National Institute of Standards and Technology

NIST Research Reports

U.S. Department of Commerce
National Institute of Standards and Technology
NIST Special Publication 743

On the cover: With the signing of the Omnibus Trade and Competitiveness Act on August 23, the National Bureau of Standards became the National Institute of Standards and Technology. See article on page 5.

NIST Research Reports

U.S. DEPARTMENT OF COMMERCE
C. William Verity, Secretary

National Institute of Standards
and Technology
Ernest Ambler, Director

National Institute of Standards
and Technology
Gaithersburg, MD 20899
301/975-2000

National Institute of Standards
and Technology
Boulder, CO 80303
301/497-3000

October 1988

NIST Special Publication 743
Prepared by the Public Information
Division
A903 Administration Building
National Institute of Standards
and Technology
Gaithersburg, MD 20899
301/975-2762

Library of Congress
Catalog Card Number: 88-600590

For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402

Research Update

Turning Shuttle Tanks Into Space Labs

Can the space shuttle's fuel tanks be turned into manned, orbiting science labs? NIST is working with the University Corporation for Atmospheric Research (UCAR), NASA, and others looking at the technical and economic feasibility of such a conversion. The 30-ton tanks—as wide as a Boeing 747 and the height of a 13-story building—now are jettisoned and burn up in the atmosphere just before the shuttle achieves orbit. Initially, the NIST researchers will be developing computer models to help determine the structural stability of the tanks when equipped with scientific instruments. Future work at NIST will include structural analysis to help develop cost-effective techniques for converting the tanks into manned laboratories.

Program Seeks Researchers in Polymer Composites

Researchers in industry, universities, and government are invited to participate in an NIST research program that addresses the most critical barriers in high-performance polymer composite processing which producers must overcome to meet increasing international competition. The U.S. market for high-technology plastic products, valued at approximately $1.6 billion in 1987, is expected to grow to $10 billion before the year 2000. The United States now has the technological lead in the use of high-performance polymer composites in defense and aerospace applications. In high-volume mass markets, however, U.S. industries face intense competition.

Polymer composites are reinforced plastics carefully engineered to meet specific performance requirements. By combining polymer resins with reinforcements such as graphite fibers, very versatile, lightweight, and high-strength materials can be made. Examples include jet aircraft parts and sporting goods like tennis rackets and fishing rods. For information contact Donald L. Hunston, A209 Polymer Building, NIST, Gaithersburg, MD 20899, 301/975-6837.

Steel Oil Tanks Should Be Evaluated

Steel oil tanks should be evaluated to ensure they are tough enough to keep small cracks from developing into catastrophic failures, according to NIST researchers. The Institute made that recommendation after investigating the January 2, 1988, failure of an Ashland Petroleum Company tank near Pittsburgh, Pa., which spilled nearly 2 million gallons of oil into the Monogahela River. NIST found that a brittle fracture that began as a 3/4-inch-wide flaw in the tank shell spread quickly and ripped the vessel wide open because the steel was not tough enough to stop the fracture.

NIST recommended that standards be reviewed to identify those with provisions for sufficient fracture toughness to prevent catastrophic brittle fracture at design stresses and temperatures. Also, steel to be used in new or reconstructed tanks should comply with these provisions, according to NIST researchers. If a tank lacks sufficient fracture toughness, NIST suggested taking remedial actions—such as converting the tank to higher temperature use, retiring the tank, or installing special crack "arresters." NIST also said that standard protocols need to be developed to test and assess the fracture of steel in tanks which lack adequate documentation.

NIST Database on Engineering Properties of Hydrocarbons

A new database for calculating viscosity, density, and other important engineering property data of hydrocarbons—natural gas, petroleum, and organic materials, including mixtures of fluids—has been developed by NIST. The "DDMIX" database was developed as part of a research project sponsored by an industry consortium of petroleum, chemical, and gas processing firms. Available on a floppy disk for personal computers, it provides rapid access to important information on the storage and transportation of fluids, and for the design of new chemical processes.

Among other things, the program allows users to calculate quickly various thermodynamic and transport properties of fluid mixtures. These mixtures can be selected from any of 17 possible pure components such as carbon dioxide, methane, ethane, nitrogen, oxygen, and heavier hydrocarbons such as hexane and heptane. Order DDMIX—Mixture Property Program (1988), NIST Standard Reference Database 14, a floppy disk for personal computers, for $400 from the Office of Standard Reference Data, A323 Physics Building, NIST, Gaithersburg, MD 20899, 301/975-2208.

Advanced Shipyard Manufacturing System Dedicated

Officials of NIST and the U.S. Navy's Naval Sea Systems Command (NAVSEA) on July 19, 1988, dedicated a state-of-the-art robotic manufacturing system designed and assembled by NIST for the Navy's Mare Island (Calif.) Naval Shipyard. The Mare Island workstation, scheduled for delivery to the shipyard later this year, will be one of a handful of facilities in the United States capable of operating, largely untended, 24 hours a day, 5 days a week.

Consisting of an automated lathe, industrial robot, automated storage and retrieval system, and various control computers, the workstation incorporates several advanced automation techniques. It is designed to produce any of 40 different pipe connector parts used to suppress noise in nuclear submarines. Such parts are not stockpiled and are produced on demand when the submarine is serviced. Current manual production methods require about 17 hours to make one of these parts. The Mare Island workstation can machine the same part in under 30 minutes and is already turning out parts for the Navy on a trial basis. The advanced manufacturing techniques used in the workstation are applicable to many manufacturing operations.

Mare Island workstation project manager Kang Lee demonstrates the control system to NAVSEA Deputy Commander R.A. Roger B. Horne, observed by John Lyons, director of the NIST National Engineering Laboratory.

NIST Inks ISDN Agreements With Nynex, Bellcore

NIST has signed agreements with NYNEX and Bell Communications Research (Bellcore) to develop test methods for evaluating product conformance to Integrated Services Digital Network (ISDN) standards. ISDN is a new telecommunications technology that makes it possible to send and receive voice, data, and image signals simultaneously over digital telephone networks. When completed, the test methods will be publicly available and will help speed up the introduction of commercial products conforming to the standards. A researcher from Bellcore—the research and development arm of the seven regional Bell holding companies—is already at NIST and others from Bellcore and NYNEX may follow. Both NYNEX and Bellcore will open up their facilities to NIST researchers. The multiyear research program is expected to lead to public demonstrations and an ISDN network for the nationwide testing of ISDN-compatible products.

Gallium Triple Point To Serve as Fixed Point

The present scale (International Practical Temperature Scale (IPTS-68)) used to calibrate all thermometers will be replaced in 1990 with a new scale which better approximates the thermodynamic temperature T. Preparing for this change, standards laboratories around the world are determining the thermodynamic temperatures of highly reproducible fixed points such as gallium's triple point (T_g),

where the solid, liquid, and vapor phases are in equilibrium. Based on work at NIST, T_g has now been proposed as a defining fixed point in future temperature scales. NIST researchers determined T_g (302.9169 ± 0.0005 K; about 85.6 °F) by making exceedingly accurate measurements of the speed of sound in argon. In making their measurement, the researchers exploited an instrument used to redetermine the universal gas constant (R). Their new acoustic techniques are simpler and more accurate than other techniques for measuring the thermodynamic temperature.

New Technique for X-Ray Fluorescence Spectroscopy

A new technique in molecular spectroscopy under study by scientists from NIST, Brookhaven National Laboratory, and Indiana University allows researchers to take "snapshots" of the electronic energy states of free molecules on a time scale so fast that the molecules can be effectively "frozen" in a particular spatial orientation. The result is an enhanced sensitivity to molecular-symmetry effects in spectroscopy not previously attained. The team has made measurements of polarized x-ray fluorescence from methyl chloride, in which polarization of the decay fluorescence of specific electronic states in the molecule clearly depends on the symmetry of the molecular orbitals involved. These experiments demonstrate the feasibility of using this technique to obtain orientation and dynamical information for specific electronic states in molecules. The structure of active sites of large molecules, such as proteins, could be studied in this fashion in "natural" states without requiring crystallization.

High-Resolution Measurements of Thin-Film Interfaces

The "microstructure" of the interface between a thin film and a bulk material is of extreme importance to the semiconductor industry because it often controls the electrical behavior of a semiconductor device. It is difficult to measure, however: Surface science techniques can only probe a solid interface destructively, by digging down to it. With more penetrating probes, the information from the interface is lost in the mass of responses from the bulk material. Now researchers from NIST, the University of Tennessee, Oak Ridge National Laboratory, and Lawrence Berkeley Laboratory have tested a technique to obtain greatly enhanced responses—up to 50 times, so far—from thin-film interface. The trick is to make multilayer "sandwiches" of alternating substrate and film and use soft x-ray fluorescence, exciting the core electrons of the atoms to measure position and chemical species. Feasibility studies on an ultra-high sensitivity spectrometer in the NIST facility at the National Synchrotron Light Source (Brookhaven) used silicon and carbon and could discern the interface characteristics of films as thin as 3 angstroms.

JANAF Thermochemical Tables Available Online

The third edition of the (Joint-Army-Navy-Air Force) *JANAF Thermochemical Tables*, published by NIST, has been computerized to provide scientists and engineers with rapid access to information on the performance of materials at high temperatures. The database is available to subscribers on STN International (Scientific and Technical Network), an online private sector retrieval service offered worldwide. The numerical data can be used to make quick performance calculations for chemical reactors such as rocket engines, air pollution control equipment, internal combustion engines, coal gasifiers, and furnaces. The database is designed to list in one table all of the values for a given property of a chemical compound when the values for that compound appear in more than one tabulation. Information can be obtained by chemical name, the formula, or by the Chemical Abstracts Registry Number. For information on the new JANAF file through STN, contact the Office of Standard Reference Data, A323 Physics Building, NIST, Gaithersburg, MD 20899, 301/975-2208.

Low-Alloy Steel Calibration Standards Announced

NIST has developed a new graded series of seven low-alloy steel standards for calibrating optical emission and x-ray fluorescence spectrometers. Great care has been used in preparing these materials to obtain a high level of homogeneity to meet the demands of new, highly precise instruments used in the quality control of alloy materials. Standard Reference Materials (SRM's) 1761-1767, prepared in consultation with ASTM and industry, are available for $135 each in the form of disks approximately 34 mm in diameter and 19 mm thick. To obtain information on the certified values of each disk, or to order the new graded series of calibration standards, contact the Office of Standard Reference Materials, B311 Chemistry Building, NIST, Gaithersburg, MD 20899, 301/975-OSRM (6776).

NBS Has New Name, Expanded Role

Some things are obvious straightaway—the letterhead, for example, or the highway signs. Other things gradually occur to one: "What about contracts? What about employee passes and parking decals?" On August 23rd, as a result of the Omnibus Trade and Competitiveness Act, the National Bureau of Standards formally became the National Institute of Standards and Technology (NIST).

The Trade Act, or rather part of it—Title 5, Subtitle B, Part 1, the Technology Competitiveness Act—goes on to make other changes, changes which constitute probably the most important legislation affecting the agency since it was founded in 1901.

"I believe the most significant part of this legislation is found right up front in the list of functions assigned to the agency," notes NIST Director Ernest Ambler. "We now have a direct, unambiguous charge to work closely with industry on the development and use of the new technologies that U.S. companies need to stay competitive in the world marketplace."

The law states that NIST is intended:

> to assist industry in the development of technology and procedures needed to improve quality, to modernize manufacturing processes, to ensure product reliability, manufacturability, functionality, and cost-effectiveness, and to facilitate the more rapid commercialization, especially by small-and medium-sized companies throughout the United States, of products based on new scientific discoveries in fields such as automation, electronics, advanced materials, biotechnology, and optical technologies;

The phrase "small- and medium-sized companies" recurs often throughout the act, observes Ambler. "The legislation recognizes that smaller companies have an important role to play in improving our national competitiveness through improvements in productivity and quality.

"Of course, we've long had interactions and cooperative research programs with small companies as well as major industrial firms. Technology transfer is not a new story here. But it has always been more difficult to assist the smaller companies because of their sheer numbers and because of limited resources, both theirs and ours.

"This act provides new mechanisms for working in cooperation with economic and technological development groups in state and local governments and in other regional institutions, which is a very attractive solution to these problems."

The act describes several new NIST programs based on this cooperative program theme, including a series of "Regional

Centers for the Transfer of Manufacturing Technology" that will be affiliated with non-profit institutions or organizations; a program to provide assistance and make federal technology available to state and local technology programs and technology extension services; and an "Advanced Technology Program" to encourage the commercialization of new high-technology products.

The act also establishes a Department of Commerce (DOC) "Clearinghouse for State and Local Initiatives on Productivity, Technology, and Innovation" to provide technical and analytical help to state and local officials making decisions on technology policy.

While the legislation adds major new programs, it also reinforces the agency's role as the nation's measurement and standards research laboratory. NIST will continue to serve as the nation's central laboratory for developing and disseminating measurement standards and scientific data for science, engineering, manufacturing, commerce, industry, and public safety.

Manufacturing Technology Centers

The regional centers are intended to be local resources, where small- and medium-sized manufacturing firms in particular could go for direct technical and managerial support in automating and modernizing their facilities.

As envisioned in the act, these centers will help businesses develop technically and financially sound plans for modernizing their production. Advanced production facilities are to be set up in the centers to demonstrate new technologies and provide a training facility for regional firms. Centers may actually loan automated manufacturing equipment to selected companies on a short-term basis to help get them started. They will sponsor the transfer of modern manufacturing and quality control techniques developed in NIST labs, and otherwise draw on the scientific resources of NIST, particularly the technology cultivated at the NIST Automated Manufacturing Research Facility.

NIST will continue to serve as the nation's central laboratory for developing and disseminating measurement standards and scientific data for science, engineering, manufacturing, commerce, industry, and public safety.

NIST is to create these centers in cooperative agreements with non-profit organizations established by state and local governments, universities, or consortia. Depending on the availability of money, NIST may provide up to 50 percent (limited to $3 million annually) of the operating funds for these centers for their first 3 years, and decreasing amounts for the next 3 years. After 6 years, the centers should be self-supporting.

In anticipation of this legislation, a limited effort was initiated in fiscal year 1988.

Technology Extension Programs

At most, there will probably never be more than a handful of the regional manufacturing technology centers, but the act also instructs NIST to forge new ties to the many state and local technology extension services that have been created throughout the country.

NIST can establish cooperative agreements with state or local programs to develop programs that transfer federally developed technology to business within their area. State and local extension services typically emphasize business advice rather than dealing with sophisticated technology. Ties with NIST will help to coordinate the state and local extension services with federal technology transfer programs. Through workshops, seminars, and other mechanisms, NIST plans to help technology extension agents make the best use of federal resources.

Evaluation of Inventions

One new program assigned to NIST under the act is to reach out to individuals: the Non-Energy Inventions Program. The somewhat unusual name is because the program is meant to complement the Institute's existing—and quite successful—Energy-Related Inventions Program sponsored by the Department of Energy.

Under the latter program, started in 1975, any inventor can submit an invention to NIST for evaluation, so long as it is in some way related to producing or conserving energy. Drawing on a national network of science and engineering consultants, NIST—for free—evaluates the technical feasibility and marketability of the invention: Will it work? Will anyone buy it?

Inventions with a favorable review (there have been 450 so far) are recommended to the Department of Energy for support, which can include development grants or marketing assistance.

The Non-Energy Invention program is expected to work in a similar fashion, except that recommendations for support will go elsewhere, such as to the new NIST Advanced Technology Program.

Advanced Technology Program

Through the Advanced Technology Program, NIST is directed to speed the commercialization of new technology and the development of new, generic manufacturing techniques. Under the Technology Competitiveness Act, NIST may support or even participate in research consortia to develop and test new equipment or production processes, provided that they are "generic" to a particular industry or group of industries.

The program will be aimed at small- to medium-sized, high-technology firms or consortia. The idea is to "leverage" the relatively small financial resources of NIST by using the Institute's support to encourage private investment in each project. Inventions receiving favorable evaluations from the Non-Energy Inventions Program will be natural candidates for the advanced technology program.

Clearinghouse

Another potentially useful creation of the act is the DOC "Clearinghouse for State and Local Initiatives on Productivity, Technology, and Innovation." The clearinghouse is to gather and analyze information on the many state and local technology development programs across the nation. The idea is to develop a central base of information on what programs are available, what has been tried, and what the results have been. The clearinghouse will be a resource for state and local governments when deciding on new technology policies. The information will be shared through workshops and other mechanisms.

Planning Under Way

Exactly how the new programs and activities will be accomplished is still under discussion. A new organization plan must be drawn up and submitted to the Congress for approval. At present, the programs for regional manufacturing technology centers and inventions evaluation have received some funding. Still, according to the NIST Director, the new legislation represents welcome recognition of a job well done.

"Of all the hundreds of laboratories in the federal government, we are the sole agency with the mission of directly serving industry, which is why we were singled out by this legislation," says Ambler. "During the past 87 years as the National Bureau of Standards, this agency developed a reputation, of which we are all quite proud, for the highest standards of technical competence and objectivity.

"As the National Institute of Standards and Technology, we will continue to maintain the same high standards and to pursue excellence."

by Michael Baum
NIST Public Affairs Specialist

Can We Talk?

Speech Recognition Research at NIST

Computers that understand spoken language and can carry on conversations with humans are a science fiction staple. But in reality, comprehending and responding to spoken language is a difficult process for most computers. Interactions between people and machines still are limited mostly to communicating through mechanical means such as a keyboard.

This is changing slowly as scientists in both government and industry are addressing some of the problems. "We have a long way to go before a machine will be able to understand naturally-spoken human speech," says David Pallett, manager of the automated recognition group at the National Institute of Standards and Technology. "But the door is beginning to open as developments in speech technology are challenging the computer keyboard as the only means of interacting with complex systems," he says.

At NIST, Pallett and his group are helping remove the barriers to recognizing and understanding continuous speech and spoken natural language. Working with the Defense Advanced Research Projects Agency (DARPA), the NIST researchers are developing improved algorithms and software for phonetically-based recognition of speech and ways to measure the performance of automatic speech recognizers. Basic research as well as measurement methods are needed to advance the technology, says Pallett.

How They Work

Speech-recognition systems are available now, and the U.S. market is growing; some analysts predict it will reach $1 billion by 1990. But even successful commercial devices are extremely limited. For the most part, they recognize only single words, such as "good" or "correction," or short phrases. People using them must talk slowly and clearly, pausing between each word—not at all a natural way of speaking. The devices are especially useful for workers entering data while their hands and eyes are busy or where voice input is faster or more convenient.

"We are trying to codify linguistic knowledge into something measurable."

Most of these machines use a complicated, electronic process of matching soundwave patterns of spoken words to patterns stored in the computer's memory. The process is very accurate for a speaker-dependent system which is "trained" by each speaker reading to the machine all the words—typically 100 to 200—it should recognize. Speaker-independent devices can be built to recognize the same word or phrase as spoken by many people. But the chances for errors are greater and the vocabularies much smaller.

Vowel Recognition

The ultimate, a computer that people can talk to as they would talk to another person, is still only a tantalizing prospect. Humans have well-developed abilities to adapt to and accommodate varia-

bilities in speech. But what the brain does routinely is enormously difficult for a machine. People tend to run words together when they talk, making it difficult for a machine to know when one word stops and another begins. "What do you want?" might sound like, "Waddayah want?" In addition, people tend to smear sounds together—called coarticulation. For example, the "d" and "y" in the middle of "did you" might come out as a "j."

In spite of the obstacles, the quest continues and progress is being made. Along with researchers at universities and elsewhere, the NIST group is attempting to emulate the way humans recognize speech by developing algorithms and software for phonetically-based recognition of speech. "We are trying to codify linguistic knowledge into something measurable," says NIST computer scientist James Hieronymus.

Methods such as pattern-matching work well for word-recognition devices; but Hieronymus believes the key to continuous speech recognition by a machine is computer programs which can pick out speech sounds, such as vowels and consonants, and use them to identify words. The NIST researchers are concentrating on a vowel-recognition system which accounts for phonetic context—sounds on either side of the vowel. "We are analyzing how vowels are formed, as well as what effect coarticulation has on the sound of a vowel," says Hieronymus.

NIST researchers David Pallett (left) and James Hieronymus discuss a computer program designed to recognize vowels.

Coarticulation—running sounds together—poses a particular problem for a machine. According to Hieronymus, vowel recognition algorithms which do not take coarticulation into account will correctly recognize phonemes in continuous speech only 75 percent of the time. "By developing methods which explicitly model the phonetic context, higher levels of performance are expected to be achieved," he reports. In fact, recognition machines incorporating the NIST method—which does account for coarticulation—can correctly identify vowels in continuous speech 85 percent of the time. "It is a difficult process," says Hieronymus, "but we believe that a good vowel recognition system will provide the anchor for successful, continuous speech recognizers."

Measuring 'Widgets'

An important link in developing the technology is finding a way to measure performance of speech recognition devices. "Technology does not come from a crystal ball," says Pallett. "When you are developing a new 'widget' you build a prototype, test it, evaluate its performance, and if it doesn't measure up, work out the kinks, build another one, and start the

process over." The idea is the same with speech recognition systems: To make progress it is vital to evaluate performance. Others agree. A study by the Committee on Computerized Speech Recognition Technologies of the National Research Council says, "The importance of performance measurement techniques cannot be over-emphasized since they provide the data for decisions about system design and effectiveness."

Working with DARPA and industry, Pallett and his group are developing ways to evaluate performance. DARPA is interested in continuous speech technology to enable jet fighter pilots to talk to on-board computers for information on vital systems such as fuel consumption, or to query tactical databases—"Display the maximum speed of the Kennedy." The NIST test methods will help identify the strengths and weaknesses of these systems and determine whether a proposed system will do the job—or compare systems to see which performs best.

An important link in developing the technology is finding a way to measure performance of speech recognition devices.

Keeping in mind that speech patterns vary because of differences in physiology, sex, age, geographic origin, and education, how do you test a machine fairly? Even if spoken by the same person, a particular word, syllable, or other element of speech may vary in loudness and pronunciation due to stresses such as physical exertion or fatigue. The NIST test method helps to overcome many of these variables by using recorded speech databases in which a number of speakers have read the same vocabulary in a controlled environment. "Using recorded material we can get a broad range of speech patterns and performance. It also allows the test to be replicated in the same way each time and ensures that the test material was properly entered into the system," says Pallett.

The NIST researchers also have developed software which keeps score of words correctly identified as well as errors. In a recent DARPA test for example, this recorded request was read: "Give the names and resources of cruisers that are in Bismark Sea." The computer's interpretation was, "Give *than* names *** resources of cruisers that are *an* Bismark Sea." Results: Seventy-five percent of the words were correctly identified; there were two substitution errors and one word was deleted. Interestingly, says Pallett, most of the errors involve one-syllable words. "These words are difficult to recognize because they are short and frequently are not pronounced carefully," he says.

Although the final goal—a computer you can converse with—still seems very far off, Pallett is convinced it is possible. "Computers that can listen and talk back are a grand idea, not only for business and industry, but also as a way to open up computers and computerized information to a larger population," says Pallett. "NIST is helping to achieve this goal by laying the groundwork of measurement science and research," he says.

by Jan Kosko
NIST Public Affairs Specialist

```
REF: give THE  names AND resources of cruisers that are IN bismark sea
HYP: give THAN names *** resources of cruisers that are AN bismark sea

SENTENCE 13
Correct              =  75.0%    9   (     86)
Substitutions        =  16.7%    2   (     24)
Subs of alpha/numeric =  0.0%    0   (      2)
Subs of mono syllable =  16.7%   2   (     21)
Deletions            =   8.3%    1   (      8)
Deletions of THE     =   0.0%    0   (      1)
Dels of alpha numeric =  0.0%    0   (      1)
Dels of mono syllable =  8.3%    1   (      8)
Insertions           =   0.0%    0   (      2)
Ins of alpha/numeric =   0.0%    0   (      0)
Ins of mono-syllable =   0.0%    0   (      2)
Errors               =  25.0%    3   (     34)

Ref. words           =            12   (    118)
Hyp. words           =            11   (    112)
Aligned words        =            12   (    120)
Ref. unknown         =             0   (      0)
Hyp. unknown         =             0   (      0)
Merges               =             0   (      0)
Merge candidates     =             0   (      5)
Splits               =             0   (      0)
Split candidates     =             0   (      1)
```

```
REF: give me alerts within the last four hours
HYP: give me alerts within the last four hours

SENTEN E 14
Correct              = 100.0%    8   (     94)
Substitutions        =   0.0%    0   (     24)
Subs of alpha/numeric =  0.0%    0   (      2)
Subs of mono-syllable =  0.0%    0   (     21)
Deletions            =   0.0%    0   (      8)
Deletions of THE     =   0.0%    0   (      1)
Dels of alpha/numeric =  0.0%    0   (      1)
Dels of mono-syllable =  0.0%    0   (      8)
Insertions           =   0.0%    0   (      2)
Ins of alpha/numeric =   0.0%    0   (      0)
Ins of mono-syllable =   0.0%    0   (      2)
Errors               =   0.0%    0   (     34)

Ref. words           =             8   (    126)
Hyp. words           =             8   (    120)
Aligned words        =             8   (    128)
Ref. unknown         =             0   (      0)
Hyp. unknown         =             0   (      0)
Merges               =             0   (      0)
Merge candidates     =             0   (      5)
Splits               =             0   (      0)
Split candidates     =             0   (      1)
```

This printout of a test to evaluate performance of speech recognition devices shows words correctly identified as well as errors.

Pinpointing the Origin of Historical Artifacts

In a remote Asian village, an archaeologist dusts off a dirt-encrusted bronze art object. Though the object appears similar to many unearthed in other excavations, a basic question must be answered before it can be catalogued or displayed in a museum: Where did it originate? More specifically, where did the raw materials come from that make up the object?

In many archaeological digs worldwide, this question can be answered readily through knowledge of culture and history. For other locations, however, limited background information makes the task tougher. Objects from the art market are also hard to place.

One of the most useful techniques of tracing an ancient artifact or verifying the authenticity of a piece is lead isotope ratio analysis. Scientists at the National Institute of Standards and Technology are using the technique in collaboration with museum researchers who seek to pinpoint just where precious art pieces come from.

Most recently, several organizations within the Smithsonian Institution have joined with NIST to study lead isotope ratios in samples from over 300 ancient Chinese bronze ceremonial vessels. NIST has contributed instrument time, space in its custom laboratory, and expertise in performing this specialized type of chemical analysis.

Many of the vessels studied are included in the collection of the Smithsonian's Arthur M. Sackler Gallery, a museum of Oriental and Near-Eastern art that opened recently in Washington, D.C. The vessels are from three Chinese dynasties: the Shang, Western Zhou, and Eastern Zhou, which together spanned the period 2500 to 221 B.C.

One of the most useful techniques of tracing an ancient artifact or verifying the authenticity of a piece is lead isotope ratio analysis.

"Lead isotopes are inherently present in these bronze pieces," says Emile C. Joel, a chemist from the Smithsonian's Conservation Analytical Laboratory who has worked full time at NIST analyzing the Sackler vessels. "This is because Chinese craftsmen routinely added 5 percent lead or more to bronze alloys, making the molten metal more fluid so it would cast better."

As part of the general examination of the vessels for preparation of a catalog, samples were taken for lead isotope analysis. Despite the spotty information that exists on raw materials in ancient China, project researchers were able to combine their findings with those of art historians to determine that different lead sources were used during different dynasties. This allowed them to classify vessels into their respective dynasties and, in the process, approximate the age of each piece.

Lead's Unique "Signature"

One of the best ways to reveal a bronze object's origin is to trace the location of the foundry where it was cast. This is not difficult—if lead samples or isotopic data are available from mines used by the

foundries. Lead ore from each mining location has a unique isotopic ratio "signature" because amounts of three lead isotopes—lead 206, 207, and 208—formed in nature as stable end-products of uranium and thorium decay, are discernibly different in most geographic locations. In an analysis, the ratios of the three isotopes to a fourth, the stable isotope lead 204, yield a signature characteristic of a particular lead deposit or mine location. This signature has remained constant through the smelting, alloying, and casting processes.

Lynus Barnes, right, NIST chemist and Emile Joel, a Smithsonian research chemist use a mass spectrometer to determine lead isotope ratios in artifacts.

Therefore, if a vessel foundry had used the same lead source for a prolonged period, the pieces produced will have the same lead isotope signature. Even without knowing in advance the signatures for a given geographic location, vessels from the same foundry or production center should group together as they did in the Sackler research.

Isotope tracing was a critical link in cataloging the Chinese vessels, says Tom Chase, head conservator of the Sackler Gallery. "We've shown that, in some cases, lead isotope ratios of particular Chinese bronze groups are nearly identical. This is almost as good as an imprinted maker's mark. Careful consideration of these results will put the technical history of early Chinese metallurgy on a much firmer footing."

The isotope technique also is valuable for spotting art forgeries. This is because a fake piece or even a later addition to a real piece will be made with lead from a different source than the original. Thus it will not produce the inherent isotopic signature. The NIST work has uncovered some bogus objects.

How dependable is the tracing technique? "Lead isotope analysis by itself is quite reliable, but it's not perfect," says I. Lynus Barnes, an NIST chemist and project manager of the Sackler isotope research. "I would say that you've got about an 85 percent chance of identifying an object's origin using the method alone if a signature has been determined through information or samples from mines." Barnes adds, however, that the isotopic technique is valuable because it is nearly always used in conjunction with some other data such as existing historical information or other chemical analyses. When combined, he says, the resulting data have "high reliability." (Smithsonian researchers are demonstrating the value of blending two methods, for example, when they examine Spanish pottery glazes by using lead isotope ratios in combination with trace element analysis to help determine the origins of those pieces.)

Besides exploiting the isotopic technique's value in analyzing artworks, Institute scientists are using the method for other studies such as determining human exposure to lead-based fuels or tracing the cause of a lead poisoning case.

A Powerful Analytical Technique

At NIST, researchers on the Sackler Gallery work have used a powerful analytical tool known as a mass spectrometer to analyze for lead isotope ratios. Only about a millionth-of-a-gram sample is needed for the analysis, which minimizes adverse effects to the object. A series of steps is carried out that includes dissolving the sample in acid and separating the lead electrochemically. Then researchers perform the mass spectrometric analysis, which sorts out by mass the sample's composition of the four lead isotopes. By comparing the

amounts of these isotopes in the sample, the unique signature can be determined, allowing the lead sample to be traced to its source.

In the past, NIST has been quite successful in tracing artifacts to such countries as Greece, Turkey, Italy, Spain, Egypt, and England because mines from these countries are well-known and lead samples or lead isotope data are readily available. In the case of the Sackler artworks, less was known historically about Chinese raw material sources, which made tracing more difficult and conclusions harder to draw. Still, information gleaned from the research has been useful in refining existing origin criteria and will likely provide information on the sources of raw materials used for vessel manufacture when additional knowledge of mining in ancient China is obtained.

Where Did Columbus Land?

Isotope ratios also have been employed successfully in recent analyses of artifacts excavated from San Salvador Island in the Bahamas—long regarded by many historians as Christopher Columbus' first landing site in the New World in 1492. NIST joined forces with researchers from The Corning Museum of Glass (Corning, N.Y.), Corning Glass Works (also Corning, N.Y.), and the Smithsonian Institution to analyze lead isotope ratios in glass beads, a metal buckle, a coin, and several other excavated pieces. The goal was to help determine if Columbus truly did land first on the island or on any number of other suspected sites such as Egg Island in the northern Bahamas. By determining where and at about what time the San Salvador pieces originated, project researchers could state more reliably how the artifacts got on the island.

Fortunately, all the pieces were found to contain intentionally added lead, which made the isotope ratio technique appropriate. By matching isotopic signatures, researchers were able to conclude that many of the San Salvador artifacts originated in Spain and could possibly have come from Columbus' ships.

Despite the encouraging results of the San Salvador analyses, no firm conclusions were drawn. "A lot more research and excavations still need to be done before we can say for sure where the landing site was," says Robert Brill, a research scientist at The Corning Museum of Glass who has collaborated with NIST on various research projects for 20 years. "What we've done with the isotope ratio data is add ammunition to the argument that Columbus first landed on San Salvador Island. The objects we found could very well have been among those given to Indians on the day of Columbus' first landfall in the New World."

What Lies Ahead

The NIST mass spectrometric lab is also host to a large study of Turkish shipwrecks in collaboration with The Corning Museum, Texas A & M University, Turkish researchers, and the Smithsonian. The first wreck in the study, dating to about 1150 A.D., was believed to be the earliest example of ship construction in the "modern" style—that is, laying the keel first, then ribs and skin. Artifacts from the ship—varied pieces of glasswork, mostly—were analyzed for lead isotopes.

Resulting information, which pinpointed the location of mines for lead used in the glass, was instrumental in revising existing theories about early trade routes from Turkey into northwestern Iran. A similar study is currently under way to analyze metal ingots and fishing weights—which contain lead—from a shipwreck found off the southern coast of Turkey that is believed to be over 3,000 years old. Data from this work will help historians map ancient trade routes.

NIST's Barnes says he expects the Institute to continue collaborating with various organizations on other similar lead isotope studies of artifacts. "The technique has proven its worth as an aid to historical documentation," he says. "Though it does have a few minor drawbacks, it continues to be one of the most valuable ways to gain this background information."

by John Henkel
NIST Public Affairs Specialist

Advanced Materials:

From Laboratory to Production Line

Materials are so basic to human progress that their importance is hard to overemphasize. Every technological advance, from the first stone hammer to today's most complex integrated circuits, sprang from the mastery of specific materials. Accomplishing many of the nation's goals, such as the National Aerospace Plane, faster computers, or electrical energy from nuclear fusion, hinges on our ability to develop new materials that are far superior to those used today.

Indeed, the technological and economic goals of many other countries are also tied to advances in materials, setting the stage for intense international competition. For example, more than half of Japan's 13 priority research and development projects involve materials science. In Europe, the Commission of European Communities has set up national and international cooperative programs that focus on advanced materials.

Research on advanced ceramics, metal alloys, polymers, composites, and the new high-temperature superconductors has already exposed some of the future technological possibilities. The ability to micro-engineer these materials—to create submicroscopic structures and combinations of elements unknown in nature—has resulted in properties and phenomena that until only recently were beyond the imagination. Now that our imaginations have been piqued and our appetites for innovation whetted, our challenge is to transform these materials from laboratory curiosities to viable products and manufacturing processes.

At the National Institute of Standards and Technology, the Institute for Materials Science and Engineering (IMSE) is responding to this challenge in many ways, addressing scientific and measurement issues that are crucial to industry's success in exploiting the potential technological advantages of advanced materials. Consistent with NIST's mission as a national science, engineering, technology, and measurement laboratory, the activities of IMSE's six units emphasize research leading to the development of standards, test methods, and reference data and materials. The guiding tenet for this work is a simple maxim: If a process or property cannot be measured, then it is not completely understood. Inherent in IMSE's mission is the need to develop scientific understanding of the underlying physical and chemical origins of the properties being evaluated.

Covering all classes of advanced materials, as well as major conventional materials, IMSE's research program investigates the relationship between the structure and properties of materials and then applies the resulting knowledge to issues related to the design, processing, and performance of materials. Our approach encompasses the full range of research and development activities, from basic studies to generic applications.

Toward Automated Process Control

In recent years, the focus of IMSE's attention has increasingly turned toward improving the un-

derstanding of materials processing. Our ultimate goal is to help U.S. industry develop real-time, automated systems of process control, so-called intelligent manufacturing methods that improve product quality and increase production efficiency. As study after study has pointed out, firms that emphasize product quality throughout the manufacturing process, rather than at the end of the line only, will strengthen their competitive position.

Intelligent processing of materials is itself the result of a process, the evolutionary development and application of scientific and engineering knowledge. Projects under way in the five IMSE divisions and those managed by the Office of Nondestructive Evaluation are gathering and evaluating much-needed data on structures and properties of materials, at increasingly fine levels of detail and under the increasingly extreme environmental conditions that characterize many high-performance applications. These data support the development of process models, which relate the specific properties of materials at each manufacturing step to the properties of the final product.

In tandem with data-gathering and modeling efforts, IMSE researchers are building and refining real-time sensors for in-process nondestructive measurements. They then develop strategies for coupling on-line measurements with process models. This work establishes the foundation for the final step—merging sensors and models with automation technology to create a truly integrated manufacturing system. Without closed-loop process-control, manufacturing methods will be inefficient, often failing to achieve the carefully controlled microstructures that govern the performance and reliability of advanced materials.

Process control is the common thread that unifies IMSE's varied technical activities—from the development and refinement of theory to innovative methods for on-line nondestructive evaluation. Our work exemplifies the increasingly close link between basic scientific understanding and technological innovation.

Materials science engineer John E. Blendell prepares ceramic material samples for research on superconductors in the NIST ultra-clean ceramic processing laboratory.

Staff and Facilities

IMSE has a research staff of nearly 400 scientists, engineers, and technicians, supported by a budget of about $40 million in 1987. Their efforts are enhanced by the broad range of scientific and engineering expertise and instrumentation available in other parts of NIST, at its facilities in Gaithersburg, Md., and Boulder, Colo. Collaborations are common: In fact, the multidisciplinary makeup of NIST is an especially valuable asset in materials science and engineering, where answers to important research

questions typically require contributions from physics, chemistry, the traditional materials-related disciplines, and many other fields.

Since it was created as the National Bureau of Standards in 1901, NIST has been a partner with other federal agencies, industry, and universities. In IMSE, cooperation is flourishing. In 1987, 374 visiting scientists and engineers conducted studies with IMSE researchers or used the Institute's specialized equipment, some of it unavailable anywhere else in the United States.

NIST's Cold Neutron Research Facility, now under construction, will be used for materials science and engineering research.

Our specialized facilities include an array of metals and ceramics laboratories for controlled materials synthesis and processing; a 12-million-pound test rig for evaluating large-scale mechanical material properties; experimental stations for studying arc-welding processes; specialized small-angle and texture x-ray diffractometers particularly suited for polymer characterization; and a 20-megawatt reactor for neutron-scattering experiments.

Soon this arsenal of research equipment will feature the nation's first dedicated facility for "cold neutron" studies, filling a serious void in the nation's materials science and engineering research. The NIST Cold Neutron Research Facility will provide beams of deeply penetrating low-energy neutrons, essential for important experiments that are impractical or even impossible with conventional neutron sources.

The facility itself will be completed in the spring of 1989 with the first experimental stations becoming available later in the year. By 1992, it will house 15 experimental stations, including five that will be instrumented and operated by outside groups.

Five instruments are now being developed, including a high-resolution small-angle neutron scattering spectrometer, a joint project of NIST and Exxon Research and Engineering. The new facility, which will be available to all U.S. users, is being designed to exploit the most recent advances in technology, resulting in research capabilities that exceed those of cold neutron sources in other countries.

A National Resource

IMSE's research programs and services are crafted according to the needs of U.S. industry. Obviously, we cannot tackle all of the many important issues that must be resolved before industry can fully achieve the promise of advanced materials and manufacturing methods. But, in many instances, we are uniquely qualified to address a certain need.

IMSE's data centers, for example, have stepped up their efforts to make vital, critically evaluated information—such as phase diagrams and corrosion-performance data—available to industry and the scientific community. The centers are also developing computer programs for searching materials databases and for applying data to specific problems.

Through conferences, workshops, and our many cooperative programs with industry, we have identified key areas where our research activities can make important contributions. IMSE's advanced ceramics program, begun in 1985 and now reaching full strength in both staff and facilities, is one example; a second is our high-performance composites project which emphasizes research relevant to high-volume, low-cost applications such as vehicles. Yet another example is IMSE's participation in the NIST-wide initiative to help U.S. industry overcome the many formidable obstacles that stand in the way of commercializing the new high-temperature superconductors.

In these areas, and others, we are working with industry to move advanced materials from the laboratory to the production line.

by Lyle H. Schwartz
Director, NIST Institute for Materials Science and Engineering

Five NIST Projects Win R&D 100 Awards

Five research projects in instrumentation and measurement technology from the National Institute of Standards and Technology received R&D 100 Awards this year. R&D 100 Awards are bestowed annually by *Research & Development* magazine to highlight 100 significant technical products of the preceding year. NIST has received 62 R&D 100 Awards since first entering the competition in 1973.

Descriptions of the award-winning projects follow.

Optical Waveguide Dosimeter

William L. McLaughlin of the NIST Center for Radiation Research and Branislav Radak, a guest scientist from the Boris Kidrič Institute in Yugoslavia, developed an extraordinarily versatile ionizing radiation dosimeter around the concept of radiation-sensitive dyes.

William L. McLaughlin (top) and Branislav Radak with the optical waveguide dosimeter.

Colorless compounds that take on color when irradiated, "radiochromic dyes" have been in use for some years as one-shot, disposable dosimeters for industrial radiation processing, an application that McLaughlin pioneered.

In the new invention, the dyes are used in the core of a long fiber-optic tube that can be coiled into a small space, about 2 centimeters square. A light source at one end and a detector at the other read changes in the dye.

Because the light path can be quite long even in a small detector, the instrument can be made extremely sensitive. The optical waveguide dosimeters can function over a range from about 0.005 to 10,000 gray.

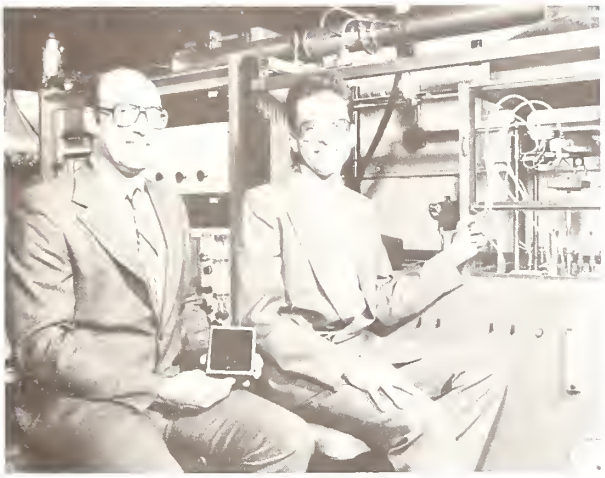
They will register either pulsed or steady radiation fields, and can measure accurately both dose and dose rates of x and gamma rays, neutrons, and charged-particle beams.

By selecting from a variety of available radiochromic dyes and plastics, researchers can tailor the dosimeters to have special properties, such as matching the radiation interaction characteristics of tissue for medical applications and radiation protection.

Cone Calorimeter

Vytenis Babrauskas and William Twilley of the NIST Center for Fire Research developed an apparatus which provides the data critical to predicting the fire hazard of a product from a small sample of material.

The instrument, known as the NIST Cone Calorimeter, measures the heat released and the rate at which it is released, the time it takes for a material to ignite, the amount of smoke produced, and the amount of several known toxic gases. Equipment



William Twilley (left) and Vytenis Babrauskas with the NIST cone calorimeter.

previously available could not measure as many fire properties.

Both the ASTM and the International Organization for Standardization are proposing voluntary fire hazard test methods based on the NIST Cone Calorimeter. Commercial units now are sold by two U.S. manufacturers and a rapidly growing number are in use worldwide.

System for Absolute Determination of Aqueous Electrolyte Conductivity

Three NIST researchers constructed a device that determines the "absolute" electrical conductivity of aqueous solutions and can be used as a primary standard against which other instruments may be compared.

The unique feature of the device is its measurement cell. Other available systems rely on cells of fixed geometry and work by comparing a solution of unknown conductivity to a standard calibration solution of known conductivity. These instruments typically are accurate to 0.1 percent.

The NIST system uses a variable cell size and does not have to be calibrated. Because its results are traceable to the physical standards of mass, length, and electrical resistance, the new device provides an "absolute" conductivity determination with an accuracy of 0.02 percent.

It also features extremely accurate temperature control, which is important because conductivity measurements are dependent on temperature.

The device has many potential applications. Standards laboratories desiring an absolute measuring system could adapt it. Other laboratories could use the device to calibrate existing conductivity measuring instruments. Oceanographers could employ it in measuring seawater salinity, and environmental scientists could determine dissolved solids.

With minor modifications, the device also could be used as a reliable indicator of water purity. Such an instrument would be valuable in the pharmaceutical, electrical power, and electronics industries, which rely on pure water for their products.

The NIST system for absolute determination of aqueous electrolyte conductivity was developed by Yung Chi Wu, Kenneth W. Pratt, and William F. Koch, all of the NIST Center for Analytical Chemistry.

Kenneth W. Pratt (l. to r.), William F. Koch, and Yung Chi Wu developed a system for absolute determination of aqueous electrolyte conductivity.

Edward F. Kelley with the image-preserving optical delay.

Image-Preserving Optical Delay

Edward F. Kelley of the NIST Center for Electronics and Electrical Engineering generated a pioneering photographic "time machine" which—when used with a high-speed camera—permits photographing events which occurred before the camera's shutter is opened.

The system, called an image-preserving optical delay, differs from conventional photography which records an event only when the shutter is open.

This new device, an arrangement of optical components including mirrors and a crystal shutter, allows researchers to take detailed, high-speed photographs of random—that is, non-triggered—events.

It is now used for processes which last from 100 nanoseconds, or billionths of a second, to 10 microseconds, or millionths of a second, to study materials utilized by the electric power industry.

This system stores optical images of a random event long enough so the shutter of a high-speed camera can be opened and photographs taken of the processes leading to the random event. Kelley has filed a patent application on the system.

Functionally, the optical delay is equivalent to forcing the image to travel an additional 120 meters before it gets to the camera. Using a series of concave and planar mirrors, this path length is folded into about 4 meters.

The system is rugged enough to be used in a variety of settings. Normal vibration, air currents, and airborne dust have minimal effect on its operation.

Trace Measurement System

Computers known as multiprocessors use more than one computing element, or "processor," to simultaneously solve many pieces of a problem. While multiprocessors can speed the processing of data, they also have unique problems including unbalanced processing loads, uneven flow of information, and an increased likelihood of communications bottlenecks.

Three researchers in the NIST National Computer and Telecommunications Laboratory (formerly Institute for Computer Sciences and Technology) developed tools to help measure the performance of multiprocessors. The ability to measure performance helps users evaluate and compare machines and manufacturers improve future designs.

Through a single circuit board added to the computer system, the Trace Measurement System—TRAMS—can measure key characteristics of a program such as the time it takes to execute a piece of code and how frequently a piece of code is executed.

Unlike other measurement systems now on the market, TRAMS does not disturb the operation being measured. Disturbances, or "perturbations," can alter the performance of a multiprocessor, making the results of the measurement meaningless.

The trace measurement system was developed by John W. Roberts (l. to r.), Robert J. Carpenter, and Alan Mink.

Robert J. Carpenter, John W. Roberts, and Alan Mink developed the measurement system with partial sponsorship from the Defense Advanced Research Projects Agency.

Biotech Center Names Top Officials

The Center for Advanced Research in Biotechnology (CARB), a joint research venture for academic, government, and industrial scientists, has named Thomas L. Poulos, 41, as director and Walter J. Stevens, 44, as associate director. Poulos, a tenured professor of biochemistry at The University of Maryland, had served as acting director of CARB. He received his Ph.D. in biology from the University of California at San Diego. His professional experience includes work at Genex Corporation and the University of California, San Diego.

Stevens, a National Institute of Standards and Technology computational physicist, was awarded his doctorate in chemical physics from Indiana University. He has been with NIST since 1975.

CARB, founded in February 1984, as a first-of-its-kind, joint effort of The University of Maryland, NIST, and Montgomery County, Md., is one of four research centers in the Maryland Biotechnology Institute (MBI).

"Protein engineering is the future direction of biotechnology."

The mission of CARB is to fashion a world-class, multidisciplinary center in protein engineering, structure, and function as well as to offer the biotechnology community capabilities not readily available in most companies. In protein engineering, scientists alter a protein's atomic structure to enhance its useful properties.

"Protein engineering is the future direction of biotechnology," says Poulos. "In time we should be able to change the sequence of amino acids [the building blocks of proteins] at will and produce novel, beneficial substances." One area of application for work at CARB is so-called rational drug design. In this approach researchers modify the structure of a therapeutic protein or drug so it attacks infection more effectively.

CARB has specifically targeted five areas for focused research. The first, x-ray crystallography, is a long-standing technique to unravel the crystal structure of proteins. A second direction is two-dimensional nuclear magnetic resonance (2-D NMR) spectroscopy, an evolving method to determine the structure of proteins in solution. The two techniques complement one another.

"We intend to use both crystallography and NMR at CARB. While crystallography gives much more precise structural data on larger proteins, NMR provides more information on the dynamics of proteins—how they wiggle and wobble in solution," explains Poulos.

A third area is the modeling of protein structures. If researchers grasp the structure then they can predict the changes that lead to specific protein properties. This work requires substantial computer capabilities and will guide the efforts of the experimental group. A mini-supercomputer will be housed at CARB.

The fourth area is physical biochemistry, necessary to charac-

terize the properties of the novel protein once it is produced. The last direction is molecular biology, which enables scientists to produce the novel protein in large quantities.

"While a number of institutions enjoy expertise in crystallography, molecular biology, or NMR spectroscopy, few have them all focused on a common theme. What's unique about CARB is the application of these tools to protein structure and function problems under one roof," says Poulos.

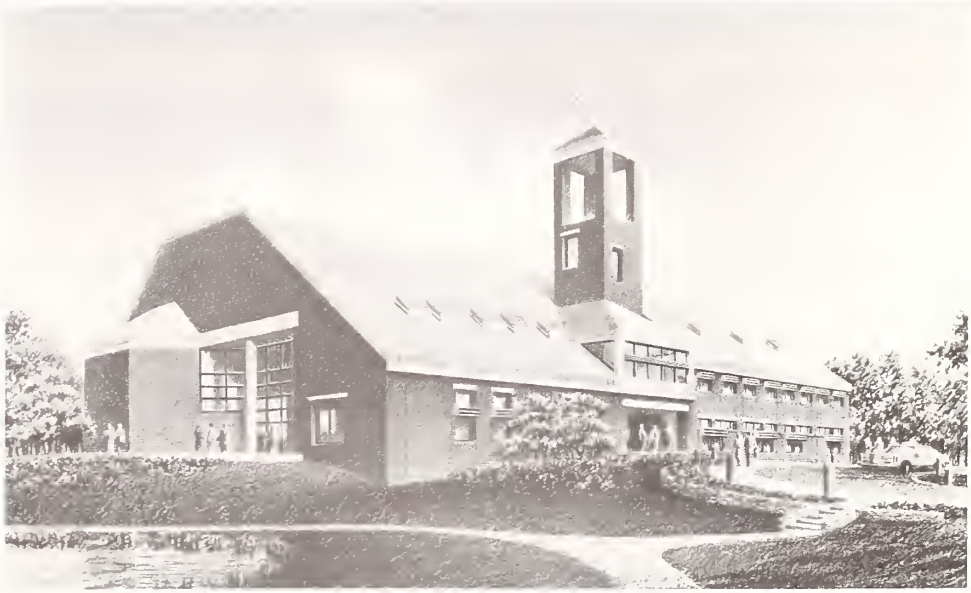
Companies can participate in CARB research by becoming industrial affiliates, jointly sponsoring specific projects, or establishing collaborative research projects....

A variety of proteins are now under investigation at CARB. These include:

- ribonuclease, a standard protein—a digestive enzyme—and a model for studies in how proteins fold. This folding affects their biological activity.
- chymosin, or rennin, a protein used in producing cheese. In collaboration with a local biotechnology company, CARB staff solved its structure recently. (See article on page 22.)
- cytochrome P450, an important enzyme in detoxification and in carcinogenesis.
- beta-lactamase, also known as penicillinase, the protein central to bacterial defense against penicillin-like antibiotics. Understanding its function is important to the rational design of more effective antibiotics.

Companies can participate in CARB research by becoming industrial affiliates, jointly sponsoring specific projects, or establishing collaborative research projects under agreements which permit the company to obtain a license to any proprietary technology resulting directly from the research.

CARB's new laboratory and office site, a 33,000-square-foot building under construction at the Shady Grove Life Sciences Center in Rockville, Md., sits on 50 acres donated by the county through the Gudelsky Foundation.



The CARB facility, now under construction, will house state-of-the-art laboratories for protein crystallography, molecular biology, NMR spectroscopy, biophysical chemistry, and computer modeling.

Montgomery County provided $9 million to construct the facility through a bond issue. The CARB staff, expected to reach nearly 100 by 1991, has been using research space made available at NIST in Gaithersburg, Md., until the opening of the CARB building later this fall.

by John S. Makulowich
NIST Public Affairs Specialist

High-Resolution Structure for Chymosin Solved

By solving a high-resolution structure for a cloned version of the cheese-producing enzyme chymosin, researchers at the Center for Advanced Research in Biotechnology (CARB) have added this fundamental protein to the growing list of biologically active molecules with known structures. Chymosin, or rennin, was originally prepared from the stomach linings of calves for the making of cheese, and is one of the oldest commercial enzymes. Working with cloned chymosin expressed in E. Coli bacteria, Gary Gilliland and colleagues at the National Institute of Standards and Technology and CARB mapped the structure of the enzyme with a resolution of approximately 2.3 angstroms—comparatively high resolution for a protein of 323 amino acids. The cloned chymosin was prepared by the Genex Corporation.

Gary Gilliland, an NIST research scientist, studies the model of chymosin structure on a workstation screen.

Chemical techniques for determining the composition of proteins—the sequence of amino acids that make up the molecule—are fairly well developed. Determining the structure of the protein, the three-dimensional configuration of the molecule, is much less straightforward. This is in part because the most exact techniques, x-ray and neutron crystallography, depend on being able to crystallize the protein, something which is still more of an art than a science.

Chymosin belongs to a class of enzymes called acid proteases which have a number of interesting functions, according to Gilliland. Chymosin itself is interesting because the particular cloned version—bovine pancreatic chymosin—is the best enzyme for producing several different types of cheese, and just what makes it the best is a matter of some commercial interest.

In addition, a similar enzyme, rennin, is found in human blood, and plays a role in regulating blood pressure. An accurate structure for chymosin can be one step on the path to developing extremely specific drugs for treating high blood pressure.

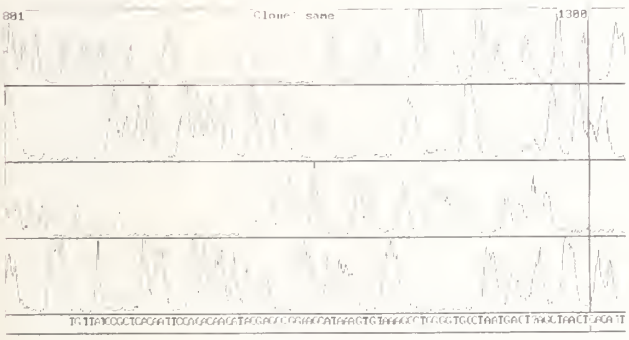
More generally, according to Gilliland, accurate structural information on chymosin will contribute to understanding what governs the shape of proteins.

"The 'folding problem'—how the amino acid sequence determines the structure—is one of the biggest problems in biology today," observes Gilliland. "The rules that govern protein folding are very crudely understood at present, and an important aspect of our work is the contribution to the data needed to determine these rules."

The chymosin structure was determined by Gilliland; Alex Wlodawer, of the National Cancer Institute Frederick Cancer Research Facility; Joseph Nachman, a guest scientist from Israel; and Evon Windborne of The University of Maryland. M.B.

New Technique Automates Sequencing of DNA

Researchers from EG&G Biomolecular and the National Institute of Standards and Technology, in collaboration with the Center for Advanced Research in Biotechnology (CARB), have cooperated in developing an improved method for automating DNA sequencing. Sequencing—determining the precise sequence of DNA bases in a gene—is one of the most important tasks in molecular biology and protein engineering. It is an extremely time-consuming job, with numerous chances for error. The key problem is to detect the positions of DNA fragments arrayed in ladder-like patterns down the electrophoretic gel plate used to separate them.



Typical display of raw data from automated sequencer shows a short segment of DNA. Each track is a separate DNA base.

"Traditionally" this is done by using radioisotopes to label the DNA fragments. A sheet of photographic film is laid over the gel plate and beta particles from the labelled DNA fragments expose the x-ray film. A researcher then examines the film to note the relative position of these small, dark bands—typically 300 DNA bases can be determined from a single analysis.

It makes it possible to design automated DNA sequencers that are smaller and less expensive than those based on fluorescent dyes.

This part of the procedure is not only very laborious, but also the greatest source of error in DNA sequencing.

Several techniques have been developed to automate the process, but these rely on fluorescent dyes as labels in lieu of radioisotopes. The dyes are expensive and can interfere with the chemistry used to sequence the DNA, or may introduce variations in the mobility of the DNA fragments during electrophoresis.

In contrast, the new technique makes use of the conventional radioisotope-labeled DNA whose behavior is comparatively well understood. It uses radioactive phosphorous, which makes it possible to study other important biomolecules such as RNA and proteins. It makes it possible to design automated DNA sequencers that are smaller and less expensive than those based on fluorescent dyes.

NIST researchers aided in developing standard sample preparation procedures. They also are studying the new technique for use in obtaining quantitative as well as qualitative information. M.B.

Role of Inflammatory Cells in DNA Damage Described

The role of white blood cells in the formation of inflammation-related malignant tumors should become clearer with a new list of DNA damage assembled by researchers from the National Institute of Standards and Technology and the Scripps Clinic and Research Foundation. White blood cells, or "leukocytes," play a key role in the defense against bacterial infection, but under the abnormal condition of chronic inflammation they are also associated with an increase in malignant tumors, although the exact mechanism is not well understood.

The researchers quantitatively analyzed damage done to the four DNA bases by the action of these leukocytes. This damage is suspected to be an important link in the formation of inflammation-related tumors.

The researchers studied a class of leukocytes called neutrophils. When triggered by the presence of foreign objects, such as bacteria, neutrophils begin a so-called "respiratory burst" in which oxygen molecules are reduced to superoxide radicals. The enzyme superoxide dismutase (SOD) then transforms these radicals to hydrogen peroxide.

Researchers believe that in the presence of some metal ions such as the iron ions which are found in the cell, the hydrogen peroxide is transformed to hydroxyl radicals, which are known to cause DNA damage.

In a recently completed paper, Janice Jackson and Charles Cochrane of the Scripps Clinic and Ewa Gajewski, Alfred Fuciarelli, and Miral Dizdaroglu of NIST report on experiments at NIST and Scripps in which calf thymus DNA was exposed to "stimulated" human neutrophils in the presence of iron ions.

"We, along with other people, have found that cells that have been bombarded with the oxidants and have DNA damage, when cultured and put into mice, will become malignant," explains Cochrane. "We now ask, 'What is the connection?' Is it the damaged DNA or something else? So we're looking at exactly what the oxidants are doing to DNA and trying then to relate that development to the malignant transformation."

The neutrophils were stimulated with a tumor promoter, phorbol myristate acetate (PMA). The DNA then was separated from the solution and analyzed using gas chromatography-mass spectrometry with selected ion monitoring (GC-MS/SIM) to identify and quantitatively determine both the altered and unaltered DNA bases present.

GC-MS/SIM is an extremely sensitive analytic technique capable of detecting damaged base products at concentrations as low as 10 femtomoles (10 parts per quadrillion.)

The results show that all four DNA bases are susceptible to neutrophil-induced changes. Six different base products were detected and measured quantitatively, including two which had been previously identified by other researchers. The quantitative results suggest, according to the researchers, that guanine is the most susceptible DNA base, followed by adenine, cytosine, and thymine. M.B.

Laser Cooling Limit Broken

How cold can a gas get? Based on recent experiments at the National Institute of Standards and Technology, a lot colder than anyone thought. Careful measurements of the temperature of "gases" of cooled atoms by a group of physicists from NIST, the University of Connecticut, and the State University of New York (SUNY) at Stony Brook have revealed that the lowest temperatures achieved may be more than 10 times lower than the limit predicted by the generally accepted model, according to a report in the July 11 issue of *Physical Review Letters*.

Extremely low-temperature gases of free atoms or ions are produced in laboratories by a technique known as "laser cooling," which is about 13 years old as a theory and about 10 years old in practice.

In laser cooling, a laser beam shines on an absorbing gas and (rather against intuition) cools it. It works because the laser is tuned to a frequency somewhat below a resonance frequency for the atom of interest. On the average, the atom radiates the light at a higher frequency, closer to resonance, so it radiates away more energy than it absorbed. The extra energy comes out of the kinetic, or thermal energy of the atoms, so the gas cools down.

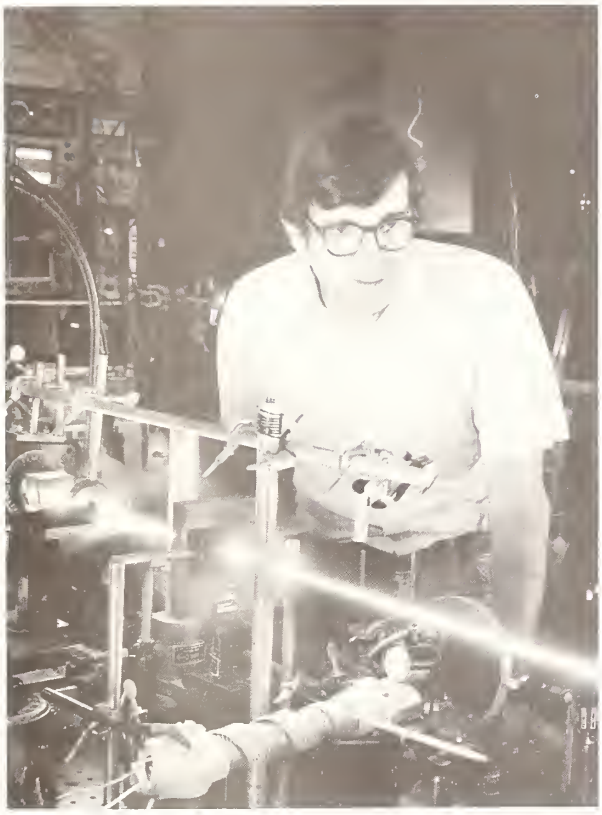
The original idea was proposed in 1975 by Theodor Hänsch and Arthur Schawlow of Stanford University and independently by David Wineland and Hans Dehmelt of the University of Washington. (Wineland now works at NIST.) Since then physicists have succeeded in cooling ions and atoms to within a thousandth of a degree of absolute zero. In one laser cooling technique, arrays of opposing laser beams have been used to create an "optical molasses," a region that the free atoms experience as a viscous medium in which they slow down and tend to stay confined.

"We have a clear and dramatic violation of the accepted model."

Since about 1977, physicists have generally accepted that there must be a lower limit to the temperature that can be achieved by these techniques. The reason is that random emissions and absorptions of photons by the atoms causes some heating, which at lower temperatures becomes as important as the cooling effect. The cooling limit is the temperature at which the cooling and the heating are in equilibrium. For neutral sodium atoms, that limit had been calculated to be about 240 microkelvins (millionths of a degree above absolute zero.) A number of research groups across the country have measured the temperature of laser cooled atoms or ions to be near their cooling limits.

Using a method suggested by Harold Metcalf of SUNY, the group at NIST measured the temperature of sodium atoms, laser-cooled in optical molasses, to be about 45 microkelvins, with an uncertainty of about 20 microkelvins.

The researchers were so surprised by this result that they



Physicist William Phillips with the laser cooling and trapping apparatus.

used three more temperature measurement methods to confirm it before reporting that the cooling limit had been broken.

"Our temperatures are completely inconsistent with the accepted value of the cooling limit," observes group leader William Phillips of NIST. "We have a clear and dramatic violation of the accepted model." At present, says Phillips, the reasons for the violation are more-or-less "a mystery," but he offers some lines to explore.

"For one thing," Phillips says, "the model is based on an idealized 2-energy-level atom. Real atoms like sodium have many levels.

"In addition, the model makes other approximations. The prediction of the cooling limit assumes the laser power is quite low, which is not the case in these experiments. Now the theory predicts that as you increase laser power, you would raise the temperature, but perhaps when you take into account multi-level atoms, greater power levels produce lower temperatures. However, at present no one is even sure what such a theory would look like."

Such experiments can make very accurate measurements of intrinsic properties of the atoms....

In theory, the cooling limit also depends on how far the laser frequency is "detuned" from the atomic resonance frequency, according to Phillips. Theory teaches that the optimum detuning is about one-half the frequency width of the resonance, but the NIST experiments were conducted with lasers tuned 2 and 3 linewidths off resonance. One reason why his group observed results which had gone unnoticed before, says Phillips, is that they specifically set out to measure how the minimum temperature changed with detuning, and so looked at detunings which otherwise might not have been used. For the detunings which produced the lowest temperatures, the theory predicts a temperature at least twice the "cooling limit," or about 10 times higher than the observed temperature.

An important goal of laser cooling experiments is to create samples of free, isolated atoms or ions, moving very slowly in a confined region, where they can be probed by various techniques. Such experiments can make very accurate measurements of intrinsic properties of the atoms—measurements which in the past have led to important advances in the theories of quantum mechanics and relativity, among others. Such measurements also form the basis for the best atomic clocks. The colder the atoms are, the less their motion contributes to uncertainties in these measurements.

The discovery of cooling below the "cooling limit" should allow even more accuracy than previously thought possible. But, as Paul Lett, first author on the recently published research paper, points out: "The atoms are going so slowly that the best measurements may need to be done in the weightless environment of an orbiting shuttle or space station. Here on Earth our atoms double their kinetic energy after falling only a few millimeters." M.B.

Tracing the Sources of Industrial Emissions

In an effort to track emissions from coal-fired industrial plants to their sources, researchers at the National Institute of Standards and Technology and The University of Maryland have developed a technique that shows promise as a simple and definitive way of tracing smoke particles. The researchers say the method may be the first one suitable for tracing fine particles over long distances. Other techniques that use tracer gases detect only gaseous components of stack emissions, not particles.

The NIST/Maryland work, sponsored by the Electric Power Research Institute, uses artificially enriched stable isotopes of rare earth elements as "tags" to permit positive identification of emission particles near the source or miles away. These isotopes are nontoxic and inexpensive.

Several rare earth elements such as neodymium or samarium are well suited for the project because they contain as many as seven stable isotopes whose relative abundances are constant in nature. This rnakes these elements nearly insensitive to contamination from outside sources. Researchers can enrich any of these isotopes (such as neodymium-148) with additional atoms to create a "signature" that can be easily measured later in the laboratory.

At the plant site, the enriched rare earth element is dissolved in a solvent and injected into the stack emission stream in the form of fine droplets. Researchers believe the solvent then evaporates immediately and the rare earth particles that are left quickly bind to emission particles. Once this binding has occurred and emissions have entered the environment, particles can be recovered, analyzed, and traced to their source. The University of Maryland Department of Chemistry is developing this system for injecting the isotopic material into the stack emissions stream.

Sample analysis is being done in the NIST Center for Analytical Chemistry by thermal ionization mass spectrometry, a powerful method that charges atoms in the sample and then separates them by mass.

"We anticipate that tagging will be especially effective in the submicrometer particle range," says W. Robert Kelly, chief NIST scientist on the project. "This is important because these tiny particles are the ones that travel the farthest."

Because up to five isotopes of a rare earth element can be tagged differently, a single element possibly can be used to trace particles simultaneously from up to five sources. That would let researchers assess individual emission contributions from several sources at one site.

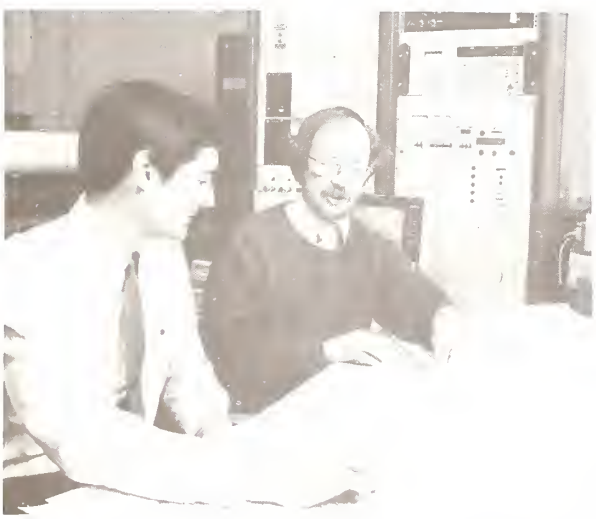
Besides allowing samples to be traced to their sources, the mass spectrometric analysis also can measure how much of the tagged material is present, in essence gauging the source's environmental impact.

At present, project work has been confined to determini.,g the tagging technique's feasibility by in-stack tests at a single coal-fired plant site. Project researchers now would like to track the emissions of more than one power plant and to analyze vegetation samples to investigate whether emission sources can be separated. J.H.

Helping Industry Find Substitute CFC's

Some things are just too good to be true. That seems to be the case with CFC's—chlorofluorocarbons—now in use. Over the past 50 years, these CFC's have significantly affected our way of life. They are used as refrigerants for home refrigerators and freezers, refrigerated tractor trailers, and automobile air conditioners as well as insulation in homes and commercial buildings.

But recent evidence has shown that these chemicals which have made modern life so comfortable also can damage the Earth's ozone layer. The threat is so great that industries worldwide are seeking substitutes. The National Institute of Standards and Technology is helping in the search for alternative refrigerants by developing data on the properties of likely candidates.



Mark McLinden (left), a chemical engineer, and Graham Morrison, a physicist, are developing property data for refrigerants that will not harm the ozone layer.

The CFC's currently in use are nontoxic, nonflammable, inexpensive, odorless, and, most essentially, stable. Stability, however, can be a double-edged sword; once emitted to the atmosphere CFC's continue to persist. There is much evidence that the CFC's now being used can break down the ozone layer which protects the Earth against harmful levels of ultraviolet radiation from the sun. An international agreement has been proposed to reduce current CFC production to 50 percent of 1986 levels before the end of the century.

Among the CFC's targeted for reduction are trichlorofluoromethane (R-11) and dichlorodifluoromethane (R-12). According to the Chemical Manufacturers Association, R-11 and R-12 account for about 70 percent of all CFC emissions. Both R-11 and R-12 are used as a foaming agent in making low-density plastics and foam insulation for buildings, refrigerated trailers and railroad cars, and home appliances. R-11 also is used in centrifugal chillers for cooling commercial buildings and R-12 is the working fluid in commercial and residential refrigerators and freezers and automobile air conditioners.

Finding Alternatives

While it seems likely that alternatives will be other CFC's, information on most CFC's is meager, proprietary, and, in some cases, conflicting or of questionable quality. But with the recently proposed international agreement to phase out R-11 and R-12, information on the chemical and physical properties of other CFC's is vitally needed by industry to evaluate possible replacements. For the most part, industry is concerned with developing the manufacturing processes for the new alternatives and determining properties such as toxicity, flammability, and materials compatibility needed to

make decisions regarding the economics and feasibility of an alternative. NIST's work will build on the Institute's long-standing research programs in refrigerants and refrigeration systems and thermodynamic properties. It will focus on determining the thermal properties needed for machinery design and adaptation. Results of the NIST research will be publicly available.

Researchers in the NIST Centers for Building Technology and Chemical Engineering are developing fundamental data on the chemical and physical properties of CFC's and mixtures of CFC's. This data is needed by industry to help evaluate the impact that likely candidates for replacement refrigerants will have on equipment. Ideally, industry would like to have "drop-in" substitutes—chemicals that perform as the CFC refrigerants now on the market. If drop-ins cannot be found, equipment manufacturers would have to redesign products and manufacturing operations and procure new tooling—a process that could cost millions of dollars. In addition, equipment still in use would have to be retrofitted or replaced.

Property Measurements

In work being funded by the American Society of Heating, Refrigerating and Air-Conditioning Engineers, the Environmental Protection Agency, and the U.S. Department of Energy, NIST researchers are developing property measurements for R-134a and R-123. These refrigerants seem to be good candidates to replace R-12 and R-11. But little information is available on their thermodynamic characteristics which engineers need to evaluate how a refrigerant will perform in equipment. NIST plans to complete the measurements and make tables and charts containing the information available later this year.

In addition to developing data for specific refrigerants, the NIST researchers are working on a mathematical model that can be used to estimate properties from a small amount of data. The model will be especially useful in helping to determine how a mixture of CFC's will perform. Information on mixtures is even more meager than information available on single refrigerants. But mixtures can expand the list of replacement refrigerants by mitigating an undesirable property of an otherwise acceptable compound. For example, the CFC refrigerant 152a is by itself moderately flammable but it can form a nonflammable substance when mixed with R-12.

Foam Insulation

Two of the most efficient insulating products used in new building construction today are polyurethane and extruded polystyrene rigid foam insulation; both contain CFC's. During the foam manufacturing process, CFC's—either R-11 or R-12—are used to form gas cells or bubbles. These cells greatly reduce the amount of heat transferred through the material, making it an excellent insulator.

In a study for the Department of Energy, NIST researchers looked at the economics of alternative insulation materials. Specifically, they investigated the cost effectiveness and potential energy consequences of using expanded polystyrene (EPS) and fiberglass—neither contains CFC's.

They found that both EPS and fiberglass typically cost less than most CFC-containing foams. But since they contain air bubbles instead of gas bubbles, they do not insulate as efficiently. Because more of the material is needed to achieve the same thermal performance, there may be an increase in cost if walls or roof areas must be expanded to accommodate the thicker insulation.

To help industry evaluate the thermal performance of new candidates for foam insulation, the researchers also are going to build a database of heat flow (thermal conductivity) measurements for foam insulation currently on the market. Only limited data now are available. They will measure the thermal conductivity of three CFC-containing foams—extruded polystyrene (R-12), polyisocyanuarate (R-11), and phenolic foam insulation (mixture of R-111 and R-113)—as well as expanded polystyrene, which does not contain CFC. As replacement candidates come along, extensive heat flow measurements will be added to the database, allowing manufacturers to compare their thermal performance. J.K.

New Publications

A Summary of the New European Community Approach to Standards Development

Cooke, P.W., Natl. Bur. Stand. (U.S.), NBSIR 88-3793-1, 13 pages (August 1988). Send a self-addressed mailing label to: Patrick W. Cooke, Office of Standards Code and Information, A629 Administration Bldg., NIST, Gaithersburg, MD 20899.

The Commission of the European Communities (EC) is acting swiftly to turn the 12-member countries into a single integrated market of 320 million people by the end of 1992. EC legislation dealing with standardization is likely to have a profound effect on U.S. exports, predicts this report. The report recommends U.S. business interests should establish communications with European subsidiaries, distributors, or their American industry associations to obtain up-to-date information on the development of European directives and standards. U.S. companies also are urged to seek and take opportunities to comment on, and attempt to influence, proposed European directives and standards. This report contains a list of EC and U.S. government contacts for information on various aspects of EC activities related to standardization.

The ABC's of Certification Activities in the United States

Breitenberg, M.A., Natl. Bur. Stand. (U.S.), NBSIR 88-3821, 28 pages (July 1988). Order by sending a self-addressed mailing label to Maureen A. Breitenberg, A629 Administration Bldg., NIST, Gaithersburg, MD 20899.

Certification programs, considered a vital link between product standards and actual products, have significant impact on the marketplace. This publication describes the different types of programs or schemes used to produce written assurance that a product or service conforms to a standard or specification. A sequel to *The ABC's of Standards-Related Activities in the United States* (1987), the new report provides a further introduction to certification for those not familiar with this important standards-related activity. Included are descriptions of product quality; self-certification; third-party certification; federal, state, international, and regional programs; choice of standards; certification methodology; and certification marks. The report also addresses some of the potential problems with certification programs.

Comparison of Direct Digital Control and Pneumatic Control Systems in a Large Office Building

Bushby, S.T. and Kelly, G.E., Natl. Bur. Stand. (U.S.), NBSIR 88-3739, 55 pages (March 1988). Order by stock no. PB #88-215470/AS from NTIS, $14.95 prepaid.

In a comparison of two energy management and control systems (EMCS), NIST researchers found the microprocessor-based EMCS performed as well as, and in many cases better than and consumed less energy than, the pneumatic control system. The microprocessor-based system was developed by NIST and constructed of "off-the-shelf" components. The communication and control software also was written in-house. The system was installed in the NIST 11-story Administration Building along with the in-place pneumatic system. Both were monitored for a year. One advantage of the microprocessor system is ease of resetting and maintaining operating schedules. A problem with the pneumatic system is that the tuning of the system "drifted" with time and was sensitive to changes made during routine maintenance. The microprocessor-based EMCS gives more information about the performance of the system allowing problems to be discovered earlier and providing information for diagnosing a problem.

Alaskan Marine Mammal Tissue Archival Project: A Project Description Including Collection Protocols

Becker, P.R., Wise, S.A., Koster, B.J., et al., Natl. Bur. Stand. (U.S.), NBSIR 88-3750, 53 pages (March 1988). Order from Stephen Wise, A113 Chemistry Bldg., NIST, Gaithersburg, MD 20899.

In an effort to pinpoint the environmental effects of industrial activities such as offshore oil exploration and mineral extraction in Alaska, NIST has joined forces with the National Oceanic and Atmospheric Administration (NOAA) to study the tissues of a variety of Alaskan marine mammals. The fatty tissues of these mammals are excellent accumulators of contaminants that upon chemical analysis provide accurate pictures of pollutant levels at a given time and place. Because these animals are top predators in the marine environment, scientists also can examine the effects of pollution on the marine food chain. Researchers in the NIST/NOAA program are using the National Biomonitoring Specimen Bank, housed at NIST headquarters in Gaithersburg, Md., for long-term storage of the samples. Their goal is to create an archive of mammal tissue collected over several years that would indicate a baseline contaminant level against which future measurements can be compared. This report describes detailed procedures for collection, analysis, and storage of samples.

Fire Research Publications, 1987

Jason, N.H., Natl. Bur. Stand. (U.S.), NBSIR 88-3758, 70 pages (April 1988). Order by stock no. PB #88-199611 from NTIS, $14.95 prepaid.

Interested in the combustion toxicity of various plastics? cigarette fire-safety? sprinklers? smoke control? soot formation? The NIST Center for Fire Research last year issued publications and articles on these topics and many others, all of which are compiled in this bibliography. NIST conducts research on how fires start and spread and how they can be detected and suppressed. This research leads to realistic material test methods, cost-effective fire safety design concepts, and new methods of fire control and extinguishment.

Directory of Federal Government Certification Programs

Breitenberg, M., editor, Natl. Bur. Stand. (U.S.) NBS Spec. Pub. 739, 229 pages (April 1988). Order by stock no. 003-003-02852-5 from GPO, $12 prepaid.

This is a guide for manufacturers, distributors, state and local government officials, importers, consumers, and others concerned with standards and procedures used in federal certification programs. It contains information on manufactured products, agricultural commodities, medical services—devices and drugs, defense procurement items, transportation, and the voluntary inspection and uniform grading of such food items as dairy products, meats, and produce. Each entry describes the scope and nature of the program, lists the testing and inspection practices, standards used, methods of identification and enforcement, reciprocal recognition or acceptance of certification, and a contact point in the federal agency. The updated directory is a joint effort by NIST and the U.S. Department of Agriculture.

GATT Standards Code Activities of the National Bureau of Standards 1987

Overman, J.R., Natl. Bur. Stand. (U.S.), NBSIR 88-3747, 31 pages (March 1988). Order from the Office of Standards Code and Information, A629 Administration Bldg., NIST, Gaithersburg, MD 20899.

This annual report describes NIST's role over the past year as the official U.S. GATT (General Agreement on Tariffs and Trade) inquiry point for information on standards and certification activities that might significantly affect U.S. trade. The NIST effort included coordinating comments on proposed foreign regulations, translating of foreign texts, and operating the GATT "hotline" (301/975-4041, not toll free) that provides the latest information on foreign notifications from the GATT Secretariat in Geneva, Switzerland. The 1987 highlights were participation in the GATT Standards Code meeting on information exchange and the ISONET (International Organization for Standardization Information Network) workshop on international trade; publication of an introduction to standardization, certification, and laboratory accreditation; and background research for the Canadian Free Trade Agreement.

The Journal of Research of the National Bureau of Standards

Kessler, K.G., chief editor, Natl. Bur. Stand. (U.S.), Vol. 93, No. 3, 525 pages (May-June 1988). Order by stock no. 703-027-00022-9 from GPO, $3 prepaid.

The proceedings of a 1987 symposium, "Accuracy in Trace Analysis—Accomplishments, Goals, Challenges," have been reprinted in this special edition of the journal. The 4-day event at NIST covered topics such as the history of trace analysis, robotics in the chemistry lab, measuring vitamins in foods, and the use of microwaves to dissolve samples. The proceedings consist of nearly 140 technical reports.

NBS Standard Reference Materials Catalog 1988-89

Seward, R.W., editor, Natl. Bur. Stand. (U.S.), NBS Spec. Pub. 260, 148 pages (January 1988). Order from the Office of Standard Reference Materials, B311 Chemistry Bldg., NIST, Gaithersburg, MD 20899, 301/975-OSRM (6776).

Nearly 1,000 Standard Reference Materials (SRM's) available from NIST are listed in this catalog. The SRM's, certified for specific chemical and physical properties, include cements, ores, metals, glass, plastics, food, and environmental and clinical items. The expanded list of nutrition and health standards includes materials to calibrate instruments to detect marijuana in a human urine sample (SRM 1507) and to improve the precision of tests for elevated levels of the enzyme aspartate aminotransferase (AST) to detect heart attacks (SRM 8430). Two new micro-length standards also are listed. The first commercial space-made product, 10-Micrometer Polystyrene Spheres (SRM 1965), is available on a glass slide to calibrate microscopes. The second commercial space-made product, 30 Micrometer Polystyrene Spheres (SRM 1961), is a new measurement standard for powder manufacturers. Also available is a series of seven individual low-alloy steels widely used in industry (SRM's 1761-1767).

Ordering Information

To order publications from NTIS, send request with payment to: National Technical Information Service, Springfield, VA 22161. Publications can be ordered from GPO by mailing the order with payment to Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402.

Conference Calendar

April 3-7, 1989

6th International Conference on High Temperatures: Chemistry of Inorganic Materials

NIST, Gaithersburg, MD

This meeting will bring together experts in the field of high-temperature materials to discuss the latest scientific and technical developments. Both plenary and selected contributed papers will be presented and published subsequent to the meeting. Academic, industrial, and government researchers worldwide having an interest in high-temperature processing, performance, and properties of inorganic materials will participate in the meeting. Organized under the joint sponsorship of the International Union of Pure and Applied Chemistry and NIST. Contact: John W. Hastie, B106 Materials Building, NIST, Gaithersburg, MD 20899, 301/975-5754.

April 17-21, 1989

Nuclear Analytical Methods in the Life Sciences

NIST, Gaithersburg, MD

Nuclear analytical methods, in particular nuclear activation techniques, constitute an important group of methods of chemical and physical-chemical analysis. Papers will be presented in oral and poster sessions on the following topics: new and emerging methodology, activation techniques, quality assurance, comparison of activation analysis with other methods, and applications of nuclear techniques in biology, medicine, biotechnology, agriculture, and nutrition as well as in public and environmental health. This international conference is organized by NIST, in cooperation with the International Atomic Energy Agency. It is cosponsored by the American Nuclear Society, the U.S. Department of Energy, and the Food and Drug Administration. Contact: Rolf Zeisler, B108 Reactor Building, NIST, Gaithersburg, MD 20899, 301/975-6290.

April 26-28, 1989

Fifty Years With Nuclear Fission

NIST, Gaithersburg, MD

Fifty years with nuclear fission will be celebrated with a conference at NIST and the National Academy of Sciences. Chaired by G.T. Seaborg and E. Segrè, the first general session, to be held at NAS, will feature invited talks devoted to a historical account of progress in the field given by leading contributors from the United States and abroad. The second and third days of the conference, to be held at NIST, will feature papers covering such topics as: fission theory, instrumentation, fission applied data, astrophysical and space applications, fission by-products in biology and medicine, industrial fission by-product applications, reactor design and development, and peaceful uses of fission technology. Sponsored by NIST and the American Nuclear Society, and cosponsored by the American Physical Society Division of Nuclear Physics and the American Chemical Society Division of Nuclear Chemistry and Technology. Contact Oren A. Wasson, B109 Radiation Physics Building, NIST, Gaithersburg, MD 20899, 301/975-5567 (FTS 879-5567).

May 4-5, 1989

9th Conference on Roofing Technology

NIST, Gaithersburg, MD

NIST and the National Roofing Contractors Association have joined to sponsor conferences on roofing technology on a biennial basis since 1969. The theme of the 9th conference is "Putting Roofing Technology to Work." Topics that will be discussed include thermal analysis for membrane characterization, field testing and the effect of surface contamination on adhesive-bonded seams, compatibility of insulations and membranes, vapor retarders, thermal bridging, planned maintenance, and new developments in coatings. Sponsored by the National Roofing Contractors Association and NIST. Contact: Walt Rossiter, B348 Building Research Building, NIST, Gaithersburg, MD 20899, 301/975-6719.

June 7-9, 1989

Second International Conference on Hot Isostatic Pressing (HIP)—Theory and Applications

NIST, Gaithersburg, MD

During the last 15 years hot isostatic pressing (HIP) has proved to be a versatile technique for the manufacture of advanced products and to increase the performance of components. Significant advances are occurring in the modeling of the densification process, in the development of more versatile HIP units, and in the application of HIP technology to new types of materials. The goal of this conference is to promote a wider awareness of advances which have occurred since the previous conference in Lulea, Sweden, in the theories and application of HIP, and to stimulate discussions of these advances and of the future directions for HIP technology. Sponsored by NIST. Contact: Robert Schaefer, A153 Materials Building, NIST, Gaithersburg, MD 20899, 301/975-6176.

☆ U.S. GOVERNMENT PRINTING OFFICE: 1988 - 242-311 - 814/92587

U.S. DEPARTMENT OF COMMERCE
National Institute of Standards and Technology
Gaithersburg, MD 20899

OFFICIAL BUSINESS
Penalty for Private Use, $300

BULK RATE
POSTAGE & FEES PAID
NIST
PERMIT No. G195