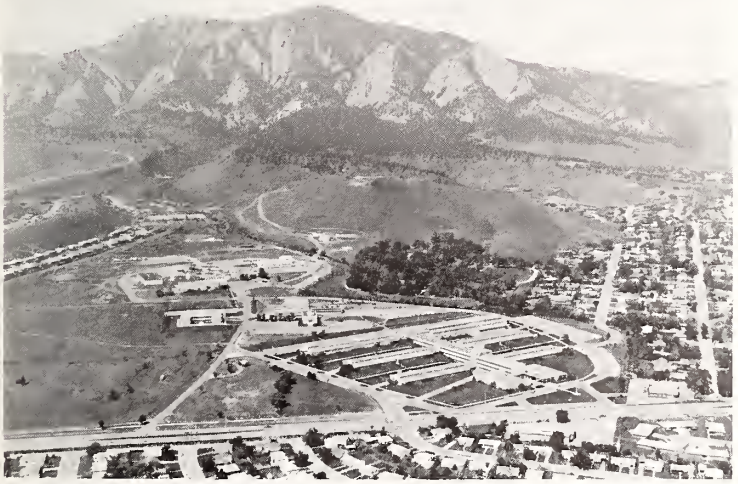
Facilities

of the National Bureau of Standards

U.S. DEPARTMENT OF COMMERCE
National Bureau of Standards

Contents

NBS Gaithersburg Laboratories



NBS Boulder Laboratories

Foreword

Every laboratory in this country is a valuable national resource. Along with the people who work in these facilities, U.S. laboratories constitute the basic foundation of this country's scientific and industrial strength.

As the nation's foremost science and engineering measurement laboratory, the National Bureau of Standards has some of the premier research and testing facilities in the United States, and several of our laboratories are unequaled anywhere in the world. Bureau scientists and engineers use these special facilities to pursue the measurement-related work that U.S. science and industry need to grow and prosper.

Many of the facilities are available for use by the scientific and engineering communities either on a cooperative or independent basis. NBS has a long history of cooperative work in these laboratories with researchers from industry, government, and academia. For example, our Research Associate Program, established in the 1920's, has provided the opportunity for numerous collaborative projects over the years. Through this program, research associates have their salaries paid by the sponsoring organizations while NBS contributes its expertise and permits researchers to use the Bureau's facilities and equipment.

Now, recognizing the strong challenges from abroad and the need for U.S. researchers to pool their resources, we have decided to make selected NBS facilities available to U.S. researchers for proprietary work on a cost-recovery basis, when equal or superior facilities are not otherwise readily available. We hope this new policy will increase the transfer of technology to industry and encourage commercially important research that otherwise might not be done.

This brochure highlights only a small number of the special facilities available at NBS and provides information about their availability for collaborative or independent research and testing. Individuals or organizations wishing to use a facility should contact the facility manager listed in each write-up. NBS has designed its system for reviewing such requests to be as efficient and responsive as possible, to encourage maximum use and minimal paperwork on the part of both NBS and the prospective user.

We encourage you to take advantage of the nation's investment in NBS.

Ernest Ambler
Director

NBS Research Reactor

The National Bureau of Standards research reactor is a national center for the application of reactor radiation to a variety of problems of national concern. Major program areas at the reactor include the application of neutron scattering methods to research in materials science, trace analysis by neutron activation, nondestructive evaluation (via neutron radiography and scattering), neutron standards and dosimetry, and isotope production and radiation effects.

Capabilities:

The NBS reactor is an enriched uranium, heavy-water moderated reactor operating at 20 MW and producing a peak thermal core flux of 4×10^{14} neutrons/$cm^2 \cdot s$. A large cold neutron source is under development which will increase the flux of long wavelength (> 1 nm) neutrons by an order of magnitude.

Experimental facilities are available for neutron single-crystal and powder diffraction and inelastic scattering studies, small-angle neutron scattering (SANS), sample preparation, irradiation and post-irradiation processing, neutron depth profiling, neutron dosimetry, and related physics.

Applications:

Elastic Scattering—Atomic-scale phase structure in catalysts, electronic and dielectric ceramics, semiconductors, and biomaterials, for example. Submicron structure studies including molecular conformations in block copolymers, characterization of microcracks and porosity damage in ceramics, creep cavitation in metal alloys, and characterization of precipitate distributions in high-strength, low-alloy steels. Phase transition kinetic studies in alloys. Atomic-level magnetic structure and behavior in crystalline and amorphous materials.

Inelastic Scattering—Lattice dynamics and vibrational spectroscopy studies of hydrogen in metals at low concentrations, vibrational spectra of molecules adsorbed in heterogeneous catalysts, diffusion processes for small molecules in solids, magnetic properties.

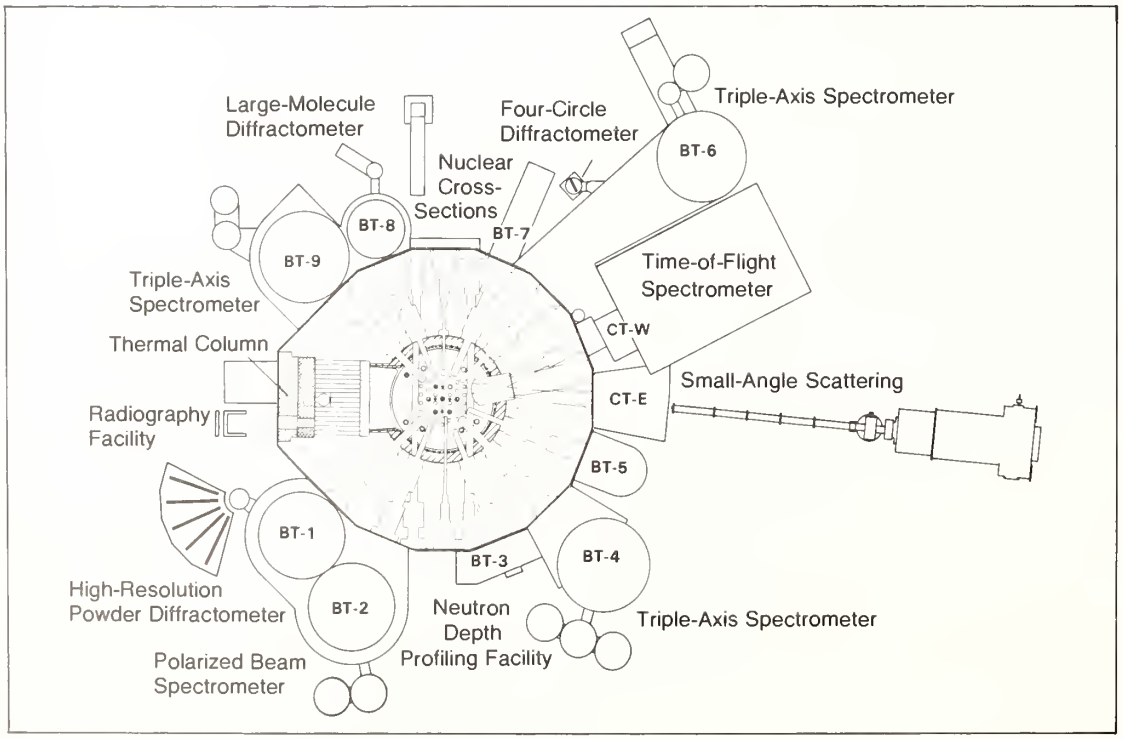
Element Analysis—Neutron activation analysis method development; applications to studies in environmental chemistry, nutrition, biomedicine, and energy systems. Neutron capture prompt gamma activation analysis method development.

Availability:

There are 25 experimental facilities at the reactor providing roughly 125,000 instrument hours per year to approximately 200 users. The users of the facilities represent 18 NBS divisions and offices, 18 other federal agencies, and approximately 35 university and industrial laboratories. Collaborative programs are arranged through the NBS Reactor Radiation Division or other NBS groups using the facility. Proposals for collaborative or independent use of the facility are reviewed by a committee which examines the merit and conditions of each application.

Contact:

Dr. Robert S. Carter, Reactor Radiation Division, Room A106 Reactor Building, National Bureau of Standards, Gaithersburg, MD 20899. Telephone: 301/921-2421.



Experimental Facilities and Research Areas at the NBS Reactor

Neutron Depth Profiling Facility

Neutron Depth Profiling Facility

The neutron depth profiling (NDP) facility at the National Bureau of Standards uses a neutron beam for nondestructive evaluation of elemental depth distributions in materials. Working with the Bureau's 20 MW nuclear reactor, researchers use the technique to provide concentration profiles for characterizing the near-surface regime of semiconductors, metals, metallic glasses, and other glasses to depths of several micrometers. The facility uses filters and collimators to create a high-quality neutron beam with good thermal neutron intensity and minimum contamination with fast neutrons and gamma rays. An aluminum target chamber is used to contain the samples in a vacuum, and a full array of electronic components is available for data acquisition and analysis.

Capabilities:

With the clean thermal neutron beam created by the reactor, depth profiling can be carried out with sensitivities approaching 10^{13} atoms/cm^2 . The method is not destructive to the sample and produces negligible radioactivation and energy deposition in the sample. A single analysis produces a profile typically 5 to 20 μm deep with a resolution of $\sim$30 nm, which is limited at present by the energy resolution of the surface barrier detector used. Once calibrated with the appropriate elemental standard, the concentration scale is fixed independently of the sample composition. The depth scale is monotonically related to the energy scale by means of the charged particle stopping power. Elements that do not produce charged particles under thermal neutron irradiation contribute no interference.

Applications:

Some of the many applications of NDP include range measurements for boron implanted in silicon; observations on near-surface boron in glass; boron concentration profiles in thin layers of borophosphosilicate glass; measurement of helium release in single-crystal nickel to investigate the He-trapping phenomena; and measurement of high-dose nitrogen implants in steels.

Availability:

The facility is available to qualified researchers on an independent or collaborative basis with NBS staff.

Contact:

Dr. Ronald F. Fleming, Inorganic Analytical Research Division, Room B108 Reactor Building, National Bureau of Standards, Gaithersburg, MD 20899. Telephone: 301/921-2166.

High-Resolution Neutron Powder Diffractometer

The high-resolution neutron powder diffractometer at the National Bureau of Standards research reactor, with five detectors for simultaneous collection of data from different parts of the diffraction pattern, is used widely for studies of the structures of many important crystalline materials that are not available as large single crystals. Accurate structural information can be obtained at temperatures from 4 to 1200 K, which is often the key to understanding the properties of technologically important materials, including catalysts, magnetic materials, high-temperature alloys, minerals and ceramics, and ionic conductors.

Capabilities:

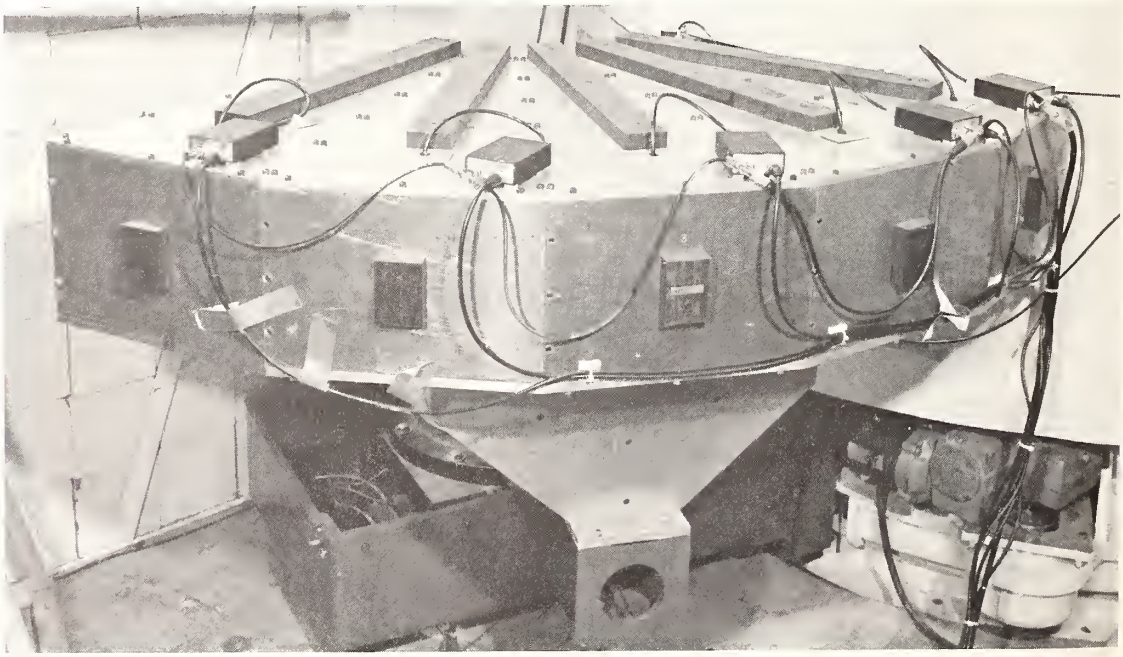
The NBS powder diffractometer system is designed to be "user-friendly" and highly flexible. For example, a variety of programs are available and documented, which allow the use of constrained refinement procedures to make use of known structural information on atomic or molecular units of the material being examined, along with advanced procedures for background, lineshape, and absorption corrections. Structural information can be analyzed at the NBS reactor using a high-speed, high-capacity superminicomputer or can be provided in convenient form on a floppy disk to be analyzed back at the user's own laboratory. A sophisticated technicolor graphics system is also available, with appropriate software to allow two- or three-dimensional displays of materials crystal structures, including stereographic projections.

Availability:

This facility is available for use by industry, academia, and government on either a collaborative or independent basis under the supervision of the NBS Reactor Radiation Division staff. The NBS powder diffractometer system is heavily utilized. Projects are scheduled on a regular basis by a committee of NBS staff.

Contact:

Dr. Edward Prince, Reactor Radiation Division, Room A106 Reactor Building, National Bureau of Standards, Gaithersburg, MD 20899. Telephone: 301/921-3634.



High-Resolution Neutron Powder Diffractometer

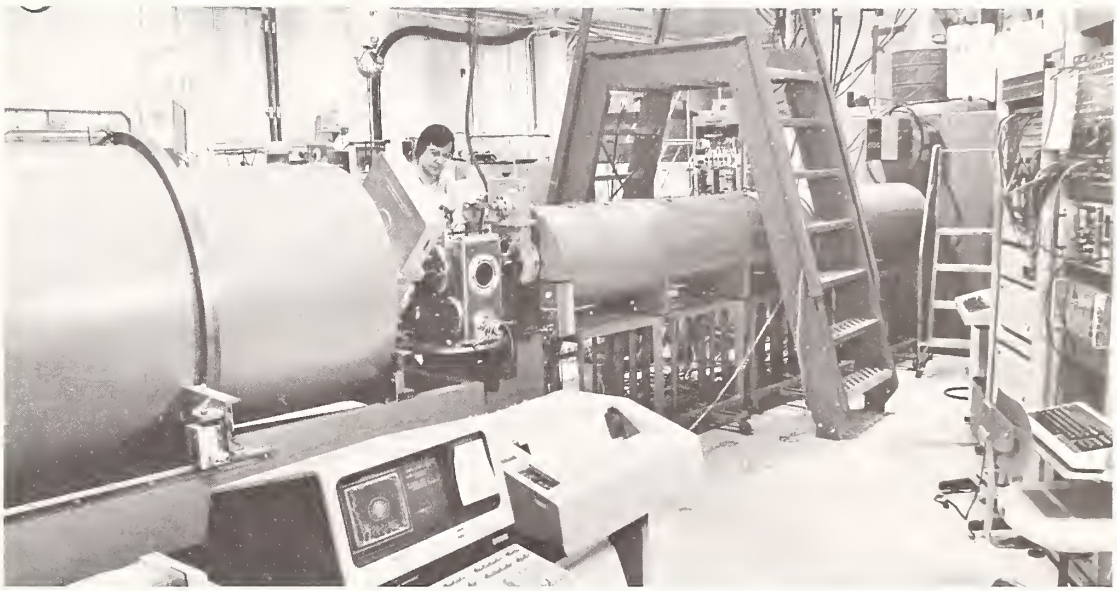
Small-Angle Neutron Scattering Facility

Small-angle neutron scattering (SANS) is a technique in which a highly collimated beam of low-energy (long wavelength) neutrons is used to probe the structure of materials on a size scale from roughly 1 to 100 nm. The small-angle diffraction patterns produced by structural features in this size regime—for example, by small precipitates or cavities in metal alloys, by micropores or cracks in ceramics, or by polymers or biological macromolecules—can be analyzed to yield important information about the size and shape of the scattering centers as well as their size distribution, surface area, and number density. In contrast to a complementary technique such as electron microscopy, a relatively large volume (up to about 1 cc) of material is examined in a SANS measurement. As a result, the information obtained represents statistical averages which are characteristic of the bulk material and which are related to bulk properties.

Capabilities:

The SANS spectrometer at the National Bureau of Standards reactor utilizes a variable speed velocity selector to provide a beam whose wavelength is continuously tunable from 0.5 to 1.2 nm. Several choices of pinhole beam collimation are available, including a unique converging beam system which provides the instrument's best angular resolution (1.6 milliradians). Apparatus is available for maintaining samples at temperatures from 4 to 700 K and in magnetic fields up to 15 kilogauss.

For measurements at near ambient temperatures (0 to 80 °C), a multispecimen sample stage is used to change samples automatically under computer control. The neutron detector is a large (65 by 65 cm^2), two-dimensional, position-sensitive proportional counter which, in most cases, enables an entire scattering pattern to be recorded in a single measurement. The detector can, however, be rotated about the sample position to measure scattering at larger angles when necessary. An interactive color graphics terminal is used for imaging and analyzing completed data sets. Computer software is available for many forms of routine data analysis and model fitting.



Small-Angle Neutron Scattering Facility

Applications:

SANS is becoming an increasingly important tool in materials science and is used, for example, to study the kinetics and morphology of precipitate growth in high-strength alloys, to measure molecular conformation of polymers and biological macromolecular complexes, to detect and quantify early stage creep and fatigue damage in metals and ceramics, and to study the magnetic microstructure of new crystalline and amorphous magnetic materials. In many of these applications, especially those involving polymers, biology, and magnetism, the structural information provided by SANS cannot be obtained by any other technique.

Availability:

The SANS facility is heavily utilized by NBS staff and others in industry, universities, and government. Proposals for collaborative or independent use of the facility are reviewed by a SANS scheduling committee, which examines the merit and conditions of each application.

Contact:

Dr. Charles J. Glinka, Reactor Radiation Division, Room B106 Reactor Building, National Bureau of Standards, Gaithersburg, MD 20899. Telephone: 301/921-3634.

140 MeV Electron Linear Accelerator

The National Bureau of Standards operates an electron linear accelerator (LINAC) which can produce beams in excess of 50 kW and be used with high-quality beam control. This facility provides the capability for conducting precision research with high-energy beams of electrons, photons, and neutrons and for developing measurement standards for these types of radiation. This nine-section, L-Band, traveling-wave LINAC and its beam transport system provide a wide variety of beam conditions to satisfy user needs. The electron beam can be directed to either of two heavily-shielded underground target rooms or to an above-ground target room where secondary neutron beams are produced for time-of-flight measurements at distances up to 200 m.

Capabilities:

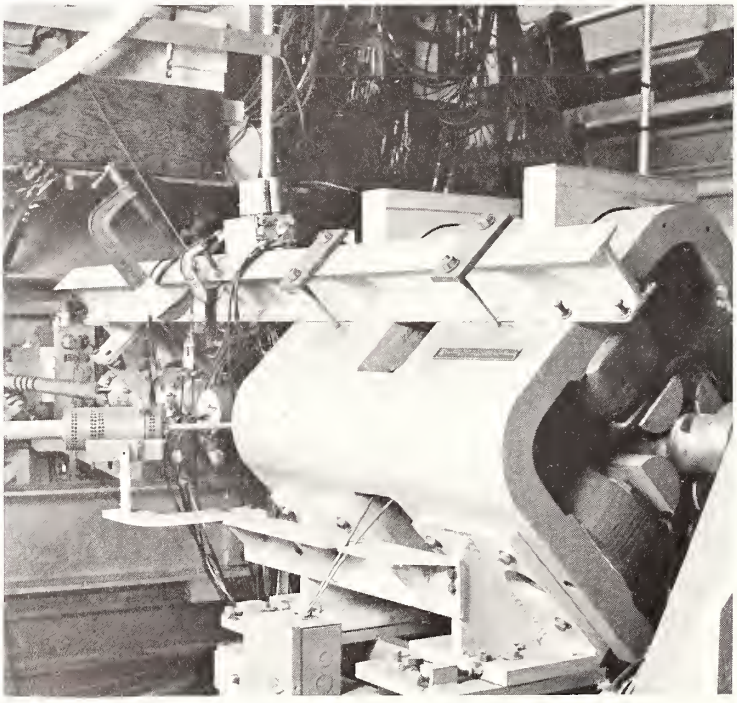
The LINAC operates at energies between 14 and 140 MeV, peak current up to several amperes, and average current up to 200 μA. Beam pulse length is variable from 5 ns to 5 μs, at pulse repetition rates up to 720/s. The time-of-flight facility includes flight paths of 5, 20, 60, and 200 m. Neutron production targets provide 10^{13} n/sec (4π) at energy ranges of thermal to 1 KeV, 1 KeV to 5 MeV, and 100 KeV to 15 MeV. Automated data processing equipment is available for rapid collection and analysis of data from state-of-the-art one- and two-dimensional neutron detectors. A high-resolution electron spectrometer and a photonuclear activation irradiation station are available in the target rooms.

Applications:

The LINAC is used in a broad range of programs in physical research and standards development. Examples of the wide variety of experimentation performed include: activation analysis with photon-induced reactions, preparation of Mossbauer sources, preparation of neutron-deficient radioactive isotopes, neutron cross-section measurement by time-of-flight including both total and reaction cross sections, and resonance neutron radiography.

Also, research is conducted in electron-volt neutron scattering, nuclear structure studies by means of photonuclear reactions and electron scattering, studies of the measurement of high-power electron beams with non-intercepting beam monitors, absolute methods of high-power electron-beam current measurement, accelerator research, and medical dosimetry for high-energy radiation therapy.

These facilities are used to produce neutron data and standards for neutron personnel dosimetry, for applied nuclear technology, and for producing neutron radiography measurement methods and standards used to measure concentrations of specific elemental isotopes in various materials found in reactor construction materials and to test welds for the presence of elements not detectable by x rays. Two-dimensional detectors and rotating target techniques have been developed and used with these facilities to provide the capability of three-dimensional analysis (i.e., neutron tomography).



Measuring Room at the Linear Accelerator

Availability:

The LINAC and associated experimental areas are available without charge for collaborative research by NBS and outside scientists in areas of mutual interest and benefit. In special cases, independent research of benefit primarily to an outside user can be performed with this facility on a time-available, cost-recovery basis. Current plans call for the LINAC and its associated research facilities to be available in the present configuration until July 1986. At that time the LINAC will be shut down for modification and dedication strictly to neutron research and standards development. Electron and photon research and standards work will be transferred to the new 185 MeV continuous-wave, microtron-type electron accelerator. The modified LINAC and the microtron should be available for research and standards development in early or mid-1987.

Contact:

Dr. Sam Penner, Radiation Source and Instrumentation Division, Room B102 Radiation Physics Building, National Bureau of Standards, Gaithersburg, MD 20899. Telephone: 301/921-2503.

Synchrotron Ultraviolet Radiation Facility-II

The Synchrotron Ultraviolet Radiation Facility-II (SURF-II) is a 280 MeV electron storage ring at the National Bureau of Standards that radiates synchrotron radiation which is highly collimated, nearly linearly polarized, and of calculable intensity. Six beam lines are available, and a user's program is in operation. SURF-II is well-suited for studies in: atomic, molecular, biomolecular, and solid state physics; surface and materials science; electro-optics; and chemistry and radiation effects on matter.

Capabilities:

The typical storage ring electron beam current is 50 mA at 280 MeV. The photon intensity in the region 60 to 120 nm is about 11×10^{11} photons per second per milliradian of orbit for an instrumental resolution of 0.1 nm. Experiments can be made conveniently throughout the wavelength range 4 to 1000 nm, from the soft x-ray region to the infrared. A grazing incidence and several toroidal grating monochromators are available to disperse the radiation. A large, ultra-high vacuum spectrometer calibration chamber, 1.2 m by 1.2 m by 2.5 m, is available for radiometric applications. A 6.65-m, normal-incidence vacuum spectrometer, with resolving power of about 300,000, is available on a beam line dedicated to high-resolution vacuum ultraviolet radiation research.

Applications:

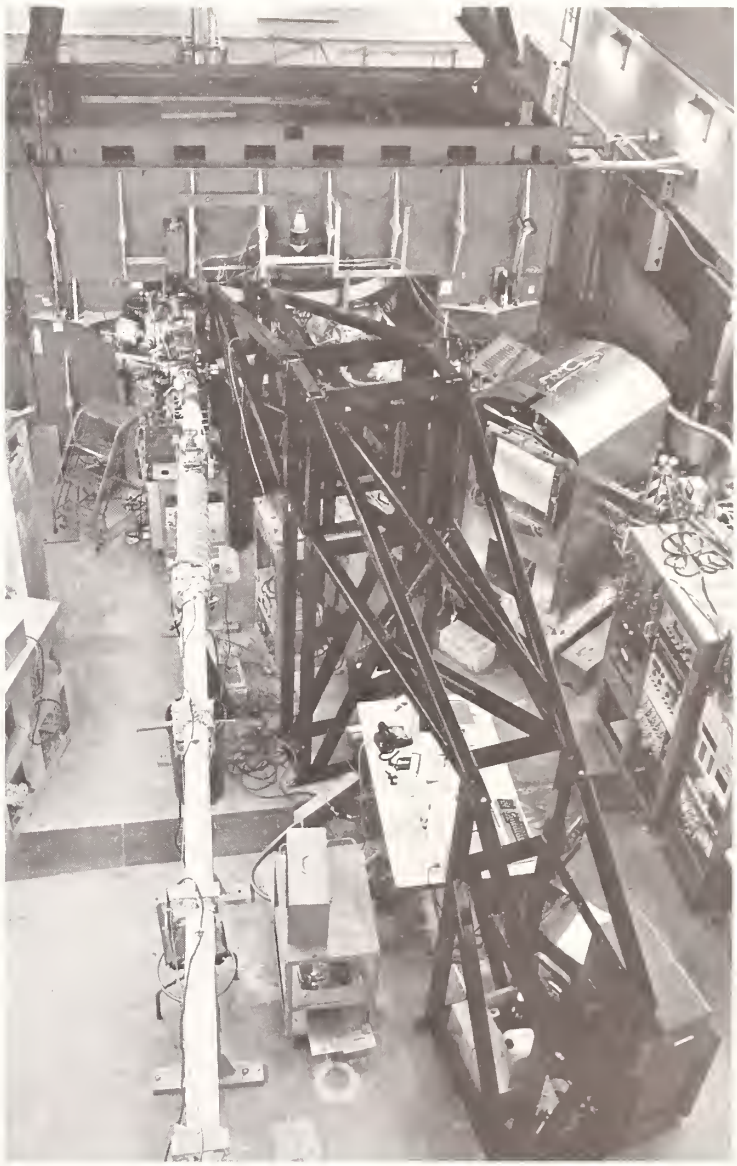
The continuous radiation from SURF-II is used as a national standard of spectral irradiance for radiometric applications and for fundamental research in: 1) atomic and molecular absorption spectroscopy; 2) optical properties of materials; 3) electron density of states in solids; 4) surface characterization; 5) photoelectron spectroscopy; 6) molecular kinetics and excitation and ionization dynamics; and 7) radiation interactions with matter (e.g., lithography, radiation damage, dosimetry, photobiology).

Availability:

Beam time on SURF-II is available to any qualified scientist provided beam line vacuum requirements are met and scheduling arrangements can be made. Proposals should be submitted for NBS review at least 2 months before use of the facility is desired. Informal contact is also encouraged.

Contact:

Dr. Robert P. Madden, Radiation Physics Division, Room A251 Physics Building, National Bureau of Standards, Gaithersburg, MD 20899. Telephone: 301/921-2031.



Synchrotron Ultraviolet Radiation Facility-II

Metals Processing Laboratory

The metals processing laboratory at the National Bureau of Standards contains special facilities for the production of rapidly solidified alloys, including equipment for inert gas atomization and electrohydrodynamic atomization to produce rapidly solidified alloy powders, melt-spinning to produce rapidly solidified alloy ribbons, and electron beam and laser surface melting to produce rapidly solidified surface layers. Hot isostatic pressing equipment is available for consolidation of the alloy powders. A plasma-transferred arc system is used to study alloy coating processes.

Capabilities:

Inert Gas Atomization—The inert gas atomization system can be used to produce up to 25 kg of rapidly solidified alloy powder per batch while maintaining an inert environment throughout the atomizing and powder handling process. High-pressure inert gas (Ar, He, or Ar-He mixtures) impinging on a liquid metal stream breaks up the liquid into small droplets which rapidly solidify. Cooling rates are up to 10^5 K/s. The atomized powder, entrained in the inert gas flow, is collected in removable, vacuum-tight canisters.

Electrohydrodynamic Atomization—In the electrohydrodynamic atomization system, a liquid metal stream is injected into a strong electric field. The field causes the stream to disintegrate into droplets which rapidly solidify to produce extremely fine (< 1 μm diameter) alloy powder. Powder produced by this process is well-suited for studying solidification dynamics. As the system is presently configured, small quantities for microscopic examination can be produced from alloys with melting points up to 900 °C.

Melt Spinning—Melt spinning techniques can be used to produce rapidly solidified alloys in ribbon form. Because of the high cooling rates (up to 10^6 K/s) with this method, amorphous alloys as well as crystalline alloys can be produced. Ribbons up to 3 mm wide and up to 0.05 mm thick can be produced in quantities of several grams per batch. Materials with a wide range of melting points, from aluminum alloys to superalloys, have been produced.

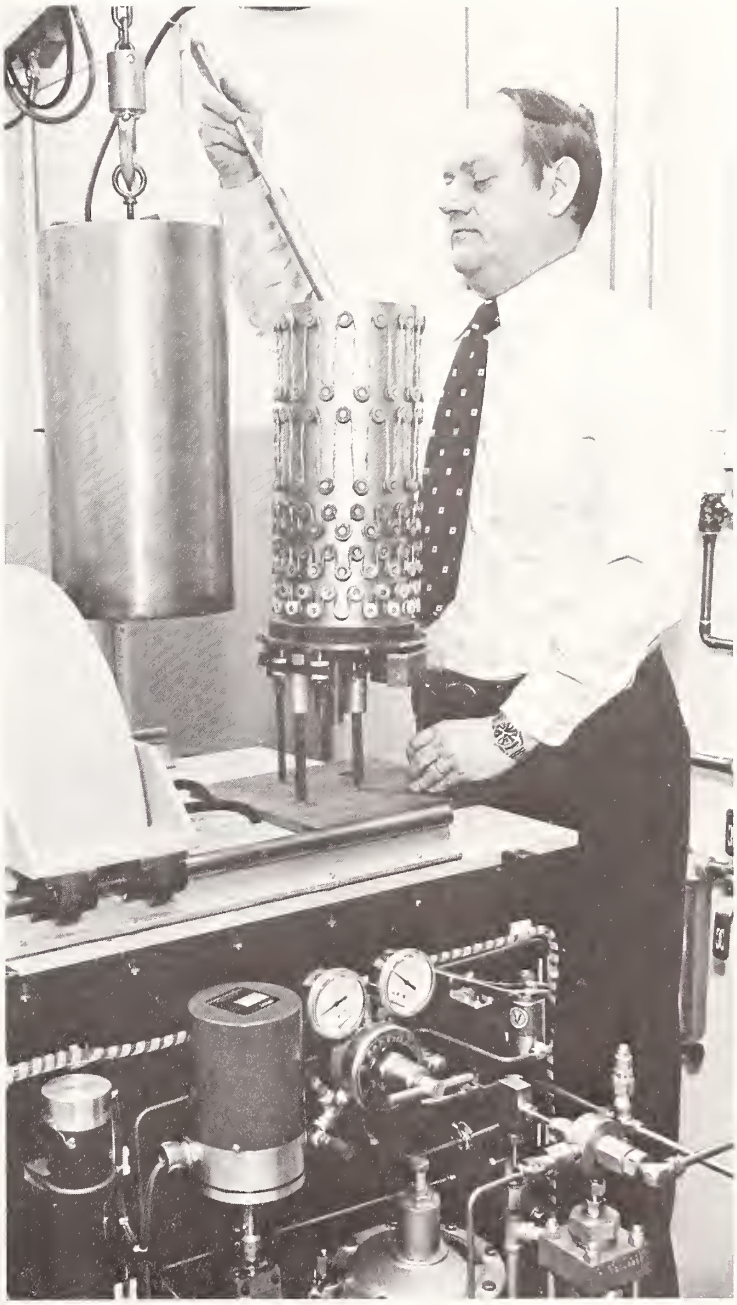
Electron-Beam and Laser Surface Melting—An electron-beam system which provides

Electrohydrodynamic Atomization Chamber in the Metals Processing Laboratory

surface melting and subsequent rapid resolidification of surface layers can be operated in either a pulsed or continuous mode. The electron beam can be focused to a spot less than 1 mm in diameter and deflected at frequencies up to 5 kHz. A pulsed neodymium-glass laser complements the electron-beam unit in producing these surface-modified layers. The laser produces pulses with energies up to 200 J with pulse width variable from 0.1 to 7 ms.

Hot Isostatic Press—A hot isostatic press (HIP) with microprocessor control of the temperature-pressure-time cycle is available for consolidation of powder or compacted powder shapes. The HIP has a cylindrical working volume 15 cm in diameter and 30 cm high. The maximum working pressure is 207 MPa. The molybdenum furnace has a maximum heating rate of 35 K/min and is capable of maintaining 1500 °C.

Plasma-Transferred Arc Coating System—The plasma-transferred arc equipment is capable of feeding independently one or two different types of powder deposits and automatically coating a surface area up to 2 in wide by 5 ft long in a single pass. This system is also capable of providing deposits under conditions of constant deposition power, while the relative heating of the substrate and deposit may be independently controlled.



Hot Isostatic Press in the Metals Processing Laboratory

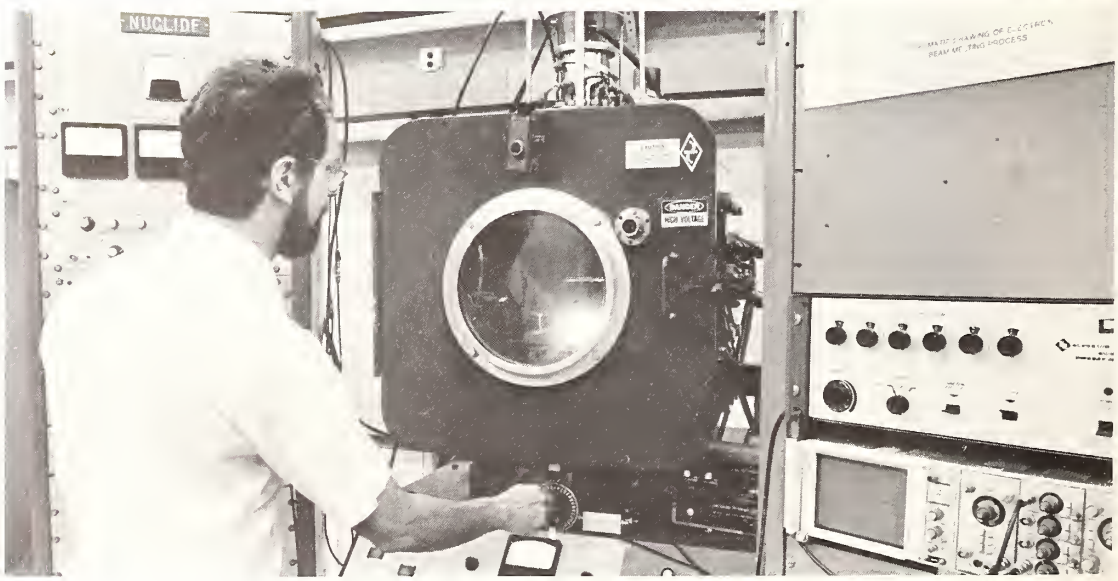
Availability:

These facilities are designed to produce alloy research samples which are difficult otherwise for users to obtain. Typically, industrial companies or universities send workers to NBS to participate in preparing alloys of special industrial and scientific interest for further analyses in their home laboratories and to collaborate with NBS scientists in investigations of generic relationships between processing conditions and resulting alloy microstructures and properties.

Contact:

Dr. John R. Manning, Metallurgy Division, Room A153 Materials Building, National Bureau of Standards, Gaithersburg, MD 20899.
Telephone: 301/921-3354.

Melt Spinning Apparatus in the Metals Processing Laboratory



Electron-Beam Surface Melting Apparatus in the Metals Processing Laboratory

Toxic Chemicals Handling Laboratory

Toxic Chemicals Handling Laboratory

The toxic chemicals handling laboratory at the National Bureau of Standards is used to store, handle, and analyze organic compounds that are extremely toxic and/or possess undesirable biological activity.

The laboratory was designed through the joint efforts of scientists from the NBS Center for Analytical Chemistry and a private architectural and engineering firm. Its features offer special protection for those using the laboratory. The facility was specially designed and is used to allow scientists to perform research that involves the characterization or analysis of toxic or mutagenic organic materials in a safe manner. The laboratory is equipped with facilities for weighing, sample storage, sample preparation (extractions, etc.), and gas and liquid chromatographic analyses.

Capabilities:

Laboratory Work Space—The laboratory has approximately 10 m of bench space for sample preparation and analytical activities. The air throughout the working area in the laboratory is recirculated at a rate of 225 m^3/min (~8000 ft^3/min) through charcoal filters to remove organic fumes and HEPA filters to remove particulate material. The air flow is directed so that scientists using the facility are continuously bathed with clean air. The air supply to the laboratory is ~11 m^3/min less than the exhaust, thereby preventing diffusion of possibly toxic vapors from the facility into the hall and adjacent laboratories.

Cabinet Space—The laboratory has 5 m^2 of actively vented cabinet space for storage of toxic chemicals. Air flowing from the storage areas is charcoal filtered and totally exhausted to the outside.

Safety Hoods—The laboratory is equipped with two air barrier fume hoods for manipulations of pure chemicals (including weighing) or concentrated solutions. All air entering the hoods is exhausted to the outside after charcoal filtration.

Other—The laboratory also has shower facilities.

Availability:

The laboratory and its facilities can be shared with qualified staff from NBS, other government agencies, universities, and industry. Since space is limited, preference will be given to NBS users and to projects that are related to NBS interests. Due to the toxic nature of the chemicals involved in various experiments and stored in the facility, all projects will be monitored by NBS personnel.

Contact:

Dr. Willie E. May, Organic Analytical Research Division, Room A113 Chemistry Building, National Bureau of Standards, Gaithersburg, MD 20899. Telephone: 301/921-3778.

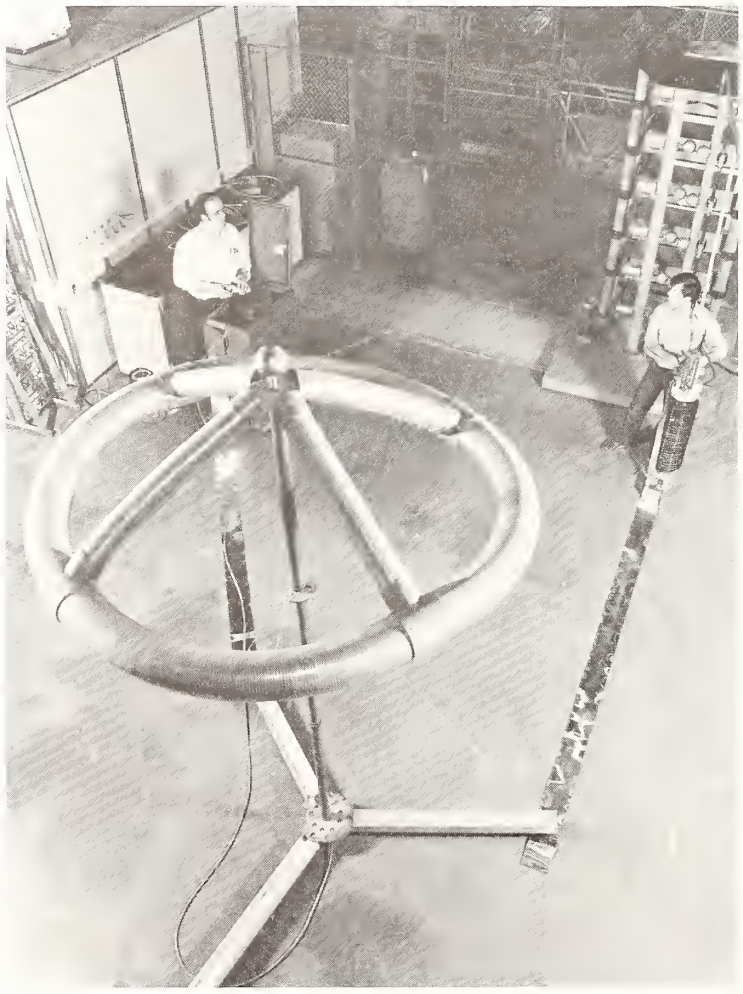
High-Voltage Measurement Facility

The National Bureau of Standards maintains a high-voltage measurement facility in which it develops and evaluates the measurement techniques needed in the orderly delivery of electric power for defense and to support industrial and university research. The major programs now being pursued using this facility are the measurement of transient voltages and currents, the development of techniques to quantify pre-breakdown and breakdown phenomena in liquid and gaseous dielectrics, and the measurement of low-frequency electric and magnetic fields.

Capabilities:

With existing power sources, direct voltages of 300 kV, 60 Hz alternating voltages of 175 kV, and standard lightning impulses of 500 kV can be produced. Selected waveforms, such as microsecond duration trapezoidal waveforms up to 300 kV and gated 60 Hz waveforms up to 100 kV, are also available. Supporting equipment includes high-voltage standard capacitors rated at 200 kV; high-accuracy, current-comparator bridges for 60 Hz measurements; a precision dc divider rated at 200 kV; dividers to measure standard lightning impulses up to 1 MV peak; partial discharge measurement systems; high-speed cameras and supporting optical equipment; a computer-controlled system to measure the electric field in transformer oil; a mass-chromatograph/mass-spectrometer system; a low-speed wind tunnel; and a system to produce a known electric field and current density in air at atmospheric pressure.

The experimental capability is presently being expanded. For example, a 400 kA source of pulsed currents on millisecond to second time scales is scheduled for installation during 1984. A calibration system for instruments used to measure transient voltages and currents on nanosecond time scales also is being developed.



High-Voltage Measurement Facility

Applications:

Instrumentation and Component Evaluation—Impulse, ac, and dc dividers; electric and magnetic field meters; capacitors; transformers; lightning arresters; and ion counters.

Dielectrics Research and Development—Chemical degradation studies; measurement of the fundamental processes of discharge initiation; onset and magnitude of partial discharges; space charge measurement; streamer propagation studies.

Availability:

The high-voltage facility is used by staff from the NBS Electrosystems Division and by guest workers from industry, universities, and other federal agencies. Use of the facilities must be scheduled in advance. Because of the complexity of the system, it is anticipated that typical use of the facility will be in the form of a collaborative investigation with staff from the Electrosystems Division.

Contact:

Dr. Robert E. Hebner, Electrosystems Division, Room B344 Metrology Building, National Bureau of Standards, Gaithersburg, MD 20899. Telephone: 301/921-3121.

Transverse Electromagnetic (TEM) Cells

The National Bureau of Standards has designed and constructed several transverse electromagnetic (TEM) cells that are available for use. A TEM cell is a device for performing radiated electromagnetic emission and susceptibility measurements of electronic equipment. It is designed based on the concept of an expanded transmission line operated in a TEM mode. The cell is a two-conductor system with the region between the inner and outer conductors used as the test zone. The tapered sections at both ends are required to match the cell to standard 50 Ω coaxial-cable connectors.

Capabilities:

The cell provides a shielded environment for testing without introducing multiple reflections experienced with the conventional shielded enclosure. It simulates very closely a planar far field in free space and has constant amplitude and linear phase characteristics. The external electromagnetic signals will not affect the measurement of low-level radiated emission from the device under test. The high-level test field generated inside a cell for radiated susceptibility tests will not interfere with external electronic systems.

Applications:

In addition to radiated electromagnetic compatibility/interference (EMC/EMI) testing, other applications of the TEM cells include the calibration of antennas and the study of biological effects of radio-frequency radiation.

Limitations:

The usable frequency range is limited by an upper bound determined by the appearance of the lowest high-order mode. The volume available for testing purposes is inversely proportional to this upper frequency limit. The size of the device to be placed inside a TEM cell for testing should be small relative to the available test volume in order that the field structure associated with the ideal TEM mode existing in an empty cell not be significantly perturbed.

Availability:

Several TEM cells with five different sizes and five upper frequency limits in the range 100 MHz to 1 GHz are available. In collaborative programs, NBS staff are available to advise and interpret measurement results. Independent testing also can be arranged through the Electromagnetic Fields Division.

Contact:

Dr. Mark T. Ma, Electromagnetic Fields Division, Room 4073 Radio Building, National Bureau of Standards, Boulder, CO 80303. Telephone: 303/497-3800.

Electromagnetic Anechoic Chamber

The electromagnetic (EM) anechoic chamber at the National Bureau of Standards is a facility for generating standard (known) electromagnetic fields. Such fields are fundamental to the research, development, and evaluation of antennas, field probes, and EM material properties.

Capabilities:

EM fields up to 100 V/m can be established in the chamber over the broad frequency range from 200 MHz to 18 GHz, and up to 200 V/m for certain frequency bands above 1 GHz. A majority of the individual systems which comprise the measurement system are under computer control, thus enhancing statistical control of the measurements. Work is underway to extend the frequency range to 40 GHz and to improve the computer control of the chamber systems. The chamber dimensions are 8.5 m, 6.7 m, and 4.9 m in length, width, and height, respectively.

Applications:

- □ Research, development, and evaluation of new EM field generation and measurement methods
- □ Antenna and field probe development and evaluation
- □ Calibration of field measurement instruments
- □ Susceptibility testing of electronic equipment
- □ Shielding effectiveness and material parameter studies
- □ Special tests for government agencies, industry, and universities

Availability:

This facility is used heavily in performing calibrations for industry and other government agencies. The facilities are available for independent or collaborative work with NBS.

Contact:

Dr. Norris S. Nahman, Electromagnetic Fields Division, Room 4643 Radio Building, National Bureau of Standards, Boulder, CO 80303.
Telephone: 303/497-5167.

Ground Screen Antenna Range

The ground screen antenna range is an open area test site located at the National Bureau of Standards. The range is completely enclosed by an air-inflated, synthetic fabric structure which allows use of the facility on a year-round basis. The air-supported structure provides an unobstructed span of the entire range with no metal parts above the level of the ground plane.

Capabilities:

The ground screen consists of 1/4-in mesh galvanized hardware cloth stretched over a level concrete slab. The screen is 30.5 m wide by 61 m long and is spring-loaded around the perimeter to ensure uniform tension, a flat surface, and adequate compensation for thermal expansion. Antenna masts up to 9 m in height can be erected within the structure. The overall size of the ground screen permits far-field measurements in the HF portion of the spectrum while the mesh dimension provides for an efficient ground plane well into the UHF region.

Applications:

- □ Antenna calibrations
- □ Antenna patterns at any polarization
- □ Electromagnetic susceptibility measurements
- □ Electromagnetic radiated emission measurements
- □ Calibration of field intensity meters
- □ Wave propagation studies in frequency or time domains

Availability:

This facility is used heavily in performing calibrations for industry and other government agencies. The facilities are available for independent or collaborative work with NBS.

Contact:

Dr. Norris S. Nahman, Electromagnetic Fields Division, Room 4643 Radio Building, National Bureau of Standards, Boulder, CO 80303.
Telephone: 303/497-5167.

Ground Screen Antenna Range

Near-Field Scanning Facility for Antenna Measurements

Capabilities:

This automated facility is designed to measure the near-zone phase and amplitude distributions of the fields radiated from an antenna under test. Mathematical transformations are then employed to calculate the desired antenna characteristics. Near-field data can be obtained over planar, cylindrical, and spherical surfaces, with the planar technique being the most popular. Efficient computer programs are available for processing the large quantities of data required.

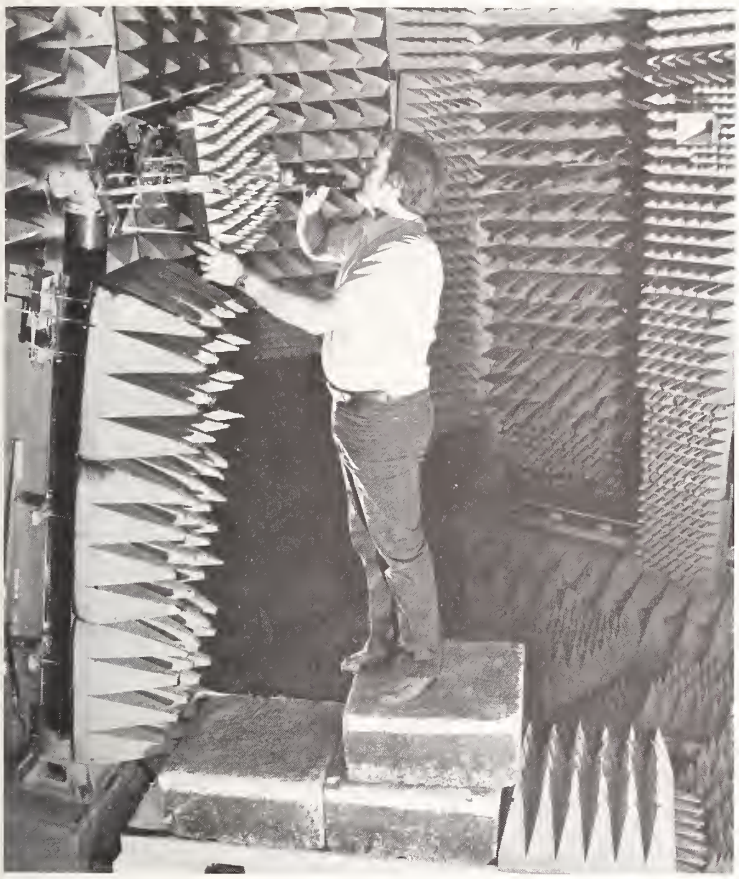
When operated in the planar mode, the facility is capable of measuring over a 4.5-m by 4.5-m area with probe position errors of less than $\pm$0.01 cm. Improved position accuracy is possible with further alignment, especially over smaller areas. Antennas with apertures up to about 3 m in diameter can be measured with a single scan and the facility has been used successfully over the frequency range 750 MHz to 75 GHz. By early 1985 the facility will be enlarged so that larger antennas can be measured by scanning in segments.

Applications:

Antenna Characteristics—The facility is used primarily for determining the gain, pattern, and polarization of antennas. Accuracies are typically $\pm$0.15 dB for absolute gain and $\pm$0.10 dB/dB for polarization axial ratio. Patterns can be obtained down to the $-$50 to $-$60 dB levels with side lobe accuracy typically about $\pm$1.0 dB at the $-$40 dB level. (The exact uncertainties depend on the frequency, type, and size of antenna, etc.) The near-field data can also be used to compute near-field interactions (e.g., mutual coupling) of antennas and radiated field distributions in the near zone.

Antenna Diagnostics—Near-field scanning is also a valuable tool for identifying problems and for achieving optimum performance of various types of antenna systems. It has, for example, been used to advantage in locating faulty elements in phased array antennas and for adjusting feed systems to obtain the proper illumination function at the main reflector. Phase contour plots of the near-field data can also be used to determine surface imperfections in reflectors used for antennas or compact ranges.

Probe Calibrations—The facility also is used as a far-field range for measuring the receiving characteristics of probes used to obtain near-field data. These measurements are required to determine the probe coefficients which, in turn, are



Near-Field Scanning Facility

used to calculate accurate probe-corrected far-field gain and pattern characteristics of an antenna.

Availability:

Two kinds of arrangements can be made to use this facility. The staff of the Electromagnetic Fields Division can perform specified tests or measurements on a reimbursable basis. In this case, the customer has no direct interaction with the facility; all measurements are performed by NBS staff and the customer is issued a test report. As an alternative, work may be performed on a cooperative basis with NBS staff. This arrangement permits the user the advantage of developing first-hand knowledge of the measurement processes, and the user is responsible in large part for the accuracy of test results. In either case, arrangements need to be made well in advance, and reimbursement is required for the facility use and time of NBS staff involved.

Contact:

Mr. Allen C. Newell, Electromagnetic Fields Division, Room 4065 Radio Building, National Bureau of Standards, Boulder, CO 80303.
Telephone: 303/497-3743.

Outdoor Extrapolation Range for Antenna Measurements

Capabilities:

This unique facility was designed to perform accurate measurements of absolute gain and polarization of microwave antennas using the "Extrapolation Method" developed by the National Bureau of Standards in the early 1970's. It consists of two towers mounted on a pair of accurately aligned rails. The towers support all or parts of the source, receiver, and data systems as well as the rotators for supporting and positioning the antennas.

Both towers are free to move, and the separation distance between them can be varied smoothly from 0 to 60 m. The towers are approximately 6 m high and the antennas under evaluation can be mounted 1 to 2 m higher if necessary. Means are provided for accurately aligning the antennas and for maintaining that alignment for all separation distances. The rails were originally aligned using a transit and precision level so that the maximum angular deviation of the antennas was less than ± 0.02 degrees about any axis as the towers were moved the full length of the rails.

Applications:

NBS uses this facility primarily for the accurate characterization of antennas by measuring absolute gain and polarization parameters. For measurements above 1 GHz, the uncertainty in gain is approximately 0.1 dB for antennas with gains between 6 dB and 45 dB. The uncertainty in polarization axial ratio is about 0.05 dB/dB. Below 1 GHz, gain accuracies may degrade to about 0.25 dB for antennas with gains as low as 10 dB.

The facility is also useful for some far-field antenna measurements or for other types of measurements where it is important to know how a transmitted signal varies with distance—millimeter wave propagation studies for example.

Availability:

Two kinds of arrangements can be made to use this facility. The staff of the Electromagnetic Fields Division can perform specified tests or measurements on a reimbursable basis. In this case, the customer has no direct interaction with the facility; all measurements are performed by NBS staff and the customer is issued a test report.

As an alternative, work may be performed on a cooperative basis with NBS staff, and the user is responsible in large part for the accuracy of test results. In either case, arrangements need to be made well in advance and reimbursement is required for the facility use and time of NBS staff involved.

Contact:

Mr. Allen C. Newell, Electromagnetic Fields Division, Room 4065 Radio Building, National Bureau of Standards, Boulder, CO 80303.
Telephone: 303/497-3743.

Automated Manufacturing Research Facility

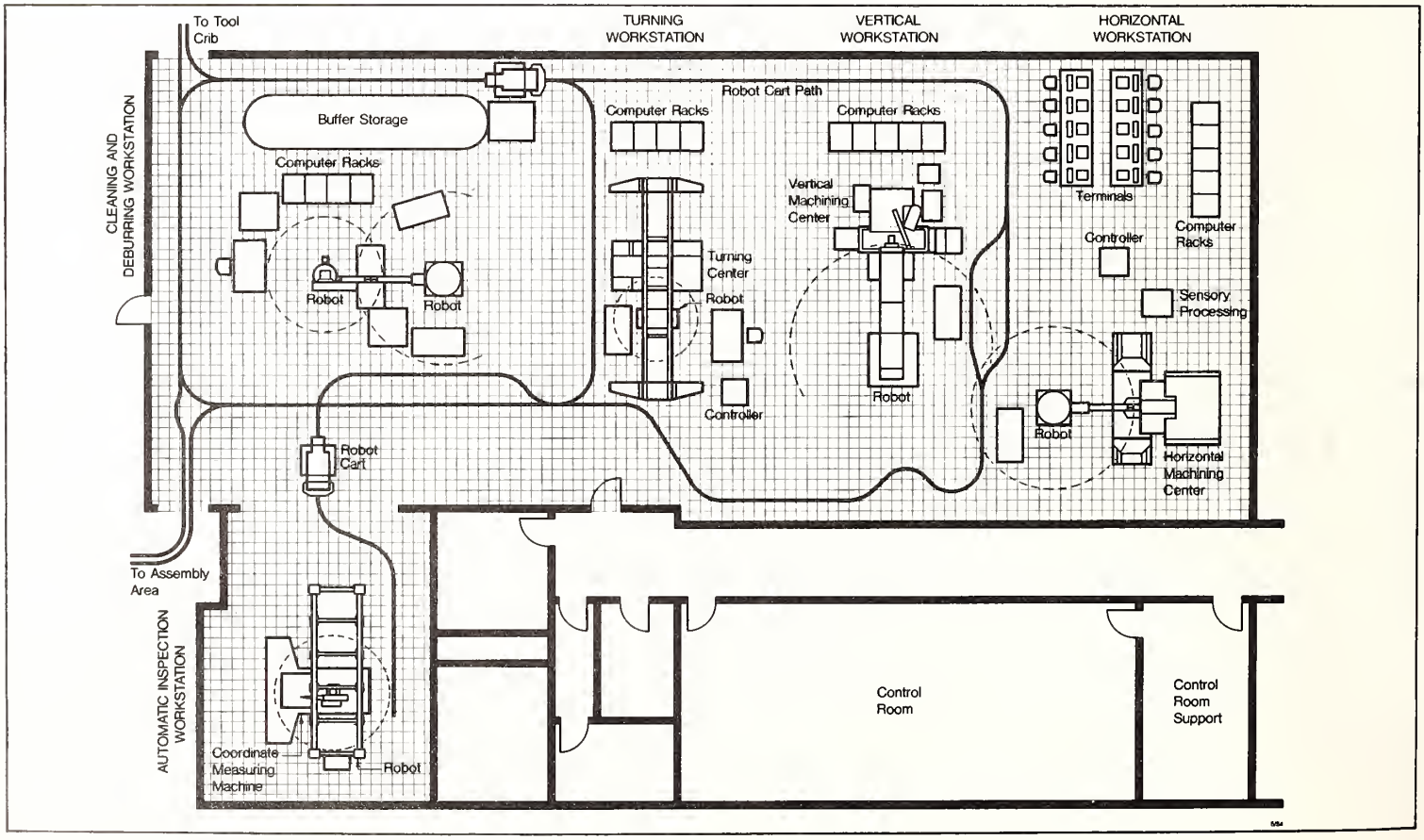
Automated Manufacturing Research Facility

The Automated Manufacturing Research Facility (AMRF) at the National Bureau of Standards is a major national laboratory for technical work related to interfaces and standards for the next generation of computer-automated manufacturing. The facility, begun in 1981, will be in full operation by the end of 1986. Initial workstations of the facility are already being used in active research programs by NBS researchers, industrial research associates, guest workers, university personnel, and scientists and engineers from other government agencies.

Capabilities:

The facility currently supports research in machine tool and robot metrology, sensors and sensory processing, robot safety, robot control, software accuracy enhancement of machine tools, process planning and data preparation for machine tools and robots, parts routing and handling, realtime control of robots and aggregations of devices, workstation control, cell control, and materials handling control. It is particularly valuable for studies of interfaces between control modules and among data users. The AMRF is unique in the opportunities it provides for studies of an integrated system of significant size.

The AMRF consists of three machining centers, a coordinate measuring machine, and a cleaning and deburring station, each tended by an industrial robot and served by a materials handling system based on an automated wire-guided vehicle and an internal buffer storage



system for tools, materials, and work in progress.

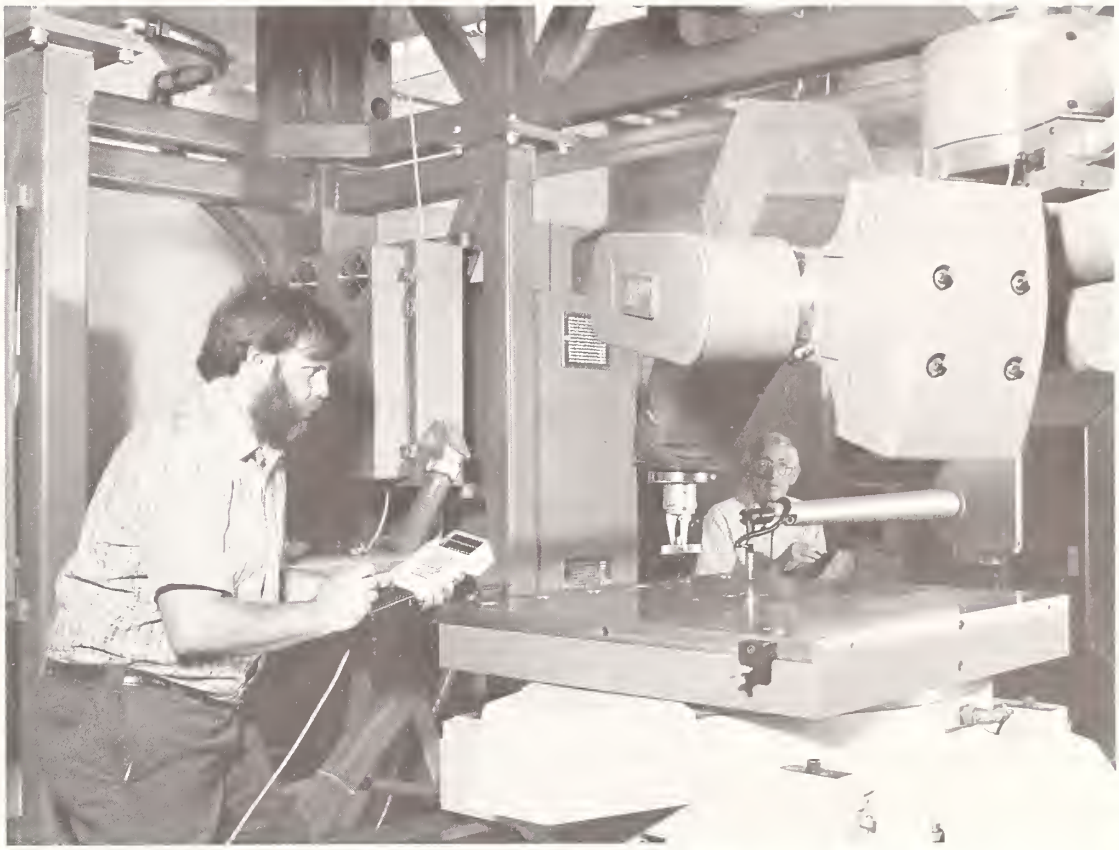
These devices are organized into workstations consisting of a major machine tool, its robot, a variety of sensors, and a workstation controller. Workstation activities are scheduled and coordinated by a cell controller. Two further control levels provide long-range planning and scheduling as well as design and engineering services, such as process planning and offline programming of machine tools and robots. Data, commands, and status information are handled over a network communications system employing a distributed data administration approach.

Availability:

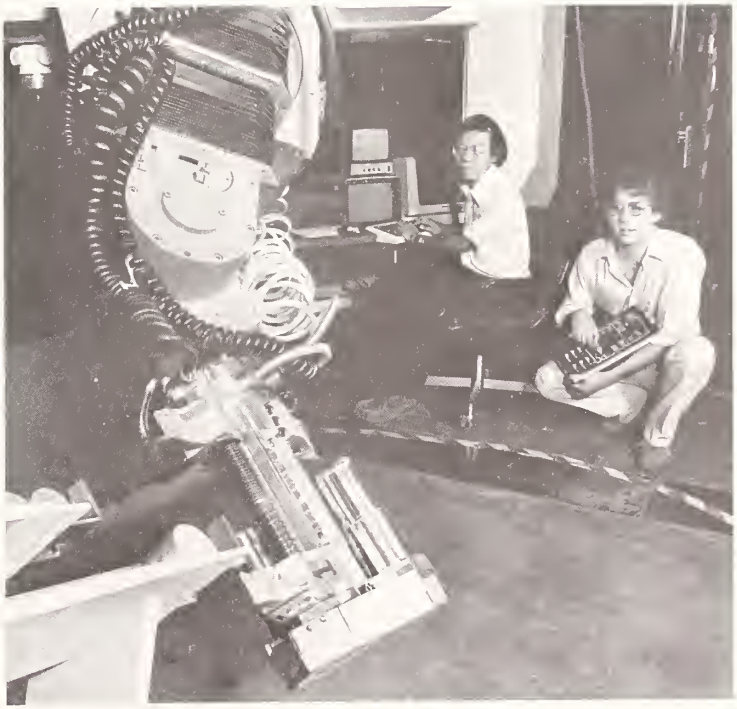
By the nature of the problems addressed, the AMRF is generally best suited for research projects of an extended nature. Most fruitful work to date has involved a close working relationship with NBS which extends for 6 months to 1 year.

Contact:

Dr. Philip N. Nanzetta, Center for Manufacturing Engineering, Room B112 Metrology Building, National Bureau of Standards, Gaithersburg, MD 20899. Telephone: 301/921-3421.



Coordinate Measuring Machine in Automatic Inspection Workstation



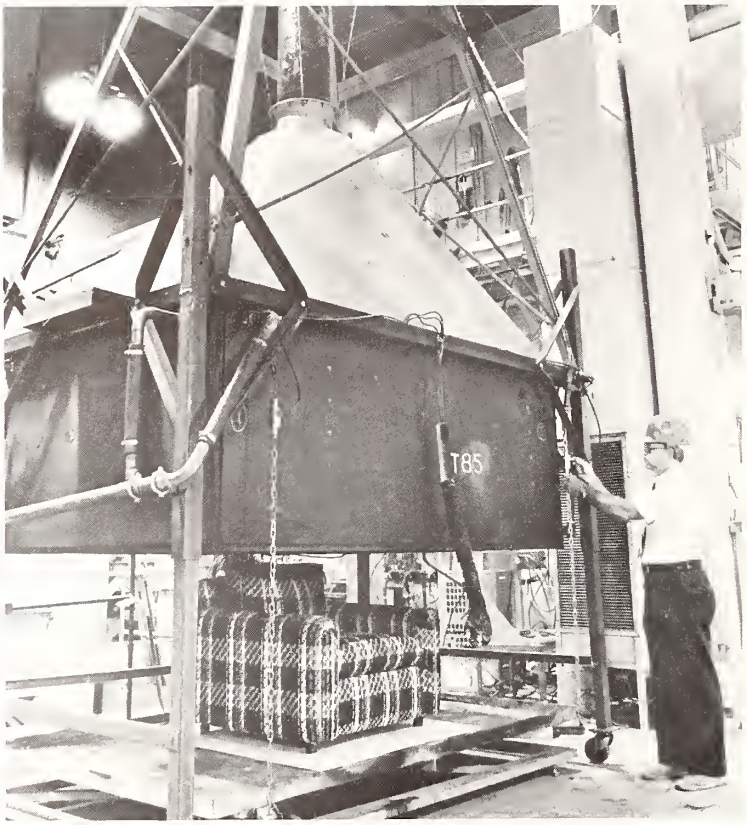
Turning Workstation

Fire Research Facilities

As the federal government's principal fire research laboratory, the Center for Fire Research at the National Bureau of Standards maintains some of the country's best and most extensive fire testing facilities. A substantial portion of NBS' fire tests are performed in a specially-equipped fire research building designed for large-scale fire experiments. The building is 27 m by 57 m. Smoke abatement equipment permits large fire tests to be conducted safely without polluting the environment.

In addition to several individual burn rooms, which are modified from time-to-time to accommodate special NBS testing requirements, the facility also houses several specially designed calorimeters for measuring the rate of heat release from materials and large samples, a new room/corridor facility for studying smoke and toxic gas transport, pilot furnaces, and reduced-scale model enclosures. Also, in 1984 construction began on a two-story "townhouse" for studying fire spread from a burning room, smoke transport between levels, and sprinkler performance.

A new computer-based data acquisition system provides state-of-the-art data collection capabilities for all large-scale fire testing. Up to 300 instruments with scanning rates over 100 channels per second can be dedicated to a single test. During an experiment, real-time, full-color graphics present the data as they are collected, with automatic conversion to engineering units for gas analysis, rate of heat release, temperature, and other measurements.



Heat-Release Rate Calorimeter

Capabilities:

Heat-Release Rate Calorimeters—The Center for Fire Research at NBS pioneered and developed the oxygen consumption methodology for measuring the rate of heat release, and has used it longer and in more devices than any other laboratory. The major benefit of this technique is the independence of the apparatus in measuring enthalpy responses to changes in heat-release rate.

A laboratory-scale calorimeter for measuring the heat-release rate of materials up to 300 mm by 300 mm under external irradiation up to about 100 kW/m^2 is available for fundamental research. Of special interest is the furniture calorimeter used for measuring the rate of heat release of upholstered chairs or furnishings of similar size; this apparatus provides data on the free-burning fire behavior of furnishings.

Room/Corridor Facility—NBS has constructed and used a room/corridor facility to evaluate an analytical model that predicts the transport of smoke and toxic gases from the room of fire origin into the corridor and secondary target rooms. The design of this facility makes it possible to measure the hazards associated with the burning of wall linings or room furnishings by evaluating the rate of heat release, smoke production, and toxic gas generation. The facility is available in its present form or with design modifications for the evaluation of a variety of building contents and furnishings.

Burn Rooms—A standard burn room built to ASTM specifications, 2.4 m by 3.7 m by 2.4 m high, adjoins a large overhead hood which collects the exhaust products from the room fires. The exhaust collection system is calibrated to measure the rate of heat release and the generation rates of smoke and other combustion products from the fire. The burn room is available for developmental and validation studies of mathematical models and for studies of fire performance of furnishings and interior finish materials.

The room fire environment can be characterized in terms of temperature and pressure gradients and the spatial distribution of thermal flux, gaseous combustion products, and smoke. Other measurements permit the calculation of thermal losses to the room boundaries and mass and energy flows from the room. Other smaller burn rooms also are available.

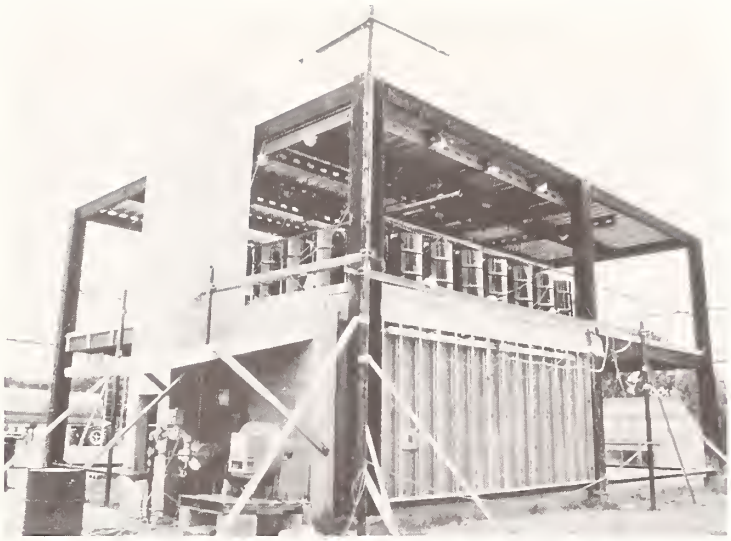
Pilot Furnaces—Two pilot furnaces for evaluating the fire endurance of wall assemblies or floor/ceiling assemblies are available. These furnaces, one

capable of handling specimens 2.4 m by 3.0 m and the other 1.0 m by 1.0 m, may be used for research purposes only and cannot be used for code acceptance testing. Typically, fire exposure similar to that specified by ASTM E 119, under carefully controlled conditions of furnace pressure and oxygen concentration, can be carried out routinely. Depending on the parameters required, a variety of other exposure conditions can be applied.

Reduced-Scale Models—NBS facilities are available for reduced-scale modeling of full-scale fire configurations. Physical models offer an economical means of achieving sufficient variation of physical parameters for a generalized understanding of fire behavior. Based on the results of reduced-scale experiments, limited full-scale verification then can be performed.

Two-Story Structural Steel Facility—This test structure consists of a two-story, four-bay structural steel frame measuring 9.75 m by 12.2 m. The steel frame is sized to reflect the structure typically found at mid-height of a 20-story building. A manually operated propane burner, with a capacity of 4.4 MW and requiring a 10 horsepower electric blower, is mounted in a masonry wall across one end of one of the bays.

Any of the eight compartments, or combinations thereof, can be enclosed to serve as a furnace or a burn compartment. The top of the structure has a poured concrete deck over steel, while the second story has a poured concrete deck over steel in two of the opposing quadrants. The other two quadrants have no floor. Extensive instrumentation and data acquisition capabilities are available for any part of the structure.



Two-Story Structural Steel Facility Used in Fire Research

The test frame is available for use as a burn compartment in which products could be burned and the resulting energy and combustion product measured. The bay containing the burner wall can be used as a fire endurance furnace for evaluating walls or floor/ceiling assemblies.

Availability:

Industry, university, and government representatives are encouraged to use NBS fire testing facilities on a collaborative or independent basis, with certain restrictions. For safety reasons, NBS staff must closely supervise all use of such facilities.

Contact:

Dr. Jack E. Snell, Center for Fire Research, Room A247 Polymers Building, National Bureau of Standards, Gaithersburg, MD 20899. Telephone: 301/921-3143.

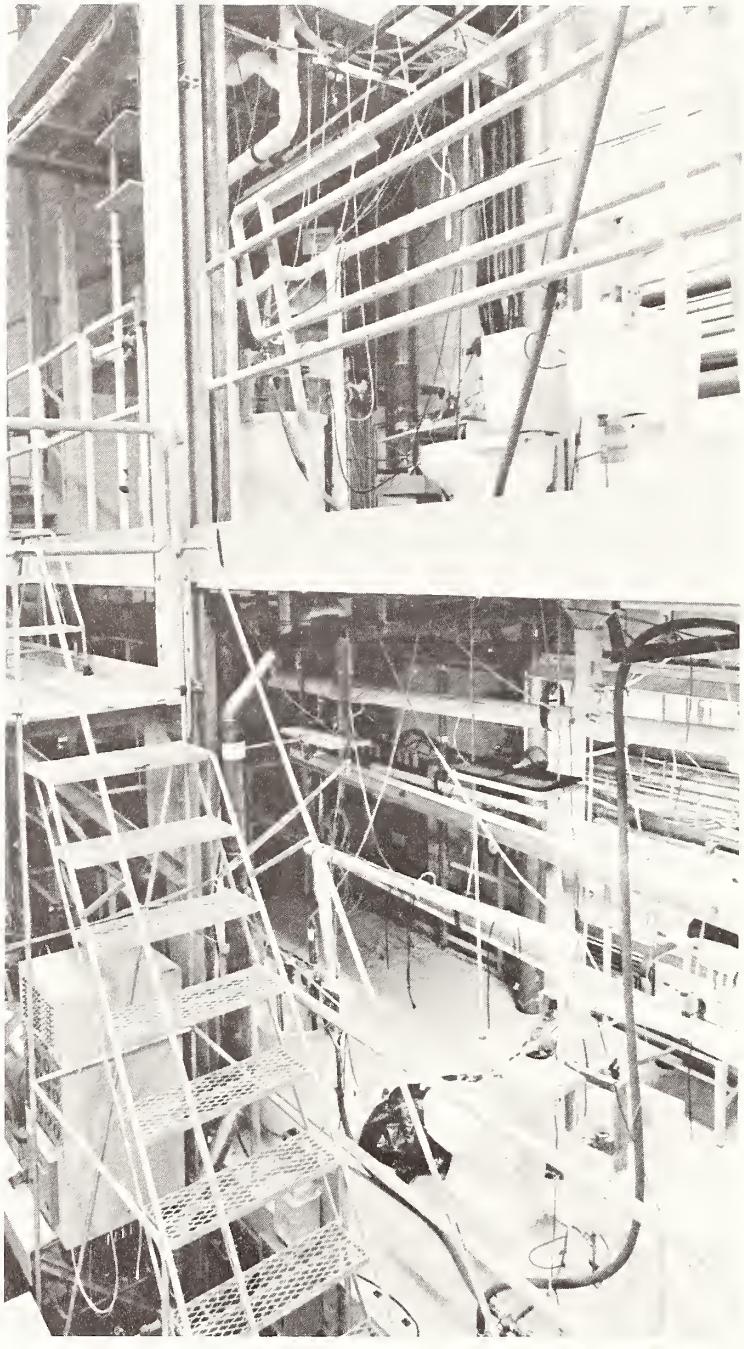
Burn Room in Fire Research Facility

Plumbing Research Laboratory

The plumbing research laboratory at the National Bureau of Standards is a five-story, highly adaptable facility capable of simulating the plumbing configurations of a low- to medium-rise building. An appendage to the principal tower allows for the simulation of single-family plumbing systems including a split-level configuration. Data are recorded using a high-speed, preprogrammed data acquisition system which can be programmed to handle both water supply and waste drainage systems.

Capabilities:

The facility allows for the construction of innovative or conventional plumbing systems at each of the five floor levels and the split-level appendage. Water closets, lavoratories, bath tubs, or other devices may be installed and provided with water supply systems, drainage systems, and venting configurations. Each of the fixtures may be activated remotely, either separately or in combination, with operation controlled manually or by computer on a programmed basis. Among the dynamic performance parameters that can be measured are pressures, velocities, and mass flow or volume-discharge rates of air and water, water levels, temperatures, piping strains and stresses, and linear or rotational movements. The facility also can be programmed to provide a measured quantity of water at a given flow rate from a holding tank at the top of the facility to simulate upper-story loading.



Plumbing Research Laboratory

Applications:

The facility is well suited to measure system dynamics of flow and pressure for drain waste and vent (DWV) components under simulated loadings. Positive and negative pressures also can be introduced at various points in the system to determine the plumbing characteristics under these conditions. Recent applications have included experiments to determine if plumbing systems perform satisfactorily with reduced-sized venting.

Availability:

The plumbing research facility is available for collaborative projects and for independent research. It must be operated under the cognizance of the NBS staff.

Contact:

Dr. Lawrence S. Galowin, Building Equipment Division, Room B326 Building Research, National Bureau of Standards, Gaithersburg, MD 20899. Telephone: 301/921-3293.

Large Environmental Chamber

The large environmental chamber at the National Bureau of Standards is 14.9 m by 12.8 m by 9.5 m high. It has an earth floor and may be excavated as needed for building construction. The chamber is one of the largest of its kind, capable of accommodating two-story houses under simulated environmental conditions. This chamber has been used for thermal performance, heating and cooling load measurements, and energy consumption for buildings of different kinds.

Capabilities:

The chamber is capable of automatically maintaining steady and/or dynamic temperature profiles from −45 to 65 °C and humidity from 50 percent RH at 1.7 °C up to 35 °C dewpoint at 49 °C. A wider range of relative humidity (15 to 80 percent) may be obtained manually. Air circulation maintains the temperature variation within the chamber to within ±1 °C. Damper-control return ducts in all eight corners of the chamber permit good air distribution. Supply air is furnished by ceiling diffusers.

Applications:

The chamber is used to measure indoor temperature fluctuation, heat loss and heat gain through the building envelope, energy conservation, moisture condensation, and air infiltration under simulated and dynamically fluctuating outdoor temperature cycles. The chamber has been used to test a wide variety of conventional and special structures and equipment, including military hardware (such as inflatable life rafts, relocatable air-inflatable hospital units, and portable walk-in coolers) under extreme climatic conditions.

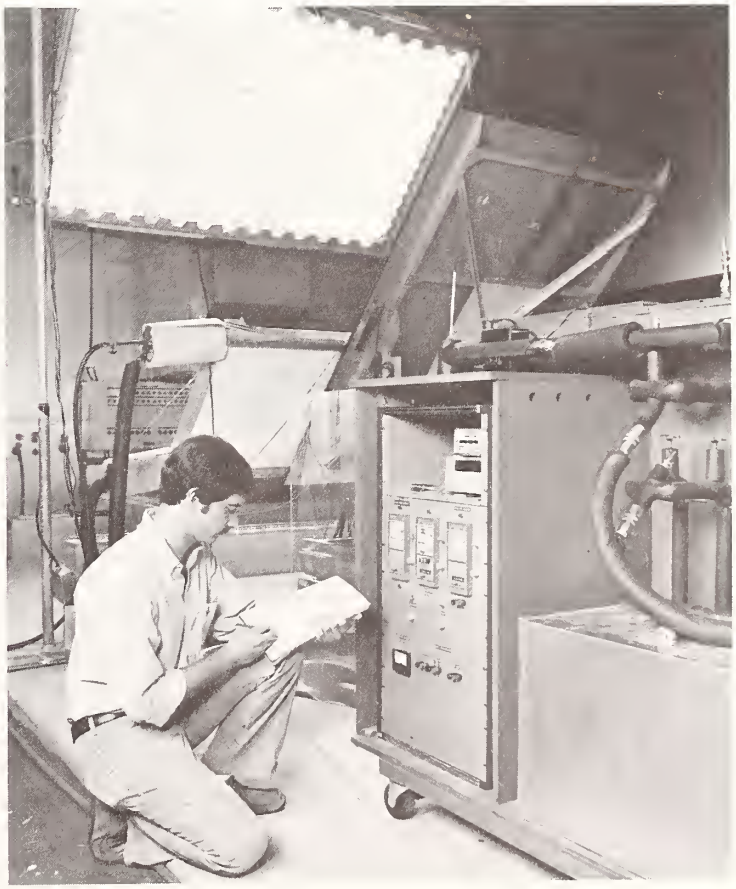
Availability:

This facility has substantial potential for use by researchers in industry and universities. Collaborative programs and individual research are arranged through NBS' Building Physics and Building Equipment Divisions.

Contact:

Dr. Tamami Kusuda, Building Physics Division, Room B218 Building Research, National Bureau of Standards, Gaithersburg, MD 20899. Telephone: 301/921-3637.

Large Environmental Chamber



Line Heat-Source Guarded Hot Plate

This 1,000-mm guarded hot-plate apparatus at the National Bureau of Standards measures the thermal conductivity of building insulation. NBS uses the hot plate to provide calibration specimens for guarded hot plates in other laboratories. It also is used to investigate edge heat loss from thick thermal insulation materials. This facility is the only one of its kind in the world which will permit low-density thick insulation to be measured with an error rate less than 0.3 percent.

Capabilities:

This apparatus has a test temperature range of 200 °C for the hot plates and −20 °C for the cold plates. The apparatus permits measurement of vertical and horizontal heat flow to simulate the heat transfer through ceilings and floors respectively. This apparatus operates within its own carefully controlled temperature and humidity environment shielded by an insulated aluminum enclosure. This facility provides for absolute measurement of thermal resistance of thick- and low-density test specimens used as transfer standards. These standards are used to calibrate or verify heat flow meter (ASTM C508) or guarded hot-plate (ASTM C177) equipment.

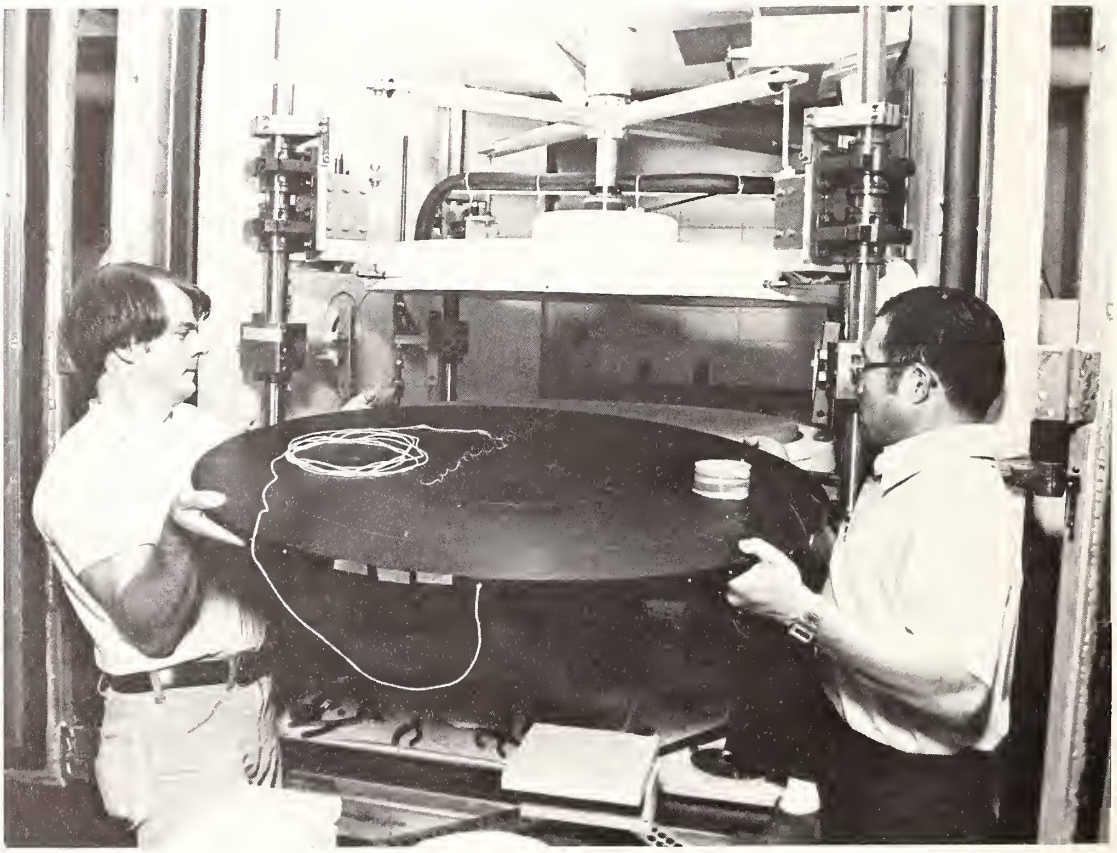
Availability:

This apparatus is available for use by those outside NBS, but it must be operated by NBS staff. Collaborative programs may be arranged through the NBS Building Physics Division.

Contact:

Mr. Thomas K. Faison, Building Physics Division, Room B114 Building Research, National Bureau of Standards, Gaithersburg, MD 20899. Telephone: 301/921-3501.

Line Heat-Source Guarded Hot Plate



Calibrated Hot Box Facility

This National Bureau of Standards apparatus measures the heat transfer coefficient of full-scale building wall sections. Designed in accordance with ASTM Standard C-976, it consists of two large heavily insulated chambers—an environmental chamber and a climatic chamber—each with one open side. Indoor and outdoor conditions are simulated in the chambers, which are 4 m high, 5.5 m wide, and 1.6 m deep. The open test section measures 3 m by 4.6 m. A well-insulated frame supports the wall specimen that is clamped between the open sides of the two chambers.

Capabilities:

This facility is the only one of its kind designed to perform simultaneous dynamic transfer measurements of air, moisture, and heat during simulated winter and summer conditions under steady state and dynamic driving functions. While the environmental chamber temperature and humidity are maintained to simulate a relatively steady and narrow range of indoor conditions, the climatic chamber can attain temperatures ranging from −40 to 65 °C with relative humidity between 20 to 80 percent. The apparatus measures the performance of homogeneous or composite walls having a range of thermal resistance from 0.35 to 8.8 m^2 C/W, air leakage rates up to 255 m^3/hr, and moisture transfer rates up to 1.4 kg/hr. It accommodates wall specimens up to 0.6 m thick and up to 700 kg/m^2 in weight per unit area.

Calibrated Hot Box Facility

Applications:

NBS will be using the facility to develop standard test methods to evaluate dynamic thermal performance of full-scale walls under cyclic temperature, humidity, and air pressure conditions. Currently these test methods do not exist. The building industry and government agencies are seeking reliable evaluation techniques for wall thermal mass, especially to predict energy consumption of buildings with heavy mass effects in comparison to standard wood-frame buildings.

Using this apparatus NBS will provide industrial laboratories and others with standard reference test specimens representing selected types of walls of different thermal conductances and thermal mass under steady and dynamic conditions. NBS has participated in round-robin test activities with domestic and overseas thermal insulation laboratories.

Availability:

This apparatus is undergoing calibration tests and will be available for external use in the spring of 1985. The facility is expected to provide a unique opportunity to measure simultaneous transfer of air, moisture, and heat through wall and roof specimens with openings for windows and doors. While it is available for use by those outside NBS, this apparatus must be operated by NBS staff.

Contact:

Mr. Thomas K. Faison or Mr. Douglas Burch, Building Physics Division, Room 114 Building Research, National Bureau of Standards, Gaithersburg, MD 20899.
Telephone: 301/921-3501.

Tri-Directional Test Facility

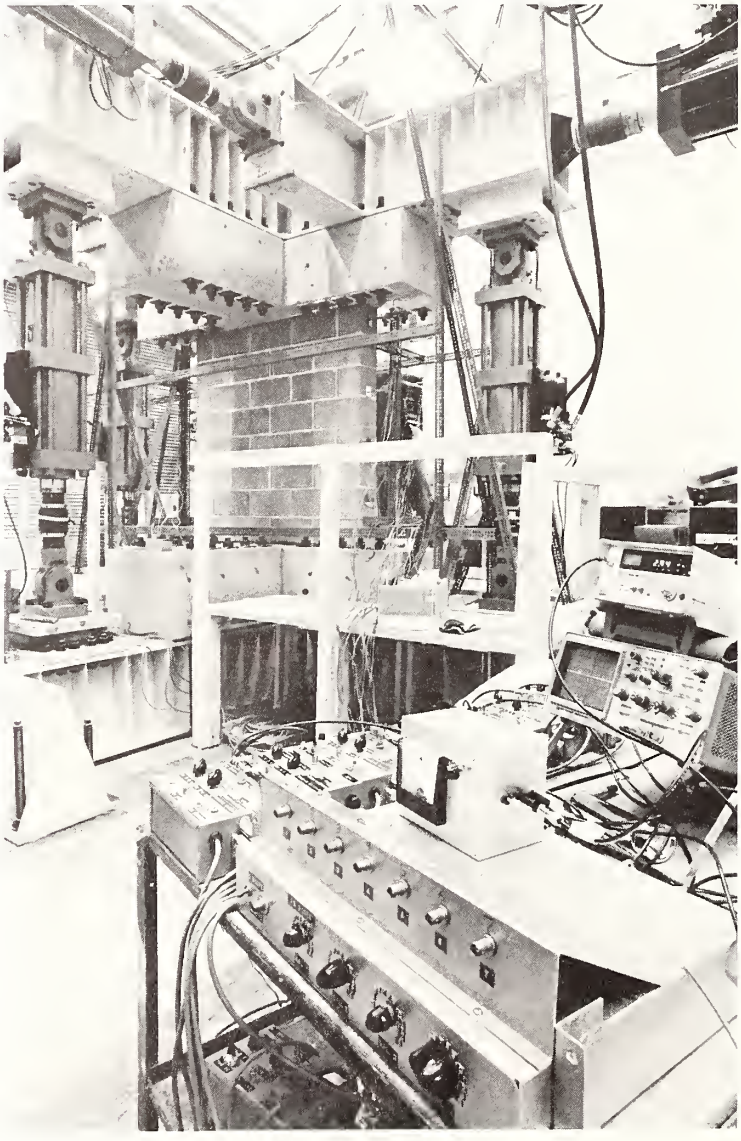
The tri-directional test facility at the National Bureau of Standards is a computer-controlled apparatus capable of applying cyclic loads simultaneously in three directions. It is used in examining the strength of structural components or assemblages under the application of a variety of loading phenomena such as earthquake or wind. This is one of the largest such facilities in the world, both in terms of its high-load capacity and its capability to handle large, full-scale specimens.

Capabilities:

The facility can apply forces and/or displacements in 6 degrees of freedom at one end of a specimen. The other end of a specimen is fixed. Specimens up to 3.3 m high and 3 m in length or width may be tested. The 6 degrees of freedom are translations and rotations in and about three orthogonal axes. The forces are applied by seven closed-loop, servo-controlled hydraulic actuators that receive instructions from a computer. Operating under computer control, the facility simultaneously maintains control of the load and/or displacements in each of the three orthogonal directions. Loads may be applied up to 2,760 kN in the vertical and about 890 kN on each of the two horizontal directions.

Applications:

The tri-directional test facility is limited only by the size of the test specimen. Loads may be cyclic or unidirectional depending on the type of loading condition being simulated. Currently the facility is being used to study masonry shear walls subjected to reversed cyclic lateral loading with a combination of boundary conditions and vertical loads. This facility supports NBS' role in developing research for seismic design and construction standards in the National Earthquake Hazards Reduction Program.



Tri-Directional Test Facility

Availability:

The tri-directional test facility is used by the NBS Structures Division in a variety of NBS research projects and collaborative projects with other agencies. It also is available for independent research, but must be operated by NBS staff.

Contact:

Dr. Edgar V. Leyendecker, Structures Division, Room B168 Building Research, National Bureau of Standards, Gaithersburg, MD 20899. Telephone: 301/921-3471.

Large-Scale Structures Testing Facility

The large-scale structures testing facility at the National Bureau of Standards consists of a universal testing machine to apply tensile and compression loads to full-scale test specimens. A 13.7-m-high reaction buttress is currently under construction which will allow use of both the testing machine and the buttress to apply combinations of vertical and lateral loads to large-scale test specimens.

Capabilities:

The universal testing machine portion of the facility is a hydraulically operated machine of 53.4 MN capacity and is one of the largest in the world. It has a height of 23.8 m above the floor level. It tests large structural components and applies the forces needed to calibrate force measuring devices of large capacity. The machine can apply axial forces of 53.4 MN to column sections or fabricated members with lengths up to 17.7 m. The reaction buttress is capable of applying lateral loads of 4.5 MN at heights varying from floor level to 12.2 m above the floor level.

Applications:

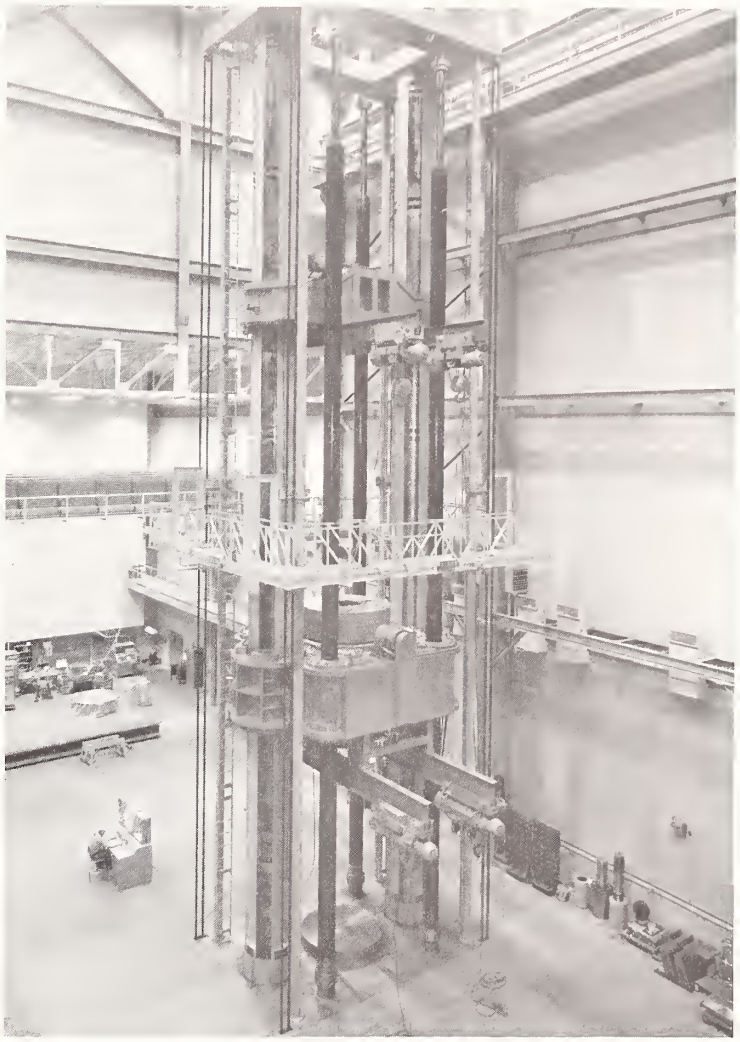
The large-scale test facility may be used to test specimens under combinations of vertical and lateral load. Currently a testing program is underway to evaluate performance of concrete columns up to 1.5 m in diameter and 9.1 m in height. The universal testing machine portion of the facility may be used conveniently to test large tensile and compression specimens and to calibrate large-capacity force measuring devices.

Availability:

Collaborative or independent programs for this test facility are arranged through the NBS Structures Division. The facility must be operated by NBS staff.

Contact:

Dr. Edgar V. Leyendecker, Structures Division, Room B168 Building Research, National Bureau of Standards, Gaithersburg, MD 20899. Telephone: 301/921-3471.



Universal Testing Machine in the Large-Scale Structures Testing Facility

Acoustic Reverberation Chamber

This facility at the National Bureau of Standards is used to determine sound absorption coefficients of building materials as well as sound power emitted from various equipment, such as air-conditioners and household appliances. The facility is a vibration-isolated, shell-within-shell type structure of reinforced concrete with inside dimensions of 9.1 m by 7.6 m by 6.1 m creating a volume of 425 m^3. The chamber's interior and its surrounding 1-m-wide air envelope are air-conditioned and humidity controlled and provided with conduits for communication and data acquisition. The chamber is equipped with adjustable, variable speed, rotating vanes to create a uniform sound-field distribution. Numerous pipe-sleeve openings of various sizes are available for other specialized uses such as conduit for hydraulic, pneumatic, fuel, or exhaust lines.

Capabilities:

The chamber is designed to provide a highly diffuse sound field in the frequency range of 100 to 10,000 Hz. The sound pressure is sampled by an array of 12 microphones, six mounted on stands placed on the floor and six suspended from booms attached to the ceiling. The booms may be rotated to give a wider range of microphone locations. Also, the facility is equipped with eight microphones mounted at each of the trihedral corners of the chamber—a unique characteristic among U.S. facilities. The loudspeaker used to determine the decay measurements and the microphones are connected to a computer in the adjacent laboratory.

Applications:

The chamber is used to develop measurements of sound absorption coefficients and to determine sound power of sound sources. It supports basic research to define the acoustical parameters for building materials and spaces and to develop and validate mathematical models for predicting acoustic field. The chamber is operated and maintained by the NBS Building Physics Division.

Availability:

This facility has substantial potential for use by researchers in industry, universities, and other government agencies. Scheduling arrangements for collaborative programs and individual research are handled by the Building Physics Division.

Acoustic Reverberation Chamber

Contact:

Dr. Simone L. Yaniv, Building Physics Division, Room A105 Sound Building, National Bureau of Standards, Gaithersburg, MD 20899.
Telephone: 301/921-3783.

Acoustic Anechoic Chamber

This facility of the National Bureau of Standards is used to determine the sound power emitted by sound sources as well as how much sound power flows in a given direction. It also is used to calibrate acoustical equipment such as microphones and loudspeakers. The facility is a vibration-isolated, shell-within-shell structure 6.7 m by 10.0 m by 6.7 m, creating a volume of 450 m^3. The absorptive treatment consists of glass wool wedge modules installed on all six inner surfaces of the room. Access to equipment within the room is provided by a wire mesh floor. Additional accessories in the room include communication line outlets and rigid supports for equipment on all six surfaces. Air-conditioning ducts are acoustically treated. Humidity control provides 45 percent relative humidity within ± 5 percent.

Capabilities:

The chamber is designed to provide a highly anechoic sound field. The walls of the chamber are designed to absorb 99 percent or more of the normally-incident sound energy at all frequencies above 45 Hz. The chamber's airflow can be cut off if a lower background sound level is required.

Applications:

The chamber is used to develop procedures for measuring sound power, to determine the direction of sound intensity, and to calibrate acoustical instruments. The chamber also can be used in psychoacoustic studies. It supports basic research to define the acoustical parameters required for the development of mathematical models for predicting acoustical fields.

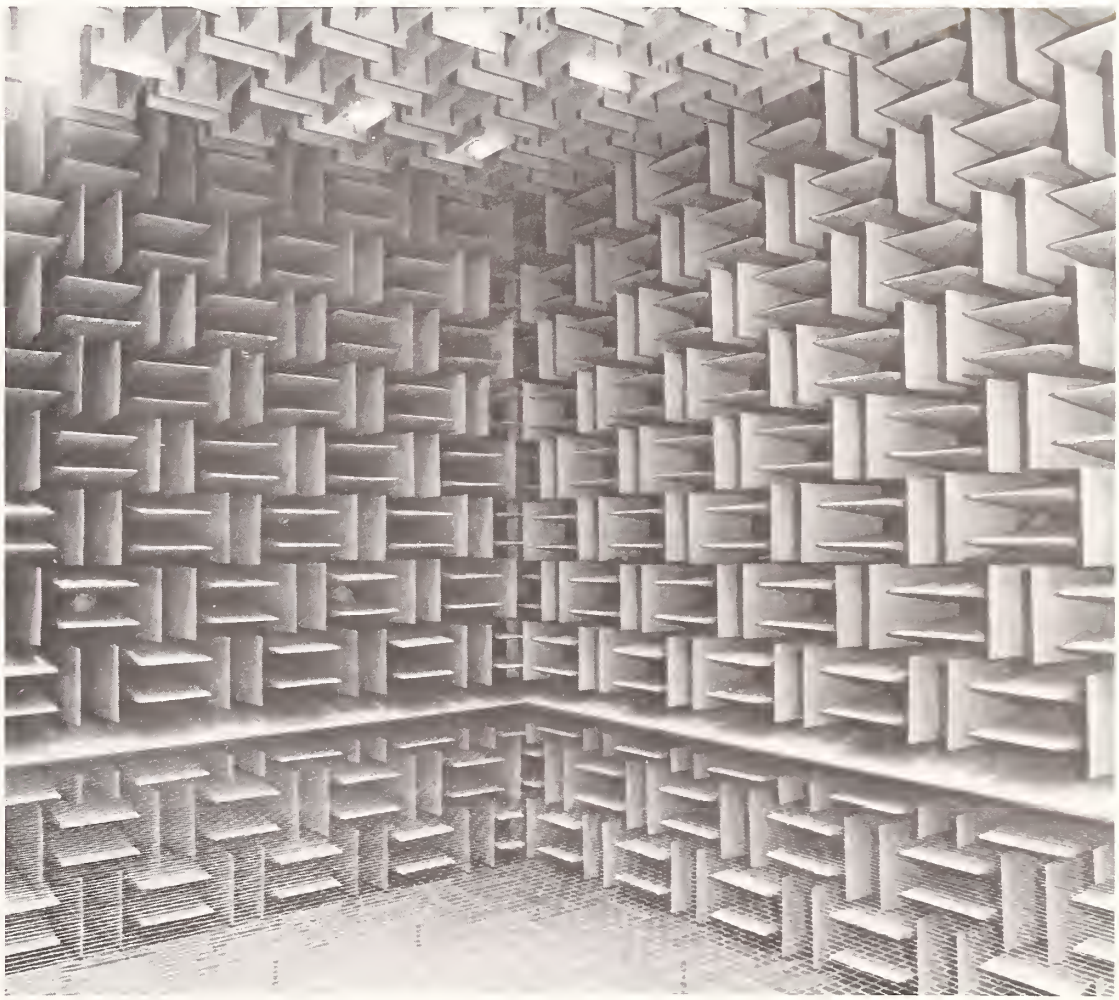
Availability:

This facility has substantial potential for use by researchers in industry, universities, and other government agencies. Scheduling arrangements for collaborative programs and individual research are handled by the NBS Mechanical Production Metrology Division.

Contact:

Mr. Daniel R. Flynn, Mechanical Production Metrology Division, Room B106 Sound Building, National Bureau of Standards, Gaithersburg, MD 20899. Telephone: 301/921-3565.

Acoustic Anechoic Chamber



Network Protocol Testing and Evaluation Facility

The Network Protocol Testing and Evaluation Facility at the National Bureau of Standards consists of eight laboratories for research in the design, implementation, and testing of computer network protocols. The laboratories are used to advance measurement methodologies for computer networks. A variety of communications technologies and applications environments have been developed for cooperative research and testing under conditions appropriate for both current and emerging technologies. These research efforts support the development of international standards for open systems interconnection to enable computer systems of different manufacturers to be interconnected for computer-to-computer communication.

Research in developing prototype implementations and testing techniques is carried out cooperatively with federal agencies and industry.

Capabilities:

Network Protocols—Prototype implementations of middle- and high-level protocol standards are developed and tested over a commercial X.25 public data network, the Department of Defense data network, and a local area network based on IEEE (Institute of Electrical and Electronics Engineers) standards. Automated techniques are used to develop formal descriptions and reference implementations of protocols. Automated testing tools have been developed to measure prototype implementations against reference implementations.

Satellite Communications—Protocols are developed and tested over satellite communications where very high band width and long propagation delays affect performance.

High-Speed and Multiprocessor Networks—Protocols are developed and tested over networks that transfer data at very high communication speeds (50 to 100 megabits per second).

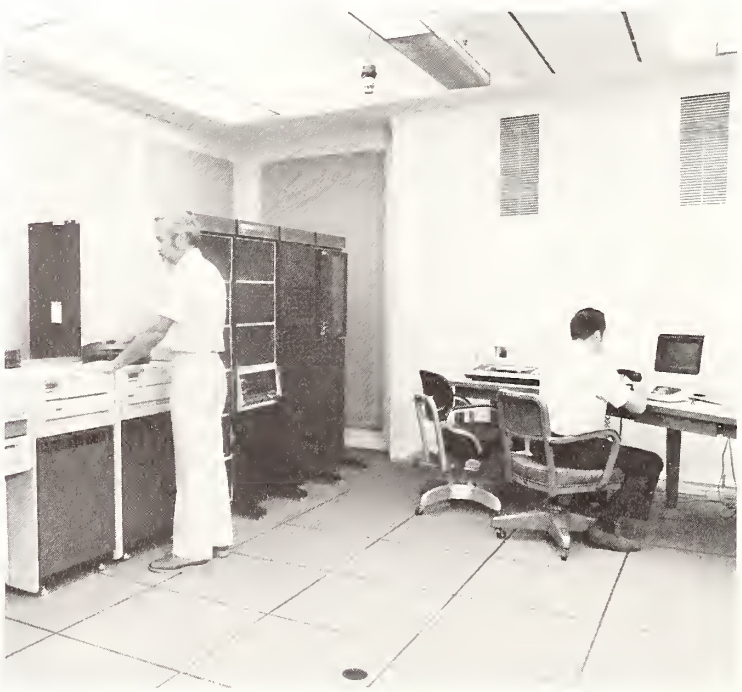
Videotex—Techniques and methods are developed to test implementations of the North American Presentation Level Protocol Standard (NAPLPS) for videotex applications.

Public Data Networks—Verification techniques are available for testing equipment and services for conformance to FIPS 100, Interface Between Data Terminal Equipment (DTE) and Data Circuit-Terminating Equipment (DCE) for Operation with Packet-Switched Data Communications Networks (based on X.25 standard of CCITT).

Network Security—Encryption techniques are developed and tested to protect data transmitted in networks, manage secret cryptographic keys, provide for personal identification of users, and provide for data integrity.

Local Area Networks—Tools and techniques are developed to test the correctness and performance of different local area network technologies, including carrier sense multiple access with collision detection (CSMA/CD) and token bus access methods.

Computer-Based Office Systems—Message and document interchange protocols are developed and tested in environments suitable for communicating word processors and desktop computers.



Network Protocol Testing and Evaluation Facility

Availability:

Cooperative research in networking involves more than 30 computer manufacturers, 10 other federal agencies, and five research laboratories in other countries. Collaborative programs are arranged through the NBS Center for Computer Systems Engineering.

Contact:

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