NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY

NATIONAL TECHNICAL INFORMATION SERVICE

FISCAL YEAR 2011

BUDGET SUBMISSION TO CONGRESS

National Institute of Standards and Technology

Exhibit 1

Department of Commerce
National Institute of Standards and Technology
BUDGET ESTIMATES, FISCAL YEAR 2011
CONGRESSIONAL SUBMISSION

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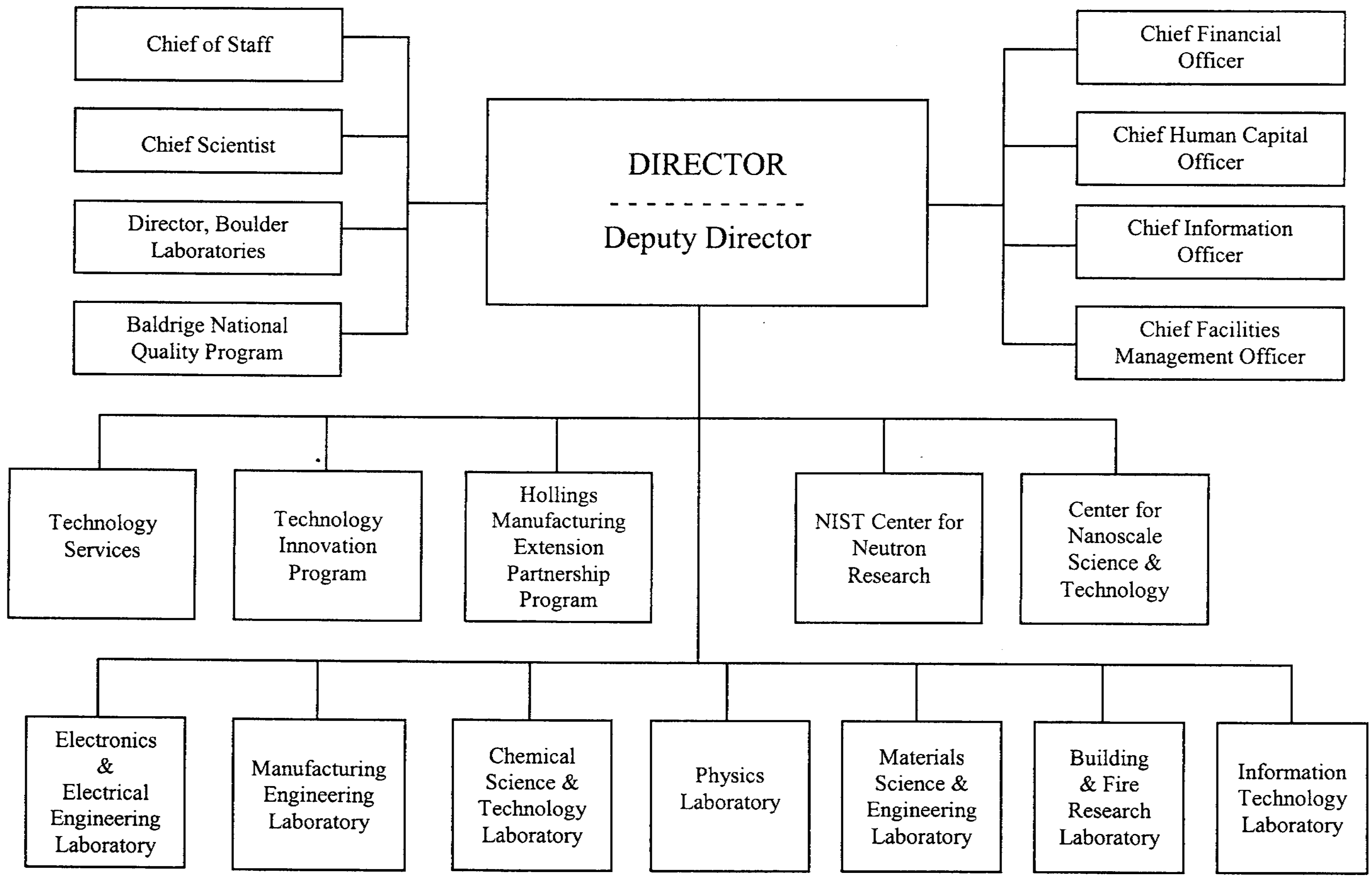
Exhibit 2

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

"In the past, government funding for scientific research has yielded innovations that have improved the landscape of American life — technologies like the Internet, digital photography, bar codes, Global Positioning System technology, laser surgery, and chemotherapy. At one time, educational competition with the Soviets fostered the creativity that put a man on the moon. Today, we face a new set of challenges, including energy security, HIV/AIDS, and climate change. Yet, the United States is losing its scientific dominance. Among industrialized nations, our country's scores on international science and math tests rank in the bottom third and bottom fifth, respectively. Over the last three decades, federal funding for the physical, mathematical, and engineering sciences has declined at a time when other countries are substantially increasing their own research budgets. President Obama and Vice President Biden believe federally funded scientific research should play an important role in advancing science and technology in the classroom and in the lab."

--From the White House, President Barack Obama
http://www.whitehouse.gov/issues/additional/

Investing in Innovation Support for the 21st Century Economy: The NIST Role

At the beginning of the last century, America was struggling to raise its citizens' standard of living. There had been an explosion of new breakthrough technologies invented in the U.S. in the late 19th century -- electric lights, the telephone, the automated assembly line. And yet European nations were the clear leaders in science and U.S. manufacturers faced stiff competition from abroad in producing the highest quality products requiring the most skilled, highly paid workers.

Congress responded to the economic challenges of 1901 by creating the Federal research agency now called the National Institute of Standards and Technology (NIST). Its mission: to improve confidence in the quality of American products, and thereby help U.S. manufacturers improve their competitiveness in global markets. The success of this joint effort contributed to the near constant U.S. economic growth of the 20th century.

At the beginning of the 21st century, the Nation is facing similar challenges. U.S. innovation has dramatically changed the world and continues to produce most of the new jobs in the current economy. In many aspects of prosperity America still leads the way. On some important measures of vitality, however, we are losing ground to other developed nations. The U.S. standard of living and more broadly the Nation's quality of life, once the envy of the world, has dropped to 13th behind countries like Norway, Australia, Iceland, Canada, and Ireland.

Now after 110 years, NIST's mission is more important than ever. All of the sophisticated technologies and modern convenience that we depend on every day for our communication, transportation, security and health, rely on a complex interconnected array of standards, high quality data, and measurement methods. Working closely with U.S. industry and academia, NIST plays a central role in advancing and maintaining this system, a kind of technology support structure that is continually upgraded and adapted as new knowledge becomes available. It is the strength of this innovation support system that will help determine the number and quality of the jobs of the future.

Several recent trends have highlighted the urgent need for expanded investment in this technology support structure, and by extension on the need for increased investment in NIST programs.

- The convergence of previously independent technology sectors such as communications, information technology, energy production, and manufacturing has put a premium on standards that allow efficient interoperability. At the same time, the key role of information technology for productivity enhancement in all economic sectors has heightened its profile as a target for attack and increased the need for stronger cybersecurity efforts. NIST has both the technical expertise and the long-standing collaborative relationships with industry to help bridge the gaps that divide these fields and to accelerate progress in critical areas such as development of a smart electric grid, the establishment of testing protocols for electronic health records, and the widespread dissemination of best practices for protection of critical information assets.

- The accumulating scientific evidence that global warming is a major threat to the Earth's people and ecosystems makes fossil fuel energy conservation and finding reliable, carbon neutral energy sources an essential priority. Rapid progress will depend on innovations from many quarters, both private and public. However, a prerequisite for U.S. success will be NIST assistance in establishing agreed upon measurement and data evaluation methods to ensure that research results can be productively shared and that buyers can have confidence in the performance metrics claimed for new technologies like photovoltaic roof tiles or new forms of energy efficient lighting such as light emitting diodes (LEDs).

- Two major sources for past U.S. prosperity, a high quality health care system and a comprehensive set of interstate roads, pipelines and other physical infrastructure components, are coming under increasing strain. Inefficiencies and dramatically rising costs have put quality health care out of reach for many Americans. Meanwhile, the sheer age of much of the Nation's physical infrastructure, which saw a major building program in the post World War II era, has put large portions of the system at risk of failure. NIST's extensive collaborations with government, industry, and academic health researchers have the potential to improve medical measurements and diagnoses, reducing costs and saving lives. NIST's world leading, interdisciplinary expertise in construction, metallurgy, advanced materials, and fire safety promises to do the same for improving the safety and extending the lifetime of physical infrastructure.

- Finally, a shift in industrial outlook, governmental policies and consumer behavior towards full accountability for the true environmental and social cost of producing a given product has refocused interest on the advantages of domestic manufacturing and local suppliers. With more than two decades of experience helping U.S. manufacturers enhance their competitiveness through its Manufacturing Extension Partnership, NIST is poised in the new climate to significantly increase its impact on the creation and retention of the high wage, skilled manufacturing jobs needed to help maintain momentum toward economic recovery.

It is in this context that the President's FY 2011 Budget request for NIST calls for increases as a necessary investment in the Nation's future.

NIST FY 2011 Budget Request under the President's Plan for Science and Innovation

NIST is a component agency of the President's Plan for Science and Innovation which, consistent with the goals of the America COMPETES Act of 2007, doubles funding for basic science research at key agencies. The FY 2011 budget request continues the foundation established by the FY 2010 President's budget and will support NIST programs which 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.

- The **Technology Innovation Program** (TIP) is a merit-based competitive grant program that 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.

- Through public (Federal-state-local) and private sector partnerships, NIST's **Hollings Manufacturing Extension Partnership** (MEP) provides technical and business assistance to small- and medium-sized 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.

- NIST's **Construction of Research Facilities** (CRF) appropriation supports projects for new buildings and the renovation and maintenance of current buildings and laboratories.

NIST's FY 2011 budget request seeks program increases in the Scientific and Technical Research and Services (STRS), Industrial Technology Services (ITS) appropriations which funds TIP and MEP, and Construction of Research Facilities (CRF). This FY 2011 request will:

1. Fund investments in the NIST Laboratories in areas that are critical for U.S. competiveness and innovations in a globalized economy.

2. Continue to revitalize NIST Extramural Programs through investment in TIP and MEP.

3. Continue to strengthen NIST's facilities to assure U.S. leadership in measurement science.

The NIST Laboratories will focus requested funds under the President's Plan for Science and Innovation to address critical challenges in identified national priority areas:

- **Energy:** Speed development of alternative, clean-energy energy sources, from production through storage to final distribution. 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. Efforts include focus on enhancing high technology manufacturing innovation in products and processes, especially nanomanufacturing, 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. Supply measurement capabilities necessary for next-generation information technologies.

Summary of FY 2011 Budget Request

For FY 2011, NIST is requesting a total budget of $918.9 million, including 3,254 permanent positions and 3,343 FTE. The request includes program changes totaling $150.2 million, 205 permanent positions, and 152 FTE from the FY 2010 levels for the STRS, ITS, and CRF appropriations.

STRS: The request totals $584.5 million (including 2,322 permanent positions and 2,324 FTE), an increase of $69.5 million above FY 2010. NIST's request is consistent with the intent of the President's Plan for Science and Innovation to double NIST laboratory research. With this amount, NIST will fund a total of $69.4 million in program initiatives and the remainder for adjustments-to-base (ATBs).

NIST will invest the $69.4 million in program initiatives in the following manner:

Standards and Conformity Assessment for Interoperability in Emerging Technologies	+$10,000,000	39 permanent positions and 29 FTE
Scalable Cybersecurity for Emerging Technologies and Threats	+$10,000,000	28 permanent positions and 21 FTE
Green Manufacturing and Construction	+$10,000,000	24 permanent positions and 18 FTE
Innovations in Healthcare – Measurement Science and Standards to Support Manufacturing and Regulatory Approval of Biologic Drugs	+$10,000,000	24 permanent positions and 18 FTE
Innovations for 21st Century U.S. Manufacturing	+$10,000,000	28 permanent positions and 21 FTE
Disaster Resilient Buildings and Infrastructure	+$5,000,000	11 permanent positions and 8 FTE
Advanced Solar Technologies – Third Generation Photovoltaics	+$5,000,000	18 permanent positions and 13 FTE
Nanomaterial Environmental, Health and Safety	+$4,000,000	10 permanent positions and 7 FTE
Strategic and Emerging Research Initiatives (SERI)	+$2,000,000	0 permanent positions and 0 FTE
NIST NRC Postdoctoral Research Associateships Program	+$3,400,000	23 permanent positions and 17 FTE
Total	+$69,400,000	205 permanent positions and 152 FTE

ITS: The request totals $209.6 million (including 148 permanent positions and 154 FTE). The request funds MEP at $129.7 million, an increase of $5.0 million above the FY 2010 enacted level (a $4.6 million increase above the 2011 base). TIP is funded at $79.9 million, an increase of $10.0 million from the FY 2010 enacted level.

TIP	+$10,000,000	0 permanent positions and 0 FTE
MEP	+$4,637,000	0 permanent positions and 0 FTE

CRF: The request totals $124.8 million. The FY 2010 enacted level included funding that allows NIST to begin work to renovate Boulder's Building 1, and conduct a space study at the Gaithersburg site to analyze the best way to renovate aging facilities. The FY 2011 request includes $66.1 million of initiative funding above the FY 2011 base amount for CRF to continue the Building 1 Renovation, begin design and planning for General Purpose Laboratories (GPL), and to provide a sufficient level of funding for NIST to address deficiencies and maintain NIST's physical plant. NIST will invest these funds in the following manner:

Boulder Laboratories - Building 1 Renovation	+$37,900,000	0 permanent positions and 0 FTE
Renovations of General Purpose Laboratories	+$14,400,000	0 permanent positions and 0 FTE
Safety, Capacity, Maintenance, and Major Repairs (SCMMR)	+$13,832,000	0 permanent positions and 0 FTE
Total	+$66,132,000	0 permanent positions and 0 FTE

The FY 2011 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 and Technical Research and Services (STRS)

1. Standards and Conformity Assessment for Interoperability in Emerging Technologies (+39 positions, +29 FTE and +$10,000,000)

Lack of standards that allow interoperability within and between cross-cutting technologies such as Smart Grid and Healthcare Information Technology (Health IT) can significantly stifle the realization of benefits from these emerging technologies. Interoperability stimulates significant confidence in industry about investing in these new technologies by broadening the market and decreasing the limitations inherent in legacy systems. It also obviates potential concerns about stranded investments, which may arise due to lack of interoperability between components of systems. Furthermore, clearly defined interoperability requirements and standards to support such implementations promote innovation and competition amongst the suppliers of components to the systems, thereby reducing costs of implementation and providing greater choice to consumers. This initiative request is to address architectural framework development for documentary standards and conformity assessment requirements that will enable interoperability in emerging technologies such as Smart Grid and Health IT.

2. Scalable Cybersecurity for Emerging Technologies and Threats (+28 positions, +21 FTE and +$10,000,000 including an $850,000 transfer to the Working Capital Fund)

Cybersecurity is vital to the economic and national security interests of the United States. The Administration has declared the cyber infrastructure a strategic asset. 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 attack from individuals, organizations, and nation states that target key information technology operations and assets. The requested funds will support the development of tools and standards necessary to enable a robust, useable, and accessible cybersecurity framework, addressing a number of factors including cryptographic key management, security automation technologies, and improved modeling and attack detection capabilities. NIST's programs will include competitive grants to strengthen U.S. capabilities in cryptography.

3. Green Manufacturing and Construction (+24 positions, +18 FTE and +$10,000,000)

Promoting innovative energy technologies to reduce dependence on energy imports and mitigate the impact of climate change while creating green jobs and new businesses is a priority of the Administration. To address this issue, NIST is focusing on programs that will develop the measurements, standards, and common framework that are required to promote sustainable operations and improve energy efficiency in both the construction and manufacturing sectors. This initiative will provide for the development of data, models, and support tools to improve energy efficiency in manufacturing and construction processes and to benchmark and stimulate the utilization of sustainable materials.

4. Innovations in Healthcare – Measurement Science and Standards to Support Manufacturing and Regulatory Approval of Biologic Drugs (+24 positions, +18 FTE and +$10,000,000 including a $2,250,000 transfer to the Working Capital Fund)

Biotechnology drugs, and protein and cell-based medications represent the fastest growing category of therapeutic drugs in the U.S. Improved characterization and manufacturing of follow-on biologic drugs will support the growth of a new industrial sector that is vital to reducing the cost of healthcare. Measurement science and standards are necessary to enable regulators to assess the "sameness" of a biologic drug made by different manufacturers and/or different manufacturing processes, and to enable manufacturers to improve efficacy and safety, and the efficiency and reliability of biopharmaceutical manufacturing processes. NIST will work with industry stakeholders to develop a program that provides reference methods for characterization of protein biopharmaceuticals' structure, function, immunogenicity and tools to test and optimize manufacturing processes. This initiative will include funds for grants to stimulate advances in biomanufacturing processes.

5. Innovations for 21st Century U.S. Manufacturing (+28 positions, +21 FTE and +$10,000,000)

The President's Framework for Revitalizing American Manufacturing calls for investment in new technologies that will spur innovation and increase the competitiveness of the U.S. manufacturing sector. This initiative will enable NIST to strengthen capabilities in multiple areas that impact manufacturing – from cutting edge research in the technologies that are needed to underpin transformational manufacturing capabilities in high-technology industries like communications, computing, and energy production – to the development of measurement technologies and standards that will enable U.S. manufacturers to adopt technology advances that lower cost, reduce processing times, and improve overall quality. This initiative will enable NIST to support efforts in nanomanufacturing that will develop the metrology tools required to quickly, inexpensively, and accurately characterize products at the relevant scales of one to hundreds of nanometers; and allow in-line, fast and inexpensive nanoscale metrology techniques necessary to enable and maintain complex, multi-step assembly processes that are needed to develop true high-capacity nanomanufacturing capabilities. Working collaboratively with industry and academia NIST will also invest programs targeted at technological innovations to increase manufacturing efficiencies in areas such as advanced sensor development, advanced robotics, and rapid prototyping.

6. Disaster Resilient Buildings and Infrastructure (+11 positions, +8 FTE and +$5,000,000)

The United States depends on a robust physical infrastructure[1] to provide a high quality of life for its citizens and to ensure competitiveness in the global economy. Much of the Nation's enormous physical infrastructure is nearing the end of its service life, and needs to be repaired or replaced, which is estimated to cost close to $2.2 trillion.[2] Considering that a large percentage of

[1] *Physical infrastructure* includes airports, bridges, tunnels, roads, ports, and other fixed portions of transportation systems, power generation and distribution facilities, water and waste facilities, government buildings, and public arenas.
[2] *ASCE 2009 Report Card for America's Infrastructure*. Available at http://www.asce.org/reportcard/2009.

the Nation's infrastructure is at risk from multiple natural hazards (earthquakes, fires, hurricanes) that can cause significant financial losses, it is important to ensure that as we renovate our Nation's infrastructure we do so in a way that minimizes susceptibility to damage from natural hazards. This initiative will focus resources on expanding NIST's activities under the National Earthquake Hazards Reduction Program (NEHRP) to address the measurement science, standards, and data resources necessary to improve resiliency against earthquakes. The initiative also funds activities related to fire performance of structures. The request will fund improved techniques, tools, and guidelines for evaluating and rehabilitating existing buildings based on analytical and experimental studies, and efforts to work with national model building code organizations to incorporate those products in appropriate model building codes.

7. Advanced Solar Technologies -- Third Generation Photovoltaics (+18 positions, +13 FTE and +$5,000,000)

The Administration supports the development of alternative energy sources that can meet our Nation's increasing energy needs while mitigating global climate change, reducing energy imports, and creating manufacturing jobs. Solar energy remains one of the most promising alternative sources of energy as it is readily available, free from geopolitical issues, and does not contribute to the environmental problems associated with carbon emissions. Despite the continued growth of solar energy technologies, adoption of these technologies is limited by the relatively high-cost and low-efficiency of conventional photovoltaic solar cells. What is known as third-generation photovoltaic (3rd-Gen PV) technologies has the potential to overcome these barriers through the application of nanotechnology which can enable more efficient absorption of solar energy, and by enabling new forms of photovoltaics that are more cost effective to manufacture. With these funds, NIST will focus on developing new and novel measurement instrumentation and methods for critical photovoltaic device phenomena. The request will help bridge the current gap in measurement technology needed to enable 3rd-Gen PV development.

8. Nanomaterial Environmental, Health and Safety (+10 positions, +7 FTE and +$4,000,000)

There are currently over 1,000 products that contain nanomaterials on the market produced by 485 companies[3] and valued at $166 billion[4]; the value of nano-enabled products is projected to climb to $2.6 trillion by 2014[5]. Nanomaterials and products that incorporate nanomaterials pose unknown risks to people and the environment. A science-based approach is needed for industry and regulatory agencies to assess and manage these risks. Regulatory agencies and industry have called on NIST to lead the effort on physical and chemical property measurements and standards. To accomplish this, NIST will establish a Nanomaterials Environmental Health and Safety (NanoEHS) program that is coordinated with other agencies participating in the National Nanotechnology Initiative. NIST will identify measurement needs and define solutions for the key nanomaterials of greatest importance to U.S. industry, begin developing or expanding

[3] According to the Consumer Products Inventory maintained by the Woodrow Wilson International Center for Scholars, www.nanotechproject.org, August 25, 2009.
[4] *The Nanotechnology Opportunity Report (NOR) 2008, 3rd Edition*, Research and Markets, June 2008.
[5] *Taking Action on Nanotechnology's Value Chain*, Lux Research, October 2004.

measurement laboratories for nanomaterial characterizations, and begin developing reference nanomaterials with fully characterized physical and chemical properties. Eventual full characterization of potential nanomaterials risks will enable safe and efficient commercialization of new nano-enabled products for a broad range of new technologies, from treatment of disease to alternative energy to remediation of environmental hazards.

9. Strategic and Emerging Research Initiatives (SERI) (+0 positions, +0 FTE and +$2,000,000 including a $200,000 transfer to the Working Capital Fund)

The SERI Fund provides the NIST Director annual flexibility necessary to pull together research teams from across NIST to address emerging and increasingly multidisciplinary research problems. In addition, the SERI fund provides the NIST Director with programmatic flexibility 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 resources for high priority activities 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. Possible areas for consideration for SERI funding in FY 2011 include work related to food safety and forensics.

10. NIST NRC Postdoctoral Research Associateships Program (+23 positions, +17 FTE and +$3,400,000)

The Administration is committed to strengthening science, technology, engineering, and mathematics (STEM) education. The NIST National Research Council (NRC) postdoctoral program provides opportunities for outstanding young scientists to gain training in measurement science, and is a critical part of ensuring that NIST has access to the top technical talent necessary to maintain leading research programs that address critical national priorities. The request will increase the number of postdoctoral research opportunities at NIST.

Industrial Technology Services (ITS)

1. Technology Innovation Program (+0 positions, +0 FTE and +$10,000,000)

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. For FY 2011, NIST requests $79.9 million, which includes an increase of $10.0 million. These funds will support new competitions and any remaining mortgage commitments from previous competitions. Areas under consideration for potential future competitions 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 United States, disseminate new knowledge, and advance the state-of-the-art in technologies that address societal challenges. The FY 2011 request is the second year of proposed increases to the program to an eventual level of $100 million by FY 2015.

2. Hollings Manufacturing Extension Partnership Program (+0 Positions, +0 FTE and +$4,637,000)

The Hollings Manufacturing Extension Partnership (MEP) program is a national network providing business and technology assistance to the Nation's critical small- and medium-sized manufacturers. For FY 2011, NIST requests $129.7 million for MEP, which includes a program increase of $4.6 million. 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 2011, MEP will continue to expand its services to better respond to future challenges and opportunities of U.S. manufacturers by supporting the adoption of technological innovations that spur economic growth and fostering the development of new products, expanded markets, process improvements, and creation of 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 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 2011 to expand upon a strong foundation and further deploy 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' negative environmental impact and related costs by promoting the development of new, environmentally-focused materials, products, and processes to gain entry into new markets. The FY 2011 request is the second year of proposed increases to the program to an eventual level of $180 million by FY 2015.

Construction of Research Facilities (CRF)

1. Boulder Laboratories Building 1 Renovation (+0 positions, +0 FTE and +$37,900,000)

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 research and measurement. The requested funding will allow NIST to continue with the efforts made in FY 2010. Specific work will include the exterior renovations of Wings 3, 5, 6, and the Center Spine, and the interior renovation of Wing 3 as well as most of Wing 5. The successful improvement of the NIST Boulder facilities – through construction of the Precision Measurement 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.

2. General Purpose Laboratories (GPLs) Renovations (+0 positions, +0 FTE and +$14,400,000)

The Gaithersburg site GPLs are nearly 45 years old, yet they house the majority of NIST research and measurement. Aging structural, mechanical, electrical, and safety systems significantly reduce the research and measurement productivity of the NIST Gaithersburg laboratories. This initiative is part of a comprehensive, multi-year plan for the phased renovation of all the GPLs at the NIST Gaithersburg laboratories. In FY 2010, a $2.0 million Gaithersburg site space utilization study was funded. This FY 2011 request of $14.4 million will provide funding for the initial cost of the planning documents based on the results of the FY 2010 study. 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.

3. Safety, Capacity, Maintenance, and Major Repairs (SCMMR) (+0 positions, +0 FTE and +$13,832,000)

Aging and deteriorating buildings and infrastructure threaten NIST's ability to meet its mission. NIST's SCMMR program funds capacity, safety improvements, as well as ongoing, recurring and preventative maintenance and major repair of the NIST physical plant in Gaithersburg, Maryland; Boulder and Fort Collins, Colorado; and Kauai, Hawaii. NIST's base SCMMR program requires a $13.8 million increase to the SCMMR base program to bring the program total to approximately $72.5 million, which will provide a sufficient level of funding to address repair deficiencies and maintain NIST's physical plant with on-going, recurring, and preventative maintenance.

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.

Resources

The following is a comparison of NIST's FY 2011 level with its FY 2010 budget request and related data on employment.

Appropriation	(Dollar amounts in millions)					
	FY 2010 Appropriation		FY 2011 Request		Increase (or Decrease) from FY 2010 Appropriation	
	FTE	**Amount**	**FTE**	**Amount**	**FTE**	**Amount**
Scientific and Technical Research and Services	2,182	515.0	2,324	584.5	142*	69.5
Industrial Technology Services	153	194.6	154	209.6	1	15.0
Construction of Research Facilities	89	147.0	89	124.8	0	(22.2)
Working Capital Fund	776	0	776	0	0	0
TOTAL	**3,200**	**856.6**	**3,343**	**918.9**	**143**	**62.3**

*Net change in FTE includes annualization of positions (+21 in STRS) funded by FY 2010 program changes and drop out of FTEs (-31) supported by ARRA in FY 2010, plus the 152 FTEs in FY 2011 program changes; please consult STRS Exhibits 8 and 13 for detail.

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 that cannot or will not be addressed by the private sector; 3) work supported by legislation that authorizes or mandates certain services; 4) work that 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 $171.2 million in FY 2010 and $147.1 million in FY 2011.

Crosswalk of FY 2011 NIST Requested Increases to Budget Subactivities, Line Items
(Dollars in thousands)

	STRS											CRF	ITS	Total
	National Measurement and standards laboratories											Construction and major renovations	Technology Innovation Program/Hollings MEP Program	
Initiative Name	Strategic and Emerging Research Initiatives	Electronics & Electrical Engineering Lab	Manufacturing Engineering Lab	Chemical Science & Technology Lab	Materials Science & Engineering Lab	Building & Fire Research Lab	Information Technology Lab	Center for Nanoscale Science & Technology	Post Doctoral Program	Working Capital Fund	STRS Total	Construction and major renovations	Technology Innovation Program/Hollings MEP Program	
Standards and Conformity Assessment for Interoperability in Emerging Technologies		$5,000					$5,000				10,000			10,000
Scalable Cybersecurity for Emerging Technologies and Threats							$9,150			$850	10,000			10,000
Green Manufacturing and Construction			$4,000			$6,000					10,000			10,000
Innovations in Healthcare - Measurement Science and Standards to Support Manufacturing and Regulatory Approval of Biologic Drugs				$7,750						$2,250	10,000			10,000
Innovations for 21st Century U.S. Manufacturing			$5,000					$5,000			10,000			10,000
Disaster Resilient Buildings and Infrastructure						$5,000					5,000			5,000
Advanced Solar Technologies - 3rd Generation Photovoltaics		$2,500						$2,500			5,000			5,000
Nanomaterial Environmental Health and Safety					$4,000						4,000			4,000
Strategic and Emerging Research Initiatives (SERI)	$1,800									$200	2,000			2,000
NIST NRC Postdoctoral Research Associateship Program									$3,400		3,400			3,400
STRS TOTAL	$1,800	$7,500	$9,000	$7,750	$4,000	$11,000	$14,150 *	$7,500	$3,400	$3,300	69,400			69,400
SCMMR												13,832		13,832
Building 1 renovation												37,900		37,900
GPL renovations												14,400		14,400
CRF TOTAL												66,132		66,132
Technology Innovation Program													10,000	10,000
Hollings MEP Program													4,637	4,637
ITS TOTAL													14,637	14,637
NIST INITIATIVE TOTAL														150,169

* Does not include Election Assistance Commission transfer of $3,250K.

APP / Exhibit 3A Format

FY 2011 Annual Performance Plan

National Institute of Standards and Technology/
National Technical Information Service

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FY 2011 Annual Performance Plan

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 21st 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 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 (BNQP) 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 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, 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 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 United States not to 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 2.1: Advance measurement science and standards that drive technological change.

Description of Performance Outcome:
As established by the America COMPETES Act in 2007, 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.

NIST Priorities / Management Challenges

The Administration realizes that technological advances can provide a powerful engine for advancing economic growth and new opportunity. Specifically, targeted R&D investments in these three areas will help to spur future innovation and economic competitiveness:

- **Lower Health Care Costs by Advancing Health IT:** Implement a networked system of electronic medical records to lower healthcare costs and improve patient care.
- **Develop New Clean Energy Sources:** In order to wean the nation off wasteful petroleum products and to create new markets for U.S. energy products abroad, develop new and cleaner energy sources.
- **Develop Next Generation Manufacturing Technologies:** Create and install new manufacturing methods so America can again create its fair share of the products we use and to revitalize the domestic job market.

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 2011 President's budget continues to realize the important role of NIST programs to advance elements of our national agenda, highlighting NIST as one of three Federal agencies that will double basic research by FY 2017. Specifically, NIST laboratory research is intended to double by FY 2017. NIST's FY 2011 budget request continues to provide support towards achieving NIST priority 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. 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. Efforts include focus on enhancing high technology manufacturing innovation in products and processes, especially nanomanufacturing, 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. 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 2011 budget requests \$709.3 million for NIST's core laboratory research and facilities; an increase of \$47.3 million over FY 2010 enacted levels. The President's budget also proposes \$129.7 million in FY 2011 for MEP, an increase of \$5.0 million above the FY 2010 appropriation. For TIP, the President's FY 2011 budget request is \$79.9 million, an increase of \$10.0 million above the FY 2010 appropriation.

NIST's programs 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;
- Security for America's computer networks; and
- Development of sustainable and innovative manufacturing capabilities.

As part of developing the FY 2011 Budget and Annual Performance Plan, NIST has identified the following high priority performance goal, in support of Administration and Departmental priorities, that will be a particular focus for the remainder of FY 2010 and for FY 2011:

- Sustainable Manufacturing and Building Practices:
  - Raise the number of firms adopting sustainable manufacturing processes through the Manufacturing Extension Partnership by 250 by the end of FY 2011.
  - Raise the percentage of construction projects involving buildings or structures funded by Economic Development Assistance Programs that are certified by the US Green Building Council's Leadership in Energy and Environmental Design (LEED) or a comparable third-party certification program to 12 percent.

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 2006 Actual	FY 2007 Actual	FY 2008 Actual	FY 2009 Actual	FY 2010 Target	FY 2011 Target
	Completed	Completed	Completed	Completed	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. NRC completed its FY 2009 assessment of the Center for Nanoscale and Technology, the Chemical Science and Technology Laboratory, the Electronics and Electrical Engineering Laboratory, the Information Technology Laboratory, and the NIST Center for Neutron Research. In FY 2010, the NRC will conduct an assessment of four other NIST Laboratories, which were last assessed in FY 2008, and the NIST Center for Neutron Research. The NRC Assessment Reports are available at http://www.nist.gov/director/nrc/ .

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 2006 Actual	FY 2007 Actual	FY 2008 Actual	FY 2009 Target	FY 2010 Target	FY 2011 Target
	New	>1.1	>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 2009 actual for this measure will lag 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 2006 Actual	FY 2007 Actual	FY 2008 Actual	FY 2009 Actual	FY 2010 Target	FY 2011 Target
	1,163	1,272	1,271	1,463	1,300	1,350

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 FY 2011 target was increased to reflect the observed trend of a higher number of publications. NIST estimates that the impact of the new and expanded programs funded under the increase for the NIST labs in FY 2010 and the requested increase in FY 2011 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.

Relevant Program Change(s): $69.4M STRS	**Title:** NIST Laboratories	**Exhibit 13 Page no:** NIST – 97

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 2006 Actual	FY 2007 Actual	FY 2008 Actual	FY 2009 Actual	FY 2010 Target	FY 2011 Target
	31,195	32,614	33,373	29,769	31,000	31,000

Description: Standard Reference Materials (SRM) 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 increase for the NIST labs in FY 2010 and the requested increase for FY 2011. The targets for FY 2010 and FY 2011 are based on the restoration of key SRMs to inventory.

Relevant Program Change(s):	Title: NIST Laboratories	Exhibit 13 Page no:
$69.4M STRS		NIST - 97

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 2006 Actual	FY 2007 Actual	FY 2008 Actual	FY 2009 Actual	FY 2010 Target	FY 2011 Target
Original Methodology	94.4M	130M	195.5M	226M	NA*	NA*
Revised Methodology	32.5M	34.7M	23.7M	34.2M	24.5M	24.5M

* Beginning in FY 2010, NIST has revised the methodology for this measure by excluding the hundreds of millions of annual downloads associated with web-based time-related services which dominated the total number of downloads in previous years. This adjusted measure will more clearly demonstrate the use of NIST's other on-line datasets covering scientific and technical databases throughout the NIST laboratories.

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, with the exception of web-based time related services. This measure also excludes the NIST Internet Time Service synchronizations which now average about three billion events per day.

Comments on Changes to Targets: The FY 2010 target in the FY 2010 Budget was projected at 200M. The FY 2010 and FY 2011 targets have been changed to reflect the revised methodology which will exclude the web-based time-related services as described above. Since the conversion of research results into robust, deliverable measurement services typically takes at least three additional years, 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 increase for the NIST labs in FY 2010 and the requested increase for FY 2011.

Relevant Program Change(s): $69.4M STRS	**Title:** NIST Laboratories	**Exhibit 13 Page no:** NIST - 97

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 2006 Actual	FY 2007 Actual	FY 2008 Actual	FY 2009 Actual	FY 2010 Target	FY 2011 Target
	13,127	27,489	25,944	18,609	15,000	18,500

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 calibration 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 FY 2011 target reflects a modest increase over the FY 2009 and FY 2010 targets of 15,000 due to an observed trend of greater calibration tests performed over the past few years. Due to the economic downturn and reduced funding for the military, NIST does not expect the level of calibration tests to exceed the FY 2008 level. 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 increase for the NIST labs in FY 2010 and the requested increase for FY 2011 is expected to increase in the outyears.

Relevant Program Change(s):	Title:	Exhibit 13 Page no:
$69.4M STRS	NIST Laboratories	NIST - 97

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 2006 Actual	FY 2007 Actual	FY 2008 Actual	FY 2009 Actual	FY 2010 Target	FY 2011 Target[3]
	24,722	28,004	31,961	32,926	29,000	31,175

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):	Title:	Exhibit 13 Page no:
$4.637M	Hollings Manufacturing Extension Partnership	NIST- 202

Measure	FY 2006	FY 2007	FY 2008	FY 2009	FY 2010	FY 2011
Measure 2B: Increased sales attributed to MEP Centers receiving Federal funding ($ in Billions)	**Actual**	**Actual**	**Actual[1]**	**Target[2]**	**Target**	**Target[3]**
	$3.1	$5.6	$3.61	$2.0	$2.5	$2.7
Measure 2C: Capital investment attributed to MEP Centers receiving Federal funding ($ in Billions)	**Actual**	**Actual**	**Actual[1]**	**Target[2]**	**Target**	**Target[3]**
	$1.65	$2.19	$1.71	$1.0	$1.0	$1.1
Measure 2D: Cost savings attributed to MEP Centers receiving Federal funding ($ in Billions)	**Actual**	**Actual**	**Actual[1]**	**Target[2]**	**Target**	**Target[3]**
	$1.1	$1.44	$1.41	$1.0	$1.2	$1.3

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.

[1] Due to the lag time associated with collecting and analyzing this data, the "actual" data reported for this measure in the FY 2009 DoC Performance and Accountability Report was an estimate based on three-quarters of actual client reported impacts and one-quarter estimated client impacts.

[2] The FY 2009 actual will be available in July 2010 due to the lag time associated with collecting and analyzing the Hollings MEP client survey data six months after the services are delivered.

[3] FY 2012-2015 targets, which assume FY 2011 requested funding, are the same as FY 2011.

Comments on Changes to Targets: The FY 2010 and FY 2011 targets are based on a funding levels of $124.7M and $129.7M (including adjustments to base) respectively for MEP. 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.

Relevant Program Change(s): $4.637M	**Title:** Hollings Manufacturing Extension Partnership	**Exhibit 13 Page no:** NIST- 202

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	FY 2011 Target
	9	25	49

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 and FY 2011 targets assume a total obligation funding level of $110.6M in FY 2010 and $83.7M in FY 2011. These obligation levels include budget authority of $69.9M and $79.9M, plus the addition of estimated carryover and prior year recoveries.

Relevant Program Change(s): $10M	Title: Technology Innovation Program (TIP)	Exhibit 13 Page no: NIST- 192

Validation and Verification (See table below for Outcome 3)

Measure 3B: Cumulative number of publications	FY 2009 Target	FY 2010 Target	FY 2011 Target
	24 in FY 2012	60 in FY 2013	78 in FY 2014

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. This lagging measure assumes that publications will be generated by the third year of project research. Thus, the number of cumulative publications are expected to be as follows: 24 in FY 2012, 60 in FY 2013, 78 in FY 2014, and 87 in FY 2015.

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

Relevant Program Change(s): $10M	Title: Technology Innovation Program (TIP)	Exhibit 13 Page no: NIST- 192

Validation and Verification (See table below for Outcome 3)

Measure 3C: Cumulative Number of patent applications		FY 2009 Target	FY 2010 Target	FY 2011 Target
		12 in FY 2012	30 in FY 2013	39 in FY 2014
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. This is a lagging measure and assumes that patent applications will be generated by the third year of project research. Thus the numbers of cumulative patent applications are expected to be as follows: 12 in FY 2012, 30 in FY 2013, 39 in FY 2014, and 43in FY 2015.				
Comments on Changes to Targets: This measure was added in FY 2009 to reflect increased funding for TIP.				
Relevant Program Change(s): $10M	**Title:** Technology Innovation Program (TIP)			**Exhibit 13 Page no:** NIST- 192
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	FY 2011 Target
		4 in FY 2012	10 in FY 2013	13 in FY 2014
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). Thus the numbers of cumulative projects generating continued R&D are expected to be as follows: 4 in FY 2012, 10 in FY 2013, 13 in FY 2014, and 14 in FY 2015.				
Comments on Changes to Targets: This measure was added in FY 2009 to reflect increased funding for TIP.				
Relevant Program Change(s): $10M	**Title:** Technology Innovation Program (TIP)			**Exhibit 13 Page no:** NIST- 192
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	FY 2011 Target
	2 in FY 2012	5 in FY 2013	6 in FY 2014

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). Thus, the number of cumulative projects with technologies under adoption are expected to be as follows: 2 in FY 2012, 5 in FY 2013, 6 in FY 2014, and 7 in FY 2015.

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

Relevant Program Change(s): $10M	Title: Technology Innovation Program (TIP)	Exhibit 13 Page no: NIST- 192

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.

NIST FY 2011 Program Changes

	Accompanying GPRA		Base		Increase/Decrease		Page of Exhibit 13
Program Change:	**APP Page no.**	**Performance Measure no.**	**FTE**	**Amount* ($000)**	**FTE**	**Amount* ($000)**	
NIST Laboratories (STRS , CRF and WCF)	**NIST- 28**	1C 1D 1E 1F	3,037	$721.0	152	$138.8	NIST- 97, 230, 239, 244
Hollings Manufacturing Extension Partnership	**NIST- 32**	2A 2B 2C 2D	74	$125.9	0	$4.6	NIST- 202
Technology Innovation Program	**NIST- 34**	3A 3B 3C 3D 3E	80	$73.7	0	$10.0	NIST- 192

*Dollars reflect obligations for all fund sources.

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 world-wide 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:

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 2011

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 2011 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 2006 Actual	FY 2007 Actual	FY 2008 Actual	FY 2009 Target	FY 2010 Target	FY 2011 Target
	673,807	744,322	813,775	745,000	765,000	780,000

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 2011 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 2006 Actual	FY 2007 Actual	FY 2008 Actual	FY 2009 Actual	FY 2010 Target	FY 2010 Target
	30,616,338	32,027,113	32,267,167	49,430,840	33,000,000	34,800,000

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 2011 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 2006 Actual	FY 2007 Actual	FY 2008 Actual	FY 2009 Actual	FY 2010 Target	FY 2011 Target
	98%	98%	96%	98%	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

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 2011 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	NTIS -	N/A	150	$43.0M	0	$0	N/A

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 2006 Actual	**FY 2007 Actual**	**FY 2008 Actual**	**FY 2009 Actual**	**FY 2010 Estimate**	**FY 2011 Base**	**Increase/ Decrease**	**FY 2011 Request**
Regular Funds ($M)	$762.4	$662.4	$759.3	$812.4	$896.1	$721.0	$138.8	$859.8
Recovery Act Funds				$125.0	$487.3			
Total Funds ($M)	$762.4	$662.4	$759.3	$937.4	$1,383.4	$721.0	$138.8	$859.8
NIST Hollings MEP Performance Outcome 2: Increase the productivity, profitability, and competitiveness of manufacturers.								
	FY 2006 Actual	**FY 2007 Estimate**	**FY 2008 Actual**	**FY 2009 Actual**	**FY 2010 Estimate**	**FY 2011 Base**	**Increase/ Decrease**	**FY 2011 Request**
Total Funds ($M)	$111.9	$107.3	$91.2	$112.6	$125.7	$125.9	$4.6	$130.5
NIST Technology Innovation Program Performance Outcome 3: Promote U.S. competitiveness by directing Federal investment and R&D into areas of critical national need that support, promote, and accelerate high-risk, high-reward research and innovation in the United States.								
	FY 2006 Actual	**FY 2007 Actual**	**FY 2008 Actual**	**FY 2009 Actual**	**FY 2010 Estimate**	**FY 2011 Base**	**Increase/ Decrease**	**FY 2011 Request**
Total Funds ($M)	$72.7	$93.4	$54.5	$50.2	$110.6	$73.7	$10.0	$83.7
NIST Total Funds ($M)	$947.0	$863.1	$905.0	$1,100.2	$1,619.7	$920.6	$153.4	$1,074.0

NTIS Performance Goal: Increase public access to world-wide scientific and technical information through improved acquisition and dissemination activities								
	FY 2006 Actual	**FY 2007 Actual**	**FY 2008 Actual**	**FY 2009 Actual**	**FY 2010 Estimate**	**FY 2011 Base**	**Increase/ Decrease**	**FY 2011 Request**
NTIS Total Funds ($M)	$27.2	$27.9	$22.5	$31.9	$42.5	$43.0	$0.0	$43.0
Grand Total (NIST & NTIS)	**FY 2006 Actual**	**FY 2007 Actual**	**FY 2008 Actual**	**FY 2009 Actual**	**FY 2010 Estimate**	**FY 2011 Base**	**Increase/ Decrease**	**FY 2011 Estimate**
Total Funding ($M)	$974. 2	$891.0	$927.5	$1,132.1	$1,662.2	$963.6	$153.4	$1,117.0
Direct	$756.7	$694.2	$733.1	$926.2	$1,436.2	$773.5	$150.1	$923.6
Reimbursable	$217.5	$196.8	$194.4	$205.9	$226.0	$190.1	$3.3	$193.4
IT Funding	$72.3	$78.2	$85.7	$97.7	$97.3	$93.4	$0.0	$93.4
Total FTE	2,896	2,891	2,934	3,000	3,350	3,341	152	3,493

*Dollars reflect obligations for all fund sources.

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Scientific and Technical
Research and Services

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
2010 Currently available	2,117	2,182	$517,750	$710,657 [4/]	$515,000
less: Reduced FTE funded by ARRA carryover	0	(31)	0	0	0
less: Unobligated balance from prior year	0	0	0	(191,907) [3/]	0
less: Transfer from COPS, DoJ	0	0	(1,500)	(1,500)	0
less: Transfer from EAC	0	0	(3,500)	(3,500)	0
2011 Adjustments to base:					
Annualization of positions financed in FY 2010	0	21			
plus: Restoration of 2010 deobligation offset	0	0	1,000	0	1,000
plus: Adjustment of WCF transfer for prior program changes	0	0	2,250	2,250	0
plus: Uncontrollable cost changes	0	0	100	100	100
less: Estimated recoveries, 2011	0	0	(1,000)	0	(1,000)
2011 Base Request	2,117	2,172	515,100	516,100	515,100
plus: 2011 Program changes	205	152	66,100	66,100	69,400
plus: Transfer from EAC			3,250	3,250	0
2011 Estimate	2,322	2,324	584,450	585,450	584,500

Comparison by activity/subactivity:		2009 Actual Per-sonnel	2009 Actual Amount	2010 Currently Available Per-sonnel	2010 Currently Available Amount	2011 Base Per-sonnel	2011 Base Amount	2011 Estimate Per-sonnel	2011 Estimate Amount	Increase/ (Decrease) Over 2011 Base Per-sonnel	Increase/ (Decrease) Over 2011 Base Amount
National measurement and standards laboratories											
National measurement and standards	Pos./Approp	1,926	$657,109	2,030	$488,596	2,030	$488,075	2,235	$557,475	205	$69,400
laboratories	FTE/Obl.	1,870	500,370	2,092	682,436	2,082	488,966	2,234	558,316	152	69,350
Baldrige national quality program	Pos./Approp	48	9,440	48	9,627	48	9,854	48	9,854	0	0
Baldrige national quality program	FTE/Obl.	47	9,448	52	9,668	52	9,869	52	9,869	0	0
Corporate services	Pos./Approp	39	25,451	39	16,777	39	17,171	39	17,171	0	0
Corporate services	FTE/Obl.	36	24,386	38	18,553	38	17,265	38	17,265	0	0
TOTALS	Pos./Approp	2,013	692,000 [1/]	2,117	515,000	2,117	515,100	2,322	584,500	205	69,400
	FTE/Obl.	1,953	534,204 [2/]	2,182	710,657 [4/]	2,172	516,100	2,324	585,450	152	69,350

Comparison by activity/subactivity:	2009 Actual Personnel	2009 Actual Amount	2010 Currently Available Personnel	2010 Currently Available Amount	2011 Base Personnel	2011 Base Amount	2011 Estimate Personnel	2011 Estimate Amount	Increase/ (Decrease) Over 2011 Base Personnel	Increase/ (Decrease) Over 2011 Base Amount
Adjustments for:										
Recoveries		(3,904)		(1,000)		(1,000)		(1,000)		0
Refunds		(29)		0		0		0		0
Unobligated balance, start of year		(6,781)		(191,907) [3/]		0		0		0
Unobligated balance, end of year		191,907 [3/]		0		0		0		0
Unobligated balance, expired account		3		0		0		0		0
Budget Authority		715,400		517,750		515,100		584,450		69,350
Financing from transfers:										
Transfers to other accounts		2,100		2,250		0		3,300		3,300
Transfer from Community Oriented Policing Services, DoJ		(1,500)		(1,500)		0		0		0
Transfer from Election Assistance Commission		(4,000)		(3,500)		0		(3,250)		(3,250)
Transfer from Office of the National Coordinator for Health Information Technology, HHS/ARRA		(20,000)		0		0		0		0
Appropriation		692,000 [1/]		515,000		515,100		584,500		69,400

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

[2/] Includes the American Recovery and Reinvestment Act obligation of $52,745K.

[3/] Includes the American Recovery and Reinvestment Act carryover of $187,255K.

[4/] Includes the American Recovery and Reinvestment Act obligation of $187,255K.

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

	2009 Actual	2010 Currently Available	2011 Base	2011 Estimate	Increase/ (Decrease) Over 2011 Base
Total Obligations	$536,494 [1/]	$720,717 [2/]	$516,100	$585,450	$69,350
Financing:					
Offsetting collections from:					
Federal funds	(12,230) [3/]	(120) [4/]	0	0	0
Non-Federal sources	0	0	0	0	0
Total offsetting collections	(12,230)	(120)	0	0	0
Adjustments for:					
Recoveries	(3,933)	(1,000)	(1,000)	(1,000)	0
Unobligated balance, start of year	(6,781)	(201,847) [5/]	0	0	0
Unobligated balance, end of year	201,847 [5/]	0	0	0	0
Unobligated balance, expired	3	0	0	0	0
Budget Authority	715,400	517,750	515,100	584,450	69,350
Financing:					
Transfer to other accounts	2,100	2,250	0	3,300	3,300
Transfer from other accounts	(25,500) [6/]	(5,000) [8/]	0	(3,250)	(3,250)
Appropriation	692,000 [7/]	515,000	515,100	584,500	69,400

[1/] Includes $52,745K ARRA appropriation and $2,290K ARRA reimbursable.

[2/] Includes $187,255K carryover from ARRA appropriation and $10,060K ARRA reimbursable.

[3/] $10,000K from DoE for smart grid and $2,230K from NTIA for broadband projects.

[4/] $120K from DoE for a superconducting magnet project.

[5/] Includes $187,255K carryover from ARRA appropriation and $9,940K carryover from ARRA reimbursable.

[6/] $20,000K from HHS for health IT, and $4,000K from EAC, and $1,500K from COPS, DoJ.

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

[8/] $3,500K from EAC and $1,500K from COPS, DoJ.

Adjustments
to Base

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	...	...	(10,500)
Reduced FTE funded by ARRA carryover	...	(31)	0
Restoration of FY 2010 deobligation offset	...	...	$1,000
Subtotal, Adjustments	...	(31)	(9,500)
Financing:			
Recoveries of prior year deobligations	...	...	(1,000)
Other Changes:			
Annualization of 2010 pay raise	...	...	1,245
2011 Pay increase and related costs	...	...	2,821
Annualization of positions financed in FY 2010	...	21	0
Personnel benefits:			
Civil Service Retirement System (CSRS)	...	...	(422)
Federal Employees' Retirement System (FERS)	...	...	1,624
Thrift Savings Plan (TSP)	...	...	261
Federal Insurance Contribution Act (FICA) - OASDI	...	...	337
Health insurance	...	...	912
Employees' Compensation Fund	...	...	42
Travel and transportation of persons:			
Mileage	...	...	(1)
Per Diem	...	...	184
Rental payments to GSA	...	...	1
Communications, utilities, and miscellaneous charges:			
Postage	...	...	2
Electricity rate increase	...	...	214
Natural Gas rate increase	...	...	471
Other services:			
Working Capital Fund (Departmental Management)	...	...	1,252

	Perm. Pos.	FTE	Amount
Commerce Business Systems (CBS)	...	...	137
NARA storage costs	...	...	4
Supplies and materials:			
Scientific journal subscriptions	...	...	114
Helium rate increase	...	...	316
General pricing level adjustment:			
Transportation of things	...	...	10
Rental payments to others	...	...	8
Communications, utilities, and miscellaneous charges	...	...	28
Printing and reproduction	...	...	3
Other services	...	...	502
Supplies and materials	...	...	168
Equipment	...	...	371
Subtotal, Other changes	0	21	10,604
Subtotal, Adjustments to base	0	(10)	104
Amount Absorbed	...	...	(4)
Total, Adjustments to base	0	(10)	100

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	($10,500)

In FY 2010, NIST received $10,500,000 in congressionally directed projects. This adjustment removes these one-time costs.

Reduced FTE funded by ARRA carryover	(31)	0

In FY 2009, NIST received $240,000,000 in one-time funding from the American Recovery and Reinvestment Act (ARRA). This adjustment reflects a reduction in FTE funded by carryover from this account.

Restoration of FY 2010 deobligation offset	0	$1,000

In FY 2010, 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 2011.

Subtotal, Adjustments	(31)	(9,500)
Financing:		
Recoveries of prior year deobligations	0	(1,000)

NIST's FY 2011 STRS budget authority is reduced by the estimated level of prior year deobligations in FY 2011.

Other Changes:

Annualization of 2010 pay raise	0	1,245

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

Total cost in FY 2011 of 2010 pay raise	$4,988,000
Less amount requested in FY 2010	(3,743,000)
Less amount absorbed in FY 2010	0
Amount requested in 2011 to provide full-year cost of 2010 pay raise	1,245,000
Payment to Departmental Management Working Capital Fund	0
Total, FY 2010 pay raise increase in FY 2011	1,245,000

2011 Pay increase and related costs	0	2,821

A general pay raise of 1.4 percent is assumed to be effective January 1, 2011.

Total cost in FY 2011 of pay increase	$2,760,000
Less amount absorbed in FY 2011	0
Amount requested for FY 2011 pay increase	2,760,000
Payment to Departmental Management Working Capital Fund	61,000
Total adjustment for FY 2011 pay increase	2,821,000

Annualization of positions financed in FY 2010	21	0

NIST requires an additional 21 FTE to staff FY 2010 requested increases at their full operating level in FY 2011.

New positions in 2010	104
Less 5 percent lapse	(5)
Full-Year FTE	99
Less FTE Funded in 2010	(78)
Annualization of Positions/FTE in 2011	21

Personnel benefits		2,754
Civil Service Retirement System (CSRS)	($422)	
Federal Employees' Retirement System (FERS)	1,624	
Thrift Savings Plan (TSP)	261	
Federal Insurance Contribution Act (FICA) - OASDI	337	
Health Insurance	912	
Employees' Compensation Fund	42	

Civil Service Retirement System (-$422,000) – 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 14.6 percent in FY 2010 to 11.8 percent in FY 2011. The contribution rate will remain at 7.0 percent in FY 2011.

Payroll subject to retirement systems ($215,213,417)	
Cost of CSRS contributions in FY 2011 ($215,213,417 x .118 x .07)	$1,777,663
Cost of CSRS contributions in FY 2010 ($215,213,417 x .146 x .07)	2,199,481
Total adjustment to base	(421,818)

Federal Employees' Retirement System ($1,624,000) – 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 85.4 percent in FY 2010 to 88.2 percent in FY 2011. The contribution rate has increased from 11.2 percent to 11.7 percent in FY 2011.

Payroll subject to retirement systems ($215,213,417)	
Basic benefit cost in FY 2011 ($215,213,417 x .882 x .117)	$22,208,733
Basic benefit cost in FY 2010 ($215,213,417 x .854 x .112)	20,584,733
Total adjustment to base	1,624,000

Thrift Savings Plan ($261,000) – The cost of agency contributions to the TSP will also rise as FERS participation increases. The contribution rate will decrease from 4.65 to 4.64 percent in FY 2011.

Thrift plan cost in FY 2011 ($215,213,417 x .882 x .0464)	$8,807,566
Thrift plan cost in FY 2010 ($215,213,417 x .854 x .0465)	8,546,340
Total adjustment to base	261,226

Federal Insurance Contributions Act (FICA) - OASDI ($337,000) – 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 $110,400 in FY 2010 to $114,975 in FY 2011. The OASDI tax rate will remain at 6.2 percent in FY 2011.

FERS payroll subject to FICA tax in 2011 ($215,213,417 x .882 x .903 x .062)	$10,627,164
FERS payroll subject to FICA tax in 2010 ($215,213,417 x .854 x .904 x .062)	10,301,188
Increase (FY 2010-FY 2011)	325,976
OTP payroll subject to FICA tax in FY 2011 ($6,999,583 x .882 x .903 x .062)	345,637
OTP payroll subject to FICA tax in FY 2010 ($6,999,583 x .854 x .904 x .062)	335,035
Increase (FY 2010-FY 2011)	10,602
Total adjustment to base	336,578

Health insurance ($912,000) – Effective January 2009, NIST's contribution to Federal employees' health insurance premiums increased by 7.0 percent. Applied against the FY 2010 estimate of $13,033,000, the additional amount required is $912,000.

Employees' Compensation Fund ($42,000) – The Employees' Compensation Fund bill for the year ending June 30, 2009 is a net $32,000 higher than for the year ending June 30, 2008. The STRS share of this increase is $42,000.

Travel and transportation of persons	0	183

The General Services Administration (GSA) decreased the mileage rate from 58.5 cents to 55.0 cents, a 6 percent decrease. This percentage was applied to the FY 2010 estimate of $10,000 to arrive at a decrease of $600. 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, 2007 through September 30, 2009. A net increase of 3.71 percent was applied to the FY 2010 base of $4,968,000 to arrive at an increase of $184,313.

Rental Payments to GSA	0	1

GSA rates are projected to increase 1.4 percent in FY 2011. This percentage was applied to the FY 2010 estimate of $36,000 to arrive at an increase of $504.

Communications, utilities, and miscellaneous charges	0	687

Postage	$2
Electricity rate increase	214
Natural Gas rate increase	471

Effective May 11, 2009, the Governors of the Postal Service implemented a rate increase for first class mail from 42 cents to 44 cents, an increase of 4.8 percent. This percentage was applied to the FY 2010 estimate of $37,000 to arrive at an increase of $1,776.

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 2009 and 2008, the per kilowatt hour rate decreased 0.7 percent (from 11.6 cents to 11.5 cents) for Gaithersburg, Maryland; increased 4.6 percent (from 34.6 cents to 36.2 cents) for Kauai, Hawaii; increased 22.3 percent (from 5.5 cents to 6.7 cents) for Boulder, Colorado; and increased 7.1 percent (from 8.2 cents to 8.8 cents) for Ft. Collins, Colorado for a net increase of $214,000.

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 March 2009 and 2008, the per therm rate increased 11.0 percent (from 1.194 to 1.325) and decreased 17.8 percent (from 8.616 to 7.078) for Gaithersburg and Boulder respectively resulting in a net increase of $471,000.

Other Services	0	1,393

Working Capital Fund (Departmental Management)	$1,252
Commerce Business Systems (CBS)	137
National Archives and Records Administration (NARA) storage costs	4

Working Capital Fund (Departmental Management) ($1,252,000) – An additional $1,252,000 is required to fund cost increases in the Departmental Management Working Capital Fund.

Commerce Business Systems (CBS) ($137,000) – An increase of $137,000 is required in FY 2011 consistent with the CBS Capital Asset Plan.

National Archives and Records Administration (NARA) storage costs ($4,000) - NARA estimates reflect an increase of $4,000 in FY 2011 for records storage and maintenance costs.

Supplies and Materials		0	430
Scientific journal subscriptions	$114		
Helium	316		

Scientific journal subscriptions ($114,000) - This adjustment to base addresses the FY 2008 to FY 2009 inflationary increase in costs for NIST's subscriptions journals which exceed the inflationary increases provided through the regular general pricing level deflator. The application of the 7.5 percent deflator results in an increase of $113,625 when applied to the FY 2010 estimate of $1,515,000.

Helium ($316,000) – This adjustment to base was derived using a year to year comparison of the average cost per liter of helium. In analyzing the 12 months ended February 2009 and 2008, the per liter rate increased 38.0 percent (from 4.999 to 6.900) resulting in an increase of $315,755 when applied to the FY 2010 estimate of $830,933.

General pricing level adjustment	0	1,090

This request applies the OMB economic assumption of 0.8 percent for FY 2011 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 $10,112; rental payments to others $7,728; communications, utilities, and miscellaneous charges $28,168; printing and reproduction $3,296; other services $501,734; supplies and materials $168,409; and equipment $371,112.

Subtotal, Other changes	21	10,604
Amount absorbed	0	(4)
Total adjustments to base	(10)	100

National Measurement and
Standards Laboratories

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		2009 Actual Personnel	2009 Actual Amount	2010 Currently Available Personnel	2010 Currently Available Amount	2011 Base Personnel	2011 Base Amount	2011 Estimate Personnel	2011 Estimate Amount	Increase/ (Decrease) Over 2011 Base Personnel	Increase/ (Decrease) Over 2011 Base Amount
Strategic and emerging research	Pos./Approp	21	$65,651	21	$9,264	21	$9,873	21	$11,873	0	$2,000
initiatives	FTE/Obl.	19	10,645	27	64,293	27	9,873	27	11,673	0	1,800
Electronics and electrical engineering	Pos./Approp	204	81,987	228	58,826	228	59,966	257	67,466	29	7,500
laboratory	FTE/Obl.	198	64,977	230	82,464	234	60,095	255	67,595	21	7,500
Manufacturing engineering	Pos./Approp	145	48,715	145	35,235	145	35,924	165	44,924	20	9,000
laboratory	FTE/Obl.	140	38,711	149	46,198	149	35,983	164	44,983	15	9,000
Chemical science and technology	Pos./Approp	261	64,719	287	60,224	287	61,505	311	71,505	24	10,000
laboratory	FTE/Obl.	251	54,265	287	69,748	292	61,572	310	69,322	18	7,750
Physics laboratory	Pos./Approp	178	71,133	197	55,846	197	56,909	197	56,909	0	0
	FTE/Obl.	172	53,157	200	72,841	204	57,014	204	57,014	0	0
Materials science and engineering	Pos./Approp	180	48,292	180	39,375	180	40,227	190	44,227	10	4,000
laboratory	FTE/Obl.	173	41,320	185	46,598	185	40,295	192	44,295	7	4,000
Building and fire research	Pos./Approp	146	42,493	152	36,393	152	37,087	177	48,087	25	11,000
laboratory	FTE/Obl.	141	34,558	156	44,592	158	37,136	177	48,136	19	11,000
Information technology laboratory	Pos./Approp	297	70,691	326	67,550	326	69,012	371	84,012	45	15,000
	FTE/Obl.	285	65,978	323	99,707	329	69,123	363	86,523	34	17,400

Line Item		2009 Actual Personnel	2009 Actual Amount	2010 Currently Available Personnel	2010 Currently Available Amount	2011 Base Personnel	2011 Base Amount	2011 Estimate Personnel	2011 Estimate Amount	Increase/ (Decrease) Over 2011 Base Personnel	Increase/ (Decrease) Over 2011 Base Amount
NIST center for neutron research	Pos./Approp	162	51,571	162	41,593	162	42,443	162	42,443	0	0
	FTE/Obl.	155	43,059	167	50,481	167	42,610	167	42,610	0	0
Center for nanoscale science and technology	Pos./Approp	71	34,871	71	27,621	71	28,181	100	35,681	29	7,500
	FTE/Obl.	68	30,628	73	33,359	73	28,212	94	35,712	21	7,500
Technology services	Pos./Approp	79	20,839	79	14,940	79	14,921	79	14,921	0	0
	FTE/Obl.	76	18,100	79	17,886	79	14,990	79	14,990	0	0
Innovations in measurement science	Pos./Approp	81	19,888	81	20,199	81	20,579	81	20,579	0	0
	FTE/Obl.	78	19,967	82	21,092	82	20,601	82	20,601	0	0
Postdoctoral research associates program	Pos./Approp	101	32,784	101	11,030	101	11,448	124	14,848	23	3,400
	FTE/Obl.	114	21,517	134	22,677	103	11,462	120	14,862	17	3,400
External projects	Pos./Approp	0	3,475	0	10,500	0	0	0	0	0	0
	FTE/Obl.	0	3,488	0	10,500	0	0	0	0	0	0
Total	Pos./Approp	1,926	657,109	2,030	488,596	2,030	488,075	2,235	557,475	205	69,400
	FTE/Obl.	1,870	500,370	2,092	682,436	2,082	488,966	2,234	558,316	152	69,350

Exhibit 12

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 the Department'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 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 are 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 who is 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.

NIST 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 a broad range of critical challenges, with substantial investment being directed at six priority areas: energy, environment, manufacturing, health care, physical infrastructure and information technology.

- **Energy:** research focused on (1) accelerating an interoperable Smart Grid through a framework and measurement tools for interoperability of Smart Grid devices and systems; and (2) advancing measurement science for net-zero energy high-performance green buildings through development and implementation of standards for energy efficient buildings. NIST continues to address critical challenges in energy through existing activities:

  - increasing energy efficiency in the automotive industry by promoting innovations including advanced lightweight materials and nanostructured materials, hybrid and electric motor systems, and thermoelectric converters;
  - neutron-based non-destructive observation of functioning fuel cells, leading to better designs and performance;
  - enabling faster commercialization of energy efficient lighting systems by improving reliability and reproducibility through precise fabrication of nanostructured materials;
  - lowering market barriers for replacing legacy lighting with LED lighting through new performance measures; and
  - improving cooling and heating system efficiency through improved measurement of air velocity distributions.

- **Environment:** research focused on (1) expanding NIST capabilities for accurate physical and chemical characterization of nanomaterials; and (2) internationally comparable measurements of point source and remote greenhouse gas emissions. NIST continues to address critical challenges in environment research through existing activities:

    - developing new measurement standards to improve the accuracy of ground, air, and satellite-based measurements of the Earth's radiation balance in support of climate change research;
    - developing methods for incorporating carbon footprint information into product lifecycle management;
    - ensuring the effectiveness and reliability of products manufactured with renewable, more environmentally sound materials to reduce or eliminate the use of toxic substances such as lead;
    - improving measurement capability to develop better ways to remove toxins from the environment; and
    - enabling industry and regulatory agencies to assess and manage environmental, health, and safety risks associated with engineered nanomaterials through measurements of nanoparticle size, shape, structure, and surface area.

- **Manufacturing:** NIST continues to address critical challenges in manufacturing research through existing activities:

    - enhancing industrial (communication, bio-medical, defense, nano-scale, and semiconductor) capability for manufacturing and testing advanced optical systems;
    - enabling manufacturers to adapt to changing applications and markets through rapid reconfiguration of factories;
    - guiding the rapid development and manufacture of advanced products by ensuring data exchange interoperability and integration with manufacturing instrumentation and equipment;
    - reducing transportation, inventory, and lead time costs through improved exchange of information across manufacturing supply chains;
    - improving robotic vehicle navigation, flexibility, and efficiency through advanced imaging systems;
    - advancing the development and production of nanotechnology products through new methods to characterize and improve the performance of nanostructured materials and devices;
    - improving performance of products in industry through improved measurements of internal stresses;
    - enabling translation of new nanoscale phenomena into commercial products through improved process and quality control using nearfield optical apertures; and
    - enhancing international acceptance of U.S. products, measurement results, and accreditation programs through improved documentary and physical standards, calibration and accreditation services, and standard reference data.

- **Health Care:** research focused on (1) ensuring the technical information infrastructure for health care is correct, complete, and testable; (2) improving the accuracy and reproducibility of clinical diagnostics; and (3) supporting innovations in quantitative medical imaging. NIST continues to address critical challenges in health care through existing activities:

  - improving uniformity and reliability of magnetic resonance imaging;
  - advancing medical diagnostics by assessing performance of DNA microarrays in quantitation of mRNA for gene expression;
  - improving accuracy of medical decisions through biomarkers for use in electronic records;
  - enabling new methods of biomedical imaging and smaller, cheaper, and more effective magnetic resonance imaging systems;
  - improving minimally invasive imaging of biological tissues for medical diagnosis and treatment based on quantum dots and vibrational resonance;
  - ensuring effective and reliable biomedical products through standards and experimental protocols that accelerate the development and growth of emerging tissue engineering and therapeutic materials industries;
  - improving nuclear medicine through NIST-traceable measurements of radionuclide content in the human body; and

- **Physical Infrastructure:** NIST continues to address critical challenges in physical infrastructure research through existing activities:

  - enabling prioritization of infrastructure remediation and helping avoid structural failure under extreme conditions;
  - improving construction productivity through improved productivity measurement and analysis methods;
  - supporting implementation of performance-based seismic design of structures through validated nonlinear response models;
  - improving resistance to progressive collapse in new steel and concrete buildings through standardized performance criteria;
  - promoting building sustainability through improved inter-laboratory comparability of emission measurements;
  - mitigating structure losses in wildland-urban interface fires by providing the scientific foundation for new and enhanced building codes and standards;
  - reducing the risk of fire spread in buildings through improved furniture flammability test methods; and
  - improving the service life of infrastructural concrete through optimal selection of nano-sized viscosity modifiers.

- **Information technology:** research focused on transformative cybersecurity technologies improving cryptographic key management and usability of security systems. NIST continues to address critical challenges in information technology through existing activities:

  - providing secure communications through single-photon sources and detectors to support quantum key distribution;

- advancing computer technology beyond the integrated circuit by studying advanced new materials and nanodevices;
- supporting advances in telecommunications through improved accuracy of atomic clocks and remote diagnosis of transmission problems on flexible networks for real-time control of signal routing;
- establishing new foundational security mechanisms to support innovative networking of emerging devices;
- accelerating the development and adoption of correct, reliable, testable software, increasing trust and confidence in software; and,
- enabling improved accuracy and interoperability of biometric recognition systems for real-time verification and identification.

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 (SERI) Funds – 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 SERI fund allows NIST the flexibility to pull together research teams from across the Institute 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 cross-section of the U.S. industrial landscape, including the U.S. semiconductor industry, which had $120 billion in U.S. sales in 2008,[1] the U. S. electric power industries, with total retail electricity revenues of $344 billion in 2007,[2] as well as the network communication and consumer electronics segments. The U.S. electronics and electrical equipment industries (including computer, communications, semiconductor component and equipment manufacturing)

[1] Semiconductor Industry Association Fact Sheet, http://www.sia-online.org/cs/industry_resources/industry_fact_sheet
[2] *http://www.eia.doe.gov/cneaf/electricity/esr/esr_sum.html*

employed almost 3 million people at the end of 2007,[3] 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 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, 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 electronics and electrical engineering 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, and leveraging funding from the American Recovery and Reinvestment Act of 2009, worked aggressively to publish the first roadmap to assess the current state of Smart Grid standards, and to propose prioritized actions towards recommending suites of interoperable standards.

[3] *http://www.bls.gov/news.release/empsit.t14.htm*

- Gamma-Ray Detection for Nuclear Non-Proliferation: NIST significantly improved its already world's-best gamma-ray sensors technology, resulting in detectors with increased dynamic range and an energy resolution—up to twenty times better than current state-of-the-art detectors. NIST has supplied Los Alamos with a complete gamma-ray spectrometer based on the new sensor technology, which for the first time enables the gamma-ray emission from ^{235}U to be clearly distinguished from that of ^{226}Ra. The isotope ^{226}Ra is present in clay-bearing materials such as kitty litter and is a common source of false alarms during cargo inspections because its gamma-ray emission closely resembles emission from ^{235}U. The isotope ^{235}U is used for nuclear weapons and thus its smuggling is a grave concern.

- Long-Range Targeting with Nanometer Precision: NIST developed a light detection and ranging (LIDAR) system that can pinpoint multiple objects with nanometer precision over distances up to 100 kilometers (~62 miles). NIST's LIDAR design derives its power from combining the best of two different approaches to absolute distance measurements: the time-of-flight method, which offers a large ambiguity range, and interferometry, which is ultraprecise. It couples these methods with optical frequency combs, tools for precisely measuring different colors (or frequencies) of light. This novel system promises to impact applications from precision manufacturing to the maintenance of perfectly-aligned satellite networks that could enable space research.

- Flexible Electronic Memory Chip: NIST researchers have used inexpensive, readily available materials to create an electronic memory chip that can be bent or twisted—some 4,000 times in tests—and still keep functioning. This new device is promising not only because of its potential applications in medicine and other fields, but because it also appears to possess the characteristics of a memristor, a fundamentally new component for electronic circuits that industry scientists developed in 2008.

- Body Armor Standard: The NIST Office of Law Enforcement Standards revised the performance standard for ballistic-resistant body armor, which is used both nationally and internationally to address critical personal protection needs of the public safety community. Nearly all 19,000 police agencies across the U.S. rely on this standard to ensure the armor used by their officers provides adequate protection, and the standard is credited with saving over 3,000 lives.

NIST's FY 2011 electronics and electrical engineering base program operating objectives include the following:

- Smart Grid Measurements and Services: Developing new measurement techniques and services to support development and adoption of interoperable Smart Grid technologies. Technology areas include: smart grid meter metrology testbed and measurements; advanced synchrometrology capability for comprehensive performance characterization; and models, test methods, and performance evaluation for power electronics-based electric power conditioning systems (PCSs) to enable renewable energy resources (wind, solar, etc.) to be readily integrated into transmission and distribution systems.

- Advanced Energy Technologies for Solar Energy and Storage: Developing advanced measurement science and test structures to accelerate the development of third-generation photovoltaic devices with higher efficiency than current solar cells. 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.

- Innovative Electronics Instrumentation: Developing and implementing new quantum-physics-based systems for fundamental electrical metrology applications, such as developing improved air conditioning 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.

- 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.

- 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 is a $1.6 trillion industry employing over 14.2 million people[4] 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.[5] Manufacturing industries account for over 65 percent of non-government R&D,[6] providing a dramatic influx of new technology to the U.S. economy.

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

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[4] *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;

[5] *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}

[6] *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/.

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 to acoustical standards for the safety of workers in noisy manufacturing environments, and 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.

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

- Dimensional Metrology: NIST led the development of new dimensional metrology (measurement) standards that harmonized the U.S. with international standards, thus removing an impediment to U.S. competitiveness. The new standards govern how automated coordinate metrology equipment is specified and tested. NIST activities in this area will result in lower costs for U.S. manufacturers by reducing the number of specifications and testing equipment needed to purchase and maintain their equipment.

- Automated Inspection Equipment: NIST developed a conformance test suite that verifies that equipment from competing manufacturers of automated inspection equipment works seamlessly together. A variety of equipment has been tested against the NIST-developed test suite over a four-year period. The testing culminated in a capstone international industry event at which dozens of suppliers demonstrated the compatibility of their new equipment. NIST research in this area lowers inspection costs for U.S. manufacturers and ensures part quality.

- Redefinition of the Kilogram: NIST researchers completed a crucial step toward redefinition of the kilogram unit of mass by constructing an apparatus to perform high precision comparisons of kilogram mass artifacts in air with kilogram mass standards in vacuum. This NIST-developed device will solve the problem of transferring a new definition of the kilogram – one based on fundamental physical constants and realized in a vacuum – to mass artifacts that are used in air. An innovative magnetic coupling technique allows the mass artifact in the air chamber to be weighed by the high precision mass balance in the vacuum chamber as if they were directly connected. In addition to disseminating the new kilogram realization to U.S. industry and standards laboratories, this new apparatus will provide traceability to the current artifact-based kilogram realization, which is one of seven base units of the International System of Units.

- Automated Industrial Vehicles: As a result of NIST testing and data analysis, NIST proposed changes to the ANSI/ITSDF B56.5 standard (safety for automated guided vehicles) resulted in changes to the standards to allow advanced, non-contact safety sensors as vehicle obstacle detection devices. The ability to use non-contact sensors for safety in automated guided vehicles will greatly increase their flexibility on the manufacturing floor while enhancing safety of workers sharing their environment.

- Sub-wavelength optical measurements: NIST made optical measurements of dense features smaller than a tenth of the wavelength in size with nanometer uncertainties. The highly accurate measurements were made possible by implementing a new Bayesian statistical approach that embeds multiple measurements in the uncertainty analysis. This technique substantially improves measurement accuracy and extends high-throughput nanometer-scale optical measurements for multiple generations of semiconductor manufacturing and process control.

- Nanometer Scale Measurements: NIST developed a new nanometer-scale calibration and validation procedure for semiconductor feature linewidth and sidewall angle. This NIST research enabled, for the first time, a comprehensive characterization and calibration procedure for sidewall angle measurements. The new calibration procedure gives the semiconductor industry a low cost way to accurately determine key measurements for manufacturing process control.

- Advanced Manufacturing: NIST, in collaboration with the automotive industry, has developed recommended best practices, standard messages, and conformance tests to apply the software applications used to manage company supply chains. The NIST research team developed tools that allow original equipment manufacturers (OEMS) to manage the movement of goods from their suppliers into their assembly plants. NIST's efforts will lead to dramatic reductions in shipment delays and transportation costs and more efficient operation of the long-distance supply chains. A pilot deployment of this technology has been implemented in a General Motors supply chain.

- Precision Manufacturing Equipment: In collaboration with an international team of experts, NIST researchers developed and tested the first draft standard that defines advanced measurement methods for evaluating the capability of manufacturing equipment to generate accurate 5-axis complex motion. These new methods allow manufacturing equipment vendors and users to assess their capabilities for manufacturing a new generation of complex products (such as high-precision turbine blades, compressors, etc.), thus reducing the need for substantial trial-and-error prototyping and speeding new products to market.

- Manufacturing Processes: NIST researchers developed a unique capability for measuring material flow and temperature distribution during metal removal processes, and characterized the respective measurement uncertainties. NIST high-quality measurement data and new NIST-developed measurement methods enable developers of cutting tools, manufacturing processes, and manufacturing software to improve the efficiency of challenging manufacturing processes, such as the machining of titanium.

- Bulk Electric System Security: NIST researchers, in collaboration with the North American Electric Reliability Corporation (NERC) standards drafting team, revised the Critical Infrastructure Protection (CIP) reliability standards that specify minimum cyber security requirements for the Bulk Electric System. NIST hosted the kick-off meeting of the NERC CIP standards drafting team and collaborated in the revision of the eight cybersecurity standards (CIP-002-1 through CIP-009-1). These standards will support reliable operation of the U.S. Bulk Electric System and play a major role in securing the U.S. Smart Grid System.

NIST's FY 2011 manufacturing engineering base program operating objectives include the following:

- Next Generation Realization of the Meter: Advance the realization of the meter through the use of an optical comb and absolute refractometry to achieve below one part in 100,000,000 (i.e., 10^8) accuracy and thereby, reduce a major uncertainty source in high-precision length measurements. NIST research will halve the uncertainty of our current realization of the meter and lower the barrier to innovation by allowing common telecommunication lasers to be easily calibrated by receiving Global Positioning System (GPS) satellites frequencies as the reference oscillator for the comb.

- Nanotechnology - Atom-based Measurements**:** Develop prototype nanometer-sized reference standards for linewidth and spacing with dimensions based on the intrinsic atom spacing in crystals and an exact counted number of atoms. This NIST research represents an entirely new paradigm and scientific basis for length standards. New standards with the level of perfection that will be achieved are urgently needed to realize the promise of nanotechnology.

- Semiconductor Industry Measurements: Develop a new scanning electron microscope (SEM) measurement competence that enables measurements of insulating samples that are difficult to measure with current SEM technology. NIST research will enable the semiconductor industry to better tune electron microscopes for defect detection (often responsible for reduced yield) and to perform more accurate measurements of nanometer-scale critical dimensions needed by the industry to tune manufacturing processes.

- Small Force Measurements: Complete the tensile testing experiments of Deoxyribonucleic acid (DNA) single molecules that will form the basis for new NIST reference data for accurate measurement of small forces and pave the way for new standard reference materials (SRMs) for single molecule biophysical studies. NIST measurement of the force associated with the overstretch transition of DNA could serve as a benchmark in the calibration of a diverse array of biophysical measurements using tools such as atomic-force microscopy and optical tweezers.

- Nanomanufacturing: Develop traceable laser-based methods for measuring the displacement and velocity of nanoscale structures and machines with unprecedented accuracy and measurement speed. NIST research in this area will provide the nanomanufacturing industry with the ability to accurately measure the motion of nanosystems, including nanoswitches in electronics, nanoresonators for biochemical sensing, and nanorobots. It will also improve the basic understanding of these technologies, as well as improve the manufacturing yield rates and device performance of nanosystems.

- Model-Based Manufacturing Enterprise: Develop measurement techniques and standards for making products using accurate models of materials and processes such as cutting, forming and assembling, enabling U.S. companies to put together best-in-class products from vendors to build creative solutions. NIST research will make it easier for U.S. manufacturers to innovate on the shop floor and deliver products found nowhere else at affordable costs.

- Industrial Control Systems: Develop security requirements for future industrial control systems. NIST research that drives innovation and technology change to provide built-in security during the design process (rather than as an add-on for current systems) for new industrial control systems will result in greater security for the critical infrastructures.

- Supply Chain Integration: Develop an integration infrastructure that will enable manufacturers to find the best supplier for their job. The infrastructure will include standards for representing the vendor's product requirements for the various components and the capabilities of suppliers who might want to manufacture those components. Software tools that match requirements against those capabilities will also be developed. The NIST-developed infrastructure will reduce manufacturing logistics cost by providing a technological foundation on which manufacturers can find domestic suppliers for their existing and new products.

- Green Manufacturing: Develop advanced representations for incorporating information and metrics about environmental factors into product representations and for use in product lifecycle management tools and techniques. The NIST-developed tools and techniques will support the development of new standards that include enhanced functionality such as design-for-recycling and smart disassembly techniques.

- Non-Traditional Manufacturing Systems: Establish performance metrics and metrology tools to characterize and improve metal-based additive manufacturing processes. These emerging processes promises quick fabrication of complex customized products and tools by building the parts layer by layer; however, standards and tools to characterize the processes do not exist. NIST's research and standards activities will help U.S. manufacturers overcome technology barriers to the widespread use of metal-based additive processes to build functional parts.

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 chemical science and technology research focuses on industry and government priorities, as demonstrated by these recent examples:

- Standard Reference Material for Metabolites in Human Plasma: The NIH Metabolomics Technology Development Initiative has articulated the need for new tools to assess the comparability of measurements in support of metabolomics research studies. NIST is developing a human blood plasma-based Standard Reference Material (SRM) to enable evaluation of new procedures and equipment for metabolomics research. SRM 1950, Metabolites in Human Plasma, will have concentration values assigned for more than 50 metabolites, including glucose, creatinine, cholesterol, uric acid and selected electrolytes, non-peptide hormones, vitamins, amino acids, and fatty acids. It is generally believed that measurements of metabolomic profiles may provide insight into the chemical and molecular pathways that are involved in both normal and diseased states.

- Standard Reference Material for Vitamin D in human serum: At the request of the NIH Office of Dietary Supplements. NIST has recently developed a human serum-based Standard Reference Material to enable evaluation of the accuracy and comparability of tests for Vitamin D in human blood serum. Vitamin D deficiency is associated with muscle weakness and osteoporosis and is thought to be linked to increased risk of colon, breast, and prostate cancer, diabetes and heart disease. It is suspected that the assays used to measure 25-OH-D (major metabolite of Vitamin D) yield discrepant results, thereby making diagnosis of Vitamin D deficiency/insufficiency difficult. The need for a certified reference material for use as a measurement accuracy control was recently highlighted when Quest Diagnostics, the world's largest clinical reference laboratory, on January 8, 2009, recalled thousands of test results for Vitamin D. It was the largest patient result recall in history and a retesting program was implemented immediately. The release of the NIST Standard Reference Material for Vitamin D to benchmark the accuracy of future tests was subsequently incorporated in Quest's internal Quality Assurance procedures.

- 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 DNA-based human identity markers to enable more accurate 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. New STR loci and assays are being examined to see if standardized approaches and genetic marker sets may be taken with kinship analysis where biological relatives are used for reference purposes, such as in immigration testing or missing persons and mass fatality investigations. NIST is researching rapid DNA amplification techniques to enable DNA biometric applications to support efforts by DHS, DOD, and DOJ. NIST is developing reference materials to enable quantitative measurement performance verification across portable DNA devices. Studies are also being conducted to examine the limitations of low-level DNA analysis.

- 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.

- Advanced Fuels Metrology: NIST research has led to a new test method and apparatus to characterize properties of complex fuels. The advanced distillation curve provides detailed information on the vaporization behavior of fuels. The property characterization method has been used to help the military develop synthetic fuels for its aircraft (and in support of the single-fuel concept) and is now being used on alternative fuels, including biofuels.

- Cryocoolers: NIST scientists have achieved several breakthroughs in cryocooler technologies—these are the low temperature closed refrigeration systems that are needed to cool infrared detectors, superconducting systems, and achieve quantum effects for metrology. The NIST work has increased efficiency and reliability, as well as helped control vibration and noise at the cold end of the system. Tiny cryocoolers are being developed to cool electronic chips and terahertz detectors: the increased frequency, smaller sizes, and rapid cool-down technologies are based on NIST advances.

- Property Data on Demand: NIST has developed the concept of dynamic data evaluation, which now allows the generation and validation of thermophysical property data for a huge variety of chemicals, even prior to their synthesis. The system includes an archive of the world's historic property data, standards for information exchange, and artificial intelligence networks for systematic analysis. Most data in the field currently being measured are automatically included in the global data system, and most chemical companies now have immediate access to the best validated thermophysical property information through NIST dissemination protocols.

NIST's FY 2011 chemical science and technology base program 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.

- Standards for Laboratory Medicine: Develop standards for laboratory medicine with emphasis on serum proteins and genetic testing to support the reliability and accuracy of current tools used to diagnose and predict disease. These efforts support achieving accurate measurements, critical for advancing predictive and preventive medicine; 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.

- Climate Change Science: CSTL efforts will address critical gaps in the understanding of the effects of aerosols on radiative forcing in global energy balance and on the development of a quantitative understanding of the effects of volatile organic compounds on atmospheric aerosols. NIST efforts will also 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 by providing SRMs, Standard Reference Data and Calibration Services that are internationally recognized and traceable to the International System of Units.

- Greenhouse Gas Measurements and Standards: Develop measurement methods and standards that address greenhouse mitigation needs, including more accurate methods to assess the amounts of CO_2 and other greenhouse gases emitted by multiple industries and technology sectors in a consistent and verifiable manner, both nationally and internationally. With other NIST operating units, develop test bed capabilities for evaluation and calibration of new and current point source monitoring technologies.

- Energy: Develop certified reference materials for bioethanol and biodiesel from various sources and continue research that supports the use of hydrogen fuel. This research enables NIST to provide the standards for next-generation fuels; facilitating biofuels to become a global commodity by quality assuring measurements used to assess conformity to different specifications in different parts of the world, developing metering standards and technology for hydrogen to address fair trade issues, and investigation of molecular structures that form the key components in solar-to-fuel technologies, and provide reference data to support the conversion of biomass to new energy products.

- 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.

5) Physics Laboratory (PL) – NIST meets the Nation's measurement needs utilizing advances in physics. Both practical and fundamental problems are addressed using expertise in atomic and optical physics, ionizing radiation, and electronic and magnetic phenomena. 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 22 million therapeutic radiation procedures[7] and nearly 37 million x-ray mammograms[8] 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.

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

- Quantitative Medical Imaging: NIST developed methods and procedures to calibrate scanners 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 1.8 million PET procedures were performed in 2007, a number

[7] *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 almost 1.5 million newly diagnosed cancers in the United States in 2009. 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 900,000. Each patient will have a total of between 25 and 30 fractionated dose procedures (between 22 million and 27 million individual procedures performed annually). Therapeutic radiation procedures are also used for diseases other than cancers. However, statistics on these are not available.*

[8] *All mammograms performed in the United States must be traceable to NIST standards. As of June 1, 2009, nearly 37 million mammograms were being performed annually. See http://www.fda.gov/cdrh/mammography/scorecard-statistics.html.*

expected to reach 7.1 million annually by 2015.[9] Accuracy and quality assurance 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.

- Energy-Efficient Lighting: NIST constructed the Spectrally Tunable Lighting Facility for research and standards development in the application of new, energy-efficient solid-state lighting. Today, lighting accounts for about a quarter of the energy used in the home[10] and commercial buildings.[11] Evaluators can be completely immersed in a real-life setting illuminated by 1,800 high-power LEDs in 22 color channels, all completely adjustable by computer. This allows researchers to simulate in advance new lighting systems that have the potential to dramatically reduce energy use owing to their energy efficiency and longevity. The facility allows engineers to achieve superior color quality and consumer acceptance, as well as high energy efficiency, and to develop quality metrics that will enable informed purchases of new lighting technologies.

NIST's FY 2011 physics base program operating objectives include the following:

- Nuclear Energy Safety: Develop new radioactivity SRMs, of relevant activity level and material composition, and validated methodologies for analyzing radionuclides, to provide the nuclear power industry with Nuclear Regulatory Commission-required measurement assurance traceable to national standards.

- Magnetometer for Healthcare: 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 enable new methods of biomedical imaging; and also to improve the effectiveness of magnetometers detecting hidden weapons and other threats.

- Quantitative Medical Imaging: Develop precision calibration standards for accurate determination of lesion sizes in Computed Axial Tomography Scan (CAT-scan) images, to improve reliability of measurements of drug response, thus improving accuracy and reducing time and costs of clinical trials.

- Environmental Monitoring: Develop new measurement standards for the bidirectional reflectance distribution function (BRDF) to improve the accuracy of ground, air, and satellite-based measurements of the reflected solar radiation from the Earth in support of

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[9] *BIO-TECH Report #280,* "The Market for PET Radiopharmaceuticals & PET Imaging," *Bio-Tech Systems, Inc, Las Vegas, Nevada.*
[10] *Energy Information Administration, Department of Energy*; http://www.eia.doe.gov/kids/energyfacts/uses/residence.html
[11] *Department of Energy*, http://apps1.eere.energy.gov/news/progress_alerts.cfm/pa_id=168

climate-change research. Develop and calibrate next-generation optical, ultraviolet, and x-ray sensors for improved space weather predictions and enhanced warning capabilities for geomagnetic events, in conjunction with National Oceanic and Atmospheric Administration Geostationary Operational Environmental Satellite-R (NOAA GOES-R) series program missions.

- 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.

- Quantum Computing Science: Use newly developed capabilities from quantum information science to perform quantum analog simulations that can allow one to mimic one quantum system with another. Demonstrate that "fictitious" magnetic fields can be created in a Bose-Einstein condensate and explore applications of quantum analog simulations to iconic condensed matter systems.

6) Materials Science and Engineering Laboratory (MSEL) – Through its materials science and engineering research and services, NIST enables its customers to acquire the integrated understanding of processing, structure, properties, and performance needed to effectively develop and use materials. NIST's direct contributions to measurement science and technology, and standards have impact on the entire spectrum of materials, including biomaterials, ceramics, hybrid materials, metals, nanomaterials, 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, x-ray and neutron scattering methods and synchrotron-based techniques that enhance and accelerate materials discovery, optimization and development;
- fundamental measurement science that enables the development of advanced materials and devices, through quantitative assessment of structural, functional, and mechanical properties;
- robust reference materials and standard test methods that accelerate development of materials processing and manufacturing routes, as well as enabling instrument calibration, and assessments of device performance and reliability;
- evaluated materials data that enable and benchmark industrial designs; and
- documentary standards that enable worldwide trade of materials products.

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

NIST materials science and engineering research focuses on industry and government priorities, as illustrated by these recent examples:

- High-Throughput Measurements: 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. Center research spurred $187.0 million[12] in economic benefits at benefit-to-cost ratio of 8.5, and accelerated industry adoption of these techniques by 2.3 years, enabling rapid development of products across the materials spectrum, including detergents, dental fillings, electronics, and contact lenses.

- 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 of fire resistant steel, and developed rapid, accurate tests of its high temperature performance.

- Pipeline Safety: In support of the Pipeline Safety and Integrity Act of 2002, NIST developed test methods and instrumentation, including a world-class high-pressure hydrogen test facility, that enable the pipeline industry to ensure the safety and reliability of petroleum pipelines, and for repurposing pipelines for alternative fuels such as hydrogen, ethanol and biodiesel. NIST expertise is guiding the pipeline standards efforts of international standards bodies such as ISO and ASTM International.

- Nanomaterials Environmental, Health and Safety: In partnership with the NIH National Cancer Institute, NIST designed and issued the first nanoparticle reference materials for biomedical imaging, diagnostic and therapeutic applications. The gold nanoparticle reference materials are used to calibrate instruments that measure particle size, and to validate pre-clinical research methodologies and tests that assess environmental, health, and safety hazards of nanoparticles. With input from other Federal agencies, and standards bodies world-wide, NIST is now developing the first silver nanoparticle reference materials.

- Carbon Nanotubes (CNTs): NIST research produced breakthroughs to realizing the application of these promising materials in advanced electronics, composites and biomaterials. NIST developed innovative processing methods to produce ultra-pure CNT specimens that enabled, for the first time, assessment of how CNT toxicity depends on CNT length, determination of the ultimate electrical performance of CNTs, and a route to critical CNT reference materials to be deployed in 2010.

- Advanced Energy Materials: NIST developed and produced the first reference materials for assessing thermoelectrics, a class of materials for waste heat recovery in automotive, aerospace, and military engines, which are expected to lead to a 10 percent improvement in fuel efficiency, as well as decreased CO_2 emissions. In addition, NIST developed an

[12]Retrospective Economic Impact Assessment of the NIST Combinatorial Methods Center, http://www.nist.gov/director/prog-ofc/report09-1.pdf

innovative suite of measurement tools, including combinatorial methods, for assessing the performance of hydrogen storage materials and fuel cells.

- Advanced Electronics: In partnership with Intel and SEMATECH, NIST's first-in-the-world measurements addressed 'grand challenge' issues in photoresist materials needed by the electronics industry to produce smaller, faster semiconductor devices. NIST electrochemical measurements and models helped the electronics industry to efficiently use metals in nanoscale devices. Moreover NIST measurement tools illuminated key links between the structure and performance of organic electronic devices, which helped Merck and Corning design new printable electronics to be used in technologies including electronic newspapers, low-cost solar cells and radio frequency identification tags.

- Regenerative Medicine: With the FDA, NIH, ASTM and others, NIST designed and issued the first tissue scaffold reference materials, which allow developers of tissue engineering to assess scaffold structure and properties for regenerative therapies. In conjunction with this effort, NIST developed a state-of-the-art spectroscopic microscope that enables three-dimensional imaging of living tissues in complex scaffold environments.

- Materials Databases: NIST developed and deployed the world's most comprehensive databases of evaluated materials structure information. With over 400,000 entries, the NIST databases guide the development and manufacture of advanced products in a broad range of technology sectors including, healthcare, communications, energy, and microelectronics.

NIST's FY 2011 materials science and engineering base program operating objectives include the following:

- Nanomaterials Environmental, Health and Safety: Develop instrumentation, measurement methods, reference materials and standards needed to examine the properties of important classes of nanomaterials that determine their exposure pathways in water and biological fluids; and to measure the stability of nanomaterials in products such as coatings and composites. NIST methods, standards, and data will allow industry and regulatory agencies to perform accurate lifecycle assessments that gauge the hazard to people and the environment posed by nanomaterials and products incorporating nanomaterials, which are projected to yield total economic benefits of $2.6 trillion by 2014.[13]

- Advanced Energy Technologies: Develop measurement methods and test systems to accelerate the development manufacture and commercialization of inexpensive solar devices that incorporate thin-film semiconductors, nanostructured materials and organic photovoltaics. Cutting-edge NIST measurement approaches and data will enable photovoltaic manufacturers to design and fabricate, reliable, high-efficiency solar devices from these advanced materials systems. In addition, NIST will develop measurements, such as non-linear spectroscopy methods and combinatorial approaches to enable advanced batteries and fuel cells.

[13] *Taking Action on Nanotechnology's Value Chain*, Lux Research, October 2004.

- Physical Infrastructure: Develop new measurement methods, test protocols and predictive models that will allow federal, state and local governments to prioritize and achieve infrastructure remediation, as well as construct long-lasting new buildings, roads and bridges, and water pipelines. NIST methods, data and models will assist engineers avoid structural failure under extreme conditions, and predict the long-term performance of critical structural components and connections such welds and rivets. In addition, a new NIST industry consortium will spur innovation in sensors that will allow inspectors to detect hidden flaws, such as sub-surface corrosion and cracks, in structures.

- Renewable and Sustainable Materials: Develop measurement tools, standards and models that enable innovations in the manufacture and reliable use of "green" building materials produced from bio-based, renewable feedstocks. NIST measurements will enable industry to incorporate renewable feedstocks into building materials with confidence in their performance and durability. In addition, NIST will further develop measurement approaches that foster the reduction or elimination of the use of toxic substances, such as lead, in electronics, while minimizing side effects that degrade performance.

- Automotive Energy Efficiency: Develop, through the NIST Metal Forming Center, measurement methods that promote automotive energy efficiency by enabling auto manufacturers to use innovative lightweight materials such as magnesium and aluminum alloys. In addition, NIST will develop measurement tools to enable the automotive industry to produce more powerful hybrid and electric motor systems, and to harvest waste heat via thermoelectric converters.

- Nanomaterials for Advanced Energy: Develop instrumentation, measurement methods, and models that advance the manufacture and use of most promising classes of nanomaterials and nanodevices, including semiconductor nanowires, self-assembled polymers, and magnetic nanomaterials. NIST measurements will enable reliable, reproducible manufacturing of nanostructured systems, thereby allowing commercialization of energy efficient lighting systems, electronics and data storage devices.

- Healthcare Technologies: Develop and validate optical and magnetic probes, as well as instrumentation and standards, to enable the quantitative imaging of biological processes and disease states at the molecular and cellular levels needed for advanced medical diagnostics. In addition, NIST will develop measurement methods to assess the reliability of electronic medical implants such as pacemakers, and that help extend the period over which pharmaceuticals can be preserved for storage and distribution.

- Nanomechanics: Develop measurement methods and standards that probe mechanical properties at length scales below 100 nm, which are critical to advancing technologies such as micro- and nano-electromechanical devices, nanocomposites, and next-generation electronic devices. NIST techniques will measure deformation and fracture properties at these length scales, enabling innovations through materials selection, device design and fabrication that optimize device durability and reliability through manufacturing and use.

7) Building and Fire Research Laboratory (BFRL) – The building and construction industry in the United States is a significant part of the Nation's economy. The industry's estimated value for construction in 2008 was $1.1 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 continues to have a fire fatality rate more than double many 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 2007, 3,430 lives were lost in fires, 17,700 people were seriously injured, direct property loss was about $14.6 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 five main thrusts:

- Measurement Science for Net Zero Energy, High-Performance Buildings: To reduce building energy-use through in-situ performance measurements, embedded intelligence in building controls, emerging building energy technologies, and carbon footprint metrics and tools for sustainability performance. Research toward this goal enables new and improved standards and codes to drive industry best practices, accelerated commercialization of advanced technologies and, ultimately, more efficient use of energy in—and reduced carbon footprint of—buildings.

- Measurement Science for Advancing Infrastructure Delivery: To fully integrate and automate construction processes by enabling real-time sensing and control systems, automated access to and integration of diverse information systems, multi-disciplinary collaboration through intelligent and automated construction testbeds, and metrics and tools for quantifying construction productivity at discrete and aggregate levels. Research toward this goal results in reduction of construction costs and delivery times; increased capabilities to identify and implement productivity-improving practices and technologies; reduced uncertainty, unpredictability and risk in construction processes; and new construction processes and capabilities.

- Measurement Science for Sustainable Infrastructure Materials: To increase sustainability through multi-scale models for predicting the life cycle performance of sustainable infrastructure materials, including materials degradation, flammability, and nanoparticle release; chemical, physical, and mechanical measurements of degradation (especially at nanoscale) that are precursors of higher scale life cycle property changes; measurement and prediction of in-service and post-service nanoparticle release rates; and sustainability metrics and models to qualify life-cycle performance by integrating technical performance with economic and environmental performance, including energy consumption. Research towards this goal leads to optimizing the service life of building materials and systems; minimizing life cycle environmental, energy, and economic impacts; and advances that exploit the unique properties of nanomaterials—and integrate waste stream materials—to optimize life cycle performance.

- Measurement Science for Innovative Fire Protection: To reduce the risk of fire spread in buildings and in wildland-urban interface communities, ensure effective and safe use of emerging fire service technologies, and derive lessons from post-fire investigations. Research toward this goal enables the development and/or use of innovative fire protection technologies; the development of science-based tools to predict and reduce fire risks; the improvement of standards, codes, and practices, especially their transformation from a prescriptive basis to a performance basis; and the reduction of fire losses from preventable systemic causes.

- Measurement Science for Disaster-Resilient Structures and Communities: To enhance the resilience of structures and communities to disasters (earthquakes, hurricanes and windstorms, and structural fires) through tools to predict structural performance and estimate losses at the community-scale in extreme events, tools for performance-based design of new buildings and rehabilitation of existing buildings, and lessons derived from post-disaster and failure investigations involving structures. Research toward this goal enables significantly enhanced disaster resilience of the nation's communities and built environment through a reduction in risk due to earthquakes, windstorms, and structural fires; science-based tools to enable hazard mitigation and resource allocation decisions; improved standards and codes; better design and construction practices; and a reduction in the operational impacts of disasters on businesses and government.

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 focus in building and fire research directly support critical national priorities in Physical Infrastructure, Energy, Environment, and Manufacturing.

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

- Infrastructure Materials: Engineers at NIST are patenting a method that is expected to double the service life of concrete. The key is a nano-sized additive that slows down penetration of chloride and sulfate ions from road salt, seawater and soils into the concrete. A reduction in ion transport translates to reductions in both maintenance costs and the catastrophic failure of concrete structures. The new technology could save billions of dollars and many lives.

- Fire Safety: NIST researchers studied people movement speeds during full-building fire drill evacuations and compared the data to already published results—including those from NIST's investigation of the World Trade Center disaster on September 11, 2001—to try to identify the factors that could hamper rapid evacuation using stairways. They found that engineering parameters used in current evacuation models could not explain the differences they observed in evacuation speeds. This discrepancy suggested that psychological and behavioral factors may be more important in determining how fast occupants can actually exit a building, and that inaccurate evacuation data based on simplifications about behavior could lead to unsafe building designs and procedures.

- Building Energy: A NIST researcher has found that dispersing sufficient amounts of copper oxide nano-particles in a common polyester lubricant and combining it with a common refrigerant improves heat transfer by between 50 percent and 275 percent. Success in optimizing mixtures of refrigerants, lubricants and nanoparticle additives would pay immediate and long-term dividends since these systems account for about 13 percent of the power consumed by the Nation's buildings, and about 9 percent of the overall demand for electric power.

NIST's FY 2011 building and fire research base program operating objectives include the following:

- Advancing Infrastructure Delivery: Develop the Intelligent and Automated Construction Job Site (IACJS) testbed to enable standardized, repeatable testing and evaluation of new construction methods, processes, and information and automation technologies. Capturing such performance information is a critical step in the process of developing the enabling measurement science for advancing infrastructure delivery.

- Sustainable Infrastructure Materials: Develop hardware and measurement protocols for capturing and characterizing nanoparticles released from weathered nanocomposite materials. Quantifying the release of nanoparticles during service and disposal is on the critical path of assessing the potential threat to environmental health and safety of these materials, a key attribute of sustainability.

- Net Zero Energy High Performance Buildings: Develop an information model for dynamic pricing and demand response signal exchanges. Such a model will enable building automation systems to interact with a future Smart Grid utility system.

- Net Zero Energy High Performance Buildings: Complete development of measurements for assessing building sustainability performance. Building sustainability metrics will enable one to directly link building technology innovation with life-cycle environmental and economic benefits and costs, and harmonization of reporting the building industry's carbon footprint.

- Disaster Resilient Communities: Develop design criteria for the combined effects of wind speed and storm surge on coastal structures using the joint probability of hurricane wind and storm surge. These criteria will provide building designers with guidance on how to apply design provisions for wind and storm surge based on a more realistic understanding of the potential hazard.

- Disaster Resilient Communities: Develop improved procedures for selecting and scaling ground motions for use in nonlinear analysis of the response of structures to earthquakes. This capability will lead to higher accuracy performance-based seismic design of buildings.

- Innovative Fire Protection: Determine a suite of structural/electromagnetic scenarios that simulate emergency response environments in which fire fighter locator/tracking systems would be used. These scenarios, representative of common residential and commercial building construction and electromagnetic interference conditions typical of emergency response sites, will form the basis upon which evaluation protocols can be developed.

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. It accounts for about 4 percent of the economy and for more than 20 percent of real economic growth.[14] 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,[15] with 55 percent having home broadband access (compared with 47 percent in 2007);[16] nearly 100 percent of public schools and 94 percent of public school instructional rooms have Internet access;[17] total e-commerce sales for 2008 are estimated at $133.6 billion, an increase of 4.6 percent from 2007.[18] 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."[19]

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.

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[14] *"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.*

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

[16] *"Home Broadband Adoption 2008," Pew/Internet and American Life Project,* http://www.pewinternet.org/~/media//Files/Reports/2008/PIP_ Broadband_2008.pdf

[17] *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.*

[18] *"Quarterly Retail E-Commerce Sales 4th Quarter 2008," United States Census Bureau, 17 February 2009, http://www.census.gov/mrts/www/data/pdf/08Q4.pdf.*

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

Many existing IT systems crash, are unreliable, unusable and untrustworthy. ITL's research in IT measurement science directly addresses these continuing challenges. 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 issues, by 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, accuracy, quality and uncertainty, and usability of information technologies.

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

- <u>Profile for Internet Protocol version 6 (IPv6)</u>: 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.

- <u>Biometrics Interoperability and Accuracy</u>: 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: NIST led the OMB-directed effort to develop the checklists and automated conformance determination and demonstration tools for Federal desktop computer security configuration. NIST is contributing directly to setting the national cybersecurity research and development agenda through White House-coordinated collaborative bodies and in direct interdepartmental coordination. The NIST IT security standards and guidelines are being adopted by the intelligence and national security communities, as well as the non-national security elements of the Federal government, and are being voluntarily adopted by state governments and industrial concerns. 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. NIST also produced the standards and provided technical expertise for government-wide implementation of a common identity credential, thus establishing a technical foundation for replacing the current password-based access controls with easier to use and more secure token-based access control.

- 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.

- Quantum Information Processing: The exotic properties of quantum states of matter may provide the basis for computational capabilities well beyond those of today's computers. The use of such technologies for computation requires very precise control of volatile quantum states. NIST has developed a novel benchmarking strategy for determining an effective error probability per quantum operation. The benchmark has been used to assess the processing capabilities of several competing quantum computing technologies by both government and academic researchers.

- Image Metrology: NIST has developed a novel mathematical framework for quantifying the smoothness of images. Applications of such a measurement tool include monitoring of performance of imaging systems, evaluation of image reconstruction software quality, detection of abnormal fine structure in biomedical images, and monitoring of surface finish in industrial applications.

- Combinatorial Methods: NIST and the University of Texas at Arlington developed and released an algorithm that is faster – in some cases by a factor of more than 100 – and produced covering arrays that are significantly smaller than possible with other currently available tools. Applications of the algorithm include software testing and genome research.

- 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.

- Test Suites for Electronic Voting Systems: ITL-developed test suites assure voters, election officials, and manufacturers of electronic voting systems of the security, usability, and reliability of future voting systems. Test laboratories will be able to use these public test suites to help evaluate the conformance of voting systems to requirements in the Voluntary Voting System Guidelines (VVSG), which were developed by ITL scientists for the U.S. Election Assistance Commission under a mandate from the 2002 Help America Vote Act.

NIST's FY 2011 information technology base program operating objectives include 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. ITL's primary Cybersecurity research and standards development focus will be responsive to the Administration's Smart Grid, Healthcare IT, voting mandates, citizen facing authentication, cloud computing, cybersecurity priorities and other IT initiatives. These activities will also 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 biometric matching systems, including iris, fingerprint, and facial images, which will enable industry to improve the accuracy, interoperability, and usability 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.

- Use and Management of Information: Accelerate the development and adoption of technologies for accessing, manipulating, analyzing, and exchanging information. NIST will develop standards and testing methodology that will allow industry to advance the state of the art of systems for information access and management. This will result in dramatically improved products and systems for productively and efficiently using the vast amounts of digital information available today, impacting both national infrastructures and commercial sectors.

- Measurement Methods and Tools: Develop mathematical, statistical, and computational methods and tools to enable NIST research on the measurement of properties of materials and processes of critical importance to national priorities such as medical diagnostics, physical infrastructure, and greenhouse gas emissions. Develop techniques and tools to reliably quantify the uncertainty in computational simulations for the estimation of properties of chemicals and materials based on mathematical models of physical processes. Begin to develop a science base for the understanding of the structure and dynamics of complex information systems that is on par with that of the physical sciences. Develop models, metrics, and related tools to assess essential properties of large-scale information systems, such as the Internet and the Smart Grid, and use these to assess and improve the performance, reliability, and security of critical national resources.

- 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.

- Smart Grid Information Network Protocols, Security, and Testing: Work with industry to address standards gaps for a secure information network in the Smart Grid system. NIST will develop necessary protocol profiles and test methodologies for new standards, and develop models to analyze the performance and emergent behavior of such network to ensure its reliable and secure operations.

- Quantum Information Science: Begin the characterization of the class of problems that can be efficiently solved by a general-purpose quantum computer in order to assess the potential vulnerabilities of existing and future cryptographic systems for secure electronic commerce.

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 Center for Neutron 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 2009. 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 2011 NIST Center for Neutron Research base program operating objectives 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 U.S. 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 innovative research that advances the state-of-the-art of measurement and fabrication takes place. As a critical complement to the Research Program, the NanoFab offers open, convenient and economical access to expensive state-of-the-art fabrication tools, 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 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 FY 2009, the CNST's second full year of operation, the number of researchers benefitting from access to the CNST NanoFab or collaborating with the CNST Research Program totaled over 450, and continued to grow rapidly.

- Energy: The CNST has established a new group dedicated solely to facilitating the development of nanotechnology that affects 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 NIST is always working on NIST'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 2011 Center for Nanoscale Science and Technology base program operating objectives 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 Nanostructures/Nanomanufacturing: Develop a new technique using near-field 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 nano-characterization effort to include nano-devices 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 nano-metrology 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, health care, agriculture, and homeland security. In collaboration with CSTL, develop new nano-sensors for measurement of blood protein health state markers.

- 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 SRMs, 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 and Federal agencies 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, publications, and patents.

NIST technology services 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.

- 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, 100,100 Enquiry Point staff from 4,040 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 2011 technology services base program operating objectives 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>Calibration Services, Standard Reference Materials, and Standard Reference Data</u>: Deliver calibration services, SRMs, 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.

- <u>Documentary Standards in Emerging Technology Areas</u>: 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.

12) <u>NIST NRC Postdoctoral Research Associateships Program</u> – NIST supports a nationally competitive Postdoctoral Research Associateships 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.

The FY 2011 NIST NRC Postdoctoral Research Associateships Program base program operating objectives 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

- 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.

<u>Performance Measures</u>

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

Exhibit 13

Department of Commerce
National Institute of Standards and Technology
Scientific and Technical Research and Services
INCREASE FOR FY 2011
(Dollar amounts in thousands)

		2011 Base		2011 Estimate		Increase/ (Decrease) Over 2011 Base	
		Personnel	Amount	Personnel	Amount	Personnel	Amount
Total, Scientific and Technical Research and Services (STRS)	Pos./Approp.	282	70,572	487	139,972	205	69,400
	FTE/Obl.	272	70,586	424	136,686	152	66,100
National Measurement and Standards Laboratories							
1. Standards and Conformity Assessment for Interoperability in Emerging Technologies	Pos./Approp.	48	11,202	87	21,202	39	10,000
	FTE/Obl.	38	11,202	67	21,202	29	10,000
2. Scalable Cybersecurity for Emerging Technologies and Threats	Pos./Approp.	15	7,500	43	17,500	28	10,000
	FTE/Obl.	12	7,500	33	16,650	21	9,150
3. Green Manufacturing and Construction	Pos/Approp.	24	6,399	48	16,399	24	10,000
	FTE/Obl.	22	6,399	40	16,399	18	10,000
4. Innovations in Healthcare – Measurement Science and Standards to Support Manufacturing and Regulatory Approval of Biologic Drugs	Pos./Approp.	16	5,800	40	15,800	24	10,000
	FTE/Obl.	13	5,800	31	13,550	18	7,750
5. Innovations for 21st Century U.S. Manufacturing	Pos/Approp.	31	11,750	59	21,750	28	10,000
	FTE/Obl	31	11,750	52	21.750	21	10,000

		2011 Base		2011 Estimate		Increase/(Decrease) Over 2011 Base	
		Personnel	Amount	Personnel	Amount	Personnel	Amount
6. Disaster Resilient Buildings and Infrastructure..	Pos./Approp.	6	1,570	17	6,570	11	5,000
	FTE/Obl.	6	1,570	14	6,570	8	5,000
7. Advanced Solar Technologies – 3rd Generation Photovoltaics	Pos./Approp.	7	1,764	25	6,764	18	5,000
	FTE/Obl.	7	1,764	20	6,764	13	5,000
8. Nanomaterial Environmental Health and Safety	Pos./Approp.	13	3,266	23	7,266	10	4,000
	FTE/Obl.	13	3,266	20	7,266	7	4,000
9. Strategic and Emerging Research Initiatives (SERI)	Pos./Approp.	21	9,873	21	11,873	0	2,000
	FTE/Obl.	27	9,873	27	11,673	0	1,800
10.NIST NRC Postdoctoral Research Associateships Program	Pos/Approp.	101	11,448	124	14,848	23	3,400
	FTE/Obl	103	11,462	120	14,862	17	3,400

STRS (+205 Permanent Positions, +152 FTE, Appropriation +$69,400,000, Direct Obligations +66,100,000, Transfer to the Working Capital Fund +$3, 300,000)

STRS Components:

National Measurement and Standards Laboratories

1. **Standards and Conformity Assessment for Interoperability in Emerging Technologies (+39 Positions, +29 FTE, +$10,000,000)**

This new initiative request is to address architectural framework development for documentary standards and conformity assessment requirements that will enable interoperability in emerging technologies such as Smart Grid and Healthcare Information Technology (Health IT).

This initiative supports the following goals and priorities:

- Promoting U.S. innovation and industrial competitiveness, a strategic goal of the Department of Commerce.
- Coordinating the development of a framework, including protocols and model standards for information management to achieve interoperability of Smart Grid devices and systems, per the legislative mandate to NIST under the Energy Independence and Security Act (EISA) of 2007.
- Accelerating the deployment of electronic health records by providing expertise on Health IT implementation and the establishment of voluntary certification programs, and by performing pilot testing of standards and implementation specifications.

Problem Magnitude and NIST Role:

Lack of standards that allow interoperability within and among cross-cutting technologies such as Smart Grid and Health IT can significantly stifle the realization of benefits from these emerging technologies. Interoperability stimulates significant confidence in industry about investing in these new technologies by broadening the market and decreasing the limitations inherent in legacy systems. It also obviates potential concerns about stranded investments, which may arise due to lack of interoperability between components of systems. Furthermore, clearly defined interoperability requirements and standards to support emerging technologies promote innovation and competition amongst the suppliers of components to the systems, thereby reducing costs of implementation and providing greater choice to consumers.

Specific examples of the magnitude of this problem are evident in the drivers for interoperability in Smart Grid and Health IT. In today's healthcare industry, only 13 percent of doctors use any form of electronic health records. The systems in use today are based on many individual clinical and technical standards, but there are no widely adopted sets of standards that include data, transport, and security. It is estimated that healthcare expenditures account for $1 out of every $6 spent in the U.S., and thus progress in achieving interoperability of electronic health records will have a significant impact on improving the efficiency of healthcare.

In the deployment of a Smart Grid, we need to contend with an electrical grid that consists of more than 9,000 power generation plants that are connected to more than 300,000 miles of transmission lines supplying electricity to residential and business consumers nationwide. The introduction of distributed renewable energy sources such as solar panels, wind turbines, and fuel cells brings additional challenges in integrating these systems seamlessly into the grid through the use of smart meters. The benefits of a Smart Grid will truly be realized with the development and deployment of smart appliances that will use demand pricing information to operate in a manner that provides consumers the greatest economic benefit, while also helping achieve the goals of minimizing energy consumption. Major appliance manufacturers such as Whirlpool Corporation and General Electric have publicly announced plans for the introduction of smart appliances, and have indicated the lack of interoperability standards as the greatest risk to their business plans. Thus, interoperability and seamless communication flow between these different components and systems is essential.

The common NIST role in these and other emerging areas is to help establish an architectural framework of standards and related test protocols, and conformity assessment requirements that would facilitate seamless, end-to-end interoperability between information, devices, and systems within each of these technologies. NIST would convene stakeholders from industry, government, academia, and standards development organizations to identify common elements, where appropriate, such as:

- Establishing terminology and definitions
- Developing a Roadmap identifying existing standards, standards gaps, conformity assessment requirements, etc.
- Identifying technical requirements for standards that enable interoperability
- Leading and coordinating on aspects related to cyber security
- Working with standards and specification developers to catalyze timely development of standards and specifications that are of high quality, efficacy, and applicability
- Working with stakeholders, including regulators, to develop required suites of testing protocols and conformity assessment methodologies.

Proposed NIST Technical Program:

The initiative will focus on the following aspects to help address issues of interoperability in the following technology areas, as well as standing up the framework to address standards issues in other emerging technology areas:

- **Smart Grid**: NIST will organize and accelerate the development of Smart Grid standards, interfaces and protocols within a common interoperability and cybersecurity framework, currently under development by NIST, to guide and coordinate the efforts of the many standards and specification developers involved in the Smart Grid infrastructure development. NIST's program includes standards coordination and refinement and implementation of a conformity assessment framework to ensure the effective integration, interoperability, and reliable and secure operation of Smart Grid systems and devices to achieve effective cooperation and two-way communication of information.

- **Healthcare Information Technology:** NIST will improve the quality and availability of healthcare and reduce healthcare costs by enabling the expansion of the health information network that is correct, complete, secure, and testable. NIST's programs will support the accelerated development and harmonization of standards for health IT technologies, expand the health IT testing infrastructure, increase the usability of health IT technologies, and address healthcare delivery beyond traditional physical locations.

Performance Measure: Outputs

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

Standards and Conformity Assessment for Interoperability in Emerging Technologies	
Technical Area	**Outputs/(Targets)**
Smart Grid	• Provide oversight and support the operations of the Smart Grid Interoperability Panel (SGIP). (on-going) • Release updated versions of the Smart Grid Interoperability Framework and Roadmap. (on-going) • Release updated versions of the Smart Grid Cyber Security Strategy and Requirements. (on-going) • Develop and implement a Smart Grid testing and certification framework. (FY 2011) • Coordinate and implement a strategy to drive international harmonization of Smart Grid standards. (FY 2012) • Develop standards, protocols, models, measurement techniques, and performance and materials data to enable the interoperability and security of Smart Grid devices and systems. (on-going)
Health IT	• Work with existing industry-led, voluntary consensus processes to develop sets of Health IT standards for clinical areas identified as national-level priorities. (FY 2014) • Expand the Health IT testing infrastructure and conformity assessment, to include test availability for new and updated industry-developed health IT standards, such as for personal health records and healthcare delivery beyond traditional physical locations. (FY 2012) • Develop usability requirements, standards, and tests for Health IT. (FY 2013) • Work with industry to develop IT requirements, standards, and tests for emerging health technologies and their applications, such as mobile care, body sensors, and implants, including cybersecurity aspects of these technologies. (FY 2014)

Performance Measures: Outcomes

At the proposed funding level, NIST technical outputs will enable the following outcomes:

Standards and Conformity Assessment for Interoperability in Emerging Technologies	
Technical Area	**Outcomes**
Smart Grid	• A more cost-efficient, reliable, secure and interoperable electrical power system ensured through uniform device and connection standards. • Improved international markets for U.S. energy products through incorporation of U.S.-developed technology in international standards. • Minimized consumer electric costs by enabling better customer awareness and control of their energy usage. • Mitigated harmful environmental impacts by enabling the integration of distributed renewable energy sources such as solar and wind energy. • Enabled commercialization and deployment of new Smart Grid technologies, a market estimated to be worth $70 billion by 2013.
Health IT	• A robust nationwide healthcare system that is safer, more affordable, and more accessible, and that will support all healthcare applications including clinical applications, home-based healthcare, clinical research, medical training, and public health enabled by new standards for Health IT. • Patients able to have real-time, ongoing monitoring of chronic conditions without having to be at a clinic, physician's office, or home monitoring station due to health IT innovations supporting new technologies such as sensors and implants enabled by standards for Health IT.

2. **Scalable Cybersecurity for Emerging Technologies and Threats (+28 Permanent Positions, +21 FTE, +$10,000,000, including an $850,000 transfer to the Working Capital Fund)**

Cybersecurity 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 attack from individuals, organizations, and nation states that target key information technology operations and assets. For most systems, their security configuration is poorly implemented and maintained, security controls are hard to use, and security postures are too complex for most administrators to understand. This combination allows many threats to successfully compromise systems and delays reactions to these compromises, allowing significant damage to occur. This undermines confidence in vital commercial and public information systems and has a large, direct economic impact -- estimates show that Americans are losing billions of dollars each year to cyber crime.

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. Cybersecurity is also a central element in legislation, including the Federal Information Security Management Act, Cyber Security & Research Development Act, Privacy Act, Sarbanes-Oxley Act, Gramm-Leach-Bliley Act, Health Insurance Portability and Accountability Act, and Clinger-Cohen Act.

Problem Magnitude and NIST Role:

Cybersecurity focuses on establishing and maintaining the three security objectives for information and information systems: (1) confidentiality, (2) integrity, and (3) availability. 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 cybersecurity is providing appropriate levels of the right security objectives in a cost-effective manner. While the security objectives are well understood, many of the security tools and mechanisms available today were designed with yesterday's technologies and threats in mind. Information systems have evolved from physically isolated systems to highly distributed heterogeneous systems interconnected not only by the global internet, but by a variety of other communication paths. Operating system and application code has become orders of magnitude longer and more complex. Many of today's information system users do not have the same degree of information technology expertise as previous generations of users.

Achieving real security in the context of today's extensively networked information systems remains an elusive goal. For example, stakeholders implemented security technologies designed to support a single application or protocol. This has created security mechanisms that cannot scale to provide a complete security solution. Two examples are current 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 need 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 operating system configurations that is usable by anyone 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 interconnected, resulting in an ever-growing number of points of attack.

NIST's expertise and internationally recognized success in cybersecurity R&D, decades-long working relationship with industry, and mandates to provide security standards and guidance for Federal agencies give NIST the ability to have a dramatic positive impact on the Nation's cybersecurity. NIST has been highly successful in interacting with industry to facilitate practical solutions based on NIST work being adopted throughout industry; these NIST efforts have included the development of industry consensus standards, the creation of test methods and programs, and successful technology transfers from NIST to industry. NIST collaborates extensively with other Federal agencies on cybersecurity efforts and will continue to do so for the work described in this initiative.

Proposed NIST Technical Program:

This initiative focuses on the following essential cybersecurity infrastructure elements.

- **Cryptographic Technologies and Capabilities:** Cryptography is a foundational science in the field of cybersecurity and information assurance. Cryptographic methods are essential tools needed to assure a trusted and resilient information and communication infrastructure. These methods provide important functionality to protect against intentional and accidental compromise and alteration of information. Through its role as the United States' premier standards and measurement laboratory, NIST is the worldwide leader in the development of cryptographic standards and test programs. Threats against cryptographic technologies continue to grow, so it is critical that cryptographic technologies evolve to counter these threats and ensure that information and communications are still protected.

  Much of the NIST efforts in this area will focus on strengthening U.S. capabilities in cryptography. Other countries outside of the U.S. are increasingly performing cutting-edge research in cryptography. With this initiative, NIST will provide a research grant to and collaborate with one or more U.S. academic institution(s) to ensure that the U.S. maintains its leadership in cryptography, as well as advance the state-of-the-art in cryptography. The grantee will be selected through an open competition for conducting cryptography research, including research into performance and usability characteristics of various algorithms, and the underlying mathematical and architectural primitives needed for the development of cryptographic standards that are resistant to both practical and theoretical analytic attacks for evolving computer environments. The resulting research will ensure that cryptography is available to support a variety of computing needs, including algorithms for small footprint environments like information technology sensor network solutions and secure wireless environments with stringent efficiency requirements. Another area the research will address is quantum computing, which has the potential to become a major disruptive technology affecting cryptography and cryptanalysis. If a practical quantum computer is developed, it will be possible to break all the digital signature algorithms and public key-based key establishment schemes that today provide the foundation for e-commerce and other critical applications. Researchers need to analyze public key-based key agreement and digital signature algorithms to determine how resistant they are to quantum-based attacks.

  Another major focus area for NIST is cryptographic key management standards. Cryptographic keys are secret numbers commonly used to grant access to authorized individuals on encrypted computer networks and systems. The lack of standards for cryptographic key management has hindered the secure adoption of many information technologies, which presents a variety of technical and organizational challenges. Without efficient and usable key management solutions, implementers often transmit and store keys insecurely, and neglect to change keys as frequently as necessary, among other problems. These practices jeopardize the security of keys, and thus, the security of the information and systems that the keys protect. To address this, NIST, in technical consultation with the National Security Agency, the Department of Defense, and other government agencies and non-government organizations, will create technical standards for generating, distributing, storing, and destroying cryptographic keys. These standards will enable cryptographic key management practices that preserve the confidentiality and integrity of cryptographically-protected information.

- **Multifactor Authentication for Online User Identity Assurance:** Authenticating a user—verifying a user's claimed identity -- has traditionally involved the user providing one or more different types of information to a system, such as a password or a biometric. Requiring two or more types of authentication information instead of just one from an end-user can achieve stronger security. There has been increasing interest in the use of multifactor authentication (MFA) to achieve stronger assurance of identity for online applications, such as government services and banking, but usability, cost, and interoperability issues have impeded the widespread use of multifactor authentication technologies. To address these issues, NIST will study factors influencing adoption of MFA and develop a standardized framework and implementation plan for interoperable tokens that contain biometric and/or cryptographic credentials to support logical access control on a multi-platform and multi-operating environment basis. This development will be coordinated with vendors and other Federal agencies, including the Department of Homeland Security.

- **Usability of Security**: Usability is an often overlooked but critical component of security. Computers can be theoretically secure but so unusable that users will either bypass the security measures, thus undermining security, or not perform the work at all. The opposite is true as well; systems that are usable and not secure are eventually unusable due to compromises. The usability principles of efficiency, effectiveness, and user satisfaction must be incorporated to ensure that it is easy for users to do the right thing and hard for them to do the wrong thing. To improve security, NIST will work with industry and academia to improve the usability of security through research and outreach.

- **Security Automation Technologies:** Federal information systems need to be persistently configured to resist execution of malicious code and other forms of attack. Currently many Federal systems do not implement required security settings, and many applications change system security settings during installation or configuration of those applications. Identifying incorrect settings and remediating them is largely a manual process, error-prone, and resource-intensive. To address this, NIST will develop specifications for security automation technologies. NIST will also create security baselines for selected widely used operating systems, applications, and network devices; these baselines are sets of standardized security settings that optimize security. Organizations can use security automation technologies and baselines that comply with the specifications to discover and remediate vulnerabilities and to ensure compliance with IT security requirements.

- **Security Measurement and Modeling for Dynamic Large-Scale Systems:** Currently there are no methods for adequately characterizing the fundamental properties of networked information systems that make them either resistant or vulnerable to attack. 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. Expected outcomes for this work are a fundamental understanding of how structure and micro-scale dynamics of large-scale interconnected systems affects the resistance to attack in emerging information systems architectures such as cloud computing and large-scale networks, and the ability to dynamically predict, and ultimately control, the behavior of interconnected networks under stress.

- **Secure Adoption of Emerging Virtual Technologies:** Platform virtualization, cloud computing, social networks, and other emerging virtual technologies are promising, but security challenges threaten their adoption. The most difficult issue to solve is the need for security isolation technologies to protect information on shared hosts and other resources (e.g., storage). Even within technologies that are wholly internal to an organization, security isolation is critical to prevent the compromise of one application from affecting others. Another concern is how to customize the security of virtual subspaces so that each transaction is protected through the security controls appropriate for the sensitivity of the transaction, while not using additional security controls that would unnecessarily reduce performance and usability. Research needs to be done on object characteristics, security negotiation mechanisms, and other protocols, standards, and mechanisms related to secure virtual subspaces. There are also other security issues that need to be addressed through new security technologies or through application of existing security technologies to reduce the risks inherent in emerging virtual technologies. Addressing these security issues will enable widespread secure adoption of virtual technologies, resulting in enormous cost savings and leap-ahead information technology functional advantages. The field of virtual technologies is highly dynamic, with new technologies arising frequently and older technologies being subsumed, so the exact technologies to be researched at any given time will be determined when appropriate.

- **Critical Infrastructure Testbed:** The Administration's recent cybersecurity policy review identified the need for game-changing research strategies, part of which involves the creation of incentives for the adoption of innovative cybersecurity practices that arise from this research. Demonstrating the effectiveness of these innovative practices is an important mechanism for driving their adoption. The Administration has chosen the financial services sector to partner with the cybersecurity research agencies in the development of a "live-traffic" testbed on which to test game-changing strategies for improving cybersecurity. NIST, Office of Science and Technology Policy (OSTP), Department of the Treasury, and Department of Homeland Security will work with the Financial Services Sector Coordinating Council (FSSCC) Research and Development Group to develop such a testbed targeting live business-to-business (B2B) traffic.

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

Scalable Cybersecurity for Emerging Technologies and Threats	
Technical Area	**Outputs/(Targets)**
Cryptographic Technologies and Capabilities	• Technical standards for generating, distributing, using, storing, and destroying cryptographic keys. (FY 2014) • Usability guideline for cryptographic key management. (FY 2014) • Evaluation of candidate protocols for resistance to quantum attack. (FY 2014) • Determination of the infrastructure required for quantum resistant protocols and interaction with protocol designs. (FY 2014) • Development of cryptographic algorithms for small footprint environments. (FY 2014)
Multifactor Authentication for Online User Identity Assurance	• Standardized framework and implementation plan for supporting multifactor authentication across computer platforms and operating systems. (FY 2013) • One or more actual or simulated prototypes. (FY 2011)
Usability of Security	• Framework for evaluating usability of security. (FY 2012) • Metrics and measures for each evaluation component of the framework. (FY 2012)
Security Automation Technologies	• Standardized settings, reference platforms, automated deployment tools, machine readable and standardized security configuration baselines. (FY 2014) • Certified assessment products for operating system environments. (FY 2014) • Assessment guideline for standard security settings. (FY 2014)
Security Measurement and Modeling for Dynamic Large-Scale Systems	• Mathematical models of data and information flow in networks. (FY 2011) • Suite of software for processing large-scale graphs. (FY 2011) • Prototype system for assessing cumulative vulnerabilities of a network. (FY 2012)
Secure Adoption of Emerging Virtual Technologies	• Recommendations for security isolation capabilities, including secure virtual subspaces. (FY 2011) • Recommendations for secure use of virtual technologies. (FY 2014)
Critical Infrastructure Testbed	• Design and requirements for a testbed pilot. (FY 2011) • Pilot implementation and experimentation. (FY 2013) • Documentation of lessons learned from the pilot. (FY 2014)

Performance Measures: Outcomes

At the proposed funding level, NIST technical outputs will enable the following outcomes:

Scalable Cybersecurity for Emerging Technologies and Threats	
Technical Area	**Outcomes**
Cryptographic Technologies and Capabilities	• Improved assurance of protecting the confidentiality and integrity of information and restricting access to computing resources. • Continued security of e-commerce and other applications despite advances in quantum computing.
Multifactor Authentication for Online User Identity Assurance	• Improved secure interoperability of systems for authenticating individuals on networks.
Usability of Security	• Measurable improvements in the usability of security systems and technologies. • Greater alignment of organizational workflow and security processes.
Security Automation Technologies	• Reduced frequency and impact of computer security incidents through improved monitoring, remediating, and reporting of security vulnerabilities. • Lower costs for vulnerability management.
Security Measurement and Modeling for Dynamic Large-Scale Systems	• Fundamental understanding of how structure and micro-scale dynamics of large-scale interconnected systems affects the resistance to attack in emerging information systems architectures such as cloud computing and large-scale networks. • Ability to dynamically predict, and ultimately control, the behavior of interconnected networks under stress.
Secure Adoption of Emerging Virtual Technologies	• Improved understanding of security requirements to support emerging virtual technologies that will lead to robust solutions added by industry and government.
Critical Infrastructure Testbed	• Expedited adoption of innovative cybersecurity technologies and practices. • Reduced disruption of e-commerce transactions.

3. Green Manufacturing and Construction (+24 Positions, +18 FTE, +$10,000,000)

- Manufacturing and construction significantly impact the U.S. economy, society, the environment, and global relations as they drive Gross Domestic Product (GDP), provide stable high-paying jobs, consume massive levels of the nation's energy, mined materials, and hazardous materials, and produce over 10 trillion kilograms of solid waste every year.

- The Administration is firmly committed to revitalizing American manufacturing[1]. Innovation and growth of the U.S. manufacturing sector critically depend on sustainable development[2,3]. Sustainability is transforming how U.S. companies think and act[4]. The complexity of the information exchanged among players in the manufacturing supply chain creates a key barrier to sustainable manufacturing. Standardization offers a unique opportunity to conquer this complexity.
- NIST will enrich the information structure in the manufacturing supply chain to support and enhance sustainable manufacturing by ensuring the availability of appropriate information at each step to plan, execute, and assess sustainability in manufacturing.
- NIST will provide the measurement science required to achieve Net-Zero Energy, High-Performance Green Buildings.

Problem Magnitude and NIST Role:

Promoting innovative energy technologies to reduce dependence on energy imports and to mitigate the impact of climate change while creating green jobs and new businesses is a priority of the Administration. To address this issue, NIST is focusing on programs that will promote sustainable operations and improve energy efficiency in both manufacturing and construction. This initiative uses the technically appropriate, well-defined phrase "sustainable manufacturing" to refer to what is commonly called "green manufacturing".

Manufacturing:

Regulatory restrictions and consumer preference for environmentally friendly products push and pull manufacturers towards sustainable practices. Regulations such as RoHS (Restriction of Hazardous Substances) and WEEE (Waste from Electrical and Electronic Equipment) restrict the sale of products containing hazardous or prohibited substances in the European Union; several other countries and states have enacted similar measures. Regulations such as the ELV (End of Life Vehicles) and the HAL (Home Appliance Law) require vendors to accept products at the end of service life to promote recycling and reduce solid waste. These regulations resulted from recognition of the environmental impact of manufacturing. Additionally, consumer-oriented labeling, such as Energy Star and labels for recycled content and recyclability of products indicate a growing consumer-interest in sustainability.

Manufacturers need to introduce innovative materials, processes and products to improve their economic, societal and environmental sustainability. Currently manufacturers are unable to accurately measure economic, societal and environmental costs of products during the entire life cycle. To address sustainability fully, manufacturers need to deal with the full life cycle analysis (LCA) of products. This requires new methods to analyze, integrate, and aggregate information across hierarchical levels, organizational entities, and supply chain participants. Manufacturers

[1] Executive Office of the President, *A Framework for Revitalizing American Manufacturing*, December 2009
[2] "Why sustainability is now the key driver of innovation", Harvard Business Review, Sept. 2009, pp. 56-64.
[3] The Bruntland Commission defined sustainable development as that "meet the needs of the present without compromising the ability of future generations to meet their own needs" in *Our Common Future: Report of the World Commission on Environment and Development*, Oxford University Press, 1987.
[4] The business of sustainability, MIT Sloan Management Review Special Report, 2009.

need defined measures and tools to demonstrate, deploy, and recognize new sustainable manufacturing practices to survive and grow in a global market.

NIST investments in sustainable manufacturing must focus on the highest priority needs of the industries with the most to gain from improvements in sustainability. At the U.S. Department of Commerce's Sustainable Manufacturing Summit and the NIST Sustainable Manufacturing Workshop held in 2009, industrial participants indicated that (1) the lack of confidence in the accuracy and applicability of sustainability metrics, and (2) the difficulties associated with collecting and managing sustainability data across supply chains hinder the pace and scope of their efforts in sustainable manufacturing. Industry clearly expressed to NIST a desperate need for dramatically better and more detailed data to enable significant advancements in energy efficiency and reduced environmental impacts. NIST has selected to address industrial pain points in dealing with information across the supply chain, gathering and disseminating best practices in sustainable manufacturing, and identifying meaningful sustainability metrics that lead to improvements. The measurement and standards technologies resulting from NIST efforts will provide the largest impact on high-paying jobs if invested in technology-intensive industries[6].

Construction:

"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.[7] " 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 (CO_2) emissions, more than the transportation or industrial sectors.[8] 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 CO_2 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 enabling and integrated measurement science to achieve Net-Zero Energy, High-Performance Green Buildings does not currently exist. 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

[6] Daniel Hecker, "High-Technology Employment: A NAICS-Based Update", Monthly Labor Review (July 2005).
[7] *IEA's World Energy Outlook*, http://www.iea.org/Textbase/npsum/WEO2006SUM.pdf
[8] *DOE Buildings Energy Data Book* http://buildingsdatabook.eren.doe.gov/

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. This initiative will, in addition to the research funded in FY 2010, provide the measurement science required to achieve Net-Zero Energy, High-Performance Green Buildings when undertaken in a holistic, integrated manner.

Proposed NIST Technical Program:

In the proposed technical program, NIST will target research to promote sustainable manufacturing and construction in the following areas:

Sustainable Manufacturing

- **Information Supply Chain Infrastructure** – The work proposed in this element of the initiative will improve competitiveness and efficiency of U.S. manufacturers by defining and enabling a closed-loop, open standards based information infrastructure to communicate critical sustainability information among suppliers, customers and regulatory agencies. The emphasis on reuse, remanufacture and recycle products and material has forced sustainable manufacturers to pay as much attention to the information flow in the 'reverse' supply chain as the traditional, forward supply chain, thus closing the loop. In addition, regulatory requirements for declaring and reporting material content in their products and production processes are forcing U.S. manufacturers to capture and share such information across the supply chain, thus creating a strong need for standardization.

- **Best Practices Development and Deployment in Key Sectors** – Activities in this technical area will provide documentation of methods and processes for sustainable manufacturing in key industrial sectors. Engineering professionals in U.S. manufacturing sector have been asking for such information[9], which can be created from careful gathering and analysis of best practices in industry. Such practices would also be deployed with the help of NIST's Manufacturing Extension Partnership (MEP) program.

- **Sustainability Metrics and National Recognition** – Activities in this technical area will provide a set of sustainability metrics suitable for various segments of the U.S. manufacturing sector, and we will use them as the basis for proposing a national recognition

[9] http://memagazine.asme.org/Web/Thoughts_Sustainability.cfm

program that promotes adoption of and recognizes implementation of sustainable manufacturing best-practices.

Net-Zero Energy, High-Performance Green Buildings

- **Establish Energy Performance Standards for New and Existing Buildings -** A key marketplace driver for achieving national goals for Net-Zero Energy, High Performance Green Buildings is the use of performance standards and their embodiment in building codes. A variety of proposed performance standards are emerging from industry groups but there is evidence that their use often does not result in the expected improvements in energy performance and other high-performance measures. To make matters worse, there are multiple model building codes and a wide variation in how model building codes become adopted and applied in local jurisdictions around the country. To overcome these deficiencies there is a need to create a feedback loop where actual building performance measurements are used to understand why performance does not meet design expectations and the lessons learned are used to drive revisions to performance standards and building code.

- **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.

- **Provide Measurement Science to Improve Indoor Air Quality in Conjunction with Energy Efficiency Improvements -** NIST will develop measurement protocols to assess indoor air quality (IAQ) to ensure that reductions in building energy consumption do not degrade indoor environments. As measures are instituted to decrease building energy consumption, it is critical that they do not lead to unacceptable indoor environments, as the potential costs associated with occupant illness and reduced productivity could quickly exceed the savings from reductions in energy use. The current state of technical knowledge and measurement science is not able to support the assessment of IAQ, which limits the ability to assess the impacts of energy reduction measures.

- **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 to provide a basis for new models, standards, and best practice guidelines.

- Collaborate with industry partners to enable laboratory testing of prototype materials using NIST-developed measurement technology and to reconcile field exposure versus laboratory results.
- Disseminate 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 indoor air quality sensor technology that compliment NIST's research and will be critical for meeting the building energy efficiency and sustainable objectives.
- 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 Department of Energy/industry strategic road mapping activities that will serve to identify and prioritize measurement needs supporting green building technology development.

Performance Measures: Outputs

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

Sustainable Manufacturing	
Technical Area	**Outputs/(Targets)**
Information Supply Chain Infrastructure	• Harmonized standards and information models for materials used in products and production processes, developed in cooperation with industrial consortia. (FY 2013 - FY 2016) • Models and information flow in reverse and forward supply chains, developed with lead industries. (FY 2014 - FY 2016)
Best Practices Development and Deployment in Key Sectors	• Best practices for sustainable methods and processes developed and documented by working with lead industries in key sectors (e.g., aerospace and electronics). (FY 2013 - FY 2016) • Best practices deployed in these key sectors by working with MEP and their regional/academic partners. (FY 2014 - FY 2016)
Sustainability Metrics and National Recognition	• Harmonized sustainability indicators and metrics appropriate for various regions and industrial segments, developed in cooperation with national and international standards bodies. (FY 2013 - FY 2016) • Pilot testing of high-level metrics as sustainability attributes through a Malcolm Baldrige Quality Award type framework; proposal for a similar national award for sustainable manufacturing. (FY 2013 - FY 2015)

Net-Zero Energy, High-Performance Green Buildings	
Technical Area	**Outputs/(Targets)**
Energy Performance Standards for New and Existing Buildings	• Comparative studies of ASHRAE Standards, International Energy Conservation Code, Model Energy Code, and state/regional codes to identify exemplary and weak code requirements. (FY 2012) • Analysis of building and system performance data for a range of innovative designs and technologies resulting in a building performance database to support net zero energy targets and standards. (FY 2013) • Standard design methods and performance requirements to encourage innovative designs and energy efficient technologies. (FY 2015) • Develop design tools and compliance strategies to enable performance-based energy standards. (FY 2016)
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. (FY 2012) • Measurements and models to characterize, quantify, and predict the end-use life-cycle performance and degradability of bio-based building materials. (FY 2013) • 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. (FY 2014) • Development of the fundamental understanding needed to formulate environmentally benign fire suppressants in building materials and furnishings. (FY 2014)
Measurement Science to Improve Indoor Air Quality (IAQ) in Conjunction with Energy Efficiency Improvements	• Study that identifies the measurement science needed to enable technologies that improve building IAQ without negatively impacting energy consumption. (FY 2012) • Identify existing IAQ standards, assessment protocols and metrics, and evaluate their technical merit for field application. (FY 2013) • Develop IAQ assessment protocols for field application. (FY2014) • Demonstrate IAQ protocols through field studies to evaluate their accuracy, completeness, and practicality. (FY 2015) • Convert IAQ protocols into consensus standards. (FY 2016)

Performance Measures: Outcomes

At the proposed funding level, NIST technical outputs will enable the following outcomes:

Sustainable Manufacturing:

- U.S. manufacturers maintain and enhance their competitive edge by their ability to proactively exchange information with their suppliers, customers and regulators on the sustainability attributes of their products and production processes.
- U.S. becomes a leader in creating jobs and profits in the reverse supply chain to reuse, remanufacture and recycle products and materials.
- U.S. engineers are proficient in the practices of sustainable manufacturing.
- U.S. manufacturing firms are viewed as world leaders in designing sustainable products and using sustainable production processes.
- Green jobs lead to employment growth in the U.S. manufacturing sector.
- U.S. industry embraces a set of sustainable manufacturing metrics to benchmark their performance and become world leaders.
- Pilot testing of high-level sustainability attributes creates strong awareness and competitive spirit for sustainability among U.S. manufacturers.

Net-Zero Energy, High-Performance Green Buildings:

- Buildings that use energy more efficiently, have a lower environmental impact, and provide better indoor air quality conditions for occupants.
- New and improved industry consensus standards and performance-based building codes.
- Building materials with longer, more predictable service life and performance.

4. Innovations in Healthcare – Measurement Science and Standards to Support Manufacturing and Regulatory Approval of Biologic Drugs (+24 Positions, +18 FTE, +$10,000,000, including a $2,250,000 transfer to the Working Capital Fund.)

Problem Magnitude and NIST Role:

The rising cost of healthcare and increasing prevalence of chronic diseases, such as heart disease and diabetes, are having a severe impact on the economic security and quality of life for many in the U.S. The Administration is committed to addressing the major challenges associated with healthcare to improve its delivery and efficacy. Innovative medical technologies can lead to meaningful improvements in the efficiency, effectiveness, and quality of healthcare. However, a sound measurement science and standards foundation must be in place to foster innovations. NIST's unique core competencies in measurement science and standards can help accelerate that innovation.

To date, NIST's efforts in the area of healthcare have targeted the measurement and standards needs associated with clinical diagnostics and medical imaging. This new initiative will further expand NIST's ability to address inefficiencies and stimulate innovation in healthcare by addressing challenges associated with the development and manufacture of biologic drugs.

The cost of biologic drugs is one of the fastest growing components to the overall cost of health care in the U.S. Biologic drugs are not small molecules like aspirin that can be synthesized chemically, but rather are much larger, complex protein molecules produced in bioreactors using living cells. Protein therapeutics have revolutionized the treatment of many life threatening diseases such as cancer and have substantially improved the quality of life of hundreds of thousands of patients. However, biologic drugs are very expensive and generics are not currently available in the U.S. The U.S. Food and Drug Administration (FDA) has been charged with developing a regulatory process to enable an abbreviated development process for follow-on biologic drugs that will be based largely on physical/chemical and biologic measurements. Companies wishing to take advantage of this upcoming opportunity need the ability to evaluate the "sameness" of their follow-on biologic drugs with the currently approved biologic drug. The data presented to the FDA would need to show that the structure and function of the follow-on biologic drug is similar enough to the original biologic drug (as determined by measurements comparing the structure and function of the two products), to provide the regulators with a high degree of confidence that the new product will be safe and effective. In addition, the cell-based production systems used for biologic drug manufacturing are plagued with inconsistencies and biopharmaceutical companies need new measurement systems to obtain a deeper understanding of the inner-workings of cells to achieve higher yields of the drug and to reduce waste. A critical safety and efficacy issue for biologic drugs is their propensity to induce an immune reaction in patients who receive them. Currently there is no reliable method to predict either the type or degree of severity of immunogenicity caused by a biologic drug before it is administered to a patient. New methods are also needed to identify and quantify various contaminants that enter biopharmaceuticals during processing and packaging.

Interactions with industry and FDA have indicated that NIST resources directed at the following needs would have a high impact:

- more accurately assess the "sameness" of a biologic drug made by different manufacturers and/or different manufacturing processes
- improve efficacy and safety, and
- improve efficiency and reliability in manufacturing processes.

Proposed NIST Technical Program:

Working with stakeholders, NIST has identified the following critical phenomena and measurement barriers as areas where the development of improved measurement technologies and methods would have great potential to positively impact the biopharmaceutical manufacturing industry and improve the ability of FDA to regulate "generic biologics".

- **Immunogenicity and Immune Response:** There is currently no measurement infrastructure in place to ensure the accuracy and comparability of the various methods used to measure key attributes of protein biologics that cause immunogenicity. Immunogenicity is the ability of a biologic drug to provoke an immune response in a patient. An immune response may range from neutralization of the drug rendering it ineffective to a life-threatening allergic reaction. A key attribute of biologic drugs linked to immunogenicity is aggregation. Aggregation is the process by which individual biologic drug molecules may "clump" together to form larger particles. For regulatory approval, biologic drugs must be carefully examined for the presence of aggregates; however, detecting and measuring the wide size range of possible aggregates remains difficult. Manufacturers often use different measurement tools and protocols that can lead to contradictory results.

Improving the measurement science for biologic drug aggregates would benefit manufacturers and patients in several ways. For example, development of standards would help to compare results from different measurement methods used by manufacturers and provide a better scientific framework for regulatory requirements and decisions. These standards would also facilitate the development and acceptance of improved instruments for measuring biologic drug aggregates during manufacturing and in final products. Improved measurement of aggregation would ultimately lead to better understanding and prediction of biologic drug aggregation and immunogenicity. The ability to predict immunogenicity of new biologic drugs would, in turn, increase the probability for their successful development. Additionally, methods are required to evaluate the potential adverse immune response invoked by a particular therapeutic treatment. These types of assays often require the measurement of cellular response *in vitro* in the presence of known peptides or peptide libraries as predictive of an *in vivo* response. Current in vitro assays require peptide and protein standards, and validated cell based analysis methods to assure the quality of these measurements. Improved in vitro immune system models are needed to provide better predictive capability related to patient outcome.

- **Biologic Drug Structural Measurements:**

    - **Three-dimensional (3-D) protein structure:** Biologic drug proteins are synthesized in cells as linear chains of amino acids that must be "folded" into precise three-dimensional (3-D) shapes to achieve full biological activity or function. The improper folding of a biologic drug affects several aspects of how a biologic drug may function once injected into a patient. Potency, efficacy and safety can all be severely compromised by misfolding events. At present, the physical or chemical characterization methods for determining the 3-D structure of biologic drugs are not consistently reliable or reproducible and are not readily applicable to *in vivo* environments.

      The development of reference methods, standards, and data for the characterization of 3-D protein structure would help biopharmaceutical manufacturers verify the accuracy and comparability of the structures of manufactured biologic drugs. Standard data and methods would also aid instrument vendors in providing reliable and standardized measurement technologies for protein 3-D structure analysis. Standards would also foster the innovation and evaluation of new, more robust approaches for structural analysis by manufacturers and instrument vendors. These efforts would help to ensure that the manufacturer is producing the same product from one batch to the next and would also allow for direct structural comparison of any new or 'follow-on' forms of a biologic drug with the original product. Standards would also help determine the relationship between the structure of a biologic drug and its function, which will be critical to our ability to develop predictive models for how it will act in the body. Standard protein 3-D structure methods and data would make the biologic drug marketplace more efficient in two key areas: batch to batch comparative analysis of biologic drugs and authentication of biologic drug identity.

- **Post-translational modification (PTM) of manufactured proteins:** Most biologic drugs contain chemical modifications known as post-translational modifications (PTMs). These modifications occur at very specific locations on the biologic drugs and can greatly impact their therapeutic function. One commonly observed PTM, glycosylation, involves the addition of complex groups of sugar molecules. PTMs, such as glycosylation, are known to be critical to the safety and efficacy of many biologic drugs and PTMs must be consistent over the market life of the product. There are many analytical methods for determining PTMs; however, assessing the accuracy and comparability of results from the different methods remains challenging. In order to evaluate the sameness of biologic drug products, these modifications must be well-understood and extensively characterized. Due to the complex and varied nature of the PTMs, improved methods are needed to quantitatively assess the structure of PTMs and understand how differences in their structure impact biologic drug potency and clinical performance.

  The development of appropriate standards would allow the precision and accuracy of the many different analytical technologies to be evaluated and enable better comparison of results. Such standards would also foster the development and evaluation of new analytical methods and protocols by instrument vendors and industry. Characterizing the PTM signature of products would also enable more streamlined comparative analysis, aid in authentication of manufactured products to safeguard against counterfeit drugs, and reduce the cost of comparing the PTMs of batches of biologic drugs produced from different manufacturing sites or companies.

- **Production cell efficiency**: Biologic drug manufacturing processes are highly variable and unpredictable due to a lack of tools to measure the internal workings of the cells that synthesize, modify and secrete the desired biologic drug product. Most biologic drugs are produced in Chinese hamster ovary (CHO) cells, but numerous problems are routinely encountered where CHO cells, for unknown reasons, do not perform appropriately. When this occurs, weeks or months of production time are wasted. The biologic drug industry has indicated to NIST a strong desire to have available measurement tools to enable a more complete understanding of the CHO cell system to a point where it can better be manipulated and controlled. This systems level characterization of CHO cells will require advanced measurement capabilities that enable the identification, quantification and measurement of the thousands of biomolecules and signaling pathways that govern the inner working of these tiny biologic drug factories.

  Industry and academia would be better equipped to understand changes in the cell function and the associated production capacity by using a systems biology-based approach to monitor production cell behavior. However, this would require greatly improved measurement capabilities and a robust measurement infrastructure to support analysis of cell behavior at this level, particularly in a manufacturing environment. With such robust capabilities available, a more fundamental understanding of processed employed by production cells to synthesize biologic drugs with the correct PTMs would be possible, enabling the agile, low cost manufacturing of safe and effective protein- and cell-based products.

Performance Measures: Outputs

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

Innovations in Healthcare: Measurement Science and Standards to Support the Manufacturing and Regulatory Approval of Biologic Drugs	
Technical Area	**Outputs/(Targets)**
Immunogenicity	• Critical evaluation of the underpinning measurement science for protein aggregate measurements. (FY 2013) • Reference methods and Standard Reference Materials for protein aggregate measurements. (FY 2014) • Validated in vitro methods and models for measurement of human immune system response. (FY 2014)
Structure (3-D and PTM)	• Reference methods in multiple spectroscopies (reference spectra, data and standards) for measuring 'sameness' related to protein 3-D structure. (FY 2013 – FY 2014) • Reference methods, data, and standards for glycan analysis. (FY 2014) • Stable Isotope Protein Labeling User Facility at the NCNR to support high resolution protein structural analysis. (FY 2012)
Production Cell Efficiency	• Reference genetic markers and methods for cell line ID. (FY 2013) • Reference methods and standards to support gene expression measurements and measurement of transcriptome of CHO cells. (FY 2013) • Reference methods and standards to support proteomic measurements of CHO cells. (FY 2014) • Reference Data (molecular signatures) for predicting CHO cell performance in Biologic Drug manufacturing. (FY 2014)

NIST intramural research and standards activities will be augmented by a competitive extramural research grants program targeting specific industry challenges in each of the three areas mentioned above.

Performance Measures: Outcomes

At the proposed funding level, NIST technical outputs will enable the following outcomes:

- Improved biologic drug aggregate measurements would enable instrument, equipment and supply vendors, methods developers and biologic drug manufacturers to develop new measurement systems.
- Harmonization of results across different measurement platforms used by manufacturers and ultimately provide a better scientific framework for regulatory decisions.
- Improved accuracy and comparability of the methods used to measure critical process and end-product characteristics of manufactured biologic drugs would enable improved process development, lower cost of goods, and increase profit.
- Industry and academia would be better equipped to develop the advanced measurement systems required for the establishment of a systems-biology-based approach for understanding the inner workings of biologic drug production cells and lead to a more fundamental understanding of bioprocessing and enable the agile, low cost manufacturing of safe and effective products.

5. Innovations for 21st Century U.S. Manufacturing (+28 Position, +21 FTE, +$10,000,000)

- Manufacturing is fundamental to the Nation's economy and to the future prosperity of all Americans. It puts progress in science, technology, and engineering into practice – and into the marketplace.
- Responding to globalization of the world's economy, the future of U.S. manufacturing will be defined by innovative, complex, high value-add, knowledge-intensive products produced with materials and processes that are similarly advanced in nature, such as those based on nanotechnology.
- Global competition and rapidly-changing market demands are pressing U.S. manufacturers to respond more and more quickly and efficiently with innovative products and processes. However, there are currently many challenges and barriers to agility throughout the product realization lifecycle—from design to fabrication to logistics and distribution.
- This program will improve the ability of U.S. manufacturers to (1) create innovative products that meet changing global market demands and (2) meet increasingly challenging quality and cost requirements through faster and more efficient manufacturing research and development based on new measurement and test methods, new standards, and advanced algorithms and tools for modeling and decision-making.

Problem Magnitude and NIST Role:

The President has identified investments in new technologies and business practices as one of seven key areas in his policy framework for revitalizing American manufacturing, stating "The key manufacturing growth areas in the 21st century will be driven by new technologies and new areas of consumer demand. The most successful areas will be combinations of the two, such as using new technologies to satisfy the increasing demand for clean energy."[10] A robust and

[10] Executive Office of the President, December 2009, "*A Framework for Revitalizing American Manufacturing*"

vibrant manufacturing sector is critical to the overall health of the U.S. economy. Today the manufacturing sector accounts for 12 percent of GDP, which amounts to a substantial $1.6 trillion, and employs 14.3 million workers. Manufacturing's leverage on the rest of the economy tops all other sectors, generating an additional $1.43 in economic activity in the rest of the economy for each $1 in merchandise sales; and the manufacturing sector is the primary source of U.S. trade revenues, accounting for almost two-thirds of the Nation's total exports. Equally critical for future U.S. economic health is the integral role of the manufacturing sector in leveraging technological innovation in the rest of the economy, especially in the large and rapidly growing service sector. It is widely acknowledged that R&D is the fundamental basis of innovation, but the fact that the manufacturing sector drives the majority of U.S. R&D efforts is often overlooked. The manufacturing sector accounts for more than 70 percent of U.S. industrial R&D, with more and more of the research effort and production coming from the high-technology portion of the manufacturing sector, which has tripled its output over the past 25 years.[11] This engine of economic growth can only be sustained if the innovations in measurements and standards necessary for progress are developed and disseminated in tandem with the industrial R&D.

Globalization has placed new pressures upon the manufacturing sector. Today global markets are becoming increasingly technology- based. In response, the U. S. manufacturing sector is adopting a wide range of technologies to compete effectively in the future. Greater use of technology is enabling American companies to provide higher quality and more customized products while also reducing costs. Equally important, the higher value added achieved through greater technology intensity is creating more productive and higher paying jobs within the domestic economy. However, other nations are rapidly expanding their economies' investment in manufacturing technologies. Greater incentives by these competitors have resulted in U.S. manufacturing companies expanding foreign R&D spending at three times the rate of their domestic investment.

This program will leverage the productivity of domestic manufacturing R&D and thereby make investment within the U.S. economy more attractive. This leverage will result from the provision of key measurements and standards that can result in a sustainable competitive advantage. The program will provide a measurable increase in domestic R&D productivity through the development of infrastructural science, technologies, and tools needed to achieve the proposed agile manufacturing innovations and next-generation capabilities for nanomanufacturing. NIST contributions are complementary to domestic industry's R&D because they address commonly shared measurement and standards problems spanning the spectrum of U.S. manufacturing, while leaving the application-specific technology and process development to industry stakeholders.

[11] Gregory Tassey, Rationales and Mechanisms for Revitalizing U.S. Manufacturing R&D Strategies, 2009 (http://www.nist.gov/director/planning/manufacturing_strategy_paper.pdf).

This program represents a critical first step in providing an advanced technical infrastructure for the future growth and prosperity of U.S. manufacturing. Two major technological areas will be emphasized:

Rapid and Cost Effective Manufacturing Capabilities: Manufacturing plays a central role in realizing the benefits of technological innovation and in the overall growth and health of the U.S. economy. The ability to *rapidly* introduce product innovations will provide a foundation for future U.S. manufacturing market growth, competitiveness, and creation and retention of high-skill, well-paying jobs. A much greater degree of manufacturing agility is also needed to fully capitalize on the unprecedented long-term manufacturing opportunities being created by new approaches to health care, energy, the environment, and transportation. In addition, domestic manufacturing agility and overall productivity are essential to national defense and homeland security by ensuring that the high-performance and high-quality products and systems needed by our military and security forces are provided in a timely and cost-effective manner throughout each technology's life cycle. In this program, NIST will conduct and sponsor research and development in technology areas central to a transformational future of U.S. manufacturers: including additive manufacturing and advanced robotics. New measurements and performance-based standards for additive manufacturing – referring to a revolutionary capability to create complex three-dimensional objects by building up layers with material composition and structure that vary like colored ink on printed pages - will enable a business environment where "new types of businesses will unleash new types of products that were previously impractical due to cost, risk, or manufacturability."[12] Advances in additive manufacturing methods will give U.S. manufacturers new capabilities to rapidly produce highly-customized and complex products with increased functionality and performance, decreased time-to-market, and reduced waste. In addition, the President's Framework for Revitalizing American Manufacturing recognizes the importance of "developing advanced robotics technologies that allow the U.S. to retain manufacturing, and respond rapidly to new products and changes in consumer demand."[13]

Nanomanufacturing: Remarkable discoveries of nanoscale materials with unique properties, along with laboratory demonstrations of a range of innovative nanoscale devices provide a broad and deep potential foundation for future U.S. manufacturing competitiveness. However, for these early discoveries to become the basis for new U.S. industries and drive future productivity and market growth, methods must be established to efficiently assemble products that integrate together billions or more of nanoscale devices with disparate functions over large areas. Current manufacturing methods, such as those used in high-volume production in the semiconductor industry, will not be adequate at the low- and medium scales of production needed in a wide range of potential markets. Radically new processing approaches are needed. Moreover, for such products to be ubiquitous in the nation's future economy while being friendly to the environment and safe to work with, the new products and associated production processes must be

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[12] "Roadmap for Additive Manufacturing Identifying the Future of Freeform Processing", 2009, University of Texas at Austin

[13] Executive Office of the President, December 2009, "*A Framework for Revitalizing American Manufacturing*"

inherently sustainable. This goal can only be achieved through radically new product and process technologies, supported by equally new and pervasive measurement technologies and standards.

Proposed NIST Technical Program:

NIST will target research to promote agile manufacturing and nanomanufacturing in the following areas:

Rapid and Cost Effective Manufacturing Capabilities:

To begin to achieve rapid and cost effective manufacturing capabilities for disruptive new technologies, foundational manufacturing research and development, new measurement methods, and associated standards are needed in a number of areas to enable rapid prototyping and scale up capabilities to enable the manufacture of high technology products. Working with industry and academic NIST will engage in research and standards efforts that promote:

Additive manufacturing and rapid prototyping systems that provide the agility needed to rapidly make innovative customized complex products that are not realizable by more traditional manufacturing technologies or produced in low-to-moderate volumes. NIST research and development in this program will provide:

- New measurement methods, tools, and test specimens to improve system performance, materials qualification, and part quality for additive manufacturing processes;
- Fundamental understanding of the physics and chemistry associated with additive processes to form the technical basis for new standards, performance metrics, next-generation product design tools, and improved materials;
- Tools and methods for integrating materials specifications and manufacturability information into enhanced product design systems; and
- New methods and tools for characterizing, optimizing, and controlling innovative additive processes within the overall production system.

Intelligent robotics and automation systems to enable robotics to be more broadly applied to mass customization robots [need] to be smarter, more flexible, and able to operate safely in less structured environments shared with human workers." NIST research and development in this program will provide:

- Performance measures for imaging sensors and perception for situational awareness in dynamic unstructured environments;
- Performance measures for tactile sensors, mechanisms, and algorithms to improve the manipulation capability of robotic systems;
- Performance measures and standards for industrial robot safety systems that allow safe operation in proximity to humans; and
- Performance measures and standards for next generation robot systems that can perform a wider range of manufacturing operations.

Nanomanufacturing:

Although the flexibility inherent in nanomaterials offers exceptionally broad possibilities for future manufactured products, four requirements to move beyond one-off nanofabrication demonstrations to volume and cost-efficient nanomanufacturing are:

- Production must be scalable up to the required throughput and yield;
- The generation, manipulation, and organization of nanostructures must be accomplished in a precise, controlled, and environmentally responsible fashion;
- All nano-based products must perform to specification over their expected lifetime without the release of potentially hazardous nanomaterials into the environment; and
- The bulk of the materials used must be recyclable with minimal waste or energy consumption.

Design of Scalable Nanomaterials, Components, and Devices: Nanomanufacturing relies on scaling up production from the laboratory demonstration level to true industrial volume production. This challenge must be addressed, in part, through nanomaterial, component, and device design that identifies and eliminates the fundamental limits to scaling. New scalable processes and techniques for generating, handling, and assembling nanostructures safely and efficiently on an industrial scale must be developed, validated, and disseminated. Many of these techniques will have to rely on the self-assembly of nanostructures in order to solve the problem of incorporating a vast number of nanocomponents into functional systems. The success of this approach will depend on the careful design of individual nanostructures as well as on the development of new control methods designed to organize matter using predominantly stochastic rather than deterministic processes. The research and development supported here will be focused on overcoming the major technical barriers encountered in transitioning from the laboratory to the production line, including the following:

- Novel processes and techniques for scalable and sustainable manufacturing of *known* beneficial nanoscale materials, components or devices, with preference given to processes applicable to broad classes of nanomaterials, components, and devices;
- Novel beneficial nanomaterial components and devices produced by *known* scalable and *sustainable* manufacturing processes and techniques;
- Fundamentals of nanomaterial, component, device and/or nanomanufacturing process design *specifically* focused on scalability and sustainability; and
- Novel metrology techniques to enable the rapid characterization of nanostructure properties and behavior to enable rational design.

Nanomanufacturing Measurement Technologies: The accuracy, precision, and reproducibility with which a structure can be manufactured are dictated in large part by the available metrology, because it cannot be made if it cannot be measured. Measurement systems and standards have enabled industry to produce reliable goods and promote successful businesses and a healthy economy through high-quality process development. Nonetheless, the ability to tune and maintain nanoscale assembly processes is severely limited by the lack of truly nanoscale, *real-time*, in-line techniques for measuring manufacturing system performance and instantly determining and executing production process adjustments. Existing methods are time-consuming, expensive, and require high-tech infrastructure and high skill levels to perform. For example, current process monitoring often requires off-line and hence time consuming product sample preparation and testing, and advanced expertise is typically required to perform the actual assessments (for example, applying electron or atomic force microscopy on nanoscale components or devices). Often, one must resort to macroscopic, and thus indirect, measurements of functionality that omit crucial information about the causal chain of process, structure, and function. The results are lower yields and less product flexibility. The research and development supported here will develop nanomanufacturing measurement technologies, including the following:

- Metrology techniques to enable the detailed understanding and development of techniques for scalable nanostructure manufacturing, including *in situ* atomic scale measurements of dynamic processes;
- Metrology tools to quickly, inexpensively, and accurately characterize products at the relevant scales of one to hundreds of nanometers, including non-contact optical measurements; and
- In-line, fast and inexpensive nanoscale metrology and control techniques to enable and maintain complex, multi-step assembly processes in which a large number of variables have to be optimized and controlled.

Performance Measures: Outputs/(Targets)

Rapid and Cost Effective Manufacturing Capabilities:

- New measurement methods and standards, advanced software tools, and infrastructural technologies to drive innovation in advanced manufacturing/rapid prototyping systems (FY 2012 – FY 2017)
- New intelligent robotics and automation and additive manufacturing technology, methods, and capabilities transferred to U.S. industry through collaborations, testbeds, and prototype development (FY 2014 – FY 2017+)

Nanomanufacturing:

- Standards and metrology tools and protocols for quantifying the characteristics of nanomaterials and structures used in nanomanufacturing (FY 2013 – FY 2016)
- Materials and processes for nanomanufacturing that are scalable, efficient, and safe (FY 2013 – FY 2018)
- Innovative, flexible systems for in-line manufacturing measurements that are fast, robust, standardized, and traceable (FY 2013 – FY 2018)
- Transfer of the materials and processes and measurement systems and protocols to industry stakeholders (FY 2015 – FY 2020)

Performance Measures: Outcomes

Manufacturing is a key driver for U.S. economic well-being, national security, wealth generation for the country, and quality of life for the nation. Manufacturing turns scientific discoveries into viable commercial products. Furthermore, manufacturing stimulates further technology innovation in a regenerative cycle that leads to realization of new products and new impacts on society, especially in emerging and growth areas such as renewable energy sources and devices, miniaturization and micro-scaled products, intelligent systems, medical devices and implants, and national security. Finally, a broad and viable manufacturing sector is essential to support the productivity and hence competitiveness of the larger high-tech service sector, which depends on manufacturing for much of its technology. At the proposed funding level, NIST technical outputs will enable the following outcomes:

- Enhanced U.S. manufacturing competitiveness where manufacturers produce high-value, knowledge-intensive products and respond rapidly to new product opportunities and changes in consumer demand through innovative rapid prototyping and mass customization manufacturing, and nanomanufacturing technologies;
- Broadened application of robots to more advanced and complex tasks to safely augment human capabilities in manufacturing, along with new and expanded domestic industries in intelligent robotics for manufacturing; and
- A new U.S. industry that develops and manufactures innovative and safe products based on integrated systems of nanoparticles and nanodevices with custom designed properties and functions.
- Overall, a larger and more technologically intensive domestic manufacturing sector based on the principles of mass customization and advanced product performance, product quality, and cost minimization.

6. Disaster Resilient Buildings and Infrastructure (+11 Positions, +8 FTE, +$5,000,000)

Problem Magnitude and NIST Role:

A large percentage of the Nation's buildings and infrastructure is concentrated in disaster-prone regions of the country.[15, 16] Despite significant progress in disaster-related science and technology, natural and technological disasters in the United States are responsible for an estimated $55 billion in average annual costs in terms of lives lost, disruption of commerce and financial networks, properties destroyed, and the cost of mobilizing emergency response personnel and equipment. Natural hazards[17] are a continuing and significant threat to U.S. buildings and infrastructure. Activities of man that are accidental, criminal, or terrorist can lead to disastrous losses as well. A single event such as a major earthquake or hurricane could potentially cause $80 billion to $200 billion in economic losses in the affected areas.

The disaster resilience of our buildings and infrastructure today is determined in large measure by the building codes, standards, and practices used when they were built. With few exceptions, these legacy codes, standards, and practices which have evolved over several decades are prescriptive, oversimplified, and inconsistent with respect to risk. There is a critical need for the transformation from prescriptive to performance-based codes and standards that will enable the use of innovative structural systems and materials. Codes and standards are developed through a

[15] *Improved Seismic Monitoring – Improved Decision Making: Assessing the Value of Reduced Uncertainty*, National Academies Press, 2006.
[16] Economic Statistics for NOAA – May 2005 – Fourth Edition.
[17] Hazards include earthquakes, wind-related hazards (hurricanes, tornadoes, windstorms), fire-related hazards (community-scale fires in the wildland-urban interface, structural fires), water-related hazards (storm surge, flood, tsunami) and human-made hazards (accidental, criminal, or terrorist).

voluntary consensus process by private sector organizations that lack the resources to carry out the research required to develop the technical basis for improved codes and standards.

As costs continue to rise, there is increasing recognition of the need to move from response and recovery to proactively identifying hazards that pose threats and taking action to reduce the potential impacts. Whether hazards become disasters depends largely upon the disaster resilience of our structures and communities. This, in turn, depends upon the capacity to prepare for and mitigate the impacts of hazards, preventing them from becoming disasters. This initiative focuses directly on selected solutions demanded by five of six Grand Challenges identified by the President's National Science and Technology Council in June 2005 for advancing science and technology to enhance disaster resilience, and thus, improve the Nation's ability to face disasters. These challenges include: (1) provide hazard and disaster information where and when it is needed, (2) understand the natural processes that produce hazards, (3) develop hazard mitigation strategies and technologies, (4) assess disaster resilience using standard methods, and (5) promote risk-wise behavior.

Currently, there is a lack of the measurement science to improve the disaster resilience of buildings and infrastructure exposed to natural and man-made hazards. This program supports NIST's mission of promoting U.S. innovation and competitiveness by anticipating and meeting the measurement science, standards, and technology needs of U.S. industries, including the building and fire safety industries. The program leverages NIST core competencies in performance of buildings and infrastructure under extreme loads. NIST has significant statutory responsibilities in these areas, including the National Earthquake Hazards Reduction Program (NEHRP) (2004), the National Construction Safety Team Act (2002), the National Windstorm Hazard Reduction Act (2004), and the Fire Prevention and Control Act (1974). Further, NIST houses the Building and Fire Research Laboratory (BFRL), whose research on standards and codes are used by practitioners around the world. This initiative addresses two critical national needs:

- **Disaster and Failure Event Studies:** Historically, the analysis of the performance of buildings and infrastructure during natural and man-made hazards has enabled improvement of the safety and functionality of the facilities in which Americans live and work. Extreme events test entire buildings and infrastructure systems in ways and on a scale that cannot be adequately or accurately replicated in a laboratory. There is a need for research that provides valuable information on hazard characteristics, structural performance, safety of building occupants, infrastructure system performance at both the component and system levels, effectiveness of emergency response and evacuation procedures, and the adequacy of building codes, standards and practices. Knowledge of all of these areas is required to provide disaster-resilience at the structure and community levels through improvements to codes, standards, practices, and to inform research to address knowledge gaps. This initiative supports the development of a National Disaster and Failure Events Database, that was initiated with funds in FY 2010, that will include natural and man-made hazards. The Database directly addresses one of nine strategic priorities of the 2008 NEHRP Strategic Plan, which calls for the development of a Post-Earthquake Information Management System (PIMS) to assemble and manage relevant scientific, social behavior, engineering, casualty, economic loss, response, and recovery cost information for damaging earthquakes. Such a database does not currently exist, and no other organization has the statutory authority, responsibility, resources, and capabilities to develop and maintain a comprehensive data repository on disaster and failure events. The repository will be developed to accept field data from NIST and other credible sources; in NEHRP, for example, information will be provided by the Federal Emergency Management Agency (FEMA), National Science Foundation (NSF), and U.S. Geological Survey (USGS), in addition to NIST, and organizations in the broader NEHRP stakeholder community. The repository will be a national, public asset that will be used by researchers, practitioners, and codes and standards development organizations.

- **Fire Performance of Structures:** Current engineering practice does not consider fire as a condition for structural design. The nearly century-old prescriptive fire endurance test standard for structural components poses a stifling barrier to innovation in the design of structural systems and connections, and in the use of new, higher performing structural and fireproofing materials. The standard test method also does not consider the performance of the structure as a system (including its connections) either in the standard test or more importantly, in real building fires, which are vastly different from the standard fire. The problem is made even harder by the difficulty of distilling the complicated elevated temperature behavior of structural materials to a model that can be incorporated into a predictive scheme without loss of the essential failure and deformation behavior. Currently, there are no science-based, accepted measurement tools to evaluate the fire performance and quantify the safety of a structure as a complete system of components and connections, or compare the fire resistance performance of different structural systems. NIST is currently constructing a $22 million[18] National Structural Fire Resistance Laboratory (NSFRL) on the Gaithersburg site, which will provide the opportunity to test real-scale structural systems under realistic structural and fire loading. This initiative supports the commissioning of and research to be conducted in the NSFRL. Both the new facility and this initiative are critical to implement Recommendations 4 through 7 from the NIST technical investigation of the collapse of the World Trade Center towers.[19]

<u>Proposed NIST Technical Program:</u>

This initiative proposes to develop the scientific basis required to enable technological innovation, improve predictive capabilities, and improve codes and standards for the cost-effective improvement of life-safety and reduction of property loss due to natural and man-made hazards. <u>The fundamental new idea underpinning this initiative is that disaster resilience can be enhanced by developing a robust capability to *predict* the effects of hazards on the *performance* of complex structural systems</u>. This will be achieved by providing *data* to characterize the hazard, validated physics-based *models* to predict performance, *metrics* for measuring performance, acceptance *criteria* for differing levels of performance objectives, and

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[18] NIST allocated American Recovery and Reinvestment Act funding for the construction of a $16 million structural fire resistance testing facility, $5 million for the expansion of pollution abatement system for its Large Fire Laboratory, and $800K for the structural loading system. The facility is anticipated to come online in FY2012.
[19] *Final Report on the Collapse of the World Trade Center Towers*, NIST NCSTAR 1, September 2005, pp. 208-213.

mitigation strategies based on performance evaluation. The scope of the proposed research focuses on disaster resilience of buildings and infrastructure.

The proposed research has the following objectives:

- **Disaster and Failure Event Studies:** NIST will develop the measurement science to derive lessons from disaster and failure events involving buildings and infrastructure. It will collect and analyze data and artifacts to improve the understanding of hazards, the real-world performance of buildings and infrastructure during disaster and failure events at both the component and the system levels, associated emergency response and evacuation procedures and social and economic factors that affect pre-disaster mitigation activities and post-disaster response efforts. The results of disaster and failure studies will lead to recommendations for improvements to building codes, standards, and practices and identification of gaps in current knowledge about buildings, infrastructure, emergency response, and human behavior. NIST will create and maintain a National Disaster and Failure Events Database to facilitate such disaster and failure studies and to widely disseminate the data, findings, and recommendations from these studies. NIST will develop this database in cooperation with its partner agencies (e.g., FEMA, NSF, USGS, and NOAA) that share national responsibilities with NIST for improving national disaster resilience.

- **Fire Performance of Structures:** NIST will develop the capability to test real-scale structures in the NSFRL under realistic structural and fire loads. NIST will develop an experimental database on the performance of materials, components, and connections under fire loading to gain knowledge, quantify performance, and validate and verify physics-based predictive models, including a library of component and connection models for use in performance-based design. Data from experiments conducted in the NSFRL will provide the technical basis for performance metrics, acceptance criteria for different levels of performance objectives, and mitigation strategies based on evaluated performance to provide adequate fire protection for the structure. This program will provide the measurement science to enable the transformation from prescriptive to performance-based standards in design of structures for fire resistance.

<u>Performance Measures: Outputs</u>

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

Disaster Resilient Buildings and Infrastructure	
Technical Area	**Outputs/(Targets)**
Disaster and Failure Event Studies	• Develop a framework for the National Disaster and Failure Event Database and conduct pilot project to test the framework. (FY 2013) • Create and implement a National Disaster and Failure Database to serve as a public archival repository on hazard characteristics, the performance of buildings and infrastructure, associated emergency response and evacuation procedures, and

Disaster Resilient Buildings and Infrastructure	
Technical Area	**Outputs/(Targets)**
	social and economic factors that affect pre-disaster mitigation activities and post-disaster response efforts. (Phase 1 – FY 2015) • Conduct field studies in the aftermath of disaster and failure events to collect data and artifacts related to the performance buildings and infrastructure, associated emergency response and evacuation procedures, and social and economic factors that affect pre-disaster mitigation activities and post-disaster response efforts. (This will be an on-going effort with a frequency of approximately once per year or less.) • Conduct technical studies to interpret and analyze the data and artifacts, build and analyze models, perform laboratory experiments, determine findings and promote implementation of recommendations for changes to codes, standards, and practices, address knowledge gaps in the prevention, mitigation, or fundamental understanding of physical performance and human behavior. (This will be an on-going effort with a frequency of approximately once per year or less.)
Fire Performance of Structures	• Commission the NSFRL by testing and calibrating the structural loading system, thermal and structural instrumentation, data acquisition system, and application and control of fire loading and safety systems. (FY 2013) • Develop NSFRL laboratory/testing operational procedures, including structural loading, specimen support and restraint, fire load application, instrumentation and data acquisition, and safety measures. (FY 2013) • Develop a comprehensive NSFRL safety program including training requirements. (FY 2013) • Develop standard test protocols, including fire characterization (fire intensity and duration), thermal and structural response measurements, characterization of measurement uncertainty, and calibration of test apparatus and instrumentation. (FY 2014) • Conduct experiments and develop an experimental database on the performance of large-scale structural connections, components, subassemblies, and systems under realistic fire and loading conditions that can be used to validate predictive models and enable the development of performance-based design methodologies. (This will be an on-going effort with a frequency of approximately one major test series every 18 months.)

Performance Measures: Outcomes

At the proposed funding level, NIST technical outputs will enable the following outcomes:

- The development of improved emergency response and evacuation procedures, and pre-disaster mitigation plans specific to hazard events.
- Data, models, guidelines, and improved standards, codes, and practices for the built environment.
- Enable the transformation from prescriptive to performance-based design of buildings and infrastructure.
- Enhance the safety of buildings, infrastructure, emergency responders, and the public at large.

7. Advanced Solar Technologies – Third Generation Photovoltaics (+18 Positions, +13 FTE, +$5,000,000)

This new initiative focuses on the development of advanced measurement tools, models, data and standards that are necessary to accelerate the development, improve the efficiency, and lower the manufacturing cost of solar devices that incorporate third generation photovoltaic material, which hold the promise of reducing the price per watt for electricity to levels at or below the cost of conventional energy generated from fossil fuels.

The following goals and priorities are supported through this initiative:

- The White House's Strategy For American Innovation proposes to develop new and cleaner energy sources that can meet our Nation's increasing energy needs while mitigating global climate change, reducing energy imports, and creating green manufacturing jobs.
- The White House's Strategy on American Innovation calls for increased investment in fundamental research to enhance competition in the global marketplace.
- The Office of Science and Technology Policy (OSTP) identifies the development of "solar cells as cheap as paint" as one of the "Grand Challenges" of the 21st century.
- The Department of Commerce (DoC) has a strategic goal of promoting innovation and industrial competitiveness.

Problem Magnitude and NIST Role:

Economic growth and expanding population are 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. The need for the development of next generation clean energy technologies that do not depend on imported oil presents a global economic opportunity for the U.S.

In addition to these challenges, 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.

Solar energy remains one of the most promising alternative sources of energy as it is readily available, free from geopolitical issues, and immune to the environmental problems associated with carbon emissions. However, despite the continued growth of solar energy technologies, adoption of these technologies is ultimately limited by the relatively high-cost and low-efficiency of conventional photovoltaic (PV) solar cells. First and second generation silicon-based devices will continue to see gains as manufacturing processes improve, but are fundamentally limited in efficiency by the mismatch between the solar spectrum and device absorption spectrum. New third generation photovoltaic technologies seek to exploit nanostructures and interfaces to dramatically improve performance and overcome these barriers, and address a wider variety of applications and economic niches. For example, advanced devices can greatly increase efficiency using nanostructured layers that generate electricity from all the colors of the full solar spectrum by tuning individual layers to specific spectral portions of the solar spectrum.

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 on measurement will be conducted in coordination with the Department of Energy (DoE) and the National Renewable Energy Laboratory (NREL), and other agencies participating in the National Nanotechnology Initiative (NNI) Signature Initiative on Nanotechnology for Solar Energy Collection and Conversions, as well as close collaborations with 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 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 of first and second-generation solar technologies. A diversity of third generation photovoltaic technologies have promise to break this paradigm by greatly increasing the efficiency significantly in order to lower the cost per watt of electricity. Common to these new technologies is the exploitation of nanoscale phenomena to improve efficiency, and nanoscale structures (nanocrystals, nanowires, quantum dots, multilayers, etc.) 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 sufficient understanding and control over these complex systems at the nanometer scale. However, technology developers lack the measurement tools with the requisite accuracy, precision, sensitivity, and temporal and spatial resolution to correlate device characteristics with nanoscale properties. Thus, device optimization is currently slow and obtained through trial and error. 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. Unless reliable performance lifetime metrics are developed, commercial adoption of third generation solar technologies may be significantly delayed.

NIST's technical plan includes:

- Measurement techniques and models that improve the understanding of the relation of the efficiency of third generation photovoltaic materials to the fundamental spatial and temporal properties of photogeneration and carrier transport.
- Measurement platforms to rapidly identify, quantify, and control material defects that compromise efficiency, long-term operation, and even structural integrity.
- Accurate methods to assess the reliability, lifetime, and failure mode of third generation solar devices.
- Dissemination of new measurement techniques to improve efficiency, accelerate the manufacturing, and lower the overall cost of third generation solar devices.

Performance Measures: Outputs

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

Advanced Solar Technologies: Third Generation Photovoltaics	
Technical Area	**Outputs/(Targets)**
Measurement Platforms for Efficiency Characterization	• Measurement platforms that characterize quantum efficiency at relevant spatial resolution and realistic illumination and thermal load conditions in third generation photovoltaic material and devices. (FY 2013) • Measurement platforms that identify and analyze spatially-resolved defects and recombination centers that compromise efficiency and long-term operation of photovoltaic material. (FY 2013) • Measurement platforms that provide three-dimensional characterization of light absorption, carrier generation and transport at nanoscale spatial resolution. (FY 2014)
Photovoltaic Lifetime Analysis	• Failure analysis standards and test methods to assess the functional lifetime of photovoltaic materials and devices at nanoscale spatial resolution. (FY 2014)
Test Structure and Reference Materials	• Three-dimensional photovoltaic test structures and reference materials to enable validation of new measurement tools that characterize the optical and electrical processes in third generation photovoltaic materials. (FY 2014)
Advanced Modeling and Simulation	• New mathematical modeling and simulation tools that can accurately link the electrical and optical processes in third generation photovoltaic material to the performance of the resulting solar device. (FY 2014)

Performance Measures: Outcomes

At the proposed funding level, NIST technical outputs will enable the following outcomes:

- Dissemination of the measurement tools and data will increase the manufacturability of the third generation photovoltaics.
- A new generation of PV technologies with increased efficiency and performance time.

8. Nanomaterial Environmental Health and Safety (+10 Permanent Positions, +7 FTE, +$4,000,000)

Industry is increasingly finding that the unknown environmental, health, and safety (EHS) risks associated with nanomaterials[20] are a threat to innovation and competitiveness in this area.

- It is critical that potentially dangerous nanomaterials and products incorporating nanomaterials be identified 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 and products containing nanomaterials may 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 essential to assess and manage the EHS risks of nanomaterials and products containing nanomaterials.

Problem Magnitude and NIST Role:

Nanomaterials are essential to three of the Administration's Science and Technology Priorities for FY 2011: driving economic growth through commercial innovation, promoting innovative energy technologies, and helping Americans live longer, healthier lives. There are currently over 1,000 products that contain nanomaterials on the market produced by 485 companies[21] and valued at $166 billion[22]; the value of nano-enabled products is projected to climb to $2.6 trillion by 2014[23]. In the report *Nanotechnologies for Energy Markets*, nanomaterials are predicted to result in more efficient use of existing resources as well new energy supplies from solar and hydrogen based technologies.[24] Through its Alliance for Nanotechnology in Cancer[25], the National Cancer Institute is committed to developing more effective and less invasive nanoparticle-based methods for early detection, prevention, and treatment of cancer; several such treatments have advanced to Phase II clinical trials. Benefits of nanomaterials to these Priorities of the Administration may never be realized due to public fears of potential hazards to human health and the environment and reluctance of U.S. industry to invest in potentially harmful technologies. The problem is that *nanomaterials and products that incorporate nanomaterials*

[20] Nanoparticles and nanotubes are the two most pervasive forms of nanomaterials by both volume production and use in products.
[21] According to the Consumer Products Inventory maintained by the Woodrow Wilson International Center for Scholars, www.nanotechproject.org, August 25, 2009.
[22] *The Nanotechnology Opportunity Report (NOR) 2008, 3rd Edition*, Research and Markets, June 2008.
[23] *Taking Action on Nanotechnology's Value Chain*, Lux Research, October 2004.
[24] *Nanotechnologies for Energy Markets,* Research and Markets, February 2007.
[25] http://nano.cancer.gov/

pose unknown risks throughout all stages of their lifecycles to people and the environment. A science-based approach is needed to address this problem so that industry and regulatory agencies are able to assess and manage these risks during nanomaterial production and fabrication, distribution, storage, use, recycling, and disposal of products. The stakeholders in Nano-EHS efforts encompass both commercial and public entities/communities, including the Federal and non-Federal government agencies. All stakeholders, including regulatory agencies, and Congress must take measures to protect the health of people and the environment. Industry must innovate, remain competitive, ensure worker safety, and comply with regulations. The public must establish trust in nanotechnology to reap the benefits of nanomaterials to health and the economy.

The solution to the EHS problem is to *establish essential linkages between physico-chemical properties of nanomaterials such as size and shape, hazard effects of nanomaterials such as toxicity, and exposure effects such as release of nanomaterials from products*. These linkages are critical for science-based risk assessment and management, as articulated in the Nano Risk Framework[26] developed by DuPont and Environmental Defense and widely endorsed by U.S. industry. Establishing linkages first requires accurate measurements of key physico-chemical properties, exposure, and hazards. NIST's role in solving the Nano-EHS problem is three-fold: (1) develop and disseminate measurement technology -- reference material standards, documentary standards, transferable measurement methodologies and instruments, models, and reference data; (2) establish measurement science -- underlying physical principles that form the basis for novel measurements; and (3) coordinate and cooperate with other organizations, particularly industry and U.S. regulatory agencies, to establish the essential linkages. More specifically, NIST efforts will focus on physico-chemical properties and toxicity of nanomaterials, and release of nanomaterials from products.

NIST's critical role in Nano-EHS has been identified by varied stakeholders. The interagency Subcommittee on Nanoscale Science, Engineering and Technology has recognized research to measure the properties of nanomaterials as a key role for the Federal government. National Nanotechnology Initiative (NNI) reports[27] on Nano-EHS research needs and strategies identify NIST as the lead agency responsible for developing instrumentation, metrology, and analytical methods, one of the four areas essential for risk assessment and management of nanomaterials. In numerous NNI Nano-EHS Workshops[28] and other public meetings, industry and regulatory agencies have called out NIST's essential role in measurements of nanomaterial properties. Various private organizations such as the Woodrow Wilson International Center for Scholars have recognized NIST as the lead agency for developing measurement methods and standards.

This unique role for NIST in Nano-EHS builds on existing NIST interdisciplinary physical and chemical science expertise and world-class measurement facilities. For example, NIST is already engaged in collaborative efforts with the National Cancer Institute to address

[26] *NANO Risk Framework*, Environmental Defense-DuPont Nano Partnership, June 2007.
[27] National Nanotechnology Initiative Reports: *Environmental, Health, and Safety Research Needs for Engineered Nanoscale Materials,* September 2006. National Nanotechnology Initiative, *Strategy for Nanotechnology-Related Environmental, Health, and Safety Research,* February 2008.
[28] For example, *Nanomaterials and the Environment & Instrumentation, Metrology, and Analytical Methods,* October 2009 and *Nanomaterials and Human Health & Instrumentation, Metrology, and Analytical Methods,* November 2009.

measurement and standards needs for physical and chemical characterization of nanoparticles for cancer treatment. NIST is also building relevant expertise and measurement facilities in the area of toxicology. NIST 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 and technology.

Proposed NIST Technical Program:

With this initiative, NIST will expand its coordinated effort for leveraging nanotechnology expertise and resources across its laboratories and facilities to create and disseminate critical measurement solutions for determining key physico-chemical and toxicological properties of nanomaterials and release of nanomaterials throughout the full life cycles of key nanomaterials and products containing these nanomaterials. NIST will partner with industry and other Federal agencies and provide the measurement technologies and methodologies necessary to establish the linkages between physico-chemical properties and hazard and exposure effects that are essential for science-based risk assessment and management of nanomaterials and products. NIST will focus on a few key nanomaterials and nanomaterial-based products that are anticipated to have the greatest potential impact on the environment and human health. At this time, the key nanomaterials of greatest regulatory concern based on volume production, widespread use in products, and potential hazards are silver, titanium dioxide, and cerium oxide nanoparticles, carbon nanotubes, and clay-based nanocomposites.

Funding provided in FY 2009 for Nano-EHS efforts enabled NIST to develop the measurement infrastructure for quantitative, accurate determination of static physico-chemical properties, such as size, shape, and surface composition of key nanomaterials and release of nanomaterials from products, and to deliver critically needed measurement outputs -- reference material standards, documentary standards, transferable measurement methodologies and instruments, models, and reference data -- in these areas. The requested FY 2011 initiative funding will be used to develop the measurement infrastructure and deliver measurement outputs for quantitative, accurate determination of dynamic physico-chemical properties associated with transformation, transport, and fate of key nanomaterials and toxicological responses of humans and ecosystems to key nanomaterials. NIST will conduct its research in media relevant to hazard and exposure effects, primarily air, water, soil, sediment, and biological matrices. Specific activities funded by this initiative are discussed below.

Transformations of nanomaterials and products:

Nanomaterials and nanomaterials in products may undergo transformations -- changes in their properties -- due to interactions with their surroundings that can increase or decrease their hazardous effects. For example, silver nanoparticles in wound dressings may dissolve or absorb certain chemical species from blood and the resulting changes in surface chemistry may render the nanoparticles toxic in dose levels that would normally be benign. Clearly, measurements and standards for accurate determination of physico-chemical and toxicological properties to enable linkages between these properties are essential to assess and even predict risks associated with the behavior of nanomaterials in relevant media.

- **Measurement Science:**

  NIST will conduct studies of chemical, mechanical, optical, and electrical responses that will enable quantitative determination of the extent and rate of transformation processes, including agglomeration and aggregation, ionic dissolution, and chemically and biologically mediated electron transport (*e.g.*, oxidation or reduction to form coatings on the surfaces of nanomaterials). In concert, NIST will conduct studies to determine the mechanisms of toxicological responses resulting from these transformation processes.

- **Measurement Technology:**

  Reference materials: NIST will develop and release reference materials for qualifying or calibrating instruments used to measure changes in physico-chemical properties of key nanomaterials in relevant media, facilitate inter-laboratory studies, and benchmark studies of toxicity effects associated with transformation processes.

  Documentary standards: NIST will play a leadership role in developing documentary standards that enable consistent and reproducible measurements of changes in physico-chemical properties of key nanomaterials in relevant media. These standards will be developed by consensus within major international standards developing organizations, including the International Organization for Standardization (ISO), ASTM International, the National Fire Protection Association (NFPA), and the Consumer Products Safety Commission (CPSC). NIST will also work with standardization consensus groups, including the Organization for Economic Cooperation and Development (OECD), the Versailles Project on Advanced Materials and Standards (VAMAS), the International Alliance for Nano-EHS Harmonization (IANH),

  Measurement methodologies: NIST will develop measurement methodologies using commercial instruments for reproducible measurements of agglomeration, aggregation, and dissolution rates of nanomaterials in relevant media. These methodologies will be broadly transferred to industry, Federal regulatory agencies, and university centers of excellence to enable researchers in these organizations to perform their own measurements on specific nanomaterials.

  Models: NIST will develop atom-based models (*e.g.*, molecular dynamics and Monte Carlo) and continuum models (as phase field, mean-field approaches, and finite element models) to predict the rates and extent of agglomeration, aggregation, and dissolution of nanomaterials in relevant media over a broad range of conditions. In many cases, such models are required to interpret results of experiments. Model descriptions, codes, and instructions for use will be broadly available via the web.

Reference Data: NIST will generate, collect, and evaluate data on rate constants for reactions of nanomaterials with their surrounding media and with other nanomaterials. These data will be made available through NIST's Measurement Services Division.

Transport and fate of nanomaterials and products:

Nanomaterials and nanomaterial-based products will be transported or moved through various parts of an ecosystem or the human body during their full lifecycles as a result of macro- to nano-scale phenomena including diffusivity, dispersivity, and effusivity. Fate is defined by the conditions at which a nanomaterial no longer undergoes transformations or transport, *e.g.*, the equilibrium state (*e.g.*, size, shape, surface composition), concentration, and distribution of the nanomaterial. For example, a nanomaterial released into a lake may be transported by chemical diffusion, ingested by animals and organisms, absorbed by plants, and deposited onto sediment.

The toxicity of the nanomaterial to various species in the ecosystem will be determined by the equilibrium state, concentration, and distribution of the nanomaterial in each individual species.

- **Measurement Science:**

  NIST will conduct studies of diffusion and dispersion rates of nanomaterials in relevant media and products in conditions of storage, use, recycling, and disposal. NIST will also conduct studies of transport mechanisms that result in partitioning of nanomaterials between different types of matter in a system and persistence of the nanomaterial in each type of matter.

- **Measurement Technology:**

  Reference materials: NIST will develop and release reference materials for qualifying or calibrating instruments used to measure diffusion and dispersion rates, distributions, and persistence of key nanomaterials in relevant media and facilitate inter-laboratory studies of transport and fate.

  Documentary standards: NIST will play a leadership role in developing documentary standards that enable consistent and reproducible measurements of diffusion and dispersion rates of key nanomaterials in relevant media. These standards will be developed by ISO, ASTM International, OECD, and IANH.

  Measurement methodologies: NIST will develop measurement methodologies using commercial instruments for reproducible measurements of diffusion and dispersion rates, distributions, partitioning, and persistence of nanomaterials in relevant media. These methodologies will be broadly transferred to industry, Federal regulatory agencies, and university centers of excellence to enable researchers in these organizations to measure transport and assess fate of their own specific nanomaterials.

Models: NIST will develop atom-based models (*e.g.*, molecular dynamics and Monte Carlo) and continuum models (as phase field, mean-field approaches, and finite element models) that predict the structural and compositional "history" of a nanomaterial or nanomaterial-based product during its full lifecycle. Models will be essential to interpret results of diffusion, partitioning, and persistence experiments. Model descriptions, codes, and instructions for use will be broadly available via the web.

Reference Data: NIST will generate, collect, and evaluate data on diffusion and dispersion rate constants and concentrations of nanomaterials in relevant media. These data will be made available through NIST's Measurement Services Division.

Toxicity of nanomaterials:

Nanomaterials and nanomaterial-based products may illicit toxicological responses in ecosystems and humans that cause irreparable damage or death. Characterizing nanomaterial/biomolecule interactions is essential to quantitative assessment of toxicological responses.

- **Measurement Science:**

  NIST measurement science will develop the techniques necessary to support toxicological studies to determine the mechanisms leading to toxicological responses in humans and high-risk ecosystems due to interactions of key nanomaterials with various biomaterials. NIST will also conduct studies to identify the most critical properties and attributes of key nanomaterials that illicit toxicological responses in ecosystems and humans, and the extent to which specific properties and attributes are connected to toxicological responses.

- **Measurement Technology:**

  Reference materials: NIST will develop and release biomarkers and other indicators that can be used to develop standard methods or assays for testing toxicological responses to key nanomaterials and to facilitate inter-laboratory toxicological studies.

  Documentary standards: NIST will play a leadership role in developing documentary standards for genotoxicity and cytotoxicity measurements. These standards are developed by consensus within major international standards organizations, particularly ISO and ASTM International. NIST will also work with standardization consensus groups, particularly OECD and IANH.

  Measurement methodologies: NIST will develop strategies to reproducibly disperse nanomaterials in serum and other biological media. NIST will also develop readily transferable mechanism-based cellular assays and quantitative DNA assays. These assays will be broadly transferred to industry, Federal regulatory agencies, and university centers of excellence to enable researchers in these organizations to study toxicity of their own specific nanomaterials.

Instruments: NIST will develop advanced measurement tools for evaluating nanomaterial/biomolecule interactions. NIST will also develop high throughput instruments for rapid screening of nanomaterials for toxicological responses.

Linkages of physico-chemical properties and hazard and exposure effects:

NIST will coordinate and cooperate with other organizations to establish the essential linkages between physico-chemical properties, and hazard and exposure effects to enable science-based lifecycle risk assessment and risk management for key nanomaterials and products that incorporate nanomaterials. Other organizations include NNI Agencies, industry groups, university-based centers, National Metrology Institutes (NMIs), standards developing organizations (SDOs), and other standardization consensus groups. Specific collaborative activities with partners and stakeholders from these organizations include:

- Identify the key physico-chemical properties, hazard effects, and exposure effects for carbon nanotubes, silver and titanium dioxide nanoparticles, and clay-based nanocomposites.
- Form working groups for each of these nanomaterials and develop strategies and plans for establishing linkages.
- Implement plans and report results of linkages to regulatory industries and industry groups responsible for risk assessment and risk management of these nanomaterials.

Performance Measures: Outputs

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

Nanomaterial Environment Health and Safety	
Technical Area	**Outputs/(Targets)**
Transformations of Nanomaterials and Products in Relevant Media	**Reference Materials:** • Dispersions of stabilized nanosilver in groundwater and serum for interlaboratory testing. (FY 2012) • Test specimens of carbon nanotubes and titanium dioxide nanoparticles designed to degrade at controlled rates on exposure to specific media. (FY 2013) • Test specimens for assessing the Ultra Violet radiation damage in products containing clay-based nanocomposites. (FY 2012)
	Documentary Standards: • Draft international consensus standards on methods to assess the stability of carbon nanotubes. (FY 2013) • Draft international consensus standards on methods to measure the stability of nanocomposites in construction and transportation materials. (FY 2013) • Reports on international inter-laboratory studies conducted in appropriate organizations on methods to measure the stability of nanomaterials in common products such as silver nanoparticles in clothing, healthcare, and personal care products. (FY 2014)

Nanomaterial Environment Health and Safety	
Technical Area	**Outputs/(Targets)**
	Measurement Methodologies: • Transferable methods for measuring dispersion, agglomeration, and aggregation of titanium dioxide and silver nanoparticles and carbon nanotubes using commercial instruments. (FY 2012) • Transferable methods to measure dissolution rates of metal nanoparticles such as silver. (FY 2013) • Recommended practice guides and training videos on protocols for measuring dispersion of nanomaterials in media and products. (FY 2012)
	Models: • Atom-based and continuum models to interpret measurements of dissolution rates of silver nanoparticles. (FY 2012) • Atom-based and continuum models to interpret measurements of agglomeration and aggregation rates of carbon nanotubes and titanium dioxide nanoparticles. (FY 2013) • Models to predict the rates and extent of agglomeration, aggregation, and dissolution of key nanomaterials. (FY 2014)
	Reference Data: • Sets of evaluated data on reaction rate constants for oxidation of metal nanomaterials in air or water. (FY 2013) • Compilation of benchmark data on reaction rates of carbon nanotubes in various media. (FY 2014)
Transport and Fate of Nanomaterials and Products in Relevant Media	**Reference Materials:** • Test specimens of carbon nanotubes designed to disperse at controlled rates when released in an enclosed volume of air. (FY 2012) • Test specimens of silver nanoparticles designed to diffuse at controlled rates when released in liquid media. (FY 2014) • Test specimens with well-known distributions of several different sizes and types of nanomaterials in sediment or soil. (FY 2013)
	Documentary Standards: • Reports on international inter-laboratory studies conducted in appropriate organizations on methods to measure dispersion rates of key nanomaterials in air and liquid media. (FY 2012) • Draft international consensus standards on methods to measure diffusion and dispersion rates of key nanomaterials. (FY 2013) • Reports on international inter-laboratory studies conducted in appropriate organizations on partitioning of nanomaterials in relevant media, such as water, plants, and fish within an ecosystem. (FY 2014)

Nanomaterial Environment Health and Safety	
Technical Area	**Outputs/(Targets)**
	Measurement Methodologies: • Transferable methods to measure dispersion rates carbon nanotubes and titanium dioxide nanoparticles in air and water. (FY 2012) • Transferable methods to measure diffusion rates of nanomaterials in clay nanocomposite products. (FY 2012) • Recommended practice guide summarizing the uses and limitations of various methods for measuring the distribution of nanomaterials in relevant media. (FY 2013)
	Models: • Atom-based and continuum models to interpret measurements of diffusion and dispersion rates. (FY 2013) • Atom-based and continuum models to interpret the results of partitioning and persistence experiments. (FY 2014) • Models to predict the distribution of nanomaterials in relevant media during the full lifecycle of nanomaterials and nanomaterial-based products. (FY 2014)
	Reference Data: • Compilation of benchmark data on dispersion rates of key nanomaterials upon release in air, water, and biological matrices. (FY 2012) • Compilation of benchmark data on diffusion rates of key nanomaterials in soil, sediment, and clays. (FY 2013)
Toxicity of Nanomaterials	**Reference materials:** • Reference biomarkers and other indicators to enable inter-laboratory studies of genotoxic and cytotoxic responses of key nanomaterials. (FY 2012) • Reference biomarkers and other indicators for development of methods to determine mechanisms leading to toxic responses. (FY 2013) • Sets of data from basic panel cell toxicological studies on each NIST nanoparticle reference material for inclusion in the Report of Investigation document distributed with the material. (FY 2012)
	Documentary Standards: • Draft ISO guidance documents led by NIST on toxicological testing of nanomaterials, and sample preparation and dosimetry for toxicological testing. (FY 2013) • Draft international consensus standards for genotoxicity measurements for key nanomaterials. (FY 2014) • Draft international consensus standards for cytotoxicity measurements for key nanomaterials. (FY 2014)

Nanomaterial Environment Health and Safety	
Technical Area	**Outputs/(Targets)**
	Measurement Methodologies: • Transferable methods to reproducibly disperse nanomaterials in serum and other biological media. (FY 2012) • Transferable mechanism-based cellular assays and quantitative DNA assays. (FY 2013) • High throughput methods for rapid screening of toxicological response. (FY 2014)
	Instruments: • Advanced tools for evaluating nanomaterial/biomolecule interactions. (FY 2014) • High throughput instruments for rapid screening of nanomaterials for toxicological responses. (FY 2013)
Linkages Between Physico-Chemical Properties and Hazard and Exposure Effects	• Consensus compilations of key physico-chemical properties, hazard effects, and exposure effects for carbon nanotubes, silver and titanium dioxide nanoparticles, and clay-based nanocomposites. (FY 2012) • Coordinated strategies and plans for establishing linkages for these nanomaterials. (FY 2012) • Reports on results of linkage efforts disseminated to regulatory industries and industry groups responsible for risk assessment and risk management of these nanomaterials. (FY 2012)

Performance Measures: Outcomes

At the proposed funding level, NIST technical outputs will enable the following outcomes:

- Industry will be able to perform accurate lifecycle risk assessments key nanomaterials and products incorporating nanomaterials.
- Regulatory agencies will be able to perform accurate lifecycle risk assessments to people and the environment key nanomaterials and products incorporating nanomaterials.
- Regulatory agencies will have data to evaluate EHS effects of products incorporating 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, subject to appropriate controls that avoid valid EHS risks.

If successful, NIST will have established the essential measurement infrastructure and delivered the essential measurement outputs for quantitative, accurate determination of dynamic physico-chemical properties associated with transformation, transport, and fate of key nanomaterials and toxicological responses of humans and ecosystems to key nanomaterials. NIST's measurement and standards work will provide industry and regulatory agencies with a scientific basis for assessing and managing EHS risks of key nanomaterials and products. The ultimate positive impact on the economy and society will be to facilitate the rapid innovation and commercialization of new nanomaterial-based products and to ensure the safety of their widespread acceptance.

9. <u>Strategic and Emerging Research Initiatives (SERI) (+0 Permanent Positions, +0 FTE, +$2,000,000 including $200,000 transfer to the Working Capital Fund)</u>

<u>Problem Magnitude and NIST Role:</u>

The tremendous breadth of scientific and engineering activity conducted at NIST spans most scientific disciplines, such as chemistry, physics, or computer science. In order to address new and emerging scientific problems, modern research has become increasingly multidisciplinary in nature. The dynamic, multidisciplinary nature of developing critical national needs requires an increased level of responsiveness and flexibility for the Institute. As a result, this multidiscipline research requires budgetary flexibility that is not encumbered by strict adherence to specific laboratory disciplines.

<u>Proposed NIST Technical Program:</u>

The Strategic and Emerging Research Initiative (SERI) fund provides the NIST Director annual flexibility necessary to pull together research teams from across the Institute to address emerging and increasingly multidisciplinary research problems. In addition, the SERI fund provides the NIST Director with programmatic flexibility 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 activities 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.

<u>Performance Measures: Outputs</u>

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.

<u>Performance Measures: Outcomes</u>

- NIST will more rapidly introduce and execute efforts to satisfy national needs in measurement and standards.
- NIST will enable innovation through high-risk high-payoff research investments for developing new competencies.

10. NIST NRC Postdoctoral Research Associateships Program (+23 Permanent Positions, +17 FTE, + $3,400,000)

The requested increase of $3.4 million for NIST's Postdoctoral Research Associateships Program in Measurement Science, currently run by the NRC, advances the Administration's goals for Science, Technology, Engineering, and Mathematics (STEM) education. The NIST postdoctoral program provides opportunities for outstanding young scientists to gain training in measurement science, and is a critical part of ensuring that NIST has access to the top technical talent necessary to maintain leading research programs that address critical national priorities. The request will increase the number of postdoctoral research opportunities at NIST.

This new initiative supports the Postdoctoral Research Associateships Program to:

- Ensure that NIST has an adequate supply of scientists and engineers who are skilled in the latest university research, which can help NIST respond more quickly to the measurement and technology needs of industry.
- Expand the pool of highly-skilled scientists and engineers from which NIST can hire future technical staff.
- Enhance the transfer of advanced technology between universities and NIST.

The NIST NRC Postdoctoral Research Associateships program provides two-year term appointments for outstanding scientists and engineers chosen through a national competition administered by the NRC of the National Academy of Sciences. The program has not had increases in its base budget in recent years, while program costs from salary, benefits relocation and contracts continue to rise resulting in a steady decrease in the number of postdoctoral associates that can be hired through the program. An increase in the support for the Postdoctoral Research Associateships Programs will return the level of postdoctoral associate appointments brought on each year to FY 2006 levels and help keep the program at a healthy, sustainable level. The program supports the major Department of Commerce (DoC) mission of keeping America competitive with cutting-edge science and technology and a premier information base.

Problem Magnitude and NIST Role:

NIST's mission to support U.S. industry with measurements, standards, and technology depends on a constant infusion of new ideas and expertise to address the rapidly advancing needs of a technology-driven economy. Skilled and motivated people are the most effective source of technology and knowledge transfer. The highly competitive NIST NRC postdoctoral program ensures a continuing infusion of postdoctoral associates who bring to NIST the benefits of the latest academic research. However, NIST competes with the private sector to attract and retain the most talented scientists and engineers and usually cannot match industry salaries inflated by labor shortages in specific fields. The NIST NRC postdoctoral program is highly effective at attracting outstanding scientists and engineers to consider a NIST career by providing an exciting and rewarding research environment.

The NIST NRC postdoctoral associates, skilled in the latest university research, participate in measurement research that advances NIST's mission, exposes permanent NIST staff to new ideas and skills developed at U.S. universities, and help NIST respond more quickly and effectively to new industry measurement and technology needs. Recognizing the benefits of this synergism, Congress authorized a change in the program to allow NIST to hire up to 120 new postdoctoral associates per year. Previously, the maximum limit was 60 new associates per year. This change was accomplished as part of the NIST reauthorization in 2007, H.R. 2272 and amended paragraph 3015, section 19 of 15 U.S.C. 278g-2.

The authorized increase in the maximum number of postdoctoral associates was not accompanied by an increase in the budget for the program. In fact, the cost of centrally funded postdoctoral associates has increased much faster than the small increases in base funding over the last ten years. Contributing to the rising costs are: 1) an increase in the cost of the contract to NRC for administering the program, due in part to a substantial increase in applications; 2) essential increases in salary for incoming postdoctoral associates to remain competitive with similar programs; and 3) accompanying increases in benefits (e.g. health benefits, relocation costs).

The program is a highly cost-effective recruitment tool for NIST. The NIST NRC postdoctoral program is widely known and respected throughout U.S. universities and effectively advertises NIST research opportunities. The comprehensive evaluation of prospective research associates is conducted by technical experts from across the Nation under NRC administration, ensuring selection of the best quality candidates. In recent years, about one third of the NIST NRC Postdoctoral Associates have accepted continued positions at NIST following their postdoctoral tenure, accounting for a significant fraction of NIST technical hires each year. Expansion of the postdoctoral program is more than likely to increase the number of conversions to permanent staff.

Proposed NIST Technical Program:

The NIST NRC Postdoctoral Research Associateships Program provides two-year excepted term appointments for outstanding scientists and engineers chosen through a national competition administered by the NRC. The appointments allow the Nation's best young scientists, mathematicians, and engineers to participate in state-of-the-art, mission-oriented research in association with senior NIST technical staff and using the advanced research facilities at NIST.

In recent years, NIST has been maintaining the program at approximately 30-35 new postdoctoral associates per year, down from the target of 40-45 associates per year. The requested increase of $3.4 million will enable the program to offer an additional 23 positions per year, and return the program to a more appropriate level of awardee/applicant ratio, which had dropped to less than 15 percent, from a previous level of 30-40 percent. The initiative will also support the continued annual salary increases, which follow the cost of living guidelines, and allow the program to remain competitive with other NRC postdoctoral programs, and other associated cost increases.

Additional funding will help to restore the program to its previous hiring levels, and would also give NIST greater flexibility to rapidly respond to new industry measurement needs. Each year, a large number of new graduates from a wide variety of technical backgrounds apply for the

NIST/NRC research associateships. Sponsoring a postdoctoral associate can be a highly effective means to broaden NIST skills into new areas through the expertise and new ideas brought to NIST by the postdoctoral associate. The limited term of the associates eases the burden of sequential hiring and dismissing of staff with specific expertise as program focus changes.

Performance Measures: Outputs

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

NIST NRC Postdoctoral Associateships Program	
Technical Area	**Outputs/(Targets)**
NIST/NRC Postdoctoral Associateships Program	• 23 additional new postdoctoral associates hired annually. (beginning in FY 2011) • 23 additional technical papers published annually by the additional postdoctoral associates. (beginning in FY 2012) • Conversion of 5-10 additional postdoctoral associates annually to NIST appointments following completion of postdoctoral tenure. (beginning in FY 2013)

Performance Measures: Outcomes

Additional funding for the Postdoctoral Research Associateship Program will benefit NIST and its customers by:

- Increasing technology transfer to NIST from universities;

  The NIST/NRC postdoctoral program is an important part of NIST's efforts to support industry through advancing measurements, standards, and technology and represents a highly cost-effective means of technology transfer to and from NIST of the latest measurement science and technology. Incoming associates bring to NIST the most recent advances in university research while actively contributing to NIST projects such as:

  - Investigations into the physics and applications of laser-cooled atoms directly coupled to a micro-mechanical resonator.
  - Development of high resolution transfer measurements for computational fire models.
  - Investigating high-temperature oxidation chemistry of hydrocarbon fuels.
  - Investigations of trace detection of explosives.
  - Developing magnetic nanoparticles for tumor MRI contrast enhancement.
  - Development of a system for automated ballistics measurement systems.
  - High-frequency characterization of novel thin-film materials.
  - Investigation of the use of light-atom coupling in a Bose-Einstein condensate of charge-neutral atoms.

- Increasing technology transfer from NIST to industry, academia, and other government agencies, and contributing to the employment pool of highly qualified scientists and engineers for these sectors;

  Outgoing postdoctoral associates take with them a wealth of expertise and knowledge about NIST science and technology to their new positions, usually in industry, academia, or other government laboratories, disseminating the unique perspective of NIST to broader areas of the economy. Expansion of the program will increase the breadth of technology transfer to and from NIST, and contribute to the pool of the highly qualified technical scientists and engineers available for STEM-related positions.

- Expanding the pool of the most highly qualified technical scientists and engineers for permanent NIST staff positions;

  The program is a highly cost-effective recruitment tool for NIST. The NIST NRC postdoctoral program is widely known and respected throughout U.S. universities and effectively advertises NIST opportunities. The comprehensive evaluation of prospective research associates is conducted by technical experts from across the Nation under NRC administration, ensuring selection of the best quality candidates at a minimal cost to NIST. In recent years, about one third of the NRC associates have accepted permanent positions at NIST following their postdoctoral tenure, accounting for a significant fraction of NIST technical hires. Expansion of the postdoctoral program is likely to increase the number of conversions of highly skilled postdoctoral associates to permanent staff.

- Enhancing the flexibility of NIST to respond to rapidly changing industry needs; and

  Additional funding for the program will give NIST greater flexibility to rapidly respond to new industry measurement needs. Each year, a large number of new graduates from a wide variety of technical backgrounds apply for the NIST NRC research associateships. Sponsoring a postdoctoral associate can be a highly effective means to broaden NIST skills into new areas through the expertise and new ideas brought to NIST by the associate. The naturally limited term of the associates eases the burden of sequential hiring and dismissing of staff with specific expertise as program focus changes.

- Enhancing opportunities for employment diversity.

  Additional funding for the NIST NRC postdoctoral program would also provide more opportunities to increase the diversity of the NIST scientific and technical staff. Industry and universities compete intensely to hire top young scientist from the limited pool of about 500 new minority Ph.D. recipients in technical fields each year. A larger NIST NRC postdoctoral program, coupled with increased NIST efforts to encourage and mentor minority applicants, could help increase the number of minority technical hires at NIST. The additional training and experience the associates receive at NIST is also transferred to industry by associates leaving NIST, thus helping NIST fulfill its mission to support industry.

Department of Commerce
National Institute of Standards and Technology
Scientific and Technical Research and Services
PROGRAM CHANGE PERSONNEL DETAIL

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

Title	Grade	Number	Annual Salary	Total Salaries
Biophysicist	ZP V	1	123,247	123,247
Computer engineer	ZP V	1	123,247	123,247
Computer scientist	ZP V	11	123,247	1,355,713
Director	ZP V	1	123,247	123,247
Electrical engineer	ZP V	3	123,247	369,740
Electronics engineer	ZP V	3	123,247	369,740
Industrial engineer	ZP V	1	123,247	123,247
Mass spectrometrist	ZP V	1	123,247	123,247
Mechanical engineer	ZP V	3	123,247	369,740
Operations research analyst	ZP V	2	123,247	246,493
Physical scientist	ZP V	1	123,247	123,247
Physicist	ZP V	3	123,247	369,740
Project manager	ZP V	1	123,247	123,247
Research chemist	ZP V	2	123,247	246,493
Social scientist	ZP V	2	123,247	246,493
Supervisory computer scientist	ZP V	1	123,247	123,247
Supervisory industrial engineer	ZP V	1	123,247	123,247
Supervisory mechanical engineer	ZP V	1	123,247	123,247
Analytical chemist	ZP IV	1	104,775	104,775
Biomedical engineer	ZP IV	2	104,775	209,551
Chemist	ZP IV	2	104,775	209,551
Computer scientist	ZP IV	9	104,775	942,979
Domain expert - earthquake	ZP IV	1	104,775	104,775
Domain expert - fire	ZP IV	1	104,775	104,775
Domain expert - structures	ZP IV	1	104,775	104,775
Domain expert - wind	ZP IV	1	104,775	104,775
Economist	ZP IV	2	104,775	209,551
Electrical engineer	ZP IV	2	104,775	209,551
Electronics engineer	ZP IV	9	104,775	942,979
Health specialist	ZP IV	1	104,775	104,775

Industrial engineer	ZP IV	1	104,775	104,775
Information technology specialist	ZP IV	3	104,775	314,326
IT specialist	ZP IV	1	104,775	104,775
Lead database architect	ZP IV	1	104,775	104,775
Materials research engineer	ZP IV	2	104,775	209,551
Materials scientist	ZP IV	3	104,775	314,326
Mathematician	ZP IV	2	104,775	209,551
Mechanical engineer	ZP IV	3	104,775	314,326
Operations manager	ZP IV	1	104,775	104,775
Physical scientist	ZP IV	4	104,775	419,102
Physicist	ZP IV	8	104,775	838,203
Protein spectrometrist	ZP IV	1	104,775	104,775
Social scientist	ZP IV	1	104,775	104,775
Analytical chemist	ZP III	1	74,562	74,562
Analytical mass spectrometrist	ZP III	1	74,562	74,562
Applied geneticist	ZP III	1	74,562	74,562
Assay biologist	ZP III	1	74,562	74,562
Bioanalytical chemist	ZP III	1	74,562	74,562
Bioinfomaticist	ZP III	2	74,562	149,124
Biomedical engineer	ZP III	2	74,562	149,124
Bioprocess engineer	ZP III	1	74,562	74,562
Cell biologist	ZP III	1	74,562	74,562
Chemist	ZP III	6	74,562	447,372
Computer scientist	ZP III	6	74,562	447,372
Electrical engineer	ZP III	8	74,562	596,496
Electronics engineer	ZP III	3	74,562	223,686
General engineer	ZP III	2	74,562	149,124
Immunologist	ZP III	2	74,562	149,124
Information specialist	ZP III	1	74,562	74,562
Information technology specialist	ZP III	5	74,562	372,810
Materials engineer	ZP III	5	74,562	372,810
Materials scientist	ZP III	1	74,562	74,562
Mathematician	ZP III	2	74,562	149,124
Mechanical engineer	ZP III	2	74,562	149,124
Molecular biologist	ZP III	1	74,562	74,562
Neutron biophysicist	ZP III	1	74,562	74,562
Physical scientist	ZP III	4	74,562	298,248
Physicist	ZP III	11	74,562	820,182
Program assistant	ZA III	1	74,562	74,562
Protein biochemist	ZP III	1	74,562	74,562
Research chemist	ZP III	2	74,562	149,124
Technician	ZT IV	2	74,562	149,124
Electronics technician	ZT III	3	56,622	169,867
Technician	ZT III	3	56,622	169,867

Administrative/technical support	ZA II	19	51,416	976,907
Secretary	ZS III	1	37,826	37,826
Subtotal		205		18,503,209
Less lapse	25 %	(53)		(4,625,802)
Total full-time permanent (FTE)		152		13,877,407
2011 Pay Adjustment (1.4%)				194,283
Total				14,071,690

Personnel Data				
Full-Time Equivalent Employment:				
Full-time permanent		152		
Authorized Positions:				
Full-time permanent		205		

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		2011 Increase/ (Decrease) Obligations
11	Personnel compensation	
11.1	Full-time permanent	14,072
11.9	Total personnel compensation	14,072
12.1	Civilian personnel benefits	3,861
21	Travel and transportation of persons	1,756
22	Transportation of things	372
23.3	Communications, utilities and miscellaneous charges	4,424
24	Printing and reproduction	137
25.1	Advisory and assistance services	0
25.2	Other services	4,917
25.3	Purchases of goods and services from Government accounts	4,747
25.5	Research and development contracts	10,135
25.7	Operation and maintenance of equipment	971
26	Supplies and materials	3,654
31	Equipment	4,574
32	Land and structures	0
41	Grants, subsidies and contributions	12,480
99	Direct obligations	66,100
	Transfer to NIST Working Capital Fund	3,300
	Total increase requested	69,400

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 2009 Actual	FY 2010 Estimate	FY 2011 Estimate
Department of Defense			
Air Force	$7,920	$10,257	$8,725
Army	3,532	3,488	2,051
Navy	1,382	1,764	1,315
Other	12,889	9,292	6,235
Subtotal, Department of Defense	25,723	24,801	18,326
Department of Agriculture	212	736	414
Department of Commerce	13,721	15,002	15,170
Department of Energy	8,214	8,598	7,508
Dept. of Health & Human Services	7,368	4,545	4,597
Dept. of Homeland Security	28,826	33,007	22,234
Department of the Interior	93	15	16
Department of Justice	12,314	16,450	13,623
Department of State	37	0	0
Department of Transportation	852	245	60
Department of the Treasury	48	40	20
Department of Veterans Affairs	165	165	165
Environmental Protection Agency	349	485	543
General Services Administration	1,052	452	0
National Aeronautics & Space Admin.	3,867	3,741	3,800
National Science Foundation	5,040	4,099	4,080
Nuclear Regulatory Commission	960	405	175
Other	6,362	6,686	5,327
Subtotal, Federal Agencies	115,203	119,472	96,058
Calibrations & Testing	8,905	8,391	8,579
Technical & Advisory Services	25,515	26,759	24,738
Standard Reference Materials	12,369	12,663	13,165
Subtotal, Other Reimbursables	46,789	47,813	46,482
Total, Reimbursable Program	161,992	167,285	142,540
Equipment Transfers	2,100	2,250	2,900
SRM Transfers	0	0	400
Subtotal, WCF transfer	2,100	2,250	3,300
Equipment Investments	14,202	26,466	24,035
IE Amortization	(20,703)	(27,155)	(24,035)
Excess Amortizations over Equipment Investments	4,401	0	0
WCF Operating Adjustments	3,089	0	0
Total, WCF Investments	989	(689)	0
Total, Reimbursable Program and WCF Investments	165,081	168,846	145,840

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

		2009 Actual		2010 Currently Available		2011 Base		2011 Estimate		Increase/ (Decrease) Over 2011 Base	
Line Item		Personnel	Amount	Personnel	Amount	Personnel	Amount	Personnel	Amount	Personnel	Amount
Baldrige national quality program	Pos./Approp	48	$9,440	48	$9,627	48	$9,854	48	$9,854	0	0
	FTE/Obl.	47	9,448	52	9,668	52	9,869	52	9,869	0	0

Exhibit 12

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 2011 base program operating objectives for the Baldrige National Quality Program include the following:

- assess the impact of the changes made to the 2010-2011 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 2009 Actual	FY 2010 Estimate	FY 2011 Estimate
Technical & Advisory Services	$3,536	$1,700	$2,200
Total, Reimbursable Program	3,536	1,700	2,200
Equipment Investments	11	13	10
IE Amortization	(14)	(13)	(10)
Excess Amortizations over Equipment Investments	3	0	0
Total, Reimbursable Program and WCF Investments	3,536	1,700	2,200

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

		2009 Actual		2010 Currently Available		2011 Base		2011 Estimate		Increase/ (Decrease) Over 2011 Base	
Line Item		Personnel	Amount	Personnel	Amount	Personnel	Amount	Personnel	Amount	Personnel	Amount
Computer support	Pos./Approp	5	$14,981	5	$6,149	5	$6,357	5	$6,357	0	0
	FTE/Obl.	4	13,874	4	7,690	4	6,393	4	6,393	0	0
Business systems	Pos./Approp	34	10,470	34	10,628	34	10,814	34	10,814	0	0
	FTE/Obl.	32	10,512	34	10,863	34	10,872	34	10,872	0	0
Total	Pos./Approp	39	25,451	39	16,777	39	17,171	39	17,171	0	0
	FTE/Obl.	36	24,386	38	18,553	38	17,265	38	17,265	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 enabling NIST's work in measurement sciences, standards, and innovations that drive technological change.

Base Program

The NIST central IT support for NIST's technical programs provides secure, centrally-managed IT infrastructure resources supporting 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 also 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; Office of Management and Budget; Government Accountability Office; Department of Treasury; General Services Administration; and Congress.

1) Computer Support - The scope of the program includes: securely deploying and managing computing, software, and networking resources as well as distributed, redundant storage for NIST data; management of the central computing facilities to meet Federal IT security requirements and the specialized requirements of the IT equipment located therein.

These resources enable NIST laboratories and programs to perform mission-specific needs, dissemination of NIST results to the public, and collaborations with NIST partners.

The FY 2011 computer support base program operating objectives include the following:

- manage the IT infrastructure including computing systems, software, data storage, networking, and security capabilities to support all NIST programs, and

- optimize the portfolio of computing platforms, data storage, backup storage, network interconnects, system security mechanisms, and software components to meet the unique requirements of NIST users and programs.

2) 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 2011 business systems base program operating objectives 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 2009 Actual	FY 2010 Estimate	FY 2011 Estimate
Department of Commerce	$570	$1,788	$1,575
General Services Administration	16	23	19
Subtotal, Federal Agencies	586	1,811	1,594
Total, Reimbursable Program	586	1,811	1,594
Subtotal, WCF transfer	0	0	0
Equipment Investments	407	4,731	4,700
IE Amortization	(3,948)	(4,854)	(4,700)
Excess Amortizations over Equipment Investments	3,541	0	0
Total, WCF Investments	0	(123)	0
Total, Reimbursable Program and WCF Investments	586	1,688	1,594

Exhibit 16

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	2009 Actual	2010 Currently Available	2011 Base	2011 Estimate	Increase/ (Decrease) Over 2011 Base
11	Personnel compensation					
11.1	Full-time permanent	$177,208	$199,600	$205,114	$219,186	14,072
11.3	Other than full-time permanent	16,347	22,953	16,511	16,511	0
11.5	Other personnel compensation	6,595	6,595	6,595	6,595	0
11.9	Total personnel compensation	200,150	229,148	228,220	242,292	14,072
12.1	Civilian personnel benefits	53,086	58,605	63,075	66,937	3,862
13	Benefits for former personnel	21	21	21	21	0
21	Travel and transportation of persons	9,731	10,471	10,746	12,502	1,756
22	Transportation of things	1,052	1,146	1,274	1,646	372
23.1	Rental payments to GSA	26	36	37	37	0
23.2	Rental payments to others	1,122	967	988	988	0
23.3	Communications, utilities, and miscellaneous charges	22,385	24,948	25,664	30,087	4,423
24	Printing and reproduction	360	412	415	552	137
25.1	Advisory and assistance services	4,375	3,245	1,667	1,667	0
25.2	Other services	63,578	59,289	27,753	35,920	8,167
25.3	Purchases of goods and services from Government account	20,677	22,905	24,391	29,138	$4,747
25.5	Research and development contracts	9,761	15,887	5,632	15,767	10,135
25.7	Operation and maintenance of equipment	12,445	10,138	11,563	12,534	971
26	Supplies and materials	23,418	22,206	23,995	27,649	3,654
31	Equipment	70,154	143,226	48,152	52,726	4,574
32	Land and structures	0	350	350	350	0
41	Grants, subsidies, and contributions	41,847	107,657	42,157	54,637	12,480
99	Total Obligations	534,204	710,657	516,100	585,450	69,350

	Object Class	2009 Actual	2010 Currently Available	2011 Base	2011 Estimate	Increase/ (Decrease) Over 2011 Base
99	Total Obligations	534,204	710,657	516,100	585,450	69,350
	Less Prior Year Recoveries	(3,904)	(1,000)	(1,000)	(1,000)	0
	Less Prior Year Refunds	(29)				
	Less Prior Year Unobligated Balance	(6,781)	(191,907)	0	0	0
	Plus Unobligated Balance, End of Year	191,907	0			
	Plus Expired Balance from EAC Transfer	3				
	Total Budget Authority	715,400	517,750	515,100	584,450	69,350
	Unobligated Balance Rescission					
	Transfer to NIST Working Capital Fund	2,100	2,250	0	3,300	3,300
	Transfer from Election Assistance Commission	(4,000)	(3,500)	0	(3,250)	(3,250)
	Transfer from Community Oriented Policing Services, DoJ	(1,500)	(1,500)	0	0	0
	Transfer from Office of the National Coordinator for Health Information Technology, HHS/ARRA	(20,000)	0	0	0	0
	Appropriation	692,000	515,000	515,100	584,500	69,400

Personnel Data

	2009 Actual	2010 Currently Available	2011 Base	2011 Estimate	Increase/ (Decrease) Over 2011 Base
Full-time equivalent employment:					
Full-time permanent	1,710	1,939	1,929	2,081	152
Other than full-time permanent	243	243	243	243	0
Total	1,953	2,182	2,172	2,324	152
Authorized Positions:					
Full-time permanent	1,961	2,065	2,065	2,270	205
Other than full-time permanent	52	52	52	52	0
Total	2,013	2,117	2,117	2,322	205

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	2011 Adjustments to Base	2011 Base	2011 Estimate	Increase/ (Decrease) Over 2011 Base
11 Personnel compensation				
11.1 Full-time permanent				
Executive level	$2	$151	$151	0
Senior executive service	55	3,635	3,635	0
Career path	2,818	191,501	205,573	14,072
Wage board	88	5,792	5,792	0
Scientific & professional (P.L. 80-313)	61	4,035	4,035	0
Subtotal	3,024	205,114	219,186	14,072
11.3 Other than full-time permanent				
Career path	250	16,442	16,442	0
Wage board	0	47	47	0
Scientific & professional (P.L. 80-313)	0	0	0	0
Experts & consultants	0	22	22	0
	0	0	0	0
Subtotal	250	16,511	16,511	0
11.5 Other personnel compensation				
Overtime	0	1,285	1,285	0
SES performance awards	0	243	243	0
Cash awards	0	4,744	4,744	0
Other	0	323	323	0
Subtotal	0	6,595	6,595	0
11.9 Total personnel compensation	3,274	228,220	242,292	14,072

	Object Class	2011 Adjustments to Base	2011 Base	2011 Estimate	Increase/ (Decrease) Over 2011 Base
12.1	Civilian personnel benefits				
	Civil service retirement	(393)	2,101	2,101	0
	Federal employees' retirement	1,953	22,036	23,682	1,646
	Thrift savings plan	393	7,991	8,272	281
	Federal Insurance Contribution Act	497	13,945	15,022	1,077
	Health insurance	960	14,145	14,982	837
	Life insurance	7	336	357	21
	Employees' Compensation Fund	42	605	605	0
	Other	0	1,916	1,916	0
	Subtotal	3,459	63,075	66,937	3,862
13	Benefits for former personnel				
	Severance pay	0	0	0	0
	Unemployment compensation	0	21	21	0
	Other	0	0	0	0
	Subtotal	0	21	21	0
21	Travel and transportation of persons				
	Common carrier	0	3,554	4,205	651
	Mileage	(1)	9	11	2
	Per diem/actual	184	5,152	5,972	820
	Other	0	2,031	2,314	283
	Subtotal	183	10,746	12,502	1,756
22	Transportation of things	10	1,274	1,646	372
23.1	Rental payments to GSA	1	37	37	0
23.2	Rental payments to others	8	988	988	0

Object Class	2011 Adjustments to Base	2011 Base	2011 Estimate	Increase/ (Decrease) Over 2011 Base
23.3 Communications, utilities, and miscellaneous charges				
Rental of ADP equipment	0	4	11	7
Rental of office copying equipment	1	84	97	13
Other equipment rental	1	144	175	31
Federal telecommunications system	0	365	465	100
Other telecommunications services	15	1,838	2,165	327
Postal Service by USPS	2	39	42	3
Utilities:				
Electric	214	14,565	16,976	2,411
HCHB Electric	0	3	3	0
Gas	471	7,140	8,433	1,293
Water/Sewer	12	1,480	1,718	238
HCHB Steam	0	2	2	0
Subtotal	716	25,664	30,087	4,423
24 Printing and reproduction				
Publications	1	182	241	59
Other	2	233	311	78
Subtotal	3	415	552	137
25.1 Advisory and assistance services				
Management & professional support services	9	771	771	0
Studies, analyses, & evaluation	9	(1)	(1)	0
Engineering & technical services	8	897	897	0
Subtotal	26	1,667	1,667	0
25.2 Other services				
Training	21	2,606	3,070	464
ADP Services	5	665	747	82
Other non-government contracts	1,313	24,482	32,103	7,621
Subtotal	1,339	27,753	35,920	8,167

	Object Class	2011 Adjustments to Base	2011 Base	2011 Estimate	Increase/ (Decrease) Over 2011 Base
25.3	Purchases of goods and services from Government accounts				
	Payments to DM, WCF	1,339	7,656	7,656	0
	[Commerce Business System (shared)]	[0]	[1,372]	[1,372]	[0]
	Office of Personnel Management	3	405	405	0
	Other Federal agencies:				
	Department of Commerce	33	4,154	7,280	3,126
	Reactor Operations	25	3,211	3,211	$0
	Other	75	8,965	10,586	1,621
	Subtotal	1,475	24,391	29,138	4,747
25.5	Research and development contracts	45	5,632	15,767	10,135
25.7	Operation and maintenance of equipment	92	11,563	12,534	971
26	Supplies and materials				
	Office & laboratory supplies	167	21,908	25,562	3,654
	Scientific publications & journals	114	1,629	1,629	0
	Fuel oil	1	142	142	0
	Helium	316	316	316	0
	Subtotal	598	23,995	27,649	3,654
31	Equipment				
	Office machines and other equipment	135	16,993	20,355	3,362
	ADP equipment	78	9,855	11,067	1,212
	Equipment amortization	158	21,304	21,304	0
	Subtotal	371	48,152	52,726	4,574
32	Land and structures	0	350	350	0
41	Grants, subsidies, and contributions	(10,500)	42,157	54,637	12,480
99	Total Obligations	1,100	516,100	585,450	69,350

Object Class	2011 Adjustments to Base	2011 Base	2011 Estimate	Increase/ (Decrease) Over 2011 Base
Less Prior Year Recoveries	(1,000)	(1,000)	(1,000)	0
Total Budget Authority	100	515,100	584,450	69,350
Transfer to NIST Working Capital Fund	0	0	3,300	3,300
Transfer from Election Assistance Commission	0	0	(3,250)	(3,250)
Appropriation	100	515,100	584,500	69,400

Department of Commerce
National Institute of Standards and Technology
Scientific and Technical Research and Services
ACTIVITY/SUBACTIVITY CHANGE CROSSWALK
Part 1 - 2010 Structure [1/]
(Dollar amounts in thousands)

Activity/Subactivity	2011 Direct Obligations	Proposed Changes
National measurement and standards laboratories		
National measurement and standards laboratories	$522,853	
Innovations in measurement science		
Innovations in measurement science	20,601	Merge into National Measurement and Standards Laboratories
Next generation measurements training		
Postdoctoral research associates program	14,862	Merge into National Measurement and Standards Laboratories
Baldrige national quality program		
Baldrige national quality program	9,869	
Corporate services		
Corporate services	17,265	
Total STRS direct obligations	585,450	

[1/] Budget Structure for FY 2010 was intended to be only three activities: National Measurement and Standards Laboratories, Baldrige National Quality Program, and Corporate Services, but the proposal was not approved in time for the President's submission. The FY 2011 budget shows the approved budget structure for FY 2010 and forward.

Exhibit 19

Department of Commerce
National Institute of Standards and Technology
Scientific and Technical Research and Services
ACTIVITY/SUBACTIVITY CHANGE CROSSWALK
Part 2 - 2011 Structure
(Dollar amounts in thousands)

Activity/Subactivity	2007	2008	2009 [1/]	2010 [2/]	2011
National measurement and standards laboratories					
National measurement and standards laboratories	414,393	424,431	500,370	682,436	558,316
Baldrige national quality program					
Baldrige national quality program	7,835	8,402	9,448	9,668	9,869
Corporate services					
Corporate services	18,586	17,202	24,386	18,553	17,265
Total STRS Direct Obligations	440,814	450,035	534,204	710,657	585,450

[1/] FY 2009 direct obligations include $52,745K of American Recovery and Reinvestment Act of 2009 (P.L. 111-5).

[2/] FY 2010 direct obligations include $187,255K from carryover of 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. $515,000,000, 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. 111-117 Consolidated Appropriations Act, 2010.

    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.

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, and makes available by reimbursable agreement $2,230,186 for a service level agreement with the National Telecommunications and Information Administration. 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.

Exhibit 34

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 2009 Actual	FY 2010 Estimate	FY 2011 Estimate
Management and professional support services	$1,867	$1,072	$771
Studies, analyses, and evaluations	1,708	1,150	0
Engineering and technical services	944	1,022	898
Total	4,519	3,244	1,669

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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Industrial
Technology Services

Exhibit 5

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
2010 Currently Available	148	153	$194,600	$235,943	$194,600
less: Unobligated balance from prior year	0	0	0	(37,543)	0
2011 Adjustments to base:					
plus: Restoration of 2010 deobligation offset	0	0	3,800	0	3,800
plus: Uncontrollable cost changes	0	1	363	363	363
less: Estimated recoveries 2011	0	0	(3,800)	0	(3,800)
2011 Base Request	148	154	194,963	198,763	194,963
plus: 2011 Program changes	0	0	14,637	14,637	14,637
2011 Estimate	148	154	209,600	213,400	209,600

		2009 Actual		2010 Currently Available		2011 Base		2011 Estimate		Increase/ (Decrease) Over 2011 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	73	$65,000	78	$69,900	78	$69,900	78	$79,900	0	$10,000
	FTE/Obl.	72	50,162	80	110,645	80	73,700	80	83,700	0	10,000
Hollings manufacturing extension partnership											
Hollings manufacturing extension partnership	Pos./Approp	64	110,000	70	124,700	70	125,063	70	129,700	0	4,637
	FTE/Obl.	70	111,037	73	125,298	74	125,063	74	129,700	0	4,637
TOTALS	Pos./Approp	137	175,000	148	194,600	148	194,963	148	209,600	0	14,637
	FTE/Obl.	142	161,199	153	235,943	154	198,763	154	213,400	0	14,637

	2009 Actual		2010 Currently Available		2011 Base		2011 Estimate		Increase/ (Decrease) Over 2011 Base	
Comparison by activity/subactivity:	Per-sonnel	Amount	Per-sonnel	Amount	Per-sonnel	Amount	Per-sonnel	Amount	Per-sonnel	Amount
Adjustments for:										
Recoveries		(6,920)		(3,800)		(3,800)		(3,800)		0
Refunds		(601)		0		0		0		0
Unobligated balance, start of year		(21,221)		(37,543)		0		0		0
Unobligated balance, end of year		37,543		0		0		0		0
Budget Authority		170,000		194,600		194,963		209,600		14,637
Unobligated balance rescission		5,000		0		0		0		0
Financing from transfers:										
Transfers to other accounts (+)		0		0		0		0		0
Appropriation		175,000		194,600		194,963		209,600		14,637

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

	Perm. Pos.	FTE	Amount
Adjustments:			
Restoration of FY 2010 deobligation offset	...	...	$3,800
Financing:			
Recoveries of prior year deobligations	...	...	(3,800)
Other Changes:			
Annualization of 2010 pay raise	...	...	85
2011 Pay increase and related costs	...	...	194
Annualization of positions financed in FY 2010	...	1	0
Personnel Benefits:			
Civil Service Retirement System (CSRS)	...	...	(30)
Federal Employees' Retirement System (FERS)	...	...	114
Thrift Savings Plan (TSP)	...	...	18
Federal Insurance Contribution Act (FICA) - OASDI	...	...	24
Health insurance	...	...	64
Employees' Compensation Fund	...	...	4
Travel and transportation of persons:			
Per diem	...	...	16
Communications, Utilities, and Miscellaneous			
Electricity rate increase	...	...	16
Natural gas rate increase	...	...	64
General pricing level adjustment:			
Rental payments to others	...	...	1
Communications, utilities, and miscellaneous charges	...	...	2
Printing	...	...	1
Other services	...	...	112
Supplies	...	...	5
Equipment	...	...	11
Subtotal, Other changes	0	1	701
Subtotal, Adjustments to base	0	1	701
Amount Absorbed			(338)
Total, Adjustments to base	0	1	363

Exhibit 9

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

	FTE	Amount
Adjustments:		
Restoration of FY 2010 deobligation offset		$3,800

In FY 2010, 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 2011.

	FTE	Amount
Financing:		
Recoveries of prior year obligations		(3,800)

This reduction is the estimated level of TIP prior year deobligations in FY 2011.

<u>Other Changes:</u>

Annualization of 2010 pay raise		0	85

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

Total cost in FY 2011 of 2010 pay raise	$338,667
Less amount requested in FY 2010	(254,000)
Less amount absorbed in FY 2010	0
Amount requested in 2011 to provide full-year cost of 2010 pay raise	84,667
Payment to Departmental Management Working Capital Fund	0
Total, FY 2010 pay raise increase in FY 2011	84,667

2011 Pay increase and related costs		0	194

A general pay raise of 1.4 percent is assumed to be effective January 1, 2011.

Total cost in FY 2011 of pay increase.	$194,000
Amount absorbed in FY 2011	0
Amount requested for FY 2011 pay raise	194,000
Payment to Departmental Management Working Capital Fund	0
Total adjustment for FY 2011 pay increase	194,000

Annualization of positions financed in FY 2010	1	0

NIST requires an additional 1 FTE to staff FY 2010 requested increases at their full operating level in FY 2011.

New positions in 2010	4
Less 5 percent lapse	(0)
Full-Year FTE	4
Less FTE funded in 2010	(3)
Annualization of Positions/FTE in 2011	1

Personnel benefits	0	194

Civil Service Retirement System (CSRS)	($30)
Federal Employees' Retirement System (FERS)	114
Thrift Savings Plan (TSP)	18
Federal Insurance Contribution Act (FICA) – OASDI	24
Health Insurance	64
Employees' Compensation Fund	4

Civil Service Retirement System (-$30,000) – 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 14.6 percent in FY 2010 to 11.8 percent in FY 2011. The contribution rate will remain at 7.0 percent in FY 2011.

Payroll subject to retirement systems ($15,138,448)	
Cost of CSRS contributions in FY 2011 ($15,138,448 x .118 x .07)	$125,044
Cost of CSRS contributions in FY 2010 ($15,138,448 x .146 x .07)	154,715
Total adjustment to base	(29,671)

Federal Employees' Retirement System ($114,000) – 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 85.4 percent in FY 2010 to 88.2 percent in FY 2011. The contribution rate has increased from 11.2 percent in FY 2010 to 11.7 percent in FY 2011.

Payroll subject to retirement systems ($15,138,448)	
Basic benefit cost in FY 2011 ($15,138,448 x .882 x .117)	$1,562,197
Basic benefit cost in FY 2010 ($15,138,448 x .854 x .112)	1,447,962
Total adjustment to base	114,235

Thrift Savings Plan ($18,000) – The cost of agency contributions to the Thrift Savings Plan will also rise as FERS participation increases. The contribution rate has decreased from 4.65 to 4.64 percent for FY 2011.

Thrift plan cost in FY 2011 ($15,138,448 x .882 x .0464)	$619,538
Thrift plan cost in FY 2010 ($15,138,448 x .854 x .0465)	601,163
Total adjustment to base	18,375

Federal Insurance Contributions Act (FICA) - OASDI ($24,000) – 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 $110,400 in FY 2010 to $114,975 in FY 2011. The OASDI tax rate will remain 6.2 percent in FY 2011.

FERS payroll subject to FICA tax in 2011 ($15,138,448 x .882 x .903 x .062)	$747,531
FERS payroll subject to FICA tax in 2010 ($15,138,448 x .854 x .904 x .062)	724,602
Increase (FY 2010-FY 2011)	22,929
OTP payroll subject to FICA tax in 2011 ($500,552 x .882 x .903 x .062)	24,717
OTP payroll subject to FICA tax in 2010 ($500,552 x .854 x .904 x .062)	23,959
Increase (FY 2010-2011)	758
Total adjustment to base	23,687

Health insurance ($64,000) – Effective January 2009, NIST's contribution to Federal employees' health insurance premiums increased by 7.0 percent. Applied against the FY 2010 estimate of $920,000, the additional amount required is $64,400.

Employees' Compensation Fund ($4,000) – The Employees' Compensation Fund bill for the year ending June 30, 2009 is a net $32,000 higher than for the year ending June 30, 2008. The ITS share of this increase is $4,000.

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, 2007 through September 30, 2009. A net increase of 3.71 percent was applied to the FY 2010 base of $420,200 to arrive at an increase of $15,589.

Communications, utilities, and miscellaneous charges 0 80

Electricity rate increase.......... 16
Natural Gas rate increase.......... 64

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 2009 and 2008, the per kilowatt hour rate decreased .7 percent (from 11.6 cents to 11.5 cents) for Gaithersburg, Maryland; increased 4.6 percent (from 34.6 cents to 36.2 cents) for Kauai, Hawaii; increased 22.3 percent (from 5.5 cents to 6.7 cents) for Boulder, Colorado; and increased 7.1 percent (from 8.2 cents to 8.8 cents) for Ft. Collins, Colorado for a net increase of $16,000.

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 March 2009 and 2008, the per therm rate increased 11.0 percent (from 1.194 to 1.325) and decreased 17.8 percent (from 8.616 to 7.078) for Gaithersburg and Boulder respectively resulting in a net increase of $64,000.

General pricing level adjustment 0 132

This request applies the OMB economic assumptions of 0.8 percent for FY 2011 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 $0; rental payments to others $1,168 communications, utilities, and miscellaneous charges $2,440; printing and reproduction $872; other services $111,664; supplies $4,776; and equipment $10,544.

Subtotal Other changes	1	701
Amount absorbed	0	(338)
Total Adjustments to base	1	363

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Technology Innovation Program

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

		2009 Actual		2010 Currently Available		2011 Base		2011 Estimate		Increase/ (Decrease) Over 2011 Base	
Line Item		Personnel	Amount	Personnel	Amount	Personnel	Amount	Personnel	Amount	Personnel	Amount
Technology innovation program	Pos./Approp	73	$65,000	78	$69,900	78	$69,900	78	$79,900	0	$10,000
	FTE/Obl.	72	50,162	80	110,645	80	73,700	80	83,700	0	10,000

Exhibit 12

Department of Commerce
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 by offering cost-shared funding for 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, institutes of higher education, national laboratories, and non-profit research organizations to conduct high-risk, high-reward 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 2011, NIST requests $79.9 million for TIP. The request consists of two parts: 1) a base of $69.9 million and 2) an initiative increase of $10.0 million. The request will support new competitions and fund remaining mortgage commitments from previous competitions. The Administration's FY 2011 request is the first step in a proposed increase of the program to a level of $100 million by the year 2015.

TIP addresses the Nation's most critical needs by offering competitive funding opportunities for high-risk, high reward research. Critical national need areas for FY 2011 and future years will respond to societal challenges that are national in scope and of sufficient magnitude to justify government attention, while building upon areas selected for funding in prior years. TIP will only fund critical national need areas that have a promising technological solution for problems that are not being addressed and for which funding is not available through other public or private sources. The projects that TIP funds must demonstrate strong potential to create transformational results by advancing the state-of-the-art and contributing to the U.S. scientific and technological knowledge base. 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, key NIST scientific and technical staff, independent science advisory bodies, collaborations with other Federal agencies, national or state science policy reports, academic reports and organizations, industry roadmaps and the public. In addition, TIP engages key NIST leadership and staff in the development of critical national need areas to ensure consistency and synergy with other NIST programs, as well as alignment with NIST priorities and competencies. This strategy ensures that TIP funding is awarded in a manner that leverages all NIST capabilities and efforts. While critical national need areas selected for funding will change with the Nation's evolving needs and priorities, TIP expects to offer topics for two to three years in order to maximize the research potential in any given topic.

TIP activities for FY 2011 will build upon the strong foundation established during the program's first two years of operation. 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 from the first year of the program 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-shared research over 3-5 years, for a total of $88 million in R&D funding. 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, which 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. In FY 2009, TIP extended the competition scope of the civil infrastructure area to include new technologies for repair and retrofit, with an emphasis on practical technologies -- including both novel materials and cost-effective methods for installing them -- that would provide enhanced performance or longer service life than existing repair and retrofit materials and practices.

In addition, in FY 2009, TIP announced a competitive funding opportunity in a second area of critical national need: manufacturing. The U.S. manufacturing sector has faced numerous and growing challenges for a number of years, yet it remains a significant force in the Nation's economy. Agile or intelligent manufacturing, sustainable manufacturing, and supply-side management are just a few of many challenges that need to be addressed. One technological need that is often a critical consideration and controlling factor in the innovation process involves materials advances and how to effectively and efficiently incorporate these new materials into manufacturing processes and end-products in a manner that preserves the unique properties of these materials. Without the ability to produce these new materials and rapidly integrate them into products while maintaining the materials' special characteristics, the U.S. may lose these value-added manufacturing innovations to overseas competition, a trend that has occurred in other industries. To address this critical national need, in FY 2009, TIP sought proposals for "Accelerating the Integration of Materials Advances into Manufacturing Processes." Specifically, TIP sought to address two challenges as they relate to three types of advanced materials (nanomaterials, superalloys and composites): 1) process scale-up, integration and design for advanced materials; and 2) predictive modeling for advanced materials and materials processing. It is expected that funding requested in FY 2010 will enable TIP to extend the critical national need topics funded in FY 2009 and/or to support research efforts in additional areas of critical national need.

On December 15, 2009, TIP awarded funding for 20 new research projects, ranging from unmanned, hovering aircraft for inspecting bridges to a high-speed sorting system for recycling aerospace metals to nanomaterials for advanced batteries from its FY 2009 competition. These cost-sharing awards represent up to $146 million in new research over the next two to five years with up to $71 million in funding provided by TIP.

As part of its base program operation objectives for FY 2011, TIP intends to hold a competitive funding opportunity in one or more areas of critical national need. Critical national need topic areas under development for FY 2011 may include one or more of the following (in alphabetical order):

Civil Infrastructure Technologies (first funded by TIP in FY 2008 and extended in FY 2009): 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 2011 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.

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.

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.

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).

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.

Manufacturing (first funded by TIP in FY 2009): The manufacturing sector supported 14 million jobs in 2007, or about 10.1 percent of total employment, and United States manufacturing firms exported $923 billion in manufactured goods in 2006—64 percent 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.

TIP's FY 2011 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; and • 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, and • 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.

Exhibit 13

Department of Commerce
National Institute of Standards and Technology
Industrial Technology Services
INCREASE FOR FY 2011
(Dollar amounts in thousands)

		2011 Base		2011 Estimate		Increase/(Decrease) Over 2011 Base	
		Personnel	Amount	Personnel	Amount	Personnel	Amount
Technology Innovation Program	Pos./Approp	78	$69,900	78	$79,900	0	$10,000
	FTE/Obl.	80	73,700	80	83,700	0	10,000

Technology Innovation Program (+0 Permanent Positions, +0 FTE, Appropriation +$10,000,000, Direct Obligations +$10,000,000)

The purpose of this initiative is to support, promote, and accelerate innovation in the United States by funding high-risk, high-reward research in areas of critical national need.

Problem Magnitude and NIST Role:

Technology is increasingly touted as the driver 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. Currently, there 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*, Clayton M. 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 Science and Technology (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 of 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. In FY 2009, TIP extended the competition scope of the civil infrastructure area to include new technologies for repair and retrofit, with an emphasis on practical technologies -- including both novel materials and cost-effective methods for installing them -- that would provide enhanced performance or longer service life than existing repair and retrofit materials and practices. In addition, in FY 2009, TIP announced a competitive funding opportunity in a second area of critical national need: manufacturing.

On December 15, 2009, TIP awarded funding for 20 new research projects, ranging from unmanned, hovering aircraft for inspecting bridges to a high-speed sorting system for recycling aerospace metals to nanomaterials for advanced batteries from its FY 2009 competition. These cost-sharing awards represent up to $146 million in new research over the next two to five years with up to $71 million in funding provided by TIP.

TIP expects to announce its third competitive funding opportunity in an area of critical national need in the spring of 2010. The specific topic area chosen will be based upon an up-to-date assessment of areas that have the greatest potential to be addressed through high-risk, high-reward scientific and technical research that is not currently being addressed by other Federal R&D agencies or the private sector. The need area will be chosen to align with the Administration's priorities.

Proposed NIST Technical Program:

For FY 2011, NIST requests $79.9 million, consisting of base funding of $69.9 million and an initiative increase of $10.0 million. The $10 million increase will support new competitions and fund remaining mortgage commitments from previous competitions. In FY 2011, TIP is planning 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 the nine awards for advanced sensing technologies. TIP extended the Civil Infrastructure topic in FY 2009 and also added a new topic to address the Nation's critical needs in Manufacturing. TIP plans to extend one or both of these topic areas further in FY 2010, and may add an additional critical national need topic. TIP may offer multiple competitions over two to three years on a single topic in order to optimize research potential of the technology community and respond to changing national priorities.

Critical national need topic areas that might be selected for the FY 2011 competition may include one or more of the following:

- **Civil Infrastructure Technologies** (funded by TIP in FY 2008 and FY 2009): 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 2011 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.

- **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 U.S. against both conventional military threats and the threat of terrorism.

- **Energy:** The U.S. economy is dependent on foreign sources of energy, and disruption in the supply of petroleum from foreign countries impacts all sectors of the economy. The total U.S. energy consumption is projected to grow from 100 quadrillion British Thermal Units (BTU) in 2004 to 131 quadrillion BTU by 2030, and other countries are competing for the same energy resources. Areas under consideration include topics such as Smart Grid and alternative energy technologies.

- **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 seven billion pounds of toxic material were disposed of or released to the environment in the U.S. in 2006.

- **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 a 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.

- **Manufacturing** (funded by TIP in FY 2009): The manufacturing sector supported 14 million jobs in 2007, or about 10.1 percent of total employment, and United States manufacturing firms exported $923 billion in manufactured goods in 2006—64 percent 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.

To ensure that 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 synergy 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; and • Foster 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 U.S. 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.

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		2011 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	244
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	9,756
99	Direct obligations	10,000
	Transfer to NIST Working Capital Fund	0
	Total increase requested	10,000

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

	FY 2009 Actual	FY 2010 Estimate	FY 2011 Estimate
Equipment Investments	$24	$30	$24
IE Amortization	(32)	(31)	(24)
Excess Amortizations over Equipment Investments	8	0	0
Total, WCF Investments	0	(1)	0
Total, Reimbursable Program and WCF Investments	0	(1)	0

Hollings Manufacturing
Extension Partnership

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

		2009 Actual		2010 Currently Available		2011 Base		2011 Estimate		Increase/ (Decrease) Over 2011 Base	
Line Item		Per-sonnel	Amount	Per-sonnel	Amount	Per-sonnel	Amount	Per-sonnel	Amount	Per-sonnel	Amount
Hollings manufacturing	Pos./Approp	64	$110,000	70	$124,700	70	$125,063	70	$129,700	0	$4,637
extension partnership	FTE/Obl.	70	111,037	73	125,298	74	125,063	74	129,700	0	4,637

Department of Commerce
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 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 MEP's focus on maintaining and increasing the competitiveness of U.S. manufacturers more important now than anytime in history. With centers in every state and Puerto Rico, MEP is positioned to continue providing U.S. manufacturers with the tools and services they need to weather the current economic crisis as well as supply new skills and resources needed to break into new markets and develop innovative products. 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 2008) impacts reported by MEP clients.

For FY 2008, clients reported:

- New and retained sales of over $9.1 billion
- More than $1.4 billion in cost savings from improved processes and waste reduction
- Investments in new equipment and business operations totaling almost $1.7 billion
- The creation and retention of 52,948 jobs.

The data above is from an independent follow-up survey of clients completing projects with MEP Centers in FY 2008.

The FY 2011 MEP base program operating objectives 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.

Exhibit 13

Department of Commerce
National Institute of Standards and Technology
Industrial Technology Services
INCREASE FOR FY 2011
(Dollar amounts in thousands)

		2011 Base		2011 Estimate		Increase/(Decrease) Over 2011 Base	
		Personnel	Amount	Personnel	Amount	Personnel	Amount
Hollings Manufacturing Extension Partnership...........	Pos./Approp	70	$125,063	70	$129,700	0	$4,637
	FTE/Obl.	74	125,063	74	129,700	0	4,637

Hollings Manufacturing Extension Partnership (MEP) Program (+0 Permanent Positions, +0 FTE, Appropriation +$4,637,000, Direct Obligations +$4,637,000)

The purpose of this initiative is to expand the MEP program to a funding level in support of the Administration's policy initiatives for reinventing domestic manufacturing to create jobs and better respond to future challenges and opportunities by supporting the adoption of technological innovations that spur economic growth and fosters the development of new products, expanded markets, and process improvements. The FY 2011 request is the second year of proposed increases to the program to an eventual level of $180 million by 2015.

Problem Magnitude and NIST Role:

A strong manufacturing base is critical to the financial and national security of the U.S. Prior to the recent financial and automotive crisis, U.S. manufacturing firms employed over 14 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 eighth 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, nearly 328,000 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. The various market imperfections faced by 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 2008) client reported impacts include:

- new sales of $3.61 billion
- retained sales of $5.46 billion
- client cost savings of $1.41 billion

- new client investment in modernization of $1.71 billion
- creation and retention of 52,948 jobs, and
- 31,961 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 MEP program 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 focus 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:

- Vestas, the world's largest manufacturer of wind turbines, was interested in locating three manufacturing facilities along the Front Range region of Colorado (in Windsor, Brighton and Pueblo) and contacted Colorado Association for Manufacturing and Technology (CAMT), an MEP affiliate center, to assist with supplier identification and workforce training. CAMT worked with local economic development organizations to identify suppliers to the company's Colorado operations. CAMT identified 25 Colorado manufacturing companies as potential suppliers who meet Vestas' requirements. In conjunction with the state, community colleges and local workforce development councils, CAMT is providing training assistance where needed to ensure local suppliers are able to meet the quality and delivery standards required by Vestas. In addition, CAMT, in partnership with Pueblo Community College is training the brand-new workforce of Vestas' manufacturing facility in Pueblo, Colorado. CAMT is providing employees with knowledge in the basics of Lean Manufacturing and Six Sigma, and developing the skills, and abilities to evaluate and improve processes, and to systematically address, correct, and prevent problems. Companies like Vestas understand that the partnership between the state, local economic development councils, community colleges and CAMT provides a strategic advantage in the rapidly growing market of global wind solutions. With MEP's help, Vestas will have quality employees and suppliers in place when its Colorado operations begin.

- Coyote Design and Manufacturing located in Boise, Idaho, invents designs, refines and manufactures orthotic and prosthetic devices that help the physically challenged adapt to their circumstances and environments. The company needed help in the areas of product design, testing and prototyping. The family-owned company with only 10 employees was not in a position to hire full time engineering help or to purchase expensive design or prototyping equipment, so they contacted TechHelp, the MEP affiliate center in Idaho. TechHelp's New Product Development Team provided access to state-of-the art design and prototyping equipment as well as the technical and engineering expertise that have improved the multi-functional mechanical devices and designs and allowed the company to offer affordable and effective products. With TechHelp's assistance, the company has increased and retained sales of $55,000 and saved more than $60,000.

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 that 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 that create new, more profitable revenue streams. This FY 2011 budget initiative allows MEP to expand upon a strong foundation and further deploy 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 to gain entry into new markets.

With the requested funding for FY 2011, MEP will continue to provide an integrated national partnership to support the Administration's policy initiatives focused on strengthening domestic manufacturing and promoting economic growth by enhancing the program's ability to meet the new 21st century needs of manufacturers through continued investments focused on MEP activities in the area of business growth services specifically technology acceleration, sustainability and enabling a manufacturing workforce.

A robust MEP system will:

- respond to the rapid global change of technology and business systems advances,
- provide manufacturers with the tools and services that allow for the identification and connection to new technologies that match the manufacturer's capabilities and create opportunities for growth through the development of new products and new markets,
- 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.

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		2011 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	147
22	Transportation of things	2
23.3	Communications, utilities and miscellaneous charges	77
24	Printing and reproduction	1
25.1	Advisory and assistance services	0
25.2	Other services	113
25.3	Purchases of goods and services from Government accounts	77
25.5	Research and development contracts	0
25.7	Operation and maintenance of equipment	8
26	Supplies and materials	30
31	Equipment	85
32	Land and structures	0
41	Grants, subsidies and contributions	4,097
99	Direct obligations	4,637
	Transfer to NIST Working Capital Fund	0
	Total increase requested	4,637

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 2009 Actual	FY 2010 Estimate	FY 2011 Estimate
Department of Defense			
Army	$349	0	0
Navy	457	0	0
Other	0	$200	$500
Subtotal, Department of Defense	806	200	500
Department of Commerce	185	0	0
Dept. of Homeland Security	197	0	0
Environmental Protection Agency	374	0	0
National Aeronautics & Space Admin.	0	200	300
Subtotal, Federal Agencies	1,562	400	800
Technical & Advisory Services	37	0	0
Total, Reimbursable Program	1,599	400	800
Equipment Investments	31	38	31
IE Amortization	(40)	(39)	(31)
Excess Amortizations over Equipment Investments	9	0	0
Total, WCF Investments	0	(1)	0
Total, Reimbursable Program and WCF Investments	1,599	399	800

Department of Commerce
National Institute of Standards and Technology
Industrial Technology Services
SUMMARY OF REQUIREMENTS BY OBJECT CLASS
(Dollar amounts in thousands)

	Object Class	2009 Actual	2010 Currently Available	2011 Base	2011 Estimate	Increase/ (Decrease) Over 2011 Base
11	Personnel compensation					
11.1	Full-time permanent	$12,841	$14,034	$14,220	$14,220	0
11.3	Other than full-time permanent	1,114	1,150	1,159	1,159	0
11.5	Other personnel compensation	490	490	490	490	0
11.9	Total personnel compensation	14,445	15,674	15,869	15,869	0
12.1	Civilian personnel benefits	3,809	4,168	4,307	4,307	0
13	Benefits for former personnel	2	2	2	2	0
21	Travel and transportation of persons	925	1,182	1,191	1,338	$147
22	Transportation of things	11	16	16	18	2
23.1	Rental payments to GSA	2	5	5	5	0
23.2	Rental payments to others	113	146	150	150	0
23.3	Communications, utilities, and miscellaneous charges	1,738	1,978	2,017	2,094	77
24	Printing and reproduction	14	109	109	110	1
25.1	Advisory and assistance services	14	0	0	0	0
25.2	Other services	10,035	18,147	16,569	16,682	113
25.3	Purchases of goods and services from government accounts	1,196	1,517	1,523	1,600	77
25.5	Research and development contracts	604	2,168	1,290	1,534	244
25.7	Operation and maintenance of equipment	1,042	1,084	1,086	1,094	8
26	Supplies and materials	358	597	600	630	30
31	Equipment	1,176	1,318	1,325	1,410	85
32	Land and structures	0	0	0	0	0
41	Grants, subsidies, and contributions	125,715	187,832	152,704	166,557	13,853
99	Total Obligations	161,199	235,943	198,763	213,400	14,637

	Object Class	2009 Actual	2010 Currently Available	2011 Base	2011 Estimate	Increase/ (Decrease) Over 2011 Base
99	Total Obligations	161,199	235,943	198,763	213,400	14,637
	Less Prior Year Recoveries	(6,920)	(3,800)	(3,800)	(3,800)	0
	Less Prior Year Refunds	(601)	0	0	0	0
	Less Prior Year Unobligated Balance	(21,221)	(37,543)	0	0	0
	Plus Unobligated Balance End of Year	37,543	0	0	0	0
	Total Budget Authority	170,000	194,600	194,963	209,600	14,637
	Plus Unobligated Balance Rescission	5,000	0	0	0	0
	Plus Transfer to BIS	0	0	0	0	0
	Appropriation	175,000	194,600	194,963	209,600	14,637

Personnel Data

	2009 Actual	2010 Currently Available	2011 Base	2011 Estimate	Increase/ (Decrease) Over 2011 Base
Full-time equivalent employment:					
Full-time permanent	126	137	138	138	0
Other than full-time permanent	16	16	16	16	0
Total	142	153	154	154	0
Authorized Positions:					
Full-time permanent	126	137	137	137	0
Other than full-time permanent	11	11	11	11	0
Total	137	148	148	148	0

Department of Commerce
National Institute of Standards and Technology
Industrial Technology Services
DETAILED REQUIREMENTS BY OBJECT CLASS
(Dollar amounts in thousands)

	Object Class	2011 Adjustments to Base	2011 Base	2011 Estimate	Increase/ (Decrease) Over 2011 Base
11	Personnel compensation				
11.1	Full-time permanent				
	Executive level	0	0	0	0
	Senior executive service	$6	$542	$542	0
	Career path	89	13,678	13,678	0
	Wage board	0	0	0	0
	Scientific & professional (P.L. 80-313)	0	0	0	0
	Subtotal	95	14,220	14,220	0
11.3	Other than full-time permanent				
	Career path	9	1,159	1,159	0
	Wage board	0	0	0	0
	Scientific & professional (P.L. 80-313)	0	0	0	0
	Experts & consultants	0	0	0	0
	Subtotal	9	1,159	1,159	0
11.5	Other personnel compensation				
	Overtime	0	152	152	0
	SES performance awards	0	35	35	0
	Cash awards	0	303	303	0
	Other	0	0	0	0
	Subtotal	0	490	490	0
11.9	Total personnel compensation	104	15,869	15,869	0

	Object Class	2011 Adjustments to Base	2011 Base	2011 Estimate	Increase/ (Decrease) Over 2011 Base
12.1	Civilian personnel benefits				
	Civil service retirement	(13)	149	149	0
	Federal employees' retirement	61	1,488	1,488	0
	Thrift savings plan	12	573	573	0
	Federal Insurance Contribution Act	18	961	961	0
	Health insurance	34	960	960	0
	Life insurance	0	22	22	0
	Employees' Compensation Fund	2	64	64	0
	Other	0	90	90	0
	Subtotal	114	4,307	4,307	0
13	Benefits for former personnel				
	Severance pay	0	0	0	0
	Voluntary separation incentives	0	0	0	0
	Unemployment compensation	0	2	2	0
	Other	0	0	0	0
	Subtotal	0	2	2	0
21	Travel and transportation of persons				
	Common carrier	0	502	558	$56
	Mileage	0	0	0	0
	Per diem/actual	9	429	497	68
	Other	0	260	283	23
	Subtotal	9	1,191	1,338	147
22	Transportation of things	0	16	18	2
23.1	Rental payments to GSA	0	5	5	0
23.2	Rental payments to others	0	150	150	0

	Object Class	2011 Adjustments to Base	2011 Base	2011 Estimate	Increase/ (Decrease) Over 2011 Base
23.3	Communications, utilities, and miscellaneous charges				
	Rental of ADP equipment	0	1	1	0
	Rental of office copying equipment	0	2	2	0
	Other equipment rental	0	12	13	1
	Federal telecommunications system	0	32	34	2
	Other telecommunications services	1	182	194	12
	Postal Service by USPS	0	2	2	0
	Utilities:				
	Electric	8	1,092	1,130	38
	Gas	30	585	605	20
	Water/Sewer	0	109	113	4
	Subtotal	39	2,017	2,094	77
24	Printing and reproduction				
	Publications	0	1	1	0
	Other	0	108	109	1
	Subtotal	0	109	110	1
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	3	444	522	78
	ADP Services	1	91	103	12
	Other non-government contracts	75	16,034	16,057	23
	Subtotal	79	16,569	16,682	113
25.3	Purchases of goods and services from Government accounts				
	Payments to DM, WCF	3	650	650	0
	Office of Personnel Management	0	29	29	0
	Other Federal agencies:				
	Department of Commerce	1	211	283	72
	Other	2	633	638	5
	Subtotal	6	1,523	1,600	77

	Object Class	2011 Adjustments to Base	2011 Base	2011 Estimate	Increase/ (Decrease) Over 2011 Base
25.5	Research and development contracts	0	1,290	1,534	244
25.7	Operation and maintenance of equipment	2	1,086	1,094	8
26	Supplies and materials				
	Office & laboratory supplies	2	389	419	30
	Scientific publications & journals	1	182	182	0
	Fuel oil	0	29	29	0
	Subtotal	3	600	630	30
31	Equipment				
	Office machines and other equipment	1	231	232	1
	ADP equipment	4	726	810	84
	Equipment amortization	2	368	368	0
	Subtotal	7	1,325	1,410	85
32	Land and structures	0	0	0	0
41	Grants, subsidies, and contributions	0	152,704	166,557	13,853
99	Total Obligations	363	198,763	213,400	14,637
	Less Prior Year Recoveries	0	(3,800)	(3,800)	0
	Total Budget Authority	363	194,963	209,600	14,637
	Total Appropriation	363	194,963	209,600	14,637

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. $124,700,000, is provided for the Hollings Manufacturing Extension Partnership to remain available until expended per P.L. 111-117 Consolidated Appropriations Act, 2010.

   $69,900,000, is provided for the Technology Innovation Program to remain available until expended per P.L. 111-117 Consolidated Appropriations Act, 2010.

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".

Exhibit 34

Department of Commerce
National Institute of Standards and Technology
Industrial Technology Services
ADVISORY AND ASSISTANCE SERVICES
(Obligations in thousands of dollars)

	FY 2009 Actual	FY 2010 Estimate	FY 2011 Estimate
Management and professional support services	$0	$0	$0
Studies, analyses, and evaluations	14	0	0
Engineering and technical services	0	0	0
Total	14	0	0

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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Construction of Research Facilities

Exhibit 5

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
2010 Currently Available	89	89	$147,000	$489,546	$147,000
less: Unobligated balance from prior year	0	0	0	(342,546)	0
2011 Adjustments to base:					
less: Non-recurring 2010 costs	0	0	(89,000)	(89,000)	(89,000)
plus: Uncontrollable cost changes	0	0	668	668	668
2011 Base Request	89	89	58,668	58,668	58,668
plus: 2011 Program changes	0	0	66,132	66,132	66,132
2011 Estimate	89	89	124,800	124,800	124,800

		2009 Actual		2010 Currently Available		2011 Base		2011 Estimate		Increase/ (Decrease) Over 2011 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	81	$532,000 *	89	$147,000	89	$58,668	89	$124,800	0	$66,132
renovations	FTE/Obl.	89	230,811	89	489,546 *	89	58,668	89	124,800	0	66,132
Adjustments for:											
Prior year recoveries			(1,294)		0		0		0		0
Prior year refunds			(5)		0		0		0		0
Unobligated balance, start of year			(40,058)		(342,546)		0		0		0
Unobligated balance, end of year			342,546								
Financing from transfers:											
Transfers to other accounts (+)			0		0		0		0		0
Appropriation			532,000 *		147,000		58,668		124,800		66,132

* Includes $360M of American Recovery and Reinvestment Act of 2009 (P.L. 111-5) supplemental funds appropriated to CRF of which $70,019K was obligated in FY 2009.

Exhibit 7

Department of Commerce
National Institute of Standards and Technology
Construction of Research Facilities
SUMMARY OF FINANCING
(Dollar amounts in thousands)

	2009 Actual	2010 Currently Available	2011 Base	2011 Estimate	Increase/ (Decrease) Over 2011 Base
Total Obligations	$231,722	$490,426	$58,668	$124,800	$66,132
Financing:					
Offsetting collections from:					
Federal funds	0	0	0	0	0
Non-Federal sources	(880)	0	0	0	0
Total offsetting collections	(880)	0	0	0	0
Adjustments for:					
Prior year recoveries	(1,294)	0	0	0	0
Prior year refunds	(5)	0	0	0	0
Unobligated balance, start of year (Direct)	(40,058)	(342,546)	0	0	0
Unobligated balance, start of year (Reimbursable)	(911)	(880)	0	0	0
Unobligated balance, end of year (Direct)	342,546	0	0	0	0
Unobligated balance, end of year (Reimbursable)	880	0	0	0	0
Budget Authority	532,000 *	147,000	58,668	124,800	66,132
Financing:					
Transfer to other accounts	0	0	0	0	0
Transfer from other accounts	0	0	0	0	0
Appropriation	532,000 *	147,000	58,668	124,800	66,132

* Includes the American Recovery and Reinvestment Act of 2009 (P.L. 111-5) supplemental appropriation to NIST (CRF $360 million).

Adjustments
to Base

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:			
Construction adjustments	...	...	($89,000)
Other Changes:			
Annualization of FY 2010 pay raise	...	...	31
2011 Pay increase and related costs	...	...	94
Personnel benefits:			
Civil Service Retirement System (CSRS)	...	...	(14)
Federal Employees' Retirement System (FERS)	...	...	56
Thrift Savings Plan (TSP)	...	...	9
Federal Insurance Contribution Act (FICA) - OASDI	...	...	12
Health insurance	...	...	33
Employees' Compensation Fund	...	...	(14)
Travel and transportation of persons:			
Per Diem	...	...	1
General pricing level adjustment:	...	...	
Communications, utilities, and miscellaneous charges	...	...	1
Other services	...	...	445
Supplies and materials	...	...	13
Equipment	...	...	1
Subtotal, Other changes	...	0	668
Subtotal, Adjustments to base	...	0	(88,332)
Amount Absorbed	...	...	0
Total, Adjustments to base	...	0	(88,332)

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:		
Construction adjustments	0	($89,000)

In FY 2010, NIST received $47,000,000 in one-time funding for construction and modernization of facilities at the Gaithersburg, Maryland, and Boulder, Colorado worksites. In addition, a downward adjustment of $42,000,000 is made to other NIST construction projects for a total reduction of $89,000,000.

	FTE	Amount
Other Changes:		
Annualization of 2010 pay raise.	0	31

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

Total cost in FY 2011 of 2010 pay raise	$147,333
Less amount requested in FY 2010	(116,000)
Less amount absorbed in FY 2010	0
Amount requested in 2011 to provide full-year cost of 2010 pay raise	31,333
Payment to Departmental Management Working Capital Fund	0
Total FY 2010 pay raise increase in FY 2011	31,333

2011 Pay increase and related costs		0	94

A general pay raise of 1.4 percent is assumed to be effective January 1, 2011.

Total cost in FY 2011 of pay increase	$94,000
Less amount absorbed in FY 2011	0
Amount requested for FY 2011 pay increase	94,000
Payment to Departmental Management Working Capital Fund	0
Total adjustment for FY 2011 pay increase	94,000

Personnel benefits		0	82

Civil Service Retirement System (CSRS)	($14)
Federal Employees' Retirement System (FERS)	56
Thrift Savings Plan (TSP)	9
Federal Insurance Contribution Act (FICA) - OASDI	12
Health Insurance	33
Employees' Compensation Fund	(14)

Civil Service Retirement System (-$14,000) – 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 14.6 percent in FY 2010 to 11.8 percent in FY 2011. The contribution rate will remain at 7.0 percent in FY 2011.

Payroll subject to retirement systems ($7,380,000)	
Cost of CSRS contributions in FY 2011 ($7,380,000 x .118 x .07)	$60,959
Cost of CSRS contributions in FY 2010 ($7,380,000 x .146 x .07)	75,424
Total adjustment to base	(14,465)

Federal Employees' Retirement System ($56,000) – 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 85.4 percent in FY 2010 to 88.2 percent FY 2011. The contribution rate will increase from 11.2 percent in FY 2010 to 11.7 percent in FY 2011.

Payroll subject to retirement systems ($7,380,000)	
Basic benefit cost in FY 2011 ($7,380,000 x .882 x .117)	$761,572
Basic benefit cost in FY 2010 ($7,380,000 x .854 x .112)	705,882
Total adjustment to base	55,690

Thrift Savings Plan ($9,000) – The cost of agency contributions to the Thrift Savings Plan will also rise as FERS participation increases. The contribution rate has decreased from 4.65 in FY 2010 to 4.64 in FY 2011.

Thrift plan cost in FY 2011 ($7,380,000 x .882 x .0464)	$302,025
Thrift plan cost in FY 2010 ($7,380,000 x .854 x .0465)	293,067
Total adjustment to base	8,958

Federal Insurance Contributions Act (FICA) - OASDI ($12,000) – 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 $110,400 in FY 2010 to $114,975 in FY 2011. The OASDI tax rate will remain 6.2 percent in FY 2011.

FERS payroll subject to FICA tax in 2011 ($7,380,000 x .882 x .903 x .062)	$364,422
FERS payroll subject to FICA tax in 2010 ($7,380,000 x .854 x .904 x .062)	353,244
Increase (FY 2010-FY 2011)	11,178
OTP payroll subject to FICA tax in FY 2011 ($636,000 x .882 x .903 x .062)	31,405
OTP payroll subject to FICA tax in FY 2010 ($636,000 x .854 x .904 x .062)	30,442
Increase (FY 2010-FY 2011)	963
Total adjustment to base	12,141

Health insurance ($33,000) – Effective January 2009, NIST's contribution to Federal employees' health insurance premiums increased by 7.0 percent. Applied against the FY 2010 estimate of $478,000, the additional amount required is $33,460.

Employees' Compensation Fund (-$14,000) – The Employees' Compensation Fund bill for the year ending June 30, 2009 is a net $32,000 higher than for the year ending June 30, 2008. CRF decreased by $14,000.

Travel and transportation of persons:	0	1

An analysis of per diem rates by city was performed based on data received from GSA for the time period of October 1, 2007 through September 30, 2009. A net increase of 3.71 percent was applied to the FY 2010 base of $20,000 to arrive at an increase of $742.

General pricing level adjustment	0	460

This request applies the OMB economic assumptions of 0.8 percent for FY 2011 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 $0; communications, utilities, and miscellaneous charges $552; other services $445,200; supplies and materials $13,384; and equipment $1,296.

Subtotal, Other changes	0	668
Amount Absorbed, Other changes	0	(0)
Total adjustments to base	0	(88,332)

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		2009 Actual Per-sonnel	2009 Actual Amount	2010 Currently Available Per-sonnel	2010 Currently Available Amount	2011 Base Per-sonnel	2011 Base Amount	2011 Estimate Per-sonnel	2011 Estimate Amount	(Increase/Decrease) Over 2011 Base Per-sonnel	(Increase/Decrease) Over 2011 Base Amount
Construction and major renovations	Pos/Approp	9	$463,700 *	9	$89,000	0	0	0	$52,300	0	$52,300
	FTE/Obl.	11	167,220	11	425,454	0	0	0	52,300	0	52,300
Safety, Capacity, Maintenance and Major Repairs	Pos/Approp	72	68,300	80	58,000	89	$58,668	89	72,500	0	13,832
	FTE/Obl.	78	63,591	78	64,092	89	58,668	89	72,500	0	13,832
Total	Pos/Approp	81	532,000 *	89	147,000	89	58,668	89	124,800	0	66,132
	FTE/Obl.	89	230,811	89	489,546	89	58,668	89	124,800	0	66,132

* Includes the American Recovery and Reinvestment Act of 2009 (P.L. 111-5) supplemental appropriation to NIST (CRF $360 million of which $180 million is for construction grants and $180 million is for NIST construction projects).

Exhibit 12

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 approximately $58.7 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 2011 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 eight percent of the total scheduled operating time.

Department of Commerce
National Institute of Standards and Technology
Construction of Research Facilities
INCREASE FOR FY 2011
(Dollar amounts in thousands)

		2011 Base		2011 Estimate		Increase/(Decrease) Over 2011 Base	
		Personnel	Amount	Personnel	Amount	Personnel	Amount
Total, Construction and Major Renovations ...	Pos./Approp	89	$58,668	89	$124,800	0	$66,132
	FTE/Obl.	89	58,668	89	124,800	0	66,132
Building 1 Renovation Construction and Major Renovations ...	Pos./Approp	0	0	0	$37,900	0	$37,900
	FTE/Obl.	0	0	0	37,900	0	37,900

Building 1 Renovation (+0 Permanent Positions, +0 FTE, Appropriation +$37,900,000, Direct Obligations +$37,900,000)

- 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 research and measurement.

- 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 research and measurement performed in Building 1 support national priorities in such areas as energy, environment, manufacturing, health care, physical infrastructure, information technology, 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 measurement, such as control of vibration, temperature, and air quality. Interior renovations are necessary to support scientific discovery and technical development of transformational technology in support of many national needs.

- This initiative enables NIST to complete the exterior renovations for Building 1, Wings 3, 5, and 6, and the Center Spine, as well as the interior renovations of Wing 3 and a portion of Wing 5.

- Renovations will emphasize the use of green technologies, saving energy, water, and construction materials to meet national environmental goals.

- This initiative enables NIST to more effectively and efficiently address the *President's Plan for Science and Innovation* calling for a doubling of NIST Laboratory research. 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 energy, environment, manufacturing, health care, physical infrastructure, information technology, and many other areas. However, this work is significantly impaired by aging facilities that cannot provide the control of temperature, vibration, humidity, and air cleanliness required for world-leading research and measurement 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 measurement needed by industry and the scientific community. Even for the limited range of work that can be attempted, current laboratory conditions create significant inefficiencies, and the aging facility systems present safety concerns. Examples of safety concerns at the Boulder facility include: the lack of adequate ventilation systems that would supply fresh air necessary for a modern laboratory building; electrical distribution wires that often contain asbestos in the insulation and many electrical system components, while code compliant when originally installed and grandfathered-in as allowed, do not meet modern/current code; the lighting condition is poor in many areas due to fixtures that are at or beyond their useful life; and while the main Boulder facility is protected by a modern fire detection system, most of the building is not protected by a fire sprinkler system. In terms of lost productivity, 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 an economic benefit to the U.S. of about 40 dollars for every dollar invested in NIST research and measurement (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.

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 measurement 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

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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.

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 research and measurement will be required.

Scientific and technical progress demand increasingly accurate and precise measurement. 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 measurement. Next generation innovations in national priorities such as energy, environment, manufacturing, health care, physical infrastructure, information technology, and many other areas currently require similar progress in the unique, world-leading research and measurement 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 Precision Measurement Laboratory (PML), formerly known as Building 1 Extension (B1E), to meet the most stringent facilities performance requirements, coupled with major renovation of existing laboratory space in Building 1 to meet less demanding but necessary performance requirements at a lower cost. NIST continually reviews the adequacy of its facilities to meet the increasingly stringent needs for research and precision measurement 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 21st century research and measurement in key areas such as energy, environment, manufacturing, health care, physical infrastructure, and information technology. The 2006 review identified the need for space of varying performance levels, 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 NIST laboratory space according to the L1 through L4 performance levels. Please see Table 1.

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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.

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 Precision Measurement 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 research and measurement 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 will best be met through the construction of the PML, begun in fiscal year 2008 and slated for completion in 2011. 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.

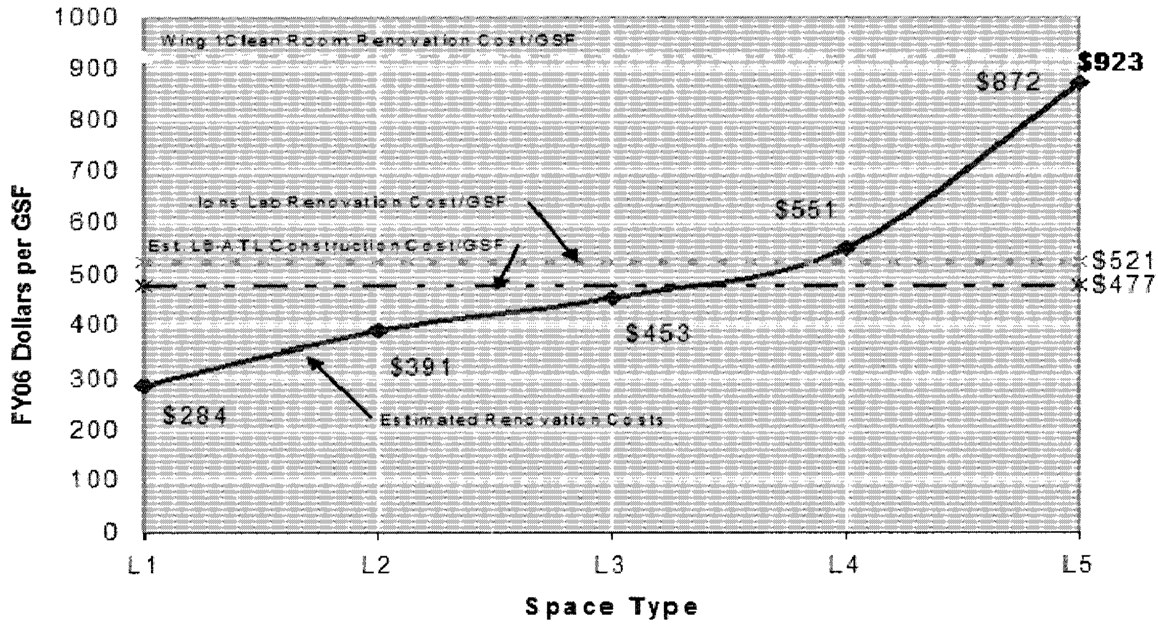
In addition to the L4 highest performance space to be provided through PML construction, NIST Boulder also requires nearly 80,000 NASF of high performance, L3 level laboratory space. As described in Table 1, this L3 space has significant performance requirements for control of temperature, vibration, 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 of Building 1 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, which is completely inadequate for the great majority of NIST Boulder research and measurement programs. Less than 25 percent of current NIST Boulder laboratory space performs to required specifications. And the PML will house only about the top 25 percent of NIST Boulder research and measurement 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 research and measurement supporting U.S. innovation and economic security. To meet the facilities needs for about 93,000 NASF of L3 performance laboratory space, the facilities plan includes the selected renovation of Building 1, including Wings 3, 4, 5, 6 and a portion of the Center Spine. (Wing 4 is occupied by the National Telecommunications Information Administration (NTIA) and will be renovated at a later date.)

The construction of the PML, as well as 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 research and measurement. 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 PML, 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 PML 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 PML, NIST determined that it is most cost-effective to perform ***renovations*** to improve laboratory 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 PML 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**



<u>Proposed NIST Technical Program</u>:

This initiative is part of a comprehensive, multi-year plan for the phased construction of new space and renovation of Building 1 at the NIST Boulder laboratories. With $12.0 million provided in FY 2010, NIST will complete the renovation design and construction documents and perform the limited renovation of Building 3 for the relocation of the Instrument Shops. The next step will be to complete exterior renovations in Building 1, Wings 3, 5, 6, and the Center Spine to support future renovation efforts. These exterior renovations will include modified roof structures, service corridors, and mechanical equipment rooms. The FY 2011 initiative request of $37.9 million enables NIST to complete exterior renovations described above as well as the interior renovations at Building 1, Wing 3 and a portion of Wing 5. The remaining interior wing renovations will be completed with future funding requests.

Elements of the FY 2011 funding request, Building 1 renovations, may include, but not be limited to:

- Approximately 22,500 gross square feet of temporary swing space to accommodate the accelerated renovation.

- Architectural/structural elements that address required space performance and compliance with modern building codes.

- Heating, ventilation, air conditioning, and mechanical elements included in the renovation address components such as air distribution, exhaust air, temperature and humidity control, system controls, plumbing systems to include domestic hot and cold water service, laboratory hot and cold water service, sanitary drains, laboratory waste, laboratory piped services for cooling water, nitrogen, compressed air, laboratory vacuum, and pure water.

- Electrical service will be provided from the primary site electrical service and distribution system. Electrical elements included in the renovation will address components such as lighting, power distribution, power quality, electromagnetic interference, and standby emergency power for critical laboratory functions.

- Communication elements that will be addressed include infrastructure components such as telephone cabling and fiber optic networks for data.

- Life safety and building security elements in the renovation include components such as fire alarm systems, fire sprinkler systems, and building access control.

- Chilled water, steam, and compressed air will be supplied from the Boulder site Central Utility Plant.

- 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/(Targets)**
Building 1 Renovation	• Award contract for exterior renovations at Building 1 Wings 3, 5, 6 and a limited portion of the Center Spine, the interior renovation of Building 1, Wing 3, and the initial interior renovation at Building 1 Wing 5 (FY 2011) • Exterior renovations complete (FY 2012) • Interior renovation complete at Building 1Wing 3 with occupancy (FY 2013) • Initial interior renovation complete at Building 1 Wing 5 with occupancy (FY 2013)

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 energy, environment, manufacturing, health care, physical infrastructure, information technology, 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 PML 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.

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**
Building 1 Renovation	0	12,000	37,900	4,500	0	0	0	0	54,400

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		2011 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	37,900
41	Grants, subsidies and contributions	0
99	Direct obligations	37,900
	Transfer to NIST Working Capital Fund	0
	Total increase requested	37,900

Department of Commerce
National Institute of Standards and Technology
Construction of Research Facilities
INCREASE FOR FY 2011
(Dollar amounts in thousands)

		2011 Base		2011 Estimate		Increase/(Decrease) Over 2011 Base	
		Personnel	Amount	Personnel	Amount	Personnel	Amount
Total, Construction and Major Renovations	Pos./Approp	89	$58,668	89	$124,800	0	$66,132
	FTE/Obl.	89	58,668	89	124,800	0	66,132
General Purpose Laboratories Renovations Construction and Major Renovations	Pos./Approp	0	0	0	$14,400	0	$14,400
	FTE/Obl.	0	0	0	14,400	0	14,400

General Purpose Laboratories Renovations (+0 Permanent Positions, +0 FTE, Appropriation +$14,400,000, Direct Obligations +$14,400,000)

- 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 research and measurement.
- 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 research and measurement performed in the GPLs support national priorities in such areas as energy, environment, manufacturing, health care, physical infrastructure, information technology, 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 measurement, 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 enables NIST to more effectively and efficiently address the *President's Plan for Science and Innovation* calling for a doubling of NIST Laboratory research. 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 research and measurement in national priority areas such as energy, environment, manufacturing, health care, physical infrastructure, information technology, and many other areas. But the aging GPLs are not able to support cutting-edge research and measurement because of poor building performance. The GPLs cannot provide the required stable temperatures, low vibrations, and air quality needed for demanding research and precision measurement. The result is substantially reduced research and measurement productivity, as poor facility conditions result in bad scientific data, and some research and measurement 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 research and measurement demonstrate an average return of 40 dollars in improved U.S. economic benefits for each dollar invested in NIST research and measurement (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 research and measurement productivity, or an annual loss of about $2 billion in unrealized economic benefits. The cost of upgrading the NIST GPLs to improve research and measurement productivity would be repaid many times over through improved economic benefits to the U.S.

The NIST Gaithersburg GPLs comprise seven research and measurement laboratory buildings and a total of about 1.2 million square feet. The more than 40-year-old buildings are unable to provide the control of temperature, vibration, and air quality that is needed for 21st century research and measurement. The major infrastructure systems in the GPLs, such as the mechanical, electrical and plumbing, are obsolete and well beyond their life expectancies resulting in systems that are increasingly difficult to maintain and more prone to potentially catastrophic failures. While in full compliance with current building codes when constructed, the buildings do not meet modern life safety building codes including egress, sprinklers, and fire proofing. Additionally, typical of older buildings, the GPLs still contain significant quantities of asbestos, lead, mercury and Polychlorinated Biphenyls (PCBs) which must be carefully addressed and remediated in even the smallest renovation. Major renovations will be required to bring the buildings to a modern performance and safety 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 Gaithersburg GPLs is a long-term program as part of NIST's strategic facilities plan.

Proposed NIST Technical Program:

This initiative is part of a comprehensive, multi-year plan for the phased renovation of all the GPLs at the NIST Gaithersburg laboratories. In FY 2010, a $2.0 million Gaithersburg site space utilization study was funded. This FY 2011 request of $14.4 million will provide funding for the initial cost of the planning documents based on the results of the FY 2010 space study. 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.

Performance Measures: Outputs

At the proposed funding level for FY 2011, NIST will generate the following outputs:

General Purpose Laboratories Renovations	
Technical Area	**Outputs/(Targets)**
General Purpose Laboratories Renovations	• Award multiyear Architectural/Engineering contract to plan, program, and design the GPL renovations (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 step in the renovation process of the GPLs to enable the research and measurement programs to better support key national priorities in energy, environment, manufacturing, health care, physical infrastructure, information technology, 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 measurement 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	0	2,000	14,400	0	0	0	0	0	16,400

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 Laboratories Renovations

Object Class		2011 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	14,400
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	14,400
	Transfer to NIST Working Capital Fund	0
	Total increase requested	14,400

Department of Commerce
National Institute of Standards and Technology
Construction of Research Facilities
INCREASE FOR FY 2011
(Dollar amounts in thousands)

		2011 Base		2011 Estimate		Increase/(Decrease) Over 2011 Base	
		Personnel	Amount	Personnel	Amount	Personnel	Amount
Total, Construction and Major Renovations	Pos./Approp	89	$58,668	89	$124,800	0	$66,132
	FTE/Obl.	89	58,668	89	124,800	0	66,132
Safety, Capacity, Maintenance, and Major Repairs Increase	Pos./Approp	89	$58,668	89	$72,500	0	$13,832
(Modifications and Improvements)	FTE/Obl.	89	$58,668	89	72,500	0	13,832

Safety, Capacity, Maintenance, and Major Repairs Increase - (+0 Permanent Positions, +0 FTE, Appropriation +$13,832,000, Direct Obligations +$13,832,000)

- This initiative will provide a sufficient level of funding in support of NIST's Safety, Capacity, Maintenance and Major Repairs (SCMMR) program. SCMMR funds capacity, safety improvements as well as ongoing, recurring and preventative maintenance and major repair of the NIST physical plant in Gaithersburg, Maryland; Boulder and Fort Collins, Colorado; and Kauai, Hawaii.

- Most of NIST's buildings were constructed in the 1950s and 1960s, and are no longer adequate for the research needed to support U.S. innovation and industrial competitiveness in key areas such as nanotechnology, biotechnology, new energy sources, telecommunications, manufacturing, and many other key technology areas. This initiative is part of a comprehensive facilities plan to systematically renovate existing research facilities while reducing the extensive maintenance and repair backlog.

- Independent analysis recommends an annual investment of SCMMR funding equal to three to four percent of the value of the facilities ($70 to $80 million). These independent engineering studies documented the need for increased funding to prevent building and infrastructure failures. The recommended funding level is based on the industry/commercial funding standard that will eventually allow the agency to adequately address its critical facility needs and provide mission ready facilities.

- This initiative enables NIST to more effectively and efficiently address the *President's Plan for Science and Innovation* calling for a doubling of NIST Laboratory research. 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 and deteriorating buildings and infrastructure threaten NIST's ability to meet its mission. The Construction of Research Facilities (CRF) appropriation funds building construction and the safety, capacity, maintenance and major repairs (SCMMR) of NIST's physical plant. NIST maintains about 50 specialized laboratories, offices and support buildings at its two major sites in Gaithersburg, Maryland, and Boulder, Colorado. To support the NIST Time Scale and Network Time Service System, a National Critical Infrastructure Asset, NIST maintains additional facilities in Fort Collins, Colorado and Kauai, Hawaii. Most of the Gaithersburg structures were built in the 1960s and the Boulder facilities are a decade older. While some increases to SCMMR have led to improvements in these facilities and infrastructure, the current state of NIST facilities – whether measured in terms of safety, capacity, or state of repair - remains a serious impediment to the NIST mission. NIST performs critical measurement science and standards research that enables scientific discovery and translation of these discoveries into economically meaningful products and services that impact the Nation and improve the quality of life for all Americans. NIST research is critical to advances in vital fields such as nanotechnology, semiconductor technology, bioscience and many other high impact areas. Deterioration of NIST buildings and infrastructure makes the task harder to achieve.

NIST measurement and standards research impact every sector of the economy ranging from advanced research, through manufacturing and distribution. The current state of NIST facilities limits NIST's ability to meet the measurement and standards challenges in each of these areas. For example, poor vibration control, poor temperature control, and low air quality due to a 40 year-old air-conditioning and heating system, increase the difficulty of even most basic calibrations such as the calibration of precision pressure gages. These calibrations are the critical first step in a national measurement chain that ensures the accuracy of airplane altimeters and supports a wide variety of manufacturing sectors, including semiconductors and pharmaceuticals.

SCMMR funds capacity and safety improvements as well as ongoing, recurring and preventative maintenance and major repair of the NIST physical plant in Gaithersburg, Maryland; Boulder and Fort Collins, Colorado; and Kauai, Hawaii. NIST first began receiving Congressional support for SCMMR work in 1995 under the CRF appropriation. The following are examples of the projects that are planned to be completed during fiscal year 2011:

Critical infrastructure investments to meet the needs of modern research facilities

- increased capacity for Gaithersburg's Steam and Chilled Water Plant and systems (boilers, chillers, cooling cells, and pumping systems)

- replacement of Boulder's aging, obsolete, failed mechanical systems (includes heating and cooling coil control valves, chillers, condenser units, steam supply and condensate return main distribution lines)
- roof replacements in Boulder
- replacement of 40 to 50 year-old networked electric transformers with new networked transformers, network protectors, unit substations, and switchgear at both Gaithersburg and Boulder sites
- replacement of the over 40-year-old condensate receivers, vacuum pumps, and steam traps for the Gaithersburg General Purpose Laboratories (GPLs)
- provide a second electrical feed to the Boulder site

Investments to ensure handicap accessibility of NIST buildings and facilities
- install new elevators in Boulder's Building 2 and Building 1, Wing 5
- refurbishment of Gaithersburg passenger elevators in Building 101
- renovate NIST radio stations to be Americans with Disabilities Act (ADA) compliant

Investments to ensure the safety of NIST staff
- remediation of asbestos and other known life safety hazards
- install fire protection system at NIST radio stations
- install new fire protection system for the clean rooms in Boulder's Building 1 to replace the halon system
- renovate stairwells in Boulder's Buildings 1, 2, and 24 to be code compliance areas of refuge
- construct code compliance separation walls between laboratories, offices, and areas of egress
- perform building-wide rebalancing of air flow thru building central air handling units (supply/return/exhaust) and fume hoods, which ensures proper safe air flow between laboratories and public areas and the proper safe operation of fume hoods
- remove non-functioning after-burner exhaust system in Gaithersburg's Building 224 (Polymers) and install modern exhaust system
- continue phased program to improve indoor air quality by systematically cleaning HVAC systems and all associated duct work to laboratories and offices in identified buildings, and by removing unwanted small particulate matter due to deteriorating duct lining
- install oxygen depletion sensors in laboratories with cryogens and in gas bottle storage areas
- continue phased program to upgrade main fire alarm panels
- eliminate slips/trips/falls potential safety hazards by repairing uneven sidewalks in identified locations

Cost effective investments to increase the energy efficiency of NIST buildings
- replacement of the over 40-year-old single pane windows with double pane, low E, argon gas filled windows in Boulder and Gaithersburg
- refurbishment of aging, failing central HVAC units that individually serve many laboratories and/or office spaces at both Boulder and Gaithersburg sites
- replacement of lights in Boulder buildings with Energy star rated fixtures
- install additional solar panels in Boulder, Fort Collins, and Kauai
- replacement of aging, obsolete, failed heating and cooling coil control valves on GPL central HVAC units

The current base level of SCMMR funding is not sufficient to keep up with the backlog of major repair work that is required to maintain the NIST facilities in good working condition. Two independent engineering studies for the Gaithersburg site, one in FY 1997 by Booz-Allen and Hamilton, Inc[1] and another completed in FY 2004 by Hanscomb, Faithful and Gould (HF&G) [2] identified a significant deferred maintenance backlog and documented the need for increased funding to prevent building and infrastructure failures. These studies recommended that SCMMR funds should be increased to at least three percent (as recommended by HF&G) to four percent (as recommended by Booz-Allen and Hamilton, Inc) of facility replacement value. The studies were based on a rigorous business case analysis and drew upon standard industry practices for high-technology laboratories such as the NIST facilities. Based on a replacement value of approximately $1.5 billion, the HF&G study recommended a FY 2004 SCMMR level of $44.6 million for Gaithersburg alone, excluding the Advanced Measurement Laboratory (AML).

A Boulder site engineering study, completed in FY 2008 by NIKA[3], valued the Boulder site's replacement value at $229.5 million. At three percent of the Boulder site replacement value, the annual SCMMR investment should be about $6.9 million for Boulder, in FY 2008 dollars. When these recommended levels are converted into FY 2011 dollars[4] and an adjustment made for the AML, the total annual SCMMR program should equate to approximately $70 to $80 million.

In the period since the completion of these analyses, the failure rate of major building systems (i.e., air handling systems, piping systems, and building closure systems – roofs, windows, and foundation waterproofing) has increased dramatically. The 2004 HF&G report focused on the Gaithersburg site, and calculated a Facility Condition Index (FCI) for each major building – a number ranging from 0.00 to 1.00 expressing the relative urgency for major repairs and renovations. In general, an index of up to 0.05 is good, 0.05 to 0.10 is fair, and any index above 0.10 is poor. All but three of the NIST Gaithersburg site buildings and structures surveyed had an FCI in excess of 0.10, indicating poor condition, and one building, an industrial laboratory, had an FCI close to 1.00. An FCI greater than 1.00 means that the least expensive option is to raze and rebuild. The FCI for the Gaithersburg site as a whole is 0.308. The HF&G report concluded that most building systems on the Gaithersburg site are well past their expected service life and, with the exception of the newer laboratory buildings, every building has at least one or more systems that need to be repaired or replaced immediately, and all remaining systems should be repaired or replaced within a seven-year period. The FCI for the Boulder site is even worse, given that the site is a decade older.

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1 Booz Allen & Hamilton, *Capital Assets Economic Analysis – Business Case for the United States Department of Commerce National Institute of Standards and Technology*, June 20, 1997.

2Hanscomb, Faithful, and Gould, *National Institute of Standards and Technology Facility Assessment Executive Summary & Project Execution Plan*, February 23, 2004.

3 NIKA, *NIST Boulder Laboratories – Facility Condition Assessment*, June 9, 2008.

4 Inflationary factors taken from OMB's economic assumptions for FY 2010 Congressional Budget dated December 4, 2008, "Alternative Price Measures: Fiscal Year Over Fiscal Year Percent Change"

Selected examples of recent building system and infrastructure failures:

In the past few years on the Gaithersburg site, there have been more examples of significant failures to critical site-wide utility systems (electric, water, steam/condensate):

In January 2009, a 500-yard length of underground steam/condensate piping had to be completely replaced ahead of its planned repair phase. Along the entire length, a wide swath of grass above the pipe had died and the ground and sidewalk overtop were very warm to the touch, clear indications that the pipe's insulating outer jacket had failed. By replacing the failing section of pipe when we did, we avoided the possibility of steam service being interrupted for an extended period of time to two complete lab buildings and the site's main service support buildings. Without steam, temperature and humidity control in the laboratories' conditioned spaces are significantly affected, as well as the buildings' hot water supply.

In November 2008, a high voltage (13,800 volt) splice catastrophically failed in an electric manhole. Since buildings are fed with redundant high voltage feeder cable, power was not interrupted to the 16 buildings that are supplied by the electrical underground distribution system that is routed through this manhole. A contributing cause to the splice's failure appears to be excessive heat from an adjacent underground steam supply/condensate return pipeline whose insulating outer jacket had failed. The high voltage splice has since been replaced as well as 400 yards of connected primary high voltage cable. During the work, all electrical power to the 16 buildings had to be secured for an overnight period. The adjacent steam line is due for replacement beginning in February 2010, when the replacement pipe arrives on-site.

In May 2008, a ten-foot section of 12-inch diameter domestic water pipeline developed longitudinal cracks and failed, as evidenced by water gushing out of the ground. Eight research buildings are totally dependent on this water main, including the NIST Center for Neutron Research (NCNR). This break was a critical utility infrastructure failure as it forced the shutdown of the NCNR facility, which cannot operate without the availability of emergency domestic cooling water backup supply and cooling tower makeup supply. An adjacent steam pipeline also had to be secured, affecting steam service to these buildings. Given the urgency of the repairs in light of the affected buildings, crews worked through the night and had water and steam restored to the affected buildings by mid-morning the next day. Due to this very quick response, the NCNR only lost eleven hours of operating research time.

In March 2008, an electrical buss duct experienced an electrical fault due to a sustained internal arcing event in the attic mechanical room of Building 221 (Physics). This caused half of the 220,000 gross square foot research building to lose critical cooling and power to exhaust fans and 480-volt equipment. By happenstance, NIST had a 1960's era out-of-production section of buss duct on hand. Personnel worked around the clock to make the necessary temporary repairs, restoring power to the affected research spaces within 24 hours.

In the past few years, the Boulder, Colorado site, as well as our supported field sites in Kauai, Hawaii and Fort Collins, Colorado, have also experienced critical facility and infrastructure issues and failures. All of these incidents have had, or could have had, an adverse impact on the research or services provided at each location:

Aging light fixtures and light ballasts are suspected in two light fixture fires that occurred recently at Boulder's Building 1 and Building 2. These were isolated incidents; one fixture out of hundreds in each building but they are cause for concern. Many older types of ballast also contain Polychlorinated Biphenyls (PCBs). A plan is being developed to systematically inspect, replace PCB containing ballasts as needed, and upgrade all fixtures on site.

Numerous Boulder site HVAC systems have exceeded their useful life. For example, HVAC systems that service the area housing the Atomic Clock and Time Scale frequently fail and cause temperature excursions. Temperature fluctuations cause the clock and associated systems to run in ambient conditions outside of required environmental conditions resulting in invalid measurements and data.

The main elevator in Building 1 is beyond its normal service life and fails to operate frequently. Employees are frequently trapped in the elevator until rescuers can arrive. Efforts are being made to replace the elevator as soon as possible, but in the meantime repairs are made as needed.

Repeated roof failures at the Boulder site Child Care Center caused mold to grow in the walls and between the insulation and the floor. The presence of mold created a serious health hazard that forced the shutdown of classrooms causing disruption to the staff that has children at the Center. Temporary roof repairs were made and the mold was remediated. A design for the complete replacement of the roof at the Child Care Center is being completed with a contract to be awarded in FY 2010.

Roof failure at the Kauai field site allowed water leakage into the electrical switchgear room creating serious electrical shock hazards to the staff and the potential for fires. Roof leaks at Kauai have also damaged asbestos containing ceiling tile that must be abated and replaced. The roof was recently replaced eliminating the hazard. A solicitation to abate and replace the damaged ceiling tiles is currently being developed with an award planned for FY 2010.

The electrical distribution system at the WWV Building in Fort Collins is antiquated and beyond its useful life. This causes the potential for catastrophic failure and causes concern for life safety. Planning and design to improve and/or replace the system will be started in January 2010.

Proposed NIST Technical Program:

SCMMR funds necessary safety and capacity improvements, routine maintenance, and major repairs to the infrastructure and about 50 specialized laboratories, offices and support buildings at sites in Gaithersburg, Maryland; Boulder and Fort Collins, Colorado; and Kauai, Hawaii. The NIST Time Scale and Network Time Service System, a National Critical Infrastructure Asset, is represented at the NIST sites in Colorado and Hawaii. The Gaithersburg facilities and infrastructure were built in the early 1960s; the Boulder facilities and infrastructure in the 1950s, and the Fort Collins and Hawaii field sites in the mid to late 1960s.

As documented above, an ever-pressing issue for NIST is the aging and obsolescence of the facilities and infrastructure at all NIST sites. These aging facilities and their extensive backlog of deferred maintenance have become serious impediments to the efficient completion of the NIST mission in all areas of research. While some progress has been made by strategically applying available SCMMR resources against the most critical repair needs, NIST still faces a large backlog of urgent SCMMR projects. Some of NIST's most serious facility deterioration directly affects the welfare and safety of the roughly 5,500 employees and guest researchers who are present on the two major sites at any given time. Each site still suffers from severe systems capacity problems, including antiquated electrical systems (transformers, switchgear, and motor starters) and non-existent or inadequate delivery of chilled water to the laboratories. Based on the independent architectural and engineering reviews and in conjunction with the need to maintain world class research, the proposed increase in funds, combined with the current base, will continue to target the most critical NIST SCMMR projects.

The requested SCMMR increase will be used for projects in the following areas:

- Aging Mechanical and Electrical Systems Repairs/Replacements;
- Hazardous Material Removal;
- Energy Conservation;
- Site Alarm System Upgrades;
- Handicap Accessibility;
- Steam and Chilled Water Generation Plant Expansion/Replacement;
- Site Utility Systems Replacements/Upgrades;
- Structural Repairs/Replacements;
- Civil and Site Environmental Repairs/Replacements;
- Conveying Systems Repairs/Replacements;
- Exhaust Air Filtration Systems Repair/Replacements; and
- Architectural Repairs/Replacements.

Performance Measures: Outputs

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

Safety, Capacity, Maintenance, and Major Repair increase	
Technical Area	**Outputs**
SCMMR increase	• For existing NIST buildings, keep the average unscheduled downtime to less than seven percent of total scheduled possible operating time.

Performance Measures: Outcomes

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

The beneficial impact of renovating NIST's facilities on the U.S. economy will be long-term and significant. NIST researchers seek to reliably and accurately measure everything from length, to time, to mass, to electric current – before industry or science hits a roadblock in its pursuit of a better product or new understanding of the way the world works. In this way, NIST research helps foster technological innovation, which is the driving force for about 50 percent of U.S. economic growth. The critical measurement science and standards research performed by NIST enables scientific discovery and speeds the translation of these discoveries into economically meaningful products and services. These new and improved products make U.S. industry more competitive and enhance the quality of life and economic security of all Americans.

Postponement of NIST's facility repairs is not cost-effective. For each year that maintenance and repair projects are delayed, the buildings become less functional, building system failures become more commonplace, and the repair costs continue to escalate.

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: Safety, capacity, maintenance, and major repairs increase

Object Class		2011 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	13,832
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	13,832
	Transfer to NIST Working Capital Fund	0
	Total increase requested	13,832

Exhibit 16

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	2009 Actual	2010 Currently Available	2011 Base	2011 Estimate	Increase/ (Decrease) Over 2011 Base
11	Personnel compensation					
11.1	Full-time permanent	$7,176	$7,347	$7,450	$7,450	0
11.3	Other than full-time permanent	33	33	33	33	0
11.5	Other personnel compensation	636	636	636	636	0
11.9	Total personnel compensation	7,845	8,016	8,119	8,119	0
12.1	Civilian personnel benefits	2,083	2,149	2,253	2,253	0
13	Benefits for former personnel	1	1	1	1	0
21	Travel and transportation of persons	56	56	57	57	0
22	Transportation of things	20	20	20	20	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	71	71	72	72	0
24	Printing and reproduction	2	2	2	2	0
25.1	Advisory and assistance services	0	0	0	0	0
25.2	Other services	66,620	107,768	45,093	73,325	$28,232
25.3	Purchases of goods and services from government accounts	86	86	87	87	0
25.5	Research and development contracts	0	0	0	0	0
25.7	Operation and maintenance of equipment	1,106	1,106	1,115	1,115	0
26	Supplies and materials	1,673	1,673	1,686	1,686	0
31	Equipment	162	162	163	163	0
32	Land and structures	4,802	147,112	0	37,900	37,900
41	Grants, subsidies, and contributions	146,283	221,324	0	0	0
42	Insurance claims and indemnities	1	0	0	0	0
99	Total Obligations	230,811	489,546	58,668	124,800	66,132

	Object Class	2009 Actual	2010 Currently Available	2011 Base	2011 Estimate	Increase/ (Decrease) Over 2011 Base
99	Total Obligations	230,811	489,546	58,668	124,800	66,132
	Less Prior Year Recoveries	(1,294)	0	0	0	0
	Less Prior Year Refunds	(5)	0	0	0	0
	Less Prior Year Unobligated Balance	(40,058)	(342,546)	0	0	0
	Plus Unobligated Balance End of Year	342,546	0	0	0	0
	Total Budget Authority	532,000	147,000	58,668	124,800	66,132
	Plus Transfers from Other Accounts	0	0	0	0	0
	Appropriation	532,000	147,000	58,668	124,800	66,132

Personnel Data

	2009 Actual	2010 Currently Available	2011 Base	2011 Estimate	Increase/ (Decrease) Over 2011 Base
Full-time equivalent employment:					
Full-time permanent	89	89	89	89	0
Other than full-time permanent	0	0	0	0	0
Total	89	89	89	89	0
Authorized Positions:					
Full-time permanent	81	89	89	89	0
Other than full-time permanent	0	0	0	0	0
Total	81	89	89	89	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	2011 Adjustments to Base	2011 Base	2011 Estimate	Increase/ (Decrease) Over 2011 Base
11	Personnel compensation				
11.1	Full-time permanent				
	Executive level	0	0	0	0
	Senior executive service	0	0	0	0
	Career path	$72	$5,152	$5,152	0
	Wage board	31	2,298	2,298	0
	Scientific & professional (P.L. 80-313)	0	0	0	0
	Subtotal	103	7,450	7,450	0
11.3	Other than full-time permanent				
	Career path	0	33	33	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	33	33	0
11.5	Other personnel compensation				
	Overtime	0	604	604	0
	SES performance awards	0	0	0	0
	Cash awards	0	32	32	0
	Other	0	0	0	0
	Subtotal	0	636	636	0
11.9	Total personnel compensation	103	8,119	8,119	0

	Object Class	2011 Adjustments to Base	2011 Base	2011 Estimate	Increase/ (Decrease) Over 2011 Base
12.1	Civilian personnel benefits				
	Civil service retirement	(13)	73	73	0
	Federal employees' retirement	66	798	798	0
	Thrift savings plan	13	304	304	0
	Federal Insurance Contribution Act	16	506	506	0
	Health insurance	36	514	514	0
	Life insurance	0	11	11	0
	Employees' Compensation Fund	(14)	0	0	0
	Other	0	47	47	0
	Subtotal	104	2,253	2,253	0
13	Benefits for former personnel				
	Severance pay	0	0	0	0
	Unemployment compensation	0	0	0	0
	Other	0	1	1	0
	Subtotal	0	1	1	0
21	Travel and transportation of persons				
	Common carrier	0	23	23	0
	Mileage	0	0	0	0
	Per diem/actual	1	21	21	0
	Other	0	13	13	0
	Subtotal	1	57	57	0
22	Transportation of things	0	20	20	0
23.1	Rental payments to GSA	0	0	0	0
23.2	Rental payments to others	0	0	0	0

	Object Class	2011 Adjustments to Base	2011 Base	2011 Estimate	Increase/ (Decrease) Over 2011 Base
23.3	Communications, utilities, and miscellaneous charges				
	Rental of ADP equipment	0	0	0	0
	Rental of office copying equipment	0	6	6	0
	Other equipment rental	0	43	43	0
	Federal telecommunications system	0	0	0	0
	Other telecommunications services	1	21	21	0
	Postal Service by USPS	0	2	2	0
	Utilities:				
	Electric	0	0	0	0
	Gas	0	0	0	0
	Water/Sewer	0	0	0	0
	Subtotal	1	72	72	0
24	Printing and reproduction				
	Publications	0	0	0	0
	Other	0	2	2	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	1	64	64	0
	ADP Services	3	368	368	0
	Other non-government contracts	(9,369)	44,661	72,893	$28,232
	Subtotal	(9,365)	45,093	73,325	28,232
25.3	Purchases of goods and services from Government accounts				
	Payments to DM, WCF	0	0	0	0
	Office of Personnel Management	0	10	10	0
	Other Federal agencies:				
	Department of Commerce	0	11	11	0
	Other	1	66	66	0
	Subtotal	1	87	87	0

	Object Class	2011 Adjustments to Base	2011 Base	2011 Estimate	Increase/ (Decrease) Over 2011 Base
25.5	Research and development contracts	0	0	0	0
25.7	Operation and maintenance of equipment	9	1,115	1,115	0
26	Supplies and materials				
	Office & laboratory supplies	13	1,686	1,686	0
	Scientific publications & journals	0	0	0	0
	Fuel oil	0	0	0	0
	Subtotal	13	1,686	1,686	0
31	Equipment				
	Office machines and other equipment	0	28	28	0
	ADP equipment	1	95	95	0
	Equipment amortization	0	40	40	0
	Subtotal	1	163	163	0
32	Land and structures	(12,200)	0	37,900	37,900
41	Grants, subsidies, and contributions	(67,000)	0	0	0
42	Insurance claims and indemnities	0	0	0	0
99	Total Obligations	(88,332)	58,668	124,800	66,132
	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	(88,332)	58,668	124,800	66,132
	Transfer to NIST Working Capital Fund	0	0	0	0
	Total Appropriation	(88,332)	58,668	124,800	66,132

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. $147,000,000, to remain available until expended per P.L. 111-117 Consolidated Appropriations Act, 2010.

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 2009 Actual	FY 2010 Estimate	FY 2011 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.

Working
Capital Fund

Department of Commerce
National Institute of Standards and Technology
Working Capital Fund
SUMMARY OF RESOURCE REQUIREMENTS
(Dollar amounts in thousands)

	Positions	FTE	Budget Authority	Obligations
2010 President's Budget	695	776	$2,250	$2,250
Reduction in transfers from prior STRS program changes	0	0	(2,250)	(2,250)
2011 Base	695	776	0	0
Transfer from STRS program changes for equipment investments			3,300	3,300
2011 Estimate	695	776	3,300	3,300

Department of Commerce
National Institute of Standards and Technology
Working Capital Fund
SUMMARY OF FINANCING
(Dollar amounts in thousands)

	2009 Actual	2010 Currently Available	2011 Base	2011 Estimate	Increase/ (Decrease) Over 2011 Base
Total Obligations	$170,802	$172,632	$147,134	$150,434	3,300
Offsetting collections from:					
Federal funds	(106,074)	(121,683)	(98,452)	(98,452)	0
Non-Federal sources	(59,999)	(48,699)	(48,682)	(48,682)	0
Total offsetting collections	(166,073)	(170,382)	(147,134)	(147,134)	0
Unobligated balance, start of year	(123,708)	(120,234)	(120,234)	(120,234)	0
Unobligated balance, end of year	120,234	120,234	120,234	120,234	0
Change in uncollected customer payments - Federal	845	0	0	0	0
Budget Authority	2,100	2,250	0	3,300	3,300
Financing:					
Transfer from other accounts	(2,100)	(2,250)	0	(3,300)	(3,300)
Appropriation	0	0	0	0	0

**Program and
Performance**

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.

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Exhibit 16

Department of Commerce
National Institute of Standards and Technology
Working Capital Fund
SUMMARY OF REQUIREMENTS BY OBJECT CLASS
(Dollar amounts in thousands)

	Object Class	2009 Actual	2010 Currently Available	2011 Base	2011 Estimate	Increase/ (Decrease) Over 2011 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	$2,100	$2,250	0	$3,300	$3,300
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	2,100	2,250	0	3,300	3,300

Personnel Data	2009 Actual	2010 Currently Available	2011 Base	2011 Estimate	Increase/ (Decrease) Over 2011 Base
Full-time equivalent employment:					
Full-time permanent	636	708	708	708	0
Other than full-time permanent	61	68	68	68	0
Total	697	776	776	776	0
Authorized Positions:					
Full-time permanent	679	665	665	665	0
Other than full-time permanent	30	30	30	30	0
Total	709	695	695	695	0

Exhibit 17

Department of Commerce
National Institute of Standards and Technology
Working Capital Fund
DETAILED REQUIREMENTS BY OBJECT CLASS
(Dollar amounts in thousands)

	Object Class	2011 Adjustments to Base	2011 Base	2011 Estimate	Increase/ (Decrease) Over 2011 Base
26	Supplies and materials				
	Office & laboratory supplies	0	0	$400	$400
	Other	0	0	0	0
	Subtotal	0	0	400	400
31	Equipment				
	Office machines and other equipment	($1,400)	0	2,050	2,050
	ADP equipment	(850)	0	850	850
	Equipment amortization	0	0	0	0
	Subtotal	(2,250)	0	2,900	2,900
99	Total Obligations	(2,250)	0	3,300	3,300

Department of Commerce
National Institute of Standards and Technology
Working Capital Fund
ADVISORY AND ASSISTANCE SERVICES
(Obligations in thousands of dollars)

	FY 2009 Actual	FY 2010 Estimate	FY 2011 Estimate
Management and professional support services	$1,175	$792	$842
Studies, analyses, and evaluations	836	60	0
Engineering and technical services	149	98	46
Total	2,160	950	888

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 2009			FY 2010			FY 2011			
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	2,013	1,953	$534,204	2,117	2,182	$710,657	2,322	2,324	$585,450	$584,500
Industrial technology services	137	142	161,199	148	153	235,943	148	154	213,400	209,600
Construction of research facilities	81	89	230,811	89	89	489,546	89	89	124,800	124,800
Gifts and bequests	0	0	2	0	0	2	0	0	2	0
Total, direct funding	2,231	2,184	926,216	2,354	2,424	1,436,148	2,559	2,567	923,652	918,900
Reimbursable Funding and WCF Investments										
Scientific and technical research and services - Smart Grid, DoE/ NTIA/Superconducting, DoE	0	0	2,290	0	0	10,060	0	0	0	
Construction of research facilities - building surcharge	0	0	911	0	0	880	0	0	0	
Research, development and supporting services:										
Federal government	499	491	117,351	489	545	121,683	489	545	98,452	
Calibrations and tests, technical and advisory services:										
Federal government	23	22	6,572	22	25	6,360	22	25	6,003	
Public and non-federal government	86	85	24,956	85	95	24,152	85	95	22,795	
Subtotal, Services	109	107	31,528	107	120	30,512	107	120	28,798	
National Voluntary Laboratory Accreditation Program	24	23	6,465	23	26	6,338	23	26	6,719	
Standard reference materials (SRMs):										
SRM Sales:										
Federal government	2	2	375	2	3	382	2	3	398	
Public and non-federal government	75	74	12,041	74	82	12,281	74	82	12,767	
Subtotal, SRM sales	77	76	12,416	76	85	12,663	76	85	13,165	
SRM investment adjustment	0	0	(47)	0	0	0	0	0	0	
Subtotal, SRM	77	76	12,369	76	85	12,663	76	85	13,165	
Total, Reimbursable program	709	697	170,914 [2]	695	776	182,136 [2]	695	776	147,134	
WCF Investments and Operating Adjustments										
WCF investments	0	0	14,675	0	0	31,278	0	0	28,800	
WCF transfers	0	0	2,100	0	0	2,250	0	0	3,300	
Excess Amortizations over Equipment Investments	0	0	7,962	0	0	0				
WCF operating adjustments	0	0	3,089	0	0	0	0	0	0	
Total, WCF Investments and operating adjustments	0	0	27,826	0	0	33,528	0	0	32,100	
Total, NIST program	2,940	2,881	1,124,956	3,049	3,200	1,651,812	3,254	3,343	1,102,886	
Offsetting adjustment for amortization of equipment	0	0	(24,737)	0	0	(32,092)	0	0	(28,800)	
Adjusted total, NIST program	2,940	2,881	1,100,219	3,049	3,200	1,619,720	3,254	3,343	1,074,086	

[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 2009 Actual	FY 2010 Estimate	FY 2011 Estimate
Department of Defense			
Air Force	$7,920	$10,257	$8,725
Army	3,881	3,488	2,051
Navy	1,839	1,764	1,315
Other	12,889	9,492	6,735
Subtotal, Department of Defense	26,529	25,001	18,826
Department of Agriculture	212	736	414
Department of Commerce	14,476	16,790	16,745
Department of Energy	8,214	8,598	7,508
Dept. of Health & Human Services	7,368	4,545	4,597
Dept. of Homeland Security	29,023	33,007	22,234
Department of the Interior	93	15	16
Department of Justice	12,314	16,450	13,623
Department of State	37	0	0
Department of Transportation	852	245	60
Department of the Treasury	48	40	20
Department of Veterans Affairs	165	165	165
Environmental Protection Agency	723	485	543
General Services Administration	1,068	475	19
National Aeronautics & Space Admin.	3,867	3,941	4,100
National Science Foundation	5,040	4,099	4,080
Nuclear Regulatory Commission	960	405	175
Other	6,362	6,686	5,327
Subtotal, Federal Agencies	117,351	121,683	98,452
Calibrations & Testing	8,905	8,391	8,579
Technical & Advisory Services	29,088	28,459	26,938
Standard Reference Materials	12,369	12,663	13,165
Subtotal, Other Reimbursables	50,362	49,513	48,682
Total, Reimbursable Program	167,713	171,196	147,134
Equipment Transfers	2,100	2,250	2,900
SRM Transfers	0	0	400
Subtotal, WCF transfer	2,100	2,250	3,300
Equipment Investments	14,675	31,278	28,800
IE Amortization	(24,737)	(32,092)	(28,800)
Excess Amortizations over Equipment Investments	7,962	0	0
WCF Operating Adjustments	3,089	0	0
Total, WCF Investments	989	(814)	0
Total, Reimbursable Program and WCF Investments	170,802	172,632	150,434

Department of Commerce
National Institute of Standards and Technology
PERIODICALS, PAMPHLETS, AND AUDIOVISUAL SERVICES
(Obligations in thousands)

	2008 Actual	2009 Actual	2010 Estimate	2011 Estimate
Periodicals	$6	$15	$34	$34
Pamphlets	21	25	25	25
Audiovisuals	15	6	15	33
Total	42	46	74	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).

Exhibit 36

Department of Commerce
National Institute of Standards and Technology
AVERAGE SALARY

	2009 Actual	2010 Estimate	2011 Estimate
Average ES salary	$163,898	$167,176	$169,516
Average scientific and professional	162,763	166,018	168,342
Average Career Path Salary	103,040	105,101	106,572
Average salary of ungraded positions	54,688	55,782	56,563

DEPARTMENT OF COMMERCE
NATIONAL TECHNICAL INFORMATION SERVICE
NTIS Revolving Fund
Budget Estimates, Fiscal Year 2011
President's Submission

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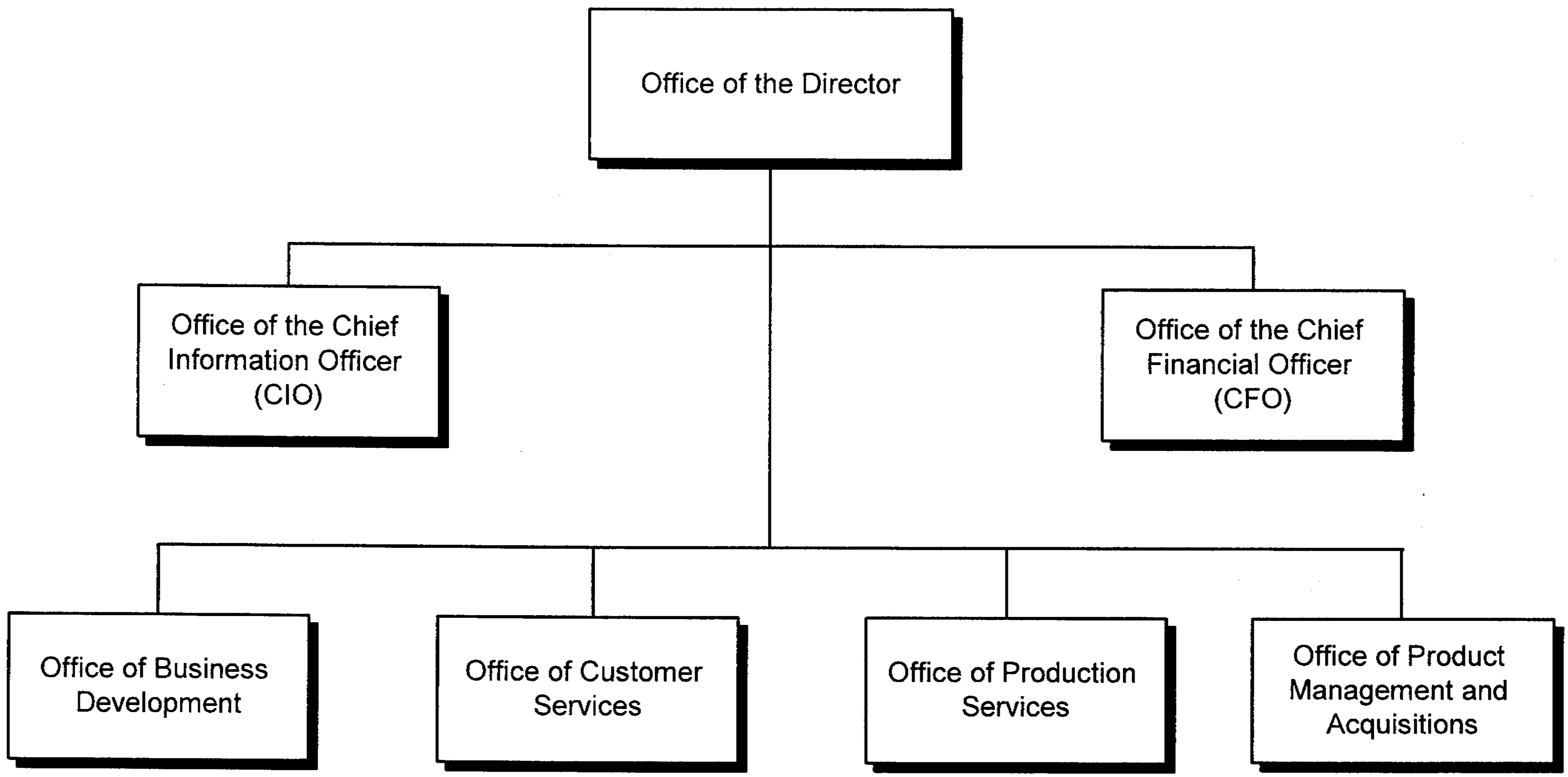
Exhibit 2

U.S. Department of Commerce
National Technical Information Service



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Department Of Commerce
National Technical Information Service
NTIS Revolving Fund
Budget Estimates, Fiscal Year 2011
President's Submission

General Statement

Goals of the Program

The National Technical Information Service (NTIS), seeks to promote innovation and economic growth of America's economy by (a) collecting, classifying, coordinating, integrating, recording and cataloging scientific and technical information from whatever sources, domestic and foreign, that may be available, (b) disseminating this information to the public, and (c) providing information management services to other Federal agencies that help them interact with and better serve the information needs of their own constituents, and to do all without appropriated funds.

Statement of Objectives

NTIS' principal objective supports the Department's strategic plan to promote U.S. innovation and industrial competitiveness by providing business and industry, academia and the general public easy access to scientific and technical research and to ensure that such research is permanently available to future generations of researchers. To this end, NTIS acquires information products from agencies; abstracts, catalogs and indexes them so that they can easily be identified and merged into NTIS' permanent bibliographic database; and physically stores them or scans them into electronic image for reproduction on demand by customers.

NTIS' objectives are to (a) make it easier for the general public to locate federal technical information electronically; (b) build an array of collaborative working arrangements with private sector partners; (c) help other federal agencies meet their own information management and dissemination requirements, and (d) meet objectives in the most cost effective and efficient manner possible.

NTIS has demonstrated innovative achievements in its information dissemination activities as provided in the National Technical Information Act of 1988, codified at 15 U.S.C. 3704b. This Act directed NTIS to "implement new methods or media for the dissemination of scientific and technical, and engineering information." Supporting this directive, NTIS, as part of its base program and without appropriations, made its bibliographic database since 1990 available on the Internet, making the collection more widely available to the public and allowing customers to download products electronically. During FY 2011 those efforts will continue to be expanded and refined as analysis of the activities warrant. In this continuing effort, NTIS continues to follow all Administration policies restricting access to information that could be used improperly.

Summary of Performance and Resources

NTIS continues to make substantial progress in improving its service to the public. NTIS collects approximately 30,000 scientific and technical reports annually that are added to its permanent collection. NTIS also makes available to the public another 750,000 items in the form of articles, updates, advisories, etc. that are contained in various subscription products and/or databases it distributes. Although the amount of new material is highly dependent on budgetary and program decisions made by other agencies, NTIS' activities and accomplishments continue to support its basic public purpose of serving as a comprehensive point of access and dissemination to federally-funded scientific, technical and related information.

The explosive growth of the Internet has provided NTIS with a unique opportunity to expand its information dissemination activities. Information products are disseminated in a variety of formats, including paper, microfiche, diskettes, audio-visual, CD-ROM, database leases, web site hits and electronic downloads. NTIS estimates it will provide approximately 34.8 million information items to the public in FY 2011.

NTIS plans to obligate $43,000,000 of earned revenue in FY 2011.

(Dollar amounts in thousands)

	2009	2010	2011	2012	2013	2014	2015
National Technical Information Service:							
Reimbursement from offsetting collections:							
Information clearinghouse program	$31,896	$42,500	$43,000	$43,500	$44,000	$44,500	$45,000
Total, NTIS	$31,896	$42,500	$43,000	$43,500	$44,000	$44,500	$45,000

Note: Reimbursable Budget Authority, receipt and obligation data are estimates. Actuals will vary depending on products and services sold.

Department Of Commerce
National Technical Information Service
NTIS Revolving Fund
SUMMARY OF RESOURCE REQUIREMENTS
(Dollar amounts in thousands)

	Positions	FTE	Budget Authority	Direct Obligations
Currently Available, 2010	0	0	0	0
Plus 2011 Adjustments to Base	0	0	0	0
Less: Obligations from prior years	0	0	0	0
2011 Base Request	0	0	0	0
Plus 2011 program changes	0	0	0	0
2011 Estimate	0	0	0	0

		2009 Actual		2010 Currently Available		2011 Base		2011 Estimate		Increase/ (Decrease) over 2011 Base	
Comparison by Activity:		Personnel	Amount	Personnel	Amount	Personnel	Amount	Personnel	Amount	Personnel	Amount
National Technical Information Service:											
Organization, Preservation and Public	Pos./BA	0	0	0	0	0	0	0	0	0	0
Access to Technical Information	FTE/Obl.	0	0	0	0	0	0	0	0	0	0
TOTALS	Pos./BA	0	0	0	0	0	0	0	0	0	0
	FTE/Obl.	0	0	0	0	0	0	0	0	0	0
Adjustments to Obligations											
Recoveries		0	0	0	0	0	0	0	0	0	0
Unobligated balance, start of year		0	0	0	0	0	0	0	0	0	0
Unobligated balance, end of year		0	0	0	0	0	0	0	0	0	0
Financing from transfers:											
Transfer from other accounts (-)		0	0	0	0	0	0	0	0	0	0
Transfer to other accounts (+)		0	0	0	0	0	0	0	0	0	0
Appropriation		0	0	0	0	0	0	0	0	0	0

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Exhibit 7

Department Of Commerce
National Technical Information Service
NTIS Revolving Fund
SUMMARY OF FINANCING
(Dollar amounts in thousands)

	2009 Actual	2010 Currently Available	2011 Base	2011 Estimate	Increase (Decrease) over 2011 Base
Total Obligations	$31,896	$42,500	$43,000	$43,000	$0
Offsetting collections from:					
Federal funds	(18,176)	(23,375)	(23,650)	(23,650)	0
Trust funds	0	0	0	0	0
Non-Federal sources	(11,154)	(19,125)	(19,350)	(19,350)	0
Recoveries	0	0	0	0	0
Unobligated balance, start of year	(7,174)	(4,608)	(4,608)	(4,608)	0
Unobligated balance transferred	0	0	0	0	0
Unobligated balance, end of year	4,608	4,608	4,608	4,608	0
Budget Authority	0	0	0	0	0
Financing:					
Transferred from other accounts (-)	0	0	0	0	0
Transferred to other accounts (+)	0	0	0	0	0
Appropriation	0	0	0	0	0

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Exhibit 12

Department Of Commerce
National Technical Information Service
NTIS Revolving Fund
JUSTIFICATION OF PROGRAM AND PERFORMANCE

Activity: National Technical Information Service
Subactivity: Revolving Fund

Goal Statement

Promote innovation and economic growth of America's economy by collecting, organizing, preserving, and disseminating government scientific, technical, and business-related information.

Base Program

Information Clearinghouse Program

Since 1945, the Department of Commerce has discharged its statutory obligation "to make the results of research and development more readily available to industry and business... and to the general public" (15 U.S.C. 1152) through NTIS and its predecessors. In support of this mission, NTIS has (1) collected technical information products both domestic and foreign, along with complementary information from foreign sources; (2) organized it so it can be located easily; (3) preserved it for the benefit of future generations of researchers; (4) disseminated it in a variety of formats; and (5) helped other Federal agencies serve the information needs of their own constituencies. As such, NTIS contributes directly and substantially to the broader Department of Commerce goal of fostering the Nation's economic growth.

During FY 2011, NTIS will, as part of its base program and without appropriations, continue to make improvements to its web site. This site contains its bibliographic database since 1990, and also offers documents to the public for downloading. NTIS expects to obligate $43 million to operate as a central source for the public sale of domestic and foreign government-funded scientific, technical and business information.

The new information environment has provided NTIS with expanded opportunities to offer public access to federally-funded R&D on the Internet as part of its base program - and to do so without appropriations. NTIS will continue to use the internet to expand its efforts to build a broader customer base, and explore new opportunities. NTIS will continue to follow all Administrative policies restricting access to information that could be used improperly.

During FY 2011 NTIS, in cooperation with other federal agencies, will continue to assist the public in finding federally-funded scientific and technical publications wherever they exist – whether in the NTIS collection or at agency web sites – and even after they no longer exist at such sites. It will offer the public the convenience of one-stop shopping and deep searching of federal databases where Government technical information is likely to be found. NTIS will continue to provide permanent access to each document entering the NTIS collection. Thus, if the report ever becomes unavailable at the agency web site, the researcher will have the option of ordering the information from NTIS in the traditional manner.

Explanation and Justification

NTIS was established by law in order "to make the results of technological research more readily available to industry and business, and to the general public" (15 USC 1151). To accomplish this, the Service has been directed to operate a Clearinghouse of scientific and technical information, which is now over three million titles.

Exhibit 12

Measures of Performance

NTIS' goal to collect and disseminate government scientific, technical, and business related information to the public can be evaluated using the following measures:

Quantitative Measures	2009 Actual	2010 Estimate	2011 Estimate
Number of updated items available (annual).....................	893,138	765,000	780,000

The number of information items available to the public includes scientific, technical, and engineering information products added to the permanent collection, as well as items made available through online electronic subscriptions. NTIS has expanded and refined its efforts to acquire new scientific and technical information products by harvesting products from the Internet. These harvesting efforts together with increased availability of online electronic subscription products demonstrate NTIS' success in making new products available to the public.

Number of information products disseminated (annual)..........	49,430,840	33,000,000	34,800,000

This measure represents the volume of information products disseminated to the public and includes compact discs, diskettes, tapes, online subscriptions, web site pages, as well as the traditional paper and microfiche products. NTIS is taking advantage of information dissemination opportunities offered by the Internet, and plans to continue to expand its customer base and meet the increased demands of the public.

Customer Satisfaction	98%	95% - 98%	95% - 98%

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 processing of that order. Orders for NTIS' vast collection of scientific and technical information are received by phone, fax, mail, and online, and are filled in a variety of formats.

NTIS continues to successfully meet the challenge of permanent preservation of and ready access to the taxpayers' investment in research and development through the acquisition, organization, and preservation of the titles added to the permanent collection, and dissemination of that information through various media. However, collection of scientific and technical information from various contributors, and dissemination of that information to an even larger audience is highly dependant on external factors and therefore, not entirely controllable. NTIS plans to continue to enhance public access to world wide scientific and technical information through increased availability of information products, increased dissemination opportunities, and consistent customer satisfaction as presented in the estimates above.

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Exhibit 16

Department Of Commerce
National Technical Information Service
NTIS Revolving Fund – Reimbursable Obligations
SUMMARY OF REQUIREMENTS BY OBJCT CLASS
(Dollar amounts in thousands)

	Object Class	2009 Actual	2010 Currently Available	2011 Base	2011 Estimate	Increase/ (Decrease) over 2011 Base
11.1	Full-time permanent (Compensation)	$9,837	$10,700	$11,235	$11,235	0
11.3	Other than full-time permanent	56	200	200	200	0
11.5	Other personnel compensation	0	500	500	500	0
11.8	Special personnel services payments	2	150	150	150	0
11.9	Total personnel compensation	9,895	11,550	12,085	12,085	0
12.1	Civilian personnel benefits	3,036	3,800	3,990	3,990	0
13	Benefits for former personnel	0	0	0	0	0
21	Travel and transportation of persons	71	200	200	200	0
22	Transportation of things	652	1,000	1,000	1,000	0
23.1	Rental payments to GSA	627	1,393	1,396	1,396	0
23.2	Rental payments to others	525	1,500	1,500	1,500	0
23.3	Communications, utilities and miscellaneous charges	501	1,800	1,800	1,800	0
24	Printing and reproduction	3,657	4,000	4,000	4,000	0
25.1	Consulting services	78	100	100	100	0
25.2	Other services	9,780	9,507	9,279	9,279	0
25.3	Purchase of goods and services from Government accounts	893	1,500	1,500	1,500	0
25.4	Operation of GOCOs	0	0	0	0	0
25.5	Research and development contracts	0	0	0	0	0
25.7	Operation and Maintenance of Equipment	267	1,150	1,150	1,150	0
26	Supplies and materials	314	3,000	3,000	3,000	0
31	Equipment	1,600	2,000	2,000	2,000	0

Department Of Commerce
National Technical Information Service
NTIS Revolving Fund – Reimbursable Obligations
SUMMARY OF REQUIREMENTS BY OBJECT CLASS
(Dollar amounts in thousands)

Object Class		2009 Actual	2010 Currently Available	2011 Base	2011 Estimate	Increase/ (Decrease) over 2011 Base
41	Grants, subsidies and contributions	0	0	0	0	0
42	Insurance claims and indemnities	0	0	0	0	0
43	Interest and dividends	0	0	0	0	0
44	Refunds	0	0	0	0	0
99	Total Obligations	31,896	42,500	43,000	43,000	0
	Earned Revenue/Reimbursable Obligations.	31,896	42,500	43,000	43,000	0
	Total Obligations	31,896	42,500	43,000	43,000	0
Personnel Data						
Full-Time equivalent Employment:						
Full-time permanent		118	145	145	145	0
Other than full-time permanent		1	5	5	5	0
Total		119	150	150	150	0
Authorized Positions:						
Full-time permanent		121	190	190	190	0
Other than full-time permanent		1	10	10	10	0
Total		122	200	200	200	0

Department Of Commerce
National Technical Information Service
NTIS Revolving Fund
DETAILED REQUIREMENTS BY OBJECT CLASS - Earned Revenue Obligations
(Dollar amounts in thousands)

Object Class		2011 Adjust. to Base	2011 Base	2011 Estimate	Increase/ (Decrease)
11	Personnel compensation				
11.1	Full-time permanent				
	Executive level	$0	$0	$0	$0
	Senior executive service	0	450	450	0
	General schedule	0	10,435	10,435	0
	Commissioned officers	0	0	0	0
	Wage board/wage marine	0	350	350	0
	Scientific & professional (P.L. 80-313)	0	0	0	0
	Senior foreign service	0	0	0	0
	Foreign service staff	0	0	0	0
	Foreign service nationals	0	0	0	0
	Consultants & experts	0	0	0	0
	Students	0	0	0	0
	Subtotal	0	11,235	11,235	0
11.3	Other than full-time permanent				
	General schedule	0	200	200	0
	Wage board	0	0	0	0
	Experts & consultants	0	0	0	0
	Hourly	0	0	0	0
	Subtotal	0	200	200	0

Department Of Commerce
National Technical Information Service
NTIS Revolving Fund
DETAILED REQUIREMENTS BY OBJECT CLASS - Earned Revenue Obligations
(Dollar amounts in thousands)

		2011 Adjust. to Base	2011 Base	2011 Estimate	Increase/ (Decrease)
11.5	Other personnel compensation				
	Overtime	0	50	50	0
	SES performance awards	0	100	100	0
	Cash awards	0	350	350	0
	Merit pay awards	0	0	0	0
	Other	0	0	0	0
	Subtotal	0	500	500	0
11.8	Special personnel services payments				
	Foreign service officers (State)	0	0	0	0
	Other	0	150	150	0
	Subtotal	0	150	150	0
11.9	Total personnel compensation	0	12,085	12,085	0
12.1	Civilian personnel benefits				
	Civil service retirement	0	690	690	0
	Federal employees' retirement	0	1,300	1,300	0
	Thrift savings plan	0	500	500	0
	Federal insurance contribution act	0	300	300	0
	Health insurance	0	900	900	0
	Life insurance	0	50	50	0
	Employees' compensation fund	0	200	200	0
	Other	0	50	50	0
	Subtotal	0	3,990	3,990	0

Department Of Commerce
National Technical Information Service
NTIS Revolving Fund
DETAILED REQUIREMENTS BY OBJECT CLASS - Earned Revenue Obligations
(Dollar amounts in thousands)

		2011 Adjust. to Base	2011 Base	2011 Estimate	Increase/ (Decrease)
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	130	130	0
	Mileage	0	50	50	0
	Vehicular	0	20	20	0
	Other	0	0	0	0
	Subtotal	0	200	200	0
22	Transportation of things	0	1,000	1,000	0
23.1	Rental payments to GSA	0	1,396	1,396	0
23.2	Rental payments to others	0	1,500	1,500	0
23.3	Communications, utilities and miscellaneous charges				
	Rental of ADP equipment	0	100	100	0
	Rental of office copying equipment	0	10	10	0
	Other equipment rental	0	90	90	0
	Federal telecommunications systems	0	0	0	0
	Other telecommunications services	0	200	200	0
	Postal Service by USPS	0	300	300	0
	Other	0	1,100	1,100	0
	Subtotal	0	1,800	1,800	0

Department Of Commerce
National Technical Information Service
NTIS Revolving Fund
DETAILED REQUIREMENTS BY OBJECT CLASS - Earned Revenue Obligations
(Dollar amounts in thousands)

		2011 Adjust. to Base	2011 Base	2011 Estimate	Increase/ (Decrease)
24	Printing and reproduction				
	Publications	0	3,700	3,700	0
	Public use forms	0	0	0	0
	Envelopes	0	5	5	0
	Other	0	295	295	0
	Subtotal	0	4,000	4,000	0
25	Consulting and Other Services				
25.1	Consulting Services				
	Management and Professional services	0	100	100	0
	Studies, analyses and evaluation	0	0	0	0
	Engineering and technical services	0	0	0	0
	Subtotal	0	100	100	0
25.2	Other Services				
	Training:				
	University	0	0	0	0
	Other	0	200	200	0
	ADP services	0	0	0	0
	Telecommunications services	0	0	0	0
	Other non-government contracts	0	3,090	3,090	0
	Other	0	5,989	5,989	0
	Subtotal	0	9,279	9,279	0

Exhibit 17

Department Of Commerce
National Technical Information Service
NTIS Revolving Fund
DETAILED REQUIREMENTS BY OBJECT CLASS - Earned Revenue Obligations
(Dollar amounts in thousands)

		2011 Adjust. to Base	2011 Base	2011 Estimate	Increase/ (Decrease)
25.3	Purchases of goods and services from Gov't accounts				
	Training:				
	Office of personnel management	0	0	0	0
	GSA reimbursable services	0	0	0	0
	Payments to GA, WCF	0	1,500	1,500	0
	Other (CAMS)	0	0	0	0
	Subtotal	0	1,500	1,500	0
25.4	Operations of GOCOs	0	0	0	0
25.5	Research and development contracts	0	0	0	0
25.7	Operations and Maintenance of Equipment	0	1,150	1,150	0
	Subtotal Object Class 25	0	12,868	12,868	0
26	Supplies and materials				
	Office supplies	0	700	700	0
	ADP supplies	0	800	800	0
	Other	0	1,500	1,500	0
	Subtotal	0	3,000	3,000	0

Department Of Commerce
National Technical Information Service
NTIS Revolving Fund
DETAILED REQUIREMENTS BY OBJECT CLASS - Earned Revenue Obligations
(Dollar amounts in thousands)

		2011 Adjust. to Base	2011 Base	2011 Estimate	Increase/ (Decrease)
31	Equipment				
	Office machines and equipment	0	100	100	0
	ADP hardware	0	1,100	1,100	0
	ADP software	0	800	800	0
	Other	0	0	0	0
	Subtotal	0	2,000	2,000	0
32	Lands and structure	0	0	0	0
33	Investments and loans	0	0	0	0
41	Grants, subsidies and contributions	0	0	0	0
42	Insurance claims and indemnities	0	0	0	0
43	Interest and dividends	0	0	0	0
44	Refunds	0	0	0	0
99	Total Obligations		43,000	43,000	0

DEPARTMENT OF COMMERCE
NATIONAL TECHNICAL INFORMATION SERVICE
NTIS Revolving Fund
CONSULTING AND RELATED SERVICES
(Obligations in thousands)

	2009 Actual	2010 Estimate	2011 Estimate
Consulting Services	$78	$100	$100
Management and professional services	0	0	0
Special studies and analysis	0	0	0
Management and Support Services for research and development	0	0	0
Total	$78	$100	$100

Exhibit 36

DEPARTMENT OF COMMERCE
NATIONAL TECHNICAL INFORMATION SERVICE
NTIS Revolving Fund
AVERAGE GRADE AND SALARIES

	2009 Actual	2010 Estimate	2011 Estimate
Average GS/GM Grade	10.0	10.8	11.0
Average GS/GM Salary	$84,630	$88,900	$93,400