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Chairman Wu, Ranking Member Gingrey and Members of the Subcommittee, thank you for the opportunity to appear before you today to present the President's Fiscal Year 2009 budget request for the National Institute of Standards and Technology (NIST). This budget reflects NIST's growth path under the President's American Competitiveness Initiative (ACI) and under the America COMPETES Act (PL110-69) that this committee passed last year. The levels reflected in this budget will further enhance NIST's ability to provide the Nation's critical measurement and standards needs.

NIST will meet this challenge by relying on partnerships with industry and academia to plan and carry out research and provide services. These partnerships also allow NIST to stay abreast of current high priority needs and to anticipate emerging needs. More than 1,800 guest researchers work with nearly 3,000 NIST staff members in NIST laboratories and facilities on several campuses to provide the nation with the most advanced measurement and standards research and services.

The FY 2009 request of $638M includes $634M for NIST's core programs (encompassing NIST's research and facilities) and $4M for the Hollings Manufacturing Extension Partnership. The budget for the NIST core represents a 22 percent increase (excluding congressionally directed grants) over the FY 2008 appropriations for these programs. The President's request focuses on high-impact research that will address critical national needs, spur economic growth and accomplish NIST's mission to advance innovation and industrial competitiveness.

**Supporting Innovation and the Economy**

The well-being of U.S. citizens is affected every day by NIST's measurement and standards work. Virtually every segment of the economy – transportation, computers, banking, food processing, health care and communication – depends on NIST research, products and services. More broadly, the quality of the water we drink, the air we breathe, and the food we eat depends in part on that work. NIST standards—which are not regulatory—ensure that consumers are confident of the quantity and quality of the product purchased whether it is a gallon of gasoline or the amount of electricity used and stated in the monthly bill. They protect our banking at ATMs and our online purchases. Soon, these standards will help to protect the privacy of our health records.

They improve the accuracy of our medical tests and treatments and help to make sure that we know the nutritional content of what we are eating. They help to convict criminals and free the innocent through more accurate and faster DNA tests. They provide crucial timekeeping that we depend upon for navigation, telecommunications, financial transactions, and basic research. And they improve the readiness of our first responders and our homeland security. The measurement and standards infrastructure provided NIST paves the way for U.S. innovation and economic competitiveness. In many instances, NIST work in measurement science is the critical path to discovery and innovations.

While companies strive to make their latest products and services as easy to use and as simple for consumers as possible, the underlying knowledge and technology base that makes this possible is certainly not simple. Consider the web of fiber optic networks that makes broadband communication–from long distance telephone, to cable television, to high-speed internet–possible. The system includes dozens of independent networks, tens of thousands of connections and millions of miles of optical fibers, each fiber capable of carrying hundreds of separate signals simultaneously. Yet, despite its already mind boggling complexity, this fiber optic system that our economy depends on may soon suffer with the same kind of traffic congestion currently clogging highways around many major metropolitan areas.

To prevent this, communications manufacturers and service companies need faster, more accurate ways to measure the quality of optical signals, data analysis tools to diagnose transmission problems, and nanoscale monitoring systems for ultra fast microchips that use light instead of electrons to store and process information. NIST is uniquely positioned to help meet these challenges. NIST has the right combination of world class scientists and engineers, outstanding scientific facilities, and strong ties with both the industrial and service sectors to provide the tools needed to realize next-generation optical technologies. As a result, the consumer will receive information faster, with fewer disruptions, and be able to interconnect between networks to get work done that suits their needs.

Medicine is facing a similar complexity explosion. As the project to decode the 3 billion "letters" of the human genome has demonstrated, the frontiers of medicine have moved in the last few decades from often qualitative assessments to increasingly quantitative measures down to the level of individual biological molecules. As a result, medical researchers skilled in the biological sciences are increasingly finding that they need to integrate physical scientists, and their quantitative measurement skills into their research teams.

Just as a systems engineer might study an entire fiber optic network from its individual components to its overall efficiency, life science researchers are beginning to treat medical and biological research problems with a "systems approach" long used in engineering and the physical sciences. Life sciences researchers are attempting to fully integrate what they know at the nano and microscale of molecules, DNA, and proteins with the macroscale problems of disease and other medical problems experienced by patients. Again, NIST, with its interdisciplinary research staff and expertise in creating groundbreaking new measurement methods and standards, can provide the tools needed to advance the field. The payoff will be faster development of new drugs, more personalized medicine, and better prediction, diagnosis, and understanding of disease. This approach leverages NIST's core competencies.

Similar opportunities exist for NIST to undertake the equally complex measurement challenges involved in safely exploiting the promise of nanotechnologies or transforming the field of computer modeling and visualization to a truly quantitative, predictive science.

To accomplish all of these goals and to meet the challenges of the ACI, NIST must continue to update and expand its own laboratory facilities. Consequently, this budget also includes a request for the final year of funding for the continued construction of an extension to NIST facilities at its laboratory in Boulder, CO (Building 1) to provide new high performance space; a new request for an expansion of facilities and capacity to train future U.S. scientists in cutting edge atomic, molecular, and optical physics at JILA–NIST's world renowned joint institute with the University of Colorado at Boulder; as well as funding for the third year of a program to expand and upgrade NIST's Center for Neutron Research–the Nation's leading facility of its kind and a critical research tool for more than 2,200 researchers annually who work in nanotechnology, advanced materials, biotechnology, and other fields.

**FY 2008 Impacts**

The ACI and the passage of the America COMPETES Act provide an unprecedented opportunity to further enhance and accelerate NIST's contributions to innovation and competitiveness.

Unfortunately, FY 2008 appropriations were well below the requested level. Those appropriations do not provide funding for NIST's laboratory research and facilities efforts at the President's request level for the ACI. We are pleased that the President's FY 2009 Request would restore NIST to the path to double over a ten-year period its core research activities. NIST will make every effort to optimize the funds provided, but the lower 2008 funding provided compared to the President's budget request will have negative impacts on NIST and its customers and partners in industry, academia, and other agencies. Those impacts include a real loss in timely research that yields positive benefits for the nation. The FY 2008 omnibus appropriation included $83M in earmarks and unrequested grants for NIST, the impact of which is to slow down or limit the core research and facilities proposed at NIST. This means that research areas critical to U.S. innovation will not be advanced as aggressively as originally proposed in critical areas such as nanotechnology, quantum computing, climate change and earthquake and other disaster resistant structures.

It also means that NIST falls $13.5M short of the amount needed to cover salary increases and other anticipated costs, requiring several actions. Consequently, NIST will slow down new hires with specialized skills and will not be able to bring on board the estimated 300 additional staff and guest researchers anticipated with the budget initiatives requested by the President. NIST managers are reviewing laboratory and administrative activities to ensure that ongoing high priority projects receive the funding that they need and that all funds are used as efficiently as possible.

As part of the ACI, NIST received $79.1M of its requested $93.9M for two new facilities initiatives and for operational maintenance, major repairs and safety of the NIST campuses. To compensate for the shortfall, NIST has adjusted its overall facilities plans in order to proceed with the two major projects. NIST will slow down its plans to reduce

the backlog of deferred maintenance projects on existing facilities. This increases the chances of unanticipated major equipment outages and temporary loss of facilities use, resulting in higher repair costs and loss of researchers' productivity.

The President's FY 2009 request for NIST would get the Institute back on a doubling track - enabling NIST to continue to aggressively lay the science and technology foundation recommended by so many reports and proclamations on U.S. innovation and competitiveness. It is paramount that NIST move rapidly and wisely toward realizing the vision of being the world's leader in creating critical measurement solutions and promoting equitable standards. Well-targeted measurement and standards investments is a proven path to stimulate innovation, foster industrial competitiveness, increase economic security, and improve the quality of life of all Americans.

## FY 2009 President's Budget

NIST's FY 2009 budget request totals $638M, which includes $634M for core research and facilities programs, a 22 percent increase (excluding congressionally directed grants) over the FY 08 appropriations for these same core programs. The increased funding for NIST's core programs provided through the FY 2009 request will directly support innovative advances in broad sectors of the economy as well as improve the safety and quality of life for our citizens. The FY 2009 budget contains a total of 17 initiatives. Five of the initiatives have not been requested before. The balance of the initiatives was proposed in the FY08 budget. After being updated, all went through a rigorous internal process to assess their value and connection to NIST's mission. Their relevance, technical merit, and priority were reaffirmed.

The following table summarizes the proposed FY 2009 budget. In this table, we show both the FY 2007 and FY 2008 enacted levels without congressionally directed projects for comparison.

**National Institute of Standards and Technology (NIST)**
**FY 2007 - FY 2009 Budget**
**Excluding Congressionally Directed Projects**
**(Dollars in Thousands)**

| | FY 2007 Enacted | FY 2008 Enacted* | FY 2009 President's Budget |
|---|---|---|---|
| **National Institute of Standards and Technology (NIST)** | | | |
| Scientific and Technical Research and Services (STRS) | 434,371 | 439,624 | 535,000 |
| Construction of Research Facilities (CRF) | 58,686 | 79,148 | 99,000 |
| NIST Core Subtotal (STRS + CRF) | 493,057 | 518,772 | 634,000 |
| **Percentage increase from preceding fiscal year** | 14% | 5% | 22% |
| Industrial Technology Services (ITS) | | | |
| Advanced Technology Program (ATP) | 79,078 | N/A | 0 |
| Technology Innovation Program (TIP) | N/A | 65,200 | 0 |
| Hollings Manufacturing Extension Partnership (MEP) | 104,741 | 89,640 | 4,000 |
| Subtotal, ITS | 183,819 | 154,840 | 4,000 |

| | | | |
|---|---|---|---|
| **NIST Total** | **676,876** | **673,612** | **638,000** |

*The FY 2008 amount for Scientific and Technical Research and Services appropriation does not include $893,000 for a congressionally directed project. The FY 2008 amount for Construction of Research Facilities appropriation does not include $51.3M in congressionally directed projects and $30M for a new competitive construction grant program that was not requested by the President.

The total request of $638M for NIST is divided into three appropriations accounts**:**

**I. SCIENTIFIC AND TECHNICAL RESEARCH AND SERVICES (STRS) $535M.** This category includes $526.5M for NIST laboratory research and $8.5M for the Baldrige National Quality Program. Major components of the FY 2009 request include four new STRS initiatives (in *italics*) and nine initiatives requested – but not funded – in FY 2008.

**Addressing Urgent Environment, Safety and Security Needs (+$26.2M)**

- ***Nanotechnology: Environment, Health and Safety***
- Climate Change Science: Measurements and Standards
- National Earthquake Hazards Reduction Program
- Disaster Resilient Structures and Communities
- Biometrics: Identifying Friend or Foe

**Investing in Strategic and Rapidly Advancing Technologies (+$42.8M)**

- ***Innovation in the Biosciences Measurements and Standards***
- ***Comprehensive National Cyber Security Initiative: Leap-Ahead Technologies***
- ***Optical Communications and Computing***
- Quantum Information Science
- Nanotechnology: Discovery to Manufacture
- Innovations in Measurement Science
- Enabling the Use of Hydrogen as a Fuel
- Manufacturing Innovation through Supply Chain Integration

**II. CONSTRUCTION OF RESEARCH FACILITIES (CRF) $99M.** This category includes $37.3M in base funding for operational maintenance, major repairs and safety of the NIST sites; and $63.7M for three initiatives outlined below.

**Boosting U.S. Science/Engineering Capacity and Capability ($63.7M)**

- ***JILA Building Expansion: Pushing the Scientific Frontiers***
- Boulder Building 1 Extension: 21st Century Tools
- Safety, Capacity, Maintenance and Major Repairs
- NIST Center for Neutron Research (NCNR) Capacity and Capability

**III. INDUSTRIAL TECHNOLOGY SERVICES (ITS) $4M.** The Hollings Manufacturing Extension Partnership (MEP) program and the Technology Innovation Program (TIP) compose NIST's Industrial Technology Services account.

The budget also reflects the Administration's focus on its highest priorities -- including basic research, consistent with the American Competitiveness Initiative --and the need to restrain spending. The request for the Hollings Manufacturing Extension Partnership is $4 million, enough for an orderly end to federal funding for the program, while no funds are requested for the Technology Innovation Program.

**FY 2009 Initiatives in Detail.**

The initiatives are described in more detail below. They are organized within appropriations accounts and by FY 2009 initiative categories.

# I. SCIENTIFIC AND TECHNICAL RESEARCH SERVICES (STRS)

## Addressing Urgent Environment, Safety and Security Needs (+$26.2M)

### *Nanotechnology: Environment, Health and Safety Measurements & Standards (+$12M)*

Products made with nanometer-scale components and materials—a thousand times thinner than a human hair and smaller—are already dramatically improving the performance of current products from stain-resistant pants to fuel-efficient aircraft. Many more applications beckon such as targeted cancer drugs, ultrafast electronics, and improved diagnostic tools for medicine.

The small size of these components produces new properties not seen in larger-scale "bulk" materials. While nanomaterials promise many useful applications, very little is known about the environmental, health, and safety (EHS) risks associated with them. The safety or toxicity of nanomaterials can be determined only with well-understood materials and well-defined testing methods.

The interagency National Nanotechnology Initiative (NNI) has designated NIST as the lead federal agency to develop metrology tools and methods for measuring and characterizing nanomaterials. NIST has the interdisciplinary physical-science expertise and the facilities needed to develop accurate, validated methods for understanding the EHS properties of nanoscale materials.

The proposed initiative funding will allow NIST to launch a three-pronged approach to the problem:

- create a classification scheme for determining the characteristics of nanoparticles necessary for assessing toxicity, including size, shape, and chemical composition;
- develop detection and measurement methods for quantifying the number and nature of nanoparticles with EHS impact in biological and environmental samples; and
- predict how modifications to nanoparticles will affect their impact on the environment, health, and safety.

**Measurements and Standards for the Climate Change Science Program (+$5M)**

The climate is changing. Determining how fast it is changing and understanding the complex relationship between all the environmental variables to allow accurate predictions is part of the objective of the U.S. Climate Change Science Program. Some of the drivers of climate, such as the sun's output, may vary slowly over decades. As a result, climate predictions depend critically on developing absolute measurements of the sun's energy that can be compared accurately over decades from different sensors. Other important variables include the sizes, shapes, and chemical composition of particles or droplets (aerosols) in the atmosphere. Whether aerosols contribute to the warming or the cooling of the Earth depends upon their composition.

With the funding provided through this initiative and in coordination with other agencies, NIST will develop:

- an international irradiance measurement scale to be used in rigorously calibrating satellite light intensity instruments prior to launch to ensure sufficient accuracy to allow valid comparisons among results from different instruments or from data sets taken over different periods of time;
- new instrument design strategies and quality assurance programs to optimize accuracy and stability of satellite and ground-based solar measurement systems;
- techniques for generating specific types of aerosols in the laboratory, measuring aerosol optical and physical properties, and simulating aerosol properties that cannot yet be measured in the laboratory; and
- a database of critically evaluated data on aerosol properties collected at NIST and elsewhere.

**National Earthquake Hazards Reduction Program (+$3.3M)**

Within the United States, more than 75 million people are located in urban areas considered to be at moderate to high risk for earthquakes. Just the economic value of the physical structures within these regions—not including the potential loss of life and economic disruption—is valued at close to $8.6 trillion. A single large earthquake in the United States, like the one that struck Kobe, Japan, in 1995, can easily cause damage of $100 billion to $200 billion.

A critical gap exists between the results produced by basic research and the implementation of that knowledge in the field. New construction materials, techniques, building codes, and standards do not reflect the current state of knowledge. Through the National Earthquake Hazards Reduction Program (NEHRP), NIST is tasked with conducting problem-focused research to bridge this gap and to promote its application by the private sector.

At the proposed funding level, NIST will:

- identify implementation gaps between basic research results and design guidance and national model building code provisions;
- develop rational cost-effective, consensus-based seismic design and analysis procedures for use in national model building codes;
- design guidelines for the testing and design of major structural systems;
- characterize fully the seismic capacities of typical older building structural components and systems as they are built; and
- develop structural performance criteria, analytical models, and cost-effective rehabilitation techniques for existing buildings.

**Disaster Resilient Structures and Communities (+$4M)**

For the past few years, natural hazards, including hurricanes, extreme winds, storm surge, wildland fires, earthquakes, and tsunamis, as well as terrorist actions, have been a continuing and significant threat to U.S. communities.

The disaster resilience of our physical infrastructure and communities today is determined in large measure by the building standards, codes, and practices used when they were built. With few exceptions, these are oversimplified and inconsistent with current risk assessments. As construction and rebuilding costs continue to rise, there is increasing recognition of the need to move from response and recovery to proactively identifying and mitigating hazards that pose the greatest threats.

NIST and the National Oceanic and Atmospheric Administration (NOAA) have coordinated their programs in this area. Initiative funding in FY 2009 will allow NIST to develop:

- standard methods to predict losses, evaluate disaster resilience, and estimate cost-to-benefit of risk management strategies at the community and regional scales as opposed to the individual building scale;
- decision support tools to modernize standards, codes, and practices consistent with the risk;
- a validated "computational wind tunnel" for predicting extreme wind effects on structures; and
- risk-based storm surge maps to be used in designing structures in coastal regions and an improved hurricane intensity classification scale.

In addition, the funding will expand and accelerate research results for projects begun with funding in FY 2007 on prediction of fire hazards at the wildland/urban interface; and improved tools for designing and constructing earthquake-resistant structures.

**Biometrics: Identifying Friend or Foe (+$2M)**

NIST has decades of experience improving human identification systems and currently is working with other federal agencies, including the Department of Homeland Security, the Federal Bureau of Investigation, and the U.S. Department of State, to evaluate and

improve the ability of biometrics to enhance border security. The USA Patriot Act and the Enhanced Border Security and Visa Entry Reform Act call for NIST to develop and certify a technology standard for verifying the identity of individuals and to determine the accuracy of biometric technologies, including fingerprint, facial, and iris recognition.

Biometrics technologies, primarily fingerprints, are being used broadly in the United States for border security. New technologies under development, in particular, "multimodal" systems that combine two or more biometric technologies, such as fingerprint, facial, and iris, promise to bring significant improvements. But NIST studies have shown that the accuracy of today's facial recognition systems is relatively poor compared to fingerprints, and iris recognition needs more study and testing to determine its accuracy in operational environments.

In conjunction with several other federal agencies, including the FBI and Department of Homeland Security, private industry and universities, NIST is managing the Multiple Biometric Grand Challenge, which aims to reduce errors in both face and iris recognition systems. Also, NIST is performing large-scale evaluations of iris recognition to promote its standardization.

NIST is also supporting the development of standards for interoperability between different fingerprint systems through large-scale testing.

With additional funding, NIST will:

- enable facial recognition technologies to be used for border security;
- build on its testing program to determine the accuracy of multimodal systems;
- develop tests and guidelines to assure that future biometric systems are interoperable, and work efficiently in real-time applications by:
    - improving the use of fingerprints with real-time fingerprint readers;
    - improve the interoperability, robustness, and usability of fingerprint systems and facial recognition systems;
- improve biometric systems by enabling simultaneous use of facial recognition, fingerprint, and iris-scan technologies

NIST will coordinate this work with other government agencies and the private sector while taking international standards developments into account.

## II. Investing in Strategic and Rapidly Advancing Technologies (+$42.8M)

### *Measurements and Standards to Accelerate Innovation in the Biosciences (+$10M)*

Inaccurate bioscience measurements sometimes make it hard to tell when treatments are healing or causing harm. They often increase costs and lower the quality of healthcare. The lack of reliable, quantitative measurements in the biosciences is also impeding progress in a number of promising life-science research areas. Compared to the

measurements made in the physical sciences, medical tests and bioscience-based measurements need to be repeated and rechecked far too frequently. Today, even standard measurements on a limited number of blood proteins often yield variable results among expert laboratories.

The research initiatives newly proposed in FY 2009 will focus on three intersecting areas of research:

- make biological data more quantitative and reliable by establishing methods, standards, and benchmark data for the fundamental measurements that underpin the life sciences in techniques such as mass spectrometry and molecular imaging;
- devise new methods for simultaneously measuring hundreds to thousands of molecules at a time by developing and validating new technologies in areas such as microfluidics and live cell imaging; and
- help laboratories more easily compare and combine their measurements and computer models with one another by developing standards for the exchange of biological data and information.

### *Comprehensive National Cyber Security Initiative: Leap-Ahead Security Technologies (+$5M)*

Many of today's tools and mechanisms for protecting against cyber attacks were designed with yesterday's technology in mind. Information systems have evolved from room-size computer workstations shut off from the rest of the world to ubiquitous mobile devices interconnected by a global Internet. In this diverse ecology of communication devices, no cyber security solution works on all operating systems and can protect every type of computer and network component. Operating systems are now composed of millions of lines of code, rather than thousands, and have many more potential holes.

The NIST request is part of the Administration's Comprehensive Cyber Security Initiative. NIST is a recognized world leader in the field of cyber security. Working with other federal agencies, NIST proposes an initiative in three essential elements of cyber security infrastructure:

- create technical standards for generating, distributing, using, storing and destroying secret numbers known as cryptographic keys, commonly used to grant access to authorized individuals on encrypted computer networks and systems. This effort will be conducted in technical consultation with the National Security Agency (NSA) and the Department of Defense (DoD), as well as other government agencies and non-government organizations;
- nurture the development of "multifactor authentication" methods. Such methods require users to verify their identities through multiple methods, such as passwords and iris scans, rather than just one. NIST will develop a standardized framework that ensures these methods work across different computer platforms and operating systems. The effort will be coordinated with vendors and federal departments, including the Department of Homeland Security; and

- extend the Federal Desktop Core Configuration, a set of standard security settings that optimize security, to other operating systems, applications, and network devices beyond the existing support for Windows XP and Vista.

### *Going at Light Speed: Optical Communications and Computing (+$5.8M)*

As demand on the U.S. communications network continues to grow, a new generation of transmission and networking technologies is required to keep pace. Keeping pace is critical because communications fundamentally drives productivity gains and economic growth; it cradles innovation in many current and future industries, including telemedicine, entertainment, and security.

This initiative will promote advances in light-scale communications ranging from the nanoscopic innards of an individual computer to the continent-spanning scale of the nation's optical communications network. Already the world leader in measurements of high-speed devices and of hybrid optical and electronic devices, NIST will work closely with industry and expand its work to include research and development of:

- new measurement capabilities to accommodate higher-speed, next-generation communications networks;
- measurements that diagnose and locate transmission problems on data networks, and provide the information needed to reconfigure and redirect traffic to match demand; and
- new measurement techniques for analyzing computer circuits that transmit light instead of electricity, enabling the manipulation of light within computer chips, and interconnecting very small electronic and optical devices.

### Quantum Information Science (+$7M)

NIST scientists are world leaders in the emerging field of quantum science. Three NIST scientists have won separate Nobel Prizes in the last 10 years based on their work in the field. Many of the best minds in physics today believe that applications of quantum science will transform the 21st century just as integrated circuits and classical electronics transformed the 20th century.

Having developed potential components for quantum computers and demonstrated other advances, NIST is proposing to expand further its quantum science program in FY 2009. Several of the projects proposed under this initiative will be in collaboration with the Joint Quantum Institute established by NIST, the University of Maryland, and the National Security Agency. NIST will:

- begin development of quantum "wires" that use "teleportation" techniques to reliably transport information between the components of a simple quantum computer based on manipulation of atoms, other elementary particles, or solid-state quantum devices;

- begin development of quantum memory analogous to the random access memory of today's computers to allow more complex logic operations;
- begin development of methods for transferring quantum-based information from one form (such as atoms) to another form (such as photons);
- develop an all-optical clock for more precise time and frequency measurement; and
- exploit the unusual quantum properties of "coherence" and entanglement to provide exquisite physical science measurement capabilities with improved sensitivity, accuracy, and speed.

**Enabling Nanotechnology from Discovery to Manufacture (+$7M)**

In FY 2007, NIST began a major initiative to address the measurement barriers hindering rapid development of nanotechnologies. A new NIST Center for Nanoscale Science and Technology (CNST) has been established that combines both research and a state-of-the-art nanofabrication and nanometrology user facility.

While a complementary NIST initiative will provide important groundwork in measuring environmental, health, and safety (EHS) risks of nanotechnology, this research initiative will build on recent NIST advances in developing nanoscale science and technology by:

- devising ways to measure strength, stress, strain, optical, and electronic properties of nanostructures to improve processes and understanding of failure mechanisms;
- creating three-dimensional, high-resolution imaging methods that reveal details of structure, chemical composition, and manufacturing defects and allow researchers to view nanostructures as they interact with their environment;
- simulating nanoscale phenomena with computer models to allow economical development of production methods for complex nanodevices; and
- pushing existing computer technology to its ultimate limit by developing measurements and standards that support "ultimate CMOS," or the development of current transistor technology to its technological limit.

**Innovations in Measurement Science (+$3M)**

As new science and technology areas emerge, NIST must quickly develop the measurement methods needed to support them. The Innovations in Measurement Science Program is one of NIST's primary mechanisms for keeping pace with the measurement requirements needed for innovation in U.S. industry.

Established in 1979, the program supports high-risk, leading-edge research projects that anticipate industry needs and develop measurement science for the next generation of technology. At some point in their careers, all three of NIST's Nobel laureates have had their research funded by this program. Current NIST expertise in quantum information science, fuel cell science, three dimensional chemical imaging, and many other areas important to national priorities were launched with "measurement innovations" funding.

This initiative will expand the scope and nature of projects selected for the Innovations in Measurement Science Program to allow this program to keep better pace with the evolving needs of industry and science. Emphasis will be placed on the development of multidisciplinary research areas with the greatest potential for fostering innovation.

The NIST Laboratories carefully evaluate the technical merit, potential impact, and staff qualifications for detailed research proposals submitted by the NIST technical staff. Successful proposals are funded for five years—ensuring enough time for the innovative measurement science approach to be developed—and are reviewed throughout the program to ensure satisfactory progress.

**Enabling the Use of Hydrogen as a Fuel (+$4M)**

Hydrogen offers the possibility of lowering the impact of motor vehicles on the environment, and reducing our nation's dependence on foreign oil. While the burning of fossil fuels produces carbon dioxide and other emissions harmful to the environment, hydrogen fuel can be made from many energy sources, including renewables.

Technical challenges need to be overcome to make hydrogen-powered vehicles more practical and economical. Hydrogen can embrittle metals and other container materials, is highly combustible, and requires storage containers larger than those for other fuels with equivalent energy. Moreover, the technical infrastructure must be developed to ensure safe production, storage, distribution, delivery, and equitable sale of hydrogen in the marketplace.

Expansion of research efforts at NIST is essential to achieving widespread use of hydrogen as a fuel. NIST has been a leading provider of data on the chemical and physical properties of hydrogen for more than 50 years. It has statutory responsibility under the Pipeline Safety Act of 2002 to develop research and standards for gas pipeline integrity, safety, and reliability. It is the lead U.S. agency for weights and measures of vehicle fuels, and the distribution and sale of hydrogen will require entirely new systems for ensuring equity in the marketplace.

NIST's Center for Neutron Research is a premier facility for real-time, three-dimensional imaging of hydrogen in operating fuel cells. Using the unique resources developed at this NIST facility will help reduce technical barriers for efficient hydrogen production, storage, and use. NIST expertise will be essential for making fuel cells less costly and more reliable.

**Manufacturing Innovation through Supply Chain Integration (+$1M)**

America's large manufacturers are globally distributed enterprises that rely on a system of small manufacturers, parts suppliers, shippers, and raw materials producers organized in extended "supply chains." Using the auto industry as an example, the average car has more than 15,000 parts coming from 5,000 manufacturers that are made to the precise specifications of the auto company and must arrive on time.

Production costs are no longer the major cost component in these global supply chains—the dominant cost is in the engineering and business activities, which depend critically upon clear and error-free exchange of information among partners.

Inefficiencies and needless roadblocks in the exchange of product design and business data in manufacturing and construction are estimated to cost the U.S. economy more than $25 billion per year. Small manufacturers are particularly hurt by these problems, but they affect the competitiveness of entire industries.

In the 1980s NIST pioneered work in developing early open standards for data exchange. Under this initiative, NIST will conduct a much more extensive, wide-ranging, and technologically advanced program. Working closely with U.S. manufacturers to develop seamless data transactions throughout global supply chains, NIST will work to shorten the design-to-manufacturing cycle, improve quality, and lower costs for large and small U.S. firms.

Major goals will include:

- creating "roadmaps" for the development of open standards for enterprise integration in target industry sectors;
- developing validation and conformance tests to help ensure the performance of these standards as well as their proper use; and
- ensuring the standards are integrated and consistent with developing international standards and easily available to small and medium-sized U.S. manufacturers.

# III. CONSTRUCTION OF RESEARCH FACILITIES (CRF)

## Boosting U.S. Science and Engineering Capacity and Capability (+$63.7M)

### *JILA Expansion: Preparing the Next Generation of Physicists (+$13M)*

Space has run out at one of the nation's most valuable training grounds of top scientific talent. JILA, a joint institute of NIST and the University of Colorado at Boulder, has produced three Nobel Laureates and two MacArthur Fellows, all named in this decade alone. JILA researchers are leaders in atomic, molecular, and optical (AMO) science, a field that the National Academies says is "key to training our best scientists, engineers, and technical professionals."

JILA is already over capacity, and the situation is getting worse. The existing group of 28 JILA research scientists could train approximately one-third more postdocs and student researchers, but there is literally no place for them to work. An expert external assessment of the JILA laboratories warned that this shortage of space threatened JILA's ability to retain and recruit world-class scientists.

NIST proposes a limited expansion of the laboratory and office space at JILA. With the expansion costing an estimated $27.5M, NIST would contribute $13M in FY 2009 and an additional $9.5M in FY 2010. The University of Colorado will contribute $5M in funding, as well as land and infrastructure services such as electricity, chilled water, and steam.

The funding would add approximately 4,610 square meters (49,600 square feet) of new space. Improving the laboratory facilities at JILA will ensure that the current world-class research staff maximizes its potential for both training a new generation of scientists and producing the nanoscale manipulation tools needed to keep U.S. industry at the forefront of science. The expansion is expected to increase the number of AMO grad students at JILA by approximately 50 percent. Because JILA produces 5 to 10 percent of all AMO science Ph.D.s in the United States per year, this will step up significantly the nation's production of scientists in this important field.

**NIST Center for Neutron Research Expansion (NCNR) and Reliability Improvements (+$2M, added to a previously funded initiative)**

Serving more scientists and engineers (over 2,100 annually) than all other U.S. neutron research facilities combined, the NIST Center for Neutron Research (NCNR) is the nation's leading neutron facility. The NCNR is especially valued for its "cold" (low-energy) neutron source, which greatly increases the utility of the neutron beam, particularly in biotech and materials research.

Although the NCNR is widely regarded as the most cost-effective and efficiently managed neutron facility in the United States, presently this critical research tool cannot possibly meet the demands placed on it.

This is a planned increase in funding for the NCNR Expansion Initiative, begun in 2007. When completed, this five-year project will provide:

- a new generation of world-class cold neutron instruments directly supporting the needs of science and industry;
- more than a 30 percent increase in the overall measurement capacity;
- the ability to serve at least 500 additional researchers each year; and
- increased operational efficiency.

The FY 2009 funding request supports the next phase of the NCNR expansion to initiate installation, testing, and commissioning of the new neutron instruments (such as spectrometers). These instruments will bring new neutron measurement capability to U.S. researchers by either exceeding the capabilities of current instruments by more than a factor of a hundred, or by providing capabilities that are not currently available in the United States.

In FY 2009, the project will focus on:

- installation of new neutron spectrometers and neutron beamlines;
- modification of beamlines and beamline shielding;

- modification of some existing instruments affected by new beamlines; and
- testing of new beamlines and instruments.

**Complete State-of-the-Art Laboratory Space at NIST's Boulder, Colorado Campus Building 1 Extension (+$43.5M)**

The Building 1 Extension (B1E) will provide the environmental control needed to reliably measure and manipulate atomic-scale phenomena in order to further enable 21st-century technologies. Improvement in environmental conditions within NIST's Boulder, Colorado research laboratories is required to make further progress in measurements related to high- frequency electronics, advanced materials characterized at the atomic level, subcellular forces, timing accuracy, and other areas.

As the final funding request for a three-year program, the $43.5M proposed in the FY 2009 budget will complete state-of-the-art laboratory space that will meet the stringent environmental conditions required for 21st-century scientific advances. With a total cost of $77.2M, the Building 1 Extension is the most cost-effective approach to enabling world-class measurement science in support of some of the country's most important economic sectors.

Construction of the B1E will dramatically enhance NIST's measurement capability and will directly support the needs of industry and academia. Some of the anticipated impacts include the ability to:

- make precision frequency measurements above 100 GHz (100 billion cycles per second), which are required for advanced commercial electronics, military systems, and homeland security;
- measure and perform research on the properties of materials at the single-atom level needed for the development of quantum and nanotechnologies;
- measure forces below $10^{-12}$ newtons (one billionth the weight of a feather) to understand the inner workings of cells and to apply this measurement capability to other physical systems; and
- make timing measurements with uncertainties reduced to one part in $10^{-18}$ (the equivalent of one second in 30 billion years), enabling whole new generations of position, navigation, and guidance systems.

**Safety, Capacity, Maintenance and Major Repairs (SCMMR) (+$5.2M)**

Aging and deteriorating buildings and infrastructure threaten NIST's ability to meet the needs of the nation's scientific and industrial enterprise. NIST maintains about 50 specialized laboratories, offices, and support buildings at its two major sites in Gaithersburg, Maryland, and Boulder, Colorado, as well as critical infrastructure in Fort Collins, Colorado, and Kauai, Hawaii. Most of the Gaithersburg structures were built in the 1960s, and the Boulder facilities are a decade older.

Since 1995, the Construction of Research Facilities (CRF) appropriation has funded building construction and the safety, capacity, maintenance, and major repairs (SCMMR) of NIST's physical plant. Although recent increases to SCMMR have led to improvements in these facilities and infrastructure, the current state of NIST facilities—whether measured in terms of safety, capacity, or state of repair—remains a serious impediment to NIST's mission. Funding for renovations has not kept pace with NIST needs. The failure rate of major building systems such as air-handling systems and piping systems has increased dramatically in the last five years. NIST's aging facilities and their extensive backlog of deferred maintenance and repairs have resulted in lost productivity and increased costs.

These problems are not confined to the most advanced research and development projects. For example, the relatively straightforward NIST task of calibrating precision pressure gauges is the critical first step in a national measurement chain that ensures the accuracy of airplane altimeters and supports a wide variety of manufacturing sectors, including semiconductors and pharmaceuticals. However, carrying out this process has been limited by vibration problems, poor temperature control, and a pervasive black grit distributed by a 40-year-old air-conditioning, ventilation, and heating system.

Based on independent architectural and engineering reviews and in conjunction with the need to maintain world-class research facilities, NIST proposes to target the most critical SCMMR projects. These areas include repair and replacement of aging mechanical and electrical systems removal of hazardous material, including remediation of asbestos; structural repairs and replacements; and efforts to ensure accessibility in all NIST facilities.

## Industrial Technology Services.

### Hollings Manufacturing Extension Partnership (MEP) ($4.0M)

The requested $4M provides the orderly end to federal funding for the Hollings Manufacturing Extension Partnership (MEP) program. The elimination of Federal funds to the local centers may have to be compensated through a combination of increased fees derived from the benefits accrued by individual companies and cost-savings in the operations of the centers.

### Technology Innovation Program (TIP) ($0)

No funds for TIP are requested in the President's FY 2009 budget. Anticipated prior year recoveries will be sufficient to phase out the program.

**Summary**

For 107 years, NIST research has been critical to our nation's innovation and competitiveness. The increased funding in the President's FY 2009 budget for the NIST core will directly support technological advances in broad sectors of the economy that will quite literally *define* the 21st century -- as well as improve the safety and quality of life for all our citizens.

Today, more than at any other time in history, technological innovation and progress depend on NIST's unique skills and capabilities. Helping the U.S. to drive and take advantage of the increased pace of technological change is a top priority for NIST.

The new technologies that are determining the global winners in the early 21st century—including nanotechnology, information technology, and advanced manufacturing—rely on NIST-developed tools to measure, evaluate, and standardize. The technologies that emerge as a result of NIST's development of these tools are enabling U.S. companies to innovate and remain competitive.

Technology-based innovation remains one of the nation's most important competitive advantages, but that advantage is in danger of being lost. The American Competitiveness Initiative (ACI) and the enactment of the America COMPETES Act are bold initiatives to maintain this advantage. They have cast a spotlight on NIST's critical importance to U.S. economic competitiveness and innovation. To ensure that NIST programs deliver the highest impact, the Institute, working with our stakeholders in Congress, industry, academia, and other government agencies, will continue to identify the most critical measurement, standards, and technological challenges. We look forward to working with you, Mr. Chairman, and members of the Subcommittee, throughout this process.

**Biography**

Dr. James M. Turner is the Acting Director and Deputy Director of the U.S. Department of Commerce's National Institute of Standards and Technology (NIST). Turner became NIST Acting Director on September 3, 2007. As Acting Director, Turner provides high-level oversight and direction for NIST.

Prior to joining NIST on April 16, 2007, Turner served as the Assistant Deputy Administrator for Nuclear Risk Reduction in the Department of Energy's National Nuclear Security Administration. In that position, he was responsible for major projects in Russia to permanently shutdown their last three weapons-grade plutonium-production reactors. He also worked with foreign governments and international agencies to reduce the consequences of nuclear accidents by strengthening their capability to respond to nuclear emergencies.

Prior to that assignment, Turner held several senior management posts at DOE concerned with laboratory oversight and with nuclear safety and the safeguarding of nuclear weapons both here and abroad.

He holds degrees in Physics from the Massachusetts Institute of Technology (Ph.D.) and Johns Hopkins University (B.A.), and taught for five years as an Associate Professor of Physics and Engineering at Morehouse College.

Among other honors, he has received the U.S. Government Presidential Rank Award for Meritorious Service, three times received the U.S. Department of Energy Exceptional Service Award, and earned the Secretary of Energy Gold Award and the National Nuclear Security Administration's Gold Medal. Dr. Turner is an active member of the American Physical Society, the American Chemical Society, the American Nuclear Society, and the American Association for the Advancement of Science, ASTM, and the Council on Foreign Relations, IEEE, Phi Beta Kappa, Sigma Xi, and the World Affairs Council.

Dr. Turner is a native of Washington, DC, is married, and has five children and one grandchild. He and his wife, Paulette, reside in Olney, Maryland.