for better and more efficient ways to use the Nation's energy resources.



oviding in a single package the utility needs of a community. A significant advantage of MIUS is the conservation of fuel through recovery of energy normally sted when essential utility vices are supplied from parate sources.

During FY 76 NBS veloped a detailed performance specification HUD, spelling out nimum performance els for MIUS products d services. This specification was used to design a US demonstration plant t could provide all utility vices for a residential and mmercial community der construction in Maryd. After the plant is built, S will measure its performance and compare it to the ginal predictions of imved utility performance l energy savings.

Last year, NBS began luating for HUD a total rgy plant serving a residtial and commercial plex in Jersey City, New ey. NBS designed and inied the data collection em that is being used to nitor the performance of the plant. The evaluation will assist decision makers in comparing the potential of alternative community energy systems.

The Nation's 46 million owner-occupied homes also offer a significant opportunity for energy conservation. A popular consumer booklet published by NBS and FEA was distributed during FY 76 to more than a quarter million homeowners. The booklet, *Making the Most of Your Energy Dollars in Home Heating and Cooling*, helps homeowners determine the best level of investment in insulation, storm windows, and other energy conservation improvements to get the maximum savings on home fuel bills. The Bureau is also assisting the Federal Community Services Administration in its nationwide program to help low income families make energy conservation improvements in their homes.

In addition, NBS worked with FEA and the Federal Trade Commission during the year to develop test methods for determining the energy efficiency of household appliances. The test methods will be used in a mandatory appliance labeling program. NBS established an appliance testing laboratory and developed recommended test methods for eight products. Bureau engineers also studied product design options that have potential for improving product efficiency.

Other energy conservation efforts at NBS were aimed at the industrial and commercial sectors which use nearly half of the Nation's energy budget. During the fiscal year, NBS and FEA issued a supplement to the widely distributed *Energy Conservation Program Guide for Industry and Commerce*, a technical handbook designed to help businesses and industries establish or improve energy conservation programs.

NBS and FEA also developed a *Waste Heat Management Guidebook* to inform engineers and plant managers of the options for recovering and using heat normally lost in industrial processes. It is estimated that a typical plant could save about 20 percent of its fuel by installing waste heat recovery equipment. □

"The construction industry is one of the largest and most important to the people of the United States and it is a function of the division of building and housing to study the needs of the industry and their relation to the public welfare. It endeavors to see that these needs are met and the public welfare advanced, partly through its own efforts and by enlisting the aid of other branches of the Federal government. . .and partly by presenting its conclusions to the industry itself."

NBS ANNUAL REPORT, 1922

Advancing Building Technology

A severe housing shortage was one of the major crises facing the United States after World War I. Stimulating construction became the personal crusade of Commerce Secretary Herbert Hoover, who called upon the National Bureau of Standards to assist in his whirlwind campaign.

NBS was a logical choice since by 1922 it had already amassed considerable experience in testing and measuring the strength and thermal performance of building materials. It was called upon to publish material on the economics of home building and ownership and to recommend revisions in local building and plumbing codes to increase uniformity. The Bureau also developed improved building practices and materials for the states to adopt.

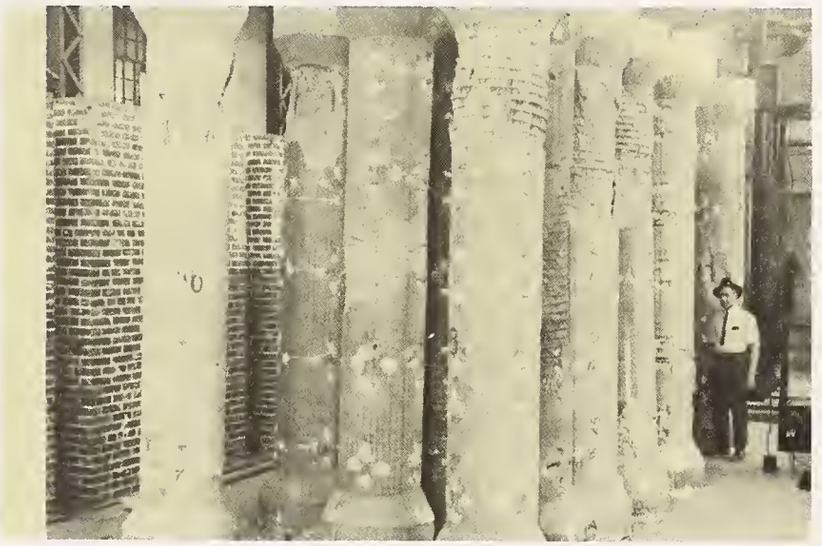
Today, the building construction industry is one of the largest in the United States, with about 3.3 million workers and $140 billion worth of new construction annually. NBS building research continues in the Center for Building Technology, where researchers from three dozen scientific and technical disciplines work together to develop technical information, measurement methods, performance criteria, and improved building practices. Studies during the past year reflect the broad base of CBT concerns, ranging from investigations of lead paint poisoning to new energy standards for buildings.

In FY 76 NBS was asked by the Department of Housing and Urban Development to investigate the existing problems and standards for thermoplastic piping, increasingly used to replace metal in some plumbing applications. After a comprehensive investigation, which included studies on the flammability of thermoplastic piping, NBS researchers concluded that plastic piping for residential plumbing can be an effective substitute for metallic piping. This was a significant finding because of the reduced cost of thermoplastics. However, Bureau scientists noted that when thermoplastics are used, certain precautions must be taken by the building designer, the contractor, and the occupant of the residence to maintain safety. The information from the study is expected to form guidelines for future use of the materials.

In another study related to plumbing, NBS engineers collected technical data on the use of smaller venting in plumbing systems. Smaller venting reduces construction costs because less materials are required. The NBS data will serve as the technical basis for improving standards that will incorporate the use of smaller vents into plumbing codes.

One material that has raised serious safety questions in recent years is lead-based paint. This paint was used extensively in homes before the 1940's and is still present in many homes, especially those located in inner city areas. Under contract to HUD, NBS engineers and scientists are working on identifying the extent of the problem and on evaluating methods for detecting and eliminating lead-based paint.

Investigations for the building and construction industry began at NBS in the 1920's. The studies, which ranged from elevator safety code work to fire-resistance testing of building materials, continue today on new materials resulting from improved technologies. Bradley A. Peavy, Jr., utilizes a variety of sensors to study the thermal performance of a mobile home in NBS' environmental chamber.



)uring the year, NBS archers concluded the t comprehensive survey statistical analysis of the poisoning problem ever ertaken in a major ropolitan area. The study l serious doubt on the -held assumption that poisoning among small ren is mainly caused by hildren eating lead- d paint. In fact, the ey of 4,000 dwellings in ittsburgh area showed rrelation between paint d in homes and lead entration in blood. In- , the study revealed that ren living in the oldest ings, regardless of the of paint used in the ings, had the highest entrations of lead in systems.

e study implies that other factors may con- e to lead poisoning, in- g lead in air, dust, dirt, ater pipes, and even cation of houses near trial plants or vehicular . NBS will continue to with HUD to deter- the importance of these s. In conjunction with dy, NBS developed a manual for use by local officials responsible for performing lead paint surveys.

Another serious safety problem in the home is slippery surfaces. About 8 million Americans slip and fall in their homes each year. Nearly 10,000 die as a result and another 1½ million suffer disabling injuries. A visiting university engineer working at NBS developed a new instrument to test the slipperiness of floor and bathtub surfaces. The new tester is light in weight, compact, easy to operate, and offers several technical improvements over current friction measurement methods. The instrument will be used to help establish standards for slip resistance of surfaces.

The rising costs of single-family houses mean that many more families are turning to mobile homes as an alternative. During the past 5 years, mobile homes have supplied nearly a third of new single-family housing in the United States. Along with the mobile home boom has come concern for their safety and durability. During the year, NBS provided HUD with technical information which was used in the Federal Mobile Home Standard. This standard, which went into effect June 19, 1976, is aimed at making mobile homes safer from fire and more livable, durable, and energy efficient.

Wind is another problem that affects mobile homes, as well as many metropolitan and rural communities that have low-rise, low cost, and often substandard housing. Under the sponsorship of the Agency for International Development, NBS developed improved criteria and design aids for protecting low-rise buildings against wind damage. In addition, an NBS engineer developed a pressure probe useful in carrying out wind-related research on mobile homes and other low-rise structures.

High-rise buildings are also affected by wind. The problem of swaying is particularly noticeable in high-rise buildings constructed after Word War II, because the newer buildings are taller and made with lighter, but stronger, materials. During FY 76 NBS engineers developed a procedure for building designers to use in estimating the effects of wind forces on tall buildings. This will lead to safer building design and increased comfort for occupants. □

"The Bureau is an intensely practical service, bearing directly and daily upon the life of our people. At one end of its work is research into things as yet unknown. At the other end is the putting of things discovered and determined at the service of our people."

DEPARTMENT OF COMMERCE ANNUAL REPORT, 1915

Protecting Public Safety

The Bureau became involved in protecting public safety early in its history. In the autumn of 1904 a fire started on Bureau grounds where several of its buildings were still under construction. A staff member pulled out all the hoses in the buildings to get a line to reach the fire, only to find that the hoses could not be coupled because of the differences in threads.

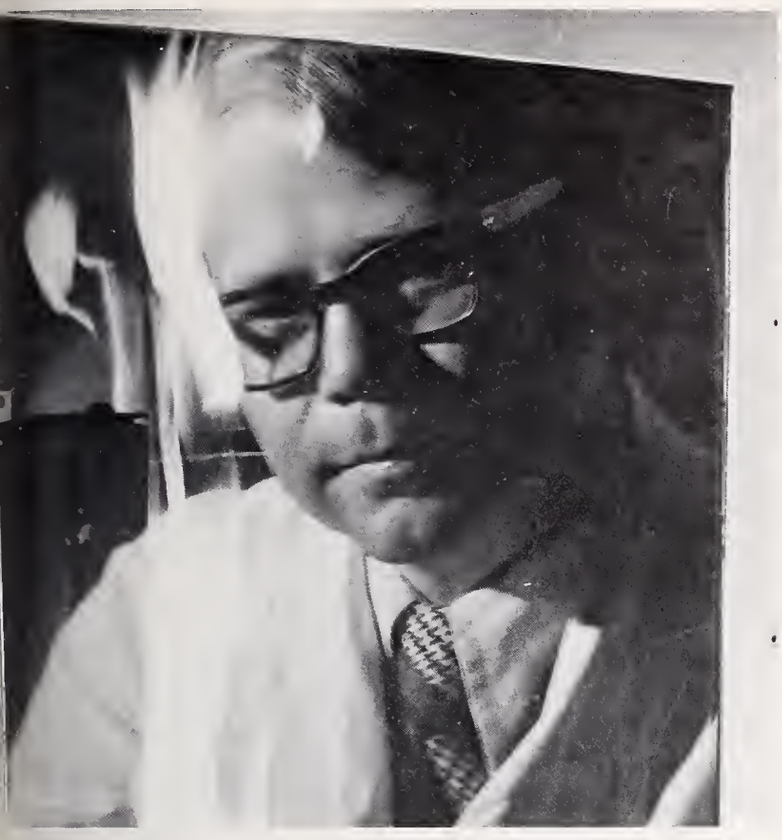
Eventually the fire was put out, but it was a grim reminder that the same lack of interchangeable standard threads had been largely responsible for the widespread destruction of the great Baltimore fire a few months earlier. In that fire, 70 city blocks were destroyed. Engine companies arriving from other cities found themselves unable to help because their hoses would not fit Baltimore hydrants.

Soon afterward, the Bureau became involved with the standardization of fire hose couplings. This marked the first of many NBS projects aimed at protecting public safety. Today, NBS is active in many areas of consumer safety including fire safety and crime prevention.

Despite great technological advances in firefighting in the last three-quarters of a century, fire is still a serious problem in the United States. More than 12,000 Americans are killed in fires every year, and 250,000 are severely burned. Property losses total nearly $3 billion.

The Bureau's Center for Fire Research conducts technical programs to help meet the national goal of reducing fire losses by 50 percent in the next generation. Research ranges from developing flammability standards for products to investigating the chemistry of fire and flame processes.

An analysis of fire data undertaken by NBS and the National Fire Protection Association during FY 76 revealed that fires starting in home furnishings are the major cause of fire deaths. This finding reinforced the need for early warning systems such as smoke detectors in homes. It is estimated that properly installed and



The Bureau became involved in fire-resistance testing early in its history. Shown above is testing performed on automatic sprinkler systems for airplane hangers in the 1930's. At the left, Randall Lawson demonstrates the test used today to evaluate the ease with which materials will ignite.

aintained smoke detectors uld save up to 3,000 lives a ar. During the year, ureau-developed perfor- ance criteria for residential oke detectors were incor- rated into a national stan- rd that permits the devices be evaluated on a common sis. This standard also pro- les a realistic measure of ir performance in actual s.

In addition, NBS studied way in which materials furnishings in a room or lding interact during a , since nearly a third of all deaths occur because the tents of the room—rather n the structure itself— n. The Bureau developed st procedure that ematically evaluates the ards posed by furnishings well as structures. This k will lead to a better un- standing of the role fur- ings play in fires and these hazards can be imized.

ransportation fires are her serious problem. king with the hington Metropolitan sit Authority, NBS tists studied, charac- terized, and pinpointed the fire hazards likely to arise in new urban mass transit vehicles. The research was coordinated with the Department of Transportation's efforts to develop new and improved fire safety standards for mass transit vehicles.

In addition to fire research, the Bureau is working in other areas affecting consumer security—crime prevention and law enforcement. Through its Law Enforcement Standards Laboratory, NBS provides the Justice Department with technical information ranging from standards for procuring sophisticated police equipment to guidelines for protecting homes against break-ins.

During the year, NBS developed a new voluntary door security standard to help thwart crimes of opportunity against homes and small businesses. The standard sets down requirements for door assemblies and entryways that will resist break-ins. An outgrowth of technical work for the standard was a new consumer booklet, *Home Security Starts at Your Door.* The booklet gives homeowners, apartment dwellers, and store owners practical ways to protect their buildings from being burglarized.

In the security area, the Bureau generated six different standards for the various types of sensors used with intrusion alarms in both commercial and residential buildings. The alarms are designed to reduce or avoid some of the multibillion dollar losses from burglaries and similar crimes.

An important part of NBS work is preparing guidelines and standards that will help law enforcement officials buy the best and safest equipment for police officers. Bureau scientists developed a standard setting forth performance and labeling requirements as well as test methods for batteries used by police in radio transmitting and receiving units. In addition, the Bureau developed a standard to insure the reliability of portable X-ray systems used by police in disarming bombs.

Last year the Bureau completed the first study of body measurements of law enforcement officers. The results of this effort will allow suppliers of police equipment to produce properly sized products, from uniforms to firearm trigger guards.

Two new Standard Reference Materials to aid forensic scientists and law enforcement officials in making more accurate analyses of evidence were issued during the year. One SRM will help insure accurate calibration of the instruments used to determine the alcohol content of the blood or breath of persons suspected of drunken driving.
The other SRM will help forensic scientists calibrate equipment used to identify glass fragments submitted as evidence, such as automobile headlight glass. □

"In many of these cases, methods of testing must be perfected, and information regarding these materials is acquired which will prove of great value to the producer and the consumer, thus bringing about better conditions under which such materials are bought and sold."

NBS ANNUAL REPORT, 1902

Improving Product Performance

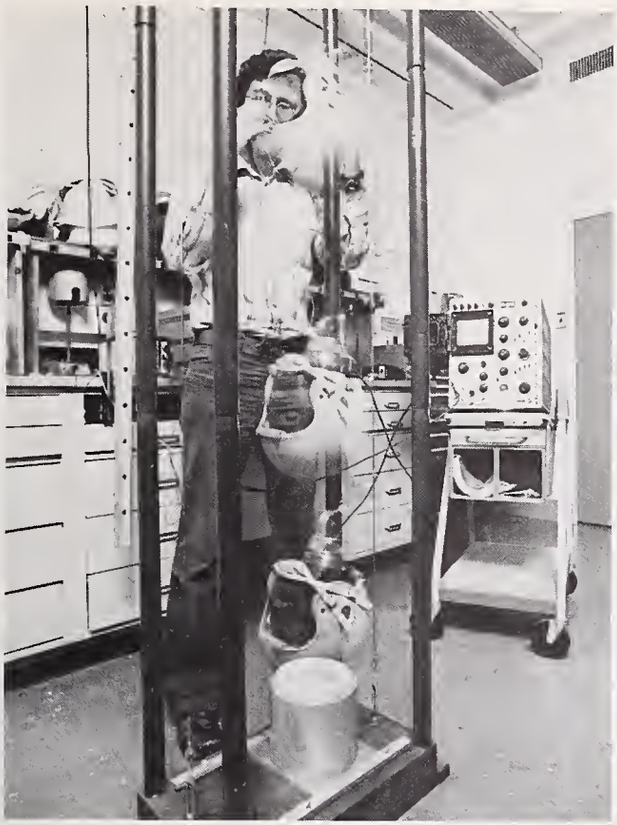
Consumers in the late 1800's, like those today, were confronted with a multitude of products in the marketplace. Unfortunately, consumers did not always get what they expected. One example of outright fraud at the turn of the century was lard oil for cooking that contained a high percentage of paraffin oil. Another example—many soaps were so harsh on clothes, that they were described in Congressional hearings in 1900 as "worse than useless."

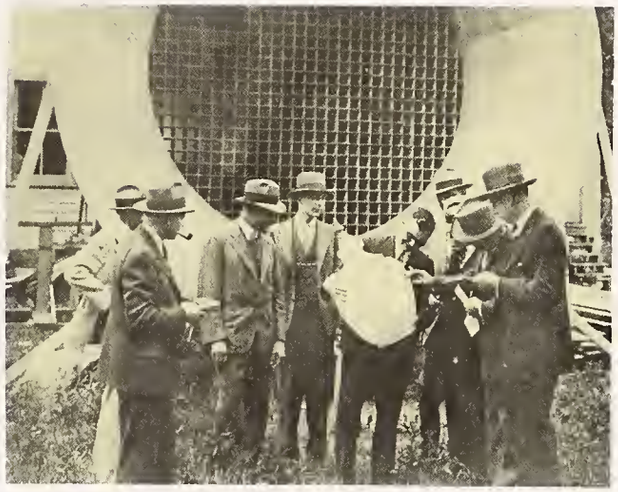
Shortly after NBS was established, the Bureau staff began to work with private standards-making groups, trade associations, technical societies, industry, and consumers to develop the standards needed for producing better products more efficiently.

Drawing on its long experience in testing and measuring qualities of materials, the Bureau today is more than ever concerned with the safety, quality, and reliability of consumer products. NBS supplies the Consumer Product Safety Commission with test methods and data on potentially hazardous products, enabling CPSC to remove such items quickly from the marketplace if necessary. For CPSC the NBS Center for Consumer Product Technology evaluates dozens of products with suspected hazards or safety problems, ranging from fireplace logs to power saws to football helmets.

One of the most significant of these projects dealt with bicycle safety. An estimated 476,000 injuries resulted from bicycle-related accidents in 1975 and about 17 percent of these were due to construction faults in the bicycles. CPSC's new regulations requiring manufacturers to meet strict performance and construction standards in making bicycles will help eliminate these problems. NBS scientists and engineers developed most of the tests that will be used by CPCS to enforce the new regulations.

The Bureau also coordinates the development of voluntary product standards, if specific standards do not already exist in the private





Over the years, NBS has tested and evaluated the performance of hundreds of products. At the upper left, Robert E. Berger operates a drop test mechanism used in a study to develop procedures for testing impact resistance of helmets. In 1928, NBS researchers, above, worked to determine why street light globes were blown away by high winds.

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During FY 76, NBS issued
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ground equipment used by children between the ages of 2 and 10.

Consumers are brought directly into the standards-making process through a nationwide network of 12 Consumer Sounding Boards. Sponsored by NBS and several other organizations, the boards provide standards organizations with direct grassroots opinions of those who use consumer products. During FY 76, consumers and manufacturers held sounding boards to discuss such issues as energy labels on home appliances, safety questions involving ladders, packaging of potentially poisonous products, and care labels in clothes.

In other areas, NBS completed a study for the Federal Trade Commission to assist it in determining what may be reasonably expected of consumers in fulfilling their end of warranty requirements for so-called portable products. If, for example, a consumer is required under the condition of a warranty to return a product for repair and the consumer cannot lift or carry the product, should the product be serviced in the home or picked up by the company for servicing? The study helped FTC define the various factors that influence whether a product is truly portable.

NBS researchers are also developing special techniques to measure the performance of new, more efficient hearing aids as part of a continuing effort to improve medical services to thousands of veterans. Last year, NBS and the University of Maryland tested more than 100 hearing aid models to help the Veterans Administration select quality products.

In addition, the Bureau is carrying out research for the Occupational Safety and Health Administration to determine performance requirements for guardrails, linemen's belts, life lines, lanyards, body harnesses, and other safety devices intended to protect workers in industrial environments. □

"Automated calculating machinery represents one of the important developments of recent years. Such machines handle large amounts of statistical data with revolutionary speed, thoroughness, and efficiency."

NBS ANNUAL REPORT, 1948

Expanding Computer Applications

In 1948 NBS had just launched a new project for the Armed Forces and the Bureau of Census involving the design and construction of an electronic digital computer. A natural outgrowth of the Bureau's World War II work in electronic components, the device was expected to help solve some of the complex computational problems of the military and scientific communities and to handle masses of statistical data faster and more efficiently than conventional means.

Less than 2 years after the Bureau began the project, the National Bureau of Standards Eastern Automatic Computer was dedicated. At that time, SEAC was the fastest general purpose, automatically sequenced electronic computer operating in the United States. Initially the Bureau was envisioned as the central national computer facility for the government. But the idea proved to be short lived because other government agencies needed their own computers. Because of their experience, NBS scientists assisted in the design and operation of the first Federal computers.

Although it was recognized in the 1940's that automatic calculators would have significant impact on the solution of scientific problems, few people realized that computers would one day affect many aspects of daily life. Today, there are hundreds of thousands of computers in operation across the country in such areas as education, health care, retail trade, air traffic control, and national defense. The modern computer operates at speeds thousands of times faster than its early predecessors.

The Bureau's multifaceted computer sciences and technology program provides standards, technical advice, and research aimed at improving the use of computers in the Federal government. With more than 8,600 computers, the government is the largest single user of computers in the world.

Federal computers store enormous amounts of personal data which by law must be protected from unauthorized use. During the year, NBS issued technical guidelines to help Federal agencies implement the Privacy Act of 1974. The Bureau also developed a computerized model for comparing costs of alternative methods used to assure compliance with the Act. With the model, agencies can evaluate the cost of proposed compliance methods before adopting them.

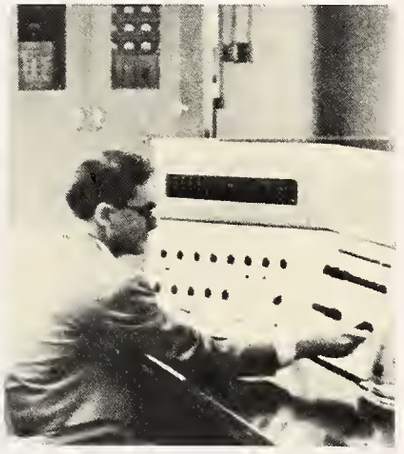
The growing reliance on computers for record-keeping functions has important implications for the privacy of the personal records involved. The Bureau sponsored the first in-depth analysis of privacy practices in one area of record-keeping—health care. This analysis will serve as a model for analyzing privacy issues in other areas, such as personnel and bank records, as well as providing specific recommendations for safeguarding medical records.

The NBS computer standards effort helps overcome the inefficiencies caused by incompatibilities between computer systems and computer-produced information by providing for more effective use of data, software (computer programs), and equipment and for improvements in the quality of computer services.

During the year, NBS added several government-wide automatic data processing standards and guidelines to its Federal Information Processing Standards Publications (FIPS PUB) Series. One of these, FIPS PUB 40, provides help in the efficient design of optical character recognition forms for data entry and for machine processing of data. Another guideline, FIPS PUB 42, assists data processing users in evaluating computer systems for competitive procurement by conducting benchmark mix demonstrations. These demonstrations enable Federal agencies to determine how different computers and/or computer programs would perform in actual situations.

The Bureau also intensified its development of interface standards and began a cooperative program with the General Services

The development of computers is one of the best examples of advancements in technology over the past three decades. At the left, James S. Albus operates a robot manipulator that is controlled by a cerebellar model arithmetic computer. Shown below is the fastest general purpose, automatically sequenced electronic computer in operation in 1950, which was developed at NBS.



Administration to foster interchangeability of computer equipment. In its effort to improve quality and to reduce costs of software, NBS developed testing and evaluation methods for computer programming. In FY 76 a technical assessment was published of low-cost, commercial data base software, which is fast becoming the key component of automated record handling systems.

Like all modern, high-technology systems, computers require measurement and quality control standards to assure reliable operation. During the year, NBS made available to the computer industry a Standard Reference Material for 1/4-inch digital magnetic tape cartridges. This SRM, together with the previously developed SRM's for 1/2-inch computer tape and digital cassettes, will serve to control the quality of magnetic media and effect interchangeability among various data processing systems.

In addition, the Bureau concluded a series of tests to determine the effects of lasers, microwaves, radar, and magnets on data stored on magnetic media. Guidelines are being developed to help Federal agencies provide secure and cost-effective media storage.

NBS also focuses on automatic control of machines in both manufacturing and service tasks. Computer-aided manufacturing in particular offers the opportunity to increase national productivity while decreasing manufacturing costs. In this area, NBS identified and evaluated existing standards for computer-aided manufacturing for the Air Force and recommended areas for future standards development. The project is part of a multi-million dollar effort by the Air Force to advance the state of the art of computer-aided manufacturing.

In addition to this project, NBS scientists continued development of a new memory device that can be used for real time control applications. Called a cerebellar model arithmetic computer, the device was inspired by a model of that part of the brain that controls and coordinates muscular actions such as picking up a drinking glass. The device is currently being tested as a servo-controller for robot manipulation and will be applicable to other areas such as controlling machine tools, aircraft and missile systems, and remote undersea and planetary exploration vehicles.

In the international area, the Bureau represented the United States in computer-related activities of the United Nations and the Organization for Economic Cooperation and Development. Also during the year, Bureau computer scientists visited and were visited by computer interest communities in more than 30 different countries. □

"A most important service which the Bureau renders is in furnishing to the public, to the various industries, and to the government. . .information on subjects within the Bureau's field."

DEPARTMENT OF COMMERCE ANNUAL REPORT, 1914

Providing Information Resources

Since 1901, providing information has been one of the Bureau's most important functions. Through its various services, NBS shares the results of its technical research with many audiences.

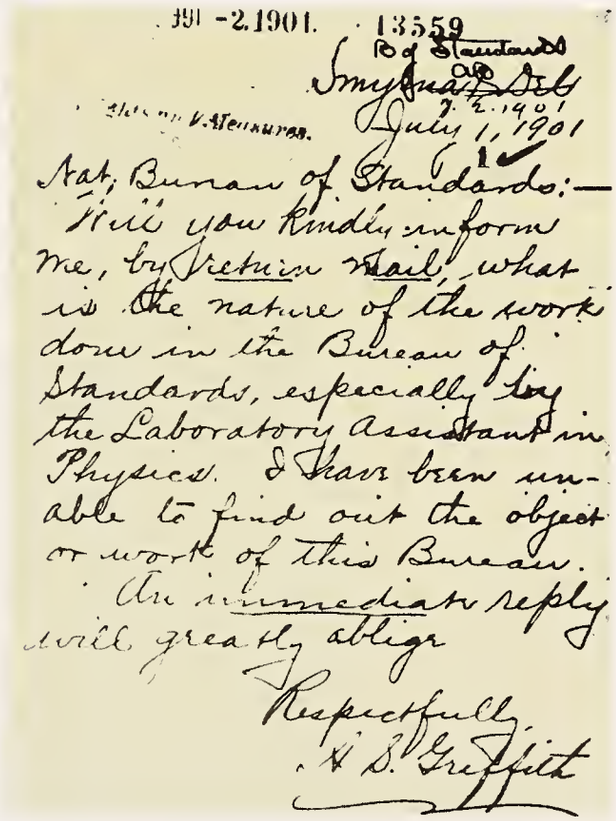
In addition to the many thousands of telephone calls and letters answered by the technical staff each year, NBS also receives thousands of requests for information from the general public. In FY 76 the NBS information and inquiries staff received 31,000 letters and 13,900 telephone calls concerning everything from energy conservation to standard colors.

Inquiries on the metric system of measurement were particularly heavy during the year, stimulated by new legislation establishing a voluntary changeover from the customary system of units to the metric system. More than 70,000 additional requests for information on metric conversion were received and answered. NBS also established a National Metric Speakers Bureau, with more than 125 persons providing metric information to all kinds of organizations. In addition, the Bureau published and distributed widely an educator's guide for teaching metric and a consumer metric information kit.

NBS publications are an important source of information to consumers, industrial organizations, government agencies, universities, and professional associations. Fifteen categories of publications, ranging from the Consumer Information Series to the NBS Journals of Research to technical handbooks and monographs, are issued. Last year, NBS published more than 40,000 pages of research in the open literature.

The Bureau provides an information center on standards, and during the fiscal year, 14,000 standards were added to its data base. This brought the collection to over 240,000 standards published by more than 500 domestic, foreign, and international standards organizations. In FY 76 the Standards Information Service responded to more than 5,700 individual inquiries for information.

Communicating its activities to its publics has been one of NBS' main objectives from the beginning. The Bureau's first letter, shown below, was an early indication of interest in NBS. Today, many thousands of requests for information are answered by NBS staff members each year.



1901 -2.1901. 13559
Bd of Standards
July 1, 1901
Nat. Bureau of Standards:—
Will you kindly inform me, by return mail, what is the nature of the work done in the Bureau of Standards, especially by the Laboratory Assistant in Physics. I have been unable to find out the object or work of this Bureau.
An immediate reply will greatly oblige
Respectfully,
A. S. Griffith

NS also supplied informa- tn and publications to a curinghouse operated by tl National Conference of Se Legislators. This curinghouse provided viable scientific and tech- nal information to state leslative science commit- tc and more than 7,600 leslators.

Another communications tc —videotapes—is used by NS in the field of electronic tcnology. In FY 76 a vi otape on laser scanning o ctive semiconductor d ces was made available o oan without charge to in- ested persons. In the vi otape presentation, the d gn of the scanner is d ribed in detail, and m y of its applications are di layed and discussed.

BS is responsible for intaining the National Standard Reference Data Sem, a nationwide pgram designed to give sc tists and engineers easy ac ss to reliable data. NRDS was established in 19 and now has a network of ore than 40 individual d centers and other pro- je located at NBS and across the country. NSRDS responds to new needs for reliable data that appear each year and disseminates the information to industry, government, and the academic community. In FY 76 NBS and its collaborators compiled critically evaluated data in such areas as energy, the environment, industrial processes, materials utilization, and the physical sciences.

Direct contact with Bureau activities and services is provided through consumer publications, tours, and exhibits. In honor of its 75th anniversary and the Nation's Bicentennial, the Bureau held open houses at its facilities in both Gaithersburg, Maryland, and Boulder, Colorado, attracting more than 50,000 people. In addition, about 4,000 people attended NBS tours, conducted twice weekly and by special request.

NBS conferences are an important means of exchanging information and ideas of mutual concern to beneficiaries of Bureau work. In FY 76 NBS sponsored or cosponsored 112 conferences, with more than 15,000 participants. Exhibits on subjects such as metric and time were displayed at 76 meetings and other events where they were viewed by over 2 million people.

Anyone wishing more detailed information on any aspect of NBS activities is encouraged to contact the Office of Technical Publications, National Bureau of Standards, Washington, D.C. 20234. □

"Obviously, the Bureau of Standards, occupying the position of a court of highest appeal in matters pertaining to weights and measures, must possess material standards as perfect as possible; the methods of measurement employed must be the latest and best; the instruments used must be the most effective that can be bought or built; (and) the laboratory facilities should be complete in all respects. . . ."

NBS ANNUAL REPORT, 1904

Facilities and Funds

To carry out its research and services, NBS operates modern physical plants in two locations. In Gaithersburg, Maryland, located north of Washington, D.C., NBS has 27 buildings in a campus-like setting on 223 hectares (1 hectare equals 2.5 acres). The Bureau has 14 buildings on 83 hectares in Boulder, Colorado. The Joint Institute for Laboratory Astrophysics, cosponsored by NBS and the University of Colorado, is also located in Boulder. Here scientists carry out studies on atomic and molecular physics.

In Ft. Collins, Colorado, NBS radio stations WWV and WWVB broadcast standard time and frequency information. Another station, WWVH, broadcasts from Kauai, Hawaii. The Bureau also has a facility in Clearing, Illinois, with a railway master track scale and two railway test cars that are used to calibrate master track scales owned by railways around the country.

As one of the Nation's largest physical science laboratories, the Bureau houses a number of special facilities and equipment. A high flux nuclear research reactor is used daily by scientists from NBS, other agencies, and universities in projects ranging from nuclear theory to analysis of food contaminants. Another facility, the Synchrotron Ultraviolet Radiation Facility, is one of the few of its kind in North America. Having been converted into a storage ring, SURF is now capable of producing intense short wavelength ultraviolet radiation, which is especially useful for radiometry in studies of controlled nuclear fusion energy sources and atmospheric and space science programs.

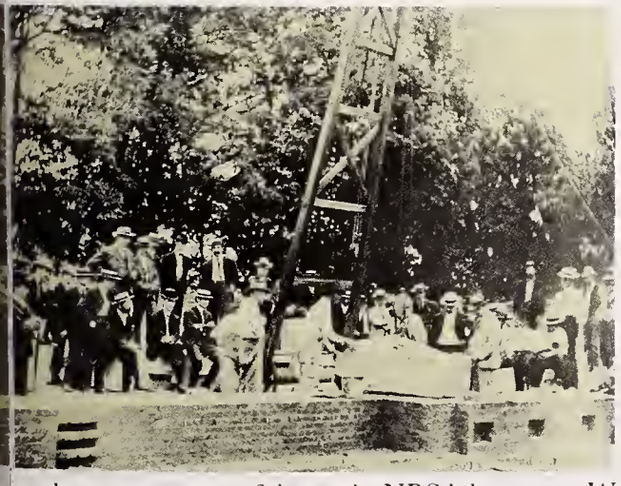
Among other NBS facilities are a cryogenic flow research facility, a fire research laboratory, an experimental computer facility, and anechoic and reverberation chambers. In addition, an extensive instrument shops division answers specialized research needs. Shop capabilities include glassblowing, optics, and metalworking.

Many of the Bureau's facilities are available for u by the scientific and engineering communities. These facilities are descrit more fully in *Special Techn cal Facilities at the National Bureau of Standards.* This 5 page booklet is available from the Superintendent Documents, U.S. Govern ment Printing Office, Washington, D.C. 20402, and may be ordered by SD Catalog No. C13.11:413/1976 Ed., for $1.35.

The Bureau's budget f FY 1976 and the transitio quarter was $142.2 millio Direct Congressional appropriations accounted fo about 56 percent of NBS funds, with an additional percent resulting from wo performed by NBS for oth government agencies. Th sale of NBS goods and se vices, such as calibrations and Standard Reference Materials, provided the fi 6 percent. Support for Bureau programs from ot agencies reflects its role a major physical sciences research laboratory for th entire Federal governmer

S Gaithersburg laboratories.

Boulder laboratories.



ng the cornerstone of the main NBS laboratory, Washington, , in 1903.

TOTAL NBS OPERATING FUNDS (All Sources)

(in millions of dollars)

	Fiscal 1975 (actual)	Fiscal 1976 (actual)	Fiscal TQ (actual)	Fiscal 1977 (est.)
Provide a national system for physical measurement	35.9	39.4	10.0	42.5
Physical measurements, units and standards	25.1	26.7	6.7	28.9
Reference measurements for physical quantities	12.0	12.7	3.3	13.6
Provide services to improve use of materials	25.6	28.3	7.6	30.1
Properties and performance of materials	20.0	21.3	5.8	22.8
Reference materials	2.1	2.5	.6	2.7
Environmental pollution measurements	3.5	4.4	1.2	4.6
Provide services to improve the application of technology	29.6	30.2	7.6	33.2
State weights and measures services	.7	.7	.1	.7
Voluntary engineering standards	1.9	2.0	.8	2.8
Building science and technology	11.0	12.9	3.2	13.5
Electronic technology	3.5	3.8	.9	3.9
Product performance and safety	5.5	6.4	1.5	6.3
Fire Research	5.8	4.5	1.1	6.0
Improve the application of computer technology	9.9	7.7	2.5	8.3
Support services to other agencies	2.8	3.0	.7	3.4
Experimental Technology Incentives Program	2.7	4.9	.3	3.1
TOTAL	106.5	113.5	28.7	120.6

"The nature of the Bureau's work is such that it should command at all times a certain proportion of the best scientific ability, the most skilled workmen, and the most accurate clerical service."

NBS ANNUAL REPORT, 1920

Current staff members turn ou to honor fellow employees receiving awards.

NBS staff members in 1909.

People

Guided by the NBS Executive Board and the Visiting Committee, the Bureau staff works to increase measurement competence and share its scientific and technical expertise with the scientific community, industry, and the public.

The staff has grown from its original 11 in 1901 to about 3100 full-time employees. Approximately 2600 are located in Gaithersburg, Maryland, with the remainder in Boulder, Colorado. More than 1400 Bureau staff members are physical scientists and engineers, and more than 42 percent of the professional staff have earned doctorates. The professional staff, the largest percentage of the NBS staff, is supported by administrative, clerical, housekeeping, and groundskeeping personnel. The staff also includes about 335 technicians.

The NBS Executive Board oversees the efforts of the entire Bureau staff. For advice, the Executive Board turns to the NBS Visiting Committee, created by the Bureau's Organic Act. The Committee is concerned with all aspects of the Bureau, including the scientific well-being of programs and the condition of equipment and facilities. Yearly, the Committee reports its findings to the Secretary of Commerce.

The contributions of NBS employees to the advancement of science and technology are often recognized by outside organizations. During the fiscal year, those staff members honored by independent and professional organizations included:

PAUL REECE ACHENBACH, chief of the Building Environment Division, received the F. Paul Anderson Award for outstanding scientific achievement from the American Society of Heating, Refrigerating, and Air Conditioning Engineers.

JAMES S. ALBUS of the Institute for Computer Sciences and Technology received an IR-100 Award for development of a cerebellar model arithmetic computer as one of the year's most significant new technological products from *Industrial Research* magazine.

DAVID W. ALLAN of the Time and Frequency Division received an IR-100 Award for development of a dual mixer time difference measurement system as one of the year's most significant new technological products from *Industrial Research* magazine.

HAROLD BERGER of the Institute for Materials Research received the Tutorial Award of the American Society for Nondestructive Testing for his contribution since 1969 as editor of *Materials Evaluation*.

PHILIP E. BLOOMFIELD and SEYMOUR EDELMAN of the Polymers Division were each awarded the 1976 Army Research and Development Achievement Award for developing a piezoelectric polymer device used in artillery shells.

FREDERIC CLARKE of the Center for Fire Research was selected as a Congressional Fellow by the American Political Science Association.

JTH M. DAVIS, director the Institute for Computer iences and Technology, as elected to membership the National Academy of ngineering and as chair- an of the Electric Power search Institute Advisory ouncil.

AYNE HANSON of the me and Frequency Ser- es Section received the 75 Carlton Award for the st technical paper from the rospace and Electronic stems Society of the In- ute of Electrical and ectronic Engineers.

HN L. HALL and MES J. SNYDER of the nt Institute for Laboratory trophysics received an -100 Award for develop- nt of a laser intensity bilizer as one of the year's st significant new tech- logical products from *In- trial Research* magazine.

ARK HAMILTON, RDON DAY, ROBERT ELAN, and JON GEIST he Institute for Basic ndards received an -100 Award for develop- nt of an electrically cali- ted pyroelectric iometer as one of the r's most significant new hnological products from *dustrial Research* magazine.

HN HASTIE of the In- anic Chemistry Section honored by the Mary- d Academy of Sciences as of five distinguished ng scientists in Maryland 1975.

ANS V. HAYWARD of Center for Radiation earch was one of six men honored by the Civil ice Commission for out- ding contributions to the iency and quality of the eral career service.

LMUT HELLWIG of Time and Frequency ision received an IR-100 rd for development of a able rubidium clock as of the year's most signifi- new technological pro- s from *Industrial Research* azine.

FRANCIS L. HERMACH of the Electricity Division received the 1976 Morris E. Leeds Award for outstanding contributions to the field of electrical measurements from the Institute of Electrical and Electronic Engineers.

JAMES HILL and TAMAMI KUSUDA of the Thermal Engineering Section received the Crosby Field Award from the American Society of Heating, Refrigerating, and Air Conditioning Engineers for the best technical paper in 1975.

DAVID HOGBEN of the Applied Mathematics Division was elected a Fellow of the American Statistical Association for his contributions to statistical computing systems.

EMANUEL HOROWITZ, deputy director of the Institute for Materials Research, was elected to Honorary Membership in the American Society for Testing and Materials for his contributions to standards development in textiles, plastics, and surgical implants.

MADELEINE JACOBS of the Office of Information Activities received second place from the National Association of Government Communicators for authoring a public service announcement on an NBS energy conservation booklet.

CHARLES JOHNSON of the Applied Mathematics Division was honored by the Washington Academy of Sciences for outstanding scientific achievement in the mathematical sciences in 1975-76.

TAMAMI KUSUDA of the Thermal Engineering Section received the Distinguished Service Award and was elected a Fellow by the American Society of Heating, Refrigerating, and Air Conditioning Engineers for his research on energy conservation.

MELVIN MEYERSON, chief of the Product Systems Analysis Division, was elected a Fellow in the Standards Engineers Society for unusual professional distinction in the field of standardization.

CEDRIC POWELL of the Optical Physics Division was elected a Fellow of the Institute of Physics (United Kingdom).

JACOB RABINOW of the Institute for Applied Technology was elected to membership in the National Academy of Engineering.

HAROLD J. RAVECHE of the Heat Division was honored by the Maryland Academy of Sciences as one of five distinguished young scientists in Maryland for 1975.

ROBERT ROSENTHAL of the Computer Networking Section was honored by the American Federation of Information Processing Societies for the outstanding review paper presented at the 1976 National Computer Conference.

ROBERT J. RUBIN of the Institute for Materials Research was elected President of the Philosophical Society of Washington.

DAVID E. SAWYER and DAVID W. BERNING of the Institute for Applied Technology received an IR-100 Award for development of a laser-flying spot scanner as one of the year's most significant new technological products from *Industrial Research* magazine.

HARRY A. SCHAFFT and FRANK F. OETTINGER of the Electronic Technology Division were honored for their outstanding contributions to the electronic industry by the Electronic Industries Association.

JOHN B. WACHTMAN, JR., chief of the Inorganic Materials Division, was elected to membership in the National Academy of Engineering.

NBS EXECUTIVE BOARD

Dr. Ernest Ambler
Acting Director

Robert S. Walleigh
Acting Deputy Director

Dr. Arthur O. McCoubrey
Director, Institute for Basic Standards

Dr. John D. Hoffman
Director, Institute for Materials Research

Dr. James R. Wright
Acting Director, Institute for Applied Technology

Dr. Ruth M. Davis
Director, Institute for Computer Sciences and Technology

Dr. Howard E. Sorrows
Associate Director for Programs

Richard P. Bartlett, Jr.
Associate Director for Administration

Dr. Edward L. Brady
Associate Director for Information Programs

NBS VISITING COMMITTEE

Dr. John G. Truxal*
Chairman July 1, 1975 - June 30, 1976
Dean, College of Engineering
State University of New York at Stony Brook

Mr. Charles E. Peck
Chairman July 1, 1976 - June 30, 1977
Vice President
Construction Group
Owens-Corning Fiberglas Corporation

Dr. Edwin A. Gee
Senior Vice President E. I. du Pont de Nemours and Company

Dr. Robert H. Dicke
Department of Physics
Princeton University

Dr. W. Dale Compton
Vice President, Research
Ford Motor Company

Mr. William D. Carey+
Executive Officer
American Association for the Advancement of Science □

*Dr. Truxal's term expired June 30, 1976.
+Mr. Carey was appointed for the term July 1, 1976 - June 30, 1981.

Directory

The NBS staff is organized into four major institutes. They are the Institutes for Basic Standards, Materials Research, Applied Technology, and Computer Sciences and Technology. The institutes are supported by the Office of the Associate Director for Administration, the Office of the Associate Director for Programs, and the Office of the Associate Director for Information Programs.

This amalgam of people and programs forms a community dedicated to service. The interdisciplinary approach allows NBS to provide the Nation with scientific measurements of high precision and accuracy, coupled with actual solutions for current technological problems.

This annual report has only highlighted some of the Bureau's programs. For more information on specific projects contact the people listed in this directory. To reach members of the Gaithersburg, Md., staff, dial (301) 921 + extension or write to the National Bureau of Standards, Washington, D.C. 20234. Bureau staff located in Boulder, Colo., can be contacted on (303) 499-1000 or at the National Bureau of Standards, Boulder, Colo. 80302. Boulder staff members are designated in the directory with asterisks.

Office of the Director

Ernest Ambler, Acting Director (2411)
Robert S. Walleigh, Acting Deputy Director (2451)
Allen J. Farrar, Legal Adviser (2425)
George A. Sinnott, Assistant to the Director for Congressional Affairs (2441)
Jordan D. Lewis, Director, Office of Experimental Technology Incentives Program (3185)

Institute for Basic Standards

The Institute for Basic Standards provides the central base within the United States for a complete and consistent system of physical measurements and coordinates that system with measurement systems of other nations. It furnishes the research and essential services leading to accurate and uniform physical measurement and reliable data throughout the Nation's scientific, industrial, and commercial communities. IBS also operates the Boulder Laboratories and cosponsors the Joint Institute for Laboratory Astrophysics with the University of Colorado.

Arthur O. McCoubrey, Director, Institute for Basic Standards (3301)
David T. Goldman, Deputy Director, Institute for Basic Standards and Manager of Acoustics and Noise Program (3304)
H. Thomas Yolken, Program Manager, Nuclear Safeguards Measurements (3747)
Chester Page, Coordinator, International Standardization Activities (3526)
Joseph M. Cameron, Chief, Office of Measurement Services (2805)
Burton H. Colvin, Chief, Applied Mathematics Division (2541)
Barry N. Taylor, Chief, Electricity Division (2701)
John A. Simpson, Acting Chief, Mechanics Division (2171)
Ralph P. Hudson, Chief, Heat Division (2034)
Karl G. Kessler, Chief, Optical Physics Division (2001)
James E. Leiss, Director, Center for Radiation Research (2551)
Bascom W. Birmingham, Deputy Director, Institute for Basic Standards (3237)*
Robert Harrington, Program Coordinator (3239)*
Raymond C. Sangster, Program Manager, Strategic Planning (4329)*
Stephen J. Smith, Associate Director for Research Coordination (3546)*
Gordon H. Dunn, Acting Chief, Laboratory Astrophysics Division (3527)*
Jesse Hord, Acting Chief, Cryogenics Division (4108)*
Harold S. Boyne, Chief, Electromagnetics Division (4343)*
James A. Barnes, Chief, Time and Frequency Division (3294)*

Institute for Materials Research

The Institute for Materials Research conducts research provide a better understand of the basic properties of ma and materials and develops standards for measuring the properties to help insure the proper utilization by the Na tion's scientific, industrial, a commercial communities. I also develops, produces, an distributes Standard Refere Materials which provide th basis for calibration of instr ments and equipment, facil comparison of measureme on materials, and aid in the trol of production processe industry.

John D. Hoffman, Director, Institute for Materials Research (2828)
Emanual Horowitz, Deput Director, Institute for Materials Research (28
Harold Berger, Manager, N destructive Evaluation Program (3331)
Donald G. Fletcher, Mana Fibrous Systems Progra (3668)
William H. Kirchhoff, Act Chief, Office of Air and Water Measurement (3
J. Paul Cali, Chief, Office Standard Reference Materials (3479)
Philip D. LaFleur, Chief, Analytical Chemistry Division (2851)
Ronald K. Eby, Chief, Polymers Division (373
A. William Ruff, Acting C Metallurgy Division (2
John B. Wachtman, Jr., C Inorganic Materials Di (2891)
John J. Rush, Acting Chie Reactor Radiation Divi (2421)
Milton D. Scheer, Chief, cal Chemistry Division (2713)

itute for Applied Technology

e Institute for Applied Tech-logy (IAT) is concerned with development and applica-n of science and technology he solution of such societal oblems as building perform-ce, fire safety, consumer pro-ct performance and safety, ergy conservation, and the iability of electronic compo-nts. IAT is also responsible the Department of Com-rce's Voluntary Product ndards and National Volun-y Laboratory Accreditation ograms, for assisting in main-ning uniform weights and asures regulations and pro-lures in the 50 states, and for viding a library of national l international standards.

nes R. Wright, Acting Direc-tor, Institute for Applied Technology (3574)
orge Suzuki, Acting Deputy Director, Institute for Ap-plied Technology (3434)
k E. Snell, Manager, Energy Conservation Programs 3235)
orge P. Lewett, Chief, Office of Energy-Related Inven-ions (3694)
ne A. Rowland, Chief, Stan-dards Application and Analysis Division (3731)
son C. French, Chief, Electronic Technology Divi-ion (3357)
nley I. Warshaw, Director, Center for Consumer Pro-duct Technology (3751)
vin R. Meyerson, Chief, Product Systems Analysis Division (2907)
drew J. Fowell, Chief, Pro-uct Engineering Division 3311)
hard N. Wright, Director, Center for Building Tech-ology (3377)
ard O. Pfrang, Chief, tructures, Materials, and afety Division (2196)
eece Achenbach, Chief, uilding Environment Divi-on (3637)
er Driscoll, Chief, Technical Evaluation and pplication Division (3704)
es G. Gross, Chief, Office of uilding Standards and odes Services (3447)
y E. Thompson, Acting hief, Office of Housing and uilding Technology (3233)
W. Lyons, Director, enter for Fire Research 3143)
ert S. Levine, Chief, Fire cience Division (3845)
n A. Benjamin, Chief, Fire afety Engineering Division 3255)

Institute for Computer Sciences and Technology

The Institute for Computer Sciences and Technology is the scientific and technical arm of the Federal government's automatic data processing management system. In this role, ICST provides advisory services to Federal agencies to support the formulation of automatic data processing management and procurement policies and to assist individual agencies in solving specific automation problems. ICST also develops Federal Information Processing Standards and conducts research in computer science and technology.

Ruth M. Davis, Director, Institute for Computer Sciences and Technology (3151)
M. Zane Thornton, Deputy Director, Institute for Computer Sciences and Technology (3155)
Edwin J. Istvan, Associate Director, Telecommunications Technology (3553)
Joseph H. Wegstein, Manager, Pattern Recognition and Description Program (3438)
John M. Evans, Acting Chief, Office of Developmental Automation and Control Technology (2381)
Harry S. White, Jr., Chief, Office of ADP Standards Management (3157)
W. Bruce Ramsey, Chief, Computer Services Division (3424)
Seymour Jeffery, Chief, Systems and Software Division (3531)
Thomas N. Pyke, Jr., Chief, Computer Systems Engineering Division (3436)
Edwin J. Istvan, Acting Chief, Information Technology Division (3553)

Office of the Associate Director for Programs

The Office of the Associate Director for Programs plans, develops, and evaluates Bureau-level programs and policy as well as providing guidance for Bureau-wide planning and programming. In addition, the office recommends priorities and alternatives at the Bureau level for resource allocation, staffs Bureau-level programmatic matters, and monitors NBS management by objectives.

Howard E. Sorrows, Associate Director (2446)
Stanley D. Rasberry, MBO, Executive Assistant (3671)
Raymond G. Kammer, Jr., Senior Analyst (3130)
Howard E. Morgan, Economist (3135)
Wayne A. Cassatt, Energy Coordinator (3132)
Robb Thomson, Assistant for Scientific Affairs (3814)
Peter R. DeBruyn, Industrial Liaison (3591)
John D. McKinley, Scientific Assistant (3196)
James M. Wyckoff, State and Local Government Liaison (3814)
Elaine Bunten, Visiting Committee/Evaluation Panel Liaison(3591)

Office of the Associate Director for Administration

The Office of the Associate Director for Administration provides support services such as procurement and personnel consultation to the Bureau staff.

Richard P. Bartlett, Jr., Associate Director (2477)
Larry D. Stout, Chief, Accounting Division (2507)
Karl E. Bell, Chief, Administrative Services Division (3444)
Raymond G. Kammer, Acting Chief, Budget Division (2544)
Mati Tammaru, Chief, Personnel Division (3555)
John N. Brewer, Chief, Plant Division (2825)
Norman H. Taylor, Chief, Supply Division (2525)
John T. Hall, Chief, Management and Organization Division (3567)
John L. Pararas, Chief, Instrument Shops Division (2436)

Office of the Associate Director for Information Programs

The Office of the Associate Director for Information Programs promotes the optimum dissemination and accessibility of all scientific and technical information to the staff, sponsors, customers, and interested publics of NBS. It also administers the Standard Reference Data System, which provides critically evaluated data in the physical sciences to the Nation's scientists and engineers, and conducts the NBS publication program. In addition, ADIP fosters and coordinates the NBS liaison for international standards-writing organizations and assists the Department of Commerce and U.S. industry in assuring adequate U.S. representation in the development of international standards.

Edward L. Brady, Associate Director (3641)
Samuel E. Chappell, Programs Coordinator (3641)
David R. Lide, Jr., Chief, Office of Standard Reference Data (2467)
Robert T. Cook, Acting Chief, Office of Information Activities (3181)
W. Reeves Tilley, Chief, Office of Technical Publications (2493)
Patricia W. Berger, Chief, Library Division (3405)
William E. Andrus, Jr., Chief, Office of International Standards (3662)
H. Steffen Peiser, Chief, Office of International Relations (2463)

Selected Publications

During fiscal year 1976 and the transition quarter ending September 30, 1976, more than 1,200 papers appeared in NBS publications and journals. The following is a selected list of publications issued during this period. Unless otherwise stated, all publications are available at the price indicated from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402. For a complete list of NBS publications, write for *Publications of the National Bureau of Standards*, NBS Special Publication 305, Supplement 7, $7.55.

Increasing Measurement Capabilities

Apparatus for Testing Oceanographic Resistance Thermometers, George T. Furukawa and John L. Riddle, SD Catalog No. C13.46:894, $1.60.

The National Measurement System for Time and Frequency, Allan S. Risley, SD Catalog No. C13.10:445-1, $1.20.

Self-Study Manual on Optical Radiation Measurement, Fred E. Nicodemus, SD Catalog No. C13.46:910-1, $2.10.

Transferring Research and Technology

A Measurement Assurance Program for Electric Energy, N. Michael Oldham, SD Catalog No. C13.46:930, 55 cents.

Catalog of NBS Standard Reference Materials, SD Catalog No. C13.10:260-1975-76, $1.50.

Productivity Measurement in R&D, John T. Hall and Roger A. Dixon, SD Catalog No. C13.46:890, $1.10.

Promoting Better Materials Use

The Destructive Pull Test, John Albers, SD Catalog No. C13.10:400-18, $1.25.

Proceedings of a Workshop on Secondary Ion Mass Spectrometry and Ion Microprobe Mass Analysis, Kurt F. J. Heinrich and Dale E. Newbury, SD Catalog No. C13.10:427, $3.00.

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