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FISCAL YEAR 2010

BUDGET SUBMISSION TO CONGRESS

Department of Commerce
National Institute of Standards and Technology
BUDGET ESTIMATES, FISCAL YEAR 2010
CONGRESSIONAL SUBMISSION

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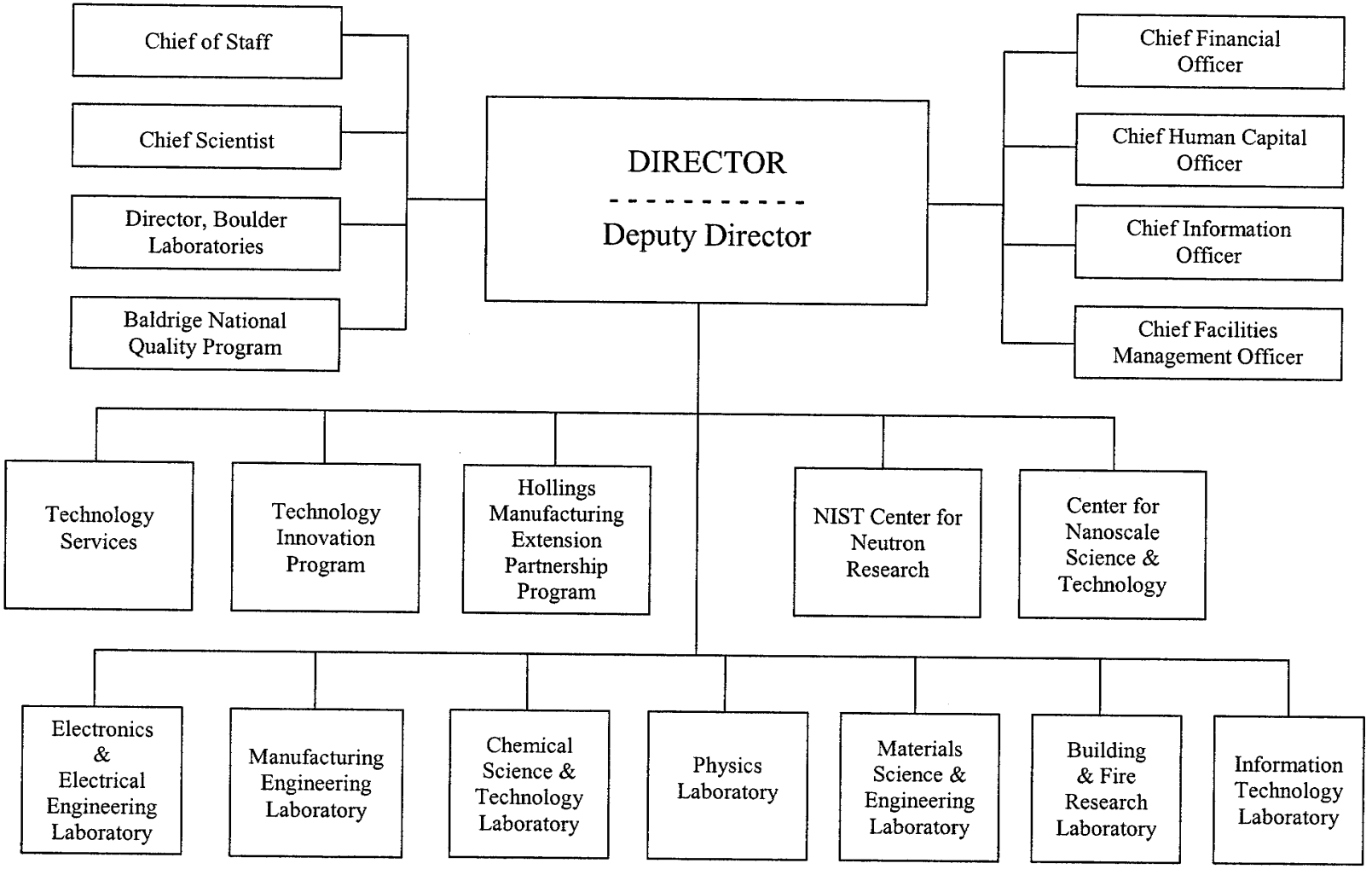
U.S. DEPARTMENT OF COMMERCE
National Institute of Standards and Technology



NTIS reports to the Department of Commerce Secretary through NIST

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EXECUTIVE SUMMARY

NIST Goals and Focus of the FY 2010 Budget Request

"Investments in science and technology foster economic growth; create millions of high-tech, high wage jobs that allow workers to lead the global economy; improve the quality of life for all Americans; and strengthen our national security."

--President Barack Obama

The FY 2010 President's Budget: Meeting Today's Economic and Societal Challenges and Laying the Foundation for Future Success

The President's Plan for Science and Innovation recognizes the importance of science and technology to make both short-term improvements that will benefit productivity and enhance economic capacity, and long-term investments that lay the foundation for future innovation and economic competitiveness.

NIST is one of the agencies participating in the President's Plan for Science and Innovation, which consistent with the goals of the America COMPETES Act of 2007, doubles funding for basic research over 10 years. The FY 2010 President's request will support NIST programs that are critical to promoting American innovation and competitiveness.

- The **NIST Laboratories** provide the measurement science and physical standards that are essential components of the technology infrastructure underpinning U.S. innovation.

- NIST's **Construction of Research Facilities** support the projects for new buildings and renovation and maintenance of current buildings and laboratories.

- The **Technology Innovation Program** (TIP) supports innovative, high-risk, high-reward research in areas of critical national need (CNN) where the government has a clear interest due to the magnitude of the problems and their importance to society. The merit-based competitive program funds cost-shared R&D projects by single small- or medium-sized businesses, as well as joint ventures that may include higher education institutions, non-profit research organizations, and national laboratories.

- Through Federal-state-local and private sector partnerships, NIST's **Hollings Manufacturing Extension Partnership** (MEP) provides technical and business assistance to smaller manufacturers through a network of centers in all 50 states and Puerto Rico.

- The **Baldrige National Quality Program** promotes proven quality and performance management practices to strengthen U.S. companies, educational organizations, and health care providers. Recognized worldwide, the program furthers organizational excellence through education, outreach, and annual awards.

The President's FY 2010 Budget requests a total of $846.1 million. This includes $651.5 million for NIST's core laboratory research and facilities, a net increase of $7.5 million over FY 2009 levels (excludes P.L. 111-5 amounts), and $108.3 million over the FY 2010 base, establishing a clear path to completing a doubling effort in FY 2016. The President's budget also proposes $124.7 million in FY 2010 for MEP, an increase of $14.7 million above FY 2009. For TIP, the President's FY 2010 budget request is $69.9 million, an increase of $4.9 million above FY 2009. NIST's FY 2010 budget request is targeted at achieving three main goals:

1. Strengthen NIST's core competencies and facilities to assure U.S. leadership in measurement science.

2. Address critical challenges in national priority areas:

    - **Energy:** Speed development of alternative, clean-energy energy sources, from production through storage to final distribution; and help to ensure interoperability of Smart Grid devices and systems (as assigned in the 2007 Energy Independence and Security Act).

    - **Environment:** Promote efficient development of sustainable products and processes, from manufacturing to end-use by consumers; help to establish the scientific measurement basis for accurate climate and greenhouse gas emissions monitoring.

    - **Manufacturing:** Improve the competitiveness of U.S. manufacturers through the development and deployment of new, green technologies and better business practices; and enhance innovation in products and processes, resulting in new jobs.

    - **Health Care:** Advance efforts aimed at achieving lower-cost, higher quality health care, including development of technologies that ensure more accurate diagnoses, reduce medical errors, and improve the efficiency and effectiveness of

therapies; develop standards essential to interoperable health-care information systems that seamlessly and accurately share information among all health-care providers; and ensure security and privacy of information.

- **Physical Infrastructure:** Develop the needed measurement solutions, models, calibration inspection methods, and technologies that complement TIP's recent awards to the private sector, and can be used to predict the remaining life or margins of safety for infrastructure systems to prioritize and optimize infrastructure spending.

- **Information Technology:** Help to develop more capable, secure, and interoperable information systems to ensure U.S. leadership in information technology; provide technical support for successful deployment of next generation broadband; and supply measurement capabilities necessary for next-generation information technologies.

3. Revitalize NIST Extramural Programs through investments in the Technology Innovation Program and the Hollings Manufacturing Extension Partnership.

The NIST Role and Budget Request

NIST's mission is to advance measurements and standards so that the next wave of innovation can peak and reach its full potential – in the marketplace and in terms of practical application and social utility. The agency's technical contributions open the way to progress in areas ranging from nanotechnology and solar energy to fire protection and cyber security. In addition, NIST is an integral component of the global trading system. Along with its counterpart national measurement institutes in other countries, NIST forms the foundation of the international measurement system. For U.S. businesses, "traceability" to NIST provides an uninterrupted measurement pedigree. In overseas markets, NIST-traceable measurements enable prospective customers to assess the reliability of a U.S. company's quality control system, and help buyers and sellers to agree on the specifications of products and services.

NIST's FY 2010 budget request of 846.1 million closely follows the bipartisan roadmap set out in the America COMPETES Act and is proposed to boost the Nation's innovation capacity and long-term economic performance. The request includes program increases of $59.9 million over FY 2010 base funding for NIST Laboratories to implement 11 initiatives tied to national priorities. The request also includes program increases over FY 2010 base funding of $4.6 million for TIP to help address critical national needs and $14.4 million for MEP to increase green manufacturing technologies efforts. An additional $48.4 million over FY 2010 base funding is requested for three initiatives under the Construction of Research Facilities (CRF) appropriation. These include important needs for

renovations to NIST's aging Boulder and Gaithersburg facilities as well as provide funding for fit-up costs for the newly expanded NIST Center for Neutron Research facility.

Scientific and Technical Research and Services (STRS): NIST's $59.9 million request in laboratory research initiatives focuses directly on eliminating measurement-related barriers and other technical challenges to achieving energy independence, protecting the environment, rebuilding America's physical infrastructure, improving Information Technology security, and improving the delivery and cost-effectiveness of health care. NIST will also advance its core capabilities in quantum-based measurements, which are at the frontiers of science and technology, and will be the source of innovations over the years and decades to come.

Technology Innovation Program (TIP): A total of $69.9 million is requested for TIP. The program focuses on developing cutting-edge technologies that address societal challenges and areas of critical national need where the government has a clear interest due to the magnitude of the problems and their importance to the nation. For example, in its first competition in January 2009, TIP awarded nine cost-shared grants for research addressing the need to monitor and cost-effectively improve the Nation's aging physical infrastructure. With cost-sharing, the grants are expected to catalyze nearly $90 million worth of research over five years, stimulating efforts to develop advanced sensing technologies for timely, detailed monitoring and inspection of the structural health of the nation's public infrastructure: bridges, roadways, and water systems. Future competitions may focus on other critical national need areas such as advanced manufacturing, water, complex networks, energy, and personalized medicine. TIP support for collaborative high-risk, high-reward technology development projects aims to attract a critical mass of talent in industry, academia, and government to address important national challenges that can be addressed through advances in technology.

Hollings Manufacturing Extension Partnership (MEP): The $124.7 million requested for MEP will expand technology and business resources needed to help small- and medium-sized manufacturers succeed against unprecedented overseas competition. MEP has a proven record of delivering cost-effective services that improve American competitiveness and help companies retain or expand jobs. Federal investment in this program galvanizes matching local and state funding that help to make MEP services affordable for manufacturing clients, and will strengthen, stabilize, and enhance the program's ability to meet the new 21st century needs of America's small manufacturers. Funding requested in FY 2010 for MEP will afford greater emphasis on activities related to green manufacturing technologies, such as energy efficient production and the production of renewable energy. This investment will provide these small manufacturers with the support they need to succeed in an increasingly challenging competitive environment.

Construction of Research Facilities (CRF): The CRF request includes $48.4 million in initiatives to support three facilities projects that strengthen NIST's core facilities to assure U.S. leadership in measurement science: 1) the initial renovation of Building 1 at NIST's Boulder, Colorado site ($26,000,000), which enables the planning, design, and initial construction of phased renovations for

Wings 3, 5, and 6 of Building 1 and the limited renovations of Building 4; 2) planning and design for the renovation of General Purpose laboratories (GPLs) at NIST headquarters in Gaithersburg, Maryland ($14,363,000), which is a necessary step toward systematic renovation of aging GPLs; and 3) NIST Center for Neutron Research and Reliability Improvements ($8,000,000) which will fund construction fit-up costs associated with configuring and occupying the completed Guide Hall facility and technical support buildings.

For decades, the United States enjoyed a period of unchallenged leadership in technology. The benefits include well-paying jobs, improvements in the average American's standard of living, world-leading levels of productivity, and long-term economic growth. Competitor nations are rapidly catching up with, even surpassing, U.S. capabilities. Home to three winners of the Nobel Prize in Physics, NIST and its programs have served as models by nations seeking to duplicate our success. NIST's FY 2010 budget proposal, described in greater detail below, is proposed to continue investing in the Nation's research and innovation infrastructure, and build on the proven value and utility of NIST programs in fostering innovation and improving economic efficiency.

Summary of FY 2010 Budget Request

NIST is requesting for FY 2010 a total budget of $846,100,000, including 3,105 permanent positions and 3,212 FTE. The request includes program changes totaling $127,339,000, 165 permanent positions, and 125 FTE from the FY 2009 levels (excluding P.L. 111-5) under the Scientific and Technical Research and Services (STRS), Construction of Research Facilities (CRF), and Industrial Technology Services (ITS) appropriations accounts.

STRS: The request totals $534,600,000 including 2,174 permanent positions and 2,195 FTE. The request includes the following initiative components totaling $59,891,000:

Towards A Nationwide Healthcare Information Infrastructure: Assuring Quality, Accessibility, and Cost Containment of Healthcare	+$5,000,000	16 permanent positions and 12 FTE
Powering Up America: Accelerating an Interoperable Smart Grid	+$5,000,000	24 permanent positions and 18 FTE
Measurement Standards and Measurement Technology to Support Innovation in Healthcare	+$9,000,000	13 permanent positions and 10 FTE

Advanced Energy Technologies: Solar Energy and Storage	+$7,500,000	24 permanent positions and 18 FTE
Greenhouse Gas Emission Measurements	+$7,000,000	21 permanent positions and 16 FTE
Measurement Science for Net Zero Energy, High Performance Green Buildings	+$7,000,000	13 permanent positions and 10 FTE
Measurements and Standards to Support Rebuilding the U.S. Physical Infrastructure	+$4,500,000	11 permanent positions and 8 FTE
Nanomaterials Environmental Health and Safety	+$3,000,000	9 permanent positions and 7 FTE
Quantum Information Sciences	+$1,500,000	4 permanent positions and 3 FTE
Comprehensive National Cyber Security	+$5,500,000	13 permanent positions and 10 FTE
Quantum Based Measurements	+$4,891,000	13 permanent positions and 10 FTE

CRF: The request totals $116,900,000, including 81 permanent positions and 81 FTE. The request includes the following initiative components:

Boulder Laboratories - Building 1 Renovation	+$26,000,000
Renovations of General Purpose Laboratories	+$14,363,000
NIST Center for Neutron Research (NCNR) Expansion and Reliability Improvements	+$ 8,000,000

ITS: The request totals $194,600,000, including 141 permanent positions and 146 FTE. The request funds TIP at $69,900,000 and MEP at $124,700,000. TIP assists U.S. businesses and institutions of higher education or other organizations, such as national laboratories and nonprofit research institutes, to support, promote, and accelerate innovation in the United States through high-risk, high-reward research in areas of critical national need. The MEP is a Federal-state-local partnership that provides U.S. manufacturers with access to technologies, resources, and expertise. The MEP consists of a NIST-led network of 59 manufacturing extension centers, in all 50 states and Puerto Rico, that work to position manufacturers to compete in the global economy through services that are grounded in technology related activities, business strategy development, the integration of supply chains, and increasing the technical and problem solving skills of the workforce.

The FY 2010 budget request for NIST provides the Nation with essential tools to enable continued innovation and economic vitality. It strongly supports the Department of Commerce Strategic Goal to "Promote U.S. Innovation and Industrial Competitiveness" as stated in the Department's FY 2007-2012 Strategic Plan.

A brief summary of NIST's initiative requests are provided on the following pages.

Scientific Technical Research and Services (STRS)

1. Towards A Nationwide Health-Care Information Infrastructure: Assuring Quality, Accessibility, and Cost Containment of Healthcare (+16 positions, +12 FTE and +$5,000,000)

Accounting for roughly one-sixth of the Nation's economy, health-care expenditures are major burdens for consumers and employers alike, and a large segment of the U.S. population lacks health insurance. The Administration is committed to computerizing the Nation's health-care records within five years. Replacing the current, inefficient paper-based medical records system with up-to-date information technology (IT) will reduce costs, prevent errors, and improve health-care quality. A major step forward will be the adoption of electronic health records (EHRs), which requires building an underlying information infrastructure. This presents enormous challenges as only 15 percent of doctors use any form of electronic health records. In addition, privacy and security of electronic records are major concerns, as theft of medical information could result in consequences more serious than those associated with identity theft. To overcome these challenges and to advance the adoption and efficient use of IT in health care, NIST is working with a range of industry groups and other stakeholders to establish uniform standards for electronic health records and for secure exchanges of this information between doctors, hospitals, and insurance companies. NIST also has the vitally important responsibility of designing test methods for demonstrating compliance with standards, and subsequently to ensure safe and correct operation of the

electronic health-care infrastructure. Funding this initiative will allow NIST to develop a robust framework for testing and validation methods, ensuring the successful adaptation and implementation of these standards.

2. Powering Up America: Accelerating an Interoperable Smart Grid (+24 Positions, +18 FTE, +$5,000,000)

The President's plan calls for implementation of a Smart Grid to modernize the Nation's century-old electric power system. When successfully implemented, the Smart Grid will save money, protect power sources from blackout or attack, and deliver solar, wind, and other clean, renewable sources of energy to homes and businesses across the nation. A key challenge in making the Smart Grid a reality is ensuring the interoperability and security of these advanced control systems, distributed generation systems, and Smart Grid appliances. Under the Energy Security and Independence Act of 2007 (EISA, PL 110-140), NIST is charged with coordinating the development of a unifying architecture, interfaces, protocols, and the other consensus standards required to enable two-way flows of information and seamless integration of equipment into the Smart Grid. An "interoperability framework" rooted in measurement science will accelerate development and adoption of Smart Grid products and practices, yielding benefits to the entire nation. This initiative will enable NIST to coordinate collaborative, high-quality standards development efforts and to create the measurement tools necessary to enable wide-spread adoption of the standards and the ability to test and validate Smart Grid equipment.

3. Measurement Standards and Measurement Technology to Support Innovation in Health Care, Clinical Diagnostics and Medical Imaging (+13 Positions, +10 FTE, $9,000,000, including a $500,000 transfer to the Working Capital Fund)

Improving the quality of health care while reducing costs of the world's most expensive health-care system is a national priority. Health care spending has risen from 7.2 percent of GDP in 1970 to 16 percent today, or almost $8,000 per person. By 2017, nearly one dollar in every five will go for heath care. Up to almost 100,000 patients die in the U.S. each year due to medical errors, according to an Institute of Medicine study. Lack of accurate, reliable diagnostic tests contributes to the high cost and suboptimal quality of health care. For example, quality-assuring measurement standards exist for only about 10 percent of the 700 most commonly ordered clinical tests. There are no traceable, quantitative standards for MRIs, CT scans, ultrasounds, and other medical imaging technologies, even though such images account for $50 billion in annual health-care spending. Lack of traceable measurement references leads to misdiagnosis, unnecessary repeat testing, and treatment decisions made with insufficient information. NIST has worked closely with industry, academia, and other government agencies to identify the measurement and standards tools required to improve the quality of current medical laboratory tests and medical imaging. Under this initiative, NIST will focus on developing new measurements and standards to ensure the accuracy and reliability of the most critical medical laboratory and imaging tests, helping to improve the quality of diagnosis and treatment, and reduce health care costs.

4. Advanced Energy Technologies: Solar Energy and Storage (+24 Positions, +18 FTE, +$7,500,000, including a +$2,500,000 transfer to the Working Capital Fund)

The FY 2010 President's budget builds upon substantial clean energy R&D investments in the Recovery Act to support renewable energy and energy efficiency technologies. NIST provides the measurement science, models, data, and reference standards that are integral to developing new, affordable clean energy technologies to meet increasing energy demand. Working collaboratively with other Federal agencies, businesses, standards organizations, and universities, NIST will focus initially on solar energy, one of the most promising alternative energy solutions. Efforts will straddle current and future generations of photovoltaic technologies. NIST will improve performance measurement and prediction tools for existing solar technologies, and it will develop the underpinning measurement science and tools to evaluate the materials and fabrication processes which will enable breakthrough developments in more efficient and less costly future generation solar cells. The tools, techniques, and expertise developed under this initiative will also benefit complementary efforts focused on energy storage devices, such as advanced batteries, fuel cells, photoelectrolysis cells, and supercapacitors. This initiative also has a nanotechnology component, as many of the structures and processes involved in the generation, storage, and transport of energy in newly developed technologies are built at the nanoscale but must be assembled into devices and large-scale systems. Thus, research will heavily leverage NIST's current investments in nanotechnology. NIST will develop measurement techniques that span the spectrum from nanoscale to full-scale system. These techniques will: 1) provide information with nanoscale resolution, 2) sample significant numbers of nanostructures, and 3) characterize real devices. Development of an alternative energy infrastructure will not only ensure U.S. energy independence, but also represents an unparalleled economic and commercialization opportunities that are being pursued by nations around the world. The groundwork for the new measurement science and standards to enable breakthrough developments in solar and advanced energy storage technologies must start now to ensure fruition within the next 10 to 15 years.

5. Greenhouse Gas Emission Measurements (+21 Positions, +16 FTE, +$7,000,000, including a +$800,000 transfer to the Working Capital Fund)

NIST will develop tools to verify greenhouse gas (GHG) emissions, measure absorption of GHGs (sinks), and enable the accurate determination of baseline GHG emissions. NIST's role is to develop the measurement science, measurement standards, documentary standards, and laboratory accreditation programs that ensure the accuracy and comparability of quantitative measurements of GHG sources and sinks. Tied to international standards, NIST measurements will increase world-wide confidence in comparability of emissions measurements across national boundaries. NIST's measurements and standards will provide the necessary tools to support future greenhouse gas mitigation efforts.

6. Measurement Science for Net Zero Energy, High Performance Green Buildings (+13 Positions, +10 FTE, +$7,000,000, including a +$840,000 transfer to the Working Capital Fund)

Buildings account for 40 percent of total U.S. energy use, including 72 percent of electric power consumption, and about 40 percent of carbon dioxide emissions—more than the transportation or industrial sectors. Emissions associated with buildings and appliances are projected to grow faster than those from any other sector. ARRA funding supports the greening of Federal buildings. This initiative extends that investment to non-Federal buildings, both new and existing, to improve energy efficiency and become carbon neutral. Progress toward these goals will reduce dependence on foreign oil, improve the economy, and help to curb emissions of greenhouse gases. Building energy consumption can be reduced through the introduction of innovative building technologies and materials. However, buildings are complex systems of integrated and interacting materials, components, and systems. Existing performance measurements developed under idealized laboratory test environments typically do not capture the complexities of actual building installation, the dynamic interactions of multiple subsystems, or the full life cycle of structures. For this reason, NIST proposes this initiative to fund a new and integrated portfolio of measurement science capabilities that not only supports innovation in the design and manufacturing of individual components, but also comprehensively captures system complexities and interactions.

7. Measurements and Standards to Support Rebuilding the U.S. Physical Infrastructure (+11 Positions, +8 FTE, +$4,500,000)

The American Society of Civil Engineers *2009 Report Card for America's Infrastructure* estimates that $2.2 trillion in spending over five years will be necessary to adequately address our infrastructure needs, that includes not only bridges and highways but also facilities that manage water, waste and energy. Since 2005, when ASCE issued its last assessment, the price tag has increased by more than a third. Given the enormous size and cost of the challenge, it is essential to ensure that spending for infrastructure renewal is aligned with the highest priority needs. Desperately needed are tools that help prioritize infrastructure spending by accurately characterizing and predicting the remaining life or margins of safety for facilities and infrastructure systems. NIST has been performing research and developing standards relevant to infrastructure design and performance for decades, and it has collaborated effectively with other federal agencies to advance hazard assessment and forecasting capabilities. NIST will develop measurement solutions required to quantify the remaining usable lifetime of components of our existing infrastructure, optimize short- and long-term investment in repairs, and enable intelligent, active asset management and control in the future. Specifically, NIST will provide the next generation of sensors, nondestructive evaluation methods, interpretive and predictive models, and data and standards to allow civil engineers and planners to accurately assess, predict the reliability, or prioritize repairs to the U.S. physical infrastructure. NIST will complement TIP's recent awards to the private sector and partner with other Federal agencies, state departments of transportation, associations, and the construction industry to ensure that work under this initiative will have high impact.

8. Nanomaterials Environmental Health and Safety; Materials Property Characterization (+9 Positions, +7 FTE, +$3,000,000)

Increasing the development, commercialization and application of new technologies to drive economic growth carries the associated responsibility of increased environmental stewardship. Nanostructure materials and devices represent a rapidly growing new technology. There are currently more than 800 products on the market that contain nanomaterials or nanoscale devices. Sales of nanotechnology-enabled products reached $166 billion in 2008 and are projected to climb to $2.6 trillion by 2014. However, nanomaterials and products that incorporate these materials pose unknown health effects to people and the environment. Industry and regulatory agencies need a science-based approach to assess and manage these risks to realize the many anticipated applications of nanotechnology. This approach hinges on establishing linkages between physical and chemical properties, potential hazards, and effects of exposure, such as toxicity and environmental persistence. Regulatory agencies and industry have called on NIST to lead the efforts to develop reliable, accurate methods for characterizing the physical and chemical properties of nanomaterials. To meet this need, NIST will establish a Nanomaterials Environmental Health and Safety (NanoEHS) program that will be coordinated with other agencies participating in the Federal government's National Nanotechnology Initiative. NIST will provide data and develop reference materials, documentary standards, and validated instruments and measurement methods for key physical and chemical properties of nanomaterials. In FY 2010, NIST will expand collaborative efforts to accelerate development of additional reference nanomaterials with fully characterized physical and chemical properties. These valuable tools will help prevent or effectively manage potential risks and clear the way for safe and efficient commercialization of new nano-enabled products with a broad range of anticipated benefits, including treatment of disease, alternative energy, and remediation of environmental hazards.

9. Quantum Information Sciences (+4 Positions, +3 FTE, +$1,500,000, including a +$150,000 transfer to the Working Capital Fund)

Strengthening basic science research and investing in technologies that will improve the security of our evolving knowledge-based economy is a Presidential priority. On the horizon are computers that operate on quantum information principles, which would be able to rapidly solve problems that either are beyond the capabilities of today's best computers or would take many years to solve. A quantum computer appears to be able to efficiently solve quantum problems that could lead to significant advances in areas ranging from drug design to understanding and creating new materials for high temperature superconductivity. A functional quantum computer would lead to a paradigm shift in 21st century science and technology. Today the U.S. has the lead in understanding and applying quantum principles to information systems, but other nations are making rapid progress. NIST is a world leader in quantum information science, and it is developing new approaches to manipulating, controlling, and using quantum systems. The tools NIST is creating will be used for practical quantum applications, including control systems, testing the limits of quantum information systems, and addressing the real power of a quantum computer. NIST's role in this field is vital to creation of improved quantum materials for

high performance quantum information processing systems and developing quantum devices for memory, communication, and processing. Leadership in quantum information sciences also is necessary to ensure the continued integrity of U.S. electronic commerce and communication systems against adversaries, who might otherwise be able to apply quantum computers against the U.S. The science and technology developed through quantum information research will also lead to new ways of applying quantum mechanics to fundamental measurement problems.

10. Comprehensive National Cyber Security (+13 Positions, +10 FTE, +$5,500,000, including a +$350,000 transfer to the Working Capital Fund)

This NIST request is part of the Administration's Comprehensive National Cyber Security Initiative. Worldwide, the cost of all forms of cyber attacks has been estimated to be $226 billion. According to the Congressional Research Service, firms that are the subject of cyber attacks typically suffer a 1 percent to 5 percent drop in stock prices following the attack, which translate into losses of between $50 million and $200 million for a large company. In addition to monetary cost, consumer privacy, trade secrets, and even national security are at risk from cyber attacks launched by criminals or foreign powers. Industrial control systems, such as those used to operate chemical plants and pipelines, often have little or no security. As the Government Accountability Office reports: "If their vulnerabilities are exploited, our Nation's critical infrastructures could be disrupted or disabled, possibly causing loss of life, physical damage, and economic losses." Recognizing these risks, the Administration believes the U.S. cyber infrastructure is essential to our economy, infrastructure, public safety, and national security, and has announced plans to support initiatives to develop secure, next-generation computing and networking technologies. NIST's roles in these efforts include developing new security components and methods, technology to enable organizations to identify and remove software vulnerabilities, security testing methods, and cooperative programs with industry for evaluating the functions of security- relevant products. NIST's cyber security research and development activities are guided by its Congressional mandate to provide security standards. Carrying out this mandate, NIST has built a strong track record of original research and technology transfer of advanced security solutions. Extending this record of success to new challenges will improve the security posture of national information technology systems and networks, lower the cost of security components, and significantly improve defenses against cyber attacks.

11. Quantum-Based Measurements (+13 Positions, +10 FTE, +$4,891,000, including a +$800,000 transfer to the Working Capital Fund)

Accurate and reliable measurements and physical measurement standards are foundational to advances in all natural and physical sciences, engineering, and technology, which is why measurement science has been described as the most helpful of all sciences. The International System of Units (SI) defines the measurement standards that are legally accepted world-wide for ensuring fair commerce and enabling comparison and communication of advances in science and technology. This initiative will enable the development of a substantially improved SI through the use of quantum-based measurements. The development of new quantum control tools and the ability to detect, manipulate, and control individual quantum objects – such as atoms, photons, or even the spin of electrons –connect the macroscopic, classical, everyday world with the quantum world of molecules, atoms, and their components. This remarkable advancement is enabling us to redefine our macroscopic measurements of time, length, electrical charge, light, and temperature based on unvarying quantum properties. For example, atomic clocks use quantum principles to measure time to the equivalent of 1 second in about 1 billion years, the most accurate absolute measurement of any quantity, which enables modern telecommunications systems, global positioning, and electric power distribution that are dependent on accurate timekeeping. This initiative directly supports the development of new measurement capabilities to improve the SI, creates new sensitive tools that will enable quantum information science, and provides new precision measurements that ultimately will open the way to progress in fundamental research. New quantum-based measurements and physical standards will enable advances in nanotechnology, telecommunications, navigation, and many other areas.

Construction Research Facilities (CRF)

1. Initial Renovation of Building 1 at NIST in Boulder, Colorado (+$26,000,000)

Aging laboratory facilities at the NIST Boulder, Colorado site, which are nearly 60 years old, cause a productivity loss of at least 20 percent and make it difficult to carry out many advanced measurement services and research projects. Renovations will significantly improve productivity and enable new measurements and research to respond to emerging industry needs. This first phase of the Building 1 Renovation includes planning, designing the first three major wings, renovating Building 3 to vacate a portion of Building 1 to create some limited swing space in the building, and constructing exterior portions of utility and service infrastructure. The initial renovations will focus on the construction of service corridors and mechanical/electrical equipment rooms to support future renovations. Renovations will emphasize use of green technologies, saving energy, water, and construction materials. Renovations will significantly improve the overall building performance. They will also significantly improve work conditions for staff, greatly

enhancing NIST's ability to provide the advanced measurements and research needed by U.S. industry and to advance the President's Plan for Science and Innovation calling for a doubling of Federal funding for basic research.

2. Planning and Design for the Renovation of General Purpose Laboratories (GPLs) at NIST Gaithersburg (+$14,363,000)

This $14.4 million initiative includes overall planning and design costs for the first phase of the systematic renovation of GPLs at NIST Gaithersburg to address deficiencies in structural, mechanical, electrical, and safety systems, and to implement modern energy efficiency measures consistent with current environmental mandates. The NIST Gaithersburg GPLs comprise a complex of seven research buildings, which represent one-third of NIST Gaithersburg's space inventory and a total of 1.2 million square feet. The buildings are more than 40 years old, and they cannot achieve the tight control of temperature, vibration, and air quality needed for 21st century measurements and research. The GPLs support the majority of NIST's research and measurements to promote innovation and technology development, which cuts across all the NIST investment priority areas. However, this critical work is hindered by the GPLs' eroding capabilities due to aging systems and equipment. The renovations will substantially improve temperature, vibration, humidity, air cleanliness, and overall building performance, as well as help NIST to meet energy reduction and environmental goals. Work conditions for staff will be significantly improved and productivity will increase, which will greatly enhance NIST's ability to provide the advanced measurements and research needed by U.S. industry and to advance the President's Plan for Science and Innovation.

3. NIST Center for Neutron Research Expansion and Reliability Improvements (+$8,000,000)

This initiative will fund construction fit-up costs associated with configuring and occupying the completed guide hall facility and technical support buildings. It also will fund the construction of a liner for the reactor fuel storage pool. This is a continuation of an effort begun in FY 2007 to develop and install a new "cold" neutron source, which, when combined with a neutron guide tube network, will convert one usable neutron beam into at least five. The guide hall facility will be approximately 18,000 square feet of industrial high-bay type space with sufficient floor loading capacity, utilities, material-handling systems, and support space suitable for housing five new neutron instruments, a neutron guide tube network, associated radiation shielding, ancillary equipment, cold source refrigeration systems, support storage, and sample preparation space suitable to support a robust neutron scattering research program. When completed the guide hall facility will require electrical and mechanical systems to be connected to support the operation of the new neutron scattering instruments, the reactor systems, and the beam delivery systems. The initiative also includes funding to upgrade existing reactor systems to ensure the continued safe and reliable operation of the facility over its expected 20-year operating life. The planned upgrade includes the construction of a liner for the reactor spent fuel storage pool. The liner is designed to minimize the likelihood of an undetected leak of water from the pool.

Industrial Technology Services (ITS)

1. Hollings Manufacturing Extension Partnership (MEP) Program (+ 4 Positions, +3 FTE, +$14,453,000)

The Hollings Manufacturing Extension Partnership (MEP) is a national network providing business and technology assistance to the Nation's critical small- and medium-sized manufacturers. MEP services result in more than $10 billion per year in increased and retained sales among thousands of manufacturing clients, and the creation and retention of more than 57,000 jobs annually. In FY 2010, MEP will expand its services to address the growing national need to support U.S. manufacturing and create new green technology jobs. While manufacturers in virtually all industries recognize that quality and lean processes are now required just to be in business, productivity and growth gained exclusively from these cost-reduction efforts are just the first steps to providing the solid foundation necessary to maintain a competitive position. Long-term competitive advantage requires manufacturers to have access to a wide-range of resources that enable them to sell to new customers, compete in new markets, and develop new products, thus creating new, more profitable revenue streams. MEP will use additional resources in FY 2010 to build upon a strong foundation and add new services with a specific focus on 1) increasing manufacturers' adoption and application of advanced and clean technologies and development of new products, and 2) reducing manufacturers' environmental impact and related costs by promoting the development of new, environmentally-focused materials, products and processes to gain entry into new markets. The Administration's FY 2010 request is the first step in a proposed increase of the program to a level of $180 million by the year 2015.

2. Technology Innovation Program (TIP) (+$4,632,000)

The Technology Innovation Program (TIP) supports, promotes and accelerates innovation in the United States through high-risk, high-reward research in areas of critical national need (CNNs). For FY 2010, NIST requests $69.9 million, which includes an initiative increase of $4.6 million. These funds will support new competitions and be applied to any remaining mortgage commitments from prior years competitions. In FY 2010, TIP intends to hold a grant competition that funds one or more CNN areas. Areas under consideration for FY 2010 are civil infrastructure, advanced manufacturing, energy, health care, complex systems and green chemistry. TIP funding will initiate innovative research and development (R&D) by small- and medium-sized U.S. based companies, universities, and national laboratories and other non-profit research organizations and will generate an equivalent amount of private sector R&D through the TIP cost-share provision. Further, it will foster research collaborations; enable the creation of intellectual property in the U.S. and the dissemination of new knowledge, and advance the state-of-the-art in technologies that address societal challenges. The Administration's FY 2010 request is the first step in a proposed increase of the program to a level of $100 million by the year 2015.

Summary of Performance and Resources

Data on performance evaluation and reporting for all NIST base programs are in Exhibit 3A of this budget request. Performance measures for program changes included in this budget request are found in the budget justification narrative of each program change. The Administration recognized during the course of the FY 2005 PART assessment of the NIST Laboratories that "R&D-performing organizations typically cannot provide unit cost measures of efficiency due to the long time frame for research, multivariate inputs, and diverse sets of outputs that derive from R&D activities."

Resources: The following is a comparison of NIST's FY 2009 level (excluding P.L. 111-5) with its FY 2010 budget request and related data on employment.

Appropriation	(Dollar amounts in thousands)					
	FY 2009 Enacted (Excluding P.L. 111-5)		FY 2010 Estimate		Increase (or Decrease) from FY 2009 Budget Resources	
	FTE	Amount	FTE	Amount	FTE	Amount
Scientific and Technical Research and Services	2,034	472,000	2,195	534,600	161	62,600
Industrial Technology Services	141	175,000	146	194,600	5	19,600
Construction of Research Facilities	77	172,000	81	116,900	4	(55,100)
Working Capital Fund	790	0	790	0	0	0
TOTAL	**3,042**	**819,000**	**3,212**	**846,100**	**170**	**27,100**

Reimbursable Program

NIST's reimbursable services consist of technical work performed for other Federal agencies, state and local governments, and the private sector. These services include calibrations and special tests, advisory services, and the sale of Standard Reference Materials. The unique measurements and standards expertise developed with appropriated funding gives NIST the capability to perform these services on a reimbursable basis. NIST accepts other-agency work based on an established set of criteria which include: 1) the need for traceability of measurements to national standards; 2) the need for work which cannot or will not be addressed by the private sector; 3) work supported by legislation that authorizes or mandates certain services; 4) work which would result in an unavoidable conflict of interest if carried out by the private sector or regulatory agencies; and 5) requests by the private sector for NIST action or services. NIST's reimbursable program is estimated to be $172,536,000 in FY 2009 and $151,454,000 in FY 2010.

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APP / Exhibit 3A Format

FY 2010 Annual Performance Plan

National Institute of Standards and Technology/
National Technical Information Service

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Mission

To promote U.S. innovation and industrial competitiveness by advancing measurement science, standards, and technology in ways that enhance economic security and improve our quality of life.

National Institute of Standards and Technology

NIST develops and disseminates measurement techniques, reference data, test methods, standards, and other infrastructural technologies and services required by U.S. industry to compete in the twenty-first century. In addition to its core measurement, testing, and standards functions, NIST also conducts several extramural programs including the Hollings Manufacturing Extension Partnership (MEP) to help smaller firms adopt advanced manufacturing and management technologies and improve their overall competitiveness; the Technology Innovation Program (TIP) to provide cost-shared awards for high-risk, high-reward research and innovation in areas of critical national need; and the Baldrige National Quality Program to help U.S. businesses and other organizations improve the performance and quality of their operations by providing clear standards and benchmarks of quality.

Corresponding DoC Strategic Goal and Objective / Outcome (NIST)

NIST Performance Outcome 1: Promote innovation, facilitate trade, and ensure public safety and security by strengthening the Nation's measurement and standards infrastructure.

Corresponding DOC Strategic Goal and Objective:

DoC Strategic Goal 2: Promote U.S. innovation and industrial competitiveness.

Performance Objective 2.1: Advance measurement science and standards that drive technological change.

Description of Performance Outcome:
As the National Measurement Institute for the United States, NIST is uniquely responsible for establishing and maintaining an efficient system that links the fundamental units of measurement to the measurement methods used by industry, universities, and other government agencies. The Nation's ability to innovate and grow relies on a robust scientific and technical infrastructure, including the measurement science, standards, and technology provided by the NIST Laboratories. The NIST Laboratories perform research to develop the measurement tools, data, and models for advanced science and technology.

NIST has designed its performance evaluation system to accommodate the organization's unique mission and impact path as well as to respond to the intrinsic difficulty of measuring the results of investments in science and technology. Like other Federal science organizations, the primary output of NIST's laboratory research is scientific and technical knowledge, which is inherently difficult to measure directly and comprehensively. In addition, the outcomes from research often do not begin to accrue until several years after the research program has been completed, and the diffusion of benefits often affects broad segments of industry and society over long time periods. Given these challenges, the NIST National Measurement and Standards Laboratories Program evaluates its performance using an appropriate mix of specific output tracking, peer review, and economic impact analyses. Together, these evaluation tools, combined with continual feedback from customers, provide NIST management and external stakeholders with a comprehensive picture of performance towards its long-term outcomes.

NIST Performance Outcome 2: Increase the productivity, profitability, and competitiveness of manufacturers.

Corresponding DOC Strategic Goal and Objective:

DoC Strategic Goal 1: Maximize U.S. competitiveness and enable economic growth for American industries, workers, and consumers.

Performance Objective 1.4: Position manufacturers to compete in a global economy.

Description of Performance Outcome:
Operating under the authority of 15 U.S.C. 278k, Hollings MEP (MEP) is a federal-state-local partnership program that provides small U.S. manufacturers with access to manufacturing technologies, resources, and expertise. Through MEP's network of manufacturing centers, linked to state, university, community college, and private sources of technology and expertise, NIST helps smaller firms adopt advanced manufacturing and management technologies as well as innovative business practices to position them to compete in the global economy.

A strong manufacturing base is critical to the financial and national security of the United States. Prior to the recent financial crisis, U.S. manufacturing firms employed over 13 million people in high-paying jobs with benefits; represented roughly two-thirds of total U.S. research and development expenditures; and accounted for more than 80 percent of all U.S. exports. Manufacturing creates millions of jobs, directly and indirectly, in a wide range of related industries, including business services such as accounting, marketing, legal support, shipping, and warehousing. Beyond these services supporting the extended manufacturing enterprise, the broader U.S. service economy also depends increasingly on the adoption of technologies from the manufacturing sector to keep pace with global competition.

Manufacturers, particularly small and mid-sized manufacturing firms, are facing new and significant challenges. Technology and globalization have fundamentally changed many manufacturing companies and products. This has resulted in a new era of cost pressures, shortened product life cycles, technology that is diffusing rapidly on a global scale, and production that now involves orchestrating networks of suppliers. Manufacturing increasingly depends on access to customers and the infrastructure needed to support the constant reinvention of their products and processes. The challenge is clear: Increasing global competition coupled with the changing nature of innovation demands the U.S. not rest on a strategy of simple productivity improvements.

With a focus on business growth and increased profitability, MEP works to position and transform manufacturers to compete in the global economy. MEP provides an integrated framework for business growth that promotes continuous improvement efforts to reduce costs while encouraging the adoption of tools focused on new product development, sustainable manufacturing processes, integrating supply chains, and increasing the technical skills of the workforce.

MEP's ultimate goal is to measurably improve the productivity, profitability and competitiveness of all of its clients.

NIST Performance Outcome 3: Promote U.S. competitiveness by directing Federal investment and R&D into areas of critical national need that support, promote, and accelerate high-risk, high-reward research and innovation in the United States.

Corresponding DOC Strategic Goal and Objective:

Strategic Goal 2: Promote U.S. innovation and industrial competitiveness.

Performance Objective: Fund high-risk, high-reward R&D in areas of critical national need.

Description of Performance Outcome:
As established by the America COMPETES Act in 2007, the Technology Innovation Program (TIP) will award funding to small or mid-sized businesses, institutions of higher education, national laboratories, or non-profit research organizations for high-risk, high-reward research, establish research collaborations through joint ventures and informal interactions and foster an equivalent amount of additional private investment through cost-share mechanism. The TIP will accelerate the creation of intellectual property vested in U.S. based businesses, universities and other organizations and the dissemination of knowledge created through patents, papers and publications.

Impact of Recovery Act

The American Reinvestment and Recovery Act (ARRA) of 2009 provided NIST $580 million in total resources, of which $220 million is for "research, competitive grants, additional research fellowships and advanced research and measurement equipment and supplies," as stipulated in the conference report to PL 111-5. The ARRA also included $360.0 million for Construction of Research Facilities activities. The $360.0 million consists of $180.0 million to address NIST's backlog of maintenance and renovation and for construction of new facilities and laboratories and $180.0 million for the competitive construction grant program for research science buildings, including fiscal year 2008 and 2009 competitions. NIST plans to invest these funds in activities promoting near-term

recovery by creating and preserving jobs. The funding will also provide longer-term sustained economic growth by investing in NIST measurements and research activities that enable U.S. innovation addressing national priority areas in technology and science. These funds augment and enhance existing programs (non-Recovery funds).

The ARRA funds apply to NIST's Performance Outcome 1: Promote innovation, facilitate trade, and ensure public safety and security by strengthening the Nation's measurement and standards infrastructure.

Objectives of NIST ARRA Appropriated Funding:

1. Procurements that focus on research and measurement equipment (purchased through a competitive award process) for use at NIST and will generate jobs while investing in NIST's measurements and standards mission.

2. Create and preserve high-value American science and technology jobs while advancing NIST's measurements and research that sustain long-term economic growth through innovation.

3. Invest in construction and major repairs infrastructure projects at NIST and through a competitive construction grant program that will yield near-term and long-term benefits for the U.S. economy.

Activities Funded by the Recovery Act

- *Advanced Scientific Equipment:* NIST will procure advanced research and measurement equipment to strengthen its measurement, standards, and technology programs.
- *Measurement Science and Engineering Grants:* NIST will conduct a competitive grants program to support research to advance NIST measurements and standards research efforts.
- *Postdoctoral Research Fellowship:* NIST will expand the NIST Postdoctoral Fellowship program to create up to 80 postdoctoral fellowships for recent Ph.D.s and retain up to 35 NIST NRC postdoctoral fellows through the end of FY 2010 following the end of their tenure.
- *Measurement Science and Engineering Fellowship Program:* NIST will establish a program for awarding a grant to organizations, which may include but are not limited to universities, non-for-profit research organizations, or scientific societies, who will provide fellowships for scientists and engineers to work at NIST.
- *Research Contracts:* NIST will award competitive research contracts to small businesses under the Small Business Innovation Research (SBIR) program to develop new technologies supporting NIST's measurement and research mission, research contracts for work related to the Smart Grid, and contracts for research on specific areas of cyber security.

- *Information Technology Infrastructure Contracts:* NIST will competitively procure critical new information systems and components to improve its IT infrastructure.
- *Health Information Technology (funds transferred from the Department of Health and Human Services):* NIST will increase and accelerate efforts on work related to electronic health records and a nationwide healthcare information network.
- *Smart Grid (funds provided by the Department of Energy):* NIST will accelerate activities associated with the development of a standards framework for Smart Grid devices and systems as established under section 1305 of the Energy Security and Independence Act of 2007.
- *NIST Construction Projects:* NIST will be awarding competitive contracts to complete 15 construction projects at NIST in order to address NIST's backlog of maintenance and renovation and for construction of new facilities and laboratories.
- *Competitive Construction Grants Program:* NIST will provide competitively awarded grants to U.S. universities, colleges, and not-for-profit research organizations for research science buildings through the construction of new buildings or expansion of existing buildings.

NIST Priorities / Management Challenges

Today, America faces its worst economic crisis since the Great Depression, with credit markets frozen, and more jobs lost in 2008 than at any other time since WWII. The President has taken a number of bold actions intended to revitalize America's economy and future. The President's Agenda to revitalize America's economy recognizes the importance of science and technology to make both short-term improvements that will benefit productivity and enhance economic capacity, and long-term investments that lay the foundation for future innovation and economic competitiveness. Critical elements of the President's agenda include:

- Doubling the production of alternative energy in the next three years.
- Modernizing more than 75% of federal buildings and improve the energy efficiency of two million American homes, saving consumers and taxpayers billions on our energy bills.
- Making the immediate investments necessary to ensure that within five years, all of America's medical records are computerized.
- Expanding broadband across America, so that a small business in a rural town can connect and compete with their counterparts anywhere in the world.
- Investing in the science, research, and technology that will lead to new medical breakthroughs, new discoveries, and entire new industries.

NIST research and programs are an essential component to the successful realization of each of these goals. NIST is the only Federal research agency specifically focused on promoting U.S. economic competitiveness. The services and products provided by NIST are

crucial to every manufacturing and service industry, and government institution. Today, more than ever, the Nation needs the services provided by NIST to confront the large inefficiencies that threaten our economy in a number of important sectors. Whether it is through the development of the advanced measurement tools and techniques that make possible the cost-effective manufacture of advanced next generation photovoltaics, or the development of the standards and associated testing and validation infrastructure necessary to enable the deployment of a nationwide healthcare information infrastructure – NIST's laboratories and programs through their focus on measurement science, standards and technology provide the tools and infrastructure critical to enable the innovation, development, and deployment of advanced technologies.

The FY 2010 President's budget realizes the important role of NIST programs to advance elements of our national agenda, highlighting NIST as one of the Federal agencies that will double by FY 2016 from FY 2009 levels. Specifically, NIST laboratory research is intended to double by FY 2016. The President's request for NIST is consistent with the goals set in the President's Plan for Science and Innovation. NIST's FY2010 budget request is targeted at achieving three main goals:

1. Strengthen NIST's core competencies and facilities to assure U.S. leadership in measurement science.

2. Address critical challenges in national priority areas:

   - **Energy:** Speed development of alternative, clean-energy energy sources, from production through storage to final distribution; and help to ensure interoperability of Smart Grid devices and systems (as assigned in the 2007 Energy Independence and Security Act).

   - **Environment:** Promote efficient development of sustainable products and processes, from manufacturing to end-use by consumers; help to establish the scientific measurement basis for accurate climate monitoring; and develop measurement capabilities necessary to measure greenhouse gas emissions.

   - **Manufacturing:** Improve the competiveness of U.S. manufacturers through the development and deployment of new, green technologies and better business practices; and enhance innovation in products and processes, resulting in new jobs.

   - **Health Care:** Advance efforts aimed at achieving lower-cost, higher quality health care, including development of technologies that enable more accurate diagnoses, reduce medical errors, and improve the efficiency and effectiveness of therapies; develop standards essential to interoperable health-care information systems that seamlessly and accurately share information among all health-care providers; and ensure security and privacy of information.

- **Physical Infrastructure:** Develop the needed measurement solutions, models, calibration inspection methods, and technologies that complement TIP's recent awards to the private sector, and can be used to predict the remaining life or margins of safety for infrastructure systems to prioritize and optimize infrastructure spending.

- **Information Technology:** Help to develop more capable, secure, and interoperable information systems to ensure U.S. leadership in information technology; provide technical support for successful deployment of next generation broadband; and supply measurement capabilities necessary for next-generation information technologies.

3. Revitalize NIST Extramural Programs through investments in the TIP and the MEP.

The President's FY 2010 Budget requests $651.5 million for NIST's core laboratory research and facilities; an increase of $7.5 million over FY 2009 levels (excludes P.L. 111-5 amounts). The President's budget also proposes $124.7 million in FY 2010 for MEP, an increase of $14.7 million above FY 2009. For TIP, the President's FY 2010 budget request is $69.9 million, an increase of $4.9 million above FY 2009.

NIST's FY 2010 budget will help address the Nation's immediate and long-term priorities by enabling:

- Development of Smart Grid standards
- Efficient manufacture of next generation photovoltaics
- Development of NetZero Energy Buildings
- Reductions in greenhouse gas emissions
- Creation of a national health IT infrastructure
- Accurate and effective medical diagnostics
- Cost effective revitalization of America's Infrastructure, and
- Security for America's computer networks.

NIST Targets and Performance Summary / FY 2010 Target Description / Measure Descriptions / Validation and Verification

NIST Performance Outcome 1: Promote innovation, facilitate trade, and ensure public safety and security by strengthening the Nation's measurement and standards infrastructure.

Measure 1A: Qualitative assessment and review of technical quality and merit using peer review	**FY 2005 Actual**	**FY 2006 Actual**	**FY 2007 Actual**	**FY 2008 Actual**	**FY 2009 Target**	**FY 2010 Target**
	Completed	Completed	Completed	Complete	Complete	Complete

Description: Beginning in FY 2007, the NRC conducted an assessment process where half of the NIST Laboratories are reviewed each year. The assessment process focuses on the quality, relevance, and technical merit of the NIST Laboratories Program to ensure it is developing and promoting the infrastructure tools and measurement standards needed by industry, academia, and other government agencies.

Comments on Changes to Targets: N/A

Relevant Program Change(s): N/A	**Title:** N/A	**Exhibit 13 Page no:** N/A

Validation and Verification

Data Source	**Frequency**	**Data Storage**	**Internal Control Procedures**	**Data Limitations**	**Actions to be Taken**
On-site interviews and discussions with NIST management and research staff by independent external scientific and technical experts, managed by the NRC.	Beginning in FY 2007, the NRC conducted an assessment process where half of the NIST Laboratories are reviewed each year.	NRC	Oversight of laboratory-specific expert review panels provided by the NRC.	Data are qualitative in nature	None

Measure 1B: Citation impact of NIST-authored publications	FY 2005 Actual	FY 2006 Actual	FY 2007 Actual	FY 2008 Target	FY 2009 Target	FY 2010 Target
	New	New	>1.1	>1.1*	>1.1	>1.1

Description: This measure demonstrates that NIST consistently produces relevant scientific and technical publications. Citation impact reflects the utility and relevance of NIST research and is outcome-oriented. The measure represents NIST's "relative citation impact" which is the average citation rate per NIST publication relative to Thomson Reuters' baseline citation rate number for a large group of peer scientific and technical organizations. *The FY 2008 actual for this measure lags at least six months.

Comments on Changes to Targets: N/A

Relevant Program Change(s): N/A	Title: N/A	Exhibit 13 Page no: N/A

Validation and Verification

Data Source	Frequency	Data Storage	Internal Control Procedures	Data Limitations	Actions to be Taken
Thomson Reuters	Ongoing	NIST	Data represents NIST's "relative citation impact" - that is, the average citation rate per NIST publication relative to Thomson Reuters' baseline citation rate number for all scientific and technical organizations. Internal controls include verification and review by NIST Information Services Division and the NIST Program Office.	Factors such as self-citations, citation circles, and multiple authorship may affect the reliability of any data of this nature.	None

Measure 1C: Peer-reviewed technical publications	FY 2005 Actual	FY 2006 Actual	FY 2007 Actual	FY 2008 Actual	FY 2009 Target	FY 2010 Target
	1,148	1,163	1,272	1,271	1,275	1,300

Description: This measure reflects the quality and demand for NIST publications providing measurements and standards to those in industry, academia, and government agencies. As of FY 2007, this reflects a direct count of NIST technical manuscripts that have been published in an elite body of influential scientific peer-reviewed journals as compiled in the Web of Science® bibliographic database maintained by Thomson Reuters.

Comments on Changes to Targets: The increase in the FY 2009 target reflects an observed trend of higher peer-reviewed publications over the past few years. The FY 2010 target was set based on the net appropriations for the NIST labs in FY 2007 and FY 2008. NIST estimates that the impact of the $59.9M requested increase for the NIST labs in FY 2010 will lag by a minimum of two years due to the time needed for research, writing, journal peer review, and publication processes. While NIST expects to produce an increase in the number of peer-reviewed technical publications over the next ten years, estimates may need to be adjusted based on the actual funding for NIST and trend data from FY 2008 and FY 2009.

Relevant Program Change(s):	Title: NIST Laboratories	Exhibit 13 Page no:
$59.9M STRS		NIST - 102

Validation and Verification

Data Source	Frequency	Data Storage	Internal Control Procedures	Data Limitations	Actions to be Taken
Web of Science® bibliographic database compiled by Thomson Reuters.	Ongoing	NIST	Publication data is collected by Thomson Reuters. Data represents analysis performed by NIST's Information Services Division.	Output Only	None

Measure 1D: Standard Reference Materials sold	FY 2005 Actual	FY 2006 Actual	FY 2007 Actual	FY 2008 Actual	FY 2009 Target	FY 2010 Target
	32,163	31,195	32,614	33,373	31,000	31,000

Description: Standard Reference Materials are the definitive source of measurement traceability in the United States. SRMs are certified in the NIST Laboratories for their specific chemical and material properties. Customers use SRMs to achieve measurement quality and conformance to process requirements that address both national and international needs for commerce and trade and public safety and health. This measure represents a direct count of the number of SRM units sold to customers in industry, academia, and other government agencies.

Comments on Changes to Targets: The conversion of research results into robust, deliverable measurement services typically takes at least three additional years. Therefore, NIST predicts that the number of SRM units sold will start to increase in the outyears as a result of NIST research associated with a few of the new and expanded programs funded under the $59.9M requested increase for the NIST labs in FY 2010. The FY 2009 and FY 2010 targets are based on the restoration of key SRMs to inventory, but may be revised based on the trends indicated by the FY 2008 and FY 2009 outcomes.

Relevant Program Change(s):	Title: NIST Laboratories	Exhibit 13 Page no:
$59.9M STRS		NIST - 102

Validation and Verification

Data Source	Frequency	Data Storage	Internal Control Procedures	Data Limitations	Actions to be Taken
NIST Technology Services	Ongoing	NIST Technology Services	Data represents direct and verifiable counts. Internal controls include verification and review by NIST Technology Services and the Measurement Services and Advisory Group.	Data provide information on output levels only.	None

Measure 1E: NIST-maintained datasets downloaded	FY 2005 Actual	FY 2006 Actual	FY 2007 Actual	FY 2008 Actual	FY 2009 Target	FY 2010 Target
	93,305,136	94,371,001	130M	195.5M	200M	200M

Description: NIST's online data systems are heavily used by industry, academia, other government agencies, and the general public and represent another method NIST uses to deliver its measurements and standards tools, data, and information. This measure is a direct count of the annual number of downloads of NIST-maintained data, and includes all NIST datasets downloaded from www.time.gov, nist.time.gov, and other websites.

Comments on Changes to Targets: The increase in the FY 2009 and FY2010 targets reflects an observed trend of greater usage in the time websites. The conversion of research results into robust, deliverable measurement services typically takes at least three additional years. Therefore, NIST predicts that the number of downloads of NIST-maintained data may increase in the outyears as a result of NIST research associated with a small portion of the new and expanded programs funded under the $59.9M requested increase for the NIST labs in FY 2010.

Relevant Program Change(s):	Title: NIST Laboratories	Exhibit 13 Page no:
$59.9M STRS		NIST - 102

Validation and Verification

Data Source	Frequency	Data Storage	Internal Control Procedures	Data Limitations	Actions to be Taken
NIST Technology Services	Ongoing	NIST Technology Services	Data represents direct and verifiable counts. Internal controls include verification and review by NIST Technology Services and the Measurement Services and Advisory Group.	Data provide information on output levels only. This measure reflects the number of times users access these datasets; it does not reflect unique users or capture how the data was used.	None

Measure 1F: Number of calibration tests performed	FY 2005 Actual	FY 2006 Actual	FY 2007 Actual	FY 2008 Actual	FY 2009 Target	FY 2010 Target
	12,849	13,127	27,489	25,944	15,000	15,000

Description: This target was revised in FY 2007 to measure the number of calibration tests performed versus the number of items calibrated to better demonstrate the calibration output. The significant upward shift in the number of calibrations tests performed in FY 2007 and FY 2008 is related to the unanticipated increased activity for the military and its contractors.

Comments on Changes to Targets: The increase in the FY 2009 and FY 2010 targets reflect an observed trend of greater calibration tests performed over the past few years. The conversion of research results into robust, deliverable measurement services typically takes at least three additional years. Consequently, the number of calibration tests as impacted by a few of the new and expanded programs under the $59.9M requested increase for the NIST labs in FY 2010 is expected to increase in the outyears.

Relevant Program Change(s):	Title: NIST Laboratories	Exhibit 13 Page no:
$59.9M STRS		NIST - 102

Validation and Verification

Data Source	Frequency	Data Storage	Internal Control Procedures	Data Limitations	Actions to be Taken
NIST Technology Services	Ongoing	NIST Technology Services	Data represents direct and verifiable counts. Internal controls include verification and review by NIST Technology Services and the Measurement Services and Advisory Group.	Data provide information on output levels only.	None

NIST Performance Outcome 2: Increase the productivity, profitability, and competitiveness of manufacturers.

Measure 2A: Number of clients served by MEP Centers receiving Federal funding	**FY 2005 Actual**	**FY 2006 Actual**	**FY 2007 Actual**	**FY 2008 Actual**	**FY 2009 Target**	**FY 2010 Target**
	16,448	24,722	28,004	31,961	25,500	29,000

Description: This measure represents the annual number of new and repeat clients served by MEP Centers who received training, technical, and business assistance ranging from informational seminars and training classes to in-depth technical assistance typically beginning with the implementation of lean enterprise concepts and progressing to strategic re-positioning and access to new markets.

Relevant Program Change(s): $14.45M	**Title:** Hollings Manufacturing Extension Partnership	**Exhibit 13 Page no:** NIST- 219

Measure 2B: Increased sales attributed to MEP Centers receiving Federal funding	**FY 2005 Actual**	**FY 2006 Actual**	**FY 2007 Actual**	**FY 2008 Target****	**FY 2009 Target**	**FY 2010 Target**
	$2,842M	$3.1B	$5.6B	$630M	$2.0B	$2.5B
Measure 2C: Capital investment attributed to MEP Centers receiving Federal funding	**FY 2005 Actual**	**FY 2006 Actual**	**FY 2007 Actual**	**FY 2008 Target ******	**FY 2009 Target**	**FY 2010 Target**
	$2,248M	$1.65B*	$2.19B	$485M	$1.0B	$1.0B
Measure 2D: Cost savings attributed to MEP Centers receiving Federal funding	**FY 2005 Actual**	**FY 2006 Actual**	**FY 2007 Actual**	**FY 2008 Target ******	**FY 2009 Target**	**FY 2010 Target**
	$1,304M	$1.1B	$1.44B	$330M	$1.0B	$1.2B

Description: These measures indicate the changes that are positively associated with productivity growth and competitiveness, which are the two factors that are crucial for American manufacturers to manage and succeed in the rapidly changing manufacturing environment. Data is collected through an annual survey of clients receiving services from MEP Centers. *The FY 2006 amount corrects the FY 2008 PAR data which was inadvertently based on the FY 2007 estimate instead of the actual survey results. ** The FY 2008 actuals will be available in January 2010 due to the lag time associated with collecting and analyzing the Hollings MEP client survey data six months after the services are delivered.

Comments on Changes to Targets: The FY 2009 and FY 2010 targets assume a funding level of $110M and $124.7M respectively for MEP consistent with the FY 2010 Congressional Budget submission. Since the FY 2007 actual data (especially in terms of sales) represents an anomaly based on historical actual performance data (trends), the outyear projections exclude this data and are based on prior years' performance. Targets may be revised as time and economic circumstances dictate.					
Relevant Program Change(s): $14.45M	**Title:** Hollings Manufacturing Extension Partnership				**Exhibit 13 Page no:** NIST- 219
Validation and Verification					
Data Source	**Frequency**	**Data Storage**	**Internal Control Procedures**	**Data Limitations**	**Actions to be Taken**
The client impact survey is administered by a private firm, Turner Marketing , located in Sanford, FL.	The survey is conducted four times per year, and clients are selected based on when they completed the first project with a MEP Center in the previous year.	Survey data is sent directly to MEP for analysis. MEP reviews and stores survey data received from Turner Marketing.	Internal controls include verification and significant review of the client responses by MEP staff. Criteria are in place for identifying outliers in the data. Centers verify the outlier and if necessary, the data are revised based on the Center review.	As with similar survey instruments, sources of uncertainty include variation in interpretation of specific questions; in the estimation techniques used in response to specific questions; in the quality of industry data; missing values; and other common survey problems.	None

NIST Performance Outcome 3: Promote U.S. competitiveness by directing Federal investment and R&D into areas of critical national need that support, promote, and accelerate high-risk, high-reward research and innovation in the United States.

Measure 3A: Cumulative number of TIP projects funded	**FY 2009 Target**	**FY 2010 Target**
	9	25

Description: This measure reflects the cumulative number of projects funded to support areas of critical national need since the program's inception. Participating organizations include small and medium-sized companies, institutions of higher education, national laboratories, non-profit research institutes, and other organizations.

Comments on Changes to Targets: This measure was added in FY 2009 to reflect increased funding for TIP. The FY 2010 target is based on a projected FY 2010 competition and assumes a funding level of $69.9M in FY 2010.

Relevant Program Change(s): $4.6M	**Title:** Technology Innovation Program (TIP)	**Exhibit 13 Page no:** NIST- 206

Validation and Verification (See table below for Outcome 3)

Measure 3B: Cumulative number of publications	**FY 2009 Target**	**FY 2010 Target**
	0	0

Description: This measure reflects scientific knowledge being generated from the funding. Publications include academic journals, conference proceedings, and other publications. The measure also reflects the dissemination of the science benefitting other organizations outside of the project participants. Projections are based on historic data from similar R&D programs estimated at 3 publications per completed project. This lagging measure assumes that publications will be generated by the third year of project research.

Comments on Changes to Targets: This measure was added in FY 2009 to reflect increased funding for TIP.

Relevant Program Change(s): $4.6M	**Title:** Technology Innovation Program (TIP)	**Exhibit 13 Page no:** NIST- 206

Validation and Verification (See table below for Outcome 3)

Measure 3C: Cumulative Number of patent applications	FY 2009 Target	FY 2010 Target
	0	0

Description: This measure reflects an additional metric of valuable knowledge and science generated from the funded research. Projections are based on historic data from similar R&D programs estimated at 2 patents per completed project. This is a lagging measure and assumes that patent applications will be generated by the third year of project research.

Comments on Changes to Targets: This measure was added in FY 2009 to reflect increased funding for TIP.

Relevant Program Change(s): $4.6M	Title: Technology Innovation Program (TIP)	Exhibit 13 Page no: NIST- 206

Validation and Verification (See table below for Outcome 3)

Measure 3D: Cumulative number of projects generating continued R&D	FY 2009 Target	FY 2010 Target
	0	0

Description: This measure reflects the creation of transformative research whose value is demonstrated by continued R&D investment by the original researchers or by others. This is a lagging measure and is assessed after the TIP funding for the cost-shared awards has stopped (generally three years or later).

Comments on Changes to Targets: This measure was added in FY 2009 to reflect increased funding for TIP.

Relevant Program Change(s): $4.6M	Title: Technology Innovation Program (TIP)	Exhibit 13 Page no: NIST- 206

Validation and Verification (See table below for Outcome 3)

Measure 3E: Cumulative number of projects with technologies under adoption	FY 2009 Target	FY 2010 Target
	0	0

Description: This measure reflects the implementation of the R&D efforts to benefit end users. Adoption includes testing of the research results at a beta site, licensing the technologies to others, or commercializing the technology through improved products and processes. This is a lagging measure and is assumed to be realized near the end of the project at the earliest (generally three years or later).

Comments on Changes to Targets: This measure was added in FY 2009 to reflect increased funding for TIP.

Relevant Program Change(s): $4.6M	**Title:** Technology Innovation Program (TIP)	**Exhibit 13 Page no:** NIST- 206

Validation and Verification for Outcome 3

Data Source	**Frequency**	**Data Storage**	**Internal Control Procedures**	**Data Limitations**	**Actions to be Taken**
Data are gathered from the portfolio of TIP project participants through company filings of patent information to the NIST Grants Office (a legal requirement) and an electronic survey instrument under TIP's Impact Assessment Reporting System (IARS).	Annual over the course of TIP funding.	TIP's Impact Assessment Group maintains IARS data in an integrated set of databases covering both descriptive information about the funded organizations and survey responses for all participants in TIP-funded research projects.	All TIP reports using IARS data and patent reports filed through the NIST Grants Office are monitored closely by TIP for research quality and are subject to extensive NIST-wide review and critique prior to being issued.	The IARS electronic survey represents a standardized reporting system. Standard sources of uncertainty include variation in interpretation of specific questions; variation in the estimation techniques used in response to specific questions; variation in the quality of industry data; and missing values.	None.

Recovery Act

NIST Performance Outcome 1: Promote innovation, facilitate trade, and ensure public safety and security by strengthening the Nation's measurement and standards infrastructure.						
Measure 1G: Cumulative number of jobs created or maintained with NIST Recovery Act funding	**FY 2005 Actual**	**FY 2006 Actual**	**FY 2007 Actual**	**FY 2008 Actual**	**FY 2009 Target**	**FY 2010 Target**
	N/A	N/A	N/A	N/A		
Description: This measure reflects the cumulative number of jobs created or retained with NIST Recovery Act funding through fellowships for Postdoctoral candidates, scientists, and engineers to work at NIST as well as jobs created throughout other sectors of the economy as a result of contracts and grants awarded for advanced scientific equipment, measurement science and engineering, small business innovation research (including cybersecurity), information technology infrastructure, health information technology, Smart Grid and construction. Due to staggered start times of ARRA programs in FY 2009, FY 2009 jobs data is not available.						
Validation and Verification (See Table Below)						
Measure 1H: Cumulative number of contracts awarded with NIST Recovery Act funding	**FY 2005 Actual**	**FY 2006 Actual**	**FY 2007 Actual**	**FY 2008 Actual**	**FY 2009 Target**	**FY 2010 Target**
	N/A	N/A	N/A	N/A		
Description: This measure reflects the cumulative number of contracts awarded with NIST Recovery Act funding and includes contracts for advanced scientific equipment, Post Doctoral Research Fellowships, small business innovation research (including cybersecuirty), information technology infrastructure, health information technology, Smart Grid, and NIST construction projects.						
Validation and Verification (See Table Below)						

Measure 1I: Cumulative number of grants awarded with NIST Recovery Act funding	FY 2005 Actual	FY 2006 Actual	FY 2007 Actual	FY 2008 Actual	FY 2009 Target	FY 2010 Target
	N/A	N/A	N/A	N/A		

Description: This measure reflects the cumulative number of grants awarded with NIST Recovery Act funding for measurement science and engineering, fellowships, and construction of scientific research facilities at U.S. universities, colleges, and not-for-profit organizations. Due to staggered start times of ARRA programs in FY 2009, FY 2009 jobs data is not available.

Validation and Verification

Data Source	Frequency	Data Storage	Internal Control Procedures	Data Limitations	Actions to be Taken
Data are gathered through information to the NIST Grants and Agreements Management Division, the Budget Division, and each Project Manager.	Quarterly over the course of the ARRA funding.	NIST ARRA Project Management Office	The number of jobs reported by external organizations is reviewed by the respective Project Manager, while the number of NIST PostDoctoral Fellowships is a direct and verifiable count maintained by the NIST Budget Division. The number of contracts and grants represent direct and verifiable counts. Internal controls for the number of contracts and grants include verification and review by the NIST Grants and Agreements Management Division and the ARRA Project Management Office.	Standard sources of uncertainty associated with the number of jobs reported by external organizations. include data quality and interpretation of the reporting requirements.	None.

NIST FY 2010 Program Changes

	Accompanying GPRA		Base		Increase/Decrease		Page of Exhibit 13
Program Change:	**APP Page no.**	**Performance Measure no.**	**FTE**	**Amount**	**FTE**	**Amount**	
NIST Core (STRS and CRF)	**NIST-32**	1C 1D 1E 1F	2944	$695.5	122	$111.6	NIST- 102, 248, 258, 263
Hollings Manufacturing Extension Partnership	**NIST-36**	2A 2B 2C 2D	68	$110.4	3	$14.5	NIST- 219
Technology Innovation Program	**NIST-38**	3A 3B 3C 3D 3E	75	$69.1	0	$4.6	NIST- 206

National Technical Information Service

NTIS provides the American public with permanent and ready access to scientific, technical, and business research through the acquisition, organization, and preservation of data added to its permanent collection. NTIS collects, classifies, coordinates, integrates, records, and catalogs scientific and technical information from whatever sources, foreign and domestic, that may stimulate innovation and discovery and then disseminates that information to the public. In an effort to provide the American public with increased access to the vast collection of government information, NTIS utilizes advanced e-commerce channels, including providing downloads of any item in its collection that is in electronic format for a single low fee or at no charge if under five pages. NTIS also helps other Federal agencies interact with and better serve the information needs of their own constituents by providing information management services.

Corresponding DoC Strategic Goal and Objective / Outcome (NTIS)

NTIS Performance Outcome 1: Increase public access to worldwide scientific and technical information through improved acquisition and dissemination activities.

Corresponding DOC Strategic Goal:

Strategic Goal 2: Promote U.S. innovation and industrial competitiveness.

Performance Objective 2.1: Advance measurement science and standards that drive technological change.

Description of Performance Outcome:

The National Technical Information Service (NTIS) operates a central clearinghouse of scientific and technical information that is useful to U.S. business and industry. Without appropriated funds, NTIS collects scientific and technical information; catalogs, abstracts, indexes, and permanently archives the information; disseminates products in the forms and formats most useful to its customers; develops electronic and other new media to disseminate information; and provides information processing services to other Federal agencies. NTIS' funding comes from (1) the sale of technical reports to business and industry, schools and universities, state and local government offices, and the public at large; and (2) services to Federal agencies that help them communicate more effectively with their employees and constituents. NTIS promotes the development and application of science and technology by providing technologically advanced global e-commerce channels for dissemination of its specialized information to business, industry, government, and the public. The NTIS bibliographic database is available for searching via the NTIS website and search engines free

of charge. Users can download full text documents for free or for a nominal fee depending on document length and can purchase the same documents in a variety of physical media formats.

NTIS Priorities / Management Challenges

NTIS: Strategic Priorities for FY 2010

NTIS' priority is to contribute successfully to the Department of Commerce's strategic goal of promoting U.S. innovation and industrial competitiveness through improved productivity, quality, dissemination, and efficiency of research. To that end, NTIS is committed to increasing the number of updated items it makes available, increasing the number of information products disseminated annually and enhancing customer satisfaction.

NTIS Targets and Performance Summary / FY 2010 Target Description / Measure Descriptions / Validation and Verification

NTIS Performance Outcome 1: Increase public access to worldwide scientific and technical information through improved acquisition and dissemination activities.						
Measure 1A: Number of Updated Items Available (Annual)	**FY 2005 Actual**	**FY 2006 Actual**	**FY 2007 Actual**	**FY 2008 Actual**	**FY 2009 Target**	**FY 2010 Target**
	658,138	673,807	744,322	813,775	745,000	765,000
Description: The number of items available for sale to the public from NTIS includes scientific, technical, and engineering information products added to the permanent collection, as well as items made available through online electronic subscriptions.						
Comments on Changes to Targets: The FY 2010 Target reflects continued increases in expected activity.						
Relevant Program Change(s): N/A	**Title:** N/A				**Exhibit 13 Page no:** N/A	
Validation and Verification						
Data Source	**Frequency**	**Data Storage**	**Internal Control Procedures**	**Data Limitations**	**Actions to be Taken**	
NTIS operates and maintains internal systems for collecting acquisition statistics.	Data is available daily. Reports are produced monthly.	All data is stored within NTIS systems.	NTIS' accounting and budget offices analyze and report performance data to management. Data verification is provided through regular internal independent auditor reporting.	Output Only	None	

Measure 1B: Number of Information Products Disseminated (Annual)	FY 2005 Actual	FY 2006 Actual	FY 2007 Actual	FY 2008 Actual	FY 2009 Target	FY 2010 Target
	26,772,015	30,616,338	32,027,113	32,267,167	32,850,000	33,000,000

Description: This measure represents information disseminated and includes compact discs, diskettes, tapes, online subscriptions, electronic document downloads, Web site pages, as well as traditional paper and microfiche products.

Comments on Changes to Targets: The FY 2010 Target reflects continued increases in expected activities.

Relevant Program Change(s): N/A	Title: N/A	Exhibit 13 Page no: N/A

Validation and Verification

Data Source	Frequency	Data Storage	Internal Control Procedures	Data Limitations	Actions to be Taken
A modified commercial order processing system and a standard Web analysis software package used by industry.	Internal management activity reports are produced daily, summaries are produced monthly.	All data is stored within NTIS systems.	NTIS' accounting and budget offices analyze and report performance data to management. Data verification is provided through regular internal independent auditor reporting.	Output Only	None

Measure 1C: Customer Satisfaction	FY 2005 Actual	FY 2006 Actual	FY 2007 Actual	FY 2008 Actual	FY 2009 Target	FY 2010 Target
	98%	98%	98%	96%	95% - 98%	95% - 98%

Description: This measure represents the percentage of NTIS customers that are satisfied with the quality of their order, the ease of order placement, and the timely fulfillment of that order. NTIS's continual efforts to maintain and possibly improve this very high rate of customer satisfaction are essential to the success of NTIS's performance and mission to collect and disseminate scientific and business-related information.

Comments on Changes to Targets: N/A

Relevant Program Change(s): N/A	Title: N/A	Exhibit 13 Page no: N/A

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Validation and Verification					
Data Source	Frequency	Data Storage	Internal Control Procedures	Data Limitations	Actions to be Taken
A modified commercial order processing system.	Internal management activity reports are produced daily, summaries are produced monthly.	All information is stored within NTIS systems.	NTIS accounting and budget offices analyze and report performance data to management. Data verification is provided through regular internal and independent auditor reporting.	None	None

NTIS FY 2010 Program Changes

	Accompanying GPRA		Base		Increase/Decrease		Page of Exhibit 13
Program Change:	**APP Page no.**	**Performance Measure no.**	**FTE**	**Amount**	**FTE**	**Amount**	
National Technical Information Service	**NIST - 45**	N/A	150	$42.5	0	$0	

NIST/NTIS Resource Requirements Table

NIST Laboratory Performance Outcome 1: Promote innovation, facilitate trade, and ensure public safety and security by strengthening the Nation's measurement and standards infrastructure.								
	FY 2005 Actual	**FY 2006 Actual**	**FY 2007 Actual**	**FY 2008 Actual**	**FY 2009 Estimate**	**FY 2010 Base**	**Increase/ Decrease**	**FY 2010 Request**
Original funds	621.6	762.4	662.4	759.3	869.7	695.5	111.6	807.1
Recovery Act Funds					610.0			
Total Funds	621.6	762.4	662.4	759.3	1,479.7	695.5	111.6	807.1
NIST Hollings MEP Performance Outcome 2: Increase the productivity, profitability, and competitiveness of manufacturers.								
	FY 2005 Actual	**FY 2006 Actual**	**FY 2007 Estimate**	**FY 2008 Actual**	**FY 2009 Estimate**	**FY 2010 Base**	**Increase/ Decrease**	**FY 2010 Estimate**
Total Funds	102.7	111.9	107.3	91.2	112.5	110.4	14.5	124.9
NIST Technology Innovation Program Performance Outcome 3: Promote U.S. competitiveness by directing Federal investment and R&D into areas of critical national need that support, promote, and accelerate high-risk, high-reward research and innovation in the United States.								
	FY 2005 Actual	**FY 2006 Actual**	**FY 2007 Actual**	**FY 2008 Actual**	**FY 2009 Estimate**	**FY 2010 Base**	**Increase/ Decrease**	**FY 2010 Estimate**
Total Funds	138.3	72.7	93.4	54.5	83.7	69.1	4.6	73.7

NTIS Performance Goal: Increase public access to world-wide scientific and technical information through improved acquisition and dissemination activities								
	FY 2005 Actual	**FY 2006 Actual**	**FY 2007 Actual**	**FY 2008 Actual**	**FY 2009 Estimate**	**FY 2010 Base**	**Increase/ Decrease**	**FY 2010 Estimate**
Total Funds	15.9	27.2	27.9	22.5	42.0	42.5	0.0	42.5
Grand Total	**FY 2005 Actual**	**FY 2006 Actual**	**FY 2007 Actual**	**FY 2008 Actual**	**FY 2009 Estimate**	**FY 2010 Base**	**Increase/ Decrease**	**FY 2010 Estimate**
Original Funding	878.5	974.2	890.9	927.5	1,107.9	917.5	130.7	1,048.2
Direct	712.9	756.5	694.1	733.1	891.4	723.2	124.7	847.9
Reimbursable	165.6	217.4	196.8	194.5	216.3	194.2	5.9	200.1
IT Funding	72.3	72.3	78.2	85.7	88.3	88.4	2.5	90.8
Recovery Act Funding					610.0			
Direct					600.0			
Reimbursable					10.0			
IT Funding					50.0			
Total Funding	878.5	974.2	890.9	927.5	1,717.9	917.5	130.7	1,048.2
Direct	712.9	756.5	694.1	733.1	1491.4	723.2	124.7	847.9
Reimbursable	165.6	217.4	196.8	194.5	226.3	194.2	5.9	200.1
IT Funding	72.3	72.3	78.2	85.7	138.3	88.4	2.5	90.8
Original FTE	2,938	2,896	2,891	2,934	3,192	3,237	125	3,362
Recovery Act FTE					48			
Total FTE	2,938	2,896	2,891	2,934	3,240	3,237	125	3,362

Department of Commerce
National Institute of Standards and Technology
Scientific and Technical Research and Services
SUMMARY OF RESOURCE REQUIREMENTS
(Dollar amounts in thousands)

	Positions	FTE	Budget Authority	Direct Obligations	Appro-priation
2009 Currently available	2,013	2,082 [5/]	$715,225 [1/]	$723,006 [1/]	$692,000 [1/]
less: Unobligated balance from prior year			0	(6,781)	0
less: Transfer from DoJ	0	0	(1,500) [2/]	(1,500) [2/]	0
less: Transfer from EAC	0	0	(4,000) [3/]	(4,000) [3/]	0
less: Transfer from HHS/ARRA	0	(10)	(20,000) [4/]	(20,000) [4/]	
2010 Adjustments to base:					
less: American Recovery and Reinvestment Act of 2009	0	(38)	(220,000)	(220,000)	(220,000)
Annualization of positions financed in FY 2009	0	39			
plus: Restoration of 2009 deobligation offset	0	0	1,000	0	1,000
plus: Adjustment of WCF transfer for prior program changes	0	0	2,025	2,025	0
plus: Uncontrollable cost changes	0	0	2,709	2,709	2,709
less: Estimated recoveries, 2010	0	0	(1,000)	0	(1,000)
2010 Base Request	2,013	2,073	474,459	475,459	474,709
plus: 2010 Program changes	161	122	53,951	53,951	59,891
plus: Transfer from EAC			3,250 [3/]	3,250 [3/]	0
2010 Estimate	2,174	2,195	531,660	532,660	534,600

Comparison by activity/subactivity:		2008 Actual		2009 [1/] Currently Available		2010 Base		2010 Estimate		Increase/ (Decrease) Over 2010 Base	
		Per-sonnel	Amount	Per-sonnel	Amount	Per-sonnel	Amount	Per-sonnel	Amount	Per-sonnel	Amount
National measurement and standards laboratories											
National measurement and standards	Pos./Approp	1,670	385,683	1,744	604,437	1,744	417,192	1,905	477,083	161	59,891
laboratories	FTE/Obl.	1,639	393,928	1,772	634,032	1,798	417,809	1,920	475,010	122	57,201
Innovations in measurement science	Pos./Approp	88	19,888	88	19,888	88	20,175	88	20,175	0	0
Innovations in measurement science	FTE/Obl.	86	19,938	93	20,791	93	20,199	93	20,199	0	0
Next generation measurements training	Pos./Approp	91	10,484	91	32,784	91	11,030	91	11,030	0	0
Postdoctoral research associates program	FTE/Obl.	88	10,565	132	32,936	94	11,047	94	11,047	0	0

Comparison by activity/subactivity:		2008 Actual Personnel	2008 Actual Amount	2009 [1/] Currently Available Personnel	2009 [1/] Currently Available Amount	2010 Base Personnel	2010 Base Amount	2010 Estimate Personnel	2010 Estimate Amount	Increase/ (Decrease) Over 2010 Base Personnel	Increase/ (Decrease) Over 2010 Base Amount
Baldrige national quality program	Pos./Approp	51	7,927	57	9,440	57	9,608	57	9,608	0	0
Baldrige national quality program	FTE/Obl.	50	8,402	56	9,489	59	9,627	59	9,627	0	0
Corporate services	Pos./Approp	33	16,535	33	25,451	33	16,704	33	16,704	0	0
Corporate services	FTE/Obl.	28	17,202	29	25,758	29	16,777	29	16,777	0	0
TOTALS	Pos./Approp	1,933	440,517	2,013	692,000	2,013	474,709	2,174	534,600	161	59,891
	FTE/Obl.	1,891	450,035	2,082	723,006 [5/]	2,073	475,459	2,195	532,660	122	57,201
Adjustments for:											
Recoveries			(2,073)		(1,000)		(1,000)		(1,000)		0
Unobligated balance, start of year			(9,098)		(6,781)		0		0		0
Unobligated balance, end of year			6,781		0		0		0		0
Unobligated balance, expired account			2								
Budget Authority			445,647		715,225		474,459		531,660		57,201
Financing from transfers:											
Transfers to other accounts					2,275		250		6,190		5,940
Transfer from Community Oriented Policing Services, DoJ			(1,880) [2/]		(1,500) [2/]						
Transfer from Election Assistance Commission			(3,250) [3/]		(4,000) [3/]				(3,250) [3/]		(3,250) [3/]
Transfer from Office of the National Coordinator for Health Information Technology, HHS/ARRA					(20,000) [4/]						
Appropriation			440,517		692,000		474,709		534,600		59,891

[1/] Includes the American Recovery and Reinvestment Act of 2009 (P.L. 111-5) supplemental appropriation to NIST (STRS $220 million).

[2/] Actual and anticipated transfers from Community Oriented Policing Services.

[3/] Actual and anticipated transfers from Election Assistance Commission.

[4/] Actual transfer from National Coordinator for Health Information Technology, per American Recovery and Reinvestment Act of 2009.

[5/] The FTE levels for FY 2009 have been adjusted to reflect a correction to the direct and reimbursable distribution. As a result, the levels shown above are different from the level reflected in the President's Budget.

Department of Commerce
National Institute of Standards and Technology
Scientific and Technical Research and Services
SUMMARY OF FINANCING
(Dollar amounts in thousands)

	2008 Actual	2009 Currently Available	2010 Base	2010 Estimate	Increase/ (Decrease) Over 2010 Base
Total Obligations	$450,035	$733,006	$475,459	$532,660	$57,201
Financing:					
Offsetting collections from:					
Federal funds	0	(10,000)	0	0	0
Non-Federal sources	0	0	0	0	0
Total offsetting collections	0	(10,000)	0	0	0
Adjustments for:					
Recoveries	(2,073)	(1,000)	(1,000)	(1,000)	0
Unobligated balance, start of year	(9,098)	(6,781)	0	0	0
Unobligated balance, end of year	6,781	0	0	0	0
Unobligated balance, expired	2	0	0	0	0
Budget Authority	445,647	715,225	474,459	531,660	57,201
Financing:					
Transfer to other accounts	0	2,275	250	6,190	5,940
Transfer from other accounts	(5,130)	(25,500)	0	(3,250)	(3,250)
Appropriation	440,517	692,000	474,709	534,600	59,891

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Department of Commerce
National Institute of Standards and Technology
Scientific and Technical Research and Services
ADJUSTMENTS TO BASE
(Dollar amounts in thousands)

	Perm. Pos.	FTE	Amount
Adjustments:			
Dropout of congressionally directed projects	...	...	($3,475)
Dropout of one-time ARRA Funding (P.L. 111-5)		(38)	(220,000)
Restoration of FY 2009 deobligation offset	...	...	1,000
Subtotal	...	...	(222,475)
Financing:			
Recoveries of prior year deobligations	...	...	(1,000)
Other Changes:			
Annualization of 2009 Pay raise	...	...	3,736
2010 Pay increase and related costs	...	...	3,743
Annualization of positions financed in FY 2009	...	39	0
Personnel benefits:			
Civil Service Retirement System (CSRS)	...	...	(310)
Federal Employees' Retirement System (FERS)	...	...	496
Thrift Savings Plan (TSP)	...	...	206
Federal Insurance Contribution Act (FICA) - OASDI	...	...	246
Health insurance	...	...	247
Employees Compensation Fund	...	...	60
Travel and transportation of persons:			
Mileage	...	...	3
Per Diem	...	...	266
Rental Payments to GSA	...	...	1
Communications, utilities, and miscellaneous charges:			
Postage	...	...	5
HCHB Steam	...	...	2
HCHB Electricity	...	...	3
Electricity rate increase	...	...	804
Natural Gas rate decrease	...	...	(2,993)
Other services:			
Working Capital Fund	...	...	758
Less Payment to WCF for utilities	...	...	(5)
Commerce Business Systems (CBS)	...	...	135
NARA storage costs	...	...	5

	Perm. Pos.	FTE	Amount
Supplies and materials:			
Scientific journal subscriptions	...	...	97
General pricing level adjustment:			
Transportation of things	...	...	13
Rental payments to others	...	...	7
Communications, utilities, and miscellaneous charges	...	...	24
Printing and reproduction	...	...	3
Other services	...	...	421
Supplies and materials	...	...	173
Equipment	...	...	332
Subtotal, Other changes	0	39	8,478
Subtotal, Adjustments to base	0	1	(214,997)
Amount absorbed	0	0	(2,294)
Total, Adjustments to base	0	1	(217,291)

Department of Commerce
National Institute of Standards and Technology
Scientific and Technical Research and Services
JUSTIFICATION OF ADJUSTMENTS TO BASE
(Dollar amounts in thousands)

	FTE	Amount
Adjustments:		
Dropout of congressionally directed projects	0	($3,475)

In FY 2009, NIST received $3,475,000 in congressionally directed projects. This adjustment removes these one-time costs.

Dropout of one-time ARRA Funding (P.L. 111-5)	(38)	(220,000)

In FY 2009, NIST received $220,000,000 in one-time funding from the American Recovery and Reinvestment Act of 2009 (ARRA). This adjustment removes the one-time funding.

Restoration of FY 2009 deobligation offset	0	1,000

In FY 2009, NIST's STRS budget authority was reduced by $1,000,000 based on an estimated level of prior year deobligations. This adjustment would restore the reduction in FY 2010.

Subtotal, Adjustments	0	(222,475)
Financing:		
Recoveries of prior year deobligations	0	(1,000)

NIST's FY 2010 STRS budget authority is reduced by the estimated level of prior year deobligations in FY 2010.

Other Changes:

Annualization of 2009 pay raise	0	3,736

A pay raise of 3.9 percent is assumed to be effective January 1, 2009.

Total cost in FY 2010 of 2009 pay raise	$8,445,517
Less amount requested in FY 2009	(4,710,000)
Less amount absorbed in FY 2009	0
Amount requested in 2010 to provide full-year cost of 2009 pay raise	3,735,517
Payment to Departmental Management Working Capital Fund	0
Total, FY 2009 pay raise increase in FY 2010	3,735,517

2010 Pay increase and related costs	0	3,743

A general pay raise of 2.0 percent is assumed to be effective January 1, 2010.

Total cost in FY 2010 of pay increase	$3,665,000
Less amount absorbed in FY 2009	0
Amount requested for FY 2010 pay increase	3,665,000
Payment to Departmental Management Working Capital Fund	78,000
Total adjustment for FY 2010 pay increase	3,743,000

Annualization of positions financed in FY 2009	39	0

NIST requires an additional 39 FTE to staff FY 2009 requested increases at their full operating level in FY 2010.

Personnel benefits 945

Civil Service Retirement System (CSRS)	($310)
Federal Employees' Retirement System (FERS)	496
Thrift Savings Plan (TSP)	206
Federal Insurance Contribution Act (FICA) - OASDI	246
Health Insurance	247
Employees Compensation Fund	60

Civil Service Retirement System (-$310,000) – The number of employees covered by the Civil Service Retirement System (CSRS) continues to drop as positions become vacant and are filled by employees who are covered by the Federal Employees' Retirement System (FERS). The estimated percentage of payroll for employees covered by CSRS will decrease from 16.8 percent in FY 2009 to 14.6 percent in FY 2010. The contribution rate will remain at 7.0 percent in FY 2010.

Payroll subject to retirement systems ($201,359,105)	
Cost of CSRS contributions in FY 2010 ($201,359,105 x .146 x .07)	$2,057,890
Cost of CSRS contributions in FY 2009 ($201,359,105 x .168 x .07)	2,367,983
Total adjustment to base	(310,093)

Federal Employees' Retirement System ($496,000) – The number of employees covered by FERS continues to rise as employees covered by CSRS leave and are replaced by employees covered by FERS. The estimated percentage of payroll for employees covered by FERS will increase from 83.2 percent in FY 2009 to 85.4 percent in FY 2010. The contribution rate will remain at 11.2 percent in FY 2010.

Payroll subject to retirement systems ($201,359,105)	
Basic benefit cost in FY 2010 ($201,359,105 x .854 x .112)	$19,259,596
Basic benefit cost in FY 2009 ($201,359,105 x .832 x .112)	18,763,447
Total adjustment to base	496,149

Thrift Savings Plan ($206,000) – The cost of agency contributions to the Thrift Savings Plan will also rise as FERS participation increases. The contribution rate will remain at 4.65 percent in FY 2010.

Thrift plan cost in FY 2010 ($201,359,105 x .854 x .0465)	$7,996,171
Thrift plan cost in FY 2009 ($201,359,105 x .832 x .0465)	7,790,181
Total adjustment to base	205,990

Federal Insurance Contributions Act (FICA) - OASDI ($246,000) – As the percentage of payroll covered by FERS rises, the cost of OASDI contributions will increase. In addition, the maximum salary subject to OASDI tax will increase from $106,425 in FY 2009 to $110,400 in FY 2010. The OASDI tax rate will remain 6.2 percent in FY 2010.

FERS payroll subject to FICA tax in 2010 ($201,359,105 x .854 x .904 x .062)	$9,638,052
FERS payroll subject to FICA tax in 2009 ($201,359,105 x .832 x .905 x .062)	9,400,152
Increase (FY 2009-FY 2010)	237,900
OTP payroll subject to FICA tax in FY 2010 ($6,872,895 x .854 x .904 x .062)	328,971
OTP payroll subject to FICA tax in FY 2009 ($6,872,895 x .832 x .905 x .062)	320,851
Increase (FY 2009-FY 2010)	8,120
Total adjustment to base	246,020

Health insurance ($247,000) – Effective January 2008, NIST's contribution to Federal employees' health insurance premiums increased by 2.1 percent. Applied against the FY 2009 estimate of $11,780,000, the additional amount required is $247,380.

Employees Compensation Fund ($60,000) – The Employees Compensation Fund bill for the year ending June 30, 2008 is a net $63,000 higher than the year ending June 30, 2007. The STRS share of the increase is $60,000.

Travel and transportation of persons 0 269

The General Services Administration (GSA) increased the mileage rate from 48.5 cents to 58.5 cents, a 20.6 percent increase. This percentage was applied to the FY 2009 estimate of $14,000 to arrive at an increase of $2,884. In addition, an analysis of per diem rates by city was performed based on data received from GSA for the time period of October 1, 2006 through September 30, 2008. A net increase of 4.96 percent was applied to the FY 2009 base of $5,361,000 to arrive at an increase of $265,906.

Rental Payments to GSA 0 1

GSA rates are projected to increase 2.5% in FY 2010. This percentage was applied to the FY 2009 estimate of $37,000 to arrive at an increase of $925.

Communications, utilities, and miscellaneous charges 0 (2,179)

Postage	$5
HCHB Steam	2
HCHB Electricity	3
Electricity rate increase	804
Natural Gas rate decrease	(2,993)

Effective May 12, 2008, the Governors of the Postal Service implemented a rate increase for first class mail from 41 cents to 42 cents, an increase of 2.4 percent. This percentage was applied to the FY 2009 estimate of $209,000 to arrive at an increase of $5,016.

HCHB Steam and Electricity will no longer fall under the Working Capital Fund but are now charged directly to the STRS account.

The electricity ATB amount was derived using a year to year comparison of the cost per kilowatt hour. In analyzing the 12 months ended February 2008 and 2007, the per kilowatt hour rate increased 4.8% (from 11.0 cents to 11.6 cents) for Gaithersburg, Maryland; increased 11.8% (from 31.1 cents to 34.7 cents) for Kauai, Hawaii; decreased 3.5% (from 5.6 cents to 5.4 cents) for Boulder, Colorado; and increased .4% (from .08 cents to .0803 cents) for Ft. Collins, Colorado for a net increase of $804,000.

The natural gas ATB amount was derived using a year to year comparison of the average cost per therm. In analyzing the 12 months ended February 2008 and 2007, the per therm rate decreased 25.2% (from 1.6 to 1.2) and decreased 18.7% (from 10.44 to 8.49) for Boulder and Gaithersburg respectively resulting in a net decrease of $2,993,000.

Other Services		0	893
Working Capital Fund (Departmental Management)	$758		
Less payment to the Working Capital Fund for utilities	(5)		
Commerce Business Systems (CBS)	135		
National Archives and Records Administration (NARA) storage costs	5		

Working Capital Fund (Departmental Management) ($758,000) – An additional $758,000 is required to fund cost increases in the Departmental Management Working Capital Fund.

Less Payment to the Working Capital Fund for utilities ($-5,000) – HCHB Steam and Electricity will no longer fall under the Working Capital Fund but are now charged directly to the STRS account. This ATB removes the costs from the Working Capital Fund.

Commerce Business Systems (CBS) ($135,000) – An increase of $135,000 is required in FY 2010 consistent with the CBS Capital Asset Plan.

National Archives and Records Administration (NARA) storage costs ($5,000) - NARA estimates reflect an increase of $5,000 in FY 2010 for records storage and maintenance costs.

Supplies and Materials		0	97
Scientific journal subscriptions	$97		

This adjustment to base addresses the FY 2007 to FY 2008 inflationary increase in costs for NIST's subscriptions journals, which exceed the inflationary increases provided through the regular general pricing level deflator.

General pricing level adjustment	0	973

This request applies the OMB economic assumptions of .8 percent for FY 2010 where the prices that the government pays are established through the market system. Factors are applied to sub-object classes that result in the following adjustments to base: transportation of things $13,016; rental payments to others $6,816; communications, utilities, and miscellaneous charges $24,112; printing and reproduction $3,368; other services $421,182; supplies and materials $173,360; and equipment $332,114.

Subtotal, Other changes	39	8,478
Amount absorbed	0	(2,294)
Total adjustments to base	1	(217,291)

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Department of Commerce
National Institute of Standards and Technology
Scientific and Technical Research and Services
PROGRAM AND PERFORMANCE: DIRECT OBLIGATIONS
(Dollar amounts in thousands)

Activity: National measurement and standards laboratories
Subactivity: National measurement and standards laboratories

Line Item		2008 Actual Personnel	2008 Actual Amount	2009 Currently Available Personnel	2009 Currently Available Amount	2010 Base Personnel	2010 Base Amount	2010 Estimate Personnel	2010 Estimate Amount	Increase/ (Decrease) Over 2010 Base Personnel	Increase/ (Decrease) Over 2010 Base Amount
Strategic and emerging research initiatives	Pos./Approp	3	$3,015	20	$65,651	20	$8,814	33	$13,705	13	$4,891
	FTE/Obl.	3	1,913	10	65,001	18	8,814	28	12,905	10	4,091
Electronics and electrical engineering laboratory	Pos./Approp	225	52,101	232	81,987	232	54,580	258	61,230	26	6,650
	FTE/Obl.	220	56,298	235	87,065	239	54,694	261	60,627	22	5,933
Manufacturing engineering laboratory	Pos./Approp	131	35,235	132	48,715	132	35,656	134	36,206	2	550
	FTE/Obl.	129	35,417	135	48,858	136	35,702	137	36,252	1	550
Chemical science and technology laboratory	Pos./Approp	243	48,174	247	64,719	247	51,959	266	60,759	19	8,800
	FTE/Obl.	237	48,321	252	64,636	254	51,779	269	58,979	15	7,200
Physics laboratory	Pos./Approp	170	44,446	181	71,133	181	49,758	195	55,858	14	6,100
	FTE/Obl.	166	44,804	181	70,562	187	49,879	197	55,220	10	5,341
Materials science and engineering laboratory	Pos./Approp	168	37,350	174	48,292	174	39,924	203	49,904	29	9,980
	FTE/Obl.	165	37,482	177	48,252	180	39,991	202	49,395	22	9,404
Building and fire research laboratory	Pos./Approp	133	28,605	140	42,493	140	32,822	153	39,542	13	6,720
	FTE/Obl.	130	28,757	139	42,467	143	32,874	153	38,956	10	6,082
Information technology laboratory	Pos./Approp	313	55,561	324	70,691	324	59,322	358	72,172	34	12,850
	FTE/Obl.	306	59,201	340	94,910	334	59,441	358	75,191	24	15,750

Line Item		2008 Actual Personnel	2008 Actual Amount	2009 Currently Available Personnel	2009 Currently Available Amount	2010 Base Personnel	2010 Base Amount	2010 Estimate Personnel	2010 Estimate Amount	Increase/ (Decrease) Over 2010 Base Personnel	Increase/ (Decrease) Over 2010 Base Amount
NIST center for neutron research	Pos./Approp	143	38,793	149	51,571	149	41,094	149	41,094	0	0
	FTE/Obl.	150	39,360	161	52,059	164	41,271	164	41,271	0	0
Center for nanoscale science and technology	Pos./Approp	66	26,621	69	34,871	69	27,571	73	29,421	4	1,850
	FTE/Obl.	60	26,548	64	35,753	65	27,595	68	28,945	3	1,350
Technology services	Pos./Approp	75	14,889	76	20,839	76	15,692	83	17,192	7	1,500
	FTE/Obl.	73	14,934	78	20,994	78	15,769	83	17,269	5	1,500
External projects	Pos./Approp	0	893	0	3,475	0	0	0	0	0	0
	FTE/Obl.	0	893	0	3,475	0	0	0	0	0	0
Total	Pos./Approp	1,670	385,683	1,744	604,437	1,744	417,192	1,905	477,083	161	59,891
	FTE/Obl.	1,639	393,928	1,772	634,032	1,798	417,809	1,920	475,010	122	57,201

Department of Commerce
National Institute of Standards and Technology
Scientific and Technical Research and Services
JUSTIFICATION OF PROGRAM AND PERFORMANCE
NATIONAL MEASUREMENT AND STANDARDS LABORATORIES

Goal Statement

This activity supports DoC's and NIST's mission of promoting U.S. innovation and industrial competitiveness by advancing measurement science, standards, and technology that drive technological change.

NIST's resources will continue to be devoted to meeting today's economic and societal challenges and lay the foundation for future success. NIST activities help address critical challenges in national priority areas:

- **Energy:** Speed development of alternative, clean-energy energy sources, from production through storage to final distribution; and help to ensure interoperability of Smart Grid devices and systems (as assigned in the 2007 Energy Independence and Security Act).

- **Environment:** Promote efficient development of sustainable products and processes, from manufacturing to end-use by consumers; help to establish the scientific measurement basis for accurate climate monitoring; and develop measurement capabilities necessary for an efficient system that results in reductions in greenhouse gas emissions.

- **Manufacturing:** Improve the competiveness of U.S. manufacturers through the development and deployment of new, green technologies and better business practices; and enhance innovation in products and processes, resulting in new jobs.

- **Health Care:** Advance efforts aimed at achieving lower-cost, higher quality health care, including development of technologies that enable more accurate diagnoses, reduce medical errors, and improve the efficiency and effectiveness of therapies; develop standards essential to interoperable health-care information systems that seamlessly and accurately share information among all health-care providers; and ensure security and privacy of information.

- **Physical Infrastructure:** Develop the needed measurement solutions, models, calibration inspection methods, and technologies that complement TIP's recent awards to the private sector, and can be used to predict the remaining life or margins of safety for infrastructure systems to prioritize and optimize infrastructure spending.

- **Information technology:** Help to develop more capable, secure, and interoperable information systems to ensure U.S. leadership in information technology; provide technical support for successful deployment of next generation broadband; and supply measurement capabilities necessary for next-generation information technologies.

NIST's National Measurement and Standards Laboratories play a unique role in the Nation's scientific, industrial and business communities. NIST's presence and leadership in the Nation's measurement and standards system enables companies, researchers, government agencies and universities to work with each other more easily, improving the Nation's economic security and quality of life. When scientists, engineers, health care professionals, manufacturers and business people compare and trade data, test results, manufactured goods, services, and commodities, they do so with greater confidence in the exchange because of NIST's presence in the background, anchoring the national measurement and standards system that is the language of research and commerce.

Ensuring an effective and viable national measurement and standards system is the oldest and one of the most important of NIST's long-standing missions. NIST affects:

- how the Nation will address rising energy costs, scarcity of fossil fuels, and the environmental impacts of energy consumption because the agency is called upon to provide the measurement science and standards needs to ensure a robust and efficient energy delivery (Smart Grid technologies), to promote efficient energy utilization (high-performance buildings and lightweight materials for automobile and light truck applications), and to enable new energy generation and storage. The term Smart Grid refers to the 21st century modernization of the current electric power grid by incorporating the technologies of broadband communications and advanced computing so that it can operate more efficiently, reliably and safely;

- efforts to address sustainability issues as industries and societies are challenged to reduce the amounts of natural resources and energy they consume and the wastes they produce. Improving sustainability is now a key business objective in addition to increasing profitability and market share, and NIST needs to ensure that the national infrastructure of measurement methods, standards, data, and data technologies are sufficient to help U.S. industry develop, evaluate, and implement sustainable business practices in areas such as chemicals, materials, processes, manufacturing methods, and products;

- every American who goes to the store, buys gasoline or pays a utility bill because each year over $4.6 trillion in wholesale and retail trade is measured against standards that are ultimately traceable to NIST;

- every American whose job depends on the ability of our industries to innovate and to compete in global trade, because product quality and productivity depend on the ability to measure and precisely control the production process, and because more and more high-tech and high-value products are subject to foreign regulations that require measurements traceable to internationally recognized standards;

- every American who relies on fundamental business services and communications devices, because so many of these services depend upon NIST measurements and standards in ways that are invisible to most consumers and service sector employees; and,

- every American concerned with homeland security because NIST is called upon increasingly to provide the measurement assurance behind sensitive detection systems for chemical, biological, explosive and radiological weapons.

NIST's mission is vital and dynamic because a modern, progressive, industrialized society in a global economy imposes constant demands for improvements in its measurements, standards, and technologies. The pace of America's technological innovation both drives and is driven by our ability to observe and to measure, and NIST's infrastructure is vital to the pace of innovation.

Base Program

NIST's support of measurements, standards and technology–a mission that embraces everything from validating the testing system used to assure the quality of concrete in new construction to the frontiers of quantum computing and quantum-level encryption–is funded under the Scientific and Technical Research and Services (STRS) appropriation.

1) Strategic and Emerging Research Initiative Funds (SERI) – The tremendous breadth of scientific and engineering activity conducted at NIST spans most scientific disciplines (chemistry, physics, computer science, etc.). Most of NIST's research fits neatly within individual disciplines and consequently is funded through appropriations to each corresponding laboratory. However, in order to address new and emerging scientific problems, modern research has become increasingly multidisciplinary in nature. As a result, this multidiscipline research requires budgetary flexibly that is not encumbered by strict adherence to specific laboratory disciplines. NIST's Strategic and Emerging Research Investment (SERI) Fund allows NIST the flexibility to pull together research teams from across the Institution to address these emerging research issues and at the same time accurately account for the budgetary resources

required. Examples of recent activities under SERI include measurement and standards work related to the Smart Grid, physical infrastructure, advanced manufacturing, and reduction of greenhouse gas emissions.

In addition, the SERI fund allows the NIST Director to seed the development of new competencies that contribute effectively to future national needs and goals by investing in high-risk, high-payoff research to enable innovation. This fund provides funding for high priority fundamental research to build new capabilities necessary to develop and maintain state-of-the-art knowledge in areas of science and engineering related to measurement techniques and fundamental data.

2) Electronics and Electrical Engineering Laboratory (EEEL) – EEEL assists and supports a huge section of the established and emerging industrial landscape, including the U.S. semiconductor industry (shipments, both domestic and international, of $118 billion in 2007[1]), U. S. electric power industries (sales of $327 billion of electricity in 2006)[2] and the U.S. communication equipment industry (shipments of $67 billion in 2007[3]). The U.S. electronics and electrical equipment industries (including computer, communications, semiconductor component and equipment manufacturing) employed almost 3 million people at the end of 2007,[4] and the products of these industries, representing over $830 billion in U.S. shipments annually, support other major manufacturing and service industries, such as the automotive, aerospace, and health-care industries. As with all high-tech industries, electronics is highly dependent on measurements that are enabled by NIST programs, the value of which has been validated by a number of economic impact studies.

NIST's work in this area includes maintaining and improving existing measurement references and standards, developing new measurement technologies and ways to tie needed measurements to fundamental national standards, and pursuing basic research on electronic devices and the processes used to manufacture these devices. NIST research in this area touches nearly every aspect of today's high-tech electronics. Examples include the fundamental properties of semiconductors and semiconductor devices, new materials and technologies for magnetic data recording, electronics for IT and communications, electronic measurement instrumentation, fiber optics, bioelectronics, optoelectronics, superconducting electronics, radio-frequency electronics, microelectromechanical systems (MEMs), and nanoscale electronic devices.

NIST also provides the fundamental measurement expertise that underlies the Nation's electric power grids, helping to assure the accuracy of electric power and energy metering and the integrity of the system. Recently NIST focused on accelerating the development of the standards infrastructure that is essential to the implementation of Smart Grid technologies for the modernization of the U.S. electric power grid. NIST also provides the foundation for all electrical measurements by maintaining the national standards

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[1] *2008 Semiconductor Industry Report*
[2] *http://www.eia.doe.gov/cneaf/electricity/esr/esr_sum.html*
[3] *http://thor.inemi.org/webdownload/RI/iNEMI_2007_Research Priorities.pdf*
[4] *http://www.bls.gov/news.release/empsit.t14.htm*

for voltage, resistance, capacitance, current and power (including electrical, microwave and laser). NIST's work in electronics-based sensors and instrumentation has broad impacts in homeland security and public health and safety. The aerospace and defense industries rely on NIST's expertise in antenna measurements when designing and using systems for satellite communications, navigation, aircraft collision-avoidance, weather monitoring, earth surveying, and defense and homeland security. This program also includes the NIST Office of Law Enforcement Standards, which helps homeland security and criminal justice agencies at all levels of government ensure that the equipment they purchase and the technologies they use are safe, dependable, and effective.

NIST research focuses on industry and government priorities, as demonstrated by these recent examples:

- Smart Grid Interoperability: NIST is leading the Nation's efforts to formulate an Interoperability Framework that will greatly accelerate the development of standards that are essential for the implementation of Smart Grid technologies in the U.S. electric power system. NIST, working with the Department of Energy, Federal Energy Regulatory Commission (FERC), and key industry stakeholders, established highly leveraged NIST Domain Expert Working Groups. These Working Groups are assessing the status and needs for standards in four critical Smart Grid technical areas. This effort is the foundation of the Interoperability Framework, and will lead to the rapid development and deployment of essential standards and required measurement technologies.

- Smart Grid Test Protocols: NIST developed test protocols that accurately and consistently characterize phasor measurement units (PMUs), and has created a synchrometrology testbed capable of replicating the dynamic electrical operating conditions that PMUs would experience in the power grid. Implementation of the Smart Grid to ensure the reliability of the U.S. electric power infrastructure requires widespread deployment of devices such as PMUs. The power industry needs standard performance test protocols in order to invest in emerging products and thus benefit from Smart Grid technologies. NIST tests using the synchrometrology testbed revealed performance shortcomings of commercial PMUs, which form the basis for major improvements in their performance. The NIST-developed protocols became the basis for the world's first guide for testing PMUs under the most challenging dynamic conditions, representative of the kind of grid instabilities that lead to widespread power outages.

- Spintronic Device: NIST made the first confirmed "spintronic" device incorporating organic molecules, a potentially superior approach for innovative electronics. In contrast to conventional electronic devices that depend on the movement of electrons and their charge, spintronics works with changes in magnetic orientation caused by changes in electron spin (imagine electrons as tiny bar magnets whose poles are rotated up and down). Already used in read-heads for computer hard disks, spintronics can offer more desirable properties, such as higher speeds and smaller size, than conventional electronics. Although spintronic devices are usually made of inorganic materials, the use of organic molecules may be preferable because electron spins can be preserved for longer time periods and distances, and because these molecules can be easily manipulated and self-assembled. The NIST researchers

created a nanoscale test structure to obtain the first clear evidence of the presence and action of specific molecules and magnetic switching behavior. The new NIST results are expected to assist in the development of practical molecular spintronic devices.

- Micro-Robotics Systems: NIST has developed power and communication infrastructures for micro-robotic systems, and is investigating the basic metrology required to make these systems controllable and reliable. While carbon nanotubes and fullerenes will form the "bricks and mortar" of 21st century technologies, micro-robots will perform the nanomanufacturing operations required to turn these basic components into complex products. In addition to core research efforts in this area, NIST stimulated innovative educational outreach through leadership of the RoboCup Nanogram micro-robotics competitions. Academic participants in these competitions developed key capabilities in microrobotic locomotion and manipulation using the standard infrastructure developed and supplied by NIST.

NIST's FY 2010 base program operating objectives in electronics and electrical engineering include the following:

- Innovative Electronics Instrumentation: Developing and implementing new quantum-physics-based systems for fundamental electrical metrology applications, such as developing improved AC and automated "turnkey" voltage standards. These standards can be used directly by technology companies to enable the development of innovative electronics instrumentation with the highest accuracy and performance, such as advanced digital-to-analog and analog-to-digital converters with highest linearity performance specifications world-wide. NIST is also utilizing the newly discovered characteristics of graphene to develop the first room temperature quantum resistance standard.

- New Electronic Kilogram: Developing a redesigned electronic kilogram experiment linking electrical and mechanical power. The kilogram is the only remaining base measurement unit in the International System of Units (SI) whose definition is based on a physical artifact rather than on fundamental properties of nature. As the recognized leader in this field, NIST will fabricate a new improved electronic kilogram with enhanced practical usability to ensure our ability to realize the kilogram on behalf of U.S. industry under proposed international redefinitions of SI units.

- Advanced Nano-electronics and Nanophotonics: Developing advanced measurement science, test structures, reliability characterization tools, and infrastructure to support the development of advanced nano-electronics and nanophotonics with capabilities beyond the projected limits of traditional semiconductor-based technologies. Examples include measurements for spin electronics ("spintronics"), molecular electronics, nanowires, quantum dots and solid-state quantum computational systems. NIST-developed infrastructure will enable industry to perform robust, reproducible measurements, support better fundamental understanding of these technologies, and improve U.S. innovation and competitiveness.

- New Sensors: Developing new sensors and metrology for biotechnology, homeland security and other imaging technologies, based on x-ray, terahertz, and other technologies, including:

  -- magnetic resonance imaging contrast agents and standards to improve the uniformity and reliability of biomagnetic imaging systems, benefiting large National Institutes of Health-sponsored medical research studies nation-wide that rely on these systems to monitor treatment progressions
  -- nanopore-based sensors and metrology based on electronic impedance measurements to enable rapid and sensitive detection of lethal toxins secreted by a variety of pathogenic organisms that pose significant threats to society and homeland security
  -- large arrays of fast, high-energy-resolution cryogenic x-ray detectors that will provide unique materials analysis capabilities for user instruments at the National Synchrotron Light Source, and
  -- electronic-based methods to manipulate and probe the response of small cell populations to enable quantitative cell-based biometrology, which will enable predictability in complex biological systems and drive innovation in health, energy and environmental applications.

- Improved Microwave Power: Developing and implementing improved microwave power and scattering parameter measurement services, including increasing the maximum frequency of coaxial power measurements services from 50 gigahertz to 110 gigahertz frequency and enabling calibrations using 1.0 mm and 1.85 mm connectors, which have been requested by U.S. industry and which are not supported by any other National Metrology Institute in the world. These advances will support innovation and promote global competitiveness for a range of U.S. industries, including microwave test equipment manufacturers, who will be introducing devices based on such connections for telecommunications, aerospace and radar applications.

- Next Generation Optical Communications Systems: Developing measurements to support higher data rate optical communications, and develop new measurement, data analysis, and modeling tools that utilize signal measurements to remotely diagnose the locations of transmission problems on flexible networks. This work will address industry's need for higher speed, flexible networks by developing measurements that permit real-time control of signal routing that is critical for next generation optical communications systems.

- Quantum Information and Communications: Developing improved single-photon sources and detectors that support quantum information and quantum communications. This work supports quantum key distribution that can provide secure communications for national security, financial, and market transactions. This work also enables advanced measurement capabilities that exceed classical techniques using quantum behavior of engineered photon states.

3) Manufacturing Engineering Laboratory (MEL) - Manufacturing, a $1.6 trillion industry employing over 14.2 million people[5] and accounting for approximately 12 percent of the Nation's total economic output, is a vital component of the U.S. economy. It is fundamentally linked to the performance of other key economic sectors - including the service industries.[6] Manufacturing industries account for over 65 percent of non-government R&D[7], providing a dramatic influx of new technology to the U.S. economy.

When only a couple months of delay in product development can jeopardize the financial health and stability of even the most established companies, manufacturers must have the tools and resources to meet the demands of increased global competition and continue to make high-quality and innovative products. As the future of manufacturing in the U.S. becomes increasingly focused on innovative, high-value added, knowledge-intensive products and high-technology materials and processes, NIST actively anticipates manufacturers' changing requirements and pushes beyond the state of the art to solve tomorrow's manufacturing measurement and standards problems today. NIST focuses its manufacturing engineering activity on high-leverage, high-impact infrastructural work on measurements and standards to stimulate innovation and foster U.S. manufacturing competitiveness. Work on measurement science, measurement services, and critical technical contributions to standards are driven by key manufacturing trends–current and anticipated–including:

- innovation at the frontiers of manufacturing processes and systems
- compressed cycles of product innovation, and
- competitive pressure for higher quality, higher performing products at lower cost.

In the area of dimensional measurement (i.e., length), mechanical measurement (i.e., mass, force, vibration and acoustics), and nanomanufacturing measurements, NIST work on measurement science and measurement services underpins areas of important industrial applications that range from the assured interchangeability of parts produced at different locations and acoustical standards for the safety of workers in noisy manufacturing environments, to promoting equity and meeting quality requirements for commerce and international trade.

In the area of manufacturing systems, processes, equipment, and data, NIST work on measurement science, standards, test methods, and performance metrics promotes innovation in manufacturing processes, fosters more efficient transactions in purchasing manufacturing equipment, and facilitates the exchange of distributed manufacturing enterprise information.

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[5] *U.S. Department of Commerce Bureau of Economic Analysis, GDP by Industry spreadsheet. Available at* http://www.bea.gov/industry/xls/GDPbyInd_VA_NAICS_1998-2007.xls;

[6] *Thomas F. Howells III, Kevin B. Barefoot, and Brian M. Lindberg, "Annual Industry Accounts. Revised Estimates for 2003-2005," Survey of Current Business, Bureau of Economic Analysis, Department of Commerce, December 2006.* An additional six million people in such fields as supply chain, finance and wholesale rely on the manufacturing industry for their jobs. http://www.nam.org/PolicyIssueInformation.aspx?DID={DD7D22D9-FD00-45A3-8F63-F6BD3ECBD0DE}

[7] *NSF, Revised Industry Classification Better Reflects Structure of Business R&D in the United States, February 2007. Available at www.nsf.gov/statistics/infbrief/nsf07313/*
U.S. Business R&D Expenditures Increase in 2006; Companies' Own and Federal Contributions Rise (NSF-09-313, August 2008) http://www.nsf.gov/statistics/infbrief/nsf08313/.

NIST research focuses on industry and government priorities, as demonstrated by these recent examples:

- Manufacturing Data Interoperability: NIST developed two infrastructural software tools, *Quality of Design* and *Naming and Design Rules*, which reduce manufacturing data interoperability problems by helping to improve the definition and organization of supply-chain data. Manufacturing organizations of all sizes can improve productivity and reduce costs using these NIST-developed tools.

- Industrial Control Systems: NIST produced two special publications, *Recommended Security Controls for Federal Information System Rev. 2* and *Guide to Industrial Control System Security* that provide guidance for security and risk professionals on how to ensure that their critical industrial control systems are safe, secure, and reliable. The industrial control system community is using these guidance documents to improve information technology security of both Federal and private-sector control systems and to help protect computer networks in manufacturing, electric power, oil and gas, and other critical infrastructure industries.

- Semiconductor and Nano-Electronics Manufacturing: NIST developed a new and revolutionary optical measurement technique, called scatterfield metrology, which extends optical measurement capability into the sub-nanometer range—well beyond what had been considered the theoretical limit. This NIST-developed advanced manufacturing technique will provide semiconductor and nanoelectronics manufacturers with low cost, high throughput, and reliable process control measurements for the next generation of device and chip production.

- Electronic Kilogram: NIST researchers successfully completed a crucial step towards the redefinition of the Kilogram by demonstrating the ability to magnetically levitate and weigh a 1 kg mass. The Kilogram (Kg) is the last remaining SI unit defined by a physical artifact, and as a result it suffers from instability attributed to wear from periodic cleanings and other chemical surface effects. NIST and other International researchers are developing a new definition of the Kg, based on fundamental properties of nature, which will overcome these limitations. However, the new Kg definition will be realized in a vacuum, and NIST must be able to tie it back to the Kg in air, where most practical mass measurements are made. NIST's magnetic levitation capability accomplishes the critical first step needed to compare mass in air to mass in vacuum, providing an essential link in the transition to a new definition of the Kg based on fundamental constants.

NIST's FY 2010 base program operating objectives in manufacturing engineering include the following:

- Advanced Manufacturing: Demonstrate advanced manufacturing tools to improve the automated exchange of logistics information across an entire manufacturing business process (i.e., supply chain) to reduce shipping and inventory costs. Mistakes in manufacturers' communications of what is needed, when, and where to their suppliers can add billions of dollars a year in costs associated with shipping, inventory, and missed business opportunities. NIST research in this area will reduce cost associated with transportation, inventory, and lead time (i.e., time between customer order and delivered product) by improving the accuracy of information conveyed between manufacturers and their suppliers.

- Green Manufacturing: Develop methods for incorporating information about carbon footprint – a key measure for green manufacturing – into the product lifecycle. NIST research will support U.S. green manufacturing efforts to prepare for a future where products are 100 percent recyclable, manufacturing itself has a zero net impact on the environment, and complete disassembly and disposal of a product at its end of life is routine.

- Manufacturing Automation Systems: Develop performance requirements and standards for advanced 3-dimensional imaging systems to spur innovation in future manufacturing automation systems. Accurate 3-dimensional imaging systems will enable safer and more fully autonomous manufacturing robotic vehicle navigation. NIST's research in this area will enable manufacturers to seize the tremendous potential these systems promise for increasing manufacturing flexibility and lowering costs through improved efficiency.

- High-Performance Optical Systems: Develop methods and calibration services for measuring the form of flat, spherical, and aspherical ultra-precision optical surfaces. Nanometer-level optical surface calibrations will powerfully enhance industry's ability to manufacture and test high-performance optical systems. NIST calibrations will enable the communication, bio-medical imaging, defense, nano-scale manufacturing, and semiconductor manufacturing industries to provide innovative new products and services such as faster internet connections, better medical tools, and higher-resolution satellite cameras.

- Next-Generation Factory Inspection and Assembly Instruments: Develop advanced measurement methods and performance procedures for large-scale optically–based coordinate measurement systems that are emerging as next-generation factory inspection and assembly instruments. Unlike fixed-in-place measurement systems, these new systems can be transported to different sites easily, have significantly lower capital equipment costs and enable rapid reconfiguration of factory floor space. NIST's work will enable manufacturers to quickly adapt to changing applications and markets through innovative measurement techniques.

4) Chemical Science and Technology Laboratory (CSTL) - NIST serves as the Nation's primary reference laboratory for chemical measurements and standards, and promotes commerce, improved quality of life and innovation in the U.S. in the areas broadly encompassed by chemistry, the biosciences, and chemical engineering. NIST develops and disseminates the standards needed to support measurements of national interest, assuring that U.S. industry has access to accurate and reliable data, and predictive models to determine the chemical and physical properties of materials and processes. NIST also maintains the national standards for temperature, pressure, vacuum, leak rate, fluid flow, humidity, liquid density, volume, air speed, pH, and electrolytic conductivity. NIST's efforts address next-generation standards and data needs that underpin the development, implementation and assessment of new technologies in critical industries such as biotechnology, pharmaceuticals, chemical manufacturing, health and medical products, and energy production. NIST measurements and standards also support environmental research and monitoring, food and nutrition analysis, criminal forensics, and homeland security.

NIST research focuses on industry and government priorities, as demonstrated by these recent examples:

- Human Blood Plasma-Based Standard Reference Material: NIST is developing a human blood plasma-based Standard Reference Material to enable evaluation of new procedures and equipment for measuring metabolites and improve the reproducibility of measurements. The NIH Metabolomics Technology Development Initiative has articulated the need for new tools to quantify metabolites in human systems. These measurements may provide insight into the chemical and molecular pathways that are involved in normal function as well as disease.

- Microsensors: NIST scientists have developed a microsensor for detection, in varied gas phase mixtures, of relatively low concentrations of a number of different toxic industrial chemical analytes. Important progress has been made toward making tunable, widely deployable microsensors for utility in differing gas mixtures. Such sensors have application in environmental health and safety monitoring and in chemical threat detection for homeland security.

- Human DNA Analysis: NIST is developing a comprehensive set of human identity DNA markers to enable more accurate DNA analysis for human identity testing. Based upon sequences reported in the literature, 26 new miniature short tandem repeats (miniSTRs) were designed to maximize their utility for human identity testing. The 26 new miniSTRs are being calibrated for use in tandem with the widely used NIST SRM 2391b to enable the highest integrity human DNA identity testing.

- Chem-BLAST: NIST developed a new web-based technology called Chem-BLAST (Chemical Block Layered Alignment of Substructure Technique) that has been incorporated into NIST data products, and that has proven to be highly successful in supporting researchers to search for therapeutic drugs that can be used to treat AIDS. Chem-BLAST is a user friendly Web

interface for organizing and retrieving chemical data based on chemical structure, not chemical name. This will enable reliable exchange of chemical data over the Web, enabling new innovations in drug discovery and development.

- Cancer Treatment: NIST is conducting research to characterize the physical size and chemical composition of organic and biological coatings of modified gold nanoparticles. Both the NIH and FDA have stated that an urgent measurement need is the development of novel methods to characterize the chemical or biological coatings on nanoparticle surfaces. These coatings play critical roles in fighting cancers because they frequently are designed as therapeutic or targeting agents.

- Drug Development: NIST is developing reference methods for the sensitive and direct measurement of proteins in blood plasma and serum, employing advanced analytical methods to help meet the standardization needs of clinical medicine and drug discovery research. In efforts to accelerate advances in cancer biomarker research, the National Cancer Institute sought NIST expertise to provide sophisticated, metrologically sound analytical approaches.

- Nanomaterials Environmental and Health Risks: NIST is providing measurement methods, data, models and standards to support spatially resolved chemical measurements at the nanoscale. This enables U.S. industry to characterize and manipulate the physical and chemical nanoscale structures in commercial devices. Improved characterization methods will help assess health and environmental risks of nanomaterials, currently considered a roadblock for commercialization of nanotechnology.

- International Measurement Standards: NIST is improving the global comparability for chemical and biochemical measurements by leading and participating in a wide range of international studies conducted under the auspices of the International Bureau of Weights and Measures. These activities provide a global, dynamic comparability structure for measurements in chemistry that help ensure efficient and fair international trade in areas such as biofuels, in vitro diagnostic devices and food and agricultural products.

NIST's FY 2010 base program in chemical science and technology includes enhanced objectives in advanced measurements, standards and data for chemical processes, nanotechnology, bioscience and health care measurements, and chemical and bio-informatics. These objectives include the following:

- Medical Diagnostics: Develop methods and standards to assess performance of DNA microarrays in quantitation of mRNA for gene expression. More reliable DNA microarray-based measurements will enable better gene expression determinations to be performed and advance new innovations in medical diagnostics.

- Climate Change Science: Research that addresses measurements and standards needs for the Climate Change Science Program. These studies address critical gaps identified in the Interagency Strategic Plan, including the development and international

benchmarking of standards for greenhouse gases, and the development of a quantitative understanding of effects of atmospheric aerosols, including water vapor, on sunlight. NIST efforts will support NOAA and its activities associated with the Global Atmospheric Watch program and will help modelers to create an accurate picture of Earth's climate through calibrations traceable to international standards.

- Nanomaterials Environmental and Health Risks: Develop measurement methods and standards needed for accurately assessing nanoparticle size/size distribution, shape, structure, and surface area, determining spatio-chemical composition, purity, and heterogeneity, and understanding the effects of chemical and physical modifications on the properties of nanomaterials. These infrastructural tools will support U.S. industry and regulatory agencies in carrying out their respective responsibilities for assessing the environmental, health, and safety risks associated with engineered nanomaterials. This research enables NIST to provide information required to facilitate development of both protective and beneficial applications of nanotechnology. Such information is necessary for sound risk assessment and risk management and will be realized through a) research and innovation, b) nanomaterial characterization, and c) validation of toxicological methods.

- Blood and Tissue Biomarkers: Accelerate innovation in healthcare delivery through improved measurement methods and standards for biomarkers in blood and tissue. This effort assures that data entered into electronic records and used to make medical decisions are accurate and comparable over both space and time.

5) Physics Laboratory (PL) - NIST meets the Nation's measurement needs in many critical areas of physics, most notably atomic and optical physics, electronic and magnetic technologies, and ionizing radiation. NIST also performs world-leading basic research in fundamental physical quantities and quantum physics.

NIST's base activities within Physics support a broad range of scientific, technological, commercial, and consumer needs.

- Time and Frequency: NIST maintains the Nation's standards for time and frequency measurement, an increasingly important field that supports advanced communications, electronic systems, power grids, and high-speed commerce. NIST focuses on developing the highest accuracy standards and methods of disseminating time and frequency, e.g., through the Internet, radio broadcasts, and satellites.

- Medical Radiation: NIST calibrations underlie the safety and efficacy of diagnostic procedures, such as mammography, and therapeutic procedures, such as brachytherapy (used to treat prostate cancer). Well in excess of 20 million therapeutic radiation procedures[8] and nearly 36 million x-ray mammograms[9] annually are traced to NIST standards.

- Optical Technology: The optical products industry is a $100 billion sector, requiring accurate and trusted standards in areas such as lighting, photography, color and appearance, spectroscopy, and imaging. Work at NIST is important for environmental monitoring instruments used to measure temperature, atmospheric composition, and other things important in large-scale climate studies.

- Quantum Information: NIST is at the forefront of the nascent field of quantum information processing–computing and communications–challenging preconceived notions of computational complexity and communications security. We seek to learn how to better measure the interactions of single photons–the fundamental constituent of light–with nanoscale structures and objects.

- Metrology Innovation: NIST's extreme ultraviolet optics facility supports the electronics industry in its drive to develop advanced lithographic systems for producing ever smaller chips. NIST researchers are developing ultrasensitive measurement tools using optical techniques that support biotechnology studies of single molecules and their effects in biological systems, and better imaging.

- Public Health and Safety: NIST expertise in radiation detection and measurement supports critical needs of first responders, homeland security surveillance, medical sterility, and nuclear energy. Optical measurement systems support needs in highway and aviation safety, missile defense, and medical diagnosis.

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[8] *All therapeutic radiation procedures performed in the United States must be traceable to NIST standards. According to the American Cancer Society (http://www.cancer.org), there will be more than 1.4 million newly diagnosed cancers in the United States in 2008. Approximately 60 percent of cancer patients are treated with radiation therapy during the course of the disease. An estimate of the number of cancer patients treated annually using radiation therapy is, therefore, about 867,000. Each patient will have a total of between 25 and 30 fractionated dose procedures (between 21 million and 26 million individual procedures performed annually). Therapeutic radiation procedures are also used for diseases other than cancers. However, statistics on these are not available.*

[9] *All mammograms performed in the United States must be traceable to NIST standards. As of April 1, 2008, nearly 36 million mammograms were being performed annually. See http://www.fda.gov/cdrh/mammography/scorecard-statistics.html.*

NIST research focuses on industry and government priorities, as demonstrated by these recent examples:

- Nuclear Medicine: NIST established a satellite facility at Oak Ridge National Laboratory to promote measurement assurance in nuclear medicine. Among other things, we use this facility to prepare and measure radioactivity standards used for Positron Emission Tomography (PET), a noninvasive technique that helps doctors diagnose diseases (such as cancer), plan medical treatment, and measure the efficacy of therapies. An estimated one million PET procedures were performed in 2004, a number expected to reach three million annually by 2010. Accuracy in medical imaging improves the quality of health care and ultimately reduces medical costs.

- Monitoring Ocean Health: NIST developed improved buoy technology to calibrate sensors monitoring ocean health. The oceans are essential in the process of removing carbon dioxide from the atmosphere, sequestering it, for example, in ocean-borne life such as phytoplankton. NIST plays a vital role for remote-sensing systems that quantify the state of the oceans and their effect on the carbon cycle.

- Fuel Cell R&D: NIST is applying neutron-imaging methods for fuel-cell engineering and for research on hydrogen storage systems. This work provided critical services to major automotive and fuel cell companies during the last few years. This is a high demand and high profile program, which received the 2007 Department of Energy Hydrogen Program R&D Award in Recognition of Outstanding Achievement in Fuel Cell R&D.

NIST's FY 2010 base program operating objectives in physics include the following:

- Distributed Radioactivity National Standards: Develop methods and measurement protocols for distributed radioactivity, traceable to National standards, for both phantoms and human subjects. Determining the radionuclide content in the human body is needed for a wide range of applications, from nuclear medicine and imaging to environmental monitoring and evaluating contamination after a potential radiological incident.

- New Magnetometer: Demonstrate a new magnetometer about the size of a rice grain and sensitive enough to detect the magnetic fields generated by heartbeats and brain activity, to make magnetic resonance imaging systems much smaller, cheaper, and more effective; to improve the effectiveness of magnetometers detecting hidden weapons and other threats; and to enable new methods of biomedical imaging.

- Alternative Energy and Efficiency: Support development of commercially competitive technology to reduce imported fossil fuel consumption. Advancements in fuel-cell imaging support real-world engineering of hydrogen-powered vehicles by the automotive

industry, while development of appropriate metrics for solid-state (LED) lighting removes barriers for market entry of replacement lighting systems.

- Optical Measurement Standards: Develop absolute optical measurement standards to improve the quality and comparability of astronomical measurements performed at national telescope facilities in support of sky surveys, satellite remote sensing, fundamental physics and astronomy, climate research, and defense.

- Atomic Clock: Develop a new type of atomic clock based on the principles of quantum computing with an accuracy equivalent to one second in one billion years to support advances in telecommunications, navigation systems, precision measurement of gravity for mineral exploration and undersea navigation, and other applications.

- Electric Dipole Moment: Characterize and test a new neutron beamline at the NCNR to provide the enhanced beam manipulation and polarization capabilities needed for Magnetic Dipole Moment experiments, which would provide the critical measurement infrastructure to an accurate measurement of the Electric Dipole Moment. This will add important new understanding about the fundamental physics of elementary particles and enable exploration of new physics beyond the "Standard Model."

6) Materials Science and Engineering Laboratory (MSEL) - Through its materials science and engineering research and services, NIST enables its customers to develop an integrated understanding of materials processing, structure, properties, and performance. NIST's direct contributions to measurement science, measurement standards and measurement technology have impact on the entire spectrum of materials, including biomaterials, ceramics, hybrid materials, metals, semiconductors and polymers. Focusing on key technology sectors and national priorities in energy, environment, physical infrastructure and healthcare, these measurement solutions provide tools needed for industrial competitiveness during all stages of innovation, and include:

- advanced measurement technologies, such as combinatorial approaches, microscopy instrumentation, scattering methods and synchrotron-based techniques that enhance and accelerate materials discovery, optimization and development
- fundamental measurement science that enables the development of cutting edge materials and devices, along with reference material standards and methods for measurement of structural, functional, and mechanical properties of materials, as well as device materials performance and reliability
- evaluated materials data that enable and benchmark industrial designs
- robust standard test methods that accelerate process development and manufacturing, and
- documentary standards that enable worldwide trade of materials products.

Industrial scientists and engineers, university researchers, national and international standards organizations, and other technical communities rely on NIST for its technical expertise, objectivity, measurement methods, materials databases, practice guides, and standard reference materials.

NIST research focuses on industry and government priorities, as demonstrated by these recent examples:

- Physical Infrastructure: Following the analysis of materials from the World Trade Center, NIST is a primary resource for measurements of infrastructural materials under extreme loading conditions. NIST identified critical properties, provided data and developed standards for the improved use of fire-resistant steel, including rapid, accurate tests of high temperature performance. NIST expertise in the area is now guiding the formation of a new ASTM International standard.

- Pipeline Safety: In support of the Pipeline Safety and Integrity Act of 2002, NIST developed test methods that ensure the safety and reliability of high strength steel pipelines for petroleum, as well as repurposing pipelines for alternative fuels such as hydrogen, thus providing the pipeline industry with more accurate data for predicting the lifetime of new construction materials. NIST expertise in pipeline testing is now guiding the efforts of international standards bodies such as ISO and ASTM International.

- Nanomaterials Environmental and Health Risks: In partnership with the NIH National Cancer Institute, NIST produced and issued the first reference materials for nanoparticles in emerging biomedical (imaging, diagnostic and therapeutic) applications. The gold nanoparticle reference materials provide an essential foundation for calibrating instruments that measure nanoparticle size, qualifying pre-clinical biomedical research methodologies, and establishing new tests that will assess potential environmental, health, and safety hazards of nanoparticles.

- Carbon Nanotubes (CNTs): NIST research CNTs produced breakthroughs to realizing the application of these promising materials in advanced electronics, composites and biomaterials. Innovative NIST processing of ultra-pure CNT specimens enabled, for the first time, assessment of how CNT toxicity depends on CNT length, and provides the route to critical CNT reference materials.

- Combinatorial Methods Center: The NIST Combinatorial Methods Center pioneered development of high-throughput measurement tools that speed innovation in materials, and helped over 30 industry parties acquire these capabilities, including Air Products, Dow Chemical, ExxonMobil, Honeywell, National Starch, and Procter and Gamble. The Center's innovative technologies enable rapid discovery and development of products across the materials spectrum, including detergents, dental fillings, electronics, and contact lenses.

- Thermoelectrics: NIST developed and produced the first reference materials for thermoelectrics, a class of materials for waste heat recovery in engines for automotive, aerospace, and military applications. The widespread use of thermoelectric materials for vehicular waste heat recovery is expected to lead to a 10 percent improvement in fuel efficiency, as well as decreased CO_2 emissions.

- Semiconductor Electronics: In partnership with Intel and SEMATECH, NIST's first-in-the-world measurements explained how proper photoresist processing will enable the semiconductor electronics industry to produce smaller, faster electronic devices, and illuminated critical limitations to this approach. In addition, NIST methods helped Merck and Corning establish design criteria for new printable electronics.

- Three-Dimensional Chemical Imaging: NIST developed a state-of-the-art spectroscopic microscope that enables three-dimensional chemical imaging of living biological systems and identification of live biological cells. This new microscope enables measurements of cell metabolism in real time, with no damage to the tissues.

NIST's FY 2010 base program operating objectives in materials science and engineering include the following:

- Nanomaterials Environmental and Health Risks: Develop critical measurement methods and standards needed by researchers and regulatory agencies to assess potential environmental, health, and safety risks posed by nanomaterials. NIST methods, standards, and data for key physico-chemical properties of the most important classes of nanoparticles will allow industry and Federal Regulatory agencies to link to toxicity and exposure effects, and assess and manage risk of such nanomaterials. Develop new measurement methods, including combinatorial approaches, and standards necessary to develop advanced energy technologies, including photovoltaic (solar) devices, hydrogen fuel cells, and batteries. NIST measurement methods will enable manufacturers to determine the performance and long-term reliability of these important energy devices.

- Physical Infrastructure: Develop new measurement methods that aid our nation rebuild its physical infrastructure. NIST methods will allow inspectors to detect hidden flaws in structures, enable local governments to prioritize infrastructure remediation, help engineers avoid structural failure under extreme conditions and predict the performance of structural components and connections; and communities rehabilitate water pipelines.

- Automotive Energy Efficiency: Develop materials science-based measurement methods for introducing innovations that will promote automotive energy efficiency by enabling auto manufacturers to use advanced lightweight materials such as magnesium and aluminum alloys, to develop more powerful hybrid and electric motor systems, and to harvest waste heat via thermoelectric convertors.

- Renewable Alternatives: Develop measurement tools and standards that promote the use of renewable, more environmentally sound, materials in products ranging from electronics and packaging, including approaches that reduce or eliminate the use of toxic substances such as lead. NIST measurements will help ensure the effectiveness and reliability of products manufactured with renewable alternatives.

- 3D Imaging of Biological Tissues: Develop measurement methods and essential optical probe materials for minimally invasive 3D imaging of biological tissues that will provide quantitative and highly specific information on cell population heterogeneity and disease states. NIST probes and methods, based on quantum dots and vibrational resonance techniques, will drive progress in emerging fields of biomedical research, including systems biology and tissue engineering.

- Nanomaterials and Nanodevices: Develop instrumentation, measurement methods, and models that advance the most promising classes of nanomaterials and nanodevices, including semiconductor nanowires, self-assembled polymers, hybrid materials, and magnetic nanomaterials. NIST measurements will enable the precise manufacturing needed to fabricate nanostructured materials and devices reliably and reproducibly, thereby allowing commercialization of advanced technology products including energy efficient lighting systems, electronics and data storage devices, and magnetic sensors with 100 times improved sensitivity.

- Magnetic Data Storage and Micro- and Nano-electromechanical Systems: Develop measurement methods and standards needed to advance technologies, including magnetic data storage and micro- and nano-electromechanical systems, for which analyses of mechanical properties at lengths less than 100 nm is critical. NIST techniques will enable measurement of elastic properties at length scales less than 10 nm, plastic properties to less than 70 nm, and fracture properties to less than 100 nm; these capabilities will represent, at least a factor of two improvements over current methods.

- Next Generation Organic and Flexible Electronic Devices: Develop an interdisciplinary suite of measurement tools that correlate the performance of next generation organic and flexible electronic devices with structure, properties, and chemistry of critical materials and interfaces. NIST standard test methods and fundamental measurements will help industry realize exciting new devices and applications, including wearable electronics, electronic newspapers, low-cost photovoltaic (solar) cells, and radio-frequency identification tags.

- Advanced Medical Technologies: Develop materials measurement methods and standards required to bring advanced medical technologies to market quickly and efficiently. NIST measurement tools will accelerate the development and growth of the emerging tissue engineering and therapeutic materials industries, through standards, and experimental protocols that ensure the development of effective and reliable biomedical products.

- Evaluated Materials Structure Database: Expand and enhance access to the world's most comprehensive databases of evaluated materials structure information. With over 400,000 entries, the NIST databases will guide the rapid development and manufacture of advanced products in a broad range of technology sectors including, healthcare, communications, energy, and microelectronics. NIST databases will provide data exchange interoperability needed to make these critical data broadly available and to integrate the data with instrumentation used in manufacturing environments.

7) Building and Fire Research Laboratory (BFRL) – The building construction industry in the United States is a significant part of the U.S. economy. The industry's estimated value for construction in 2007 was $1.2 trillion, and accounted for almost eight percent of the workforce. The vast majority of construction firms are small (including about 1.8 million self-employed workers), and do not have the resources to conduct the in-depth research needed to improve building practices. Fire is a major problem in the United States, which has one of the worst fire fatality rates of the world's industrialized nations. Fire protection and firefighting are largely handled by local communities, who also lack research resources. Even with improvements in fire protection and safety, in 2006, 3,245 lives were lost in fires, 16,400 more people were seriously injured, direct property loss was almost $12 billion, and fire cost the U.S. economy in excess of $250 billion. NIST's building and fire research program was established to meet the need for a continuing, high-quality research effort to support the construction and fire-safety communities. A significant part of the NIST portfolio in this area includes research on better buildings that are safer, built faster, at lower cost and higher quality, and that are less costly to operate and have less impact on the environment.

NIST's program in building and fire research has four main thrusts:

- High performance construction materials and systems to enable scientific and technology-based innovation to modernize and enhance the performance of construction materials and systems. Among other services, NIST is pioneering the development of highly-reliable materials-science-based methods for measuring and predicting the performance, durability, and sustainability of concrete and a wide range of polymeric materials used outdoors such as paints, coatings, vinyl siding, asphalt materials, sealants, and caulks. NIST also is developing the enabling measurement science for integrating sensing, information, and automation technologies to achieve significant productivity improvements in the construction process.

- Enhanced building performance to provide the means to assure buildings work better throughout their useful lives by increasing energy efficiency and integrating renewable energy technologies. Among other services, NIST maintains the national standard for measuring the R-value of thermal insulation used in construction and other industrial applications and has enabled energy savings, reduced operating costs, and consumer awareness by supporting the development of standard testing and rating procedures for heating, ventilating, and air-conditioning (HVAC) equipment, water heaters, and appliances.

- Measurement science for innovative fire protection technologies to enable engineered fire safety for people, products, and facilities, and to enhance fire fighter effectiveness. Among other services, NIST enabled reductions in loss of life and property due to fire by developing the only installation and design standard for residential sprinkler systems, and reductions in smoking related fires and unsafe mattresses through standard test methods for reduced-ignition-propensity cigarettes and mattress flammability. We are now developing the measurement and prediction tools to prevent, characterize, detect, and mitigate fire hazards associated with accidental or intentional hydrogen releases in buildings and structures.

- Homeland security and disaster resilience to enable the development and implementation of the standards, technology, and practices needed for cost-effective improvements to the safety, security, and disaster resilience of buildings, building occupants, first responders, and communities (including evacuation, emergency response procedures, and mitigation of natural and manmade threats such as earthquakes, fires at the wildland-urban interface, and windstorms).

In recognition of NIST's expertise in building and fire safety, the Congress passed, and the President signed into law, the National Earthquake Hazards Reduction Program (NEHRP) Reauthorization Act of 2004, which transferred the lead agency function for this multi-agency program to NIST from the Federal Emergency Management Agency. NEHRP is the Federal government's long-term program to reduce U.S. earthquake risks to life and property. The statute assigned major new research and coordination responsibilities for the program to NIST. In addition, the National Windstorm Impact Reduction Act of 2004 authorizes NIST to support research and development to improve codes, standards, and practices for buildings, structures, and lifelines that will measurably reduce the loss of life and property from windstorms.

NIST's programmatic thrusts in building and fire research directly support three of six NIST Investment Priority Areas: Physical Infrastructure, Energy, and Manufacturing. They also less directly support NIST's Environment Investment Priority Area.

NIST research focuses on industry and government priorities, as demonstrated by these recent examples:

- Building Codes: As a result of NIST's investigation of the World Trade Center disaster, recommendations stimulated fundamental and substantial changes in U.S. building codes and standards that represent a significant improvement in public safety over current practice. The International Code Council approved a comprehensive set of building code changes that were incorporated into the organization's International Building Code, a model code used as the basis for building regulations promulgated and enforced by U.S. state and local jurisdictions.

- Fire Safety: On November 10, 2006, members of a NIST research team studied flames erupting from an abandoned Chicago apartment to test the positive pressure ventilation (PPV) in high-rise fires. The controlled fires in the high-rise were part of a real-world laboratory experiment to study the effectiveness in multistory buildings of PPV, the use of powerful fans during fires to force smoke and heat from corridors and stairwells so that they stay passable and safe for both escaping occupants and entering emergency responders. In the past, such as the October 2003 fire in a government building in Chicago where six people died, fire flow into corridors and stairwells has often resulted in tragedy.

- Consumer Safety: The Consumer Product Safety Commission (CPSC) enlisted NIST to help quantify the dangers of improperly used portable generators, and evaluate the possible technical solutions to the problems. The same gasoline-powered portable generators that keep the lights burning, the freezer cold, and the house warm when a storm shuts off the electricity, can also kill you in minutes if you fail to follow safe practices. A single generator can emit several hundred times more poisonous carbon monoxide than a modern car's exhaust. NIST researchers will collect data that quantifies carbon monoxide infiltration into a sensor-equipped house during different weather and house conditions. NIST expects to report to CPSC on its study in the summer of 2009.

NIST's FY 2010 base program operating objectives in building and fire research include the following:

- Construction Productivity Metrics and Analysis Tools: Complete development of task-level and project-level construction productivity metrics and analysis tools. Work with key construction industry stakeholders to test metrics and analysis tools by evaluating their ability to produce baseline measures of performance and to identify opportunities for improving construction productivity.

- Performance-Based Seismic Design: Develop validated nonlinear response models for multi-degree-of-freedom structural systems that incorporate results of experimental testing and post-earthquake reconnaissance data. The models will provide nationally recognized design tools that support further implementation of performance-based seismic design.

- Building Standards: Develop performance criteria for mitigating progressive collapse in steel and concrete buildings. These criteria will provide the technical basis for development of a pre-standard for design of new buildings to resist progressive collapse.

- Improved Infrastructural Concrete: Complete and verify the development of the measurement science for optimizing the selection of nano-sized viscosity modifiers leading to doubling the service life of infrastructural concrete. The addition of nano-viscosity

modifiers has the potential to dramatically reduce ion permeability, a property that is highly correlated with an increase in the service life of concrete.

- Environment/Building Sustainability: Develop a reference material for volatile organic compound emissions from building materials. This reference material will be used to support inter-laboratory comparisons of emission measurements and test methods development to provide an improved technical basis for materials labeling programs being used in the promotion of building sustainability.

- Energy Efficiency: Characterize, using the particle image velocimetry technique, inlet air velocity profiles for heat exchangers in cooling and heating installations, and validate computational fluids dynamics-based models for predicting inlet air distributions. Knowledge of inlet air distribution is necessary for design optimization of heat exchangers, which results in improved system efficiency and reduced energy consumption.

- Wildland-Urban Interface (WUI) Fires Building Codes/Standards: These measurement methods will provide the scientific foundation for new and enhanced WUI building codes/standards Develop measurement methods to quantify the vulnerabilities of structures to ignition from a firebrand attack in wildland-urban interface fires. These measurement methods will provide the scientific foundation for new and enhanced WUI building codes/standards intended to mitigate structure losses in WUI fires.

- Fire Safety: Complete evaluation of multi-scale fire test methods which enable a reduction in the flammability of upholstered furniture. Development of scalable flammability test methods will enable implementation of material formulations into end products that reduce the risk of fire spread in buildings.

8) Information Technology Laboratory (ITL) – The IT sector encompasses computer and electronic products, publishing industries (including software), information and data processing services, and computer systems design and related services and continues to be one of the Nation's fastest growing sectors. This sector of the economy increased its contribution to the real GDP with double-digit growth for the fourth consecutive year, increasing 13.2 percent in 2007. It accounts for 3.9 percent of the economy but for 22.3 percent of real economic growth.[10]. Today, people use IT to work, shop, play, and connect with colleagues, family, and friends. The statistics tell the story: access to the Internet in U.S. households has grown rapidly to more than 70 percent,[11] with 70 percent of those utilizing broadband access;[12] nearly 100 percent of public schools and 94 percent of public school instructional rooms have

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10 *"Downturn in Finance and Insurance Restrains Real GDP Growth in 2007," U.S. Department of Commerce, Bureau of Economic Analysis, http://www.bea.gov/newsreleases/industry/gdpindustry/gdpindnewsrelease.htm.*

11 *"Home Broadband Adoption 2006," Pew/Internet and American Life Project, http://www.pewinternet.org/pdfs/PIP_Broadband_trends2006.pdf.*

12 *"Home Broadband Adoption 2007," Pew/Internet and American Life Project,* http://www.pewinternet.org/PPF/r/217/report_display.asp, *March 2007.*

Internet access;[13] total e-commerce sales for 2007 are estimated at $136.4 billion, an increase of 19 percent from 2006.[14] The tremendous increase in the dependence of the U.S. population on cell phones and PDAs adds to the vital role IT plays in the U.S. economy and day-to-day activities. It is now reported that "62 percent of all Americans are part of a wireless, mobile population that participates in digital activities away from home or work."[15]

IT is an industry that impacts the daily lives of every American. With this dependence on IT for the daily activities of millions of citizens, as well as the critical areas of national security, healthcare, and science and engineering R&D, it is crucial that the IT systems are interoperable, usable, accessible, reliable, and secure. Many current IT systems are not able to reach the level of trustworthiness considered necessary by users today. The cost to American consumers and the economy is significant. For example, a NIST planning study estimated that inadequate software testing is costing the economy $60 billion per year, of which approximately $22 billion could be eliminated with an improved testing infrastructure. NIST programs are guided by these national priorities, including mandated activities, and broad IT industry drivers, such as the globalization and pervasiveness of IT, the information explosion, the new fundamental technologies enabled by IT, and the inadequate reliability, quality, security, and trustworthiness of computing.

NIST collaborates with industry, consortia, and other Federal agencies to utilize its core competencies in IT measurement and testing, mathematical and statistical analysis for measurement science, modeling and simulation for measurement science, and IT standards development and deployment to resolve the most critical issues in the Nation's IT infrastructure, including in the areas of identity management systems; knowledge discovery, information exchange, and information usability; cyber and network security and trustworthy information systems. NIST programs also focus on critical issues for enabling scientific discovery; pervasive information systems; virtual measurement systems and the measurement and standards needs of complex information systems. NIST has a mandate to develop and implement computer security standards and guidelines for Federal civilian agencies that are also widely used in industry. NIST also provides leadership and collaborative research in the application of mathematics, statistics, and computing for measurement science problems with wide impact on the science and engineering research community at large. In each of these areas, NIST responds to the critical issues by applying its core competencies and technical expertise to develop methods, tests, metrics, and tools that accelerate improvements in the interoperability, security, privacy, scalability, quality and uncertainty, and usability of information technologies.

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[13] *U.S. Department of Education, National Center for Education Statistics (2006). Internet Access in U.S. Public Schools and Classrooms: 1994-2005 (NCES 2007-020), http://nces.ed.gov/fastfacts/display.asp?id=46.*

[14] *"Quarterly Retail E-Commerce Sales 4th Quarter 2007," United States Census Bureau, 15 February 2008, http://www.census.gov/mrts/www/data/html/07Q4.html.*

[15] *"Mobile Access to Data and Information," Pew/Internet and American Life Project,* http://www.pewinternet.org/pdfs/PIP_Mobile.Data.Access.pdf, *March 2008.*

NIST leverages its efforts through close collaboration with the IT industry, industry consortia, and the Federal government, including participating in interagency planning activities such as the Federal Networking and Information Technology R&D (NITRD) Program.

NIST research focuses on industry and government priorities, as demonstrated by these recent examples:

- Profile for Internet Protocol version 6 (IPv6): NIST developed a Profile for Internet Protocol version 6 (IPv6) for use in the U.S. Government, and is establishing an IPv6 conformance testing program. The profile provides a selection of IPv6 standards and specifications to assist Federal agencies in developing plans to acquire and deploy products that implement IPv6. The profile recommends IPv6 capabilities for common network devices, including hosts, routers, intrusion detection systems, and firewalls that will meet the minimum operational requirements of most Federal agencies. By clarifying the functional requirements, the profile guides the government agencies in planning for their IPv6 networks, while the conformance testing program will help to ensure correct operation of IPv6 equipment.

- Biometrics Interoperability and Accuracy: NIST completed the fingerprint Minutia Interoperability Exchange Test (MINEX) for standard fingerprint minutia templates and developed a report, *MINEX: Performance and Interoperability of the INCITS 378 Fingerprint Template*, describing accuracies using these templates by various vendors. MINEX provides the capability to measure biometric interoperability and accuracy for combinations of different vendor products which helps vendors improve their tools and users to select interoperable products.

- IT Security: In response to the Federal Information Security Management Act (FISMA), NIST published Draft Special Publication 800-53 Rev. 3, *Recommended Security Controls for Federal Information Systems* and Draft SP 800-53A *Guide for Assessing the Security Controls in Federal Information Systems*. These documents, when used together with a comprehensive Risk Management Framework, will ensure that agencies select and validate appropriate security controls to protect their critical enterprise operations and information.

- Virtual Measurement of Atomic Properties: Computational scientists at NIST have published the most accurate values yet of fundamental properties of the hydrogen molecule H_2–values calculated from theory alone. Accurate to one part in 100 billion, these are the most accurate energy values ever obtained for a molecule of that size, 100 times better than any previous calculated or experimental value. The "virtual measurement" techniques developed represent an important new method for determining fundamental atomic properties.

- Fuel Cell Design: NIST researchers made advances in statistical methods to facilitate the use of hydrogen as a fuel, which included the development of methods that improve the quality of images of fuel cells obtained by neutron tomography. Neutron

tomography is used to study whether water accumulates in fuel cells without the need for destructive testing. Improving the image quality associated with neutron tomography enables improvements in fuel cell design.

- Health Care IT: NIST developed the Cross Enterprise Document Sharing (XDS) Profile, which allows clinical documents to be shared regardless of where they are located or what format they are in, and an XDS reference implementation that is used by over 40 vendors and is currently part of several countries' national health care infrastructures. This will help advance the national goal of providing doctors access to all patients' electronic health records, thereby enabling accurate diagnosis and treatment of disease.

NIST's FY 2010 base program operating objectives in information technology includes the following:

- IT Security: Develop information security standards, measurements, and tools to address systems and networks extending the reach of strong mechanisms to emerging lightweight platforms. Produce guidelines and automated tools to promote adoption of interoperable, secure technologies and infrastructures. These activities will support innovative classes of networked devices by establishing new foundational security mechanisms necessary to establish end-user trust.

- Interoperability of Key Network Technologies: Develop techniques, in collaboration with industry, to evaluate and improve the mobility, interoperability, security, resilience, and robustness of key network technologies. This will provide the telecommunications industry with new, improved standards needed to develop and offer interoperable mobile devices that allow dynamic roaming between various wireless network technologies. In addition, this will give the networking industry the means to maintain a more resilient network even under stress, and to provide support for public safety communications.

- Biometrics Interoperability and Accuracy: Measure the performance of multimodal biometrics matching systems, including iris, fingerprint, and facial images, which will enable industry to improve the accuracy and interoperability of biometric recognition systems, thereby enhancing the real-time verification and identification of those seeking to enter the United States. Providing the infrastructure for industry to measure the performance of biometric technologies will lead to improved performance through lower error rates and greater interoperability. This allows industry to increase innovation and competitiveness as it develops new biometric system technologies.

- Measurement Methods and Tools: Develop mathematical, statistical, and computational methods and tools to enable NIST research on measurement of the properties of materials and processes operating at all physical levels, including nanoscale. Those methods and tools are the result of creative research in mathematics, statistics, and computation, and the measurement science they enable provides the foundation for the development of innovative processes and materials relevant to government and industry.

- Software Testing: Accelerate the development and adoption of correct, reliable, testable software, leading to increased trust and confidence in deployed software. NIST will advance the state of the art of software testing by developing scientifically rigorous, breakthrough techniques to automatically generate tests that are cheaper to develop and more comprehensive. NIST will work with industry in the transfer of these activities and technologies into national infrastructures and commercial sectors.

9) NIST Center for Neutron Research (NCNR) – The NCNR is the Nation's premier neutron research facility. It is a major national user facility that serves the majority of all neutron scattering users in the United States. Neutrons – uncharged particles from the nucleus of atoms – have unique properties that make them ideal probes of the structure and motion of materials at the scale of atoms and molecules in a material. The NCNR provides an intense source of neutron beams that are used to probe the molecular and atomic structures and dynamics of a wide range of materials. The facility also boasts a unique, large-volume, liquid hydrogen *cold source*, which produces the highest intensity of "cold" (or low-energy) neutron beams in the country. Cold neutrons are used to probe the underlying structures and slow dynamics in advanced materials such as plastics, magnetic films, chemical catalysts, biological materials, and composites. With such state-of-the-art measurement capabilities unavailable elsewhere in North America, the NCNR plays an essential role in broad sectors of nano-science and technology. In a wide range of applications, neutron beam measurement techniques are on a par with the x-ray or microscope in their ability to probe materials that are the focus of study in today's most important research areas, including materials technology, biotechnology, and nanotechnology. The NCNR operates as a national user facility that provides merit-based access to all qualified researchers. The NCNR also supports critical NIST research in materials research, chemistry, physics, nanoscale science, and other related fields. Use of the NCNR facilities for proprietary research is possible on a full-cost recovery basis. As a result, researchers from industry, academia, and other Federal agencies depend on NCNR's unique research capabilities to work on cutting edge science. The capabilities of the NCNR are further leveraged through a variety of cost-sharing partnerships with other agencies, industries, and universities to expand specific measurement capabilities, and to broaden the access to unique neutron instrumentation. The NCNR is significantly expanding its collaboration with the Nation's industrial and academic researchers with new instrumentation and analysis methods for macromolecular dynamics, neutron trace analysis, neutron chemical spectroscopy, neutron imaging, and neutron spectroscopy.

NIST research focuses on industry and government priorities, as demonstrated by these recent examples:

- National Research Facility/Neutrons: Last year, more than 2,200 researchers directly benefited from access to NCNR capabilities, which accounts for over two-thirds of all neutron research done in the United States. Researchers from 40 States, Puerto Rico, and the District of Columbia are included in this total. These researchers also represent over 140 U.S. universities, 40 U.S. corporations, and nearly 40 U.S. government organizations and laboratories.

- High Impact Research: Research performed at the NCNR resulted in over 320 publications in FY 2008. With a significant fraction of these papers published in prominent journals, the NCNR ranks as one of the highest impact neutron facilities in the world.

The FY 2010 base program operating objectives in the NIST Center for Neutron Research include the following:

- New Neutron-Based Measurement Capability: Developing new neutron scattering instrumentation as part of the NCNR Expansion that will provide revolutionary new neutron-based measurement capability to the United States. The planned suite of instruments takes advantage of the latest in beam delivery and detector technology to realize capabilities more than 100 times greater than current instruments, or new instruments that are unavailable anywhere else in the world.

- Energy Efficiency and Alternative Energy: Studying nanomaterials for the structure and behavior of new materials at the nano-scale, making it possible to improve process technologies and develop new materials applications in areas ranging from lighter weight composites for the auto industry to advanced materials for the efficient storage of hydrogen for energy applications.

- Fuel Cell Design: Imaging the interior of complex devices and materials non-destructively to "see" how they function under various operating conditions. NCNR neutron imaging has made it possible to look through the steel casings of operating fuel cells and watch the flow and movement of water molecules as the cell functions, leading to better designs and performance.

- Drug and Vaccine Development: Improving the study of the structure and motions of very large biological molecules such as proteins. Neutrons can see how they bend and fold- properties essential to protein function. The insights gained could lead to the development of new drug therapies, new anti-toxins, and improved vaccines.

- Environment: Studying chemical interactions with porous or other complex structured materials. The unparalleled penetration and imaging power of neutrons is being used to develop new, more efficient, industrial catalysts and better ways to remove toxins from the environment, as well as to achieve a better understanding of complex biological systems at the cellular level.

- Advanced Computer Technology: Studying advanced new materials that can be used to advance computer technology beyond the integrated circuit. As the size of transistors reaches fundamental limits, further advances in the computation power of computer chips will require new materials that can exploit other electronic properties, such as electronic spin, to carry information in the device.

- Materials Performance: Probing the internal stresses in materials such as turbine blades, railroad rails, and shock absorbers, which are essential to understanding and improving the performance of products used in industry, transportation, and national defense.

10) Center for Nanoscale Science and Technology (CNST) – Established by Congress in May of 2007, the CNST has already become a major national resource for nanoscale science and the development of nanotechnology. Unique in its mission to provide the measurement infrastructure that underlies all progress in this critically important 21st century technology, the CNST serves the U.S. industrial and scientific research communities through its highly collaborative, multidisciplinary research program and its national shared-use nanofabrication facility, the NanoFab. The continued development of nanotechnology is key to establishing US leadership in such diverse fields as energy, information technology, electronics, health, biotechnology, and manufacturing. In the case of energy, nanoscale phenomena lie at the heart of many energy production, storage, and transmission processes. Research aimed at optimizing the nanoscale structure of photovoltaic devices can, for example, have a profound impact by enhancing the conversion of the sun's energy to electricity. Such research demands a multidisciplinary approach and the development and ready availability of advanced tools which manipulate and measure the properties of structures where size can be counted in atoms. The CNST has been purposely built to satisfy these demands. Offering several unique measurement capabilities not available elsewhere, the CNST Research Program provides an open, collaborative, multi-disciplinary research environment that focuses on national nanoscale measurement needs in such areas as next-generation energy systems, future electronics, nanofabrication, and nanomanufacturing. This environment is where the cutting edge research that advances the state-of-the-art of measurement and fabrication takes place. As a complement to the Research Program, the NanoFab offers open, convenient and economical access to expensive state-of-the-art fabrication, measurement tools, and processes in an environment designed to support both new ventures seeking assistance and training and experienced practitioners needing access to a research "fab" with a broad selection of advanced tools. Quick access is available through a simple, merit-based application process. Proprietary research can be performed on a full cost recovery basis. Following a two-year ramp up of staff, equipment, facilities, and processes, both the Research Program and the NanoFab are expanding their strategic relationships and collaborations with industrial and academic partners.

CNST research focuses on industry and government priorities, as demonstrated by these recent examples:

- National Research Facility: In FY2008, the CNST's first full year of operation, the number of researchers benefitting from access to the CNST NanoFab or collaborating with the CNST Research Program totaled nearly 400, which represents an approximately 100 percent increase over the prior year.

- Energy: Last year, the CNST established a new group dedicated solely to facilitating the development of nanotechnology that impacts energy conversion, storage, or transmission. By recruiting researchers with specific energy related experience gained in industry, national laboratories, and academia, a group was established with both the experience and the preexisting relationships necessary to make a quick impact in an area of critical national need.

- Workshops: To assure that we were always work on our mission's highest priority items, the CNST co-organized workshops on "Nanoscale Measurement Challenges for Energy Applications" and "Directed Assembly of Functional Materials and Devices".

The FY 2010 base program operating objectives in the Center for Nanoscale Science and Technology include the following:

- New Paradigm for Electronics: In collaboration with the semiconductor industry's Nanoelectronics Research Initiative, the Georgia Institute of Technology and others, develop new instruments and methods to investigate the feasibility of a new paradigm for electronics based on graphene.

- Renewable Energy: In collaboration with the National Renewable Energy Laboratory, develop broad-spectrum measurement techniques capable of mapping the transport of charge and the characterization of materials to aid in the optimization of next generation solar cells with increased efficiency and lower cost.

- Imaging of Nanostructrures/Nanomanufacturing: Develop a new technique using nearfield optical apertures that greatly increases the speed with which nanostructures can be imaged thus greatly improving process and quality control in nanomanufacturing - necessary steps if the discoveries of new nanoscale phenomena are to be translated into commercial products.

- Nanofabrication and Nanomanufacturing/Electron Optics: In collaboration with the College of Nanoscale Science and Engineering of the State University at Albany, develop methods to validate electron-optics and space-charge modeling to enable the production of robust, high-resolution, high-throughput electron beam writers to advance nanofabrication and nanomanufacturing. Bring a second, high resolution electron beam writer on-line within the NanoFab and concurrently establish electron beam lithography as an area of special focus within the CNST.

- Advanced Communications and Information Technology: Broaden the scope of our nanocharacterization effort to include nanodevices proposed as a basis for future electronics, thereby facilitating advances in communications and information technology that promise to transform our lives while maintaining the vitality of the electronics industry.

- Nanofabrication and Nanomanufacturing/New Methods: Develop new methods for nanofabrication and nanomanufacturing and extend current methods to create industrial standards and, consequently, maintain the U.S. leadership position in nanotechnology.

- National Research Facility: Further expand access to the exceptional nanometrology and nanofabrication capabilities of the CNST Research Program and Nanofab, thus providing new research opportunities for researchers from industry, academia, and other Federal laboratories over a broad range of scientific, engineering, and technological fields.

- Nanostructured Materials and Devices/Characterization: Develop new ways to characterize and, thereby, improve the performance and reliability of nanostructured materials and devices. This effort will advance both the development of U.S. nanoproducts and their manufacture, affecting a wide variety of applications in transportation, housing, defense, medicine, agriculture, and homeland security.

- New Generation of Nanotechnologists: Help educate the new generation of nanotechnologists by providing young scientists and engineers with the ability to use some of the world's most advanced instrumentation to address the challenge of measuring the subtle phenomena of nature that occur only on the atomic scale.

11) Technology Services - For research and technology advances of the NIST Laboratories to be most useful, the results must reach the intended users. NIST enables U.S. industry to develop competitive technologies by providing central access to NIST measurements including standard reference materials, standard reference data, calibrations, and laboratory accreditation, and thereby traceability to national and international standards of measurement. These NIST services meet industry needs for accurate measurements and traceability to ensure product quality, production efficiency, parts interchangeability, conformance to specifications, and performance suitability. NIST programs also provide a central source of information, coordination, and leadership for U.S. industry regarding national and international standardization and conformity assessment activities, including product testing and certification. NIST impacts standardization efforts in strategic technology areas for the U.S. economy and trade, in areas ranging from nanotechnology and renewable energy to sustainable buildings and IT security. NIST's outreach to foreign governments on standards and conformity assessment issues enables NIST to advocate effectively on behalf of U.S. industry interests to the European Union (EU), China, Brazil, India and other key foreign markets. NIST works to establish uniform and accurate legal metrology standards by providing the measurements and standards underpinning the U.S. commercial metrology system, through the development and dissemination of handbooks, guidance, documents and recommendations, focused training, and technical laboratory metrology support. NIST also ensures the transfer of NIST technology through measurements, standards, knowledge, and patents.

NIST research focuses on industry and government priorities, as demonstrated by these recent examples:

- Standards for Federal Agencies: NIST provides leadership and coordination for Federal agencies in their continuing use of and participation in standards developed in the private sector, increasing confidence in the U.S. standards system. Federal agencies now use more than 20,000 such standards, tracked in a NIST database, in their regulatory and procurement actions.

- Federal Use of Conformity Assessment Programs: NIST provides the technical groundwork to ensure effective Federal use of conformity assessment programs, often in cooperation with the private sector. Recent examples include significant enhancements

to the current Department of Justice body armor certification program; assistance in the implementation and maintenance of Environmental Protection Agency's WaterSense program to certify water-efficient products; guidance to the Consumer Product Safety Commission on appropriate conformity assessment requirements in response to the Consumer Product Safety Improvement Act, and a certification program for radiation detectors for use by the Department of Homeland Security. NIST now accredits 17 state metrology laboratories, thereby underpinning the integrity of their weights and measures efforts.

- United States Measurement System (USMS) Measurement Knowledge Hub: NIST developed and implemented an on-line infrastructure, the United States Measurement System (USMS) Measurement Knowledge Hub (usms.nist.gov), to enable Measurement Solution providers and users to access measurement knowledge. This Hub serves as a meeting place for measurement solution providers and users, and contains a continually evolving Measurement Needs Database as the foundation for later analyses. Key Hub features include individual discussion corners for specific interests, with opportunities to discuss sets of measurement needs; a Technology Roadmaps database; tools for tailoring analyses of measurement needs and proposed solutions; and links to important events and resources.

- USMS Assessment Report: NIST has completed its second USMS Assessment Report, containing an assessment of the USMS in the areas of Nanotechnology Environmental, Health and Safety, Core Metrology, and Alternative Energy; a description of advanced assessment methodologies for the application of the web-based measurement knowledge hub; an update of the survey of technology roadmaps; and recommended next steps for the strengthening of the USMS.

- Road Safety: NIST provides the leadership for developing International Organization of Legal Metrology Recommendations dealing with Road Safety, including radar devices and breathalyzers. The U.S. is a significant exporter of these devices and the publication of this standard will greatly benefit U.S. industry by improving the international harmonization of system requirements and acceptance parameters will greatly benefit U.S. industry.

- Intelligent Transportation Systems and Transportation Management Systems: NIST conducted a workshop in Israel on standards for Intelligent Transportation Systems and Transportation Management Systems that enabled technical discussions between 100 Israeli participants and U.S. experts. The workshop resulted in these transportation standards becoming the basis for Israeli procurement actions for which U.S. firms can now submit bids. In addition, U.S. standards organizations are actively inviting greater participation of Israeli experts in their development activities.

- Export Assistance: NIST expanded its marketing and promotion efforts for its subscriber service, *Notify U.S.*, with training sessions on its capabilities to provide regulatory and associated standards information for more than 100 U.S. Export Assistance Centers around the country, and by opening the *Notify U.S.* service to World Trade Organization Technical Barriers to Trade

Agreement foreign Enquiry Points for transparency and technical assistance. To date, 100100 Enquiry Point staff from 4040 countries have registered with *Notify U.S.* NIST also trained more than 50 international Department of Commerce trade experts stationed in both the U.S. and in the EU on standards information.

NIST's FY 2010 base program operating objectives in technology services include the following:

- International Trade: Coordinate Federal agency use of and participation in documentary standards to ensure that Federal standards needs are met. Deliver comprehensive standards-related information provided through the National Center for Standards and Certification Information and the U.S. Inquiry Point for the World Trade Organization to provide to U.S. industry market intelligence and information from priority foreign markets, and provide training for regulatory and trade officials from developing countries on the proper use of documentary standards, conformity assessment practices, and metrology to enhance foreign acceptance of U.S. procedures and products.

- International Standards: Improve the national infrastructure for advanced legal metrology by providing laboratory metrology training, conducting proficiency testing to ensure accurate measurements, and promoting the documentation and use of quality system practices in conformity with international standards and guidelines for testing and calibration laboratories resulting in increased international acceptance of U.S. measurement results and accreditation programs.

- State and Local Weights and Measures Programs: Strengthen state and local weights and measures programs through training and technical support. Use industry/regulatory working groups to implement standards that address device requirements, methods of sale, and test procedures to support the commercial infrastructure, including the development of hydrogen as a viable commercial fuel. Ensure compatibility of U.S. and international standards by developing uniform legal metrology requirements, manuals, training, and test methods to improve efficiency and fairness in the U.S. and foreign markets resulting in fewer differing requirements for manufacturers to meet and sell their instruments and products, thereby reducing overall costs to both the manufacturer and the consumer.

- U.S. Measurement System (USMS): Address the health and viability of the U.S. Measurement System by working with NIST and other entities to identify measurement needs and solutions needed to support innovation, competitiveness and societal needs. Extend the USMS focus area assessments to other critical national needs, such as physical infrastructure and environment. Extend the functionalities of the measurement knowledge hub to increase the accessibility of critical measurement solutions.

- Calibration Services, Standard Reference Materials, and Standard Reference Data: Deliver calibration services, standard reference materials, and standard reference data to provide industry, government, and the public with accurate physical, chemical, and engineering measurements. NIST measurement services support U.S. industry through traceability to NIST and to the International System of units, and are recognized as complying with the international measurement system, thus reducing the need for additional testing.

- Documentary Standards in Emerging Technology Areas: Provide the leadership in documentary standards in emerging technology areas such as alternative/renewable energy, nanotechnology and biotechnology and engage governmental authorities in standards for critical areas such as information technology with the Chinese government, global biofuels with Brazilian, European and Asian authorities, and e-accessible products and systems with the European Commission.

Performance Measures

Data on NIST programmatic performance evaluation and reporting are provided in Exhibit 3A of this budget request.

Department of Commerce
National Institute of Standards and Technology
National Measurement and Standards Laboratories
REIMBURSABLE PROGRAM AND WORKING CAPITAL FUND INVESTMENTS
(Dollar amounts in thousands)

	FY 2008 Actual	FY 2009 Estimate	FY 2010 Estimate
Department of Defense			
Air Force	$12,592	$12,592	$8,340
Army	2,492	2,492	1,776
Navy	1,516	1,516	975
Other	11,130	11,130	9,525
Subtotal, Department of Defense	27,730	27,730	20,616
Department of Agriculture	185	185	200
Department of Commerce	10,864	10,864	11,021
Department of Energy	5,705	5,705	4,400
Department of Health & Human Services	6,904	6,904	7,103
Department of Homeland Security	33,834	33,834	25,701
Department of the Interior	114	114	50
Department of Justice	14,670	14,670	14,668
Department of State	333	333	16
Department of Transportation	1,001	1,001	25
Department of the Treasury	33	33	25
Department of Veterans Affairs	139	139	165
Environmental Protection Agency	1,776	1,776	1,346
General Services Administration	268	268	753
National Aeronautics & Space Administration	3,821	3,821	4,373
National Science Foundation	5,382	5,382	3,334
Nuclear Regulatory Commission	532	532	50
Other	8,392	8,392	4,826
Subtotal, Federal Agencies	121,683	121,683	98,672
Calibrations & Testing	9,374	9,489	9,600
Technical & Advisory Services	25,528	22,332	24,264
Standard Reference Materials	10,091	12,251	12,566
Subtotal, Other Reimbursables	44,993	44,072	46,430
Total, Reimbursable Program	166,676	165,755	145,102
Equipment Transfers	0	2,275	6,190
Subtotal, WCF transfer	0	2,275	6,190
Equipment Investments	16,281	17,767	17,767
IE Amortization	(20,415)	(18,230)	(17,767)
WCF Operating Adjustments	(1,344)	0	0
Total, WCF Investments	(5,478)	(463)	0
Total, Reimbursable Program and WCF Investments	161,198	167,567	151,292

Department of Commerce
National Institute of Standards and Technology
Scientific and Technical Research and Services
INCREASE FOR FY 2010
(Dollar amounts in thousands)

		2010 Base		2010 Estimate		Increase/ (Decrease) Over 2010 Base	
		Personnel	Amount	Personnel	Amount	Personnel	Amount
Total, Scientific and Technical Research and Services (STRS)	Pos./Approp.					161	59,891
	FTE/Obl.					122	53,951
National Measurement and Standards Laboratories							
1. Towards a Nationwide Healthcare Information Infrastructure: Assuring Quality, Accessibility, and Cost Containment of Healthcare	Pos./Approp.	2	712	18	5,712	16	5,000
	FTE/Obl.	2	712	14	5,712	12	5,000
2. Powering Up America: Accelerating an Interoperable Smart Grid	Pos./Approp.	4	1,241	28	6,241	24	5,000
	FTE/Obl.	4	1,241	22	6,241	18	5,000
3. Measurement Standards and Measurement Technology to Support Innovation in Healthcare	Pos/Approp.	51	14,777	64	23,777	13	9,000
	FTE/Obl.	51	14,777	61	23,277	10	8,500
4. Advanced Energy Technologies: Solar Energy and Storage	Pos./Approp.	12	3,376	36	10,876	24	7,500
	FTE/Obl.	12	3,376	30	8,376	18	5,000
5. Greenhouse Gas Emissions Measurements	Pos./Approp.	4	6,096	25	13,096	21	7,000
	FTE/Obl.	4	6,096	20	12,296	16	6,200

		2010 Base		2010 Estimate		Increase/(Decrease) Over 2010 Base	
		Personnel	Amount	Personnel	Amount	Personnel	Amount
6. Measurement Science for Net Zero Energy, High Performance Green Buildings	Pos./Approp.	8	1,670	21	8,670	13	7,000
	FTE/Obl.	8	1,670	18	7,830	10	6,160
7. Measurements and Standards to Support Rebuilding the U.S. Physical Infrastructure	Pos./Approp.	11	3,275	22	7,775	11	4,500
	FTE/Obl.	11	3,275	19	7,775	8	4,500
8. Nanomaterials Environmental Health and Safety	Pos./Approp.	9	3,000	18	6,000	9	3,000
	FTE/Obl.	9	3,000	16	6,000	7	3,000
9. Quantum Information Sciences	Pos/Approp.	16	9,425	20	10,925	4	1,500
	FTE/Obl	16	9,425	19	10,775	3	1,350
10.Comprehensive National Cyber Security	Pos/Approp.	33	9,834	46	15,334	13	5,500
	FTE/Obl	33	9,834	43	14,984	10	5,150
11.Quantum-Based Measurements	Pos/Approp.	3	1,210	16	6,101	13	4,891
	FTE/Obl	3	1,210	13	5,301	10	4,091

STRS (+161 Permanent Positions, +122 FTE, Appropriation +$59,891,000, Direct Obligations +53,951,000, Transfer to the Working Capital Fund +$5,940,000)

STRS Components:

National Measurement and Standards Laboratories

1. Towards a Nationwide Healthcare Information Infrastructure: Assuring Quality, Accessibility, and Cost Containment of Healthcare (+16 Permanent Positions, +12 FTE, +$5,000,000)

- The U.S. healthcare industry lacks a comprehensive nationwide information infrastructure.
- Healthcare spending accounts for $1 out of every $6 spent in the U.S., with the U.S. spending more money per capita ($5.7K) per year on healthcare than any other country, but we rank 24th in life expectancy.[1]
- Adults get, on average, only 55 percent of the recommended care for many common conditions.[2]
- Today's healthcare industry lags behind other fields in use of information technology – for example, only 13 percent of doctors use any form of electronic health records.[3]
- The expanded use of health information technologies is seen as a key component of improving the cost and quality of healthcare.
- Studies show a savings of more than $81 billion per year from better healthcare IT.[4]

Problem Magnitude and NIST Role:

Accounting for roughly one sixth of the Nation's economy, healthcare represents a major expenditure for consumers and employers alike, yet the U.S. healthcare industry lacks a comprehensive nationwide healthcare information infrastructure. Today's healthcare industry lags behind other fields in use of information technology – for example, only 13 percent of doctors use any form of electronic health records[5]. Advancing the healthcare IT infrastructure will improve the quality of care (e.g., reduce medical errors), make

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[1] From a study by Johns Hopkins Bloomberg School of Public health described in *Science Daily*, July 2006: and, "WHO Issues New Healthy Life Expectancy Rankings," World Health Organization Press Release, 4 June 2000.

[2] McGlynn, E.A., et al. (2003). "The quality of health care delivered to adults in the United States." *New England Journal of Medicine*, 348(26), 2635-2645.

[3] Firshein, J., "Physician Adoption of Electronic Health Records Still Extremely Low", Health Information Technology Adoption Initiative http://hitadoption.org/index.php?module=News&id=cntnt01&cntnt01action=detail&cntnt01articleid=4&cntnt01returnid=30i

[4] Hillestad R, Bigelow J, Bower A, Girosi F, Meili R, Scoville R, Taylor R. "Can Electronic Medical Record systems Transform Health Care? Potential Health Benefits, Savings, and Costs." *Health Affairs*, Vol. 24, No. 5, Sept/Oct 2005, pp. 1103-1117.

[5] Firshein, J., "Physician Adoption of Electronic Health Records Still Extremely Low", Health Information Technology Adoption Initiative http://hitadoption.org/index.php?module=News&id=cntnt01&cntnt01action=detail&cntnt01articleid=4&cntnt01returnid=30i

healthcare more affordable (e.g., reduce redundant tests and processing costs), and make healthcare more accessible, with records available to those who need to know anywhere, anytime. Studies show a savings of more than $81 billion per year from better healthcare IT.[4]

The Administration has made improving the healthcare information infrastructure a national priority and is committed to the adoption of Electronic Health Records (EHRs) and building a standards-based, secure, and interoperable nationwide healthcare information network within five years. In his inaugural address, President Obama said that "[o]ur health care is too costly" and we will "wield technology's wonders to raise health care's quality and lower its cost." The Administration is committed to computerizing healthcare records within five years. The American Recovery and Reinvestment Act (P.L. 111-5) jump starts efforts for interoperable electronic health records and a nationwide health information network.

NIST with its core competencies in standards, measurements, and technology deployment will play a pivotal role in the development of a nationwide healthcare information infrastructure. NIST will accelerate the development of healthcare information standards and the necessary conformance tests, interoperability tools, and techniques that are essential to the acceptance and utilization of the standards. These activities will raise the quality of the clinical outcomes, lower cost of health IT implementation, and foster adoption of healthcare systems.

NIST is well positioned to meet these challenges. NIST has a long history of collaborating with other Federal agencies, major standards development organizations, professional societies, industry groups, and the public sector in fostering secure, interoperable, standards-based solutions for the exchange of health information. Additionally, NIST has also worked closely with the Office of the National Coordinator at the Department of Health and Human Services (HHS) since 2005 to support their health IT initiatives, and NIST's roles are clearly articulated in the Federal Health IT Strategic Plan (2008-2012).

Proposed NIST Technical Program:

This initiative focuses on three essential elements to contribute to a healthcare information infrastructure.

- **Health Information Technology (Health IT)**
  Health IT includes deployment of a nationwide network and interoperable electronic health records (EHRs), through which a consumer's legal medical record will be available anywhere, anytime, but only to those authorized for access. Successful small, closed systems exist, and NIST has the expertise and competencies to make major contributions to making widespread adoption a reality. NIST will accelerate industry-led, consensus-based standards development and harmonization to help ensure that the full set of necessary basic query and retrieval functions, including security and privacy provisions, for clinical

information exist. NIST will collaborate with industry to ensure that a testing infrastructure exists allowing health IT vendors and implementers to quickly build standards-based, secure solutions and increase innovation.

- **Telemedicine**
  Telemedicine includes capabilities where wellness, diagnoses, and treatment can occur anyplace and anytime, basically extending the reach of healthcare services to people's homes and/or other remote areas, and making use of consumer-controlled personal health records (PHRs). Working with industry, NIST expertise in health IT systems, networking, security and hardware device communication can focus on ensuring that these new but necessary environments are able to integrate into the U.S. healthcare infrastructure.

- **Pervasive Healthcare**
  Pervasive healthcare explores the use of emerging technologies such as body sensors, implants, and medical equipment for routine monitoring of chronic conditions, and technologies that support home care for our aging population. NIST will collaborate with industry to develop standardized interfaces for connecting new healthcare devices to the U.S. healthcare infrastructure and research radio and wireless technologies in the healthcare domain for aspects such as coexistence, robustness, and security.

Performance Measures: Outputs

At the proposed funding level, NIST will generate the following outputs:

Towards a Nationwide Healthcare Information Infrastructure	
Technical Area	**Outputs**
Health IT	• Work with existing industry-led, voluntary consensus processes, develop a set of health IT standards that fully define basic data query and retrieval functionality, including security and privacy provisions. • Expand health IT testing infrastructure to include test availability for new and updated industry-developed standards that focus on basic infrastructure capabilities. • Work with industry to ensure that industry standards, a testing infrastructure and industry certification criteria are consistent to support interoperable EHR systems and healthcare enterprises.
Telemedicine	• Apply usability and accessibility concepts to health IT systems and devices with a focus on use by consumers and for use in homecare environments.

Towards a Nationwide Healthcare Information Infrastructure	
Technical Area	**Outputs**
	• Work with industry, help ensure that standards and guidelines exist to promote the appropriate use of IT in telemedicine environments to include the secure capture, storage and rendering of clinical images and clinical reports while ensuring long-term quality and fidelity.
Pervasive healthcare	• Work with industry; develop standardized secure interfaces to exchange information between monitoring devices and healthcare systems such as EHRs and personal health records (PHRs). • Research the use of radio technologies to transfer medical, physiological, and control information between sensors, devices, and networks.

Performance Measures: Outcomes

At the proposed funding level, NIST will generate the following outcomes:

Towards a Nationwide Healthcare Information Infrastructure	
Technical Area	**Outcomes**
Health IT	• Health IT vendors and implementers have fully-defined set of interoperability standards for basic exchange of clinical information. • Purchasers of Health IT products can easily determine the interoperability capabilities of those products. • Market-based certification bodies have robust test criteria and testing capabilities through the NIST –developed testing infrastructure. • The U.S. healthcare infrastructure can exist such that U.S. technology solutions and innovation can occur.
Telemedicine	• Healthcare domains and specialties can use IT products in their environments with the confidence that the equipment is providing an appropriate level of quality and fidelity. • Expanded use of telemedicine technologies for non-traditional telemedicine areas in healthcare.
Pervasive healthcare	• Clinical results from home monitoring devices are easily available to healthcare providers through an EHR or a PHR. • New technologies such as sensors and implants will lead to health IT innovations allowing patients to have real-time, ongoing monitoring of chronic conditions without having to be at a clinic, physician's office, or home monitoring station.

2. **Powering Up America: Accelerating an Interoperable Smart Grid (+24 Permanent Positions, +18 FTE, +$5,000,000)**

- The economic welfare and security of our Nation depends critically on the availability of clean and affordable energy. This goal can be realized through future increased use of new renewable and distributed energy sources that are widely accessible to industry, businesses and consumers through the Nation's electric power grid.
- The Administration calls for accelerated development, demonstration and implementation of a smart electricity grid (the "Smart Grid") to enable the Nation to more efficiently and effectively use electricity, reduce blackouts and power disturbances, develop energy-saving technologies, reduce pollution and greenhouse gas emissions, and ensure future U.S. national energy security.
- The need for NIST to provide new and improved measurement science and to coordinate standards development for the Smart Grid is highlighted in recent energy legislation, the 2007 Energy Independence and Security Act (EISA) and the American Recovery and Reinvestment Act of 2009.
- Through this initiative and in collaboration with the lead agency on energy, the Department of Energy, and with other Federal agencies, industry, standards organizations, and universities, NIST, as our Nation's measurement and standards laboratory, is called upon to:

    - Provide the measurement science, models, protocols, data, and standards that permit the efficient management, storage, transmission and distribution of electricity by ensuring compatibility with distributed renewable energy sources using interoperable Smart Grid technologies that enhance reliability or power quality;
    - Enable better management of total energy use by consumers and industry through improved measurements and metrics for electric power transmission and distribution systems, and Smart Grid devices and systems; and
    - Enable increased use of renewable and low-carbon energy sources such as solar and wind by providing measurements and standards for their reliable and efficient integration into the new Smart Grid.
    - Through these tasks, NIST will develop the measurement science, data, and standards to accelerate commercialization of U.S. energy technologies and ensure world-wide acceptance of U.S. energy-producing, energy-distributing, and energy-conserving products.

Problem Magnitude and NIST Role:

Our rising demand for electricity, coupled with an aging, overburdened and patch-worked power grid, is increasing the likelihood of serious blackouts, as evidenced by the widespread service disruption in August 2003 which affected 50 million customers from the upper Midwest and the northeast coast of the U.S. Today, outages and power quality issues are estimated to cost the U.S. economy, on average, more than $100 billion each year. The incorporation of Smart Grid technologies is the recognized solution to changing how we manage electricity and moving the antiquated, 100-year-old electric power grid into the 21st century. The goal is to meet the

ever-increasing demands for electric power with improvements in reliability, minimization of energy losses and interruptions using intelligent real-time grid monitoring and control, and reduction in dependence on fossil fuels through widespread accessibility of distributed, renewable and alternative energy sources. The President's Council of Advisors on Science and Technology has noted the inconsistency and even absence of grid interconnection standards and rules, between the States, to be "high barriers" to the incorporation of decentralized and renewable energy sources (American Energy Imperative report). Without the standards to ensure interoperability of intelligent devices and the measurement techniques to ensure performance, Smart Grid technologies will never be adequately utilized.

The development of the Smart Grid is essential to the future economic and physical health of the Nation. The Administration calls for accelerated development, demonstration and implementation of the Smart Grid to enable the Nation to more efficiently and effectively use electricity to reduce blackouts and power disturbances, develop energy-saving technologies, and reduce pollution and greenhouse gas emissions. Smart Grid technologies will reduce electricity losses and minimize power interruptions through the use of intelligent, real-time grid monitoring and control systems, reduce fossil fuel consumption by enabling time-varying distributed renewable alternative energy sources (solar, wind, etc.) to be reliably incorporated into the grid, and provide industry, businesses and consumers with unprecedented control and capabilities with new smart energy management systems, devices and appliances. A Smart Grid is also necessary for the Administration's proposed large-scale incorporation of plug-in hybrid electric vehicles (PHEVs).

NIST's role is specifically called out in Title XIII of the EISA to coordinate the development of the Smart Grid interoperability framework, for which NIST is working with stakeholders to organize and characterize the broad universe of relevant protocols and model standards. In the short term, in partnership with the DOE GridWise Architecture Council (GWAC), NIST efforts have focused on creating and leading Domain Expert Working Groups (DEWGs) consisting of power, communication, IT and other experts in Smart Grid areas, and holding workshops that allow all stakeholders to participate, increase their mutual awareness and better coordinate their independent efforts. These activities have encouraged broad input to the NIST effort and have provided venues to discuss the vision of the stakeholders, many of whom have not previously worked with each other. Using their collective expertise, NIST has begun the analysis necessary to create the comprehensive interoperability framework for the Smart Grid. The framework, Smart Grid standards and their implementation will enable the grid to function more efficiently and affordably, and lessen the impact of electricity generation on our environment. In the longer term, the adoption of the Smart Grid will transform every facet of the electric delivery system, including generation, transmission, distribution and consumption. Beyond the interoperability framework necessary for power generators, grid operators, and end users to embrace and invest in the Smart Grid, is the vast need for presently unavailable measurement techniques, models, technical data, reference standards, operation protocols, and knowledge required to actually assemble, operate and optimize a national Smart Grid system. NIST's efforts in these areas will bridge the gap and shorten the timeline between the short-range goals of the interoperability framework and standards development roadmap, and the long-range goal of the U.S. electric power industry fully investing with confidence in the Smart Grid. The specific roles for NIST in these areas are the

measurement science and standards needed to ensure robust and efficient energy delivery and use though Smart Grid tools such as enabling technologies, interoperability based on standards, and low-cost communications and electronics.

Through this initiative, NIST will overcome the measurement and standards hurdles in these areas that are critical to enabling national energy security, economic growth, and improved quality of life.

Proposed NIST Technical Program:

NIST will bring nationally recognized expertise and critical partnerships, in coordination with other Federal agencies, to address critical issues with the Smart Grid.

Interoperability of Smart Grid Devices and Systems

NIST will organize, initiate, and accelerate development of new Smart Grid standards and protocols within a common interoperability framework being developed by NIST to guide and coordinate the efforts of the Nation's many standards-developing organizations. These efforts will complement and be performed in coordination with the Department of Energy, in particular its Office of Electricity Delivery and Energy Reliability (OE), the GridWise Architecture Council (GWAC), the Federal Energy Regulatory Commission (FERC), other Federal agencies, organizations such as the Institute of Electronics and Electrical Engineers (IEEE) and the North American Electric Reliability Corporation (NERC), electric utility companies, the Electric Power Research Institute (EPRI), National Electrical Manufacturers Association (NEMA), manufacturers, consumer organizations and other stakeholders. NIST will identify the most critically needed Smart Grid technologies, such as those supporting transmission and distribution of electricity, to ensure that appropriate standards and protocols are developed, evaluated, recommended and implemented. NIST will work with utility regulators, State governments and industry to create standardized performance tests and protocols to facilitate adoption of such standards. This will:

- Accelerate investment and deployment of Smart Grid devices and systems to upgrade and reinforce the electric power grid infrastructure;
- Support the successful implementation of DOE Smart Grid pilot programs and demonstration projects that are cost-shared between the Federal government and the electric power industry;
- Provide economic benefits, reduce technical barriers to innovation, and improve public health and safety through interoperability of Smart Grid technologies; and
- Enable development and support new ready integration of innovative Smart Grid products and technologies, such as electric vehicles, through the widespread use of standardized approaches to charging and metering.

Robust and Efficient Electric Power Delivery

NIST will develop new measurements, models, reference implementations, and interoperability testbeds for Smart Grid devices and systems to support the electric power industry. As part of this effort, NIST will develop new measurements for Smart Grid monitoring and control devices and characterize new distributed sensors to improve situational awareness and response to real-time power grid conditions, preventing widespread outages, and ensuring rapid recovery from power disruptions. NIST will also establish new electric power measurement capabilities and testbeds to support advanced development and deployment of conventional and smart meters, and develop precision sampling measurement systems for improved power quality monitoring to support the Smart Grid. In addition, NIST will develop models, test methods and performance evaluation for power electronics-based electric power conditioning systems to enable time-varying renewable energy sources to be integrated reliably into transmission and distribution systems. To promote effective management of present and anticipated electric power use for improved reliability and resiliency of the Smart Grid, NIST will develop models and protocols including secure standardized communications bridging the interface between the grid and industrial, building, and home energy management systems and appliances. This will:

- Provide economic benefits through efficiency improvements from optimized transmission and distribution operations and pave the way for ready deployment of innovative devices;
- Meet increasing energy demands while minimizing the need for construction of new transmission and distribution lines, and decrease grid outages through grid modernization and provide the customer with greater awareness and control of their energy usage; and
- Guarantee the efficiency, reliability and robustness of interfacing renewable, low-carbon and distributed energy sources into existing transmission and distribution systems.

Performance Measures: Outputs

At the proposed funding level, NIST will generate the following outputs:

Powering up America: Accelerating an Interoperable Smart Grid	
Technical Area	**Outputs**
Interoperability of Smart Grid devices and systems	• Analysis and needed measurement capabilities to support development of an overall interoperable Smart Grid system architecture. • Standards, protocols, models, measurement techniques, and performance and materials data that enable the development, interoperability and interchangeability of Smart Grid devices and systems that include protection of the Smart Grid from cyber events, ready integration of renewable resources, and accommodate widespread use of electric vehicles. • Accelerated development and use of national and international Smart Grid standards.
Robust and efficient electric power delivery	• Measurements, reference models, and test methods to enable the interoperability and interchangeability of Smart Grid devices and systems to increase the efficiency, reliability and resiliency of the power grid. • Integration of comprehensive automated grid monitoring and control systems for increased efficiency and robustness. • Models, test protocols, standards, and materials data for development of high-voltage, high-speed low-cost power conditioning technologies. • Interoperability testbeds for evaluating standards, protocols, and cybersecurity for Smart Grid technologies, including at the interface between the grid and industrial, building and home users.

Performance Measures: Outcomes

At the proposed funding level, NIST will generate the following outcomes:

- Increase security, efficiency, and reliability through uniform device and connection standards for distributed energy sources;
- Mitigate harmful environmental impacts by reducing the amount of electricity generated from fossil-fuel sources from its present level of 73 percent by enabling the development and ready integration of distributed renewable energy sources;
- Minimize consumer electric energy costs by enabling better customer awareness and control of their energy usage;
- Boost public confidence through safe and controlled power generation and protection of workers and the community;

- Improve international markets for U.S. energy products through incorporation of U.S.-developed technology in international standards; and
- Enable the commercialization and deployment of new Smart Grid technologies, a market estimated to be worth $70 billion by 2013.

3. Measurement Standards and Measurement Technology to Support Innovation in Healthcare (+13 Permanent Positions, +10 FTE, +$9,000,000, including $500,000 transfer to the Working Capital Fund)

- The Administration's agenda for technology calls for investments in biomedical research that will increase the quality and lower the cost of healthcare[6].
- The FDA's Critical Path Initiative[7] and subsequent Opportunities List[8] specifically call out the need for enhanced evaluation tools to support drug development and other innovations in the health care industry.
- Enhanced biomedical measurement capabilities would provide researchers with tools to enable a more complete understanding of human health and disease, dramatically impacting the biotechnology, pharmaceutical, and health care industries by enabling predictive and preventative medicine and by decreasing both the time and cost associated with drug development, and improving the quality of patient care
- This initiative will be heavily leveraged through collaborations with a number of stakeholders including: NIH (NCI, NIBIB), FDA, multiple universities, private research institutes (Mayo Clinic, Institute for Systems Biology), and industry.

Problem Magnitude and NIST Role:

The cost and quality of health care is a major issue facing all Americans. Health care spending has risen dramatically over the past 35 years from 7.2 percent of GDP in 1970 to 16 percent of GDP in 2005, and projections forecast that health expenditures will account for 20 percent of the GDP by 2015.[9] This dramatic rise in health care costs is having a negative effect on other sectors of the economy, with individuals, corporations, and governments forced to shift ever-greater percentages of their budgets to address these increasing costs. At some point, health care spending will become unsustainable. These dramatic cost increases are being driven by multiple

[6] White House Technology Agenda, http://www.whitehouse.gov/agenda/technology/
[7] *Challenge and Opportunity on the Critical Path to New Medical Products*, 2004, Food and Drug Administration, http://www.fda.gov/oc/initiatives/criticalpath/whitepaper.pdf
[8] *Critical Path Opportunities List*, 2006, Food and Drug Administration, http://www.fda.gov/oc/initiatives/criticalpath/reports/opp_list.pdf
[9] Centers for Medicare and Medicaid Services, Office of the Actuary, National Health Statistics Group, http://www.cms.hhs.gov/NationalHealthExpendData/

inefficiencies throughout the health care system. One area in which significant improvements could be made, which would both decrease costs of and improve the overall quality of healthcare, is in the area of laboratory medicine and medical imaging.

Currently laboratory medicine suffers from a lack of standards – test results are neither accurate nor comparable over space and time. Standards exist for only 10 percent of the 700 most commonly ordered clinical tests. In the area of medical imaging, where it is estimated that U.S. healthcare consumers spent a combined $50 billion on medical imaging tests (MRI, CT scans, etc.) in 2008, the software and standards needed to enable physicians to extract and compare relevant data and to make clear determinations as to whether or not a tumour actually shrank or grew do not exist. These measurements and standards shortcomings result in repeat testing, misdiagnosis, and ineffective treatment decisions -- all of which drive up healthcare costs.

NIST has worked closely with industry, academia, and other government agencies to identify the measurement and standards tools required to improve the quality of current biomedical measurements and foster the development of the new technologies needed for next generation healthcare delivery. NIST will develop the measurement tools to support improved accuracy and reproducibility of current clinical diagnostics; enable quantitative and comparable medical imaging on current and future imaging platforms; and, develop the tools necessary to enable and validate the next generation medical measurement tools. Improvements to the accuracy and precision of clinical and diagnostic measurements will have significant short- and long-term economic impacts in the areas of drug/therapeutic development, and most importantly, the quality of patient care. Furthermore, without the measurements and standards that improve the comparability and accuracy of diagnostics tests, developing the healthcare information technology infrastructure will not be effective at lowering the cost of healthcare.

Proposed NIST Technical Program:

The initiative will focus on developing the measurements and standards infrastructure for both clinical diagnostics and medical imaging.

Measurement Tools to Support Improved Accuracy and Reproducibility of Clinical Diagnostics

Current laboratory medicine technology suffers from a lack of attention to standards. Even though approximately 70 percent of health care decisions are based upon results from a test performed in a clinical laboratory, internationally recognized Reference Methods and Materials exists for only about 10 percent of the ~700 most routinely run tests. NIST has provided support to this vital area, but considerably more effort is needed. This initiative will focus on developing:

- *Higher Order Reference Methods and Certified Reference Materials for Clinical Analytes* - The *in vitro* diagnostic (IVD) manufacturing, medical professional, and medical laboratory accreditation communities have requested that NIST and other National Metrology Institutes (NMIs) develop and inter-compare additional Higher Order Reference Measurement Procedures and accompanying Certified Reference Materials. Priorities for this work are established in consultation with the American Association for Clinical Chemistry, the International Federation for Clinical Chemistry and the BIPM, IFCC, and ILAC Joint Committee on Traceability in Laboratory Medicine. Additional Measurement science, Reference Methods, Certified Reference Materials and technology and measurement services are needed in the following areas:

    - *Non-Peptide Hormones* – several clinically significant hormones comprise this category for which there are no standards – these include; serotonin, melatonin, dopamine and leukotrienes.
    - *Serum Proteins* – those single analytes with known clinical utility for medical decision-making – these include; prostate specific antigen (PSA), C-reactive protein, HER-2-nu, protein hormones, infectious disease-associated antibodies, auto antibodies, and metalloproteinase. Important parameters include identity, quantity, post-translational modification, sample integrity, standardized capture reagents, and improving efficiency of probe generation.
    - *Nucleic acids* – important parameters include RNA and DNA virus copy number, micro-RNA identity and quantity, fidelity of DNA amplification, low abundant genomes.
    - *Cells* – important parameters include size and volume.

General measurement challenges and issues in this area include sample integrity and quality, IT tools for data interpretation, annotation of results for the health record, security of genetic sequence data, and signal/noise.

Measurement Tools to Support Quantitative Medical Imaging

With funding received in FY 2007 NIST began to apply its core competencies in electromagnetic and radiation-based measurement methods, biomaterials, information technology, and software validation to the measurement problems associated with medical imaging. This preliminary work has set the stage (and raised community expectations) to establish a coordinated program aimed at providing national standards for all the major imaging diagnostic methods being used clinically, and supporting industrial and medical researchers in developing new and better medical imaging instruments and methods. The expanded program in quantitative medical imaging will be focused on the following programmatic areas:

- CT and Spiral CT Imaging Standards
- PET Imaging Standards
- MRI Imaging Standards

- Bone Densitometry Clinical Standards
- Medical Optical Imaging Standards.

Work in these programmatic areas will address a number of critical measurements and standards needs highlighted by the medical imaging community including:

- Developing standards and measurement quality assurance processes to enable quantitative medical imaging for the modalities most often used in medical diagnostics, including PET-CT, SPECT, Spiral CT, and MRI; in out-years, methods will be extended to include standards for new diagnostic instruments and techniques being developed by the U.S. health care instrumentation industry and medical researchers.
- Developing a dual-modality PET-MRI phantom will be designed and developed to provide the necessary physical quantities to quantify medical images in terms of spatial dimension and contrast/positron emission intensity.
- Creating new optical measurement standards to enable the quantification of appearance factors, in particular color and texture. Optical imaging measurement science will be advanced to allow improved contrast, biopsy selection, and diagnosis in endoscopic and laparoscopic procedures in collaboration with medical researchers and industrial associations.
- Evaluating the efficacy of newly developed non-invasive optical measurements techniques against known standards.
- Developing an absolute, well-defined x-ray phantom, traceable to standard measurements and units to provide a confident means of calibrating a variety of instruments and systems all back to a common point and reduce variability among instruments due to system-specific technical and engineering issues.

Performance Measures: Outputs

At the proposed funding level NIST will provide the following outputs:

Advanced Biomedical Measurements for Accelerating Innovation in Healthcare	
Technical Area	**Outputs**
Clinical diagnostics ($5.45 M)	• Standardization of antibody-based measurements. • Standardize capture agents for autoantibody measurements. • Methods and procedures to test alternative affinity methods. • Validation of measurement platforms for multiplex serum protein analysis. • Validation of multiplex protein and genomic measurement platforms. • Validation and calibration of new technologies and improved instrumentation for clinical diagnostic testing.

Advanced Biomedical Measurements for Accelerating Innovation in Healthcare	
Technical Area	**Outputs**
	• Establish round-robin inter-comparisons and proficiency testing of current diagnostic protocols. • Systems to better correlate measurement of mRNA and proteins in dynamic networks to determine which proteins function in a particular processes. • Validated data, protocols, and reagents for imaging systems used in cell-based protein functional determination. • Validated physical and chemical measurements of small molecule /protein interactions for the development of computer models. • Models to determine the correlation of DNA sequences with protein functional changes in normal and perturbed biological systems.
Quantitative medical imaging ($3.55M)	• Identify, evaluate, and if possible, eliminate sources of variability and of error in imaging modalities. • Develop well-characterized phantoms to reliably and accurately calibrate a variety of instruments and systems. • Develop NIST-traceable measurement methods. • Develop standardized image databases for comparing internal dose models for radiation-based imaging modalities. • Conduct and evaluate round-robin inter-comparisons. • Work with industry and agencies to optimize image processing and reconstruction software, and to develop automated (or semi-automated) image analysis. • Implement a proficiency testing process to ensure the inter-comparability of imaging data across different clinical sites and across different modalities. • Develop standards and methods for inter-comparability of clinical imaging data to support improved analysis of change to determine drug efficacy.

Performance Measures: Outcomes

By developing the proposed enabling capabilities, NIST will provide the measurements and standards infrastructure necessary to improve the quality and reduce the cost of healthcare. This advanced measurements and standards infrastructure will enable dramatic improvements in advanced medical imaging for detection, diagnostics, and therapeutic evaluation, and will improve the reliability and

accuracy of clinical diagnostic testing -- leading to improved and more efficient healthcare delivery. Specifically, this work will improve healthcare quality and lower costs through:

Improved reliability of laboratory medicine testing, resulting in:

- Increased accuracy of laboratory testing
- Greater comparability over time and space
- Fewer misdiagnosis and unnecessary repeated tests.

More "truth in and from" medical imaging data, resulting in:

- More accurate monitoring of disease progression and therapeutic response
- Earlier detection of disease facilitating more effective treatment decisions
- Improved reliability and accuracy of clinical trial data.

Increased quality of the information that goes into electronic health records, resulting in:

- Fewer medical errors
- Increased efficiency in healthcare delivery to mobile patients
- Greater confidence for patients and healthcare providers in the information used to make medical decisions.

4. Advanced Energy Technologies: Solar Energy and Storage (+24 Permanent Positions, +18 FTE, +$7,500,000, including $2,500,000 transfer to the Working Capital Fund)

- The Administration calls for decreasing our dependence on foreign oil imports through enhancing "U.S. energy supplies through responsible development of domestic renewable energy…".
- Solar energy is the most promising of the alternative energy sources. It is readily available, free from geopolitical tension and not a threat to the environment through pollution or to the climate through greenhouse gas emission.
- Today's photovoltaic solar cells are not up to the challenge. New approaches are needed to support breakthroughs in the discovery and innovation of next generation photovoltaic solar cell technologies as well as to overcome the current barriers with existing technologies.

- Through this initiative and in collaboration with the lead energy agency, the Department of Energy (DOE), other Federal agencies, states, industry, and universities, NIST, as our Nation's measurement and standards laboratory and with an initial focus on solar energy as one of the most promising alternative energy solutions, will:

    - Develop the advanced measurement science and tools to generate the information needed to have a real impact and accelerate the development of breakthroughs in emerging third-generation photovoltaic solar cell technologies.
    - Improve performance measurements and prediction tools to overcome barriers for the adoption of next generation of existing solar technologies.
    - Provide the tools, techniques, and expertise developed under this initiative to benefit the research, development, and manufacturing enterprises associated with next generation photovoltaic solar cells, and extend this expertise in future years to address issues with advanced energy storage devices such as batteries, fuel cells, photoelectrolysis cells, and supercapacitors. Energy storage solutions are critical for fully enabling the use of alternative, intermittent energies such as solar.

Problem Magnitude and NIST Role:

Economic growth and expanding population is predicted to double the world's demand for energy by 2050 and triple it by the end of the century, even with aggressive conservation efforts. Moreover, the U.S. faces unique multiple challenges in meeting its energy needs. These include:

- Energy Independence: the use of energy in the U.S. currently exceeds our Nation's production capacity.
- Environmental Stewardship: the combustion of fossil fuels is 85 percent of current U.S. energy supply. There is increasing pressure for the U.S. to reduce its emissions of CO_2 and other greenhouse gases that contribute to climate change.
- Economic Security: the U.S. economy is threatened by the high and variable cost of imported energy. There is a need for the development of next generation clean energy technologies that do not depend on imported oil. This presents a global economic opportunity for the U.S.

The magnitude of the energy challenge is immense. The threat of climate change imposes further requirements on potential future energy sources. The distribution of existing carbon-neutral energy technologies is simply not sufficient to secure our Nation's energy future. Instead, meeting the energy challenge will require new technologies for producing, storing, and using energy with performance levels far beyond what is now possible. One of the most promising of the carbon-neutral energy technologies is solar energy. More energy from sunlight strikes the earth in one hour than all of the energy consumed world-wide in a year. This means that harnessing only 0.01 percent of the energy from sunlight that hits the surface of the earth is necessary to supply the world's energy needs.

However, we are far from achieving this goal. New developments in the efficiency and cost-effectiveness of solar energy technologies are needed and will only come from breakthroughs in our improved understanding of energy transfer between light and electricity.

The DOE Basic Energy Sciences Office has identified in a series of workshops the critical research directions needed in solar energy technologies to meet our Nation's energy needs. The reports repeatedly call for the development of new measurement methods to measure and characterize devices to understand the underlying science. This understanding will enable revolutionary breakthroughs in next generation solar energy technologies. DOE and its National Renewable Energy Laboratory (NREL) are committed to stimulating revolutionary advances in all of these technologies, and agree that NIST, whose mission is to promote U.S. innovation and industrial competitiveness by advancing measurement science, standards, and technology, is critical to providing the measurement infrastructure:

"NIST has unique advanced measurement capabilities that would make a valuable and welcome contribution to existing DOE programs on materials for solar energy production. Interagency cooperation, enhanced by an expanded focus on measurements for solar energy at NIST will accelerate the development of this technology most critical to future U.S. energy independence."

--Letter of Support from David Ginley, DOE/NREL Fellow and Research Manager, May 2008.

NIST's role, in a national program for developing advanced solar energy technologies, is to provide the measurement science, models, data, and standards that are integral to developing new solar technologies to meet increasing energy demand and rising energy costs. NIST's work will be conducted in close collaboration with DOE and NREL, in addition to other Federal agencies, industry, and universities. NIST will enable acceleration of the development of new solar energy technologies by providing the advanced measurement science and tools to generate the information needed to have a real impact and to accelerate breakthroughs in future (second and third generation) photovoltaic solar cell technologies. The development of a solar energy infrastructure will not only ensure U.S. energy independence, but also represents an unparalleled economic opportunity if the U.S. can maintain scientific and industrial leadership in this field. However, the groundwork for the new measurement science and standards to enable such breakthrough developments in solar and advanced energy storage technologies must start now to ensure fruition within the next 10 to 15 years.

Proposed NIST Technical Program:

The largest efforts by the photovoltaics industry and the DOE to make solar power more economically competitive have focused on incremental improvements to existing, i.e. semiconductor-based generation I and II technologies. A diversity of third generation photovoltaic technologies have the promise to break this paradigm by greatly reducing both the manufacturing costs and the capital

required to increase production capacity. Common to these new technologies are an emphasis on mixtures of nanostructured components (nanocrystals, nanowires, quantum dots) engineered for optimal performance. Performance and manufacturability of such systems are closely tied to the interaction of these components: details that are beyond current measurement techniques. Successful technology breakthroughs today can only occur if technology developers can achieve control over the interactions of components, particularly during operation. This requires the successful development of methods to correlate device performance through measurements of fundamental processes at the nanoscale with unprecedented accuracy, precision, sensitivity, and resolution. Additionally, essentially all proposed technologies have severe lifetime limitations given the required solar panel lifetime of 10 to 20 years. Improvements in lifetime are difficult as the origins of degradation are unknown. Reliable performance lifetime metrics are essential for commercial adoption.

A number of recent workshops sponsored by DOE and The Nanoscale Science, Engineering, and Technology (NSET) Subcommittee of the NSTC Committee on Technology have stressed crucial needs in developing measurement methods of processes important to the development of both solar cell and advanced energy storage technologies. The following quotes demonstrate the need for new measurement methods in these areas:

"Learning to control energy transport across nanoscale interfaces is crucial to advances in energy use and energy harvesting"
--from Nanoscience Research for Energy Needs: Report of the March 2004 National Nanotechnology Initiative Grand Challenge Workshop (http://www.sc.doe.gov/bes/reports/files/NREN-rpt/pdf)

"...a new set of analysis tools is needed that are capable of selectively characterizing the processes at unprecedented levels of spatial and temporal resolution. Novel strategies are required to

- *Characterize local processes on timescales that are relevant to the electrochemical process (fs – days)*
- *Determine the structural changes induced in active and passive battery components during electrochemical cycling, both in and ex situ, over nm to macroscopic length scales*
- *Probe structure and reactivity at all the relevant interfaces in batteries and electrochemical capacitors*
- *Image structural, electrochemical, and physical/electronic properties."*

--DOE Office of Science, Basic Research Needs for Electrical Energy Storage, 2007

The lack of suitable measurement tools with the requisite accuracy, precision, sensitivity, and temporal and spatial resolution to correlate device characteristics with nanoscale properties has driven the industry to rely almost solely on device efficiency for process optimization, resulting in costly iterative process design that is currently to slow to maintain our domestic lead in this U.S. developed technology.

To address these potentially show-stopping issues in the efficiency of third generation photovoltaics, NIST will deliver:

- Advanced measurement methods and predictive modeling tools to understand:
    - electron and hole concentration and mobility in individual 3D nanoscale structures and in nanostructured arrays,
    - energy capture and carrier generation from photons
    - carrier transport (mobility, recombination, lifetime) with nanoscale resolution,
    - *in situ* measurements of transport with nanoscale resolution and at fast times, and
    - absolute quantum efficiency at wavelength (and subwavelength) scales.

- Accurate methods to assess why next-generation solar cells fail, i.e. reliability, lifetime, and failure modes. This capability will be fully developed in the subsequent fiscal year for device-level measurements
- In future years, by further extending and adopting the measurement methods developed here, understanding of the processes in advanced energy storage technologies (critical to fully enabling solar and other intermittent alternate energies) in which nanoscale tailoring of electrode structure improves the energy density, lifetime, and charging rate of batteries.

Performance Measures: Outputs

At the proposed funding level, NIST will generate the following outputs:

Advanced Energy Technologies: Solar Energy and Storage	
Technical Area	**Outputs**
Standards	• Begin development of standard measurement and test methods to assess the functional lifetime of third generation photovoltaic materials and devices; reference values and test methods for optical and electrical properties will be provided with these standards.
Fundamental Process Measurements	• New multi-functional techniques combining nanoscale spatial resolution with ultrafast time resolution to measure fundamental electron-hole dynamics in individual 3D nanoscale structures and in nanostructured arrays. • Measurements that integrate *in situ* measurements of the nanoscale structure, the dynamic evolution of ion or charge transport pathways, and interfacial chemistry governing processes in third generation solar cell technologies.

Advanced Energy Technologies: Solar Energy and Storage	
Technical Area	**Outputs**
	• New electromagnetic measurement methods that probe photoinduced carrier generation, carrier scattering processes that lead to energy relaxation, trapping, and recombination, as well as carrier transport and localization in individual nanostructures and heterogeneous assemblies of nanostructures, such as polycrystalline materials, nanowires, and quantum dots. • Development of advanced tomography procedures for measurement of 3D nanoscale chemical structure.
Efficiency and Lifetime	• Local absolute quantum efficiency (QE) measurements and loss mechanism identification with improved spatial resolution. • Begin detailed measurements of device performance loss as a function of time, temperature, and light exposure. This data will be interpreted with data from measurements of structure change with performance loss during device lifetime tests.
Modeling	• Begin modeling of 3D electron-hole transport processes to interpret measurement data and inform solar cell design.

Performance Measures: Outcomes

At the proposed funding level, NIST will generate the following outcomes:

- The measurement infrastructures to understand, characterize, and enable the development of efficient and inexpensive second and third generation photovoltaic devices.
- New data will enable industry to accelerate the manufacturing of next-generation photovoltaics by reducing costly iterative process design that is too slow to maintain the domestic lead in this U.S. developed technology.
- Shift a larger share of the solar market to U.S. based companies. The worldwide solar market is expected to be $51 billion dollars in 2015. Currently, about 90 percent of photovoltaic solar cells are manufactured outside of the United States. Several of the leading next generation (organic) photovoltaic companies, e.g., Flextronics and Konarka, are based in the United States.
- Low-cost, renewable energy will ensure energy independence for the United States and would significantly mitigate climate change.

5. Greenhouse Gas Emissions Measurements (+21 Permanent Positions, +16 FTE, +$7,000,000, including $800,000 transfer to the Working Capital Fund)

- Policy makers throughout the U.S. acknowledge climate change as a serious problem and that greenhouse gas (GHG) emissions are a major driver.
- Any effective GHG mitigation strategy to climate change needs to be based upon rigorous standards, methods and procedures for measuring, reporting and verifying GHG emissions.
- Accurate measurements and methods to verify greenhouse gas baselines are needed to provide robust, unbiased scientific data to inform policy makers as they debate efforts both nationally and globally to mitigate effects of climate change, such as global warming.
- Through this initiative NIST, as our Nation's measurement and standards laboratory, will:

    - Provide the measurement science basis for accurate and comparable quantitative measurements of GHG emissions.
    - Ensure the accurate and reliable assessment of current GHG baselines, verification of GHG emissions, and quantification of GHG sinks.
    - Enable the development of international measurement standards to ensure the accurate global assessment of GHG emissions.

Problem Magnitude and NIST Role:

Over the past century, particularly in recent decades, scientists internationally have documented the effects of global warming: polar ice caps are shrinking causing sea levels to rise; extreme weather is wreaking havoc across the globe; droughts are becoming more severe, tropical diseases are migrating north and numerous species are being threatened with extinction. A consensus of the world's climate scientists assert that steps must be taken now to reduce greenhouse gas (GHG) emissions from industrial economies before the year 2015 to avoid a projected tipping point in atmospheric GHG levels.[10] Discussions of GHG mitigation strategies have begun amongst policy makers. Any mitigation strategy will require accurate data and methods to verify the policy decisions are achieving their desired effect. Accurate and reliable assessment of current GHG baselines, verification of GHG emissions, and quantifying GHG sinks are critical measurement challenges and provide essential input to any potential GHG mitigation implementation.

[10] Intergovernmental Panel on Climate Change, *Climate Change 2007: Synthesis Report Summary for Policymakers*, http://www.ipcc.ch/pdf/assessment-report/ar4/syr/ar4_syr_spm.pdf.

NIST offers the unique capability to expand the measurement science base and laboratory accreditation programs to ensure the increased accuracy and comparability of quantitative measurements of GHG emissions. Rigorous standards, methods and procedures for measuring, reporting and verifying GHG emissions provide the unbiased, scientific basis for enhancing scientifically credible metrics useful to policy makers as they debate efforts, both nationally and globally, to mitigate effects of climate change, such as global warming.

New measurement capabilities need to be developed to accurately measure GHG emissions from the myriad of GHG emission sources, such as the techniques for the validation of point source emissions to developmental technologies needed to quantify geographically-disperse GHG sources and sinks. Key issues to be addressed include:

- Accurate Baseline Emissions – More accurate methods to measure baseline GHG amounts emitted by multiple industries and technology sectors in a consistent and verifiable manner, both nationally and internationally, are needed to inform effective global strategies for climate change mitigation.
- Improve Monitoring Technologies – Accurate and standardized monitoring technologies are needed to support GHG emission measurements. The development of robust measurements of GHG monitoring for large area GHG emission sources or sinks are a current measurement challenge.
- International Recognition – Ensuring transparent and trustworthy measurements of GHG emissions internationally will require a centralized and agreed-upon set of measurement standards and methods for accrediting various monitoring organizations and laboratories. Implementation of such a system will benefit from the existing infrastructure of the international system of units and the international metrology community.

Proposed NIST Technical Program:

NIST's offers unique capabilities to improve national and international capabilities for GHG emissions measurements, i.e., the measurement science, artifact and chemical standards, documentary standards, and laboratory accreditation programs that will ensure the accuracy and comparability of quantitative measurements of greenhouse gases. Improvements in GHG emission measurements requires that gaps in the areas of physical standards, sensor calibration technology, statistical methods, and sensor technology development be addressed. These gaps limit the absolute accuracy of currently available monitoring methods and practices for both localized and remote detection and measurement applications.

NIST will:

- Provide rapid and unbiased scientific assessment of the quality of current GHG measurements and data;
- Support the verification of data and models to determine the baselines of GHG emissions and the effect of GHG emissions on health and welfare; and
- Provide the measurement science, artifact and chemical standards, documentary standards, and laboratory accreditation programs to support the development of new technologies for monitoring GHG emissions and offsets.

Performance Measures: Outputs

At the proposed funding level, NIST will generate the following outputs:

Greenhouse Gas Emissions Measurements	
Technical Area	**Outputs**
Point source GHG emission monitoring and standards	• Develop GHG emission baseline assessment methodologies for stationary and mobile sources. • Develop a testbed to demonstrate new GHG emissions monitoring instrumentation protocols, methodologies, and usage. • Strengthen existing capabilities to broaden the availability of GHG standard reference materials (SRMs) as the measurements basis for current and next generation point monitoring systems. • Develop non-optical sensors for point source monitoring for both mobile and stationary emission sources.
Remote GHG emission monitoring and standards	• Develop advanced remote monitoring and verification technologies to enable quantitative, three dimensional GHG profiling having the required spatial and temporal resolution to discriminate between closely spaced emitters and to characterize GHG sinks. • Provide high accuracy reference data tied to the International System of Units, including optical absorption properties of GHGs.
Accreditation of private and state laboratory networks	• Develop a laboratory accreditation program framework based on ISO 17025 and ISO 14065 standards for testing laboratories to ensure accurate calibration procedures and methodologies for the variety of GHG monitoring methods.

Greenhouse Gas Emissions Measurements	
Technical Area	**Outputs**
International comparability of GHG emission measurements	• Ensure early international comparability of GHG measurements to facilitate integration into international climate change mitigation efforts. • Provide the measurements linkage to the International System of Units for the quantification of GHG emissions. • Represent the U.S. within the framework established by the working arrangements between the World Meteorological Organization (WMO) and the International Committee for Weights and Measures (CIPM).

Performance Measures: Outcomes

At the proposed funding level, NIST will generate the following outcomes:

- Develop standards, methods and procedures for measuring, reporting and verifying GHG emissions.
- Provide accurate measurements and verification methods of emissions from myriad GHG sources.
- Provide robust, unbiased scientific data of GHG emissions to policy makers.

6. Measurements Science for Net Zero Energy, High Performance Green Buildings (+13 Positions, +10 FTE, +$7,000,000, including $840,000 transfer to the WCF)

The Administration, through ARRA funding, supports the greening of Federal buildings. This initiative extends that investment to non-Federal buildings, both new and existing, to improve energy efficiency and become carbon neutral.

Problem Magnitude and NIST Role:

"The world is facing twin energy related threats: that of not having adequate and secure supplies of energy at affordable prices and that of environmental harm caused by consuming too much of it.[11]" Any successful response to these threats must consider buildings. Buildings account for 40 percent of the United States' energy use and a similar percentage of carbon dioxide emissions, more than the

[11] *IEA's World Energy Outlook, http://www.iea.org/Textbase/npsum/WEO2006SUM.pdf*

transportation or industrial sectors.[12] Buildings consume 72 percent of all U.S. electrical energy production. Emissions associated with buildings and appliances are projected to grow faster than those from any other sector. To ensure adequate supplies of energy and to curtail the projected growth of CO2 emissions, it is essential that building energy consumption be significantly reduced while minimizing life cycle environmental impacts.

The National Science and Technology Council's Committee on Technology report entitled "Net-Zero Energy, High Performance Buildings" articulates the dual vision of Net Zero energy buildings -- buildings that use as much energy from renewable sources as they consume, and doubling the service life of building materials, products, and systems to minimize their life-cycle impact. Using currently accessible and cost-effective technologies, building energy consumption can be reduced by approximately one-third. The remaining portion can only be achieved through the introduction of innovative building technologies and materials enabled by new measurement science. The existing measurement science remains lacking in terms of its ability to accurately quantify the energy and sustainability performance of building components, systems, and materials as installed in a building; to optimize control system performance while detecting and responding to performance degradations, or to accurately assess the performance of emerging green building technologies. Buildings are complex systems of integrated and interacting materials, components, and systems. Past improvements in the energy performance of individual materials/components/systems have not resulted in the expected reductions in overall building energy consumption. Performance measurements made on individual materials and components in carefully controlled laboratory test environments are idealized and typically capture neither the complexities of actual building installation nor the dynamic interactions of multiple subsystems. For this reason, a new and integrated portfolio of measurement science capabilities is needed that not only supports innovation in the design and manufacturing of individual components, but also comprehensively captures the system complexities and interactions seen in a real building. Each individual measurement capability presents technical challenges, and the overall goal of significantly improved energy and environmental performance can only be achieved by applying an integrated portfolio of such measurement science capabilities.

The enabling and integrated measurement science to achieve Net-Zero Energy, High-Performance Green Buildings does not currently exist. The Department of Energy (DOE) focuses on the development and demonstration of energy technologies but, together with industry, depends on NIST to develop the measurement science needed to evaluate energy technologies and sustainable material performance. The European Union is promoting building energy efficiency through a directive that requires efficiency improvements through a combination of education, financial incentives, and mandatory performance targets. In the U.S., efforts to improve building energy efficiency and environmental performance have been promoted by the U. S. Green Building Council. None of these efforts, however, address the underlying measurement science needs. Emerging green building technologies often fail to be recognized in the marketplace, as existing performance metrics fail to capture their impact on the overall performance of building energy systems.

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[12] *DOE Buildings Energy Data Book http://buildingsdatabook.eren.doe.gov/*

Proposed NIST Technical Program

The scope of the proposed work will be focused on building energy and sustainable performance measurements that operate in a holistic, integrated manner considering complex system interactions involving weather, building envelope components, and various indoor environment control systems and equipment. New measurement systems are needed to:

- Enable energy-use reductions through in-situ performance measurements over a building's life
- Enable building energy-use reductions through embedded intelligence in building control systems
- Determine the performance of emerging building energy technologies reliably
- Enable the development and usage of sustainable materials, components, and systems
- Provide carbon-based sustainability metrics and tools to evaluate the energy and environmental performance of buildings.

The technical plan is comprised of five thrusts that will provide the measurement science required to achieve Net-Zero Energy, High-Performance Green Buildings when undertaken in a holistic, integrated manner. Specifically, the research proposed in this initiative has five objectives.

Enable Energy-Use Reductions in Buildings through In-Situ Performance Measurements

The actual energy performance of buildings frequently fails to meet design goals. New measurement systems are required that can provide detailed, ongoing information on how energy is being used within a building, thus enabling design integration to achieve better performance as well as encouraging owners/occupants to make informed energy use decisions during service.

Enable Building Energy Use Reductions through Embedded Intelligence

Building systems almost never achieve their design efficiencies at any time during building operation and their performance typically degrades over time. Case studies indicate that energy consumption for heating, ventilation, and air-conditioning can be reduced 20 percent just by detecting mechanical faults and ensuring that systems are operating correctly.[13] The key to realizing design potentials is combining new measurement technology and performance metrics with analysis techniques that can be implemented in building automation and control products. The resulting systems have a distributed, embedded intelligence that can detect and respond to faults and operational errors and inefficiencies. By developing appropriate communication protocol standards these intelligent systems can also interact with a new Smart Grid utility infrastructure.

[13] *Energy Impact of Commercial Building Controls and Performance Diagnostics: Market Characterization, Energy Impact of Building Faults and Energy Savings Potential, TIAX Report No. D0180*

Provide Measurement Science for Emerging Building Energy Technologies

Energy and energy efficiency are invisible attributes. Potential users of emerging building energy technologies require actual, as opposed to advertised or rated, performance measures and data before making capital investments. Credible performance measures and data will create market demand for emerging building energy technologies (e.g., photovoltaics, solid state lighting, advanced insulation systems, co-generation and fuel cell systems), economies of scale, and reduced cost.

Enable the Development and Usage of Sustainable, Materials, Components and Systems

The sustainable performance of building materials, components, furnishings, and systems (coatings, sealants, concrete, organic photovoltaics, etc) often degrade prematurely, resulting in inefficient use of materials, increased energy use associated with the production of replacement materials, and disposal costs. The focus of this thrust is to extend their service life through a scientific understanding of methods of degradation and of how performance can be enhanced using waste stream and recycled materials such as fly ash.

Develop Carbon Footprint Metrics and Tools for Building Sustainability Performance Evaluation

The U.S. construction industry needs compelling metrics to support investments in buildings using advanced green building technologies. Proponents of Net-Zero Energy, High Performance Green Buildings seek a transformational change in the industry's life-cycle greenhouse gas emissions, or "carbon footprint," but this goal is neither supported by measurement science nor tempered by economic reality. As a result, promising R&D opportunities are not fully exploited by industry due to their uncertain sustainability performance outcomes. Next-generation metrics and tools enabling rigorous carbon footprint and sustainability assessments over the building service life are needed to link green building technology innovation to environmental/economic benefits.

Performance Measures: Outputs

At the proposed funding level, NIST will generate the following outputs:

Measurement Science for Net Zero Energy, High Performance Green Buildings	
Technical Area	**Outputs**
Energy use reduction: in-situ measurements	• Develop non-invasive techniques, such as radio-frequency scanning and/or sensor networks, to readily determine if the building envelope is meeting design goals. • Develop measurement techniques and performance metrics to quantify ventilation rates in buildings to ensure occupant comfort while minimizing building energy consumption.

Measurement Science for Net Zero Energy, High Performance Green Buildings	
Technical Area	**Outputs**
	• Identify sensor performance characteristics and develop the methods needed to accurately measure indoor air contaminant concentrations to enable intelligent ventilation control. • Develop performance metrics to measure the in-situ performance of heating and cooling systems, including the ability to detect refrigerant loss. • Optimize sensor deployment in buildings to fully quantify the energy consumption of the various components/systems in buildings to encourage energy savings by making occupants more aware of consumption.[14,15]
Energy use reduction: embedded intelligence	• Determine through laboratory experimentation and simulation studies the number and type of sensors needed to detect common building equipment faults and control errors. • Develop fault detection metrics and tools for a comprehensive range of heating, ventilating, and air-conditioning (HVAC) equipment that can be embedded in control products. • Develop hierarchical analysis techniques that can determine when an apparent fault in one piece of equipment is actually the result of a failure of a component earlier in the process stream. • Develop information models, validation tools, and performance metrics to enable advanced building control systems with integrated fault detection capability. • Develop supervisory control techniques based on autonomous, intelligent agents that can optimize system performance in areas where classical optimization techniques have failed. • Develop information exchange requirements/protocols for interfacing building controls with utilities.
Innovative building energy technologies	• Significantly reduce the uncertainty associated with photovoltaic power measurements to levels that facilitate greater adoption of photovoltaics through development/characterization of novel techniques for simulating the solar spectrum. • Develop test and performance prediction tools to predict the energy savings potential of stationary fuel cells for various geographical locations, electric loads, and thermal loads. • Develop the measurement science, methods of test, and standard reference materials needed to quantify the 3-D performance of innovative insulation technologies that can reduce the heat loss through building walls by orders of magnitude.

[14] *http://www.mnp.nl/ipcc/pages_media/AR4-chapters.html, page 394*
[15] *World Business Council EEB Report http://www.wbcsd.org/DocRoot/seqH6hKIxVrTRYxAhemY/EEBSummaryReportFINAL.pdf, p. 31*

Measurement Science for Net Zero Energy, High Performance Green Buildings	
Technical Area	**Outputs**
	• Develop measurement science to accelerate the commercialization and consumer acceptance of solid-state lighting (SSL) products and develop the enabling measurements for next generation SSL.
Sustainable materials, components and systems	• Test methods and models that enable the development of building structural and envelope materials (coatings, sealants, concrete, and composite materials) longer service life, lower embodied energy, and reduced environmental impact. • Measurements and models to characterize, quantify, and predict the end-use life-cycle performance and degradability of bio-based building materials. • Resolution of the technical barriers that prohibit the increased use of industrial waste-stream materials (WSM - fly ash, blast furnace slag) as a substitute for cement in concrete. • Development of the fundamental understanding needed to formulate environmentally benign fire suppressants in building materials and furnishings.
Carbon footprint and sustainable assessment	• Develop "bottom-up" databases of life-cycle carbon emissions from the production, installation, operation, and disposal of building materials/components/subsystems. • Work with academia to develop "top-down" databases of life-cycle carbon emissions from the U.S. construction industry by enhancing the Commerce Department's economic input-output tables to trace carbon emissions throughout the U.S. economy from economic activity in the U.S. construction industry. • Develop a "hybrid" measurement protocol enabling building-scale carbon footprint assessment. The protocol will synthesize bottom-up and top-down data at the building scale and be tailored to buildings of different types, U.S. climatic regions, and materials/component/subsystem technologies. • Develop carbon-efficiency (i.e. sustainability performance) metrics assessing the life-cycle cost effectiveness of buildings employing alternative green technologies. • With industry input, develop practical decision making tools and databases facilitating sustainability performance assessments of building materials, components, and systems. • Develop carbon scorecards and tools that assess and track building sustainability performance at the community and national levels by aggregating building-based measures based on geographically-sensitive building stock criteria (e.g. building densities, types, technologies, and weather).

Performance Measures: Outcomes

Technology Transfer -- The green building reduction goals that motivate this research can only be achieved if the research results are widely adopted throughout the building industry in both new and existing buildings. NIST will take the following actions to achieve this result and outcome:

- Disseminate research results to key industry organizations such as the American Society of Heating, Refrigerating, and Air-Conditioning Engineers, the Air-Conditioning and Refrigeration Institute, the U.S. Green Buildings Council, ASTM International, American Concrete Institute, the National Fire Protection Association providing a basis for new models, standards, and best practice guidelines.
- Collaborate with industry partners to enable laboratory testing of prototype products using NIST-developed measurement technology and to reconcile field versus laboratory results.
- Dissemination of consensus intelligent decision making tools and databases for facilitating life cycle assessments of building materials, components and systems.
- Provide grants to universities that support graduate student research in performance measurement and sensor technology that compliments NIST's research and will be critical for meeting the building energy efficiency objectives of the initiative.
- Utilize NIST's Guest Researcher Program and Technology Fellowship Program to collaborate with experts through joint research and use of our laboratory facilities in ways that contribute to meeting initiative objectives.
- Continue to support and contribute to DOE/industry strategic road mapping activities that will serve to identify and prioritize measurement needs supporting green building technology development.

Measuring Progress -- Success will be measured by the level of building energy efficiency and environmental performance gains that are attributable to the measurement science resulting from this initiative. The impacts of new and improved standards, codes, and practices addressing the energy efficiency and sustainable performance of buildings will be assessed. The number of peer-reviewed publications, patents, CRADAs, and pilot projects to assess emerging green building technologies will also measure success.

7. Measurement and Standards to Support Rebuilding the U.S. Physical Infrastructure (+11 Permanent Positions, +8 FTE, +$4,500,000)

- The Administration calls for reinvestment in the Nation's obsolete physical infrastructure to improve the economy and increase our safety and security. This initiative builds upon the recent ARRA investment in our Nation's physical infrastructure to improve roads, bridges, schools, etc.

- The American Society of Civil Engineers 2009 Report Card estimates that more than $2.2 trillion over five years will be necessary to adequately address our infrastructure needs that extend beyond bridges and highways to include the facilities to manage water, waste and energy.[16]
- It is therefore essential to ensure that spending for infrastructure is aligned with the highest priority needs.
- Tools that help prioritize infrastructure spending, by accurately characterizing and predicting the remaining life or factors of safety in facilities and infrastructure systems are an essential component of the Nation's efficient solution to its infrastructure challenges.

Problem Magnitude and NIST Role

The U.S. depends on an extensive network of physical infrastructure to transport millions of people, resources, and goods across our country daily. The vast majority of this infrastructure has been in place for over 50 years without extensive repair and is aging poorly. Long commutes, unending flight delays, failing dams and levees, contaminated water, bridge collapses, and pipeline ruptures threaten our economic viability and quality of life. Our bridges are in particularly poor condition, with nearly a third considered substandard. Years of limited investment and poor maintenance have resulted in a looming failure en masse, with multiple competing strategies to prioritize the remediation projects on the horizon. To make matters worse, structural engineers currently have to base these decisions on very little data, relying on historical comparisons (assuming similar structures will fail similarly), periodic visual observation (monitoring each structure every few years), and limited nondestructive evaluation (which can miss sub-surface flaws that later become catastrophic). Better inspection tools are critical, as are calibration standards to reduce errors associated with these measurement techniques. Additionally, predictive models will be the cornerstone of prioritization efforts. Accurate data is needed to populate these models and provide foundational guidance on when and how to repair or replace the 160,000+ structurally deficient or functionally obsolete U.S. bridges and other physical components and systems comprising our national public infrastructure.

The foundation of the current measurement system of data and models is inadequate to accurately assess and predict remaining infrastructure lifetimes, and then prioritize repairs and upgrades. The failure of the I-35W Bridge in Minneapolis, which was inspected just 3 months before its collapse, has raised new questions about the current inspection system used by state transportation departments. Greater and more extensive analysis of failed, failing, and structurally sound infrastructure materials is needed in order to better determine the effects of material, design, construction method, system load, and environment on remaining service lifetimes. The data acquired from using a comprehensive destructive analysis of aged materials combined with evaluation of the remaining fatigue life would feed new fracture mechanics models that seamlessly connect material behavior to component and system failures. The Federal Highways Administration (FHWA) and state Departments of Transportation (DOTs) could use such data and models to

[16] See http://www.asce.org/reportcard/2009/grades.cfm

accurately prioritize each wave of infrastructure repair projects. The overarching need is for a robust scientific framework that can be used for objective prioritization of repair needs in support of the emerging national strategy for infrastructure remediation.

Proposed NIST Technical Program

NIST is respected for research and measurement standards development relevant to infrastructure design and performance, and has collaborated widely with other Federal agencies to advance hazard assessment and forecasting capabilities. NIST has an extensive history in evaluating fracture, fatigue, impact damage, and corrosion of structural materials, including many unique capabilities for "accelerating" environmental wear (e.g., freeze-thaw cycles, chemical corrosion). In the 1980s and 1990s, NIST conducted a program in conjunction with the FHWA to perform mechanical property assessment on rail track and bridge suspension systems by both destructive and non-destructive methods. More recently, NIST has concentrated its efforts on the structural integrity of oil and gas pipelines in support of the Pipeline Safety Act, which recognized the need for prioritization of repair and replacement to prevent catastrophic pipeline explosions. NIST has provided crucial data on pipeline aging as a function of service lifetime and environmental conditions. The proposed effort represents a challenging extension of this work, requiring unique NIST capabilities for mechanical testing under a range of conditions as well as complex fracture mechanics modeling.

NIST is ideally qualified to develop the measurement solutions that can be used to quantify the remaining usable lifetime of our existing infrastructure, maximize effectiveness of short- and long-term investment in its repair, and enable intelligent, active asset management and control in the future. Specifically, NIST can provide the next generation of sensors; nondestructive evaluation methods; interpretive and predictive models, and data and standards to allow civil engineers and planners to accurately assess and predict the reliability, or prioritize the repairs to the U.S. physical infrastructure. In doing so, NIST will partner with the Federal Highways Administration, state departments of transportation, Pipeline and Hazardous Materials Safety Administration, National Transportation Safety Board, Department of the Interior, American Society for Testing and Materials, American Society of Civil Engineers, and the construction industry. NIST will have four focus areas in this initiative.

Assembling a Comprehensive Bridge Failure Database

NIST will collaborate with FHWA and state Departments of Transportation (DOTs) to develop a categorical database linking bridge construction designs with collapses, failures, and deficiencies, including their root causes. The root cause could be natural (flooding, earthquake), or related to material, poor design, structural detail failure, fatigue, fracture, overload, corrosion, connection failure (welds, bolts, rivets) or other factors. These data can be used to develop statistical models that predict the likelihood of catastrophic collapse to guide immediate repair projects. The database will also establish the necessary material parameters that must be accurately determined for improved service life prediction.

Providing Critical Data on Aged and New Structural Materials

NIST will measure the mechanical properties (fracture toughness, fatigue lifetime, crack growth rate, yield strength, etc.) of steels removed from deficient or failed bridges as well as properties of new materials that are proposed for repair of bridge structures. This assessment will include bridge detail connections (bolted, riveted, welded joints) and effects of temperature extremes, chemical attack (e.g. de-icers), and loading conditions. Only limited data exist today regarding the effects of service life and service conditions on performance. Predictive and interpretive models will be used to ascertain the role of these various properties on the retained strength of aged connections. These critical data and models will provide the necessary foundation for comparing systems in their current state of operation.

Qualifying New Inspection Tools and Smart Sensors

NIST will develop "gold standard" techniques, calibration protocols, and reference materials to reduce the error and uncertainty associated with field inspection of structures. These same reference techniques and materials will also be used to qualify new sensors with vastly improved resolution to better monitor corrosion and sub-surface defects in real-time. The NIST Center for Sensor Calibration will serve as the U.S. resource for an industry consortium and all infrastructure stakeholders to promote accelerated development and commercialization of new inspection methodologies.

Enabling Rapid and Cost-Effective Repair and Replacement

Once a metrology foundation is established to prioritize remediation, documentary standards will be needed to speed up repair activities and utilize existing structures to the maximum extent possible. NIST will work with American Society of Civil Engineers (ASCE) and other consensus standards bodies to develop and harmonize standards for bridge design, develop translators that allow interchange of information between different graphical design formats, promote modular components for more efficient construction, and promote rapid fabrication and installation of bridges through computer-aided design (CAD) machining and high-productivity welding.

Performance measures: Outputs

At the proposed funding level, NIST will generate the following outputs: 1) property data on aged infrastructure materials, including the effects of extreme conditions; (2) advanced structural models that more accurately predict weakening at critical components such as bolts and rivets; (3) calibration standards for reducing uncertainties associated with field inspection of infrastructure systems and for qualifying high-resolution sensors; and (4) improved documentary standards for infrastructure repair and future construction.

Rebuilding the Physical Infrastructure: Prioritizing Infrastructure Remediation	
Technical Area	**Outputs**
Data: (yield strength, fracture toughness, modulus, hardness, crack identification, crack growth rate, extent of corrosion; effects of extreme conditions)	First-ever material property data on 50+ year operational structures, allowing determination of the corresponding reduction in safety margin due to service lifetime. Includes effects of extreme conditions (impact, temperature) on structural weakening to guide improvements in construction codes to ensure structural safety.
Structural models: deformations at component level	10x more accurate models of how structural components (welds, bolts, rivets) deform under load, allowing more accurate assessment of service life.
Calibration standards: for field inspection techniques (eddy current, ultrasonics, acoustic based sensing, strain monitoring, corrosion monitoring, etc).	Factor of 2 reductions in error in state-of-the-art nondestructive inspection tools through improved calibration standards, enabling more accurate detection of minor flaws in existing structures and assessment of immediacy of repair needs.
Sensors: for corrosion monitoring (magnetic) and for structural defect monitoring (acoustic, ultrasonic)	Magnetic sensors with an order of magnitude increase in resolution for monitoring corrosion at critical components, such as rebar in concrete, allowing earlier and cheaper remediation over time. Acoustic and ultrasonic sensors with increased resolution for monitoring structural defects at critical components (cracks, inclusions, lack of fusion) enabling more targeted repairs.
Standards and codes: construction codes and documentary standards	Quantitative vs. experience-based standards for infrastructure repair and construction, providing a consistent, objective framework for ensuring safety of structures over projected 100-year lifetimes.

Performance Measures: Outcomes:

At the proposed funding level, NIST will generate the following outcomes:

- Improved calibration standards for inspection techniques will increase the safety of existing infrastructure.
- More accurate detection of flaws in the field, allowing safety engineers to better assess the immediacy of repair needs.
- Better definition of remaining safety margins on existing structures to allow civil engineers to prioritize repairs.
- Improved accuracy of prediction models to provide a more comprehensive assessment of remaining service lifetime.

- More accuracy in defining necessary reductions in safety margins due to natural and man-made extreme conditions, guiding improvements in new construction to enable sustainable structures.
- Enhanced abilities for early detection of corrosion at critical components and connections, allowing earlier and cheaper remediation.

If successful, NIST will have provided a trusted scientific framework for consistent, objective assessment of infrastructural safety, while enabling improved bridge repair/installation, reducing costs to bridge owners and commuter downtime.

8. Nanomaterials Environmental Health and Safety (+9 Permanent Positions, +7 FTE, +$3,000,000)

- Industry is increasingly finding that the unknown environmental, health, and safety (EHS) risks associated with nanotechnology are a threat to innovation and competitiveness in this area.

  - It is critical that potentially dangerous nanomaterials be detected before they can harm the public.
  - It is also critical that the next breakthrough technology or new medical miracle cure not be halted by unsubstantiated fears of adverse health effects.
  - Industrial innovation will suffer in an uncertain regulatory, liability, and investment environment if EHS risks are not addressed.

- There is no measurement infrastructure in place to assess the EHS risks that nanomaterials pose.
- NIST has been called on by the President's Council of Advisors on Science and Technology, the Food and Drug Administration, and the National Nanotechnology Initiative working group on EHS, among others, to lead in developing metrologies to determine the EHS risks of these materials.

Problem Magnitude and NIST Role:

The Administration calls for increased use of new technologies to enable innovation and economic growth, and also increased environmental stewardship. Nanomaterials represent a rapidly growing new technology, but the potential environmental and health effects of these new types of materials are unknown. There are currently over 800 products on the market that contain

nanomaterials[17]. The value of nano-enabled products reached $166 billion in 2008[18] and the total economic benefit of nanomaterials is projected to climb to $2.6 trillion by 2014[19]. Though nanotechnology is expected to continue to enjoy a bright economic future, the innovation that is derived from nanotechnology is vulnerable to backlash caused by unsubstantiated fears of new technology as well as concerns regarding delayed health effects and liability of products. Nanomaterials and products that incorporate nanomaterials pose unknown risks throughout the stages of their life cycles to people and the environment. A science-based approach is needed for industry and regulatory agencies to assess and manage these risks. This approach hinges on establishing linkages between physico-chemical properties of nanomaterials and hazard and exposure effects such as toxicity and environmental persistence. Regulatory agencies and industry have called on NIST to lead the effort on physico-chemical property measurements and standards. In doing so, NIST will provide data and develop reference materials, documentary standards, and transferable instruments and measurement methods for key physico-chemical properties of nanomaterials. In the out-years, NIST will partner with industry and regulatory agencies to establish the linkages of these properties to hazard and exposure effects essential for sound risk assessment and management.

NIST's critical role in nanotechnology-related environmental, health, and safety research (NanoEHS) has been identified by varied stakeholders. The 2006 report[20] on the *Environmental, Health, and Safety Research Needs for Engineered Nanoscale Materials* from the interagency Subcommittee on Nanoscale Science, Engineering and Technology identifies supporting research to develop metrology tools and methods for measuring and characterizing nanomaterials as a role of the Federal Government. The report highlights NIST as the lead agency for nanometrology. This initiative builds upon existing NIST expertise. NIST is already engaged in collaborative efforts with the National Cancer Institute to address metrology needs that will enable physical and chemical characterization of nanoparticles. In addition, the 2008 strategic plan for NanoEHS identifies metrology as one of four top priorities.

"A fundamental requirement for assessing the potential impacts of new nanomaterials on both human health and the environment is the ability to make precise accurate measurements at the nanoscale in multiple, complex media."

--National Science and Technology Council[21]

"NIST is ideally positioned to lead the development of characterization methods and standards building on extensive expertise and experience in this area."

--Woodrow Wilson International Center for Scholars[22]

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[17] According to the Consumer Products Inventory maintained by the Woodrow Wilson International Center for Scholars, www.nanotechprogect.org, accessed 02/05/09.
[18] *The Nanotechnology Opportunity Report (NOR) 2008, 3rd Edition*, Research and Markets, June 2008.
[19] *Taking Action on Nanotechnology's Value Chain*, Lux Research, October 2004.
[20] National Nanotechnology Initiative, *"Environmental, Health, and Safety Research Needs for Engineered Nanoscale Materials"*, September 2006.
[21] National Nanotechnology Initiative, *"Strategy for Nanotechnology-Related Environmental, Health, and Safety Research"*, February 2008

NIST has interdisciplinary physical science expertise and world-class national facilities. The Institute conducts research on new analytical methods and measurement technology, develops methods to characterize and validate performance of conventional instrumentation, and creates and supplies Standard Reference Materials that enable accurate and uniform measurements in laboratories across the Nation. It also operates centers with unique national capabilities. For this initiative, NIST-wide facilities, such as the Advanced Measurement Laboratory (AML), the Advanced Chemical Sciences Laboratory (ACSL), and the Center for Neutron Research provide access to a wide range of measurement capabilities. In particular, the AML is uniquely designed to assist U.S. industry, universities, and government partners to promote advances in nanomaterial science.

Proposed NIST Technical Program:

With this initiative, NIST will launch a coordinated effort for leveraging nanotechnology expertise and resources across its laboratories and facilities to develop transferable methods and reference material standards to enable consistent measurements of nanomaterial properties, provide data on physico-chemical properties essential for risk assessments, and coordinate a national effort to provide sets of accurate physico-chemical data. Specific activities funded by this initiative are discussed below.

Reference materials

NIST will develop and release reference materials for several of the most widely produced nanomaterials used for a broad range of commercial and research applications, including electronics, personal care products, and construction materials. The reference materials are essential for benchmarking toxicity studies, qualifying or calibrating instruments used to measure physico-chemical properties of nanomaterials, and facilitating inter-laboratory studies.

Documentary standards

NIST will play a leadership role in developing documentary standards that enable consistent and reproducible measurements of nanomaterial properties for materials of current or future commercial importance. These standards are developed by consensus within major international standards developing organizations, including the Organization for Economic Cooperation and Development (OECD), the International Organization for Standardization (ISO), ASTM International, and the Versailles Project on Advanced Materials and Standards (VAMAS).

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[22] *"Nanotechnology: A Research Strategy for Addressing Risk"*, Andrew D. Maynard, Project on Emerging Nanotechnologies, Woodrow Wilson International Center for Scholars, July 2006.

Instruments and methods

NIST will develop instruments and transferable methods to measure key physico-chemical properties of nanomaterials, including agglomeration state, surface chemistry, surface charge, and surface area. These instruments and methods will be broadly disseminated to industry, Federal regulatory agencies, and university centers to enable researchers in these organizations to perform their own measurements on specific nanomaterials.

Data

NIST will generate sets of accurate physico-chemical properties data on key nanomaterials in relevant media such as serum and groundwater, including the short-term and long-term stability of the properties. These data are essential for industry and Federal regulatory agencies to make sound, science-based assessments of the life-cycle risks of nanomaterials and products that incorporate nanomaterials to people and the environment.

Performance Measures: Outputs

At the proposed funding level, NIST will generate the following outputs:

Environment, Health and Safety Measurements and Standards for Nanotechnology	
Technical Area	**Outputs**
Reference materials	• High-purity carbon nanotubes with reference values for nanotube length • Titanium dioxide nanoparticles with reference values for specific surface area, primary particle size, and chemical composition • Silver nanoparticles with reference values for dissolution rate in various media
Documentary standards	• ISO consensus standards for carbon nanotube measurement and characterization • Draft consensus standards through ISO and ASTM International for physico-chemical measurements of dimensions, surface area, surface charge, and chemical composition for several key nanomaterials • Reports on international inter-laboratory studies conducted through OECD and VAMAS for selected measurements on several key nanomaterials

Environment, Health and Safety Measurements and Standards for Nanotechnology	
Technical Area	**Outputs**
Instruments and methods	• Recommended practice guides for measuring nanoparticle dimension and chemical composition • Publications reviewing the applicability of instrumentation used to measure key properties of nanomaterials, including agglomeration state, surface chemistry, surface charge, and surface area. • Transferable test methods for determining the stability of key physico-chemical properties
Data	• Comprehensive data sets on the physical and chemical stability of several key nanomaterials in various media under relevant conditions such as temperature and nanoparticle concentration • Comprehensive data sets on photo-catalytic activity of nanomaterials used in paints and coatings

Performance Measures: Outcomes

At the proposed funding level, NIST will generate the following outcomes:

- Industry will be able to accurately assess the quantities, types and EHS risks of common nanomaterials used in products.
- Regulatory agencies will be able to accurately assess the quantities and types of nanomaterials in products and the environment.
- Regulatory agencies will have data to evaluate EHS effects of nanomaterials and thus enable appropriate regulation of their use.
- Consumers will be able to obtain full and accurate information concerning the EHS risks of products containing nanomaterials.
- Industrial innovation will be enabled, while appropriately limited to avoid real EHS risks.

If successful, NIST will have provide the physico-chemical data and the measurement tools to allow industry and regulatory agencies to make consistent and accurate measurements of physico-chemical properties in order to make science-based risk assessment and risk management decisions. Ultimately this will make a positive impact on the economy and society by facilitating the rapid innovation and commercialization of new nanomaterials-based products and ensuring their widespread acceptance.

9. Quantum Information Sciences (+4 Permanent Positions, +3 FTE, +$1,500,000, including $150,000 transfer to the Working Capital Fund)

"Quantum information is a radical departure in information technology, more fundamentally different from current technology than the digital computer is from the abacus."

-- William D. Phillips, NIST 1997 Nobel Laureate in Physics

By exploring and harnessing the "special" properties of the quantum realm, NIST will open the gateway to a new and powerful technological frontier. If successful, NIST's work will pave the way for:

- A quantum computer that can efficiently solve important problems that cannot be efficiently solved on electronic computers,
- Develop the foundation for next generation secure communications for our information economy,
- Enable advanced measurement capabilities that exceed classical techniques.

Problem Magnitude and NIST Role:

"Now we know that devices can be made that allow the non-intuitive quantum logic to reveal itself in practical systems. Some of the physical phenomena involved are familiar and have already been captured in applications: superconductivity, laser light, atomic clocks. It appears that these and similar phenomena can be employed to process information in a way that transcends at least some of the built-in limitations of conventional computing. Some of the "impossible" problems are known to be solvable by a large scale quantum device."

--- Letter from John H. Marburger III, Former Director Office of Science and Technology Policy, in the National Science and Technology Council report "A Federal Vision for Quantum Information Science"

Since the early 20th century we have known that the atomic, or quantum, realm works under vastly different rules than the world of our everyday experience. The ability to understand and exploit many aspects of the quantum realm led to many of the technological advances that defined the last century. Yet the quantum realm holds still more surprises, and more possibilities. Unique quantum properties that have no counterparts in our everyday world have been the most difficult aspects of the quantum world to understand. But understanding and mastering these quantum properties hold great promise for new technologies. It has only been in recent years that we have developed the capacity to create and control quantum properties in the laboratory, and it is this capacity that is opening a door to new possibilities with broad societal impact. Many of the greatest physicists believe that exploitation of these *counter intuitive* properties of nature will transform the technology of the 21st century, just as electronics transformed the technology of the 20th. However, because there are so many unanswered questions, there must be "a Federal presence to attain long-term national goals."

Researchers at NIST have been and are in the forefront of demonstrating that unique quantum properties can be created and controlled in the laboratory. These advances, which have led to three Nobel Prizes for NIST scientists, have fostered the hope of fantastic new capabilities, such as quantum computing that could efficiently solve some problems that are impossible to solve today on even the world's most powerful classical computer. NIST scientists were the first to demonstrate a quantum logic operation with "quantum bit", or "qubit", and among the first to demonstrate the principle of quantum communication. These early advances prompted NIST to begin a focused program in Quantum Information Science. That program is now the largest intramural quantum research program in

the Federal government and one of the most successful programs in the world. Now NIST scientists are hoping to push still further ahead. The ultimate goal for the NIST program is to parlay early proof-of-principle demonstrations into working components from which integrated quantum systems might be built. That this can be done is by no means certain.

The research and development steps required to realize a quantum computer can be described in analogy with those of the familiar desktop computer based on classical microelectronic circuits. The desktop computer is an integrated system built from several distinct components including a central processing unit (CPU) which functions as the brain of the computer, a temporary memory device for holding CPU instructions and data, a permanent storage device (hard drive) for holding data over the long term, input/output devices such as a keyboard, monitor, or internet connection for getting information into or out of the computer, and a communications bus for passing information between components.

NIST's previous initiatives in quantum information focused on demonstrating the most elementary function of a processing unit, a quantum logic operation on a quantum "bit", or "qubit". The classical desktop computer has a processing unit capable of processing billions of bits per second. Although a quantum computer will be very powerful while operating with far fewer logic "bits" than a classical computer, a great deal of effort is required to produce an integrated quantum processing unit with several hundred qubits. In the case of classical computing, the time between demonstration of a single logic "bit" and an integrated processor was more than two decades. Work on building a quantum processing unit with more than one qubit has been initiated with existing resources, but with the successful proof-of-principle demonstration of a few qubits, additional investment in this work to increase the rate of progress is warranted.

The realization of a quantum computer will also require the development of other components. Among these is a temporary memory capability, analogous to the random access memory (RAM) of the classical desktop computer. At present, qubits are lost relatively rapidly because of the extreme sensitivity of quantum "coherence" to external interactions. The ability to store qubits before or after a logic operation will enable more complex logic operations.

Also required for the realization of a quantum computer is some kind of communications bus that allows for the transfer of information, or qubits, between processor and memory or input/output devices. In a classical computer, this capability is achieved by the metal wires conducting electrical currents to the various devices. NIST scientists have already achieved a proof-of-principle demonstration of the quantum analogy of a communications bus through a process called "teleportation" of information. Now they must show that quantum information can be teleported reliably and quickly, and that these "quantum wires" can be incorporated into a working component.

The incorporation of input/output devices in a quantum computer will require the ability to convert qubits from one form to another. In a processor, a qubit may be an atom, ion, or solid-state system prepared in a "coherent" state. An output device will sometimes require conversion of the processor qubit into a "flying" qubit, i.e., a photon, the smallest unit of light. The analogy in the classical computer is the conversion of electrical signals in a computer to the optical signals that flow through the optical fibers of the internet. A robust, reliable conversion process requires further research.

Proposed NIST Technical Program:

In moving closer to the realization of manipulating quantum phenomena in the quest for developing new measurement techniques and technologies, NIST is proposing to further expand its quantum science program in FY 2010. Initiative funding in FY 2010 is being requested to develop a program to better understand the real power of a quantum computer, to begin a focused process of converting qubits, and on pursuing applications to few qubit devices. NIST will:

- Initiate a program to understand the class of problems that a quantum computer can efficiently solve;
- Pursue applications to exploit quantum coherence and quantum entanglement for measurement capabilities exceeding classical limitations in sensitivity and accuracy.

The funding requested in FY 2010 will enable NIST to build on and exploit the research accomplishments supported by previous requests. For instance, NIST has already demonstrated simple quantum logic operations, the basis for a quantum processor, using neutral atoms, trapped ions, and superconducting qubits. NIST has also demonstrated single photon sources and detectors, the basis of quantum communication system and the key to moving quantum information. Previous requests enabled NIST to develop quantum components and early applications of quantum information science, specifically the demonstration of a complete quantum communication system operating at speeds high enough for practical use. NIST has already demonstrated a quantum logic clock capable of serving as an improved time and frequency standard for the next generation of the Global Positioning System and in tests of fundamental physical theories. Previous requests also funded efforts for a quantum input/output device and expanded work on quantum logic operations, with the demonstration of quantum logic in a superconducting solid-state system as an alternative to trapped ions and neutral atoms; and the establishment of a Joint Quantum Institute, leveraging the interdisciplinary capabilities of NIST with those of the National Security Agency and the University of Maryland. All previous initiatives will continue at existing or increased levels in FY 2010.

What is the Real Power of a General Purpose Quantum Computer?

One of the big questions described in *"A Federal Vision for Quantum Information Science,"* a report from the National Science and Technology Council's new Subcommittee on Quantum Information Science is "What is the true power of a general purpose quantum

computer, what problems does it allow us to compute efficiently, and what does it teach us about nature?" An early understanding of this question can help foster the basic research and development process that is now being Federally coordinated. Strong evidence exists that a general purpose quantum computer should be able to simulate important quantum processes that may lead to improved drug design and the development of new improved high temperature superconducting materials. In addition in order to create new algorithms for public key infrastructure that are resistant to attacks from a quantum computer it is essential to fully understand what a quantum computer can do. NIST will initiate a focused effort to both help us understand the *real power of a general purpose quantum computer* and to improve our understanding of how to create error codes for such a computer.

Few Qubit Applications

NIST initially became involved in Quantum Information Science because of the realization by NIST's David Wineland, 2009 National Medal of Science Laureate, that by engineering exotic states of a few ions one could in principle build a more accurate atomic clock. NIST will initiate and pursue the application of few qubit devices to new measurement based capabilities including novel approaches to future atomic clocks. Again this will be the first step in expanding this application arena.

Performance Measures: Outputs

At the proposed funding level, NIST will generate the following outputs:

Quantum Information Sciences	
Technical Area	**Outputs**
Power of a general purpose quantum computer	• Improve our understanding of the problems that a quantum computer can efficiently solve • Use knowledge of the problem class that a quantum computer can solve to support a new generation of public key infrastructure that will be resistant to quantum attacks • Develop and understand quantum error correcting codes and their fault tolerant thresholds
Few qubit applications	• Exploit few qubit applications for improved clocks and improved frequency measurement • Explore other potential applications of few qubit technologies

Performance Measures: Outcomes

At the proposed funding level, NIST will generate the following outcomes:

- NIST will develop an improved understanding of the power of a general purpose quantum computer to better guide both NIST's intramural program and the U.S. national program.
- NIST will begin to bridge the gap between fundamental quantum science and new technologies by developing some of the quantum components needed for realization of a quantum device and a quantum computer.
- NIST will develop few qubit applications that are related to NIST core mission and to the Nation's fundamental measurement needs.

10. Comprehensive National Cyber Security (+13 Permanent Positions, +10 FTE, +$5,500,000 including +$350,000 transfer to the Working Capital Fund)

- Cyber security is vital to the economic and national security interests of the United States: In addition to more than $200 billion of e-commerce transactions in the U.S. alone for 2008, interconnected networks of computers are essential for life-critical functions such as air traffic control, factory operation, and electric power distribution. These networked systems face an ever-increasing threat of malicious attack from individuals, organizations, and nation states that are targeting key information technology operations and assets.
- Improving the security of the government and commercial information systems is a national priority: The Administration has declared the cyber infrastructure a strategic asset and announced its intention to establish the position of national cyber advisor reporting directly to the President. Cyber security is also a central element in legislation, including the Federal Information Security Management Act, Cyber Security & Research, Privacy Act, Sarbanes-Oxley, Gramm-Leach-Bliley, HIPPA, and Clinger-Cohen Acts.
- Advanced research is needed to ensure the Nation's ability to defend against the growing threats by sophisticated attackers: This research includes the development of scalable, affordable, flexible security approaches that average individuals can use easily and effectively to protect systems against emerging threats.

Problem Magnitude and NIST Role:

Cyber security is focused upon establishing and maintaining the three security objectives for information and information systems: confidentiality, integrity, and availability. Confidentiality preserves authorized restrictions on information access and disclosure, including means for protecting personal privacy and proprietary information. Integrity guards against improper information

modification or destruction, and includes ensuring information non-repudiation and authenticity. Availability ensures timely and reliable access to and use of information. Depending upon the nature of the system or information store, some or all of these objectives may be desired to some degree. The essential challenge of cyber security is providing appropriate levels of the right security objectives in a cost-effective manner.

While the security objectives are well understood, many of the tools and mechanisms available today were designed with yesterday's technology in mind. Information systems have evolved from physically isolated systems to highly distributed heterogeneous systems interconnected by the global internet. Operating systems are composed of millions of lines of code, rather than thousands. Information system users are now ordinary individuals, rather than information technology experts. Achieving real security in the context of today's extensively networked information systems remains an elusive goal, and even greater challenges are on the horizon. For example, many implementations of security technologies have been developed to support single applications or protocols. This has created security mechanisms that cannot scale to provide a complete security solution. Two examples are cryptographic key management and identity management solutions. In addition, the complexity of essential information technologies has compounded the problem of providing robust security environments that thwart attacks. Attackers must only find one point of penetration for success while the security practitioner must close all potential vulnerabilities in the system. This begins with operating systems that support the core of all information systems. Providing consistent core operating system configurations that can be used by ordinary individuals to support computers and other devices is an essential challenge to protecting the entire network infrastructure. Compounding this problem is the rapidly increasing degree to which systems are networked together, resulting in an ever-growing number of points of attack.

NIST has the necessary expertise and experience in fundamental security technologies such as: cryptography, risk management, biometrics, tokens, operating system security, security protocols, and authentication. In addition, NIST has experience in design usability of information systems and can establish broad based framework solutions that cut across independent, proprietary solutions. NIST has the strategic relationships with IT system developers and vendors to promote adoption of the research results.

Proposed NIST Technical Program:

This initiative focuses on four essential cyber security infrastructure elements.

Security Metrics /Mathematical Foundations

Currently there are few methods for adequately characterizing the resistance to attack for information systems. Cloud, grid, and other interconnected systems are increasingly being used to reduce cost and ease systems administration, but security is not well understood

for these systems and the interconnection protocols that are used. NIST will develop methods built on sound mathematical foundations that are needed to characterize macro-scale structure and dynamics of large-scale interconnected systems. Realistic, yet tractable, models capable of predicting the behavior of interconnected networks under stress can be used to establish metrics to estimate security, which in turn will allow researchers to predict the effect on reliability and security of changes to network components, either dynamically or for long-term planning.

Quantum-resistant Public Key Infrastructure and Protocols

NIST and other research organizations are working toward implementation of quantum computers, that is, computers based on exotic properties of quantum mechanics that enable vastly more computing power than is attainable today. If a quantum computer can be built, it will be possible to break all public key algorithms that are used today for electronic commerce and other critical applications. A few algorithms have been proposed that would not be breakable by a quantum computer, but these have not been studied thoroughly and their properties are not well understood. NIST will evaluate proposed quantum-resistant public key algorithms and work towards new algorithms. For some key distribution applications, symmetric (i.e., non-public key) algorithms exist that provide quantum resistance if longer keys are used. NIST will analyze modifications needed for protocols that use symmetric key algorithms to make them quantum-resistant.

Virtualization for Isolation of Inbound Traffic

Operational networks need to appropriately separate incoming data from external networks according to security requirements, including the risks that the data poses to the network and the sensitivity of the information carried. There would be many practical advantages to using virtualization technology to provide needed separation between different classes of data that have been received from external networks. Virtualization allows rapid and dynamic adjustment of system resources as well as use of feature-rich legacy software. It is not known, however, whether virtualization boundaries can withstand concerted attack. If virtualization techniques can be made strong enough, this would enable enterprises to allow, for example, law enforcement officers and first responders to safely process data of different sensitivity levels. NIST will develop methods to measure the effectiveness of the high assurance virtualized platforms in preventing information leakage from a trusted secure computing environment to an open general purpose environment running on the same general purpose physical hardware. Using a single physical system to host various virtualized computing environments at different sensitivity levels promises substantial management flexibility, allowing systems to dynamically adapt to network load and security requirements. A secondary benefit would be substantial reductions in the consumption of electrical power across the enterprise because of the reduction in the physical hardware and supporting infrastructure needed to satisfy network demand.

Usability of Security

Usability is an often overlooked but critical component of cyber security. There is a belief that there is an inherent tradeoff between cyber security and usability. Computers can be theoretically secure but so unusable that they do not improve the security because users are forced to perform in less secure ways. The opposite is true as well; systems that are usable and not secure are eventually unusable due to worms, viruses, and botnets. The usability principles of efficiency, effectiveness and user satisfaction must be incorporated in order to ensure that it is easy for users to do the right thing and hard for them to do the wrong thing. NIST will work with industry to develop usability and security metrics, facilitate integration of usability principles into product design processes, and lead research projects to investigate methods for aligning user goals with organizational security goals.

Performance Measures: Outputs

At the proposed funding level, NIST will generate the following outputs:

Comprehensive National Cyber Security	
Technical Area	**Outputs**
Security metrics / mathematical foundations	• Metrics to characterize macro-scale structure and dynamics of large-scale interconnected systems. • Models capable of predicting emergent collective behavior. • Diagnostics for identifying impending macro-scale change in system behavior.
Quantum-resistant asymmetric cryptography	• Adaptation of symmetric-key cryptosystems and protocols to provide resistance to quantum attack. • Explore development of a new generation of asymmetric cryptography for quantum-resistant protocols.
Virtualization for isolation of inbound traffic	• Methods to measure the effectiveness of the high assurance virtualized platforms in preventing information leakage from a trusted secure computing environment. • Practical tools to implement processing of security rules in a virtualized environment.
Usability of security	• Measurement and testing methods to evaluate usability of security systems and products. • Methods for incorporating usability into the software and hardware development cycle. • Study of the intersection between user goals and organizational security goals.

Performance Measures: Outcomes

At the proposed funding level, NIST will generate the following outcomes:

Comprehensive Cyber Security	
Technical Area	**Outcomes**
Security metrics / mathematical foundations	• Understanding of the effects of the resistance to attack for emerging information systems architectures such as cloud computing and highly interconnected networks. • Ability to dynamically predict the behavior of interconnected networks under stress.
Quantum-resistant asymmetric cryptography	• Continued security of e-commerce and other applications despite advances in quantum computing.
Virtualization for isolation of inbound traffic	• Enterprises will have practical and cost-effective technology to safely process data from diverse applications of different sensitivity levels. • Reductions in the consumption of electrical power across enterprises using the technology.
Usability of security	• Measurable improvements in the usability of security systems and technologies. • Greater alignment of organizational workflow and security processes.

11. Quantum-Based Measurements (+13 Permanent Positions, +10 FTE, +$4,891,000, including $800,000 transfer to the Working Capital Fund)

"What would happen if we could arrange the atoms one by one the way we want them ... When we get to the very, very small world---say circuits of seven atoms---we have a lot of new things that would happen that represent completely new opportunities for design. Atoms on a small scale behave like nothing on a large scale, for they satisfy the laws of quantum mechanics. So, as we go down and fiddle around with the atoms down there, we are working with different laws, and we can expect to do different things. We can manufacture in different ways."

--From Richard Feynman's 1959 *"Plenty of Room at the Bottom"* speech

The continued march forward to develop more compact technology has naturally moved us from the everyday, *classical world* to the *quantum world* and toward fulfilling the vision of Richard Feynman. The quantum world describes the everyday world at the atomic scale, from electrons and photons to atoms and molecules. To the general public, the birth of the quantum world is often associated

with revolutions in theoretical physics by Albert Einstein. In reality, it underlies many of the 20th century's technological advances including most of our modern electronic technologies. It is this capacity to exploit the strange capabilities of the quantum world that is opening a door to new possibilities with broad societal impact in areas such as the design and development of new pharmaceutical drugs, the creation of new materials for more efficient solar cells and near lossless energy storage and transmission, and the creation of improved sensors for applications from GPS positioning and navigation to the discovery of minerals and oil deposits. Some of the greatest physicists of our time believe that exploitation of these *counter intuitive* properties of nature will transform the technology of the 21st century just as electronics and information processing transformed the technology of the 20th. Because there are so many unanswered questions in the new quantum world, a Federal presence to attain long-term national goals is required. As a result the National Science and Technology Council (NSTC) through its Committee on Technology established the Subcommittee for Quantum Information Science (SQIS).

NIST will take further steps to prepare for a new quantum world where new quantum devices allow us to do things not currently feasible with existing technology. NIST goals are to create the basis for a natural set of units where quantum based measurements of time, charge and light can be tied to the macroscopic units on which the International System of Units (the metric system) is currently based. If successful in this endeavor, NIST will:

- create tools for manipulating and controlling quantum systems;
- develop the foundation for engineering complex quantum devices with improved quantum materials; and
- exploit precision quantum measurements to improve our understanding of the underlying laws of nature.

With these new capabilities, NIST will be developing the measurement tools and capabilities that will eventually be required to evolve quantum mechanics and quantum information science into a basis for 21st century technology, thereby supporting the American COMPETES Act. This drive to exploit the quantum world responds directly to the National Academies' report *Controlling the Quantum World: The Science of Atoms, Molecules and Photons*[23] and to the National Science and Technology Councils' recent document from the SQIS *A Federal Vision for Quantum Information Science*[24], in addition to addressing the need for new approaches to quantum-based measurement capabilities. Our effort includes expanding and coordinating our collaborations and interactions – including the Joint Quantum Institute, JILA, Sandia (DoE), the National Security Agency (NSA), and Intelligence Advanced Research Projects Activity (IARPA). This initiative, presented in three major integrated themes, builds upon current NIST expertise in this area.

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[23] *Controlling the Quantum World: The Science of Atoms, Molecules, and Photons*; National Academies Press: Washington, D.C., 2007.
[24] *A Federal Vision for Quantum Information Science*; National Science and Technology Council: Washington, D.C., 2008.

Problem Magnitude and NIST Role:

This initiative proposes to introduce and expand work in key technical areas that are crucial to exploiting the quantum world, preparing for a new measurement system tied to fundamental quantum properties, making key precision measurements essential to the new measurement system, and developing the measurement tools essential to control at the quantum limit. The realization of sophisticated quantum devices requires development of numerous components from quantum memory to quantum wires to a quantum processor. Making and controlling these devices is complicated in part because of the extreme fragility of basic units of quantum information known as quantum "bits" or "qubits", whether they be individual dopant atoms, single electrons, or some other characteristic quantum object. As a result, we need to create (1) improved quantum materials capable of overcoming the inherent fragility of qubits, and (2) robust quantum control systems for manipulating and transforming the excitations of these quantum objects. Applying our ability to precisely control quantum systems will also allow us to make precision measurements of some of the quantum world's most fundamental processes and constants. This *small physics* approach to testing fundamental aspects of nature (space and time) appears to provide an inexpensive alternative to the *big physics* experiments being explored by our sister agencies – the National Aeronautics and Space Administration (NASA) and the Department of Energy (DoE) – to test the most basic theories of the universe These problems are some of the challenging next steps that must be addressed in order to take advantage of previous scientific breakthroughs.

Researchers at NIST are at the forefront in demonstrating the rudimentary capabilities for exploiting the quantum world. These advances, which have led to three Nobel Prizes for NIST scientists, have fostered the hope of fantastic new capabilities, such as quantum computing with vastly superior power compared to today's computers, and quantum devices capable of sensing magnetic fields or measuring time at levels of precision heretofore unimagined. With previous investment in this area, NIST scientists were the first to demonstrate a quantum logic operation with a "qubit" and have used their expertise to engineer the most sensitive single photon detector ever built. Based on these early advances NIST has developed one of the largest intramural quantum research programs in quantum and quantum information science within the Federal government and one of the most successful programs in the world. NIST scientists are now poised to create the broad measurement science needed to push these preliminary breakthroughs to a point where early engineering breakthroughs might become possible. As part of this initiative NIST plans to expand its interactions and coordination with other U.S. government agencies, national laboratories, and academic institutions to help ensure U.S. competitiveness as this basic research begins to provide the tools that will allow us to advance from science and basic research to future technologies.

Proposed NIST Technical Program:

This initiative focuses on three key research thrusts that will further create the broad scientific basis for future exploitation of the quantum world. First, NIST will significantly enhance its current effort to create the tools for the control of quantum systems

ultimately needed for manipulating, transforming, and moving quantum information in quantum devices. Second, NIST will initiate a focused effort to develop improved quantum materials and reproducibly test their properties. Characterization of the quality and uniformity of these quantum materials will rely on many of our new control tools developed in the first capability. Finally, NIST will apply the tools developed for our control and understanding of the quantum world to test the very nature of space and time in order to further our understanding of both the universe and the ultimate limits of the new technology that will result from these quantum tools and systems. This new technology is key to creating a quantum based measurement system that will help redefine the International System of Units by relating unvarying quantum properties to the macroscopic measurements of time, length, charge, light, and temperature. If we are successful we will be able to connect the macroscopic and quantum measurement scales, put severe constraints on the potential theories for unifying gravity and quantum mechanics, and develop quantum based measurement tools that are more precise than the best classical tools. Success here will support the future metrology required to build smaller and faster devices with potential applications from new computational paradigms to greatly improved imaging technology.

Quantum Control

Improved control of quantum systems is a key enabling technology that allows us to exploit them. In order to pave the way for building a quantum device or a quantum computer that will be able to controllably simulate arbitrarily complex quantum systems, we need to develop the control tools for manipulating individual or small numbers of qubits. Creating these control tools will allow us to improve both the underlying quality of rudimentary quantum operations, as well as to remove some of the environmental fragility of the qubits. Using these new tools along with our ability to manipulate individual qubits such as atoms, NIST will perform complicated analog quantum simulations of complex quantum systems. In doing so, we will attempt to find a solution to a quantum problem that no classical computer is capable of simulating. Success here could also lead to breakthroughs in the design of new materials for high temperature superconductivity, thereby realizing an old dream and addressing a key challenge relevant to both energy and the environment.

Other new tools based on key enabling technologies, such as femtosecond lasers and frequency combs, will be used to characterize and control the effects of environmental fragility of quantum systems, such as superconducting qubits and quantum dots, to manipulate atomic qubits, and transform pairs of atoms into a molecule – the first step for demonstrating complete control of a basic chemical reaction. We will also use our ability to control and entangle qubits along with comb technology to both improve our ability to measure and to transmit time.

As with classical information, transformation and transmission of quantum information is essential for building useful integrated quantum devices. The demonstration of a practical quantum computer requires some kind of communications bus that allows for the transfer of information between processor and memory or input/output devices. In today's computers, this capability is achieved by

the metal wires conducting electrical currents to the various components. In quantum systems, the coupling to photonic crystals and high finesse cavities will provide new pathways for interconnecting two or more quantum systems, for controlling the quantum systems, and for converting a material excitation into a photonic excitation thereby enabling the transmission of information. NIST will thus explore numerous approaches to the transformation, control, and transmission of quantum information.

Future work will extend theses efforts to the miniaturization of these control tools and to the creation of technologies for use as magnetometers and gravimeters opening up new measurement frontiers in areas such as medicine and mineral exploration. We also plan to develop new types of microscopes for improved nanometer characterization of quantum nanostructures, and the tools for the precision atomic doping of a host material. These new tools require new means for placing dopants at nanometer to sub-nanometer accuracy with separations between individual dopants being a 100 to 1000 times larger. Future work will also use our control and ability to count and manipulate individual photons and electrons to connect the quantum scale for light and charge to the macroscopic scale for light, charge, and current. The ability to robustly detect single photons also has potential applications to the *in situ* detection of biomarkers for cancer detection applications. The efforts to count photons and electrons are essential since the basic units of light and charge at the quantum limit must be consistently related to the macroscopic units that are the basis for modern commerce. Failure to create this connection will mean that our quantum based units cannot be precisely related to the macroscopic world that we use every day.

Quantum Materials

In contrast with naturally occurring qubits such as atoms, ions and photons, a quantum material is an artificial atom that requires fabrication. Whereas naturally occurring qubits tend to provide good isolation from their environment (*i.e.*, very long coherence times) and appear optimal for quantum memory, artificial atoms perform elementary operations much faster. The problem is that nature's ideal qubits do not appear best suited for high speed operation and manufacturing, while artificial atoms (*e.g.*, superconducting qubits, single electron transistors, and quantum dots), which are better suited to those functions, suffer significant degradation because of the complex material environment in which they sit. Improved quantum materials will allow us to assess which potential quantum systems may lead to future breakthroughs for quantum technologies and allow us to understand what essential material characteristics are required in an integrated device. The ability to interconvert quantum information between various types of qubits will enable the development of more complicated quantum devices that use optimal qubits for things like memory, communication, and processing. For example, one promising quantum material candidate is microfabricated superconducting (SC) circuits. However, the materials from which the SC circuit is constructed have not yet been optimized to maintain quantum coherence for long times. In particular, SC circuits have evolved to rely on thin insulating layers of material. However, we know that these layers lead to loss of coherence in the SC circuits. NIST plans to explore alternative fabrication techniques that will remove these layers and replace them with materials that should provide significantly better coherence times. Similarly, focused development of quantum dots in well patterned arrays or

with specific single atom doping may produce artificial atoms with extended coherence times and significantly improved performance. In addition to these efforts, NIST will explore controlled single ion implant techniques that use on demand single ion sources to dope materials. We will explore new classes of quantum materials such as doped graphene sheets and doped silicon wires for creating charge based single electron qubits using single electron transistors. The creation of precision doped materials requires the development of new measurement tools for placing atoms at atomically defined, subnanometer locations and thereby pushes the accuracy of current length metrology. We will also plan to develop new microscopies that can characterize these quantum materials at the level where their quantum properties are affected. Each material effort and the corresponding tools for characterization require a large investment in equipment and manpower and thus we will initiate one or two such efforts each year.

Precision Measurements and Tools for Improved Metrology in the Quantum World

The development of new quantum control tools creates the possibility of placing fundamental limits on our understanding of the nature of space and time, thereby helping us to better understand our universe. The basic exploration of the universe is often done through large scale science by our sister agencies NASA and DoE. However, in some cases we can answer basic questions of the fabric of space and time at a fraction of the cost and with different systematics by making very precise measurements of fundamental constants and fundamental processes. The tools we are developing above, along with existing capabilities at NIST, will be used to make precision measurements of the fine structure constant (α), the Rydberg constant (R_∞), Planck's constant (h), the Boltzmann constant (k_B), the electric dipole moment, and the time variation of the fine structure constant. We have selected these particular constants and fundamental processes because our approach to these problems complements those of our sister agencies and because of their important role in ensuring the self-consistency of the U.S. and world's measurement system.

It is crucial that our measurements of time, length, charge, light, and temperature are sufficiently precise that we can make them at the quantum limit yet remain fully consistent with the macroscopic measurement scales typical of our everyday world. Thus, we must be able to connect these measurement scales that are increasingly being tested as we require ever more precise measurements for our efforts to build smaller and faster devices. Pursuing these precision measurements both uses the new tools we develop and pushes these tools to their ultimate performance. At the quantum limit the fundamental constants create the basis for a set of natural units.[25] Measuring these constants and fixing their values in our everyday (macroscopic) units is essential if we are to create the level of precision and internal consistency necessary to build and manufacture things reliably in the quantum world. The first step towards this process was taken in 1983 when the meter was redefined in terms of the second and a fixed value of the speed of light. This initiative will strategically develop both the measurement tools and the precision measurements needed to transform our measurement system from a macroscopic classical system to a macroscopic quantum based system by fixing additional fundamental constants, thereby

[25] http://en.wikipedia.org/wiki/Natural_units

creating a natural units basis for our macroscopic units. In some cases the quantum limit places discrete limits on these values since electrons and photons come one at a time and not in fractional numbers. As with other parts of this initiative, we will initiate the various efforts based on a multiyear investment strategy.

Performance Measures: Outputs

At the proposed funding level, NIST will generate the following outputs:

Quantum-Based Measurements	
Technical Area	**Outputs**
Quantum control	• Combine control of light from femtosecond combs with laser cooling and trapping of atoms to transform atom pairs to molecules – the first step in controlling chemical reactions. • Perform quantum analog simulations of condensed matter physics problems – *i.e.* simulate a quantum problem that is impossible to simulate classically. • Develop interconnects to allow quantum information transmission by coupling superconductive qubits to high finesse cavities. • Use the control tools to improve our ability to disseminate time.
Quantum materials	• Create artificial atoms using low loss, high fidelity materials. • Develop new quantum materials such as doped sheets and wires, including doped graphene sheets for spin-based quantum computing.
Precision measurements & tools	• Measurement of the Rydberg and fine structure constant. • Johnson noise thermometry for determination of the Boltzmann constant.

Performance Measures: Outcomes

At the proposed funding level, NIST will generate the following outcomes:

- The development of improved quantum materials will allow us to assess which potential quantum systems may lead to future breakthroughs and allow us to understand what essential material characteristics are required in an integrated device and to enable significantly higher performance quantum information processing systems to be built.

- The ability to interconvert quantum information between various types of qubits will enable the development of more complicated quantum devices that use optimal qubits for things like memory, communication, and processing.
- Precision measurement of the fundamental constants and fundamental processes allows for alternative approaches for testing the nature of space and time thereby complementing efforts by our sister agencies (NASA, DoE).
- The development of quantum-based measurements and standards provides a self-consistent, interconnected system of metrology that is immune to drift of standards and provides a firmer basis for international comparability of measurements.
- The existing and anticipated NIST collaborations, including those through the Joint Quantum Institute and JILA, in conjunction with the NIST Research Associateships Program, will help to create a supply of highly trained experts to support a future workforce in this evolving research area.

Department of Commerce
National Institute of Standards and Technology
Scientific and Technical Research and Services
PROGRAM CHANGE PERSONNEL DETAIL
(Dollars in thousands)

Activity: National measurement and standards laboratories
Subactivity: National measurement and standards laboratories
Program Change: President's plan for science and innovation

Title	Grade	Number	Annual Salary	Total Salaries
Chemist	ZP V	3	120,830	362,490
Computer scientist	ZP V	7	120,830	845,811
Economist	ZP V	1	120,830	120,830
Electrical engineer	ZP V	1	120,830	120,830
Electronics engineer	ZP V	2	120,830	241,660
Materials scientist	ZP V	1	120,830	120,830
Mathematician	ZP V	2	120,830	241,660
Mechanical engineer	ZP V	1	120,830	120,830
Metallurgist	ZP V	1	120,830	120,830
Physical scientist	ZP V	2	120,830	241,660
Physicist	ZP V	6	120,830	724,981
Radiologist	ZP V	1	120,830	120,830
Social scientist	ZP V	1	120,830	120,830
Biochemist	ZP IV	1	102,721	102,721
Biologist	ZP IV	2	102,721	205,442
Chemical engineer	ZP IV	2	102,721	205,442
Chemist	ZP IV	9	102,721	924,489
Cognitive scientist	ZP IV	1	102,721	102,721
Computational scientist	ZP IV	1	102,721	102,721
Computer scientist	ZP IV	4	102,721	410,884
Economist	ZP IV	1	102,721	102,721
Electrical engineer	ZP IV	3	102,721	308,163
Electronics engineer	ZP IV	2	102,721	205,442
Engineer	ZP IV	1	102,721	102,721
Industrial engineer	ZP IV	1	102,721	102,721
Information specialist	ZP IV	1	102,721	102,721
Materials research engineer	ZP IV	7	102,721	719,047
Materials scientist	ZP IV	2	102,721	205,442

Title	Grade	Number	Annual Salary	Total Salaries
Mathematician	ZP IV	6	102,721	616,326
Mechanical engineer	ZP IV	3	102,721	308,163
Metallurgist	ZP IV	2	102,721	205,442
Physical scientist	ZP IV	6	102,721	616,326
Physicist	ZP IV	19	102,721	1,951,699
Statistician	ZP IV	1	102,721	102,721
Biomedical engineer	ZP III	2	73,100	146,199
Chemist	ZP III	6	73,100	438,598
Computer scientist	ZP III	3	73,100	219,299
Electrical engineer	ZP III	2	73,100	146,199
Electronics engineer	ZP III	2	73,100	146,199
Engineering technician	ZT IV	1	73,100	73,100
Information specialist	ZP III	1	73,100	73,100
Materials research engineer	ZP III	2	73,100	146,199
Materials scientist	ZP III	2	73,100	146,199
Mechanical engineer	ZP III	3	73,100	219,299
Metallurgist	ZP III	1	73,100	73,100
Physical scientist	ZP III	8	73,100	584,798
Physicist	ZP III	9	73,100	657,897
Administrative/technical support	ZA II	12	50,408	604,891
Electronics engineer	ZP II	2	50,408	100,815
Secretary	ZS III	1	37,084	37,084
Subtotal		161		15,021,126 [1]
Less lapse	25 %	(39)		(3,755,282)
Total full-time permanent (FTE)		122		11,265,844
2010 Pay Adjustment (2.0%)				225,317
Total				11,491,161

Personnel Data	
Full-Time Equivalent Employment:	
Full-time permanent	122
Authorized Positions:	
Full-time permanent	161

[1] Subtotal off by $3 (dollars in thousands) due to rounding.

Exhibit 15

Department of Commerce
National Institute of Standards and Technology
Scientific and Technical Research and Services
PROGRAM CHANGE DETAIL BY OBJECT CLASS
(Dollars in thousands)

Activity: National measurement and standards laboratories
Subactivity: National measurement and standards laboratories
Program Change: President's plan for science and innovation

Object Class		2010 Increase/ (Decrease) Obligations
11	Personnel compensation	
11.1	Full-time permanent	$11,491
11.9	Total personnel compensation	11,491
12.1	Civilian personnel benefits	3,111
21	Travel and transportation of persons	2,134
22	Transportation of things	466
23.3	Communications, utilities and miscellaneous charges	3,865
24	Printing and reproduction	76
25.1	Advisory and assistance services	0
25.2	Other services	8,728
25.3	Purchases of goods and services from Government accounts	2,844
25.5	Research and development contracts	6,865
25.7	Operation and maintenance of equipment	1,049
26	Supplies and materials	2,798
31	Equipment	2,789
32	Land and structures	350
41	Grants, subsidies and contributions	7,385
99	Direct obligations	53,951
	Transfer to NIST Working Capital Fund	5,940
	Total increase requested	59,891

Department of Commerce
National Institute of Standards and Technology
National Measurement and Standards Laboratories
REIMBURSABLE PROGRAM AND WORKING CAPITAL FUND INVESTMENTS
(Dollar amounts in thousands)

	FY 2008 Actual	FY 2009 Estimate	FY 2010 Estimate
Department of Defense			
Air Force	$12,592	$12,592	$8,340
Army	2,492	2,492	1,776
Navy	1,516	1,516	975
Other	11,130	11,130	9,525
Subtotal, Department of Defense	27,730	27,730	20,616
Department of Agriculture	185	185	200
Department of Commerce	10,864	10,864	11,021
Department of Energy	5,705	5,705	4,400
Department of Health & Human Services	6,904	6,904	7,103
Department of Homeland Security	33,834	33,834	25,701
Department of the Interior	114	114	50
Department of Justice	14,670	14,670	14,668
Department of State	333	333	16
Department of Transportation	1,001	1,001	25
Department of the Treasury	33	33	25
Department of Veterans Affairs	139	139	165
Environmental Protection Agency	1,776	1,776	1,346
General Services Administration	268	268	753
National Aeronautics & Space Administration	3,821	3,821	4,373
National Science Foundation	5,382	5,382	3,334
Nuclear Regulatory Commission	532	532	50
Other	8,392	8,392	4,826
Subtotal, Federal Agencies	121,683	121,683	98,672
Calibrations & Testing	9,374	9,489	9,600
Technical & Advisory Services	25,528	22,332	24,264
Standard Reference Materials	10,091	12,251	12,566
Subtotal, Other Reimbursables	44,993	44,072	46,430
Total, Reimbursable Program	166,676	165,755	145,102
Equipment Transfers	0	2,275	6,190
Subtotal, WCF transfer	0	2,275	6,190
Equipment Investments	16,281	17,767	17,767
IE Amortization	(20,415)	(18,230)	(17,767)
WCF Operating Adjustments	(1,344)	0	0
Total, WCF Investments	(5,478)	(463)	0
Total, Reimbursable Program and WCF Investments	161,198	167,567	151,292

Department of Commerce
National Institute of Standards and Technology
Scientific and Technical Research and Services
PROGRAM AND PERFORMANCE: DIRECT OBLIGATIONS
(Dollar amounts in thousands)

Activity: Innovations in measurement science
Subactivity: Innovations in measurement science

Line Item		2008 Actual		2009 Currently Available		2010 Base		2010 Estimate		Increase/ (Decrease) Over 2010 Base	
		Personnel	Amount	Personnel	Amount	Personnel	Amount	Personnel	Amount	Personnel	Amount
Innovations in measurement science	Pos./Approp	88	$19,888	88	$19,888	88	$20,175	88	$20,175	0	0
	FTE/Obl.	86	19,938	93	20,791	93	20,199	93	20,199	0	0

Department of Commerce
National Institute of Standards and Technology
Scientific and Technical Research and Services
JUSTIFICATION OF PROGRAM AND PERFORMANCE
INNOVATIONS IN MEASUREMENT SCIENCE PROGRAM

Goal Statement

This activity supports DoC's and NIST's mission of promoting U.S. innovation and industrial competitiveness by advancing measurement science, standards, and technology that drive technological change.

Base Program

NIST must maintain the capacity to contribute effectively to future national needs and goals by investing in high-risk, high-payoff research to enable innovation.[1] This program provides funding for high priority fundamental research to build new capabilities necessary to develop and maintain state-of-the-art knowledge in areas of science and engineering related to measurement techniques and fundamental data. The capacity to respond is based on the availability of teams of scientists and engineers, working at the forefront of research in various areas related to future advanced technologies, who have the ability to devote their efforts to specific, new problems as they arise.

Projects previously undertaken in this program have resulted in focused areas for new program development. *In the past, all three of NIST's Nobel Prizes began with work funded by the Innovations in Measurement Science (IMS) Program.* One successful new effort established as a result of the IMS program is the Testbed for Combinatorial Methods. The demonstration of sound infrastructure technologies and next-generation measurement platforms to rapidly screen and analyze performance of polymer thin films attracted strong industrial and institutional support that led to the establishment in 2002 of a new type of "non-proprietary" consortium, the NIST Combinatorial Methods Center (NCMC), and a Department of Commerce Silver Medal in Customer Service. To date over 30 institutions have been served by this consortium, and this cross-cutting technology has been successfully transferred to companies such as Air Products, Dow, National Starch, Intel, Boston Scientific, and Proctor and Gamble, accelerating innovation in products as diverse as microelectronics fabrication, packaging, and hydrogels like contact lenses. The wide impact is also illustrated by over 650

[1] *Called for in Rising Above the Gathering Storm, National Academies Report.*

literature citations and over 200 national and international presentations. The NCMC is poised to provide measurement solutions for fresh industrial challenges in the emerging areas of nanostructured materials, organic electronics, energy, and fuel materials.

The FY 2010 base program operating objectives for the Innovations in Measurement Science Program include the following:

- select and initiate several new exploratory projects through a competitive review process, and
- continue to support for a maximum of five years existing projects that build NIST's research capabilities and technical readiness to address state-of-the-art measurement and standards opportunities and needs.

Performance Measures

Data on NIST programmatic performance evaluation and reporting are provided in Exhibit 3A of this budget request.

Department of Commerce
National Institute of Standards and Technology
Innovations in Measurement Science
REIMBURSABLE PROGRAM AND WORKING CAPITAL FUND INVESTMENTS
(Dollar amounts in thousands)

	FY 2008 Actual	FY 2009 Estimate	FY 2010 Estimate
Total, Reimbursable Program	0	0	0
Subtotal, WCF transfer	0	0	0
Equipment Investments	$7,261	$3,228	$3,228
IE Amortization	(59)	(3,311)	(3,228)
Total, WCF Investments	7,202	(83)	0
Total, Reimbursable Program and WCF Investments	7,202	(83)	0

Department of Commerce
National Institute of Standards and Technology
Scientific and Technical Research and Services
PROGRAM AND PERFORMANCE: DIRECT OBLIGATIONS
(Dollar amounts in thousands)

Activity: Next generation measurements training
Subactivity: Postdoctoral research associates program

		2008 Actual		2009 Currently Available		2010 Base		2010 Estimate		Increase/ (Decrease) Over 2010 Base	
Line Item		Personnel	Amount	Personnel	Amount	Personnel	Amount	Personnel	Amount	Personnel	Amount
Postdoctoral research associates program	Pos./Approp	91	$10,484	91	$32,784	91	$11,030	91	$11,030	0	0
	FTE/Obl.	88	10,565	132	32,936	94	11,047	94	11,047	0	0

Department of Commerce
National Institute of Standards and Technology
Scientific and Technical Research and Services
JUSTIFICATION OF PROGRAM AND PERFORMANCE
NEXT GENERATION MEASUREMENTS TRAINING

Goal Statement

This activity supports DoC's and NIST's mission of promoting U.S. innovation and industrial competitiveness by advancing measurement science, standards, and technology that drive technological change.

Base Program

Postdoctoral Research Associates Program - NIST supports a nationally competitive Postdoctoral Research Associates Program, which is administered in cooperation with the National Research Council (NRC). The Postdoctoral program recruits outstanding research scientists and engineers to work on NIST research projects, strengthens communications with university researchers, and provides a valuable mechanism for the transfer of research results from NIST to the scientific and engineering communities. In 2007, an independent evaluation of the program was carried out by the National Academy of Sciences[1]. Data was taken from the more than fifty year history of the NIST NRC postdoctoral program. In the report, the results confirm that outreach efforts have produced more qualified applicants than NIST had slots to fill for Research Associates[2] and that the pool of applicants includes many from top research institutions. The report results also confirmed that research associates contribute to the pool of qualified applicants to permanent positions at NIST.

The FY 2010 base program operating objectives for the Postdoctoral Research Associates Program include the following:

- select postdoctoral scientists and engineers of exceptional promise and ability for two-year appointments to perform advanced research related to the NIST mission, and

[1]Approaches for Evaluating the NRC Resident Research Associateship Program at NIST, The National Academies Press, 2007.

[2] Prior to August 2007, the ceiling for the number of NIST NRC Postdoctoral Research Associates was 60 per year; this ceiling has now been increased to 120 per year, although the budgetary support for centrally-funded research associates was not increased.

- introduce the latest university research results and techniques to NIST technical programs and share NIST's unique research capabilities with the U.S. scientific and engineering communities.

Performance Measures

Data on NIST programmatic performance evaluation and reporting are provided in Exhibit 3A of this budget request.

Department of Commerce
National Institute of Standards and Technology
Postdoctoral Research Associates Program
REIMBURSABLE PROGRAM AND WORKING CAPITAL FUND INVESTMENTS
(Dollar amounts in thousands)

	FY 2008 Actual	FY 2009 Estimate	FY 2010 Estimate
Total, Reimbursable Program	0	0	0
Subtotal, WCF transfer	0	0	0
Equipment Investments	0	$72	$72
IE Amortization	0	(74)	(72)
Total, WCF Investments	0	(2)	0
Total, Reimbursable Program and WCF Investments	0	(2)	0

Department of Commerce
National Institute of Standards and Technology
Scientific and Technical Research and Services
PROGRAM AND PERFORMANCE: DIRECT OBLIGATIONS
(Dollar amounts in thousands)

Activity: Baldrige national quality program
Subactivity: Baldrige national quality program

Line Item		2008 Actual		2009 Currently Available		2010 Base		2010 Estimate		Increase/ (Decrease) Over 2010 Base	
		Personnel	Amount	Personnel	Amount	Personnel	Amount	Personnel	Amount	Personnel	Amount
Baldrige national quality program	Pos./Approp	51	$7,927	57	$9,440	57	$9,608	57	$9,608	0	0
	FTE/Obl.	50	8,402	56	9,489	59	9,627	59	9,627	0	0

Department of Commerce
National Institute of Standards and Technology
Scientific and Technical Research and Services
JUSTIFICATION OF PROGRAM AND PERFORMANCE
BALDRIGE NATIONAL QUALITY PROGRAM

Goal Statement

This activity supports DoC's and NIST's mission of promoting U.S. innovation and industrial competitiveness by advancing measurement science, standards, and technology that drive technological change.

Base Program

The program has, as its foundation, the Malcolm Baldrige National Quality Award (MBNQA), created by P.L. 100-107 in August 1987. In 1999, the award was expanded to include categories in education and health care as authorized by the Technology Administration Act of 1998 (P.L. 105-309). In October 2004, Congress expanded the award to include all nonprofit organizations, including Federal, state, and local governments (P.L. 108-320). Funds were appropriated in fiscal year 2006 for this purpose. The Baldrige program conducted a pilot project for the nonprofit category in fiscal year 2006 and launched the full category in fiscal year 2007. The Baldrige Award has proven to be highly effective in stimulating interest in performance improvement, performance excellence, sharing and cooperation, and creation of new information networks within the business community and the public benefit sectors. With the program's expansion to the nonprofit sector, all American organizations are now able to receive these benefits.

NIST responsibilities under P.L. 100-107, P.L. 105-309, and P.L. 108-320 are carried out by the Baldrige National Quality Program (BNQP). The program continues to build key linkages with other organizations and provide limited educational outreach services. U.S. businesses and non-profit organizations throughout the country are now turning to NIST for leadership in performance improvement. The BNQP aims to improve its leadership as a focal point and educational resource for all U.S. organizations interested in improving their competitiveness and overall performance.

The program's design and operational strategy is three-fold: 1) to create a standard for performance excellence that fosters communication and sharing among organizations of all types (e.g., business, education, health care, and nonprofit/government); 2) to build networks and other key linkages with external organizations to promote performance excellence, quality, and competitiveness

throughout the United States; and 3) to build on the success of the present program by sharing lessons learned from recipient organizations in the business, education, health care, and nonprofit sectors with other organizations, thereby accelerating the process of performance improvement.

The FY 2010 base program operating objectives for the Baldridge National Quality Program include the following:

- assess the impact of the changes made to the 2009-2010 Criteria for Performance Excellence including the new emphasis on sustainability and societal responsibility, understanding of core competencies, and the development of a customer focused organization,
- implement the MBNQA competition, including examiner selection, examiner training, and application review, to provide services to applicants in manufacturing, service, small business, education, health care, and nonprofit categories,
- conduct the Quest for Excellence Conference and Baldrige Regional Conferences where MBNQA recipients share their performance excellence strategies,
- strengthen collaboration and information sharing with state and local quality award programs;
- facilitate information sharing among all sectors of the U.S. economy through partnerships with key business, education, health care, and nonprofit organizations, and
- use e-technology (e.g., e-learning and online collaborative tools) to provide improved services to Baldrige stakeholders while maintaining confidentiality and security of stakeholder information.

Performance Measures

The BNQP evaluates its performance through a combination of methods, including independent expert review of all aspects of the program's plans and operations by its Board of Overseers, analysis of input from all key stakeholder groups, and review of output and outcome measures focused on the program's operational strategy, increasing participation in the MBNQA, promoting awareness of performance excellence throughout the United States, and improving the efficiency and effectiveness of all key program processes.

Department of Commerce
National Institute of Standards and Technology
Baldrige National Quality Program
REIMBURSABLE PROGRAM AND WORKING CAPITAL FUND INVESTMENTS
(Dollar amounts in thousands)

	FY 2008 Actual	FY 2009 Estimate	FY 2010 Estimate
Technical & Advisory Services	0	$3,500	$3,500
Subtotal, Other Reimbursables	0	3,500	3,500
Total, Reimbursable Program	0	3,500	3,500
Subtotal, WCF transfer	0	0	0
Equipment Investments	$51	41	41
IE Amortization	(29)	(42)	(41)
Total, WCF Investments	22	(1)	0
Total, Reimbursable Program and WCF Investments	22	3,499	3,500

Department of Commerce
National Institute of Standards and Technology
Scientific and Technical Research and Services
PROGRAM AND PERFORMANCE: DIRECT OBLIGATIONS
(Dollar amounts in thousands)

Activity: Corporate services
Subactivity: Corporate services

Line Item		2008 Actual		2009 Currently Available		2010 Base		2010 Estimate		Increase/ (Decrease) Over 2010 Base	
		Personnel	Amount	Personnel	Amount	Personnel	Amount	Personnel	Amount	Personnel	Amount
Chief information office	Pos./Approp	5	$6,065	5	$14,981	5	$6,128	5	$6,128	0	0
	FTE/Obl.	5	6,732	5	15,182	5	6,149	5	6,149	0	0
Business system division	Pos./Approp	28	10,470	28	10,470	28	10,576	28	10,576	0	0
	FTE/Obl.	23	10,470	24	10,576	24	10,628	24	10,628	0	0
Total	Pos./Approp	33	16,535	33	25,451	33	16,704	33	16,704	0	0
	FTE/Obl.	28	17,202	29	25,758	29	16,777	29	16,777	0	0

Department of Commerce
National Institute of Standards and Technology
Scientific and Technical Research and Services
JUSTIFICATION OF PROGRAM AND PERFORMANCE
CORPORATE SERVICES

Goal Statement

This activity supports DoC's and NIST's mission of promoting U.S. innovation and industrial competitiveness by advancing measurement science, standards, and technology that drive technological change.

Base Program

The NIST central IT support for science programs provides secure, centrally-managed IT infrastructure resources in support of NIST's technical mission leading to improved measurement methods, standards advances, reference data, and research results benefiting numerous sectors of the U.S. economy. This program provides the necessary resources to operate and maintain administrative and financial management systems at NIST that satisfy the requirements established by the Department of Commerce (DoC); Office of Management and Budget; Government Accountability Office; Department of Treasury; General Services Administration; and Congress.

a) Computer Support - The scope of the program includes: deploying and managing new secure, high-performance computing and networking resources; providing computer facilities meeting Federal IT security requirements, as well as the specialized requirements of the equipment located at NIST; and providing secure, distributed, redundant storage for NIST data.

These resources enable NIST laboratories and programs to implement computational platforms supporting research-specific needs, dissemination of NIST results to the public, and collaborations with NIST partners.

The FY 2010 base program operating objectives for Computer Support include the following:

- manage the IT infrastructure including computing systems, associated communications, mass storage, networking, and software capabilities to support all NIST programs, and

- optimize the portfolio of computing platforms, online data storage, backup and archival storage, network interconnects, system security mechanisms, and application software packages to meet mission-specific requirements of NIST users and programs.

b) Business Systems - The DoC and the Administration have undertaken major modernization initiatives of various business systems, functions, and processes. DoC envisions common, Department-wide, user-friendly, and flexible systems to support financial management, procurement management, travel management, grants management, property management, and other administrative functions. New business systems or upgrades to existing systems will be implemented over the next several years. Any new systems acquired will be integrated with the Department's Commerce Business System (CBS). They will also interface with other internal and external administrative and management systems. NIST's business systems are an integral part of the vision for the administrative and financial management systems formulated by the DoC.

The FY 2010 base program operating objectives for Business Systems include:

- implement, operate, and maintain administrative management systems that support the delivery of administrative services to NIST and its cross service customers, and

- operate and maintain CBS and the NIST CBS Portal that supports delivery of services to NIST and its cross-service customers.

Performance Measures

Data on NIST programmatic performance evaluation and reporting are provided in Exhibit 3A of this budget request.

Department of Commerce
National Institute of Standards and Technology
Corporate Services
REIMBURSABLE PROGRAM AND WORKING CAPITAL FUND INVESTMENTS
(Dollar amounts in thousands)

	FY 2008 Actual	FY 2009 Estimate	FY 2010 Estimate
Department of Commerce	2,652	2,652	2,652
Subtotal, Federal Agencies	2,652	2,652	2,652
Total, Reimbursable Program	2,652	2,652	2,652
Subtotal, WCF transfer	0	0	0
Equipment Investments	$32	34	34
IE Amortization	(18)	(35)	(34)
Total, WCF Investments	14	(1)	0
Total, Reimbursable Program and WCF Investments	2,666	2,651	2,652

Department of Commerce
National Institute of Standards and Technology
Scientific and Technical Research and Services
SUMMARY OF REQUIREMENTS BY OBJECT CLASS
(Dollar amounts in thousands)

	Object Class	2008 Actual	2009 Currently Available	2010 Base	2010 Estimate	Increase/ (Decrease) Over 2010 Base
11	Personnel compensation					
11.1	Full-time permanent	$165,889	$182,139	$191,682	$203,173	$11,491
11.3	Other than full-time permanent	14,766	23,737	16,359	16,359	0
11.5	Other personnel compensation	6,514	6,514	6,514	6,514	0
11.9	Total personnel compensation	187,169	212,390	214,555	226,046	11,491
12.1	Civilian personnel benefits	48,525	52,769	56,124	59,235	3,111
13	Benefits for former personnel	9	9	9	9	0
21	Travel and transportation of persons	10,691	11,450	11,470	13,604	2,134
22	Transportation of things	1,350	1,627	1,628	2,094	466
23.1	Rental payments to GSA	47	37	37	37	0
23.2	Rental payments to others	848	858	880	880	0
23.3	Communications, utilities, and miscellaneous charges	23,308	25,087	22,097	25,962	3,865
24	Printing and reproduction	353	421	422	498	76
25.1	Advisory and assistance services	2,295	2,008	1,336	1,336	0
25.2	Other services	49,791	43,641	28,348	40,326	11,978
25.3	Purchases of goods and services from Government accounts	18,402	56,162	20,851	23,695	2,844
25.5	Research and development contracts	2,606	23,411	6,265	13,130	6,865
25.7	Operation and maintenance of equipment	10,966	11,375	11,382	12,431	1,049
26	Supplies and materials	21,992	23,130	23,149	25,947	2,798
31	Equipment	36,928	164,795	41,545	44,334	2,789
32	Land and structures	0	0	0	350	350
41	Grants, subsidies, and contributions	34,749	93,836	35,361	42,746	7,385
43	Interest and dividends	6	0	0	0	0
99	Total Obligations	450,035	723,006	475,459	532,660	57,201

	Object Class	2008 Actual	2009 Currently Available	2010 Base	2010 Estimate	Increase/ (Decrease) Over 2010 Base
99	Total Obligations	450,035	723,006	475,459	532,660	57,201
	Less Prior Year Recoveries	(2,073)	(1,000)	(1,000)	(1,000)	0
	Less Prior Year Unobligated Balance	(9,098)	(6,781)	0	0	0
	Plus Unobligated Balance, End of Year	6,781	0			
	Plus Expired Balance from EAC Transfer	2				
	Total Budget Authority	445,647	715,225	474,459	531,660	57,201
	Unobligated Balance Rescission					
	Transfer to NIST Working Capital Fund	0	2,275	250	6,190	5,940
	Transfer from Election Assistance Commission	(3,250)	(4,000)	0	(3,250)	(3,250)
	Transfer from Community Oriented Policing Services, DoJ	(1,880)	(1,500)	0	0	0
	Transfer from Office of the National Coordinator for Health Information Technology, HHS/ARRA		(20,000)	0	0	0
	Appropriation	440,517	692,000	474,709	534,600	59,891

Personnel Data

Full-time equivalent employment:					
Full-time permanent	1,647	1,790	1,829	1,951	122
Other than full-time permanent	244	292	244	244	0
Total	1,891	2,082	2,073	2,195	122
Authorized Positions:					
Full-time permanent	1,881	1,961	1,961	2,122	161
Other than full-time permanent	52	52	52	52	0
Total	1,933	2,013	2,013	2,174	161

Department of Commerce
National Institute of Standards and Technology
Scientific and Technical Research and Services
DETAILED REQUIREMENTS BY OBJECT CLASS
(Dollar amounts in thousands)

Object Class	2010 Adjustments to Base	2010 Base	2010 Estimate	Increase/ (Decrease) Over 2010 Base
11 Personnel compensation				
11.1 Full-time permanent				
Executive level	$4	$156	$156	0
Senior executive service	103	3,570	3,570	0
Career path	5,193	177,265	188,756	$11,491
Wage board	186	6,432	6,432	0
Scientific & professional (P.L. 80-313)	118	4,259	4,259	0
Subtotal	5,604	191,682	203,173	11,491
11.3 Other than full-time permanent				
Career path	470	16,337	16,337	0
Wage board	0	1	1	0
Scientific & professional (P.L. 80-313)	0	0	0	0
Experts & consultants	2	21	21	0
	0	0	0	0
Subtotal	472	16,359	16,359	0
11.5 Other personnel compensation				
Overtime	0	1,137	1,137	0
SES performance awards	0	247	247	0
Cash awards	0	4,818	4,818	0
Other	0	312	312	0
Subtotal	0	6,514	6,514	0
11.9 Total personnel compensation	6,076	214,555	226,046	11,491

Object Class		2010 Adjustments to Base	2010 Base	2010 Estimate	Increase/ (Decrease) Over 2010 Base
12.1	Civilian personnel benefits				
	Civil service retirement	(238)	2,323	2,323	0
	Federal employees' retirement	1,073	19,147	20,432	1,285
	Thrift savings plan	446	7,436	7,666	230
	Federal Insurance Contribution Act	538	12,563	13,442	879
	Health insurance	291	12,071	12,770	699
	Life insurance	12	315	333	18
	Employees' Compensation Fund	60	623	623	0
	Other	44	1,647	1,647	0
	Subtotal	2,226	56,124	59,235	3,111
13	Benefits for former personnel				
	Severance pay	0	0	0	0
	Unemployment compensation	0	9	9	0
	Other	0	0	0	0
	Subtotal	0	9	9	0
21	Travel and transportation of persons				
	Common carrier	0	4,239	4,979	740
	Mileage	0	14	17	3
	Per diem/actual	20	5,381	6,421	1,040
	Other	0	1,836	2,187	351
	Subtotal	20	11,470	13,604	2,134
22	Transportation of things	1	1,628	2,094	466
23.1	Rental payments to GSA	0	37	37	0
23.2	Rental payments to others	1	880	880	0

Object Class	2010 Adjustments to Base	2010 Base	2010 Estimate	Increase/ (Decrease) Over 2010 Base
23.3 Communications, utilities, and miscellaneous charges				
Rental of ADP equipment	0	7	7	0
Rental of office copying equipment	0	123	146	23
Other equipment rental	0	177	204	27
Federal telecommunications system	0	405	494	89
Other telecommunications services	0	1,243	1,513	270
Postal Service by USPS	0	209	209	0
Utilities:				
Electric	0	14,729	16,969	2,240
Gas	(2,991)	3,739	4,806	1,067
Water/Sewer	1	1,465	1,614	149
Subtotal	(2,990)	22,097	25,962	3,865
24 Printing and reproduction				
Publications	0	173	193	20
Other	1	249	305	56
Subtotal	1	422	498	76
25.1 Advisory and assistance services				
Management & professional support services	(1)	59	59	0
Studies, analyses, & evaluation	0	304	304	0
Engineering & technical services	1	973	973	0
Subtotal	0	1,336	1,336	0
25.2 Other services				
Training	1	1,984	2,537	553
ADP Services	1	1,613	1,799	186
Other non-government contracts	1,020	24,751	35,990	11,239
Subtotal	1,022	28,348	40,326	11,978

Object Class	2010 Adjustments to Base	2010 Base	2010 Estimate	Increase/ (Decrease) Over 2010 Base
25.3 Purchases of goods and services from Government accounts				
Payments to DM, WCF	762	6,069	6,069	0
[Commerce Business System (shared)]	[0]	[1,349]	[1,349]	[0]
Office of Personnel Management	0	224	224	0
Other Federal agencies:				
Department of Commerce	2	3,626	6,005	2,379
Reactor Fuel/Department of Energy	0	2,156	2,156	0
Other	6	8,776	9,241	465
Subtotal	770	20,851	23,695	2,844
25.5 Research and development contracts	4	6,265	13,130	6,865
25.7 Operation and maintenance of equipment	7	11,382	12,431	1,049
26 Supplies and materials				
Office & laboratory supplies	12	21,225	24,023	2,798
Scientific publications & journals	7	1,467	1,467	0
Fuel oil	0	457	457	0
Reactor materials	0	0	0	0
Subtotal	19	23,149	25,947	2,798
31 Equipment				
Office machines and other equipment	9	13,592	15,567	1,975
ADP equipment	7	10,587	11,401	814
Equipment amortization	11	17,366	17,366	0
Subtotal	27	41,545	44,334	2,789
32 Land and structures	0	0	350	350

	Object Class	2010 Adjustments to Base	2010 Base	2010 Estimate	Increase/ (Decrease) Over 2010 Base
41	Grants, subsidies, and contributions	(3,475)	35,361	42,746	7,385
42	Insurance claims and indemnities	0	0	0	0
43	Interest and dividends	0	0	0	0
99	Total Obligations	3,709	475,459	532,660	57,201
	Less Prior Year Recoveries	(1,000)	(1,000)	(1,000)	0
	Total Budget Authority	2,709	474,459	531,660	57,201
	Transfer to NIST Working Capital Fund	0	250	6,190	5,940
	Transfer from Election Assistance Commission	0	0	(3,250)	(3,250)
	Appropriation	2,709	474,709	534,600	59,891

Department of Commerce
National Institute of Standards and Technology
Scientific and Technical Research and Services
ACTIVITY/SUBACTIVITY CHANGE CROSSWALK
Part 1 - 2009 Structure
(Dollar amounts in thousands)

Activity/Subactivity	2010 Direct Obligations	Proposed Changes
NIST Laboratories		See below [1/]
Laboratories and Technical Programs	$452,617	See below [2/4/]
National Research Facilities	70,416	See below [2/4/]
Total NIST Laboratories	523,033	
Baldrige National Quality Program		See below
Baldrige National Quality Program		See below [3/]
Total Baldrige National Quality Program	9,627	
Total STRS direct obligations	532,660	

[1/] The activities entitled "NIST Laboratories" will crosswalk to four activities: "National Measurement and Standards Laboratories," "Innovations in Measurement Science," "Next Generation Measurements Training," and "Corporate Services."

[2/] Subactivity entitled "Laboratories and Technical Programs" will be combined with the "National Research Facilities" as one activity and previous research programs, "Innovations in Measurement Science" and "Next Generation Measurements Training" (i.e., Postdoctoral Research Associates Program), as well as, activities associated with "Corporate Services" will no longer be reported under the "Laboratories and Technical Programs"; instead these programs will be reported as separate activities on Exhibit 5.

[3/] The activities entitled "Baldrige National Quality Program" remain unchanged under the new budget structure.

[4/] Line items reported on Exhibit 10 within these activities/subactivities will be based on NIST laboratories and service units under the new budget structure.

Department of Commerce
National Institute of Standards and Technology
Scientific and Technical Research and Services
ACTIVITY/SUBACTIVITY CHANGE CROSSWALK
Part 2 - 2010 Structure
(Dollar amounts in thousands)

Activity/Subactivity	2006	2007	2008	2009 [1/]	2010
National measurement and standards laboratories					
National measurement and standards laboratories	347,981	387,321	393,928	634,032	475,010
Innovations in measurement science					
Innovations in measurement science	16,260	16,987	19,938	20,791	20,199
Next generation measurements training					
Postdoctoral research associates program	9,923	10,085	10,565	32,936	11,047
Baldrige national quality program					
Baldrige national quality program	7,068	7,835	8,402	9,489	9,627
Corporate services					
Corporate services	17,389	18,586	17,202	25,758	16,777
Total STRS Direct Obligations	398,621	440,814	450,035	723,006	532,660

[1/] FY 2009 direct obligations include funds from the American Recovery and Reinvestment Act of 2009 (P.L. 111-5).

Department of Commerce
National Institute of Standards and Technology
Scientific and Technical Research and Services
APPROPRIATION LANGUAGE AND CODE CITATIONS

1. For necessary expenses of the National Institute of Standards and Technology,

15 U.S.C. 272; 273; 278b-j; p
15 U.S.C. 290b-f
15 U.S.C. 1151-52
15 U.S.C. 1454(d-e)
15 U.S.C. 1511, 1512
15 U.S.C. 3710a-d
15 U.S.C. 3711a
15 U.S.C. 7301-7313
15 U.S.C. 7406
15 U.S.C. 7506(a)

15 U.S.C. 272; 273; 278b-j; p provides basic authority for the performance of the functions and activities of the National Institute of Standards and Technology, authorizes appropriations for these purposes to be provided to the general public and specific institutions, governments, firms, and individuals, and requires the notification of Congress of a reprogramming of funds that exceeds a limit specified in public law.

15 U.S.C. 290b-f directs the Secretary of Commerce to provide for the collection, compilation, critical evaluation, publication, and dissemination of standard reference data and the authority to establish a non-agricultural technology office.

15 U.S.C. 1151-1152 establishes within the Department of Commerce, a central clearinghouse for technical information useful to American business and industry and provides for the dissemination of this technical, scientific information via the National Technical Information Service.

15 U.S.C. 1454(d-e) provides NIST with the authority to request that manufacturers and distributors of a commodity participate in voluntary product standards when there is undue proliferation of weights, measures, and quantities. Reports and recommendations to Congress are to be made upon industry failure to adopt these standards.

15 U.S.C. 1511, 1512 specifies that all bureaus of the Department of Commerce come under the authority of the Secretary of Commerce and that such bureaus including NIST shall be subject to the authority of the Secretary of Commerce.

15 U.S.C. 3710a-d provides the authority to enter into CRADAs, to make cash awards to scientific personnel for inventions, to retain royalties and to distribute royalties for inventions, and to communicate and coordinate for the Offices of Research and Technology Applications in Federal laboratories.

15 U.S.C. 3711a provides the authority for the Baldrige National Quality award.

15 U.S.C. 7301-7313 establishes National Construction Safety Teams within NIST to respond to building and structural emergencies.

15 U.S.C. 7406 provides authority for NIST to conduct Cyber Security Research and Development to minimize security risks associated with computer systems used by the Federal government.

15 U.S.C. 7506(a) provides for the establishment of a nanotechnology research and development program within NIST.

P.L. 110-143 121 STAT 1809 provides NIST to assist in developing a research program to establish guidelines for the remediation of former methamphetamine laboratories in the United States as well as developing new detection technologies and appropriate Standard Reference Materials for methamphetamine detection testing..

2. $472,000,000, to remain available until expended,

no specific authority

3. of which not to exceed $9,000,000 may be transferred to the "Working Capital Fund." P.L. 111-8 Omnibus Appropriations Act, 2009.

15 U.S.C. 278b

15 U.S.C. 278b provides in part: "The National Institute of Standards and Technology is authorized to utilize in the performance of its functions the Working Capital Fund".

4. Public Law 110-69, America Competes Act, 121 Stat 572, passed August 9, 2007 reauthorizes the Scientific and Technical Research and Services appropriation through 2010. Includes funding for NIST's portion of the President's Plan for Science and Innovation, which puts NIST's core budget (laboratories and facilities) on track to double over 10 years.

5. Public Law 111-5 American Recovery and Reinvestment Act of 2009 appropriates $220,000,000 for the Scientific and Technical Research and Services appropriation from FY 2009 to FY 2010 and makes available by reimbursable agreement $10,000,000 from the Department of Energy for the development of Smart Grid Technology by reference to Public Law 110-140, the Energy Independence and Security Act of 2007. In addition, $20,000,000 is transferred from the Department of Health and Human Services for continued work on advancing health care information enterprise integration.

Department of Commerce
National Institute of Standards and Technology
Scientific and Technical Research and Services
ADVISORY AND ASSISTANCE SERVICES
(Obligations in thousands of dollars)

	FY 2008 Actual	FY 2009 Estimate	FY 2010 Estimate
Management and professional support services	$61	$60	$60
Studies, analyses, and evaluations	934	669	304
Engineering and technical services	1,300	1,279	973
Total	2,295	2,008	1,337

Significant Activities

Advisory and assistance services funded by the STRS appropriation include the review and evaluation of the technical functions and operations of NIST by the Board on Assessment of the National Academy of Sciences. The Evaluation Panels consider the importance and relative priority of projects, quality of staff, equipment needs, and finances, and the relation of the programs to the mission of NIST.

Need for Advisory and Assistance Services:

The need for advisory and assistance services stems from the NIST role in dealing with the private sector, professional organizations, and the public sector. Inputs must be obtained from consultants who can bring their individual expertise to bear and help NIST in assessing its program plans to meet the needs of its customers. The alternative to utilizing these services is to make no attempt to have expertise from sources outside NIST and risk degradation of the working and professional relationship with those in the business of using the products and services offered by NIST.

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Department of Commerce
National Institute of Standards and Technology
Industrial Technology Services
SUMMARY OF RESOURCE REQUIREMENTS
(Dollar amounts in thousands)

	Positions	FTE	Budget Authority	Direct Obligations	Appro-priation
2009 Currently Available	137	141	$170,000	$195,521	$175,000
less: Unobligated balance from prior year	0	0	0	(21,221)	0
2010 Adjustments to base:					
plus: Restoration of 2009 deobligation offset	0	0	3,800	(500)	3,800
plus: Restoration of prior year unobligated balance rescission	0	0	5,000	5,000	0
plus: Uncontrollable cost changes	0	2	515	515	515
less: Estimated recoveries 2010	0	0	(3,800)	0	(3,800)
2010 Base Request	137	143	175,515	179,315	175,515
plus: 2010 Program changes	4	3	19,085	19,085	19,085
2010 Estimate	141	146	194,600	198,400	194,600

		2008 Actual		2009 Currently Available		2010 Base		2010 Estimate		Increase/ (Decrease) Over 2010 Base	
Comparison by activity/subactivity:		Per-sonnel	Amount	Per-sonnel	Amount	Per-sonnel	Amount	Per-sonnel	Amount	Per-sonnel	Amount
Technology innovation program											
Technology innovation program	Pos./Approp	69	$65,200	73	$65,000	73	$65,268	73	$69,900	0	$4,632
	FTE/Obl.	71	54,339	73	83,664	75	69,068	75	73,700	0	4,632
Hollings manufacturing extension partnership											
Hollings manufacturing extension partnership	Pos./Approp	64	89,640	64	110,000	64	110,247	68	124,700	4	14,453
	FTE/Obl.	68	90,542	68	111,857	68	110,247	71	124,700	3	14,453
TOTALS	Pos./Approp	133	154,840	137	175,000	137	175,515	141	194,600	4	19,085
	FTE/Obl.	139	144,881	141	195,521	143	179,315	146	198,400	3	19,085

Comparison by activity/subactivity:	2008 Actual Personnel	2008 Actual Amount	2009 Currently Available Personnel	2009 Currently Available Amount	2010 Base Personnel	2010 Base Amount	2010 Estimate Personnel	2010 Estimate Amount	Increase/ (Decrease) Over 2010 Base Personnel	Increase/ (Decrease) Over 2010 Base Amount
Adjustments for:										
Recoveries		(9,295)		(4,300)		(3,800)		(3,800)		0
Refunds		(1,633)		0		0		0		0
Unobligated balance, start of year		(19,734)		(21,221)		0		0		0
Unobligated balance, end of year		21,221		0		0		0		0
Budget Authority		135,440		170,000		175,515		194,600		19,085
Unobligated balance rescission		18,800		5,000		0		0		0
Financing from transfers:										
Transfers to other accounts (+)		600		0		0		0		0
Appropriation		154,840		175,000		175,515		194,600		19,085

Department of Commerce
National Institute of Standards and Technology
Industrial Technology Services
ADJUSTMENTS TO BASE
(Dollar amounts in thousands)

	Perm. Pos.	FTE	Amount
Adjustments:			
FY 2010 Restoration of FY 2009 Unobligated balance rescission	...	...	$5,000
Restoration of FY 2009 deobligation offset	...	...	3,800
Subtotal, adjustments	...	...	8,800
Financing:			
Recoveries of prior year deobligations	...	...	(3,800)
Other Changes:			
Annualization of 2009 Pay raise	...	...	261
2010 Pay increase and related costs	...	...	254
Annualization of positions financed in FY 2009	...	2	...
Personnel Benefits:			
Civil Service Retirement System (CSRS)	...	...	(22)
Federal Employees' Retirement System (FERS)	...	...	35
Thrift Savings Plan (TSP)	...	...	14
Federal Insurance Contribution Act (FICA) - OASDI	...	...	17
Health insurance	...	...	17
Travel and transportation of persons:			
Per diem	...	...	16
Communications, Utilities, and Miscellaneous			
Electricity rate increase	...	...	20
Natural gas rate decrease	...	...	(61)
General pricing level adjustment:			
Rental payments to others	...	...	1
Communications, utilities, and miscellaneous charges	...	...	2
Printing	...	...	1
Other services	...	...	127
Supplies	...	...	4
Equipment	...	...	6
Subtotal, Other changes	...	2	692
Subtotal, Adjustments to base	...	2	5,692
Amount absorbed			(177)
Total, Adjustments to base	...	2	5,515

Department of Commerce
National Institute of Standards and Technology
Industrial Technology Services
JUSTIFICATION OF ADJUSTMENTS TO BASE
(Dollar amounts in thousands)

	FTE	Amount
Adjustments:		
FY 2010 Restoration of FY 2009 Unobligated balance rescission	0	$5,000

In FY 2009, unobligated balances in NIST's ITS account was reduced by a $5,000,000 rescission. This adjustment would restore that funding in FY 2010.

Restoration of FY 2009 deobligation offset		3,800

In FY 2009, NIST's ITS budget authority was reduced by $3,800,000 based on an estimated level of TIP prior year deobligations. This adjustment would restore $3,800,000 in FY 2010.

Subtotal, Adjustments	0	8,800

Financing:

Recoveries of prior year obligations			(3,800)

This reduction is the estimated level of TIP prior year deobligations in FY 2010.

Other Changes:

Annualization of 2009 pay raise		0	261

A pay raise of 3.9 percent is assumed to be effective January 1, 2009.

Total cost in FY 2010 of 2009 pay raise	$589,931
Less amount requested in FY 2009	(329,000)
Less amount absorbed in FY 2009	0
Amount requested in 2010 to provide full-year cost of 2009 pay raise	260,931
Payment to Departmental Management Working Capital Fund	0
Total, FY 2009 pay raise increase in FY 2010	260,931

2010 Pay increase and related costs		0	254

A general pay raise of 2.0 percent is assumed to be effective January 1, 2010.

Total cost in FY 2010 of pay increase.	$254,000
Amount absorbed in FY 2009	0
Amount requested for FY 2009 pay raise	254,000
Payment to Departmental Management Working Capital Fund	0
Total adjustment for FY 2010 pay increase	254,000

Annualization of positions financed in FY 2009	2	0

NIST requires an additional 2 FTE to staff FY 2009 requested increases at their full operating level in FY 2010.

Personnel benefits.	0	61

Civil Service Retirement System (CSRS)	($22)
Federal Employees' Retirement System (FERS)	35
Thrift Savings Plan (TSP)	14
Federal Insurance Contribution Act (FICA) – OASDI	17
Health Insurance	17

Civil Service Retirement System (-$22,000) – The number of employees covered by the Civil Service Retirement System (CSRS) continues to drop as positions become vacant and are filled by employees who are covered by the Federal Employees' Retirement System (FERS). The estimated percentage of payroll for employees covered by CSRS will decrease from 16.8 percent in FY 2009 to 14.6 percent in FY 2010 The contribution rate will remain at 7.0 percent in FY 2010.

Payroll subject to retirement systems ($14,009,844)	
Cost of CSRS contributions in FY 2010 ($14,009,844 x .146 x .07)	$143,181
Cost of CSRS contributions in FY 2009 ($14,009,844 x .168 x .07)	164,756
Total adjustment to base	(21,575)

Federal Employees' Retirement System ($35,000) – The number of employees covered by FERS continues to rise as employees covered by CSRS leave and are replaced by employees covered by FERS. The estimated percentage of payroll for employees covered by FERS will increase from 83.2 percent in FY 2009 to 85.4 percent in FY 2010. The contribution rate will remain at 11.2 percent in FY 2010.

Payroll subject to retirement systems ($14,009,844)	
Basic benefit cost in FY 2010 ($14,009,844 x .854 x .112)	$1,340,014
Basic benefit cost in FY 2009 ($14,009,844 x .832 x .112)	1,305,493
Total adjustment to base	34,521

Thrift Savings Plan ($14,000) – The cost of agency contributions to the Thrift Savings Plan will also rise as FERS participation increases. The contribution rate will remain at 4.65 percent.

Thrift plan cost in FY 2010 ($14,009,844 x .854 x .0465)	$556,345
Thrift plan cost in FY 2009 ($14,009,844 x .832 x .0465)	542,013
Total adjustment to base	14,332

Federal Insurance Contributions Act (FICA) - OASDI ($17,000) – As the percentage of payroll covered by FERS increases, the cost of OASDI contributions will increase. In addition, the maximum salary subject to OASDI tax will increase from $106,425 in FY 2009 to $110,400 in FY 2010. The OASDI tax rate will remain 6.2 percent in FY 2010.

FERS payroll subject to FICA tax in 2010 ($14,009,844 x .854 x .904 x .062)	$670,581
FERS payroll subject to FICA tax in 2009 ($14,009,844 x .832 x .905 x .062)	654,029
Increase (FY 2009-FY 2010)	16,552
OTP payroll subject to FICA tax in 2010 ($487,156 x .854 x .904 x .062)	23,318
OTP payroll subject to FICA tax in 2009 ($487,156 x .832 x .905 x .062)	22,742
Increase (FY 2009-2010)	576
Total adjustment to base	17,128

Health insurance ($17,000) – Effective January 2008, NIST's contribution to Federal employees' health insurance premiums increased by 2.1 percent. Applied against the FY 2009 estimate of $819,000, the additional amount required is $17,199.

Travel and transportation of persons	0	16

An analysis of per diem rates by city was performed based on data received from GSA for the time period of October 1, 2006 through September 30, 2008. A net increase of 4.39 percent was applied to the FY 2009 base of $369,000 to arrive at an increase of $16,199.

Communications, utilities, and miscellaneous charges	0	(41)
Electricity rate increase	20	
Natural Gas rate decrease	(61)	

The electricity ATB amount was derived using a year to year comparison of the cost per kilowatt hour. In analyzing the 12 months ended February 2008 and 2007, the per kilowatt hour rate increased 4.8% (from 11.0 cents to 11.6 cents) for Gaithersburg, Maryland; increased 11.8% (from 31.1 cents to 34.7 cents) for Kauai, Hawaii; decreased 3.5% (from 5.6 cents to 5.4 cents) for Boulder, Colorado; and increased .4% (from .08 cents to .0803 cents) for Ft. Collins, Colorado for a net increase of $20,000.

The natural gas ATB amount was derived using a year to year comparison of the average cost per therm. In analyzing the 12 months ended February 2008 and 2007, the per therm rate decreased 25.2% (from 1.6 to 1.2) and decreased 18.7% (from 10.44 to 8.49) for Boulder and Gaithersburg respectively resulting in a net decrease of $61,000.

General pricing level adjustment	0	141

This request applies the OMB economic assumptions of .8 percent for FY 2010 where the prices that the government pays are established through the market system. Factors are applied to sub-object classes that result in the following adjustments to base: rental payments to others $1,048; communications, utilities, and miscellaneous charges $2,264; printing and reproduction $872; other services $127,080; supplies $4,176; and equipment $6,224.

Subtotal Other changes	2	692
Amount absorbed	0	(177)
Total Adjustments to base	2	5,515

Department of Commerce
National Institute of Standards and Technology
Industrial Technology Services
PROGRAM AND PERFORMANCE: DIRECT OBLIGATIONS
(Dollar amounts in thousands)

Activity: Technology innovation program
Subactivity: Technology innovation program

Line Item		2008 Actual		2009 Currently Available		2010 Base		2010 Estimate		Increase/ (Decrease) Over 2010 Base	
		Personnel	Amount	Personnel	Amount	Personnel	Amount	Personnel	Amount	Personnel	Amount
Technology innovation program	Pos./Approp	69	$65,200	73	$65,000	73	$65,268	73	$69,900	0	$4,632
	FTE/Obl.	71	54,339	73	83,664	75	69,068	75	73,700	0	4,632

Department of Commerce
Technology Administration
National Institute of Standards and Technology
Industrial Technology Services
JUSTIFICATION OF PROGRAM AND PERFORMANCE
TECHNOLOGY INNOVATION PROGRAM

Goal Statement

The Technology Innovation Program (TIP) supports, promotes and accelerates innovation in the United States through high-risk, high-reward research in areas of critical national need. Critical national need areas are those for which government attention is demanded because the magnitude of the problem is large and the societal challenges that need to be overcome are not being addressed. TIP was explicitly established within NIST, and "linked to the purpose and functions of the Institute" to assist U.S. small- and medium-size businesses, institutions of higher education, national laboratories, and non-profit research organizations to conduct research that has the potential for yielding transformational results with far- or wide-reaching implications, and that is within NIST's areas of technical competence. TIP was established through the America COMPETES Act of 2007.

Base Program

For FY 2010, NIST requests $69.9 million for TIP. The request consists of two parts: 1) a base of $65.3 million and an initiative increase of $4.6 million. The increase provides $ 4.6 million in new TIP awards, in addition to funding any remaining prior-year commitments (mortgages) arising from prior-year awards. The Administration's FY 2010 request is the first step in a proposed increase of the program to a level of $100 million by the year 2015.

In FY 2010, TIP intends to hold a grant competition that funds one or more areas of identified critical national need. Critical national need areas selected for funding will build upon areas addressed in prior-year TIP competitions. Critical National Need areas selected for funding are based on the societal need—not the specific technologies—as determined based on input from a variety of sources, including the TIP Advisory Board, science advisory bodies, collaborations with other Federal agencies, national or state science policy reports, academic reports and organizations, industry roadmaps and the public. TIP will engage key NIST staff in the development of critical national need areas to ensure consistency and synergies with other NIST programs, as well as NIST priorities and

competencies, to ensure that funding areas are appropriately linked with the purpose and functions of NIST. This strategy ensures that TIP funding is awarded in a manner that maximizes leveraging across all NIST capabilities and efforts.

Critical National Need areas for FY 2010 and future years will respond to societal challenges that are national in scope and of sufficient magnitude in FY 2010 to justify government attention, while building upon areas selected for funding in prior years. For example, TIP's inaugural competition for funding in FY 2008 addressed the nation's critical need for improvements in physical infrastructure. Specifically, TIP conducted a competition for high-risk, high-reward research addressing "Advanced Sensing Technologies for Infrastructure: Roads, Bridges, Highways and Water Systems." Outputs for the first Program year include the awarding of 9 cooperative agreements with 31 recipients, including 17 small or medium businesses, 11 universities and 3 local government laboratories in 12 states. These 9 awards have the potential to generate an additional $46 million in industry cost-share over 3-5 years. The awards are for new research projects to develop advanced sensing technologies that would enable timely and detailed monitoring and inspection of the structural health of bridges, roadways and water systems that comprise a significant component of the nation's public infrastructure. If successful, these high-risk technologies funded by TIP will target new, efficient, accurate, low-cost and reliable sensors and related technologies that provide quantitative assessments of the structural integrity or degree of deterioration of bridges, roads, water mains and wastewater collection systems.

Critical national need topic areas under development for FY 2010 may include one or more of the following (TIP may offer multiple competitions over 2-3 years on a topic in order to optimize research potential and depending upon changing national priorities):

Civil Infrastructure Technologies (first funded by TIP in FY 2008): The continuing and accelerating deterioration of a large fraction of our nation's infrastructure requires a leap in technology that can only be acquired through transformative research. TIP funding activities for 2010 may include such topic areas as continuation of R&D for advanced sensing systems or funding for development of next-generation advanced materials having superior properties of light weight, strength, and durability with corrosion resistant and fire retardant characteristics.

Energy: The United States economy is dependent on foreign sources of energy, and disruption in the supply of petroleum from foreign countries and/or a rise in price impacts all sectors of the economy. The total United States energy consumption is projected to grow from 100 quadrillion Btu in 2004 to 131 quadrillion Btu in 2030, and other countries are competing for the same energy resources. Areas under consideration include topics such as smart grid or alternative energy technologies.

Manufacturing: The manufacturing sector supported 14 million jobs in 2007, or about 10.1% of total employment, and United States manufacturing firms exported $923 billion in manufactured goods in 2006—64% of all United States goods and services exported. If manufacturing, R&D, and innovation continue to move offshore, an important part of our national economy will be lost. Potential for advancement exists for the accelerated development of next-generation high performance processes and materials, and in areas such as nanomanufacturing.

Healthcare: Personalized medicine is attempting to unlock the vast implications of genetic variability within the human organism to significantly alter approaches to new drug development, diagnostics and treatment regimens. Currently, approved drugs work only in a fraction of the population, and doctors are unable to select optimal drug treatments and dosages based on patient's unique genetics, physiology, and metabolic processes. Understanding the connection between genetic variations and disease states could provide earlier and more accurate diagnosis and targeted treatment.

Green Chemistry: Green Chemistry is the design of chemical products and processes that are designed to reduce or eliminate the use and generation of hazardous substances. It is an approach to chemistry that seeks inherently safer, cleaner, and more energy and material-efficient products and processes. Although industry has made tremendous strides in transitioning to cleaner, safer chemical products (for example, the phaseout of CFCs), over 7 billion pounds of toxic material were disposed of or released to the environment in United States in 2006.

Complex Systems: Complex networks characterize many of the systems that we take for granted in our daily lives, such as electronic communications networks, transportation systems, the electric power grid, and financial systems. However, the primitive state of fundamental knowledge about how complex networks behave makes predictability difficult, potentially jeopardizing the integrity and stability of these systems that are indispensable to the workings of a global economy and to the defense of the United States against both conventional military threats and the threat of terrorism.

TIP's FY 2010 base program includes short-term, medium-term and long-term objectives.

New TIP Awards –short term	• Awards to small or mid-sized businesses, institutions of higher education, national laboratories, or non-profit research organizations for high-risk, high-reward research • Establishment of research collaborations through joint ventures and informal interactions • Fostering an equivalent amount of additional private investment through cost-share mechanism.
New TIP awards – medium term	• Creation of intellectual property vested in U.S. based businesses, universities and other organizations. • Dissemination of knowledge created through patents, papers and publications.
New TIP awards – long term	• Implementation of high-risk, high-reward technologies that address societal challenges in areas of critical national need.

Performance Measures

Data on NIST programmatic performance evaluation and reporting are provided in Exhibit 3A of this budget request.

Department of Commerce
National Institute of Standards and Technology
Industrial Technology Services
INCREASE FOR FY 2010
(Dollar amounts in thousands)

	2010 Base		2010 Estimate		Increase/(Decrease) Over 2010 Base	
	Personnel	Amount	Personnel	Amount	Personnel	Amount
Technology Innovation Program ....Pos./Approp	73	$65,268	73	$69,900	0	$4,632
FTE/Obl.	75	69,068	75	73,700	0	4,632

Technology Innovation Program (Appropriation +$4,632,000, Direct Obligations +$4,632,000)

Problem Magnitude and NIST Role:

Technology is increasingly touted as the cure for addressing major societal challenges -- from slowing climate change to reducing our nation's "addiction" to oil. The nation's investment in enabling this technology follows traditional strategies and inter-agency roadmaps that are technically sound, methodical, but generally low risk. There currently exist few mechanisms for the private sector to propose truly transformative concepts to the Federal Government.

A 2006 survey performed by IBM of 750 CEO's worldwide highlight many of the issues that make disruptive technological innovation difficult to achieve. More than 65 percent of those surveyed recognized that significant technological innovation is needed over the next two years to remain competitive, however less than half felt they had been successful at managing such radical innovation in the past. In his book, "*The Innovator's Dilemma*", Christensen provides multiple examples of the barriers industry faces related to disruptive technology. Whether it was hard drives, power shovels, or printers Christensen's work illustrates how disruptive breakthroughs in technology were often mismanaged, ignored, or completely disavowed by the leading companies of the time.

The barriers to successful innovation and disruptive technology development faced by the private sector also exist in government with programs that support investment in S&T often being risk averse. This reality has limited the availability of funds for high-risk research to solve societal challenges within the government domain despite the clear recognition of the need to support the development transformative technologies.

The Technology Innovation Program (TIP) was specifically created to address this gap. Created by the America COMPETES Act in 2007 to "...support, promote and accelerate innovation in the United States through high-risk, high-reward research in areas of critical national need." TIP is an integral piece of this comprehensive legislation that authorized balanced increases in both the intramural and extramural programs at NIST in response to the National Academies report *Rising Above the Gathering Storm*. TIP was explicitly established within NIST, and "linked to the purpose and functions of the Institute" to assist U.S. small- and medium-size businesses, institutions of higher education, national laboratories, and non-profit research organizations to conduct research that has the potential for yielding transformational results with far- or wide-reaching implications, and that is within NIST's areas of technical competence.

TIP specifically supports transformational research at small and mid-size businesses, universities, and other research institutions that target areas of critical national need. Areas of critical national need are defined as those areas *for which government attention is demanded because the magnitude of the problem is large and the societal challenges that need to be overcome are not being addressed.* TIP's inaugural competition for funding in FY 2008 addressed the nation's critical need for improvements in physical infrastructure. Specifically, TIP conducted a competition for high-risk, high-reward research addressing "Advanced Sensing Technologies for Infrastructure: Roads, Bridges, Highways and Water Systems." Outputs for the first Program year include the awarding of 9 cooperative agreements with 31 recipients, including 17 small or medium businesses, 11 universities and 3 local government laboratories in 12 states. These 9 awards have the potential to generate an additional $46 million in industry cost-share over 3-5 years. The awards are for new research projects to develop advanced sensing technologies that would enable timely and detailed monitoring and inspection of the structural health of bridges, roadways and water systems that comprise a significant component of the nation's public infrastructure. If successful, these high-risk technologies funded by TIP will target new, efficient, accurate, low-cost and reliable sensors and related technologies that provide quantitative assessments of the structural integrity or degree of deterioration of bridges, roads, water mains and wastewater collection systems. Funding requested in FY2010 will enable TIP to support additional research efforts in additional areas of critical national need.

Proposed NIST Technical Program:

For FY 2010, NIST requests $69.9 million, consisting of base funding of $65.3 million and an initiative increase of $4.6 million. These funds will support new competitions and be applied to any remaining mortgage commitments from prior years competitions. In FY 2010, TIP intends to hold a competition for funding in one or more areas of Critical National Need.

Critical National Need areas selected for funding will build upon areas addressed in prior year TIP competitions in order to optimize research potential and program participation across technology challenges within a Critical National Need area. For example, TIP first held a competition in the area of Civil Infrastructure in FY 2008 and funded 9 awards in advanced sensing technologies for the infrastructure. TIP expects to continue and extend this topic in FY 2009 and plans to extend the topic area further in FY 2010 to include additional technical subtopic areas, which may include, for example, infrastructure repair and detection technologies or advanced materials for the infrastructure. In FY 2009, we currently have an open competition for the Civil Infrastructure and Manufacturing CNNs. In addition to civil infrastructure and manufacturing, we have identified a number of tentative CNN topics for FY 2010 or later competitions, including energy, green technologies, healthcare, networks and water.

Critical national need topic areas that might be selected for a FY 2010 competition may include one or more of the following (TIP may offer multiple competitions over 2-3 years on a topic in order to optimize research potential and depending upon changing national priorities):

- **Civil Infrastructure Technologies** (first funded by TIP in FY 2008): The continuing and accelerating deterioration of a large fraction of our nation's infrastructure requires a leap in technology that can only be acquired through transformative research. TIP funding activities for FY 2010 may include such topic areas as continuation of R&D for advanced sensing systems or funding for development of next-generation advanced materials having superior properties of light weight, strength, and durability with corrosion resistant and fire retardant characteristics.

- **Energy:** The United States economy is dependent on foreign sources of energy, and disruption in the supply of petroleum from foreign countries and/or a rise in price impacts all sectors of the economy. The total United States energy consumption is projected to grow from 100 quadrillion Btu in 2004 to 131 quadrillion Btu in 2030, and other countries are competing for the same energy resources. Areas under consideration include topics such as smart grid or alternative energy technologies.

- **Manufacturing:** The manufacturing sector supported 14 million jobs in 2007, or about 10.1% of total employment, and United States manufacturing firms exported $923 billion in manufactured goods in 2006—64% of all United States goods and services exported. If manufacturing, R&D, and innovation continue to move offshore, an important part of our national economy will be lost. Potential for advancement exists for the accelerated development of next-generation high performance processes and materials, and in areas such as nanomanufacturing.

- **Healthcare:** Personalized medicine is attempting to unlock the vast implications of genetic variability within the human organism to significantly alter approaches to new drug development, diagnostics and treatment regimens. Currently, approved drugs work only in a fraction of the population, and doctors are unable to select optimal drug treatments and dosages based on patient's unique genetics, physiology, and metabolic processes. Understanding the connection between genetic variations and disease states could provide earlier and more accurate diagnosis and targeted treatment.

- **Green Chemistry:** Green Chemistry is the design of chemical products and processes that are designed to reduce or eliminate the use and generation of hazardous substances. It is an approach to chemistry that seeks inherently safer, cleaner, and more energy and material-efficient products and processes. Although industry has made tremendous strides in transitioning to cleaner, safer chemical products (for example, the phase-out of CFCs), over 7 billion pounds of toxic material were disposed of or released to the environment in United States in 2006.

- **Complex Systems:** Complex networks characterize many of the systems that we take for granted in our daily lives, such as electronic communications networks, transportation systems, the electric power grid, and financial systems. However, the primitive state of fundamental knowledge about how complex networks behave makes predictability difficult, potentially jeopardizing the integrity and stability of these systems that are indispensable to the workings of a global economy and to the defense of the United States against both conventional military threats and the threat of terrorism.

To ensure funding areas are appropriately linked with the purpose and functions of NIST, TIP will engage key NIST staff in the development of Critical National Need areas to ensure consistency and complementarity between NIST programs, priorities and competencies and the Critical National Need areas selected by TIP. This strategy is intended to ensure that TIP funding is awarded in a manner that maximizes leverage across all NIST capabilities and efforts.

Performance Measures: Outputs

At the proposed funding level, NIST will generate the following outputs:

Generating Use-Inspired Measurements and Technology	
Component	**Outputs**
New TIP Awards –short term	• Awards to small or mid-sized businesses, institutions of higher education, national laboratories, or non-profit research organizations for high-risk, high-reward research; • Establishment of research collaborations through joint ventures and informal interactions; • Fostering an equivalent amount of additional private investment through cost-share mechanism.
New TIP awards – medium term	• Innovations in high-risk, high reward research in areas of Critical National Need created TIP single awardees and joint venture partners; • Creation of intellectual property vested in U.S. based businesses, universities and other organizations; and • Dissemination of knowledge may be created through patents, papers and publications.

Performance Measures: Outcomes

At the proposed funding level, NIST will generate the following outcomes:

- Direction of federal investment into high-risk, high-reward research that has the potential for yielding transformational results with far-ranging or wide-ranging implications;
- Direction of R&D into areas of Critical National Need that support, promote, and accelerate innovation in the United States and is within NIST's areas of technical competence;
- Resolution of societal challenges that, if not addressed, could negatively affect the overall function and quality of life of the nation, and as such demand government attention; and
- Advances in the state-of-the-art and contributions to the United States science and technology base in funded areas.

Performance Measures

(Total Program)

Data on the performance evaluation and reporting methods for all NIST programs are provided in Exhibit 3A of this budget request.

Exhibit 15

Department of Commerce
National Institute of Standards and Technology
Industrial Technology Services
PROGRAM CHANGE DETAIL BY OBJECT CLASS
(Dollars in thousands)

Activity: Technology innovation program
Subactivity: Technology innovation program
Program Change: Technology Innovation Program

Object Class		2010 Increase/ (Decrease) Obligations
11	Personnel compensation	
11.1	Full-time permanent	$0
11.9	Total personnel compensation	0
12.1	Civilian personnel benefits	0
21	Travel and transportation of persons	0
22	Transportation of things	0
23.3	Communications, utilities and miscellaneous charges	0
24	Printing and reproduction	0
25.1	Advisory and assistance services	0
25.2	Other services	0
25.3	Purchases of goods and services from Government accounts	0
25.5	Research and development contracts	113
25.7	Operation and maintenance of equipment	0
26	Supplies and materials	0
31	Equipment	0
32	Land and structures	0
41	Grants, subsidies and contributions	4,519
99	Direct obligations	4,632
	Transfer to NIST Working Capital Fund	0
	Total increase requested	4,632

Department of Commerce
National Institute of Standards and Technology
Technology Innovation Program
REIMBURSABLE PROGRAM AND WORKING CAPITAL FUND INVESTMENTS
(Dollar amounts in thousands)

	FY 2008 Actual	FY 2009 Estimate	FY 2010 Estimate
Technical & Advisory Services	$151	0	0
Subtotal, Other Reimbursables	151	0	0
Total, Reimbursable Program	151	0	0
Subtotal, WCF transfer	0	0	0
Equipment Investments	$125	100	100
IE Amortization	(70)	(102)	(100)
Total, WCF Investments	55	(2)	0
Total, Reimbursable Program and WCF Investments	206	(2)	0

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Department of Commerce
National Institute of Standards and Technology
Industrial Technology Services
PROGRAM AND PERFORMANCE: DIRECT OBLIGATIONS
(Dollar amounts in thousands)

Activity: Hollings manufacturing extension partnership
Subactivity: Hollings manufacturing extension partnership

Line Item		2008 Actual		2009 Currently Available		2010 Base		2010 Estimate		Increase/ (Decrease) Over 2010 Base	
		Personnel	Amount	Personnel	Amount	Personnel	Amount	Personnel	Amount	Personnel	Amount
Hollings manufacturing	Pos./Approp	64	$89,640	64	$110,000	64	$110,247	68	$124,700	4	$14,453
extension partnership	FTE/Obl.	68	90,542	68	111,857	68	110,247	71	124,700	3	14,453

Department of Commerce
Technology Administration
National Institute of Standards and Technology
Industrial Technology Services
JUSTIFICATION OF PROGRAM AND PERFORMANCE
HOLLINGS MANUFACTURING EXTENSION PARTNERSHIP

Goal Statement

This program supports NIST's mission of promoting U.S. innovation and industrial competitiveness by advancing measurement science, standards, and technology in ways that enhance economic security and improve our quality of life. This program also supports the Department of Commerce (DoC) strategic goal to maximize U.S. competitiveness and enable economic growth for American industries, workers, and consumers. To achieve the NIST goal and realize the DoC strategic goal, the Hollings Manufacturing Extension Partnership (MEP) Program acts as a strategic advisor to promote business growth and connect manufacturers to public and private resources essential for increased productivity, profitability and competitiveness.

Base Program

The MEP program is a Federal-state-local partnership that provides U.S. manufacturers with access to technologies, resources, and industry experts. The MEP program consists of manufacturing extension centers, which are linked to state, university, and private sources of technology. Funding for the MEP centers is a cost-sharing arrangement consisting of support from the Federal government, state and local government, and the charging of fees for services. The Administration's FY 2010 request is the first step in a proposed increase of the program to a level of $180 million by the year 2015.

The importance of a strong manufacturing base to the economy of the United States coupled with rapid changes to the economic, business and technology environment makes the role of MEP acting as a catalyst for maintaining and increasing the competitiveness of U.S. manufacturers more important now than anytime in history. The MEP centers work to position manufacturers to compete in the global economy through services that are grounded in business growth principles by encouraging, new product development, sustainable manufacturing processes and "green" products, the integration of supply chains, and increasing the technical and problem solving skills of the workforce.

MEP will maintain its national network, continuing to serve as a resource for manufacturing and innovation by leveraging resources to couple cost reduction strategies with profitable growth through new product development and market expansion. Through the Next Generation strategy MEP will continue to facilitate the transformation of manufacturing into a more powerful engine of innovation providing manufacturers with a framework that addresses the drivers of business growth and competitiveness. Specifically, MEP couples continuous performance improvement strategies with enhanced productivity to free up capacity for growth. Technology acceleration, supplier development and sustainability strategies represent the next logical steps toward generating increased profit, creating jobs, and bolstering a long-term competitive position. Continued success requires that manufacturers develop proactive growth strategies and foster an entrepreneurial workforce. By encouraging firms to invest in themselves across all elements of their organization, MEP will work to create an environment that puts firms in position to innovate in order to create new sales, enter into new markets and adopt new technologies that build competitive advantage.

MEP has established itself as the connecting point for manufacturers, state and local governments, private sector resources, research organizations, and the federal government. Through these partnerships, the MEP program is committed to identifying and providing services that respond to the challenges and needs of U.S. manufacturers. As a system, MEP is improving manufacturing competitiveness throughout the United States. The program's success is demonstrated through the most recent (FY 2007) impacts reported by MEP clients.

For FY 2007 clients reported:

- New and retained sales of over $10 billion
- More than $1.4 billion in cost savings from improved processes and waste reduction
- Investments in new equipment and business operations totaling almost $2.2 billion
- The creation and retention of 57,079 jobs

The data above is from an independent follow-up survey of clients completing projects with MEP Centers in FY 2007.

The FY 2010 base program operating objectives for the MEP program include the following:

- Work with the manufacturing extension centers and state and local governments to further develop their industrial extension infrastructure to increase capabilities and effectiveness and enhance the integration of the network of centers, while reaching more manufacturing customers.

- Manage and evaluate the MEP centers.
- Build selected partnerships with state and local governments, private sector resources, research organizations, and the federal government to develop and deploy the tools and services need by U.S. manufacturers.

Performance Measures

Data on NIST programmatic performance evaluation and reporting are provided in Exhibit 3A of this budget request.

Department of Commerce
National Institute of Standards and Technology
Industrial Technology Services
INCREASE FOR FY 2010
(Dollar amounts in thousands)

	2010 Base		2010 Estimate		Increase/(Decrease) Over 2010 Base	
	Personnel	Amount	Personnel	Amount	Personnel	Amount
Hollings Manufacturing Extension Partnership...Pos./Approp	64	$110,247	68	$124,700	4	$14,453
FTE/Obl.	68	$110,247	71	$124,700	3	$14,453

Hollings Manufacturing Extension Partnership (MEP) program (+4 Permanent Positions, +3 FTE, Appropriation +$14,453,000, Direct Obligations +$14,453,000) – The purpose of this initiative is to expand the MEP program to a funding level in support of the Administration's policy initiatives for strengthening domestic manufacturing to create jobs and meet the challenges of the 21st century by supporting the adoption of technological innovations that spur economic growth and fosters the development of new products, expanded markets, and process improvements.

This initiative supports:

the MEP goal: to act as a strategic advisor to promote business growth and connect manufacturers to public and private resources essential for increased productivity, profitability and competitiveness;

the NIST mission: to promote U.S. innovation and industrial competitiveness by advancing measurement science, standards, and technology in ways that enhance economic security and improve our quality of life;

the Department of Commerce strategic goal: to maximize U.S. competitiveness and enable economic growth for American industries, workers, and consumers.

Problem Magnitude and NIST Role:

A strong manufacturing base is critical to the financial and national security of the United States. Prior to the recent financial crisis, U.S. manufacturing firms employed over 13 million people in high-paying jobs with benefits; represented roughly two-thirds of total U.S. research and development expenditures; and accounted for more than 80 percent of all U.S. exports. If the U.S. manufacturing sector were a country, it would be the 8th largest country in terms of gross domestic product (GDP) in the world. Manufacturing creates millions of jobs, directly and indirectly, in a wide range of related industries. These include business services such as accounting, marketing, legal support, shipping, and warehousing as well as millions more indirect jobs in other local industries. Beyond these services supporting the extended manufacturing enterprise, the broader U.S. service economy also depends increasingly on the adoption of technologies from the manufacturing sector to keep pace with global competition.

Now more than ever, manufacturers, particularly small and medium-sized manufacturing firms, are facing new and significant challenges. Technology and globalization have fundamentally changed many manufacturing companies and products. This has led in turn to a new era of cost pressures, shortened product life cycles, technology that is diffusing rapidly on a global scale, and production that now involves orchestrating networks of suppliers. Manufacturing increasingly depends on access to customers and the infrastructure needed to support the constant reinvention of their products and processes. The challenge is clear: Increasing global competition -- coupled with the changing nature of innovation -- demands that the U.S. not rest on a strategy of simple productivity improvements.

Modern day manufacturing requires not only an efficient production system but also developing business strategies that highlight the unique capabilities of a firm and demonstrate their advantages over competitors. This means manufacturers must master innovative product design, understand the benefits of adopting environmentally sustainable processes, invest in human and physical capital, leverage a range of financing options, realize international trade opportunities, and forecast future customer demands – even before the customer knows their needs. The manufacturers of the future will need to understand their brand and take advantage of all their assets – tangible and intangible – to distinguish themselves in the market. The firms that succeed will be those best able to manage the complexity and rapid change affecting all aspects of the manufacturing enterprise. Sustaining and strengthening this vital sector requires an efficient, catalytic Federal role – partnering with state and local governments – to supply high-quality, unbiased information, advice, and assistance that help firms respond to new requirements.

NIST/ MEP is an essential element to continue providing that catalytic role. NIST has historically been at the core of our Nation's technical infrastructure for manufacturing firms. For the past 20 years, teaming with non-profit organizations, states and economic development agencies, MEP has provided many U.S. manufacturers with the tools and services to become more competitive, productive, and profitable while making it possible for even the smallest firms to tap into specialists from across the country with

manufacturing expertise. MEP offers an effective delivery system of technology and technology-related services to these firms working at the grassroots level to ensure that our Nation's manufacturing firms can compete globally and that their combined capabilities can help support U.S. based manufacturing supply chains.

MEP's potential customers, approximately 330,000 small and medium-sized manufacturers, are a cornerstone of the U.S. economy, and they contribute significantly to national and economic security. Given the geographic dispersion of this segment of industry along with the high cost of adopting innovative technology, maintaining the marketplace for productivity-enhancing and growth-focused services for small manufacturers is difficult and costly. This diseconomies of scale associated with smaller manufacturing firms is why many advanced economies operate MEP-like programs, and the U.S. trading partners that lack them are trying to put them in place as fast as they can. The Internet, inexpensive computers, and new supply chain logistics, while helpful, do not solve the problem.

The MEP program has a strong history of measurably improving the productivity and competitiveness of Hollings MEP clients. The most recent (FY 2007) client reported impacts include:

- new sales of $5.60 billion,
- retained sales of $4.88 billion,
- client cost savings of $1.44 billion,
- new client investment in modernization of $2.19 billion,
- creation and retention of 57, 079 jobs, and
- 28,004 clients served.

MEP successfully provides the services that reduce manufacturers' bottom-line expenses, increase efficiencies and build capacity. While continuous performance improvement strategies enhance productivity and free up capacity for growth, the Next Generation MEP represents the next logical steps toward generating profit, creating jobs, and bolstering a long-term competitive position through services focused on technology acceleration, supplier development and sustainability. Long-term success requires that manufacturers develop proactive growth strategies and foster an entrepreneurial workforce. By encouraging firms to invest in themselves across all elements of their organization, MEP will work to create an environment that puts firms in position to innovate in order to create new sales, enter into new markets and adopt new technologies that build competitive advantage.

MEP's expanded service offerings are and will be focused on business strategy development, market expansion, new product development, integration into supply chains, and engaging the creativity and technical and problem solving skills of the workforce that require unique partnerships between industry, academia, and state, local and Federal government.

MEP and its non-profit and state partners help thousands of U. S. manufacturers each year by working one-on-one to implement the best combination of tools and services for each individual company. Continuous improvement initiatives offer reduced expenses while growth services are aimed at increasing profitability through the development of new sales, new markets, and new products along with the adoption of new technologies. MEP center service offerings provide the tools to keep manufacturers competing and thriving in today's global marketplace. Recent examples include:

- Halcyon Products, Inc., located in Chagrin Falls, Ohio, manufacturers high-quality, innovative products that improve safety and promote efficiencies for emergency first responders. The company had an idea for a hand-held, illuminated compass to provide navigation during a fire. Halcyon worked with the Ohio Manufacturing Extension Partnership to help develop concept drawings and working beta-unit prototypes. Halcyon sent the prototypes to 70 fire departments around the country for testing and received positive feedback. In mid-2008, the company went into full production and began shipping units to the market. As a result of this new product, the company created 5 new jobs and estimates sales of $350,000 in the 2008-2009 calendar year.

- Transco Products, Inc. located in Streator, Illinois produces fabricated components and services for the nuclear power industry. When the company decided to explore new opportunities to grow the business, they contacted the Illinois Manufacturing Extension Center (IMEC), an MEP affiliate center. IMEC walked Transco through a disciplined and analytical process to create new ideas, discover market opportunities and efficiently bring the ideas into development. Together, the Transco team developed a total of 78 ideas and began looking into the top 3 that have the most marketplace appeal. Through the ideation process, the company quickly developed the ideas and began testing their feasibility. One idea focused on the redesign of a core product. Transco is working with University of Illinois senior engineering students to design the product and manufacture it economically so that the product remains price competitive. The company hopes to launch the new product in time to benefit from the construction of new nuclear power plants in Asia. Transco estimates that this new product could help it to more than double its international market share, and double or triple revenue in five to ten years.

Proposed NIST Technical Program:

As the global marketplace continues to evolve, and become increasingly more competitive, productivity improvements of U.S. manufacturers will continue to be critical for this sector of the economy. While manufacturers in virtually all industries recognize that quality and lean processes are now required just to be in business, productivity and growth gained exclusively from these cost reduction efforts are just the first steps to providing a solid foundation necessary to maintain a competitive position. Long-term competitive advantage requires manufacturers have access to a wide-range of resources that enable them to sell to new customers,

compete in new markets, and develop new products thus creating new, more profitable revenue streams. The FY 2010 initiative will allow MEP to build upon a strong foundation and add new services with a specific focus on 1) increasing manufacturers' adoption and application of advanced and clean technologies and the development of new products and 2) reducing manufacturers' environmental impact and the related costs by promoting the development of new, environmentally-focused materials, products and processes.

With the requested funding for FY 2010, the Next Generation MEP will be providing a robust national partnership to support the Administration's policy initiatives focused on strengthening domestic manufacturing and promoting economic growth by expanding and enhancing the program's ability to meet the new 21st century needs of manufacturers.

A robust MEP system will:

- respond to the rapid global change of technology and business systems advances,
- provide manufacturers with the latest available tools and services to grow and strengthen their business through the development of new sales, new markets, new products and the adoption of innovative technologies,
- accelerate the adoption of advanced and clean technologies into commercialized products,
- improve manufacturers' competitive position through reduced environmental costs and impact and facilitate the development of new environmentally-focused products and processes, and
- foster innovative industry, academia and local, state and federal government partnerships focused on meeting the increased challenges facing U.S. manufacturers.

Performance Measures
(Total Program)

Data on the performance evaluation and reporting methods for all NIST programs are provided in Exhibit 3A of this budget request.

Department of Commerce
National Institute of Standards and Technology
Industrial Technology Services
PROGRAM CHANGE PERSONNEL DETAIL

Activity: Hollings manufacturing extension partnership
Subactivity: Hollings manufacturing extension partnership
Program Change: Hollings manufacturing extension partnership

Title	Grade	Number	Annual Salary	Total Salaries
Contracts procurement advisor	ZA IV	1	102,721	102,721
IT webmaster	ZA IV	1	102,721	102,721
Federal project officer	ZA III	1	73,100	73,100
Technology deployment specialist	ZA III	1	73,100	73,100
Subtotal		4		351,642
Less lapse	25 %	(1)		(87,911)
Total full-time permanent (FTE)		3		263,731
2010 Pay Adjustment (2.0%)				5,275
Total				269,006

Personnel Data	
Full-Time Equivalent Employment:	
Full-time permanent	3
Authorized Positions:	
Full-time permanent	4

Exhibit 15

Department of Commerce
National Institute of Standards and Technology
Industrial Technology Services
PROGRAM CHANGE DETAIL BY OBJECT CLASS
(Dollars in thousands)

Activity: Hollings manufacturing extension partnership
Subactivity: Hollings manufacturing extension partnership
Program Change: Hollings manufacturing extension partnership

Object Class		2010 Increase/ (Decrease) Obligations
11	Personnel compensation	
11.1	Full-time permanent	$269
11.9	Total personnel compensation	269
12.1	Civilian personnel benefits	73
21	Travel and transportation of persons	57
22	Transportation of things	5
23.3	Communications, utilities and miscellaneous charges	301
24	Printing and reproduction	1
25.1	Advisory and assistance services	0
25.2	Other services	2,460
25.3	Purchases of goods and services from Government accounts	157
25.5	Research and development contracts	0
25.7	Operation and maintenance of equipment	42
26	Supplies and materials	139
31	Equipment	142
32	Land and structures	0
41	Grants, subsidies and contributions	10,807
99	Direct obligations	14,453
	Transfer to NIST Working Capital Fund	0
	Total increase requested	14,453

Department of Commerce
National Institute of Standards and Technology
Hollings Manufacturing Extension Partnership
REIMBURSABLE PROGRAM AND WORKING CAPITAL FUND INVESTMENTS
(Dollar amounts in thousands)

	FY 2008 Actual	FY 2009 Estimate	FY 2010 Estimate
Department of Homeland Security	$296	$296	$100
Department of Labor	109	109	0
Environmental Protection Agency	0	0	100
Other	224	224	0
Subtotal, Federal Agencies	629	629	200
Total, Reimbursable Program	629	629	200
Subtotal, WCF transfer	0	0	0
Equipment Investments	133	106	106
IE Amortization	(75)	(109)	(106)
Total, WCF Investments	58	(3)	0
Total, Reimbursable Program and WCF Investments	687	626	200

Department of Commerce
National Institute of Standards and Technology
Industrial Technology Services
SUMMARY OF REQUIREMENTS BY OBJECT CLASS
(Dollar amounts in thousands)

	Object Class	2008 Actual	2009 Currently Available	2010 Base	2010 Estimate	Increase/ (Decrease) Over 2010 Base
11	Personnel compensation					
11.1	Full-time permanent	$12,206	$13,083	$13,467	$13,736	$269
11.3	Other than full-time permanent	1,118	1,152	1,188	1,188	0
11.5	Other personnel compensation	493	493	493	493	0
11.9	Total personnel compensation	13,817	14,728	15,148	15,417	269
12.1	Civilian personnel benefits	3,589	3,775	3,921	3,994	73
13	Benefits for former personnel	0	0	0	0	0
21	Travel and transportation of persons	840	1,041	1,041	1,098	57
22	Transportation of things	22	40	40	45	5
23.1	Rental payments to GSA	4	5	5	5	0
23.2	Rental payments to others	91	130	133	133	0
23.3	Communications, utilities, and miscellaneous charges	1,940	2,009	1,948	2,249	301
24	Printing and reproduction	10	109	109	110	1
25.1	Advisory and assistance services	7,923	7,450	7,450	7,450	0
25.2	Other services	3,029	6,404	7,623	10,083	2,460
25.3	Purchases of goods and services from government accounts	1,197	1,228	1,242	1,399	157
25.5	Research and development contracts	1,246	1,360	1,448	1,561	113
25.7	Operation and maintenance of equipment	935	935	935	977	42
26	Supplies and materials	497	522	522	661	139
31	Equipment	762	778	778	920	142
32	Land and structures	0	0	0	0	0
41	Grants, subsidies, and contributions	108,979	155,007	136,972	152,298	15,326
42	Insurance claims and indemnities	0	0	0	0	0
99	Total Obligations	144,881	195,521	179,315	198,400	19,085

	Object Class	2008 Actual	2009 Currently Available	2010 Base	2010 Estimate	Increase/ (Decrease) Over 2010 Base
99	Total Obligations	144,881	195,521	179,315	198,400	19,085
	Less Prior Year Recoveries	(9,295)	(4,300)	(3,800)	(3,800)	0
	Less Prior Year Refunds	(1,633)	0	0	0	0
	Less Prior Year Unobligated Balance	(19,734)	(21,221)	0	0	0
	Plus Unobligated Balance End of Year	21,221	0	0	0	0
	Total Budget Authority	135,440	170,000	175,515	194,600	19,085
	Plus Unobligated Balance Rescission	18,800	5,000	0	0	0
	Plus Transfer to BIS	600	0	0	0	0
	Appropriation	154,840	175,000	175,515	194,600	19,085

Personnel Data

Full-time equivalent employment:					
Full-time permanent	123	125	127	130	3
Other than full-time permanent	16	16	16	16	0
Total	139	141	143	146	3
Authorized Positions:					
Full-time permanent	122	126	126	130	4
Other than full-time permanent	11	11	11	11	0
Total	133	137	137	141	4

Department of Commerce
National Institute of Standards and Technology
Industrial Technology Services
DETAILED REQUIREMENTS BY OBJECT CLASS
(Dollar amounts in thousands)

	Object Class	2010 Adjustments to Base	2010 Base	2010 Estimate	Increase/ (Decrease) Over 2010 Base
11	Personnel compensation				
11.1	Full-time permanent				
	Executive level	0	0	0	0
	Senior executive service	$24	$680	$680	0
	Career path	360	12,787	13,056	$269
	Wage board	0	0	0	0
	Scientific & professional (P.L. 80-313)	0	0	0	0
	Subtotal	384	13,467	13,736	269
11.3	Other than full-time permanent				
	Career path	36	1,188	1,188	0
	Wage board	0	0	0	0
	Scientific & professional (P.L. 80-313)	0	0	0	0
	Experts & consultants	0	0	0	0
	Subtotal	36	1,188	1,188	0
11.5	Other personnel compensation				
	Overtime	0	142	142	0
	SES performance awards	0	48	48	0
	Cash awards	0	303	303	0
	Other	0	0	0	0
	Subtotal	0	493	493	0
11.9	Total personnel compensation	420	15,148	15,417	269

	Object Class	2010 Adjustments to Base	2010 Base	2010 Estimate	Increase/ (Decrease) Over 2010 Base
12.1	Civilian personnel benefits				
	Civil service retirement	(15)	173	173	0
	Federal employees' retirement	71	1,336	1,366	30
	Thrift savings plan	31	530	536	6
	Federal Insurance Contribution Act	35	870	891	21
	Health insurance	25	855	871	16
	Life insurance	0	21	21	0
	Employees' Compensation Fund	0	60	60	0
	Other	0	76	76	0
	Subtotal	147	3,921	3,994	73
13	Benefits for former personnel				
	Severance pay	0	0	0	0
	Voluntary separation incentives	0	0	0	0
	Unemployment compensation	0	0	0	0
	Other	0	0	0	0
	Subtotal	0	0	0	0
21	Travel and transportation of persons				
	Common carrier	0	445	465	20
	Mileage	0	0	0	0
	Per diem/actual	0	369	396	27
	Other	0	227	237	10
	Subtotal	0	1,041	1,098	57
22	Transportation of things	0	40	45	5
23.1	Rental payments to GSA	0	5	5	0
23.2	Rental payments to others	0	133	133	0

	Object Class	2010 Adjustments to Base	2010 Base	2010 Estimate	Increase/ (Decrease) Over 2010 Base
23.3	Communications, utilities, and miscellaneous charges				
	Rental of ADP equipment	0	0	0	0
	Rental of office copying equipment	0	3	3	0
	Other equipment rental	0	14	15	1
	Federal telecommunications system	0	40	46	6
	Other telecommunications services	0	120	143	23
	Postal Service by USPS	0	7	7	0
	Utilities:				
	Electric	0	1,076	1,252	176
	Gas	(61)	582	665	83
	Water/Sewer	0	106	118	12
	Subtotal	(61)	1,948	2,249	301
24	Printing and reproduction				
	Publications	0	4	4	0
	Other	0	105	106	1
	Subtotal	0	109	110	1
25.1	Advisory and assistance services				
	Management & professional support services	0	4,864	4,864	0
	Studies, analyses, & evaluation	0	2,586	2,586	0
	Engineering & technical services	0	0	0	0
	Subtotal	0	7,450	7,450	0
25.2	Other services				
	Training	0	450	506	56
	ADP Services	0	32	45	13
	Other non-government contracts	(5)	7,141	9,532	2,391
	Subtotal	(5)	7,623	10,083	2,460
25.3	Purchases of goods and services from Government accounts				
	Payments to DM, WCF	14	607	607	0
	Office of Personnel Management	0	13	13	0
	Other Federal agencies:				
	Department of Commerce	0	11	141	130
	Other	0	611	638	27
	Subtotal	14	1,242	1,399	157

	Object Class	2010 Adjustments to Base	2010 Base	2010 Estimate	Increase/ (Decrease) Over 2010 Base
25.5	Research and development contracts	122	1,448	1,561	113
25.7	Operation and maintenance of equipment	0	935	977	42
26	Supplies and materials				
	Office & laboratory supplies	0	314	453	139
	Scientific publications & journals	0	159	159	0
	Fuel oil	0	49	49	0
	Subtotal	0	522	661	139
31	Equipment				
	Office machines and other equipment	0	50	134	84
	ADP equipment	0	566	624	58
	Equipment amortization	0	162	162	0
	Subtotal	0	778	920	142
32	Land and structures	0	0	0	0
41	Grants, subsidies, and contributions	4,878	136,972	152,298	15,326
42	Insurance claims and indemnities	0	0	0	0
99	Total Obligations	5,515	179,315	198,400	19,085
	Less Prior Year Recoveries	0	(3,800)	(3,800)	0
	Total Budget Authority	5,515	175,515	194,600	19,085
	Transfer to NIST Working Capital Fund	0	0	0	0
	Total Appropriation	5,515	175,515	194,600	19,085

Department of Commerce
National Institute of Standards and Technology
Industrial Technology Services
APPROPRIATION LANGUAGE AND CODE CITATIONS

1. For necessary expenses of the Hollings Manufacturing Extension Partnership Program of the National Institute of Standards and Technology,

15 U.S.C.271
15 U.S.C. 278b
15 U.S.C. 278k
15 U.S.C. 278l
15 U.S.C. 278n
15 U.S.C. 7506(b)(2)

15 U.S.C. 271 provides for NIST to support State technology programs supporting scientific and engineering research for accurate measurements and standards and improved technological processes.

15 U.S.C. 278b provides for a Working Capital Fund to support NIST activities.

15 U.S.C. 278k directs the Secretary, through the Director of NIST, to provide assistance for the creation of Regional Centers for the Transfer of Manufacturing Technology.

15 U.S.C. 278l provides authority for technical assistance to State technology programs.

15 U.S.C. 278n established the Advanced Technology Program within NIST to assist U.S. businesses in applying generic technology and research results to commercialize scientific discoveries and refine manufacturing technologies. Public Law 110-69 signed on August 9, 2007 has now abolished the Advanced Technology Program (ATP).

15 U.S.C. 7506(b)(2) instructs the NIST Director to utilize the Manufacturing Extension Partnership program to ensure that results of research on issues related to the development and manufacture of nanotechnology reach small- and medium-sized manufacturing companies.

2. $110,000,000, is provided for the Hollings Manufacturing Extension Partnership to remain available until expended per P.L. 111-8 Omnibus Appropriations Act, 2009.

   $65,000,000, is provided for the Technology Innovation Program to remain available until expended per P.L. 111-8 Omnibus Appropriations Act, 2009.

3. Public Law 110-69, America Competes Act, 121 Stat 572, passed August 9, 2007 reauthorizes the Industrial Technology Services appropriation through 2010. In addition, it eliminated the Advanced Technology Program (ATP) and established the Technology Innovation Program (TIP) which provides grants to eligible companies or joint ventures whose proposed technology has strong potential to address critical national needs. It also amended 15 U.S.C. 3711 by changing the name of the National Medal of Technology from "Technology Medal" to "Technology and Innovation Medal".

Department of Commerce
National Institute of Standards and Technology
Industrial Technology Services
ADVISORY AND ASSISTANCE SERVICES
(Obligations in thousands of dollars)

	FY 2008 Actual	FY 2009 Estimate	FY 2010 Estimate
Management and professional support services	$5,672	$4,864	$4,864
Studies, analyses, and evaluations	2,251	2,586	2,586
Engineering and technical services	0	0	0
Total	7,923	$7,450	7,450

Significant Activities

Advisory and assistance services funded by the Industrial Technology Services appropriation are used to conduct evaluations of the programmatic outcomes, service delivery efficiency, and internal infrastructure requirements of ATP/TIP and the Hollings MEP Program.

Need for Advisory and Assistance Services:

The need for advisory and assistance services stems from the role of NIST's extramural programs with its outside partners and small businesses to relate to the private sector, professional organizations, and the public sector. Inputs must be obtained from consultants who can bring their individual expertise to bear and help NIST in assessing its program plans to meet the needs of its customers. The alternative to utilizing these services is to make no attempt to have expertise from sources outside NIST and risk having a poorer working and professional relationship with those in the business of using the products and services offered by NIST. These services provide for economic assessment and external evaluation of NIST's extramural programs.

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Department of Commerce
National Institute of Standards and Technology
Construction of Research Facilities
SUMMARY OF RESOURCE REQUIREMENTS
(Dollar amounts in thousands)

	Positions	FTE	Budget Authority	Direct Obligations	Appro-priation
2009 Currently Available*	81	77	$532,000	$572,058	$532,000
less: Unobligated balance from prior year	0	0	0	(40,058)	0
2010 Adjustments to base:					
less: American Recovery and Reinvestment Act of 2009			(360,000)	(360,000)	(360,000)
less: Non-recurring 2009 costs	0	0	(103,700)	(103,700)	(103,700)
plus: Uncontrollable cost changes	0	4	237	237	237
2010 Base Request	81	81	68,537	68,537	68,537
plus: 2010 Program changes	0	0	48,363	48,363	48,363
2010 Estimate	81	81	116,900	116,900	116,900

		2008 Actual		2009 Currently Available		2010 Base		2010 Estimate		Increase/ (Decrease) Over 2010 Base	
Comparison by activity/subactivity:		Per-sonnel	Amount	Per-sonnel	Amount	Per-sonnel	Amount	Per-sonnel	Amount	Per-sonnel	Amount
Construction and major renovations											
Construction and major	Pos/Approp	66	$160,490	81	$532,000 *	81	$68,537	81	$116,900	0	$48,363
renovations	FTE/Obl.	66	138,153	77	572,058	81	68,537	81	116,900	0	48,363
Adjustments for:											
Prior year recoveries			(639)		0		0		0		0
Prior year refunds			(2)		0		0		0		0
Unobligated balance, start of year			(17,080)		(40,058)		0		0		0
Unobligated balance, end of year			40,058		0		0		0		0
Financing from transfers:											
Transfers to other accounts (+)			0		0		0		0		0
Appropriation			160,490		532,000		68,537		116,900		48,363

* Includes the American Recovery and Reinvestment Act of 2009 (P.L. 111-5) supplemental appropriation to NIST (CRF $360 million).

Department of Commerce
National Institute of Standards and Technology
Construction of Research Facilities
SUMMARY OF FINANCING
(Dollar amounts in thousands)

	2008 Actual	2009 Currently Available	2010 Base	2010 Estimate	Increase/ (Decrease) Over 2010 Base
Total Obligations	$138,306	$572,969	$68,537	$116,900	$48,363
Financing:					
Offsetting collections from:					
Federal funds	0	0	0	0	0
Non-Federal sources	(911)	0	0	0	0
Total offsetting collections	(911)	0	0	0	0
Adjustments for:					
Prior year recoveries	(639)	0	0	0	0
Prior year refunds	(2)	0	0	0	0
Unobligated balance, start of year (Direct)	(17,080)	(40,058)	0	0	0
Unobligated balance, start of year (Reimbursable)	(153)	(911)	0	0	0
Unobligated balance, end of year (Direct)	40,058	0	0	0	0
Unobligated balance, end of year (Reimbursable)	911	0	0	0	0
Budget Authority	160,490	532,000	68,537	116,900	48,363
Financing:					
Transfer to other accounts	0	0	0	0	0
Transfer from other accounts	0	0	0	0	0
Appropriation	160,490	532,000	68,537	116,900	48,363

Department of Commerce
National Institute of Standards and Technology
Construction of Research Facilities
ADJUSTMENTS TO BASE
(Dollar amounts in thousands)

	Perm. Pos.	FTE	Amount
Adjustments:			
Dropout of congressionally directed projects	...	...	($74,000)
Dropout of one-time ARRA Funding (P.L. 111-5)		...	(360,000)
Adjustment for one-time construction items	...	...	(29,700)
Subtotal	...	...	(463,700)
Other Changes:			
Annualization of 2009 Pay raise	...	...	88
2010 Pay increase and related costs	...	...	116
Annualization of positions financed in FY 2009	...	4	0
Personnel benefits:			
Civil Service Retirement System (CSRS)	...	...	(10)
Federal Employees' Retirement System (FERS)	...	...	16
Thrift Savings Plan (TSP)	...	...	7
Federal Insurance Contribution Act (FICA) - OASDI	...	...	8
Health insurance	...	...	9
Employees Compensation Fund	...	...	3
General pricing level adjustment:			
Communications, utilities, and miscellaneous charges	...	...	5
Other services	...	...	450
Supplies and materials	...	...	26
Equipment	...	...	2
Subtotal, Other changes	...	4	720
Subtotal, Adjustments to base	...	4	(462,980)
Amount absorbed	...	...	(483)
Total, Adjustments to base	...	4	(463,463)

Department of Commerce
National Institute of Standards and Technology
Construction of Research Facilities
JUSTIFICATION OF ADJUSTMENTS TO BASE
(Dollar amounts in thousands)

	FTE	Amount
Adjustments:		
Dropout of congressionally directed projects	0	($74,000)

In FY 2009, NIST received $74,000,000 in congressionally directed projects. This adjustment removes the one-time costs.

Dropout of one-time ARRA Funding (P.L. 111-5)	0	(360,000)

In FY 2009, NIST received $360,000,000 in one-time funding from the American Recovery and Reinvestment Act (ARRA). This adjustment removes the one-time funding.

Adjustment for one-time construction items	0	(29,700)

In FY 2009, NIST received $29,700,000 in one-time funding for construction and modernization of facilities at the Gaithersburg, Maryland, and Boulder, Colorado worksites.

Subtotal, Adjustments	0	(463,700)

Other Changes:

Annualization of 2009 pay raise		0	88

A pay raise of 3.9 percent is assumed to be effective January 1, 2009.

Total cost in FY 2010 of 2009 pay raise	$199,034
Less amount requested in FY 2009	(111,000)
Less amount absorbed in FY 2009	0
Amount requested in 2010 to provide full-year cost of 2009 pay raise	88,034
Payment to Departmental Management Working Capital Fund	0
Total FY 2009 pay raise increase in FY 2010	88,034

2010 Pay increase and related costs		0	116

A general pay raise of 2.0 percent is assumed to be effective January 1, 2010.

Total cost in FY 2010 of pay increase	$116,000
Less amount absorbed in FY 2009	0
Amount requested for FY 2009 pay increase	116,000
Payment to Departmental Management Working Capital Fund	0
Total adjustment for FY 2010 pay increase	116,000

Annualization of positions financed in FY 2009		4	0

NIST requires an additional 4 FTE to staff FY 2009 requested increases at their full operating level in FY 2010.

Personnel benefits	0	33

Civil Service Retirement System (CSRS)	($10)
Federal Employees' Retirement System (FERS)	16
Thrift Savings Plan (TSP)	7
Federal Insurance Contribution Act (FICA) - OASDI	8
Health Insurance	9
Employees Compensation Fund	3

Civil Service Retirement System (-$10,000) – The number of employees covered by the Civil Service Retirement System (CSRS) continues to drop as positions become vacant and are filled by employees who are covered by the Federal Employees Retirement System (FERS). The estimated percentage of payroll for employees covered by CSRS will decrease from 16.8 percent in FY 2009 to 14.6 percent in FY 2010. The contribution rate will remain at 7.0 percent in FY 2010.

Payroll subject to retirement systems ($6,432,000)	
Cost of CSRS contributions in FY 2010 ($6,432,000 x .146 x .07)	$65,735
Cost of CSRS contributions in FY 2009 ($6,432,000 x .168 x .07)	75,640
Total adjustment to base	(9,905)

Federal Employees' Retirement System ($16,000) – The number of employees covered by FERS continues to rise as employees covered by CSRS leave and are replaced by employees covered by FERS. The estimated percentage of payroll for employees covered by FERS will increase from 83.2 percent in FY 2009 to 85.4 percent FY 2010. The contribution rate will remain at 11.2 percent in FY 2010.

Payroll subject to retirement systems ($6,432,000)	
Basic benefit cost in FY 2010 ($6,432,000 x .854 x .112)	$615,208
Basic benefit cost in FY 2009 ($6,432,000 x .832 x .112)	599,359
Total adjustment to base	15,849

Thrift Savings Plan ($7,000) – The cost of agency contributions to the Thrift Savings Plan will also rise as FERS participation increases. The contribution rate will remain at 4.65 percent.

Thrift plan cost in FY 2010 ($6,432,000 x .854 x .0465)	$255,421
Thrift plan cost in FY 2009 ($6,432,000 x .832 x .0465)	248,841
Total adjustment to base	6,580

Federal Insurance Contributions Act (FICA) - OASDI ($8,000) – As the percentage of payroll covered by FERS increases, the cost of OASDI contributions will increase. In addition, the maximum salary subject to OASDI tax will increase from $106,425 in FY 2009 to $110,400 in FY 2010. The OASDI tax rate will remain 6.2 percent in FY 2010.

FERS payroll subject to FICA tax in 2010 ($6,432,000 x .854 x .904 x .062)	$307,868
FERS payroll subject to FICA tax in 2009 ($6,432,000 x .832 x .905 x .062)	300,268
Increase (FY 2009-FY 2010)	7,600
OTP payroll subject to FICA tax in FY 2010 ($641,000 x .854 x .904 x .062)	30,681
OTP payroll subject to FICA tax in FY 2009 ($641,000 x .832 x .905 x .062)	29,924
Increase (FY 2009-FY 2010)	757
Total adjustment to base	8,357

Health insurance ($9,000) – Effective January 2008, NIST's contribution to Federal employees' health insurance premiums increased by 2.1 percent. Applied against the FY 2009 estimate of $418,000, the additional amount required is $8,778

Employees Compensation Fund ($3,000) – The Employees Compensation Fund bill for the year ending June 30, 2008 is a net $63,000 higher than the year ending June 30, 2007. The CRF share of the increase is $3,000.

General pricing level adjustment	0	483

This request applies the OMB economic assumptions of .8 percent for FY 2010 where the prices that the government pays are established through the market system. Factors are applied to sub-object classes that result in the following adjustments to base: communications, utilities, and miscellaneous charges $5,368; other services $449,536; supplies and materials $26,232; and equipment $1,552.

Subtotal, Other changes	4	720
Amount Absorbed, Other changes	0	(483)
Total adjustments to base	4	(463,463)

Department of Commerce
National Institute of Standards and Technology
Construction of Research Facilities
PROGRAM AND PERFORMANCE: DIRECT OBLIGATIONS
(Dollar amounts in thousands)

Activity: Construction and major renovations
Subactivity: Construction and major renovations

Line Item		2008 Actual Personnel	2008 Actual Amount	2009 Currently Available Personnel	2009 Currently Available Amount	2010 Base Personnel	2010 Base Amount	2010 Estimate Personnel	2010 Estimate Amount	(Increase/ Decrease) Over 2010 Base Personnel	(Increase/ Decrease) Over 2010 Base Amount
Construction and major renovations	Pos/Approp	7	$123,904	0	$463,700	0	0	0	$48,363	0	$48,363
	FTE/Obl.	7	100,932	0	502,905	0	0	0	48,363	0	48,363
Safety, Capacity, Maintenance and Major Repairs	Pos/Approp	59	36,586	81	68,300	81	$68,537	81	68,537	0	0
	FTE/Obl.	59	37,219	77	69,153	81	68,537	81	68,537	0	0
Site Security	Pos/Approp	0	0	0	0	0	0	0	0	0	0
	FTE/Obl.	0	2	0	0	0	0	0	0	0	0
Total	Pos/Approp	66	160,490	81	532,000	81	68,537	81	116,900	0	48,363
	FTE/Obl.	66	138,153	77	572,058	81	68,537	81	116,900	0	48,363

Department of Commerce
National Institute of Standards and Technology
Construction of Research Facilities
JUSTIFICATION OF PROGRAM AND PERFORMANCE
MODIFICATIONS AND IMPROVEMENTS

Goal Statement

This program supports the Department of Commerce's and NIST's goal to promote U.S. innovation and industrial competitiveness by strengthening the Nation's measurement and standards infrastructure.

Base Program

The base program includes funding for the maintenance, repair, improvements and construction of facilities occupied or used by NIST in Gaithersburg, Maryland; Boulder and Fort Collins, Colorado; and Kauai, Hawaii; to meet the measurement and research needs of the 21st century. Base funding of $68.5 million is used to address the highest priority safety, capacity, maintenance and major repair projects at NIST. This will help ensure compliance with various health and safety regulations, improve access for people with disabilities, and permit the performance of maintenance and major repairs, as well as safeguard the utility infrastructure of existing buildings.

The FY 2010 base program operating objectives include the following:

- continue the repair/upgrade of facilities that have a high impact on staff and visitor safety;
- continue abatement of hazardous materials from site buildings and structures;
- continue to modify the sites to comply with the Access to Federal Buildings Act and the Americans with Disabilities Act;
- continue repairs/replacements of utility systems, exhaust and air filtration systems, mechanical-electrical systems, and site alarm fire safety systems that are failing at an accelerated rate due to the fact that the systems are over 40 to 50 years old;
- continue architectural, structural, and energy conservation related repairs, as needed;
- continue site infrastructure to include roads, docks, pedestrian walk areas, and storm water drainage; and
- enable or maintain building environmental conditions required for meeting scientific requirements.

While a plan for the use of the base funds has been developed, it is important to note that the planned use of these funds is subject to change if and when facilities-related emergency situations arise. Also, in many cases, final cost estimates resulting from contract negotiations may affect the number of projects that can be funded.

Performance Measures

Within available resources, the goal of this program is to keep laboratory and office space safe and appropriate for the work conducted. For existing buildings, NIST will keep the average unscheduled downtime to less than seven percent of the total scheduled operating time.

Department of Commerce
National Institute of Standards and Technology
Construction of Research Facilities
INCREASE FOR FY 2010
(Dollar amounts in thousands)

		2010 Base		2010 Estimate		Increase/(Decrease) Over 2010 Base	
		Personnel	Amount	Personnel	Amount	Personnel	Amount
Total, Construction and Major Renovations...	Pos./Approp	81	$68,537	81	$116,900	0	$48,363
	FTE/Obl.	81	68,537	81	116,900	0	48,363
Building 1 Renovation.....	Pos./Approp	0	0	0	26,000	0	26,000
(Construction and major renovations)	FTE/Obl.	0	0	0	26,000	0	26,000

Building 1 Renovation (Appropriation +$26,000,000, Direct Obligations +$26,000,000)

- This initiative is part of a long-term plan to renovate Building 1 of the NIST Boulder laboratories, which houses the majority of NIST Boulder measurements and research.

- Building 1 is nearly 60 years old. Aging structural, mechanical, electrical, and safety systems significantly reduce the research and measurement productivity of the NIST Boulder laboratories.

- NIST measurements and research performed in Building 1 support national priorities in such areas as alternative energy, advanced manufacturing, information technology, improved health care, nanotechnology, and many other areas. But this crucial work is impeded by continually worsening problems with laboratory facilities that cannot provide the stable environment needed for cutting-edge research and measurements, such as control of vibration, temperature, and air quality.

- This initiative enables the planning, design, and initial construction of phased renovations for Building 3 and Wings 3, 5, and 6 of Building 1. Completion of the planning, design, and construction of the initial renovations will position NIST to begin interior renovations necessary to support scientific discovery and technical development of transformational technology in support of many national needs.

- Renovations will emphasize use of green technologies, saving energy, water, and construction materials to meet national environmental goals.

- This initiative would enable NIST to more effectively and efficiently address the *President's Plan for Science and Innovation* calling for a doubling of NIST Laboratory research by FY 2016. This investment also addresses NIST's priorities to "Strengthen NIST's laboratories and facilities to ensure U.S. leadership in measurement science"...and to "Enhance the NIST facilities and equipment that enable cutting-edge research."

Problem Magnitude and NIST Role:

Aging laboratory facilities at NIST Boulder substantially hinder NIST's mission of fostering innovation and ensuring U.S. competitiveness, and impose significant costs to the Nation. Scientific work at the NIST Boulder laboratories supports national priorities such as alternative energy, information technology, health care, advanced manufacturing and many other areas. However, this work is significantly impaired by aging facilities that cannot provide the tight control of temperature, vibration, humidity, and air cleanliness required for world-leading measurements and research to support twenty-first century innovation and competitiveness. The nearly 60-year-old facilities cause a productivity loss of at least 20 percent[1], and prevent NIST from performing the most demanding research and measurements needed by industry and the scientific community. Even for the limited range of work that can be attempted, current laboratory conditions create significant inefficiencies. Much research and many measurements can only be conducted sporadically when environmental conditions are temporarily stable and much experimental data and construction of nanoscale devices becomes worthless because of corruption due to poor laboratory conditions. This reduced productivity represents a direct loss of about $10 million per year to NIST Boulder laboratory programs. But the impact on the Nation is much greater. The results of numerous external economic impact studies demonstrate a economic benefit to the U.S. of about 40 dollars for every dollar invested in NIST measurements and research (http://www.nist.gov/director/planning/summary-studies.htm). The $10 million productivity loss represents a loss of about $400 million per year to the U.S. in unrealized economic benefits. Much research and measurement planned for the future will not be possible without significantly upgraded facilities.

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1 NIST Boulder Facilities Review Team, *Report on NIST Boulder Laboratory Facilities: Findings and Recommendations on Possible Renovation of Existing Facilities and Possible Construction of New Laboratory Facilities*, January 31, 2006.

Problems due to poorly-performing laboratory facilities directly affect NIST customers in industry and other Federal agencies. A partial list of other Federal agencies relying on NIST Boulder research and measurements to fulfill their missions includes Department of Defense, Department of Energy, Department of Homeland Security, Defense Advanced Research Project Agency, National Aeronautics and Space Administration, National Institutes of Health, National Oceanic and Atmospheric Administration, Department of the Interior, Department of Justice, Department of Transportation, Federal Communications Commission, Food and Drug Administration, Occupational Safety and Health Administration, and Environmental Protection Agency. The ability of NIST Boulder scientists to support these agencies is already compromised by poorly-performing laboratory facilities, and the problem will continue to worsen as more stringent measurements and research will be required.

Scientific and technical progress demand increasingly accurate and precise measurements. For example, NIST scientists invented atomic clocks which have enabled the Global Positioning System (GPS), high capacity telecommunications, synchronization of electric power grids, and many other key technologies and infrastructures supporting national needs and promoting U.S. innovation. Planned improvements by NIST Boulder scientists to atomic clock accuracy by a factor of 100 or more–to the equivalent of one second in 30 billion years–will enable improvements in these applications and create new applications in a wide range of precision measurements. Next generation innovations in national priorities such as nanotechnology, homeland security, telecommunications, materials testing, electrical and electronic measurements, timing and synchronization, electromagnetic interference, biotechnology, and many other areas currently require similar progress in the unique, world-leading research and measurements performed by NIST Boulder laboratories.

Increasing the accuracy and the precision of measurements critical to next generation scientific and technical advancements demands stringent environmental control beyond the current capabilities of NIST Boulder laboratories. Recent funding has enabled NIST Boulder to make excellent progress in improving laboratory space and the utility infrastructure; however, additional funding is needed to complete the necessary facility improvements at NIST Boulder.

The comprehensive facilities plan for NIST Boulder includes a phased approach to most cost-effectively and efficiently provide the required high performance laboratory space. This plan includes a combination of construction of the Building 1 Extension (B1E) advanced laboratory to meet the most stringent facilities performance requirements, coupled with major renovation of existing laboratory space to meet less demanding performance requirements at a lower cost. NIST continually reviews the adequacy of its laboratory facilities to meet the increasingly stringent needs for precision measurements and research that require ever tighter control of temperature, vibration, humidity and air cleanliness. This on-going review process included a major internal study[2] in 2006 to review the capabilities of existing laboratory space compared to the type and amount of high-performance laboratory space that NIST needs to support

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2 NIST Boulder Facilities Review Team, *Report on NIST Boulder Laboratory Facilities: Findings and Recommendations on Possible Renovation of Existing Facilities and Possible Construction of New Laboratory Facilities*, January 31, 2006.

21st century measurements and research in key areas such as nanotechnology, biotechnology, alternative energy sources, telecommunications, and advanced manufacturing. The 2006 review identified the need for approximately 178,000 net assignable square feet (NASF) of laboratory space of varying performance level, from L1 through L4. Performance level L1 indicates modest performance requirements for control of temperature, vibration, humidity, and air cleanliness. Performance requirements increase through the most stringent level L4. The study also categorized the existing approximately 183,000 NASF of current laboratory space according to the L1 through L4 performance levels. Please see Table 1.

Table 1: NIST Boulder Advanced Laboratory Space Requirements and Current Capabilities

	General Lab Level 1 (L1)	General Lab Level 2 (L2)	General Lab Level 3 (L3)	Instrument Lab (L4)
Temperature Control (°C)	+/- 2	+/- 1	+/- 0.5	+/- 0.25
Relative Humidity Control	NA	+/- 20%	+/-20%	+/- 5%
Air Filtration Class	100,000	100,000	10,000	100
Vibration Control (micrometers/second)	Insensitive	12.5	< 12.5	3
Current NIST Boulder Lab Capabilities (NASF)	139,930*	39,100	3,900	No existing space meets these requirements
NIST Boulder Lab Needs Assessment (NASF)	39,000	12,500	78,700	48,000
	Can be achieved by renovation of existing laboratories			Can only be achieved by construction of the advanced Building 1 Extension laboratory.

**Much of the existing NIST Boulder laboratory space does not even meet the minimal L1 requirement.*

Because renovation or construction costs increase substantially as performance levels increase from the lowest level (L1) through the highest level (L4), NIST was careful to determine exactly how much laboratory space is needed at each performance level, to ensure the lowest possible total cost for the required facilities improvements.

Table 1 indicates that NIST requires 48,000 NASF of very high performance laboratory space at the L4 (Instrument Lab) level to meet the most demanding measurement and research needs, such as atomic clocks accurate to one second in 30 billion years and chemical characterization of nanodevices at the level of individual atoms, among many other crucial programs. These needs can best be met through

the construction of the B1E advanced laboratory, begun in fiscal year 2008 and slated for completion in 2011 (assuming full funding). As discussed, it is not cost-effective to try to renovate existing laboratory space to the L4 level, and it may not even be technically feasible.

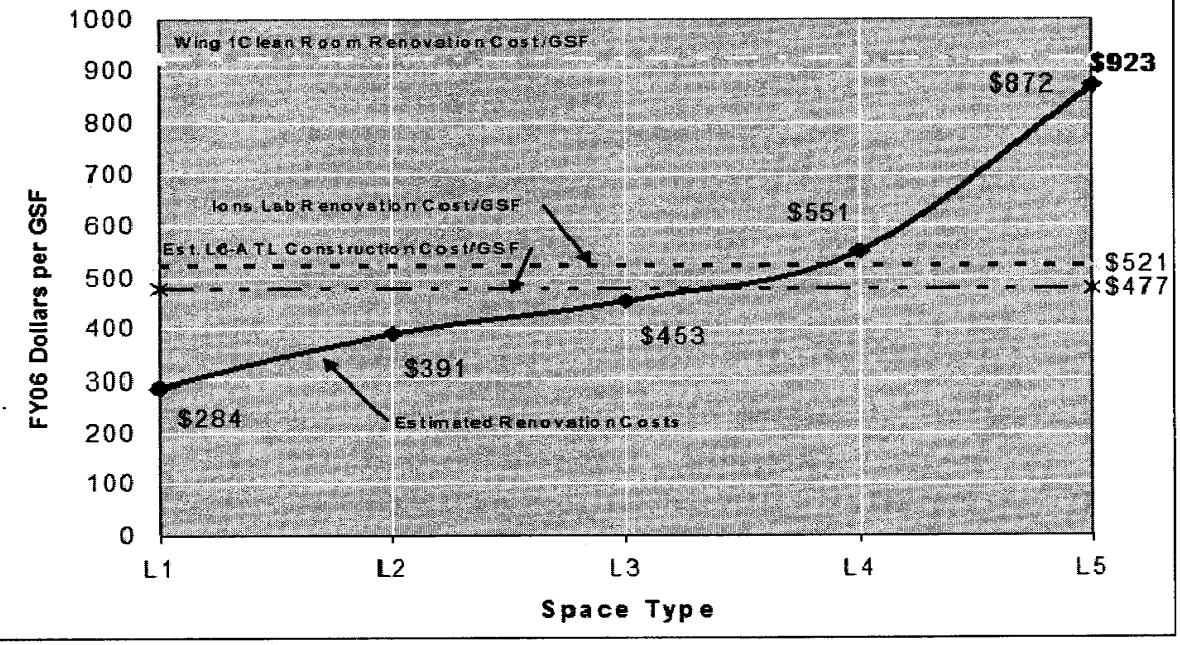
In addition to the L4 highest performance space to be provided through B1E construction, NIST Boulder also requires nearly 80,000 NASF of high performance, L3 level laboratory space. As described in Table 1, this L3 space has significant performance requirements for control of temperature, vibration, humidity and air cleanliness – but the requirements are not as stringent as the L4 requirements, and the L3 space can be more cost-effectively provided through renovation rather than new construction.

However, NIST Boulder currently has only about 3,900 NASF of L3 performance lab space. In fact, nearly 140,000 NASF – or more than three-quarters of existing NIST Boulder laboratory space – is at the L1 or lower performance level, completely inadequate for the great majority of NIST Boulder measurement and research programs. Less than 25 percent of current NIST Boulder laboratory space performs to required specifications. And the B1E will house only about the top 25 percent of NIST Boulder measurement and research programs with the most stringent needs for environmental control. Thus NIST Boulder needs to renovate about 50 percent of its existing laboratory space to meet the performance requirements for 21st century measurements and research supporting U.S. innovation and economic security. To meet the facilities needs for about 80,000 NASF of L3 performance laboratory space, the facilities plan includes the selected renovation of about half of Building 1, including Wings 3, 5, 6 and a portion of the Center Spine.

The construction of the B1E, the planning, design, and construction of the selected renovations will enable NIST to support scientific discovery and technical development of transformational technology in homeland security, telecommunications, nanotechnology, precision timing, hydrogen energy sources, precision electrical standards, biotechnology, applications of lasers, electromagnetic interference testing, quantum computing and quantum communications, and other national needs. These are all complex technical programs that require several different laboratory spaces for each project, with each laboratory space contributing different parts to the measurements and research. For example, NIST Boulder research in quantum computing includes studies of using laser-cooled trapped ions to do the calculations, and complementary programs that use solid-state nanotechnology devices to do the calculations. For technical reasons, the laser-cooled ion approach requires very stringent control of temperatures and vibration (L4), while the solid-state nanotechnology approach has significantly less stringent requirements (L3). So NIST plans to locate the laser-cooled ion program in the L4 labs of the B1E, but to save significant funds by locating the solid-state nanotechnology program in the less expensive L3 renovated laboratories. For each of the other programs listed above (electromagnetic interference testing, precision electrical standards, nanotechnology, etc.), it is similarly true that parts of each program must be located in the B1E to benefit from the very tight environmental control (L4 level), while other parts can be successfully conducted in the less-stringent L3 renovated space at a net cost savings. However, all of these programs – and many other NIST Boulder programs – will be significantly impaired or rendered useless without the renovation to L3 performance levels. Failure to act will dramatically limit the ability of NIST to provide the technical infrastructure to support disruptive technologies that are critical to the future economic security and industrial competitiveness in the 21st century.

Part of the 2006 NIST Boulder facilities review included a detailed comparison of the costs of renovation of existing facilities compared to the cost of new construction. Based on data from previous renovation projects on the NIST Boulder site, and on data for construction of new high performance laboratory space such as required for the B1E, NIST determined that it is most cost-effective to perform ***renovations*** to improve lab facilities up to the ***L3 level***, but it is most cost-effective to ***construct new facilities for L4 performance.*** For the greatest cost-savings, the NIST facilities plan includes construction of the B1E to provide the required L4 performance space, coupled with selected renovations to provide the required L3 performance space. Table 2 summarizes the costs of renovation and new construction for different laboratory performance levels.

Table 2: **Boulder Renovation Costs**



Proposed NIST Technical Program:

This initiative will identify project scopes for all work associated with the renovations planned for the Boulder site. Components of this initiative include: development of renovation phasing plan and migration plans for the orderly relocation of staff and research activities to accommodate the planned renovation activities, verification of estimated construction budgets, the completion of renovation design and construction documents, the limited renovation of Building 3 for the relocation of the Instrument Shops, and the construction of modified roof structures, service corridors and mechanical equipment rooms in Building 1, Wings 3, 5, and 6 to support future renovation efforts.

Specific elements in the design documents included in this initiative are:

- Moving the instrument shop from Wing 3 of Building 1 to renovated space in Building 3. The instrument shop occupies a substantial fraction of Building 1. Included in the out year funding associated with this initiative, the vacated Wing 3 space is planned as the first renovation. The Wing 3 space would be renovated to high quality laboratory space; the renovated space would serve as initial laboratory swing space to enable future renovations in other parts of Building 1.

- Construction of service corridors along the external walls and the modification of the roof structure at Building 1, Wings 3, 5 and 6. The modified roof structures and the service corridors will provide space separate from the pedestrian corridor for the distribution of utilities such as steam, chilled water, compressed air, and electrical power; these areas will also carry the duct systems necessary for heating, ventilation, air conditioning.

- Construction of mechanical equipment rooms for utility connection points to the Central Utility Plant and for distribution of mechanical and electrical services to the wings. These mechanical equipment rooms provide the space at each wing for equipment such as electrical switchgear and transformers, pumps, motors, and air handling equipment. These spaces also provide for loading dock access.

- Renovation design and construction will comply with the Energy Policy Act of 2005 and will be submitted for Leadership in Energy and Environmental Design System (LEEDS) certification for existing buildings.

Performance Measures: Outputs

At the proposed funding level, NIST will generate the following outputs:

Building 1 Renovation	
Technical Area	**Outputs**
Building 1 Renovation	• Award contract for renovation planning and design (FY 2010) • Renovation planning and design complete (FY 2010) • Contract awarded for the limited renovation of Building 3 (FY 2010)

Performance Measures: Outcomes

At the proposed funding level, NIST will generate the following outcomes:

As part of a comprehensive plan for upgrading the aging and inadequate NIST Boulder facilities to enable 21st century research and measurement, this initiative is a crucial first step in the renovation process to enable the NIST Boulder laboratories programs to better support key national technology priorities in nanotechnology, homeland security, new energy sources, biotechnology, and many other areas.

Scientific progress and technical advances demand increasingly accurate and precise measurements that are currently not available anywhere in the world. NIST Boulder laboratories lack the stringent environmental control needed to deliver critical measurements ranging from time to electrical quantities to materials properties to electromagnetic interference. By completing the selected renovations as part of a long-term plan for improving aging NIST Boulder facilities, NIST will be able to develop the measurement infrastructure needed to give domestic industry a unique resource to enhance domestic innovative capacity and foster scientific discovery and technological innovation which have driven about half of U.S. economic growth. NIST's job is to provide U.S. manufacturers and scientists with "world standard" templates that are indispensable to enable new generations of science, technology, and competitive products.

The technologies that will define the first half of the 21st century – nanotechnology, bioscience and information technology among them– rely to an unprecedented degree on measurement capabilities that push the limits of science. They will not be accomplished in laboratories with systems that are well past their life expectancy and cannot be cost-effectively renovated to 21st century research and measurement capabilities.

The successful improvement of the NIST Boulder facilities – through construction of the B1E advanced laboratory and the extensive renovation of parts of the existing facilities – will enable NIST to support scientific discovery and technical development of transformational technology in homeland security, telecommunications, nanotechnology, precision timing, hydrogen energy sources, precision electrical standards, biotechnology, applications of lasers, electromagnetic interference testing, quantum computing and quantum communications, and other national needs. The renovation of Wing 6 in particular will support improved application of nanotechnology to make much higher speed electronics for surveillance and sensing applications in homeland security and defense; dramatically improved characterization of how interference affects defense, homeland security, and space systems, and how to better harden instruments against interference; new applications of microwaves and radio waves for diagnosis and treatment of disease; development of new ways to ensure effective radio communications in mines, tunnels, and buildings to enable better emergency response; and many other areas of research and measurement. Failure to act fully on this comprehensive facilities upgrade plan will dramatically limit the ability of NIST to provide the technical infrastructure to support disruptive technologies that are critical to the future economic security and industrial competitiveness in the 21st century.

Outyear Funding Estimates (Budget Authority in Thousands)									
	FY 2009 and Prior	**FY 2010**	**FY 2011**	**FY 2012**	**FY 2013**	**FY 2014**	**FY 2015**	**Estimate to Complete**	**Total Program Estimate**
Renovation of Building 1		26,000	22,400	14,400	7,400	0	0	0	70,200

**Outyear costs are estimates and are subject to change. Current Boulder Renovation Plans do not currently extend past 2013. Future requests will be determined through the annual budget process.*

Exhibit 15

Department of Commerce
National Institute of Standards and Technology
Construction of Research Facilities
PROGRAM CHANGE DETAIL BY OBJECT CLASS
(Dollars in thousands)

Activity: Construction and major renovations
Subactivity: Construction and major renovations
Program Change: Building 1 renovation

Object Class		2010 Increase/ (Decrease) Obligations
11	Personnel compensation	
11.1	Full-time permanent	$0
11.9	Total personnel compensation	0
12.1	Civilian personnel benefits	0
21	Travel and transportation of persons	0
22	Transportation of things	0
23.3	Communications, utilities and miscellaneous charges	0
24	Printing and reproduction	0
25.1	Advisory and assistance services	0
25.2	Other services	8,900
25.3	Purchases of goods and services from Government accounts	0
25.5	Research and development contracts	0
25.7	Operation and maintenance of equipment	0
26	Supplies and materials	0
31	Equipment	0
32	Land and structures	17,100
41	Grants, subsidies and contributions	0
99	Direct obligations	26,000
	Transfer to NIST Working Capital Fund	0
	Total increase requested	26,000

Department of Commerce
National Institute of Standards and Technology
Construction of Research Facilities
INCREASE FOR FY 2010
(Dollar amounts in thousands)

		2010 Base		2010 Estimate		Increase/(Decrease) Over 2010 Base	
		Personnel	Amount	Personnel	Amount	Personnel	Amount
Total, Construction and Major Renovations.....	Pos./Approp	81	$68,537	81	$116,900	0	$48,363
	FTE/Obl.	81	68,537	81	116,900	0	48,363
Renovation of General Purpose	Pos./Approp	0	0	0	14,363	0	14,363
Laboratories (Construction and major renovations)	FTE/Obl.	0	0	0	14,363	0	14,363

Renovation of General Purpose Laboratories (Appropriation +$14,363,000, Direct Obligations +$14,363,000)

- This initiative is part of a long-term plan to renovate the General Purpose Laboratories (GPLs) at NIST Gaithersburg, which house the majority of NIST measurements and research.

- The GPLs are nearly 45 years old. Aging structural, mechanical, electrical, and safety systems significantly reduce the research and measurement productivity of the NIST Gaithersburg laboratories.

- NIST measurements and research performed in the GPLs support national priorities in such areas as alternative energy, advanced manufacturing, information technology, enabling the Smart Grid, improved health care, nanotechnology, and many other areas. But this crucial work is impeded by continually worsening problems with laboratory facilities that cannot provide the stable environment needed for cutting-edge research and measurements, such as control of vibration, temperature, and air quality.

- This initiative enables the initial planning and design of the multi-phase, multi-year Gaithersburg GPL renovations.

- The renovations will include installation of energy-saving and water-saving technologies to meet national environmental goals.

- This initiative would enable NIST to more effectively and efficiently address the *President's Plan for Science and Innovation* calling for a doubling of NIST Laboratory research by FY 2016. This investment also addresses NIST's priorities to "Strengthen NIST's laboratories and facilities to ensure U.S. leadership in measurement science"...and to "Enhance the NIST facilities and equipment that enable cutting-edge research."

Problem Magnitude and NIST Role:

The NIST Gaithersburg General Purpose Laboratories (GPLs) house the majority of NIST measurements and research in national priority areas such as alternative energy, advanced manufacturing, nanotechnology, information technology, biosciences, improved national infrastructure, and many other areas. But the aging GPLs are not able to support cutting-edge measurements and research because of poor building performance. The GPLs cannot provide the required stable temperatures, low vibrations, and air quality needed for precision measurements and demanding research. The result is substantially reduced measurement and research productivity, as poor facilities conditions results in bad scientific data, or as some measurements and research cannot be properly conducted at all.

Although it is difficult to quantify, NIST scientists recently estimated a very conservative ten percent loss to their productivity resulting from poor laboratory conditions. This has dramatic impacts on the U.S. economy as well. Numerous external studies of the economic impact of NIST measurements and research demonstrate an average return of 40 dollars in improved U.S. economic benefits for each dollar invested in NIST measurements and research (http://www.nist.gov/director/planning/summary-studies.htm). Using a rough estimate of $500 million for the NIST laboratories appropriation, a ten percent productivity loss represents an annual loss of about $50 million in measurement and research productivity, or an annual loss of about $2 billion in unrealized economic benefits. The cost of upgrading the NIST GPLs to improve measurement and research productivity would be repaid many times over through improved economic benefits to the U.S.

The NIST Gaithersburg GPLs comprise seven measurement and research laboratory buildings and a total of about 1.2 million square feet. The more than 40 year old buildings are unable to provide the tight control of temperature, vibration, and air quality that is needed for 21st century measurements and research. Major renovations will be required to bring the buildings to a modern performance level.

As part of the renovations, NIST will install modern energy-saving and water-saving technologies to meet national energy and environmental goals.

The renovation of all the GPLs is a long-term program as part of NIST's facilities plan. The FY 2010 funding represents a first step, beginning the planning and design for the multi-phase, multi-year renovations.

Proposed NIST Technical Program:

In FY 2010, this initiative will fund the planning, programming and migration planning for the renovation, and the swing space for the entire GPL renovation program. This initiative will identify the phasing plans, the basis of design and budget for each phase of the renovation program. A comprehensive schedule will be developed for the GPL renovations as part of this initiative. Additional funding, estimated at $35.6 million, will be needed in the out years to complete the design for renovating all of NIST Gaithersburg GPLs.

Performance Measures: Outputs

At the proposed funding level for FY 2010, NIST will generate the following outputs:

Renovation of General Purpose Laboratories	
Technical Area	**Outputs**
Renovation planning documentation	• Award multiyear Architectural/Engineering contract to plan and design the GPL renovations (FY 2010). • Renovation planning complete (FY 2011).

Performance Measures: Outcomes

At the proposed funding level, NIST will generate the following outcomes at the completion of the project:

As part of a comprehensive plan for upgrading the aging and inadequate NIST Gaithersburg facilities to enable 21st century research and measurement, this initiative is a crucial first step in the renovation process of the GPLs to enable the NIST Gaithersburg GPL programs to better support key national priorities in alternative energy, advanced manufacturing, information technology, biosciences, and many other areas.

Scientific progress and technical advances demand increasingly accurate and precise measurements that are currently not available anywhere in the world. NIST Gaithersburg GPLs lack the stringent environmental control needed to deliver critical measurements ranging

from time to electrical quantities to materials properties to electromagnetic interference. By completing the selected renovations as part of a long-term plan for improving aging NIST Gaithersburg facilities, NIST will be able to develop the measurement infrastructure needed to give domestic industry a unique resource to enhance innovative capacity and foster scientific discovery and technological innovation, which have driven about half of U.S. economic growth. NIST's job is to provide U.S. manufacturers and scientists with "world standard" templates that are indispensable to enable new generations of science, technology, and competitive products.

The technologies that will define the first half of the 21st century – nanotechnology, bioscience, and information technology among them– rely to an unprecedented degree on measurement capabilities that push the limits of science. They will not be accomplished in laboratories with 45-year old systems that are well past their life expectancy.

The successful improvement of the NIST Gaithersburg facilities – through the extensive renovation of GPLs – will enable NIST to support scientific discovery and technical development of transformational technology in national technology priority areas. Failure to act fully on this comprehensive GPL renovation program will dramatically limit the ability of NIST to provide the technical infrastructure to support disruptive technologies that are critical to the future economic security and industrial competitiveness in the 21st century.

Outyear Funding Estimates
(Budget Authority in Thousands)

	FY 2009 and Prior	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	Estimate to Complete	Total Program Estimate
Renovation of the General Purpose Laboratories		14,363	35,637	50,000	50,000	50,000	50,000	250,000	500,000

Department of Commerce
National Institute of Standards and Technology
Construction of Research Facilities
PROGRAM CHANGE DETAIL BY OBJECT CLASS
(Dollars in thousands)

Activity: Construction and major renovations
Subactivity: Construction and major renovations
Program Change: General purpose laboratory renovation

Object Class		2010 Increase/ (Decrease) Obligations
11	Personnel compensation	
11.1	Full-time permanent	$0
11.9	Total personnel compensation	0
12.1	Civilian personnel benefits	0
21	Travel and transportation of persons	0
22	Transportation of things	0
23.3	Communications, utilities and miscellaneous charges	0
24	Printing and reproduction	0
25.1	Advisory and assistance services	0
25.2	Other services	14,363
25.3	Purchases of goods and services from Government accounts	0
25.5	Research and development contracts	0
25.7	Operation and maintenance of equipment	0
26	Supplies and materials	0
31	Equipment	0
32	Land and structures	0
41	Grants, subsidies and contributions	0
99	Direct obligations	14,363
	Transfer to NIST Working Capital Fund	0
	Total increase requested	14,363

Department of Commerce
National Institute of Standards and Technology
Construction of Research Facilities
INCREASE FOR FY 2010
(Dollar amounts in thousands)

		2010 Base		2010 Estimate		Increase/(Decrease) Over 2010 Base	
		Personnel	Amount	Personnel	Amount	Personnel	Amount
Total, Construction and Major Renovations...	Pos./Approp	81	$68,537	81	$116,900	0	$48,363
	FTE/Obl.	81	68,537	81	116,900	0	48,363
NIST Center for Neutron Research (NCNR) Expansion and Reliability Improvements...	Pos./Approp	0	0	0	8,000	0	8,000
(Construction and major renovations)	FTE/Obl.	0	0	0	8,000	0	8,000

NIST Center for Neutron Research (NCNR) Expansion and Reliability Improvements (Appropriation +$8,000,000, Direct Obligations +$8,000,000)

The NCNR is widely regarded as the most cost-effective neutron facility in the United States and is currently the Nation's leading neutron research facility, serving more scientists and engineers than all other U.S. facilities combined. Neutron scattering techniques, in which high intensity beams of neutrons are used as a probe to "see" the structure and dynamics of materials at the nano-scale, are some of the most powerful measurement tools available. The role of the NCNR is to develop and apply neutron measurement techniques to problems of national importance. The quality and quantity of NCNR research consistently rank among the best in the world.

NIST has an opportunity to address a critical national need in a highly cost-effective manner by expanding the use of the existing facility. This is a continuation of an effort begun in FY 2007 to develop and install a new "cold" neutron source, which when combined with a neutron guide tube network, essentially converts one usable neutron beam into at least five. This expansion requires new instruments that would be fed by the additional neutron beams and a new guide hall in which to house these instruments. This would substantially augment NIST's neutron measurement capacity without the prohibitive cost of constructing a new facility, which is estimated to exceed $800 million. Central to the strategy of leveraging the existing NIST source is ensuring that the highly reliable operation of the

facility continues over its useful life, which will be at least an estimated additional 20 years. This expansion represents a unique opportunity to NIST has an opportunity to effectively and efficiently address the President's Technology Agenda which includes targets investments "strengthen NIST's laboratories and facilities to ensure U.S. leadership in measurement science"...and to "enhance the NIST facilities and equipment that enable cutting-edge research.

This initiative is part of a long-term plan to increase the capacity and effectiveness of the NIST Center for Neutron Research (NCNR). This is the fifth and final year of requests for this project. In FY 2007 and FY 2008, a total of $31 million was appropriated under the Construction of Research Facilities (CRF) appropriation to support the construction and expansion of a new Guide Hall and technical support buildings. Concurrently, in FY 2007, $10 million was appropriated under the Scientific and Technical Research and Services (STRS) appropriation for design and development of a new neutron source, a new guide tube system, and new instrumentation. In FY 2009, an additional $2.0 million of STRS was appropriated to allow NIST to begin installation of the new instruments on the new guide tubes, and to initiate testing, commissioning, and eventual operation of the instruments.

- This initiative will fund construction fit up costs for the expanded instrument building (called a Guide Hall) which houses the research and measurement instruments used by scientists and engineers from across the U.S. working at the NCNR. The initiative will also fund fit up costs for Technical Support Buildings crucial to the operations of the NCNR.

- These improvements are part of the overall plan to increase the measurement capacity of the NCNR by more than 25 percent, to increase the number of NCNR users by more than 500 each year, and to improve NCNR neutron measurement capabilities by more than a factor of 100.

Problem Magnitude and NIST Role:

Just as lasers use controlled light to enable a wide range of research and measurements, the NCNR uses controlled beams of neutrons to "see" and measure the properties and functions of materials at the scale of individual atoms, in ways that are impossible with any other imaging or measurement techniques. The NCNR develops and applies neutron measurement techniques to address national scientific and technical needs in areas such as energy, health care, and manufacturing. The NCNR is a user facility, with more than 2,000 scientists and engineers from universities, industry labs, and research organizations across the U.S. using the unique NCNR capabilities each year. NIST scientists also use the NCNR for measurements and research in a wide range of technical areas. Demand for use of NCNR unique facilities far outstrips current capacity and capabilities. External researchers make competitive proposals to use the NCNR, and many high-quality research proposals must be turned down because of limited capacity.

This proposal is part of a longer-term plan to expand the NCNR in a cost-effective manner, increasing research and measurement capacity by more than 25 percent, increasing the number of external users by 500 each year, and improving the quality of some research and measurement capabilities by more than a factor of 100. This upgrade program began in FY 2007 with the development of a new cold neutron source, which enables the number of research and measurement instruments used at the NCNR to be increased by a factor of five.

To fully utilize this expanded capacity, NIST is constructing a new Guide Hall (building housing the research and measurement instruments) and purchasing the new instruments. It is estimated that it would cost $800 million to build a new facility with the same capabilities as the NCNR expansion, so the expansion represents a dramatic cost savings for new research and measurement capabilities.

Neutrons are produced from a nuclear reactor, similar to nuclear power reactors but much smaller. Nuclear power reactors have a limited lifetime for both technical reasons and because the U.S. Nuclear Regulatory Commission (NRC) provides limited term operating licenses based on conditions of the reactor. This proposal also includes technical upgrades related to the reactor which will expand its lifetime by 20 years – to at least 2029 – by enabling upgrades that will result in NRC re-licensing.

Proposed NIST Technical Program:

In FY 2010, this initiative will fund construction fit up costs associated with configuring and occupying the completed Guide Hall facility and Technical Support Buildings. It will also fund the construction of a liner for the reactor fuel storage pool.

- In FY 2010, this initiative will provide funding for the construction of the new Guide Hall that will house the neutron instruments, and provide needed supporting facilities. The Guide Hall facility will be approximately 18,000 square feet of industrial high-bay type space with sufficient floor loading capacity, utilities, material handling systems, and support space suitable for housing five new neutron instruments, a neutron guide tube network, associated radiation shielding, ancillary equipment, cold source refrigeration systems, support storage and sample preparation space suitable to support a robust neutron scattering research program.

- The initiative will also provide for the electrical and mechanical systems needed in the new Guide Hall to support the operation of the new neutron scattering instruments, the reactor systems, and the beam delivery systems.

- The initiative also includes funding to upgrade existing reactor systems to ensure the continued safe and reliable operation of the facility over its expected additional 20 year operating life. For FY 2010, the planned upgrade includes the construction of a liner for the pool that stores spent (used) fuel for the nuclear reactor. The liner is designed to minimize the likelihood of an undetected leak of water from the storage pool.

Performance Measures: Outputs

At the proposed funding level for FY 2010, NIST will generate the following outputs:

NIST Center for Neutron Research (NCNR) Expansion and Reliability Improvements	
Technical Area	**Outputs**
Construction fit up	Installation of utility connections needed to begin operation of the new neutron scattering instruments.
Reactor reliability improvements	Installation of a pool liner for the spent fuel storage pool for the NCNR reactor.

Performance Measures: Outcomes

At the proposed funding level, NIST will generate the following outcomes at the completion of the project:

- A 50 percent increase in the number of cold neutron beams suitable for use by next-generation neutron scattering instruments, and
- Five new, world-class neutron instruments for U.S. researchers.

The demand for atomic and nanoscale characterization enabled by cold neutron scattering far exceeds the current capacity, and is expected to increase. The FY 2010 initiative to complete construction of a guide hall and add five new instruments to utilize the new neutron source begun in FY 2007 will go a long way towards meeting this need and will provide a competitive advantage to U.S. researchers who have access to the facility. Access to the NCNR is granted by a competitive proposal process, which ensures the research enabled will have the greatest impact.

Outyear Funding Estimates (Budget Authority in Thousands)									
	FY 2009 and Prior	**FY 2010**	**FY 2011**	**FY 2012**	**FY 2013**	**FY 2014**	**FY 2015**	**Estimate to Complete**	**Total Program Estimate**
Construction and major renovations – NCNR Expansion and Reliability Improvements	31,000	8,000	0	0	0	0	0	0	39,000

**Outyear costs are estimates and are subject to change. Future requests will be determined through the annual budget process.*

Department of Commerce
National Institute of Standards and Technology
Construction of Research Facilities
PROGRAM CHANGE DETAIL BY OBJECT CLASS
(Dollars in thousands)

Activity: Construction and major renovations
Subactivity: Construction and major renovations
Program Change: NIST center for neutron research expansion and reliability improvements

Object Class		2010 Increase/ (Decrease) Obligations
11	Personnel compensation	
11.1	Full-time permanent	$0
11.9	Total personnel compensation	0
12.1	Civilian personnel benefits	0
21	Travel and transportation of persons	0
22	Transportation of things	0
23.3	Communications, utilities and miscellaneous charges	0
24	Printing and reproduction	0
25.1	Advisory and assistance services	0
25.2	Other services	0
25.3	Purchases of goods and services from Government accounts	0
25.5	Research and development contracts	0
25.7	Operation and maintenance of equipment	0
26	Supplies and materials	0
31	Equipment	0
32	Land and structures	8,000
41	Grants, subsidies and contributions	0
99	Direct obligations	8,000
	Transfer to NIST Working Capital Fund	0
	Total increase requested	8,000

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Department of Commerce
National Institute of Standards and Technology
Construction of Research Facilities
SUMMARY OF REQUIREMENTS BY OBJECT CLASS
(Dollar amounts in thousands)

	Object Class	2008 Actual	2009 Currently Available	2010 Base	2010 Estimate	Increase/ (Decrease) Over 2010 Base
11	Personnel compensation					
11.1	Full-time permanent	$5,044	$6,068	$6,603	$6,603	0
11.3	Other than full-time permanent	0	0	0	0	0
11.5	Other personnel compensation	574	641	641	641	0
11.9	Total personnel compensation	5,618	6,709	7,244	7,244	0
12.1	Civilian personnel benefits	1,451	1,735	1,899	1,899	0
13	Benefits for former personnel	0	0	0	0	0
21	Travel and transportation of persons	0	8	8	8	0
22	Transportation of things	33	37	37	37	0
23.1	Rental payments to GSA	0	0	0	0	0
23.2	Rental payments to others	0	0	0	0	0
23.3	Communications, utilities, and miscellaneous charges	161	682	682	682	0
24	Printing and reproduction	0	2	2	2	0
25.1	Advisory and assistance services	0	0	0	0	0
25.2	Other services	25,455	111,907	53,592	76,855	$23,263
25.3	Purchases of goods and services from government accounts	0	104	104	104	0
25.5	Research and development contracts	0	0	0	0	0
25.7	Operation and maintenance of equipment	1,298	1,496	1,496	1,496	0
26	Supplies and materials	2,972	3,279	3,279	3,279	0
31	Equipment	144	194	194	194	0
32	Land and structures	49,757	138,942	0	25,100	25,100
41	Grants, subsidies, and contributions	51,262	306,963	0	0	0
42	Insurance claims and indemnities	2	0	0	0	0
99	Total Obligations	138,153	572,058	68,537	116,900	48,363

	Object Class	2008 Actual	2009 Currently Available	2010 Base	2010 Estimate	Increase/ (Decrease) Over 2010 Base
99	Total Obligations	138,153	572,058	68,537	116,900	48,363
	Less Prior Year Recoveries	(639)	0	0	0	0
	Less Prior Year Refunds	(2)				
	Less Prior Year Unobligated Balance	(17,080)	(40,058)	0	0	0
	Plus Unobligated Balance End of Year	40,058	0	0	0	0
	Total Budget Authority	160,490	532,000	68,537	116,900	48,363
	Plus Transfers from Other Accounts	0	0	0	0	0
	Appropriation	160,490	532,000	68,537	116,900	48,363

Personnel Data

Full-time equivalent employment:					
Full-time permanent	66	77	81	81	0
Other than full-time permanent	0	0	0	0	0
Total	66	77	81	81	0
Authorized Positions:					
Full-time permanent	66	81	81	81	0
Other than full-time permanent	0	0	0	0	0
Total	66	81	81	81	0

Department of Commerce
National Institute of Standards and Technology
Construction of Research Facilities
DETAILED REQUIREMENTS BY OBJECT CLASS
(Dollar amounts in thousands)

	Object Class	2010 Adjustments to Base	2010 Base	2010 Estimate	Increase/ (Decrease) Over 2010 Base
11	Personnel compensation				
11.1	Full-time permanent				
	Executive level	0	0	0	0
	Senior executive service	0	0	0	0
	Career path	$121	$4,917	$4,917	0
	Wage board	50	1,686	1,686	0
	Scientific & professional (P.L. 80-313)	0	0	0	0
	Subtotal	171	6,603	6,603	0
11.3	Other than full-time permanent				
	Career path	0	0	0	0
	Wage board	0	0	0	0
	Scientific & professional (P.L. 80-313)	0	0	0	0
	Experts & consultants	0	0	0	0
	Subtotal	0	0	0	0
11.5	Other personnel compensation				
	Overtime	0	632	632	0
	SES performance awards	0	0	0	0
	Cash awards	0	9	9	0
	Other	0	0	0	0
	Subtotal	0	641	641	0
11.9	Total personnel compensation	171	7,244	7,244	0

	Object Class	2010 Adjustments to Base	2010 Base	2010 Estimate	Increase/ (Decrease) Over 2010 Base
12.1	Civilian personnel benefits				
	Civil service retirement	(8)	69	69	0
	Federal employees' retirement	30	671	671	0
	Thrift savings plan	13	253	253	0
	Federal Insurance Contribution Act	19	447	447	0
	Health insurance	9	427	427	0
	Life insurance	0	9	9	0
	Employees' Compensation Fund	3	14	14	0
	Other	0	9	9	0
	Subtotal	66	1,899	1,899	0
13	Benefits for former personnel				
	Severance pay	0	0	0	0
	Unemployment compensation	0	0	0	0
	Other	0	0	0	0
	Subtotal	0	0	0	0
21	Travel and transportation of persons				
	Common carrier	0	3	3	0
	Mileage	0	0	0	0
	Per diem/actual	0	4	4	0
	Other	0	1	1	0
	Subtotal	0	8	8	0
22	Transportation of things	0	37	37	0
23.1	Rental payments to GSA	0	0	0	0
23.2	Rental payments to others	0	0	0	0

	Object Class	2010 Adjustments to Base	2010 Base	2010 Estimate	Increase/ (Decrease) Over 2010 Base
23.3	Communications, utilities, and miscellaneous charges				
	Rental of ADP equipment	0	0	0	0
	Rental of office copying equipment	0	45	45	0
	Other equipment rental	0	118	118	0
	Federal telecommunications system	0	11	11	0
	Other telecommunications services	0	27	27	0
	Postal Service by USPS	0	0	0	0
	Utilities:				
	Electric	0	312	312	0
	Gas	0	148	148	0
	Water/Sewer	0	21	21	0
	Subtotal	0	682	682	0
24	Printing and reproduction				
	Publications	0	1	1	0
	Other	0	1	1	0
	Subtotal	0	2	2	0
25.1	Advisory and assistance services				
	Management & professional support services	0	0	0	0
	Studies, analyses, & evaluation	0	0	0	0
	Engineering & technical services	0	0	0	0
	Subtotal	0	0	0	0
25.2	Other services				
	Training	0	40	40	0
	ADP Services	0	30	30	0
	Other non-government contracts	(57,000)	53,522	76,785	$23,263
	Subtotal	(57,000)	53,592	76,855	23,263
25.3	Purchases of goods and services from Government accounts				
	Payments to DM, WCF	0	0	0	0
	Office of Personnel Management	0	0	0	0
	Other Federal agencies:				
	Department of Commerce	0	57	57	0
	Other	0	47	47	0
	Subtotal	0	104	104	0

	Object Class	2010 Adjustments to Base	2010 Base	2010 Estimate	Increase/ (Decrease) Over 2010 Base
25.5	Research and development contracts	0	0	0	0
25.7	Operation and maintenance of equipment	0	1,496	1,496	0
26	Supplies and materials				
	Office & laboratory supplies	0	3,279	3,279	0
	Scientific publications & journals	0	0	0	0
	Fuel oil	0	0	0	0
	Subtotal	0	3,279	3,279	0
31	Equipment				
	Office machines and other equipment	0	16	16	0
	ADP equipment	0	178	178	0
	Equipment amortization	0	0	0	0
	Subtotal	0	194	194	0
32	Land and structures	(130,200)	0	25,100	25,100
41	Grants, subsidies, and contributions	(276,500)	0	0	0
42	Insurance claims and indemnities	0	0	0	0
99	Total Obligations	(463,463)	68,537	116,900	48,363
	Less Prior Year Recoveries	0	0	0	0
	Less Unobligated Balance start of year	0	0	0	0
	Plus Unobligated Balance end of year	0	0	0	0
	Total Budget Authority	(463,463)	68,537	116,900	48,363
	Transfer to NIST Working Capital Fund	0	0	0	0
	Total Appropriation	(463,463)	68,537	116,900	48,363

Department of Commerce
National Institute of Standards and Technology
Construction of Research Facilities
APPROPRIATION LANGUAGE AND CODE CITATIONS

1. For construction of new research facilities, including architectural and engineering design, and for renovation and maintenance of existing facilities, not otherwise provided for the National Institute of Standards and Technology, as authorized by 15 U.S.C. 278c-278e.

   15 U.S.C. 278c authorizes that the Secretary of Commerce to acquire land for such field sites as are necessary for the proper and efficient conduct of the activities authorized.

   15 U.S.C. 278d authorizes that the Secretary of Commerce to undertake such construction of buildings and other facilities and to make such improvements to existing buildings, grounds, and other facilities as are necessary for the proper and efficient conduct of authorized activities.

   15 U.S.C. 278e provides that in the performance of the functions of the National Institute of Standards and Technology the Secretary of Commerce is authorized to undertake: the care, maintenance, protection, repair, and alteration of Institute buildings and other plant facilities, equipment, and property.

2. $172,000,000, to remain available until expended per P.L. 111-8 Omnibus Appropriations Act, 2009.

3. Public Law 110-69, America Competes Act, 121 Stat 572, passed August 9, 2007 reauthorizes the Construction of Research Facilities appropriation through 2010. It also provided for the Retention of Fees to the Construction of Research Facilities account. "The Director is authorized to retain all building use and depreciation surcharge fees collected pursuant to OMB Circular A-25. Such fees shall be collected and credited to the Construction of Research Facilities Appropriation Account for use in maintenance and repair of the Institute's existing facilities".

4. Public Law 111-5, American Recovery and Reinvestment Act of 2009 appropriated $360,000,000 to the Construction of Research Facilities appropriation from FY 2009 to FY 2010.

Department of Commerce
National Institute of Standards and Technology
Construction of Research Facilities
ADVISORY AND ASSISTANCE SERVICES
(Obligations in thousands of dollars)

	FY 2008 Actual	FY 2009 Estimate	FY 2010 Estimate
Management and professional support services	$0	$0	$0
Studies, analyses, and evaluations	0	0	0
Engineering and technical services	0	0	0
Total	0	0	0

Significant Activities

Professional support and engineering and technical services are obtained when required to support the construction and major repairs and renovations of NIST's physical infrastructures in Gaithersburg, Maryland, and Boulder, Colorado. Strategies and action plans are also developed to further ensure structural building safety when the need arises.

Need for Advisory and Assistance Services

NIST uses outside professional support and engineering and technical services whenever necessary expertise is not available in-house to ensure the safety of NIST staff and visitors.

Department of Commerce
National Institute of Standards and Technology
Working Capital Fund
SUMMARY OF RESOURCE REQUIREMENTS
(Dollar amounts in thousands)

	Positions	FTE	Budget Authority	Direct Obligations
2009 Estimate	709	790	2,275	2,275
Reduction in transfers from prior STRS program changes	0	0	(2,025)	(2,025)
2010 Base	709	790	250	250
Transfer from STRS program changes for equipment investments			5,940	5,940
2010 Estimate	709	790	6,190	6,190

Department of Commerce
National Institute of Standards and Technology
Working Capital Fund
SUMMARY OF FINANCING
(Dollar amounts in thousands)

	2008 Actual	2009 Currently Available	2010 Base	2010 Estimate	Increase/ (Decrease) Over 2010 Base
Total Obligations	$171,981	$174,256	$151,704	$157,644	$5,940
Offsetting collections from:					
Federal funds	(108,034)	(124,694)	(101,524)	(101,524)	0
Non-Federal sources	(46,039)	(47,287)	(49,930)	(49,930)	0
Total offsetting collections	(154,073)	(171,981)	(151,454)	(151,454)	0
Unobligated balance, start of year	(140,778)	(123,708)	(123,708)	(123,708)	0
Unobligated balance, end of year	123,708	123,708	123,708	123,708	0
Unobligated balance expiring	(838)	0	0	0	0
Budget Authority	0	2,275	250	6,190	5,940
Financing:					
Transfer from other accounts	0	(2,275)	(250)	(6,190)	(5,940)
Appropriation	0	0	0	0	0

Department of Commerce
National Institute of Standards and Technology
Working Capital Fund
JUSTIFICATION OF PROGRAM AND PERFORMANCE

Goal Statement

This Working Capital Fund (WCF) supports the Department of Commerce's (DoC) and NIST's goal to promote U.S. innovation and industrial competitiveness by strengthening the Nation's measurement and standards infrastructure. The WCF reflects the full-time equivalent (FTE) employment and reimbursable obligations associated with the reimbursable work performed by NIST for other agencies and the public, and WCF investments.

Base Program

NIST's reimbursable services consist of technical work performed for other Federal agencies, state and local governments, and the private sector, including calibrations and special tests, advisory services, and the sale of Standard Reference Materials (SRMs). The unique measurement and standards expertise developed with appropriated funding gives NIST the capability to perform these services on a reimbursable basis. NIST accepts other agency work based on an established set of criteria which include: (1) the need for traceability of measurements to national standards; (2) the need for work which cannot or will not be addressed by the private sector; (3) work supported by legislation that authorizes or mandates certain services; (4) work which would result in an unavoidable conflict of interest if carried out by the private sector or regulatory agencies; and (5) requests by the private sector for NIST action or services.

The operations of the NIST WCF are reported in a program and financing schedule printed in the President's Budget, as well as reflected in the reimbursable amounts throughout this budget. In addition to its function as a revolving fund, the WCF is also used to handle annual leave on an accrued basis, to acquire equipment as an investment to be recovered through amortization charges to programs, to distribute indirect costs to programs as overhead, to carry the recoverable costs associated with the production of SRMs, and to carry supply inventories until issued for program use. A detailed cost accounting system is used to ensure that the actual cost of work performed for each job or task is recorded and identified with the appropriate source of financing.

Performance Measures

Data on NIST programmatic performance evaluation and reporting are provided in Exhibit 3A of this budget request.

Department of Commerce
National Institute of Standards and Technology
Working Capital Fund
SUMMARY OF REQUIREMENTS BY OBJECT CLASS
(Dollar amounts in thousands)

	Object Class	2008 Actual	2009 Currently Available	2010 Base	2010 Estimate	Increase/ (Decrease) Over 2010 Base
11	Personnel compensation					
11.1	Full-time permanent	0	0	0	0	0
11.3	Other than full-time permanent	0	0	0	0	0
11.5	Other personnel compensation	0	0	0	0	0
11.9	Total personnel compensation	0	0	0	0	0
12.1	Civilian personnel benefits	0	0	0	0	0
13	Benefits for former personnel	0	0	0	0	0
21	Travel and transportation of persons	0	0	0	0	0
22	Transportation of things	0	0	0	0	0
23.1	Rental payments to GSA	0	0	0	0	0
23.2	Rental payments to others	0	0	0	0	0
23.3	Communications, utilities, and miscellaneous charges	0	0	0	0	0
24	Printing and reproduction	0	0	0	0	0
25.1	Advisory and assistance services	0	0	0	0	0
25.2	Other services	0	0	0	0	0
25.3	Purchases of goods and services from Government accounts	0	0	0	0	0
25.5	Research and development contracts	0	0	0	0	0
25.7	Operation and maintenance of equipment	0	0	0	0	0
26	Supplies and materials	0	0	0	0	0
31	Equipment	0	$2,275	$250	$6,190	$5,940
32	Land and structures	0	0	0	0	0
41	Grants, subsidies, and contributions	0	0	0	0	0
42	Insurance claims and indemnities	0	0	0	0	0
99	Total Obligations	0	2,275	250	6,190	5,940

Personnel Data	2008 Actual	2009 Currently Available	2010 Base	2010 Estimate	Increase/ (Decrease) Over 2010 Base
Full-time equivalent employment:					
Full-time permanent	648	722	722	722	0
Other than full-time permanent	68	68	68	68	0
Total	716	790	790	790	0
Authorized Positions:					
Full-time permanent	635	679	679	679	0
Other than full-time permanent	30	30	30	30	0
Total	665	709	709	709	0

Department of Commerce
National Institute of Standards and Technology
Working Capital Fund
DETAILED REQUIREMENTS BY OBJECT CLASS
(Dollar amounts in thousands)

	Object Class	2010 Adjustments to Base	2010 Base	2010 Estimate	Increase/ (Decrease) Over 2010 Base
26	Supplies and materials				
	Office & laboratory supplies	0	0	0	0
	Other	0	0	0	0
	Subtotal	0	0	0	0
31	Equipment				
	Office machines and other equipment	($2,025)	$250	$4,540	$4,290
	ADP equipment	0	0	1,650	1,650
	Equipment amortization	0	0	0	0
	Subtotal	(2,025)	250	6,190	5,940
99	Total Obligations	(2,025)	250	6,190	5,940

Department of Commerce
National Institute of Standards and Technology
Working Capital Fund
ADVISORY AND ASSISTANCE SERVICES
(Obligations in thousands of dollars)

	FY 2008 Actual	FY 2009 Estimate	FY 2010 Estimate
Management and professional support services	$589	$669	$689
Studies, analyses, and evaluations	1,503	93	125
Engineering and technical services	1,153	0	0
Total	3,245	762	814

Significant Activities

Advisory and assistance services funded by the Working Capital Fund represent services funded by reimbursable funds in support of reimbursable work conducted at NIST.

Need for Advisory and Assistance Services

Advisory and Assistance services have been necessary to obtain additional expertise for conducting activities like the technical evaluation of the World Trade Center collapses, for example.

Working Capital Fund, National Institute of Standards and Technology (NIST)

The operations of the NIST Working Capital Fund are reported in a program and financing schedule printed in the President's Budget, as well as reflected in the reimbursable amounts throughout this budget. The fund finances the initial costs of work performed by NIST and is reimbursed by applicable appropriations and advances or reimbursements from other agencies. A detailed cost accounting system is used to ensure that the actual cost of work performed for each job or task is recorded and identified with the appropriate source of financing. In addition to its function as a revolving fund, the Working Capital Fund is also used to handle annual and sick leave on an accrued basis, to acquire equipment as an investment to be recovered through amortization charges to programs, to distribute indirect costs to programs as overhead, to carry the recoverable costs associated with the production of Standard Reference Materials, and to carry supply inventories until issued for program use.

The table below summarizes the total NIST program, according to the source of financing. Following this table is a summary of the NIST reimbursable program by sponsor and source of support.

Summary of Total NIST Program
(Obligations in thousands)

	FY 2008			FY 2009			FY 2010			
Source and Use of Funds Spent	Perm. Pos. [1]	FTE	Oblig.	Perm. Pos. [1]	FTE	Oblig.	Perm. Pos. [1/]	FTE	Oblig.	Approp. Requested
Direct Funding										
Scientific and technical research and services	1,933	1,891	$450,035	2,013	2,082	$723,006	2,174	2,195	$532,660	$534,600
Industrial technology services	133	139	144,881	137	141	195,521	141	146	198,400	194,600
Construction of research facilities	66	66	138,153	81	77	572,058	81	81	116,900	116,900
Gifts and bequests	0	0	2	0	0	2	0	0	2	0
Total, direct funding	2,132	2,096	733,071	2,231	2,300	1,490,587	2,396	2,422	847,962	846,100
Reimbursable Funding and WCF Investments										
Scientific and technical research and services - Smart Grid,	0	0	0	0	0	10,000	0	0	0	
Construction of research facilities - building surcharge	0	0	153	0	0	911	0	0	0	
Research, development and supporting services:										
Federal government	462	496	124,964	492	548	124,964	492	548	101,524	
Calibrations and tests, technical and advisory services:										
Federal government	22	24	6,098	24	27	6,047	24	27	6,420	
Public and non-federal government	86	93	23,506	92	102	23,307	92	102	24,744	
Subtotal, Services	108	117	29,604	116	129	29,354	116	129	31,164	
National Voluntary Laboratory Accreditation Program	19	21	5,449	20	23	5,967	20	23	6,200	
Standard reference materials (SRMs):										
SRM Sales:										
Federal government	2	2	294	2	2	288	2	2	297	
Public and non-federal government	74	80	12,179	79	88	11,963	79	88	12,269	
Subtotal, SRM sales	76	82	12,473	81	90	12,251	81	90	12,566	
SRM investment adjustment	0	0	(2,382)	0	0	0	0	0	0	
Subtotal, SRM	76	82	10,091	81	90	12,251	81	90	12,566	
Total, Reimbursable program	665	716	170,261 [2/]	709	790	183,447 [2/]	709	790	151,454	
WCF Investments and Operating Adjustments										
WCF investments	0	0	23,883	0	0	21,348	0	0	21,348	
WCF transfers	0	0	0	0	0	2,275	0	0	6,190	
WCF operating adjustments	0	0	(1,344)	0	0	0	0	0	0	
Total, WCF Investments and operating adjustments	0	0	22,539	0	0	23,623	0	0	27,538	
Total, NIST program	2,797	2,812	925,871	2,940	3,090	1,697,657	3,105	3,212	1,026,954	
Offsetting adjustment for amortization of equipment	0	0	(20,666)	0	0	(21,903)	0	0	(21,348)	
Adjusted total, NIST program	2,797	2,812	905,205	2,940	3,090	1,675,754	3,105	3,212	1,005,606	

[1/] Most NIST scientists and engineers are not engaged solely on one research project. Individuals may divide their time between two or more projects financed by different sources of support. Also, salary costs of many staff members are charged to an overhead account and subsequently prorated to all directly funded projects. For these reasons, it is not possible to report employment directly for any source of financing. The Permanent Positions above are statistically-derived numbers, based on the estimated work years distribution for NIST programs.

[2/] Total reimbursable numbers are different from the next page due to inclusion of STRS and CRF reimbursable.

Department of Commerce
National Institute of Standards and Technology
REIMBURSABLE PROGRAM AND WORKING CAPITAL FUND INVESTMENTS
(Dollar amounts in thousands)

	FY 2008 Actual	FY 2009 Estimate	FY 2010 Estimate
Department of Defense			
Air Force	$12,592	$12,592	$8,340
Army	2,492	2,492	1,776
Navy	1,516	1,516	975
Other	11,130	11,130	9,525
Subtotal, Department of Defense	27,730	27,730	20,616
Department of Agriculture	185	185	200
Department of Commerce	13,516	13,516	13,673
Department of Energy	5,705	5,705	4,400
Department of Health & Human Services	6,904	6,904	7,103
Department of Homeland Security	34,130	34,130	25,801
Department of the Interior	114	114	50
Department of Justice	14,670	14,670	14,668
Department of Labor	109	109	0
Department of State	333	333	16
Department of Transportation	1,001	1,001	25
Department of the Treasury	33	33	25
Department of Veterans Affairs	139	139	165
Environmental Protection Agency	1,776	1,776	1,446
General Services Administration	268	268	753
National Aeronautics & Space Administration	3,821	3,821	4,373
National Science Foundation	5,382	5,382	3,334
Nuclear Regulatory Commission	532	532	50
Other	8,616	8,616	4,826
Subtotal, Federal Agencies	124,964	124,964	101,524
Calibrations & Testing	9,374	9,489	9,600
Technical & Advisory Services	25,679	25,832	27,764
Standard Reference Materials	10,091	12,251	12,566
Subtotal, Other Reimbursables	45,144	47,572	49,930
Total, Reimbursable Program	170,108	172,536	151,454
Equipment Transfers	0	2,275	6,190
Subtotal, WCF transfer	0	2,275	6,190
Equipment Investments	23,883	21,348	21,348
IE Amortization	(20,666)	(21,903)	(21,348)
WCF Operating Adjustments	(1,344)	0	0
Total, WCF Investments	1,873	(555)	0
Total, Reimbursable Program and WCF Investments	171,981	174,256	157,644

Department of Commerce
National Institute of Standards and Technology
PERIODICALS, PAMPHLETS, AND AUDIOVISUAL SERVICES
(Obligations in thousands)

	2007 Actual	2008 Actual	2009 Currently Available	2010 Estimate
Periodicals	$9	$6	$34	$34
Pamphlets	25	21	35	25
Audiovisuals	5	15	16	33
Total	39	42	85	92

The National Institute of Standards and Technology produces only one periodical - The Journal of Research. *The Journal of Research of the National Institute of Standards and Technology,* issued six times a year, reports NIST research and development in those disciplines of the physical and engineering sciences in which NIST is active (physics, chemistry, engineering, mathematics, and computer sciences).

Department of Commerce
National Institute of Standards and Technology
AVERAGE SALARY

	2008 Actual	2009 Estimate	2010 Estimate
Average ES salary	$158,667	$166,251	$171,571
Average scientific and professional	157,987	165,539	170,836
Average Career Path Salary	98,812	103,535	106,848
Average salary of ungraded positions	51,941	54,424	56,166